BURNS McDONNELL

PDX FACILITY IMPROVEMENTS STORMWATER DESIGN NARATIVE

PDX FACILITY IMPROVEMENTS

PROJECT NO. 153929

DECEMBER 21, 2023

CONTENTS

Date: December 2023
To: Port of Portland
From: Michael Greufe, Burns & McDonnell
Subject: PDX Facility Improvements Stormwater Design Narrative

This design narrative is intended to meet the requirements of the Port of Portland (Port) Stormwater Design Standards Manual (DSM) in summarizing the stormwater design approach for the PDX Facility Improvements (commonly referred to as Phase 2) project, located at the fuel facility, in conjunction with the completed DSM Stormwater Checklist (included as Appendix A).

I. Overview of Project Design and Function

PDX Fuel Company, LLC, the airline fueling consortium for Portland International Airport (PDX) has retained Burns & McDonnell (BMcD) to design and construct improvements to the existing fuel storage facility located at PDX. The improvements include:

- Construction of 3 new fuel storage tanks and associated containment
- Demolition of 3 existing fuel storage tanks and associated dike containment
- Demolition of existing operations building and construction of new one
- Hydrant Cart Test Stand (HCTS) and truck unloading facility with two lanes
- Firewater loop and foam system
- Utilities to serve new buildings and tanks
- New Fuel lines with curbed containment where needed
- Demolition of existing utilities
- Grading and storm drainage infrastructure with associated stormwater ponds
- Paving and aggregate surfacing (driveway and non-driveway aggregate)

The estimated disturbed area for the project is approximately 9.29 acres. The total drainage area of approximately 10.98 acres, represented in Attachments B through D, includes disturbed area, areas where water runs onto the site, and areas of existing site infrastructure. To be conservative and accurate for drainage running onsite this drainage area of 10.98 acres was used in lieu of the 9.29 disturbed acres in this report. This drainage area includes the area within the grading/surfacing limits, proposed containment and demolition of existing containment and tanks.

For the purposes of the stormwater calculations, approximately 1.18 acres of the site are within proposed containment areas. The site calculations do not include this contained area and therefore the disturbed area calculations are based off 9.80 acres. Drainage areas DA-9 for both existing and proposed conditions represent this containment area.

The site boundary was selected to encompass areas to be disturbed as part of this project, water running onto the site, and existing site infrastructure. It does not denote the current or future lease limits of the facility. The selected site is consistent with the definition of "Project Site" per the DSM.

II. Overview of Project Site

A. Soils

Using the Natural Resources Conservation System's (NRCS) Web Soil Survey tool (and corroborated by the site-specific geotechnical investigation performed by Haley & Aldrich, included as Appendix D), geotechnical explorations encountered up to 7 to 16 feet of dredge sand fill overlying overbank deposits of Columbia River Sand Alluvium up to 50 feet bgs, which then overlies sand of the Columbia River Sand Aquifer to the base of the explorations. The Web Soil Survey report for the site is included in Appendix B.

The Haley & Aldrich geotechnical investigation found groundwater as high as 5-7 feet below grade. This measurement is believed to be a perched groundwater table, and typical depths to groundwater are estimated closer to 10.5-14.5 feet below grade, fluctuating with the level of the nearby Columbia River.

B. Pervious/Impervious Surfaces

The pre-developed and post-developed sites were analyzed to determine the amount of pervious and impervious surfacing according to the following categories:

- <u>Paved/Impervious (SCS CN 98):</u> Includes pavement, buildings, and canopies which will shed nearly all runoff.
- <u>Driveway Aggregate (SCS CN 96):</u> Includes all aggregate surfacing areas intended to receive vehicle traffic. The design section for this aggregate includes more fines to provide more longevity, however this will also result in greater runoff. All aggregate in the pre-developed site was assumed to be Driveway Aggregate.
- <u>Non-Driveway Aggregate (SCS CN 81):</u> Includes all aggregate surfacing areas surrounding new and existing facilities but not intended to receive regular vehicle traffic. The design section for this aggregate is intended to be well-drained and minimize runoff while providing a working surface that does not require regular maintenance (e.g. mowing). This area is treated as impervious area for water quality calculations (below).
- <u>Grass (SCS CN 39):</u> Includes all existing grass areas and areas in the post-developed site not intended to receive new surfacing. The site is surrounded by maintained grass which will be restored following construction.

Secondary containment areas were not included in the overall stormwater analysis, as they will not contribute to stormwater runoff during a rain event. In the pre-developed site, the containment areas include the pump pad, waste tank offload pad and dike containment. The post-developed site adds the new containment areas for each tank, HCTS/truck offload area containment, and a seismic transition pad and removes the existing dike containment.

Attachments B and C graphically represent the surfacing present in the pre-developed and post-developed sites.

C. *Drainage Areas – Pre-Developed*

The pre-developed site has one inlet that drains to a vegetated swale (FS6) to the west of the existing site. All runoff, except that captured in secondary containment as described above and drainage collected by this inlet, is shed offsite as sheet flow to existing grass areas or to the existing storm to the east of the site.

As shown in Attachment D, the pre-developed site has been divided into four drainage areas (DA) DA-1, DA-3, DA-8, and DA-9 with subsequent denoting letters to divide them up into smaller drainage areas. DA-1 and DA-3 drain to the existing vegetated swale (FS6) and discharge through the existing 8" outlet pipe which ultimately discharges to the wetland ditch to the west. DA-8 runs off to existing grassy areas surrounding the site, to the existing storm drainage inlet to the east, or over land to the existing wetland ditch to the west. DA-9 are the areas of secondary containment and not included in the existing site calculations.

Table 1 shows the approximate area of each surfacing type in each drainage area for the pre-developed site.

Table 1: Pre-Developed Surfacing Type by Drainage Area (acre)

	Containment	*Paved (98)*	*Driveway Agg (96)*	*Non-Driveway Agg (81)*	*Grass (39)*	***Totals***
DA - 1A	0.00	0.00	0.03	0.00	0.46	**0.50**
DA - 3A	0.00	0.14	0.25	0.09	0.00	**0.48**
DA - 8A	0.00	0.02	0.00	0.31	2.18	**2.51**
DA - 8B	0.00	0.34	0.32	0.00	1.21	**1.87**
DA - 8C	0.00	0.07	0.07	0.00	0.30	**0.45**
DA - 8D	0.00	0.00	0.51	0.00	1.96	**2.47**
DA - 8E	0.00	0.00	0.05	0.00	0.61	**0.66**
DA - 9A	1.97	0.00	0.00	0.00	0.00	**1.97**
DA - 9B	0.06	0.00	0.00	0.00	0.00	**0.06**
DA - 9C	0.01	0.00	0.00	0.00	0.00	**0.01**
Totals	**2.04**	**0.57**	**1.23**	**0.40**	**6.74**	**10.98**

D. Drainage Areas – Post-Developed

For the post-developed site, similar drainage areas and naming were used and further subdivided to reflect proposed grading and additional drainage infrastructure. The post-developed drainage areas are shown in Attachment E. There are nine drainage areas DA-1, DA-2, DA-3, DA-4, DA-5, DA-6, DA-7, DA-8, and DA-9 with subsequent denoting letters to divide them up into smaller drainage areas. DA-1 and DA-3 drain to the expanded vegetated swale (FS6), on the plans as storm water west BMP, to the west along with DA-2 and DA-4 and discharge through the existing 8" outlet pipe. DA-5, DA-6, and DA-7 drain to the new bioretention BMP (FS4), on the plans as storm water east BMP, to the east and discharge to the existing storm system to the east. DA-8 runs off to existing grassy areas surrounding the site, to the existing storm to the east, or to the existing wetland ditch to the west. Similar to the pre-developed conditions, DA-9 are the areas of secondary containment and not included in the existing site calculations.

Drainage areas DA-1, 2, 3, and 4 drain to the expanded vegetated swale via multiple storm drainage systems. The vegetated swale is intended to collect runoff from the areas between the new electrical facilities, around the Operations Building and HCTS roof, and the area between the tanks and south of the pump pad and alleviate ponding north of the pump pad area. The existing vegetated swale west of the facility will be extended to receive stormwater from two new pipes. The vegetated swale is designed for the water quality flow rate from the tributary area to each branch, including the main combined swale. The tested infiltration rates for the site are high, but underdrains have been included to increase drawdown of any standing water. The swale and underdrains will flow to an inlet on an existing pipe which discharges to the jurisdictional wetland west of the fuel facility.

Drainage areas DA-5, 6, and 7 are the tributary areas that drain to the new bioretention BMP via multiple storm pipes. The proposed bioretention BMP is intended to collect runoff from the areas between the new operations building and existing maintenance facility and around the HCTS. The bioretention BMP is designed for full infiltration, with a riser up to 22.70' and discharge pipe connected to the existing storm system east of the facility for overflow. Due to the site constraints, it is infeasible to provide an underdrain in this BMP.

Table 2 shows the approximate area of each surfacing type in each drainage area for the post-developed site.

Table 2: Post-Developed Surfacing Type by Drainage Area (acre)						
	Containment	Paved (98)	Driveway Agg (96)	Non-Driveway Agg (81)	Grass (39)	**Totals**
DA - 1A	0.00	0.00	0.04	0.06	0.69	**0.79**
DA - 2A	0.00	0.06	0.02	0.04	0.06	**0.19**
DA - 2B	0.00	0.24	0.02	0.22	0.02	**0.51**
DA - 2C	0.00	0.07	0.00	0.01	0.00	**0.08**
DA - 2D	0.00	0.14	0.00	0.00	0.00	**0.14**
DA - 2E	0.00	0.23	0.07	0.09	0.09	**0.49**
DA - 3A	0.00	0.18	0.30	0.11	0.00	**0.59**
DA - 4A	0.00	0.00	0.08	0.09	0.21	**0.39**
DA - 4B	0.00	0.01	0.00	0.61	0.11	**0.72**
DA - 4C	0.00	0.00	0.02	0.15	0.00	**0.17**
DA - 4D	0.00	0.00	0.01	0.11	0.00	**0.12**
DA - 4E	0.00	0.00	0.11	0.06	0.00	**0.16**
DA - 4F	0.00	0.00	0.09	0.11	0.00	**0.19**
DA - 5A	0.00	0.00	0.00	0.04	0.10	**0.14**
DA - 6A	0.00	0.42	0.00	0.08	0.00	**0.49**
DA - 7A	0.00	0.17	0.13	0.33	0.00	**0.63**
DA - 8A	0.00	0.00	0.12	0.04	0.13	**0.28**
DA - 8B	0.00	0.11	0.50	0.00	0.34	**0.94**
DA - 8C	0.00	0.00	0.50	0.00	0.21	**0.71**
DA - 8D	0.00	0.00	0.19	0.12	1.30	**1.61**
DA - 8E	0.00	0.06	0.07	0.05	0.21	**0.39**
DA - 8F	0.00	0.00	0.03	0.01	0.01	**0.05**
DA - 9A	0.01	0.00	0.00	0.00	0.00	**0.01**
DA - 9B	0.06	0.00	0.00	0.00	0.00	**0.06**
DA - 9C	0.36	0.00	0.00	0.00	0.00	**0.36**
DA - 9D	0.36	0.00	0.00	0.00	0.00	**0.36**
DA - 9E	0.36	0.00	0.00	0.00	0.00	**0.36**
DA - 9F	0.01	0.00	0.00	0.00	0.00	**0.01**
Totals	**1.18**	**1.70**	**2.29**	**2.32**	**3.49**	**10.98**

III. Description of Stormwater Management (SWM) Strategy

A. Low-Impact Development (LID) – DSM 4.2:

Minimize Disturbance and Impact (DSM 4.2.2.1 and 4.2.2.2): The site is constrained by existing development, buried utilities, and grades which are generally flat across the facility and surrounding area. As a result, the footprint of new development was limited as much as possible while still meeting the project objectives. In areas where aggregate surfacing is required for operations, but which are not expected to receive vehicle traffic, the soil will remain uncompacted and a well-draining surface aggregate with minimal fines will be used to promote infiltration.

Manage Runoff (DSM 4.2.2.3): The Best Management Practices (BMPs) for the project were selected to minimize soil disturbance while meeting the requirements of the DSM and generally matching existing site hydrology. All runoff is being directed by sheet flow, shallow surface channels, or piping to grassy areas with high potential for infiltration. The existing vegetated swale to the west will be expanded to receive additional runoff from the north and west sides of the expanded facility. The new bioretention BMP to the east and adjacent swale will receive runoff form the truck offload/HCTS area.

B. Infiltration – DSM 4.3

An infiltration rate of ten (10) inches per hour was given for the site based on the Geotech Report from Haley & Aldrich, dated December 2023. Based on project modeling, a rate of five (5) inches per hour was used as the infiltration rate and is sufficient to allow the project to implement Full Infiltration of the Water Quality Design Storm. See *Water Quality* below.

The site is graded to two main water quality BMPs: a vegetated swale (FS6) with multiple branches on the west side (storm water west BMP), and a bioretention area (FS4) on the east side (storm water east BMP). The vegetated swale and its branches will include underdrains for partial infiltration to reduce drawdown time, although the infiltration rates are sufficient to support full infiltration. The bioretention BMP will be designed for full infiltration of the water quality volume.

All runoff that was not able to be directed towards the BMPs will be shed offsite mainly to nearby grassy areas to promote as much infiltration as possible with a small amount going to the nearby storm system east of the site. The water quality volume from the tributary areas shedding runoff offsite is assumed to infiltrate in the existing flat grassy areas, consistent with existing drainage patterns. Site elevation constraints make it infeasible to install additional BMPs or direct runoff from these areas to existing stormwater infrastructure.

C. *Water Quantity Control – DSM 4.4*

Tables 3 and 4, respectively, show the pre- and post-developed SCS peak flows and volumes for the 25-year, 24-hour design storm with and without BMP controls in place.

Table 3: Pre-Developed Peak Flow and Volume (25, 24-hour)

	Drainage Location	*SCS Peak Flow w/out BMP (cfs)*	*SCS Volume w/out BMP (cf)*	*SCS Peak Flow w/ BMP (cfs)*	*SCS Volume w/ BMP (cf)*
DA - 1A *DA - 3A*	Vegetated Swale	2.04	4051	0.11	87
DA - 8A *DA - 8B* *DA - 8C* *DA - 8D* *DA - 8E*	Offsite	2.81	9757	2.81	9757
DA - 9A *DA - 9B* *DA - 9C*	Containment	-	28662	-	28662
Totals		**4.85**	**42471**	**2.92**	**38507**

Table 4: Post-Developed Peak Flow and Volume (25, 24-hour)

	Drainage Location	*SCS Peak Flow w/out BMP (cfs)*	*SCS Volume w/out BMP (cf)*	*SCS Peak Flow w/ BMP (cfs)*	*SCS Volume w/ BMP (cf)*
DA - 1A DA - 2A DA - 2B DA - 2C DA - 2D DA - 2E DA - 3A DA - 4A DA - 4B DA - 4C DA - 4D DA - 4E DA - 4F	Vegetated Swale (Storm Water West BMP)	14.11	27486	2.97	23261
DA - 5A DA - 6A DA - 7A	Bioretention BMP (Storm Water East BMP)	5.75	11631	0.60	2744
DA - 8A DA - 8B DA - 8C DA - 8D DA - 8E DA - 8F	Offsite	6.49	13286	6.49	13286
DA - 9A DA - 9B DA - 9C DA - 9D DA - 9E DA - 9F	Containment	-	16509	-	16509
Totals		**26.35**	**68912**	**10.06**	**55800**

The outlet controls from both BMPs significantly reduce the flow and volume from the main project development area in addition to meeting water quality goals (see section III.D).

The increases from DA-8 are directed offsite to adjacent flat, grassy areas and are spread along the perimeter of the site. The 13,286 cubic feet of additional runoff equates to an approximately 0.92-inch depth for the 25-year, 24-hour storm spread over DA-8. Site topography makes it infeasible to capture and redirect this runoff to new or existing BMPs without significantly increasing the project footprint and disturbed area and increasing the potential for concentrations of standing water.

The stormwater system is designed to fully convey the 100-year storm runoff away from all pavements and structures with no surcharge. The Hydrocad model shows a maximum (100-year) water surface elevation (MWSE) of 20.19' at the vegetated swale and 21.49' at the bioretention BMP.

For the DSM Checklist, both BMPs were modeled as "ponds" with no outlet to represent drainage areas DA-1, 2, 3, and 4 and drainage areas DA-5, 6, and 7 without any outlet. Without these controls, the 100-year storm resulted in a MWSE of 20.83' for the vegetated swale and a MWSE of 21.62' for the bioretention BMP. Each BMP has an overflow route lower than the nearest adjacent structure 22.70' for the vegetated swale and 21.75' for the bioretention BMP. In the event that any of the individual storm inlets become plugged they have an overflow route towards either BMP or offsite direction to flow before flooding an adjacent building or structure. The only exception to this would be for SDI-8. The overflow route towards the bioretention BMP is at the same elevation as the finished floor of the existing maintenance shop. Due to this constraint, DA-4C area was minimized to alleviate this concern as much as possible.

D. Water Quality – DSM 4.5

The vegetated swale (FS6) is designed as an on-line BMP to treat the WQF from major developed portions of the site and convey flows to the existing stormwater outfall. It is an expansion and extension of the vegetated swale installed as part of the Phase 1 improvements. Although the site infiltration rates are sufficient for complete infiltration, the existing underdrain will be extended to minimize the potential for standing water. Each branch of the vegetated swale has a 10-foot width, an assumed Manning's 'n' value of 0.20, 0.5% longitudinal slopes, and 4:1 side slopes. See calculations below showing normal depth with relating WQF calculations.

The bioretention area (FS4) is designed as an on-line BMP to retain the WQV from the east side of the site, including the truck offload/HCTS facility. It will have a maximum ponding depth of approximately 11 inches to the riser elevation of 22.70'.

The calculations for the water quality flow for the vegetated swale on the west side of the site can be found below. Since the vegetated swale has three branches it was calculated for four different scenarios. WQF was calculated for each of the three branches, DA – 2, 3, and 4, and once for all of them combined, DA-1 through DA-4.

WQf from Drainage Area DA-2

Volumetric Runoff Coefficient (Rv) - DA-2		
Rv = 0.82 x IMP + 0.02		
IMP	0.87	
Impervious	1.23 acres	(excludes containment)
Total Area	1.41 acres	(excludes containment)
Rv	0.73	

Water Quality Flow (WQf) - DA-2		
WQf = iwqf x A x Rv		
iwqf	0.2 in/hr	from Table 4-3, Tc = 5 min
A	1.41 acres	Disturbed Area
Rv	0.73	see above
WQf	0.21 cfs	

WQf from Drainage Area DA-3 (existing pipe)

Volumetric Runoff Coefficient (Rv) - DA-3 (EX)		
Rv = 0.82 x IMP + 0.02		
IMP	1.00	
Imperviou	0.59 acres	(excludes containment)
Total Area	0.59 acres	(excludes containment)
Rv	0.84	

Water Quality Flow (WQf) - DA-3 (EX)		
WQf = iwqf x A x Rv		
iwqf	0.2 in/hr	from Table 4-3, Tc = 5 min
A	0.59 acres	Disturbed Area
Rv	0.84	see above
WQf	0.10 cfs	

WQf from Drainage Area DA-4

Volumetric Runoff Coefficient (Rv) - DA-4		
Rv = 0.82 x IMP + 0.02		
IMP	0.82	
Impervious	1.45 acres	(excludes containment)
Total Area	1.77 acres	(excludes containment)
Rv	0.69	

Water Quality Flow (WQf) - DA-4		
WQf = iwqf x A x Rv		
iwqf	0.2 in/hr	from Table 4-3, Tc = 5 min
A	1.77 acres	Disturbed Area
Rv	0.69	see above
WQf	0.24 cfs	

WQf from Drainage Areas DA-1 through DA-4

Volumetric Runoff Coefficient (Rv)		
Rv = 0.82 x IMP + 0.02		
IMP	0.74	
Impervious	3.37 acres	(excludes containment)
Total Area	4.56 acres	(excludes containment)
Rv	0.63	

Water Quality Flow (WQf) - WEST		
WQf = iwqf x A x Rv		
iwqf	0.2 in/hr	from Table 4-3, Tc = 5 min
A	4.56 acres	Disturbed Area
Rv	0.63	see above
WQf	0.57 cfs	

The vegetated swale was modeled using Bentley® Flowmaster® V8i (Flowmaster) and is designed with maximum 4H:1V side slopes and a longitudinal slope of 0.5%. See Figure 1.

Figure 1: Design Information for Vegetated Swale (Bentley Flowmaster)

Vegetated Swales WQF

Label	Roughness Coefficient	Channel Slope (ft/ft)	Normal Depth (in)	Left Side Slope (H:V)	Right Side Slope (H:V)	Bottom Width (ft)	Discharge (cfs)	Top Width (ft)	Velocity (ft/s)
DA-1 - DA-4	0.200	0.005	3.1	4.000	4.000	10.00	0.57	12.07	0.20
DA-2	0.200	0.005	1.9	4.000	4.000	10.00	0.24	11.24	0.15
DA-4	0.200	0.005	1.7	4.000	4.000	10.00	0.21	11.15	0.14
DA-3 (Ex)	0.200	0.005	1.1	4.000	4.000	10.00	0.10	10.74	0.10

The calculations for the water quality volume for the east bioretention BMP can be found below. The drainage areas DA-5, 6, and 7 drain to this bioretention BMP. The BMP volume up to the outflow pipe of 22.70' is 1,175 cf, slightly higher than the required volume calculated below.

WQv from Drainage Area DA-2

Water Quality Volume (WQv) - EAST		
WQv = Pwqv x Rv x (A/12)		
Pwqv	0.31 in	from Table 4-2, 12 hr drawdown
Rv	0.77	see below
A	1.26 acres	Disturbed Area
WQv	0.03 ac-ft	1095 CF

Volumetric Runoff Coefficient (Rv)		
Rv = 0.82 x IMP + 0.02		
IMP	0.92	
Impervious	1.16 acres	(excludes containment)
Total Area	1.26 acres	(excludes containment)
Rv	0.77	

Drainage areas DA-8 calculations are not included in this report since, as mentioned before, site constraints make it infeasible to install additional BMPs or direct runoff from these areas to existing stormwater infrastructure. The water quality volume from the tributary areas shedding runoff offsite is assumed to infiltrate in the existing flat grassy areas, consistent with existing drainage patterns. The WQV for each individual basin in DA-8 is minimal compared to the area of infiltration that is available and ranges from a maximum of around 500 cf to a minimum of around 40 cf with an average of about 290 cf.

E. Source Controls – DSM 4.6

The existing fuel facility and proposed improvements are in compliance with applicable local, state, and federal codes, including of the City of Portland Source Control Manual (SCM).

The facility Integrated Contingency Plan (ICP) is included as Appendix C. This document includes information on Spill Prevention Control and Countermeasure (SPCC) requirements in 40 CFR §112 (EPA Oil Pollution Prevention).

1. Summary of Secondary Containment for Proposed Improvements

This project will demolish the existing bulk fuel storage tanks, containment, and containment drainage and existing below grade oil/water separator (OWS). Three new bulk fuel storage tanks will be constructed with individual steel secondary containment walls around each tank. Each of these individual steel containment areas will have a concrete sloped floor draining to a storm system. Each containment area will be isolated by a normally closed valve located on the outside of the steel containment. Stormwater accumulating within the tank containment areas will be released to the stormwater system following a visual inspection for oil sheen.

The Hydrant Cart Test Stand (HCTS) and associated offload positions will have a canopy to minimize stormwater accumulation in fuel areas. The offloads will serve as an emergency backup to the Kinder Morgan supply pipeline and will not be utilized regularly. The HCTS and associated equipment will be within a concrete curbed area draining to the containment inlets in the offload positions. The containment drain inlets will be connected by pipes that do not connect to any downstream system besides a manhole for ease of pumping out in the event of a spill. This containment area is designed to contain a spill from the largest compartment of the trucks that would be offloading, with a capacity of 8,000 gal. See calculations in second sheet of Attachment J.

The area outside of the covered HCTS will be a curbed asphalt pavement area that drains to one curb inlet. This curb inlet will have an oil stop valve installed to automatically shut off drainage to the downstream storm system in lieu of a manual shut off valve, or an oil/water separator.

The existing hydrant pump and filter pad consists of a curbed containment slab which slopes to a trench drain and sump structure with a submersible pump that automatically pumps stormwater into the existing tank dike area. Since this existing tank dike is going away, the pump discharge line will be rerouted to a newly installed above ground OWS. The pump will have sensors that shut off the fuel and stormwater pumps in case of a spill at the pad. The OWS will also have a high oil sensor that will shut off the stormwater pump. This new above ground OWS will discharge to the site storm system. Since this is a pumped system there will be no valve on the downstream end of the OWS. See variances in Attachments I for more information.

With the seismic classification of this site the fuel lines need to have flexible flanged connections in case of a seismic event. Since these connections are not inside of the containment or over the existing hydrant pump pad, there is a seismic transition pad being installed in accordance with the SCM to provide containment underneath these flanged connections and valving. The pad is intended to catch drips and spills from the connections and valving. This hydraulically isolated area will be a curbed pad with a typically closed valve to be opened after visually inspected and will then drain to the nearest inlet of the drainage system.

2. Summary of City of Portland Source Control Manual (SCM) Requirements

Several elements of this project fall under Section 6.5 (Above-Ground Storage, Processing, or Transfer of Liquids) and/or Section 6.6 (Fuel Transfer and Fuel Dispensing) of the SCM. The SCM requires the following:

- Per Section 6.5
  - The sized containment for tanks should contain at least 110% of the tank volume.
  - For uncovered storage areas, accumulated stormwater must be collected (behind a normally closed shut-off valve) and inspected for oil sheen and/or pH prior to discharge to the stormwater system.
  - If contaminated, stormwater must be pumped from the containment area and hauled offsite for disposal or discharged to a sanitary sewer system or pretreatment facility.
- Per Section 6.6
  - All "fuel dispensing areas" must have a cover with an overhang "so precipitation cannot come in contact with the fueling activity area."
  - The "fueling activity" area must be on a concrete fueling pad, with fuel pumps at least 7 feet from the edge of the pad.
  - The fuel dispensing area must be covered with a permanent canopy, roof, or awning to prevent stormwater from comingling with the fueling activity. "Rainfall must be directed from the cover to a stormwater discharge point that meets all applicable code requirements."
  - "The paved area beneath the cover must be hydraulically isolated through grading, berms, or drains," and must be directed to a sanitary sewer system or pretreatment facility.

- A spill control manhole or OWS must be installed on the sanitary discharge line.
- A normally closed shut-off valve must be installed downstream of the spill control manhole and only opened for "incidental drainage activities that do not pose a threat or risk to the discharge point system."
- Traffic pathways surrounding fueling pads require a normally open valve on the storm drainage system which must be immediately closed in the event of a spill.
- Valves, pumps, connections, and nozzles not located within secondary containment must be hydraulically isolated.

3. Comparison of Proposed Improvements with SCM Requirements

The new tanks and containment meet the requirements of the SCM. The HCTS and emergency offload facility will be covered with a canopy and hydraulically isolated via curbs and a blind sump. These sumps will drain to a manhole for ease of pumping out without a downstream connection as the SCM specifies. This eliminates the need for an OWS. The area outside of the HCTS will be a curbed area draining to an oil stop valve curb inlet. Instead of a normally open valve this oil stop valve will automate the requirement in the SCM. The hydrant pump pad will be pumped to an OWS and then discharged to the storm system. This pump will have sensors to shut off the system in the event of a spill and an alarm on the OWS to shut down the pump in the event of too much oil in the OWS. This set up meets the intent of the SCM by providing hydraulic isolation for the event of a spill at the hydrant pump pad. Lastly, valves and flanges located outside of containment will be hydraulically isolated with a blind sump. We are asking for variances to the SCM for a few items on this list due to site constraints and existing infrastructure. See Attachments I for more information.

F. Hazardous Wildlife Attractants – DSM 4.7

The project site is within the PDX Primary Wildlife Zone. All vegetation, including within BMPs, will be the standard airfield turf mix. The vegetation within both BMPs will be mowed and maintained as part of the larger surrounding grassy area. Each BMP will drain down within 12 hours of the end of each storm to prevent standing water. See attached Hydrocad calculations.

G. Floodway and Natural Resource Protection – DSM 4.8

The project site is not within a Flood Hazard Area, Greenway Overlay Zone, or Environmental Overlay Zone as defined in the DSM.

H. Erosion & Sediment Control – DSM 4.9

The project Erosion, Sediment, and Pollutant Control Plan (ESPCP) is being revised for the reduced project scope and will be submitted separately to the Port for review. Burns & McDonnell also plans to apply for the 1200-C Construction Stormwater General Permit from the Oregon Department of Environmental Quality.

IV. Description of Stormwater Management BMPs

The existing site has a vegetated swale (BMP FS6 from the DSM) from Phase 1 that will be expanded in Phase 2 to accommodate new infrastructure. This BMP will have additional underdrains added to it to promote infiltration and will be used for water quality treatment, volume reduction, and peak flow control as described above. The existing outlet structure will be reduced to 18.20' to align with WQf calculations and promote less ponding of water. The existing bottom will be maintained at 18.20' as well as the existing bottom slope of 0.5% from the new and existing discharge points. The swale will be widened to 10 feet at the bottom. The groundwater elevation, based on the geotechnical investigation from Haley & Aldrich, is approximately 12.5, 5.7 feet below the lowest BMP elevation to be used for infiltration. The vegetated swale receives runoff flow from drainage area DA-1, 2, 3 and 4 via multiple storm systems.

Calculations for the vegetated swale underdrains were not included in the design to stay consistent with Phase 1, however, an infiltration rate of at least one inch per hour was not assumed. Since Phase 1, site explorations have found the site provides more infiltration and a new infiltration rate of five inches per hour was used, see attached geotechnical report form Haley & Aldrich. Since the site is located in the Primary Zone for Hazordous Wildlife Attractants the vegetation is proposed to stay consistent with what is in the existing vegetated swale.

The storm water east BMP, will be a bioretention BMP (FS4) focusing mainly on water quality treatment through infiltration and an elevated outlet pipe to achieve a WQV and volume. It is infeasible for the bioretention BMP to have an underdrain due to the elevation constraints and flatness of the site. The bioretention BMP will collect runoff from drainage areas DA-5, 6, and 7. The 6" outlet pipe will be set at 20.70 and the bottom will slope at 0.5% to the discharge locations. This elevation is approximated 7.3' from the ground water elevation.

Like the vegetated swale an infiltration rate of 5 inches per hour was used to model the bioretention BMP. Also, since the site is located in the Primary Zone for Hazordous Wildlife Attractants the vegetation is proposed to stay consistent with what is in the existing vegetated swale. This will minimize the attraction to wildlife and with an existing high infiltration rate the bioretention BMP should operate in line with the DSM.

The proposed BMP's are intended to require minimal maintenance. See Attachment K. The bioretention areas and surrounding grassy areas disturbed by construction activities will be re-seeded in accordance with FAA Seeding Specification T-901 as modified by the Port of Portland. This specification is included as Attachment A and aligns with the Wildlife Attractant Considerations in the DSM.

V. Description of Project Drainage System

A. Hydraulic Modeling – DSM 5.2.1, 5.2.2

Stormwater modeling was performed using Hydrocad and the Hydraflow Hydrographs Extension for Autodesk® Civil 3D (Hydraflow). Stormwater volumes were assessed using the Soil Conservation Service (SCS) Method. Peak flows through pipes were checked using the Rational Method, which gives a more conservative estimate of flow rates.

The SCS Curve Numbers used for each surfacing type are described above. For this site, drainage areas were sufficiently small that the minimum time of concentration of five minutes was used for all areas.

B. Design Storm – DSM 5.2.1, 5.2.2

As shown in Figure 2, the PDX Stormwater Design Standards Manual (DSM) gives a depth of 3.9 inches for the 25-year, 24-hour rainfall and specifies a Type IA storm.

Figure 2: PDX Stormwater DSM Rainfall Data

Table 5-2: 24-Hour Rainfall Depths at Portland International Airport (City of Portland 2008)

Recurrence Interval, Years	2	5	10	25	100
24-Hour Depth, Inches	2.4	2.9	3.4	3.9	4.4

The results of the Hydrocad modeling are summarized in Attachment G. The 2-, 5-, 10-, 25-, and 100-year storm events are modeled.

The DSM designates the following design storms for site features included in this project:

- 10-year: Piped flow with no surcharge
- 25-year: Swales and culverts
- 100-year: Ponding check storm

C. Velocity – DSM 5.2.3

The stormwater pipes were modeled at full-flow capacity using Hydraflow. These results are included in Attachment H. Per the DSM, a Manning's "n" roughness coefficient of 0.013 was used for all piping. This is a conservative value. Corrugated HDPE has a published "n" of 0.012 (Attachment F).

Proposed storm lines full-flow velocities are in the attachments below. They are all calculated using a Manning's "n" of 0.013 as required by the DSM. The full-flow velocities are mostly below the DSM requirements. Attachment I-1 includes a Variance Request to allow this pipe to be installed at a minimum 0.30% slope due to site elevation constraints.

D. Ponding Allowance – DSM 5.2.4

The vegetated swale and bioretention BMP were modeled as "ponds" using Hydrocad. See Attachment H. The ponds were modeled assuming a 5 inch per hour infiltration rate. This is believed to be conservative based on the soil types (HSG A), and Geotechnical Report from Haley & Aldrich.

The vegetated swale was designed with an outlet at 18.20' to the existing 8-inch outlet pipe. For the 100-year storm, the vegetated swale stores approximately 9,383 cubic feet and reaches a maximum elevation of 20.19'. The full volume for the 100-year storm is drained in less than 12 hours after the storm event assuming an infiltration rate of five inches per hour.

The bioretention BMP was designed with a 6-inch outlet pipe to restrict flows set at 22.70'. For the 100-year storm, the vegetated swale stores approximately 3,029 cubic feet and reaches a maximum elevation of 21.49'. The full volume for the 100-year storm is drained in less than 12 hours after the storm event assuming an infiltration rate of five inches per hour.

E. Pavement Drainage – DSM 5.5

Pavement drainage matches the drainage areas patterns and is sloped to provide sufficient runoff. The pavement leading to the new operations building is sloped to inlets eventually draining to the vegetated swale where feasible. The pavement surrounding the HCTS is curbed aligning with the SCM to provide a source of secondary containment. This area drains through an oil stop valve and then to the bioretention BMP. The pavement replacing the existing fuel facility entrance drive is sloped to a swale and then drains to the bioretention BMP. The pavement replacing the new gravel entrance drive will match existing surrounding grades and drainage patterns.

F. Open Channel – DSM 5.6

This project does not contain any open channels.

G. Culverts – DSM 5.7

This project does not contain any culvert pipes.

H. Outfalls – DSM 5.9

The outlet of stormwater pipes into both the east bioretention BMP and west vegetated swale will have a flared end section and a five-foot by five-foot area of ODOT Class 100 riprap to dissipate flows. However, even peak flow rates and velocities are expected to be relatively low, as described above.

I. Stormwater Piping – DSM 5.10

There are two main stormwater systems proposed as part of this project one: drains DA-2 and is referred to as the north system, and the other drains DA-4, referred to as the south system. The north system drains the entrance drive around the operations building and the HCTS roof. The south system drains the area in between the tanks and south of the hydrant pump pad. The stormwater systems were designed to fully convey the 100-year storm runoff away from all pavements and structures with no surcharge. The calculations provided from the Hydraflow model are for the 25-year event. Hydraulic Grade Line Calculations are also provided from the Hydraflow model with profile representations of the storm systems.

The stormwater systems were designed with a minimum depth of cover of 12-inches at the inlet locations, increasing along the pipe's length. The inlets were located to be out of main traffic patterns and located along roadways out of driving paths and in parking spaces as much as possible. The stormwater system also has a minimum slope of 0.30% and velocities just slightly less than 3 feet per second. The minimal cover, minimum slope and slightly lower velocities are due to multiple reasons, one main driver being the crossing of the existing Kinder Morgan fuel pipeline. The flatness of the site, other existing utility constraints and trying to minimize the overall impact area also drove these constraints. However, with these slight deviations from the DSM the pipes were sized larger to help accommodate these constraints and the site was designed to optimize slope, cover, and velocities where it could.

Attachment F includes documentation supporting a minimum 12-inch depth of cover for corrugated HDPE pipe. A Variance Request from the 2-foot minimum depth of cover, minimum slope of pipes and velocity requirements from the DSM are all included in Attachment I-2.

J. Manholes and Structures – DSM 5.11

Inlets are specified as ADS Nyloplast® drain basins with traffic rated grates. See plans for more details. One manhole structure is used for containment drainage and is detailed on the plans as well. There is also a curb inlet structure for the oil stop valve aligning with the Source Control Manual and variance request below. See plans for more details.

K. Pump Stations – DSM 5.12

No pump stations have been incorporated into the stormwater design for this project.

VI. Description of Variance Requests

Variance requests are included as Attachment I:

- I-1: Variance from 3 fps full-flow velocity requirement for stormwater pipe SD-1 (DSM Section 5.2.3). Calculated velocities for pipe designs are in Attachment H below and are using Manning's "n" of 0.013. The pipe design is based on site elevation constraints and the estimated depth of an existing buried jet fuel pipe, overall flatness of site, other utilities, and trying to have minimum overall disturbance. The specified pipe has a published Manning's "n" design value of 0.012 (Attachment F).
- I-2: Variance from 2-foot minimum depth of cover requirement for stormwater pipe SD-1 (DSM Exhibit K-5). The pipe design is based on site elevation constraints and the estimated depth of an existing buried jet fuel pipe, overall flatness of site, other utilities, and trying to have minimum overall disturbance. The specified pipe has an allowable minimum cover of one foot (Attachment F).

See sections V.C (Velocity) and V.I (Stormwater Piping) above for more information on these requests.

VII. Required Regulatory Approvals

The Federal Aviation Administration has been engaged directly by the Port to obtain the 7460 (Airspace) permit for this project, with applications for new permanent structures and for temporary construction equipment (cranes) within the project area.
If the Port has questions regarding any information presented herein and/or would like to arrange a meeting to further discuss this project, please contact Burns & McDonnell at the phone number or email below.

Michael Greufe, PE* \ Burns & McDonnell
Staff Civil Engineer
952-656-2673 \ mgreufe@burnsmcd.com
*Registered in NE & MN

ATTACHMENTS:
A: PDX Modification of FAA T-901 Seeding Specification
B: Pre-Developed Surface Conditions
C: Post-Developed Surface Conditions
D: Pre-Developed Drainage Areas
E: Post-Developed Drainage Areas
F: Corrugated HDPE Pipe Information
G: Hydrocad Model Data
H: Hydraflow Model Data
I: Variance Requests
J: Containment Calculations
K: Project O&M Form

APPENDICES:
A: Project-Specific DSM Stormwater Checklist (DSM Appendix E)
B: Web Soil Survey Data
C: Facility Integrated Contingency Plan (ICP; includes Operations & Maintenance Info)
D: Report of Geotechnical Engineering Services (DRAFT November 23)
E: Civil Design Drawings (DRAFT 12/21/23 Permit Submittal)

cc: Stacy Wagner, BMcD Civil Engineer of Record
Reid Unke, BMcD Project Manager
Brian Battey, BMcD Senior Civil Engineer
Jeremy Jewell, BMcD Environmental

SECTION 32 92 00 - CLEARING AND SEEDING

This Section includes project-specific modifications to FAA Item T-901 Seeding

DESCRIPTION

901-1.1 This item shall consist of soil preparation and seeding all areas disturbed by construction.

MATERIALS

901-2.1 Seed (as modified for Port of Portland Projects).
The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. The seed mix shall conform to the requirements of ORS 633. The seed mix shall be untreated tested seed of good quality and free of noxious weeds. Seed shall be dry, not moldy, and show no sign of having been wet or otherwise damaged.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and ORS 633 with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Subcontractor shall furnish the Port duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected. Seed mix shall be a three-way blend of endophyte enhanced dwarf turf type tall fescues meeting the following criteria:

Seed	Percent PLS	Minimum Seed Purity (Percent)	Minimum Germination (Percent)	Endophyte Enhanced
Seed Type 1	33	98	90	80 min
Seed Type 2	33	98	90	80 min
Seed Type 3	33	98	90	80 min
Inert Matter	1	--	--	--

PLS (pure live seed) is the amount of living, viable seed in a larger total amount of seed. The amount of seed to be applied is obtained by using the purity and germination percentages from the label on the actual bag of seed to be used on the project. To calculate the amount of seed to be applied:

a. Obtain the PLS factor by multiplying the seed label germination percentage times the seed label purity percentage;
b. Divide the specified PLS rate by the PLS factor;
c. Round off the result as approved.

For example, assume a PLS seeding rate of 350 lbs/acre is specified and the seed label shows a purity of 98 percent and germination of 90 percent. Multiply 0.98 by 0.90 to obtain a PLS factor of 0.88. The specified PLS rate of 350 lbs/acre, divided by the factor of 0.88, equals 397.73. Thus 400 lbs/acre of total seed needs to be applied in order to meet a specified PLS seeding rate of 350 lbs/acre (approximately 1,600 seeds/sq ft).

Seeding shall be performed during the period between September 1 and October 15 inclusive, unless otherwise approved or directed by the Port. Seeding on stockpile areas shall be completed prior to September 1.

901-2.2 Fertilizer. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers shall be a dry, free-flowing fertilizer suitable for application by a common fertilizer spreader. The minimum percentage of nutrients by weight shall be:

25 percent nitrogen, 5 percent potash, and 3 percent iron, slow release.

Fertilizer shall be applied at the rate recommended by the manufacturer.

901-2.3 Soil for repairs. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the Engineer before being placed.

CONSTRUCTION METHODS

901-3.1 Advance preparation and cleanup. After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Subcontractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches as a result of grading operations and, if immediately prior to seeding, the top 3 inches of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches. Clods shall be broken and the top 3 inches of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 Dry application method.

a. Fertilizing. Following advance preparations and cleanup fertilizer shall be uniformly spread at the rate that will provide not less than the minimum quantity recommended by the manufacturer.

b. Seeding. Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

c. Rolling. After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot of width for sandy or light soils.

a-3.3 Wet application method.

a. General. The Subcontractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

b. Spraying equipment. The spraying equipment shall have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons per minute at a pressure of 100 lb / sq inches. The pump shall be mounted in a line that will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet. One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet in length shall be provided to which the nozzles may be connected.

c. Mixtures. Seed and fertilizer shall be mixed together in the relative proportions specified, but not more than a total of 220 pounds of these combined solids shall be added to and mixed with each 100 gallons of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. The Subcontractor shall identify to the Contractor all sources of water at least two (2) weeks prior to use. The Contractor may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Subcontractor shall not use any water from any source that is disapproved by the Contractor following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within two (2) hours from the time they were mixed or they shall be wasted and disposed of at approved locations.

d. Spraying. Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray that shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to ensure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area.

Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

901-3.4 Maintenance of seeded areas. The Subcontractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the Engineer. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Subcontractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Subcontractor establish a good stand of grass of uniform color and density to the satisfaction of the Contractor. A grass stand shall be considered adequate when bare spots are one square foot or less, randomly dispersed, and do not exceed 3% of the area seeded.

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C602	Standard Specification for Agricultural Liming Materials

Federal Specifications (FED SPEC)

FED SPEC	JJJ-S-181, Federal Specification, Seeds, Agricultural

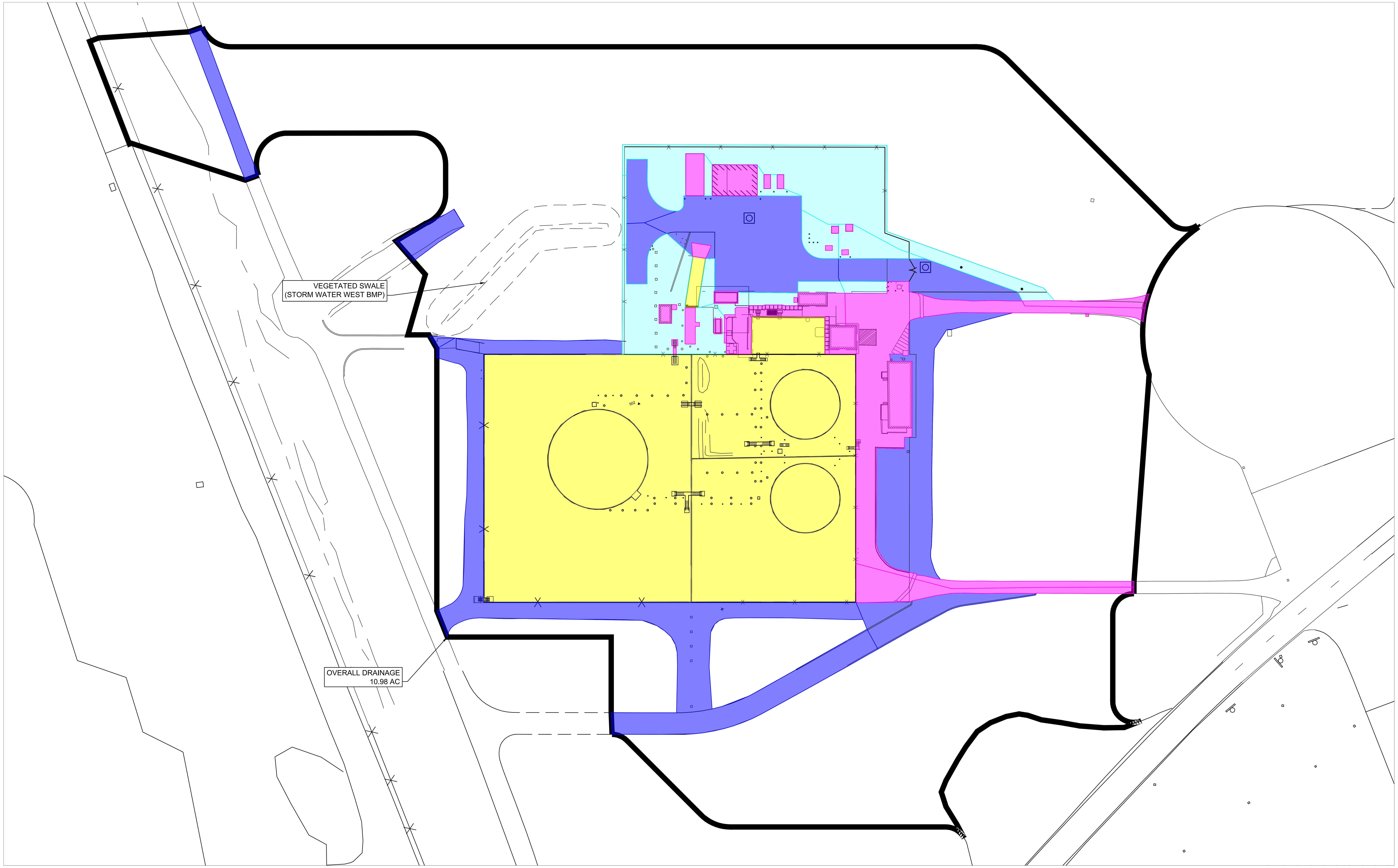
Advisory Circulars (AC)

AC 150/5200-33	Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF SECTION 32 90 00



PRE-DEVELOPED SURFACE CONDITIONS

0 50' 100'
SCALE IN FEET

NORTH

LEGEND

- IMPERVIOUS
- DRIVEWAY AGGREGATE
- NON-DRIVEWAY AGGREGATE
- CONTAINMENT (NO RUNOFF)
- DISTURBED AREA

no.	date	by	ckd	description
A	12/21/23			ISSUED FOR PERMIT

ISSUED FOR PERMIT ONLY

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.

date 12/21/23
detailed
designed
checked

PDX FUEL COMPANY L.L.C

PORTLAND INTERNATIONAL AIRPORT
5000 NE MARINE DR.
PORTLAND, OREGON 97218

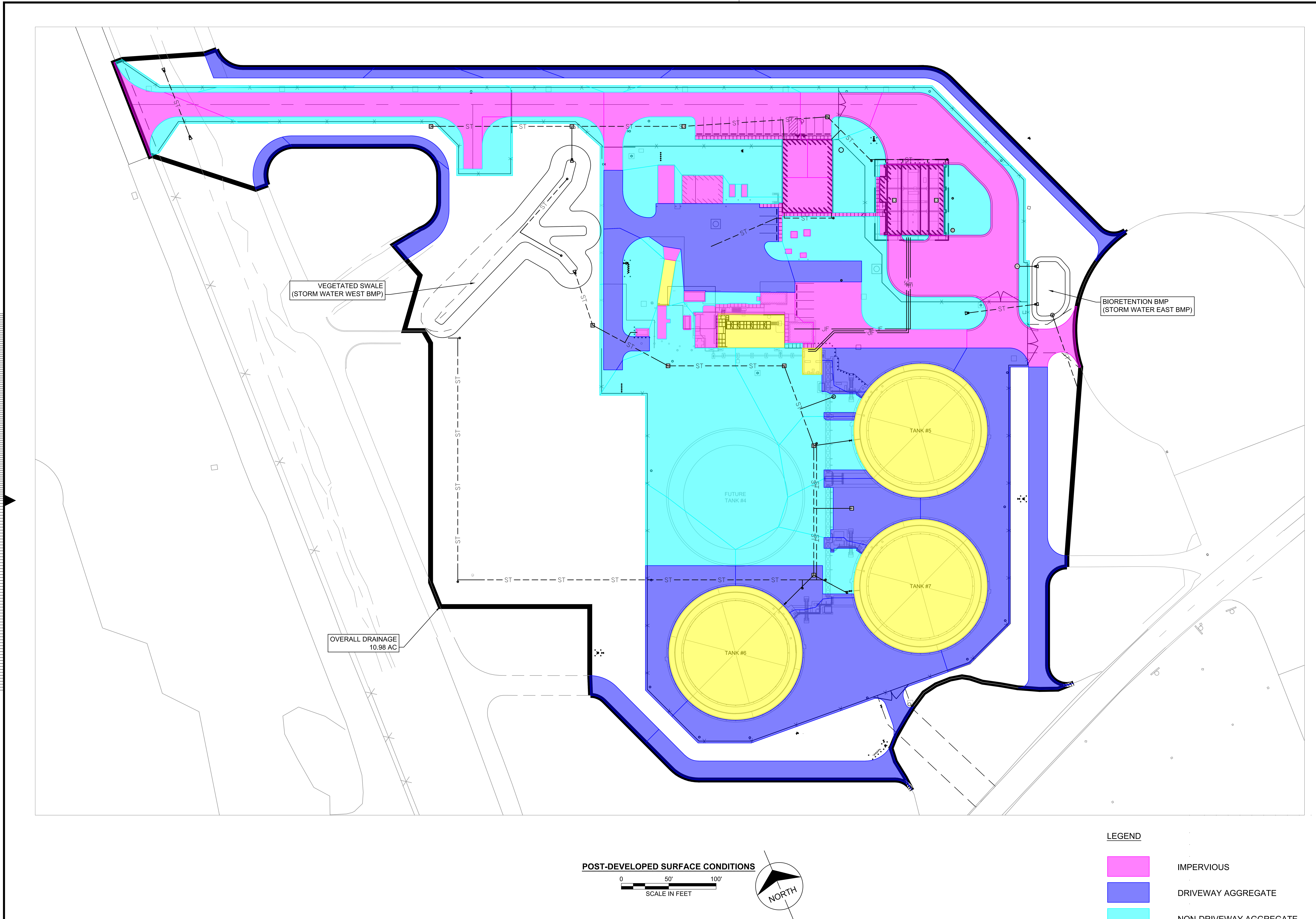
PDX FACILITY IMPROVEMENTS
PRE-DEVELOPED SURFACE CONDITIONS

project 153929
contract
drawing
rev.

file PRE DEV DA MAP.DWG

ATTACHMENT B:
PRE-DEVELOPED SURFACE CONDITIONS

\\BMCD\DFS\CLIENTS\ANF\PORTLANDPORT\PDX\153929_FACILITYIMPRV\DESIGN\CIVIL\DSGN\STORMWATER\PRE DEV DA MAP.DWG



no.	date	by	ckd	description
A	12/21/23			ISSUED FOR PERMIT

ISSUED FOR PERMIT ONLY

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.

date 12/21/23 | detailed
designed | checked

PDX FUEL COMPANY L.L.C

PORTLAND INTERNATIONAL AIRPORT
5000 NE MARINE DR.
PORTLAND, OREGON 97218

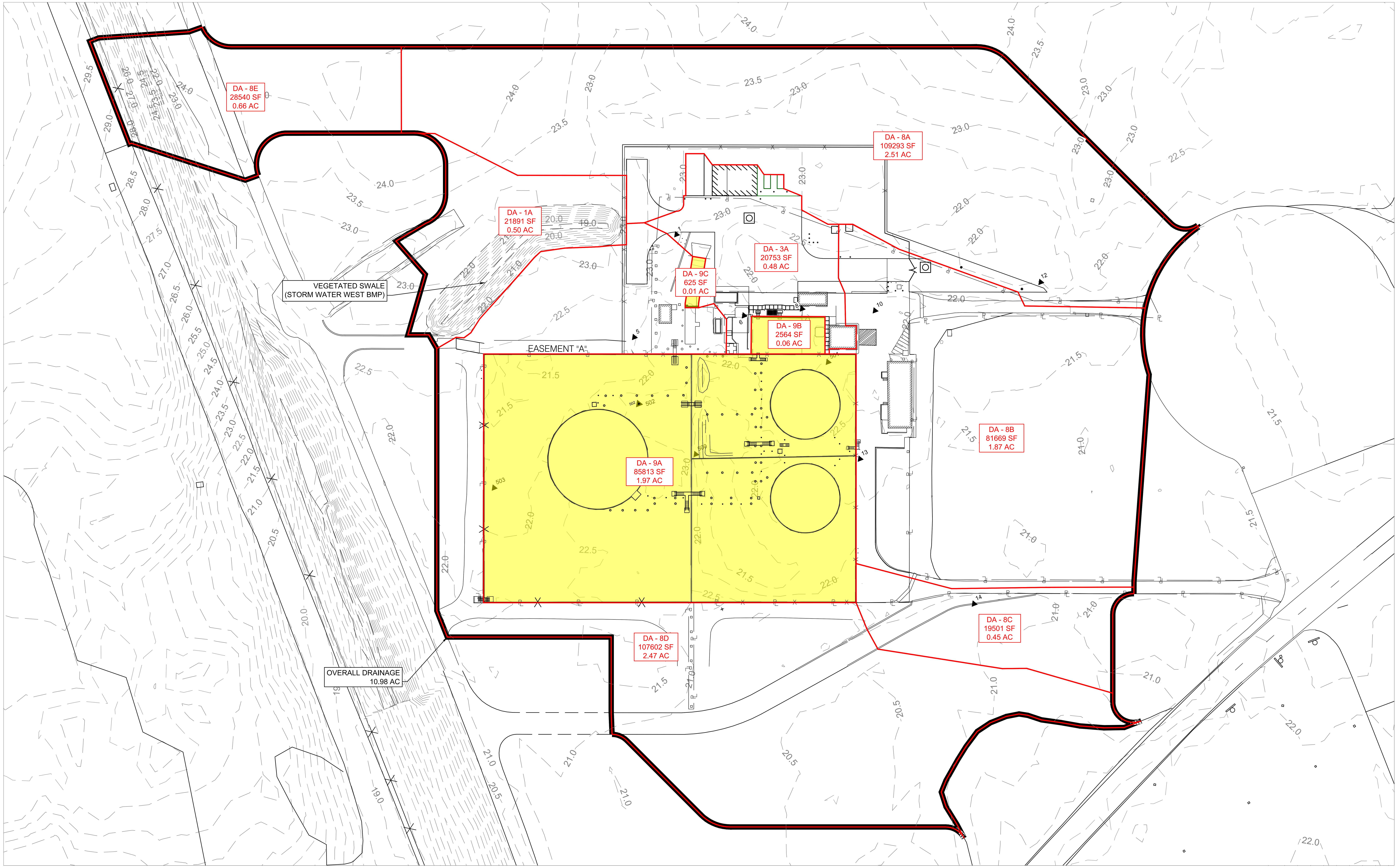
PDX FACILITY IMPROVEMENTS
POST-DEVELOPED SURFACE CONDITIONS

project 153929 | contract
drawing | rev.

file POST DEV DA MAP.DWG

ATTACHMENT C:
POST-DEVELOPED SURFACE CONDITIONS

\\BMCD\DFS\CLIENTS\ANF\PORTLANDPORT\PDX\153929_FACILITYIMPRV\DESIGN\CIVIL\DSGN\STORMWATER\POST DEV DA MAP.DWG



PRE-DEVELOPED DRAINAGE AREAS

0 50' 100'
SCALE IN FEET

NORTH

LEGEND

CONTAINMENT (NO RUNOFF)

DRAINAGE AREA BOUNDARIES

DISTURBED AREA

no.	date	by	ckd	description
A	12/21/23			ISSUED FOR PERMIT

ISSUED FOR PERMIT ONLY

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.

date 12/21/23
detailed
designed
checked

PDX FUEL COMPANY L.L.C

PORTLAND INTERNATIONAL AIRPORT
5000 NE MARINE DR.
PORTLAND, OREGON 97218

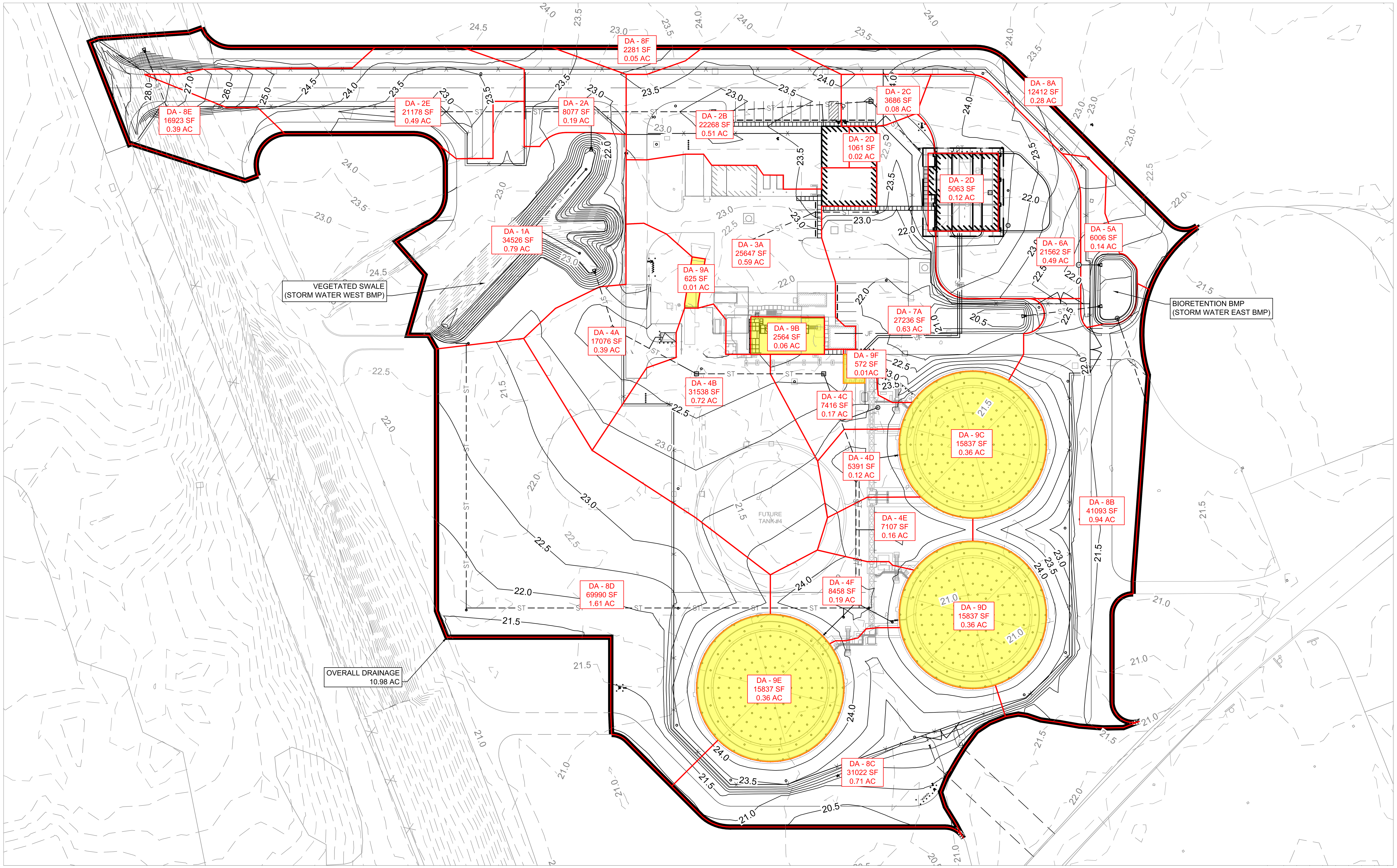
PDX FACILITY IMPROVEMENTS
PRE-DEVELOPED DRAINAGE AREAS

project 153929
contract
drawing
rev.

file PRE DEV DA MAP.DWG

ATTACHMENT D:
PRE-DEVELOPED DRAINAGE AREAS

\\BMCD\DFS\CLIENTS\ANF\PORTLANDPORT\PDX\153929_FACILITYIMPRV\DESIGN\CIVIL\DSGN\STORMWATER\PRE DEV DA MAP.DWG



POST-DEVELOPED DRAINAGE AREAS

0 50' 100'
SCALE IN FEET

NORTH

LEGEND

- CONTAINMENT (NO RUNOFF)
- DRAINAGE AREA BOUNDARIES
- DISTURBED AREA

no.	date	by	ckd	description
A	12/21/23			ISSUED FOR PERMIT

ISSUED FOR PERMIT ONLY

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.

date 12/21/23
detailed
designed
checked

PDX FUEL COMPANY L.L.C

PORTLAND INTERNATIONAL AIRPORT
5000 NE MARINE DR.
PORTLAND, OREGON 97218

PDX FACILITY IMPROVEMENTS
POST-DEVELOPED DRAINAGE AREAS

project 153929
contract
drawing
rev.

file POST DEV DA MAP.DWG

ATTACHMENT E:
POST-DEVELOPED DRAINAGE AREAS

\\BMCD\DFS\CLIENTS\ANF\PORTLANDPORT\PDX\153929_FACILITYIMPRV\DESIGN\CIVIL\DSGN\STORMWATER\POST DEV DA MAP.DWG

ATTACHMENT F:

Corrugated HDPE Pipe Information

ADS N-12® WT IB PIPE (PER AASHTO) SPECIFICATION

Scope

This specification describes 4- through 60-inch (100 to 1500 mm) ADS N-12 WT IB pipe (per AASHTO) for use in gravity-flow land drainage applications.

Pipe Requirements

ADS N-12 WT IB pipe (per AASHTO) shall have a smooth interior and annular exterior corrugations.

- 4- through 10-inch (100 to 250 mm) pipe shall meet AASHTO M252, Type S.
- 12- through 60-inch (300 to 1500 mm) pipe shall meet AASHTO M294, Type S or ASTM F2306.
- Manning's "n" value for use in design shall be 0.012.

Joint Performance

Pipe shall be joined using a bell & spigot joint meeting the requirements of AASHTO M252, AASHTO M294, or ASTM F2306. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.

Fittings

Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306. Bell and spigot connections shall utilize a welded bell and valley or saddle gasket meeting the watertight joint performance requirements of AASHTO M252, AASHTO M294, or ASTM F2306.

Field Pipe and Joint Performance

To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM F2487. Appropriate safety precautions must be used when field-testing any pipe material. Contact the manufacturer for recommended leakage rates.

Material Properties

Material for pipe and fitting production shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch (100 to 250 mm) diameters, and 435400C for 12- through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The 12- through 60-inch (300 to 1500 mm) pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306 respectively.

Installation

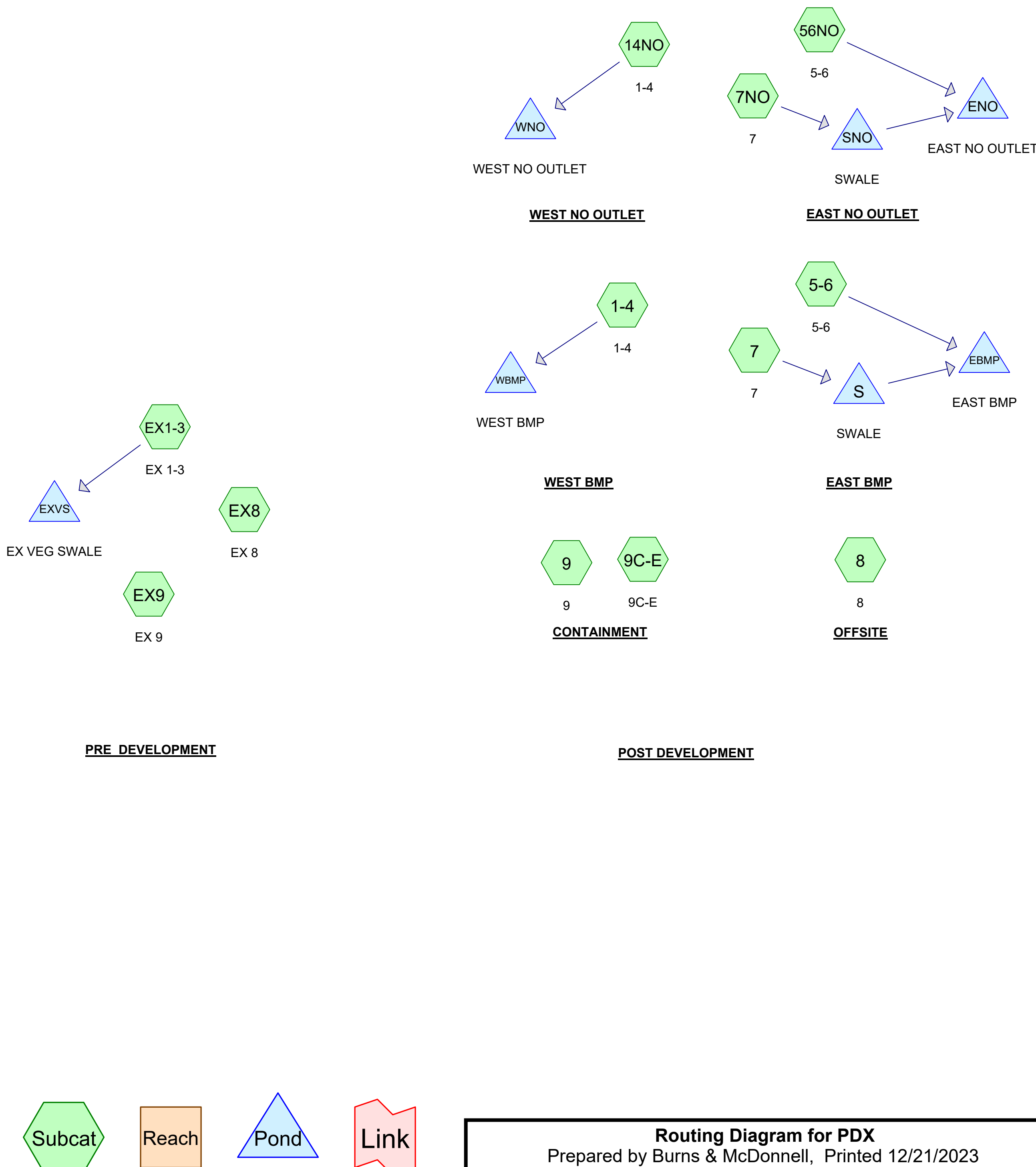
Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot. (0.3 m) and for 60-inch (1500 mm) diameter the minimum cover shall be 2 ft. (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1 (compacted), Class 2 (minimum 90% SPD) or Class 3 (minimum 95%) material. Maximum fill heights depend on embedment material and compaction level; please refer to Technical Note 2.01. Contact your local ADS representative or visit our website at www.ads-pipe.com for a copy of the latest installation guidelines.

Pipe Dimensions

	Nominal Diameter, in (mm)											
Pipe I.D. in (mm)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	15 (375)	18 (450)	24 (600)	30 (750)	36 (900)	42 (1050)	48 (1200)	60 (1500)
Pipe O.D.* in (mm)	4.8 (122)	6.9 (175)	9.1 (231)	11.4 (290)	14.5 (368)	18 (457)	22 (559)	28 (711)	36 (914)	42 (1067)	48 (1219)	54 (1372)	67 (1702)

*Pipe O.D. values are provided for reference purposes only, values stated for 12 through 60-inch are ±1 inch. Contact a sales representative for exact values

ATTACHMENT G:
Hydrocad Model Data



Routing Diagram for PDX
Prepared by Burns & McDonnell, Printed 12/21/2023
HydroCAD® 10.20-2g s/n 08510 © 2022 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type II 24-hr		Default	24.00	1	2.40	2
2	5-Year	Type II 24-hr		Default	24.00	1	2.90	2
3	10-Year	Type II 24-hr		Default	24.00	1	3.40	2
4	25-Year	Type II 24-hr		Default	24.00	1	3.90	2
5	100-Year	Type II 24-hr		Default	24.00	1	4.40	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
9.113	76	(1-4, 14NO)
1.266	85	(5-6, 56NO)
1.251	89	(7, 7NO)
3.988	64	(8)
4.311	100	(9, 9C-E, EX9)
0.975	68	(EX1-3)
7.960	51	(EX8)
28.864	**72**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
28.864	Other	1-4, 5-6, 7, 7NO, 8, 9, 9C-E, 14NO, 56NO, EX1-3, EX8, EX9
28.864		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	28.864	28.864		1-4, 5-6, 7, 7NO, 8, 9, 9C-E, 14NO, 56NO, EX1-3, EX8, EX9
0.000	**0.000**	**0.000**	**0.000**	**28.864**	**28.864**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	EBMP	19.81	19.35	92.0	0.0050	0.012	0.0	6.0	0.0
2	EXVS	16.13	16.00	25.0	0.0052	0.130	0.0	8.0	0.0
3	S	20.25	19.92	74.0	0.0045	0.012	0.0	8.0	0.0
4	SNO	20.25	19.92	74.0	0.0045	0.012	0.0	8.0	0.0
5	WBMP	16.17	16.00	25.0	0.0068	0.013	0.0	8.0	0.0

Time span=1.00-50.00 hrs, dt=0.01 hrs, 4901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1-4: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=0.63"
Tc=5.0 min CN=76 Runoff=5.23 cfs 0.241 af

Subcatchment5-6: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=1.10"
Tc=5.0 min CN=85 Runoff=1.29 cfs 0.058 af

Subcatchment7: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=1.37"
Tc=5.0 min CN=89 Runoff=1.57 cfs 0.071 af

Subcatchment7NO: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=1.37"
Tc=5.0 min CN=89 Runoff=1.57 cfs 0.071 af

Subcatchment8: 8 Runoff Area=173,721 sf 0.00% Impervious Runoff Depth=0.24"
Tc=5.0 min CN=64 Runoff=1.11 cfs 0.078 af

Subcatchment9: 9 Runoff Area=51,272 sf 100.00% Impervious Runoff Depth>2.38"
Tc=5.0 min CN=100 Runoff=4.17 cfs 0.233 af

Subcatchment9C-E: 9C-E Runoff Area=47,511 sf 100.00% Impervious Runoff Depth>2.38"
Tc=5.0 min CN=100 Runoff=3.87 cfs 0.216 af

Subcatchment14NO: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=0.63"
Tc=5.0 min CN=76 Runoff=5.23 cfs 0.241 af

Subcatchment56NO: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=1.10"
Tc=5.0 min CN=85 Runoff=1.29 cfs 0.058 af

SubcatchmentEX1-3: EX 1-3 Runoff Area=42,470 sf 0.00% Impervious Runoff Depth=0.35"
Tc=5.0 min CN=68 Runoff=0.51 cfs 0.028 af

SubcatchmentEX8: EX 8 Runoff Area=346,757 sf 0.00% Impervious Runoff Depth=0.02"
Tc=5.0 min CN=51 Runoff=0.02 cfs 0.015 af

SubcatchmentEX9: EX 9 Runoff Area=89,002 sf 100.00% Impervious Runoff Depth>2.38"
Tc=5.0 min CN=100 Runoff=7.24 cfs 0.405 af

Pond EBMP: EAST BMP Peak Elev=20.90' Storage=1,574 cf Inflow=1.95 cfs 0.117 af
Discarded=0.28 cfs 0.111 af Primary=0.11 cfs 0.006 af Secondary=0.00 cfs 0.000 af Outflow=0.39 cfs 0.117 af

Pond ENO: EAST NO OUTLET Peak Elev=20.93' Storage=1,637 cf Inflow=1.95 cfs 0.116 af
Discarded=0.28 cfs 0.116 af Secondary=0.00 cfs 0.000 af Outflow=0.28 cfs 0.116 af

Pond EXVS: EX VEG SWALE Peak Elev=18.64' Storage=215 cf Inflow=0.51 cfs 0.028 af
Discarded=0.12 cfs 0.028 af Primary=0.00 cfs 0.000 af Outflow=0.12 cfs 0.028 af

Pond S: SWALE Peak Elev=21.00' Storage=649 cf Inflow=1.57 cfs 0.071 af
Discarded=0.04 cfs 0.012 af Primary=0.67 cfs 0.059 af Secondary=0.00 cfs 0.000 af Outflow=0.71 cfs 0.071 af

Pond SNO: SWALE Peak Elev=21.00' Storage=649 cf Inflow=1.57 cfs 0.071 af
Discarded=0.04 cfs 0.013 af Primary=0.67 cfs 0.059 af Secondary=0.00 cfs 0.000 af Outflow=0.71 cfs 0.071 af

Pond WBMP: WEST BMP Peak Elev=18.93' Storage=1,600 cf Inflow=5.23 cfs 0.241 af
Discarded=0.44 cfs 0.029 af Primary=2.24 cfs 0.210 af Secondary=0.00 cfs 0.000 af Outflow=2.68 cfs 0.239 af

Pond WNO: WEST NO OUTLET Peak Elev=19.32' Storage=3,416 cf Inflow=5.23 cfs 0.241 af
Discarded=0.66 cfs 0.239 af Primary=0.00 cfs 0.000 af Outflow=0.66 cfs 0.239 af

Total Runoff Area = 28.864 ac Runoff Volume = 1.716 af Average Runoff Depth = 0.71"
85.06% Pervious = 24.553 ac 14.94% Impervious = 4.311 ac

Summary for Subcatchment 1-4: 1-4

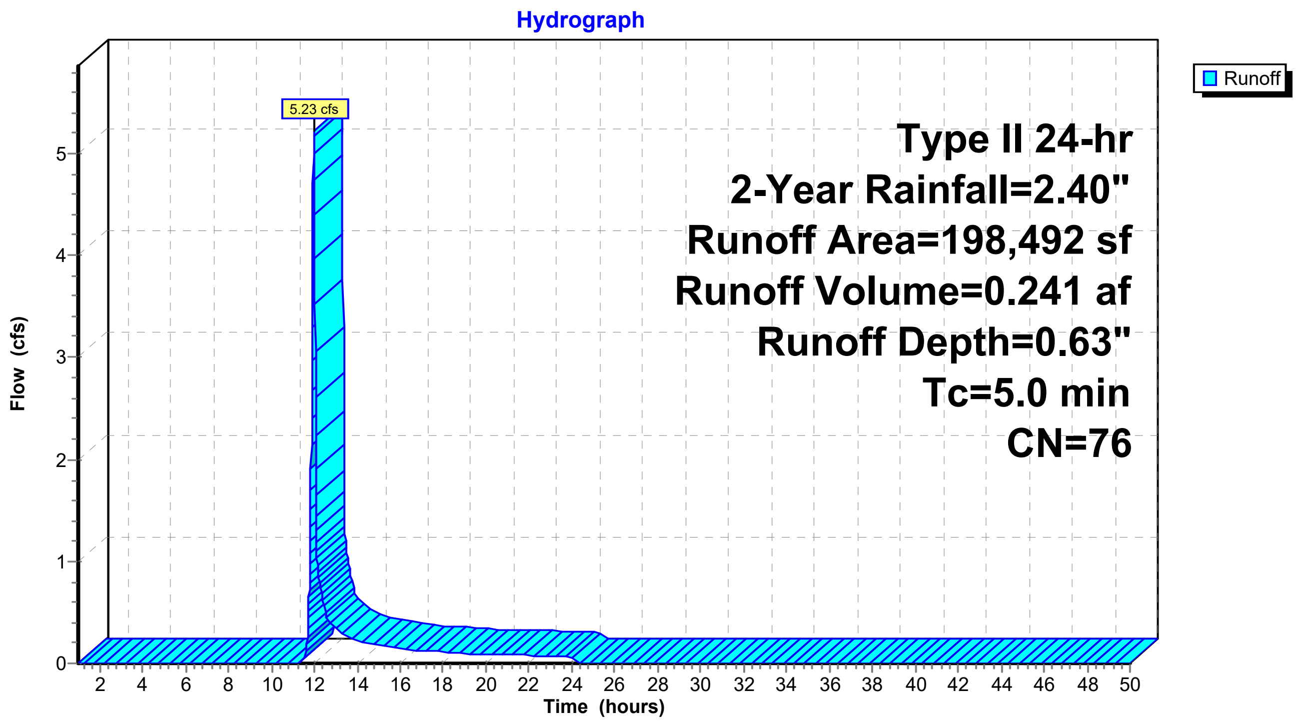
Runoff = 5.23 cfs @ 11.97 hrs, Volume= 0.241 af, Depth= 0.63"
Routed to Pond WBMP : WEST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1-4: 1-4



Summary for Subcatchment 5-6: 5-6

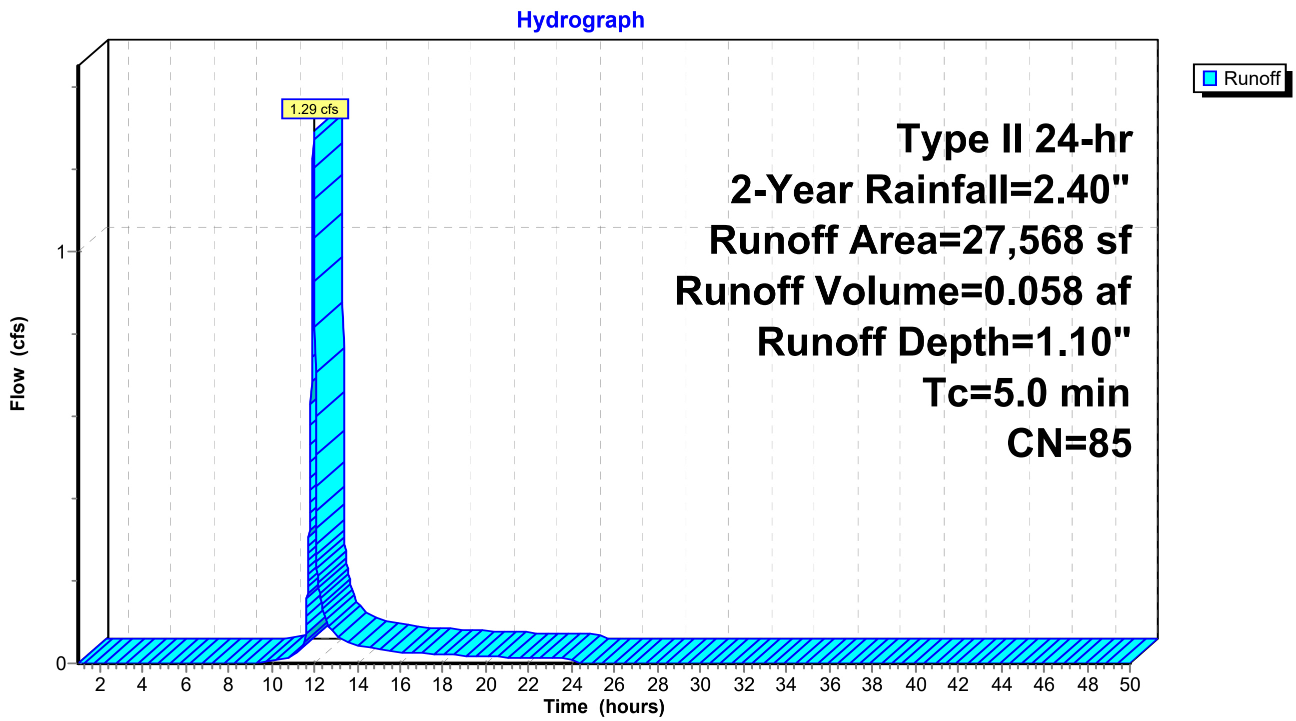
Runoff = 1.29 cfs @ 11.96 hrs, Volume= 0.058 af, Depth= 1.10"
Routed to Pond EBMP : EAST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5-6: 5-6



Summary for Subcatchment 7: 7

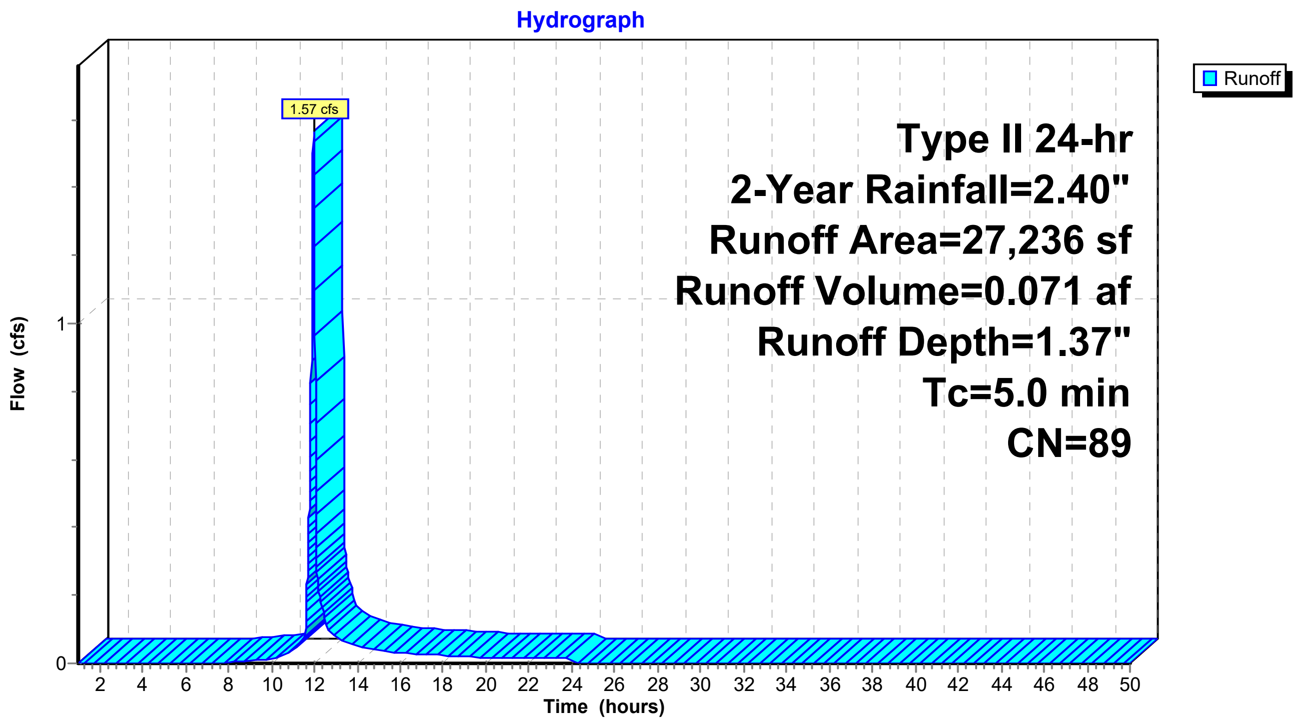
Runoff = 1.57 cfs @ 11.96 hrs, Volume= 0.071 af, Depth= 1.37"
Routed to Pond S : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7: 7



Summary for Subcatchment 7NO: 7

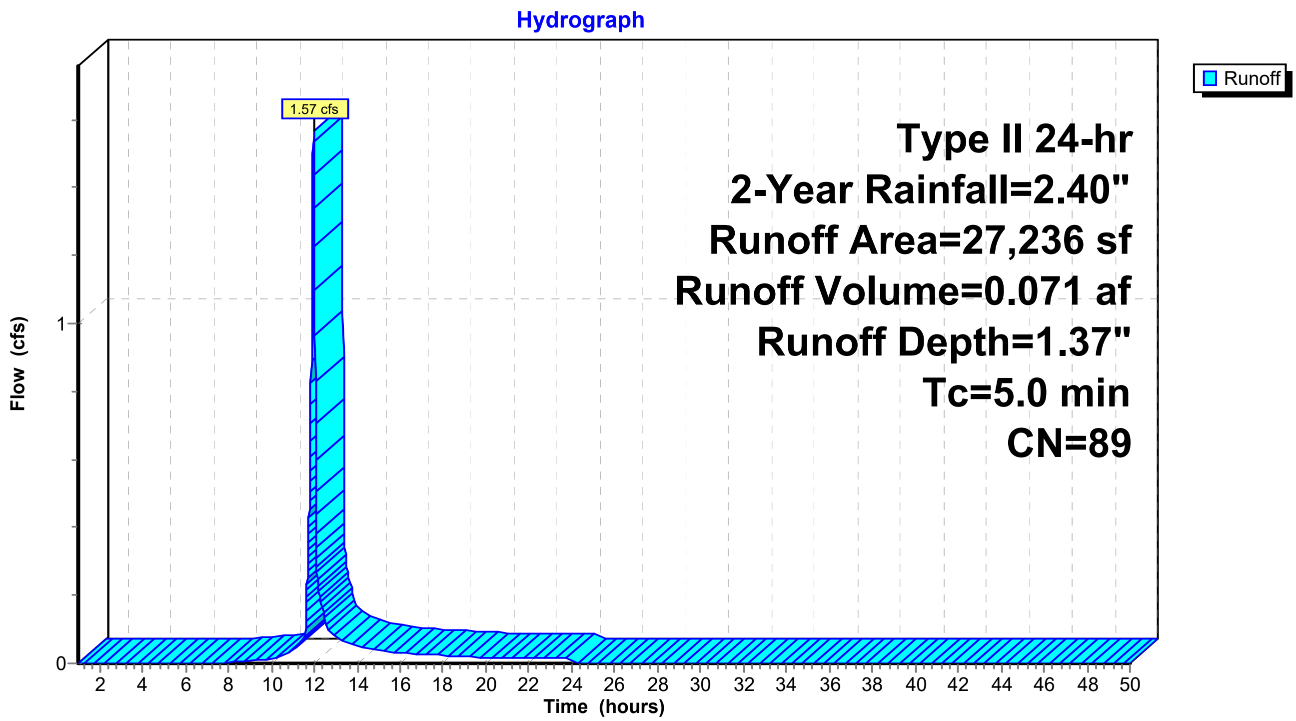
Runoff = 1.57 cfs @ 11.96 hrs, Volume= 0.071 af, Depth= 1.37"
Routed to Pond SNO : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7NO: 7



Summary for Subcatchment 8: 8

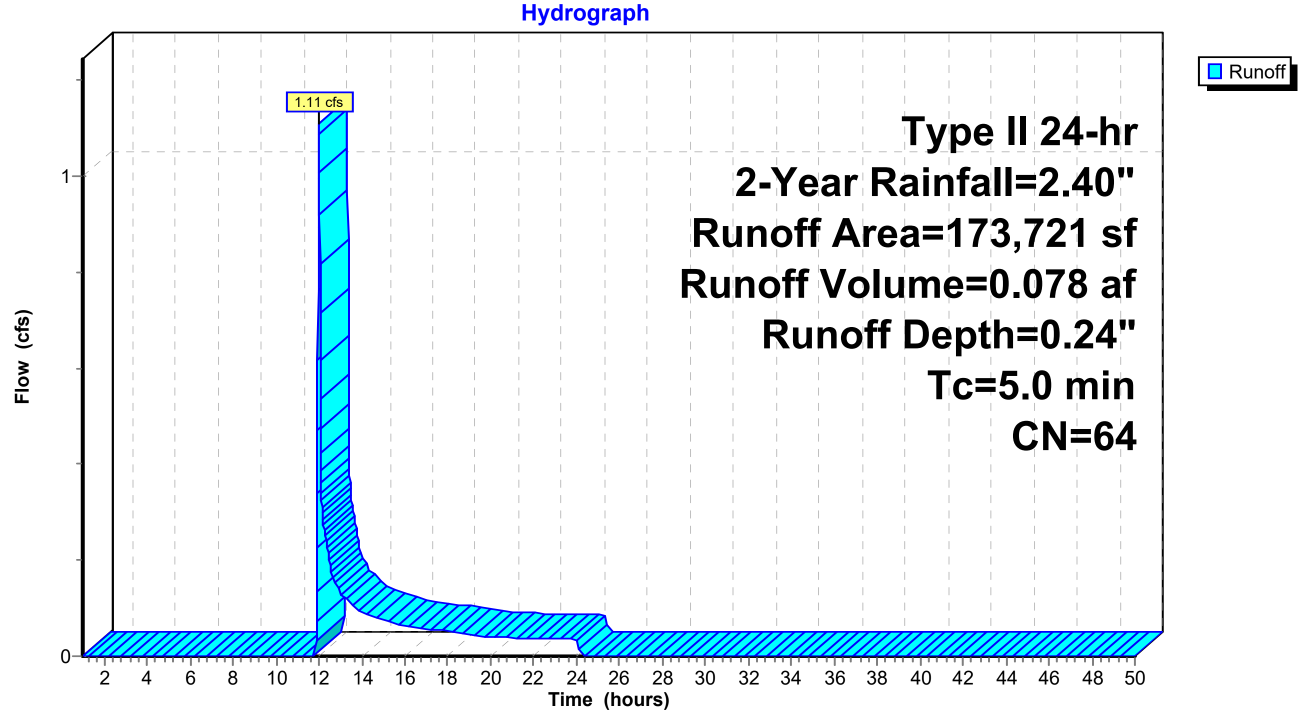
Runoff = 1.11 cfs @ 11.99 hrs, Volume= 0.078 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	173,721	64	
	173,721		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 8: 8



Summary for Subcatchment 9: 9

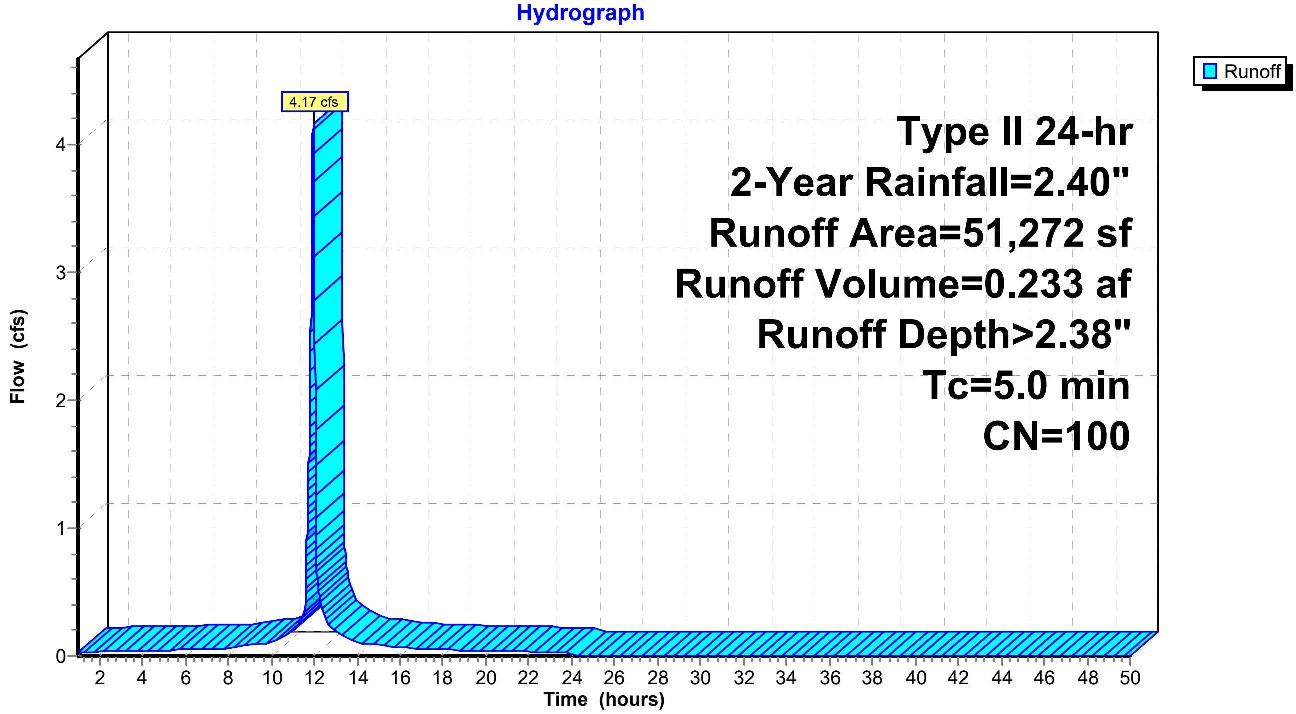
Runoff = 4.17 cfs @ 11.96 hrs, Volume= 0.233 af, Depth> 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	51,272	100	
	51,272		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9: 9



Summary for Subcatchment 9C-E: 9C-E

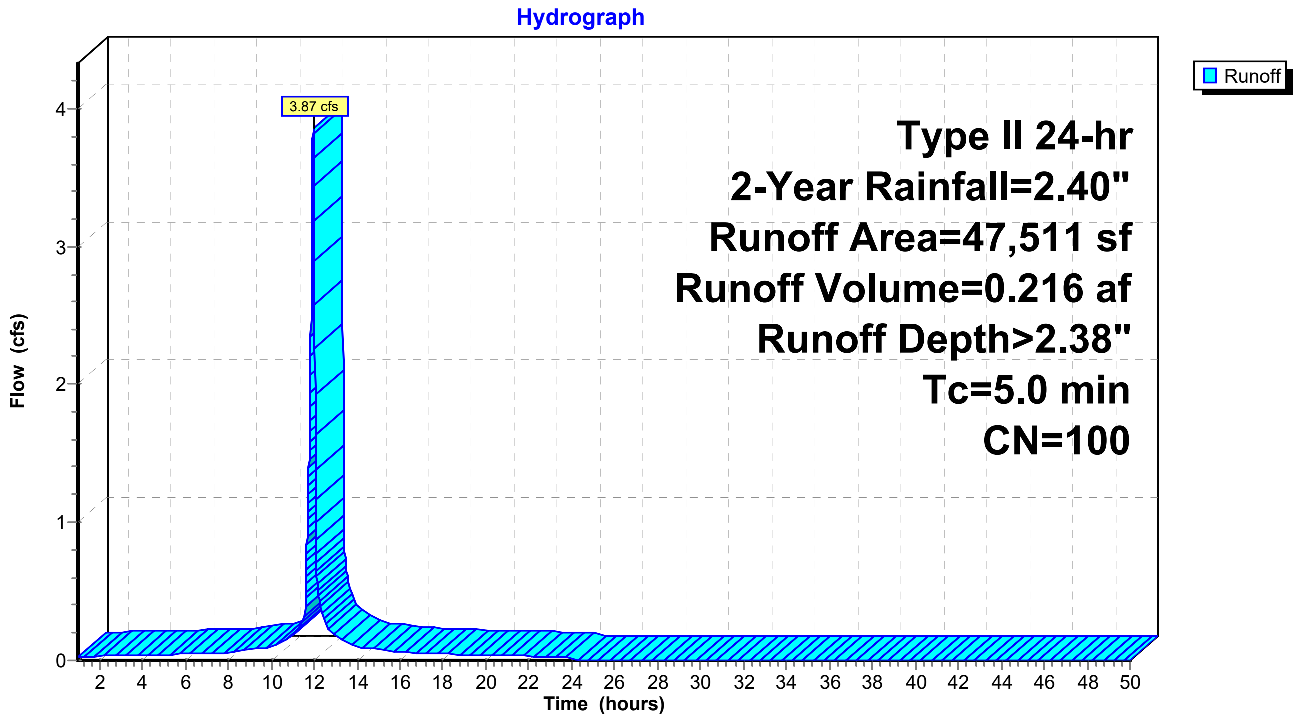
Runoff = 3.87 cfs @ 11.96 hrs, Volume= 0.216 af, Depth> 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	47,511	100	
	47,511		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9C-E: 9C-E



Summary for Subcatchment 14NO: 1-4

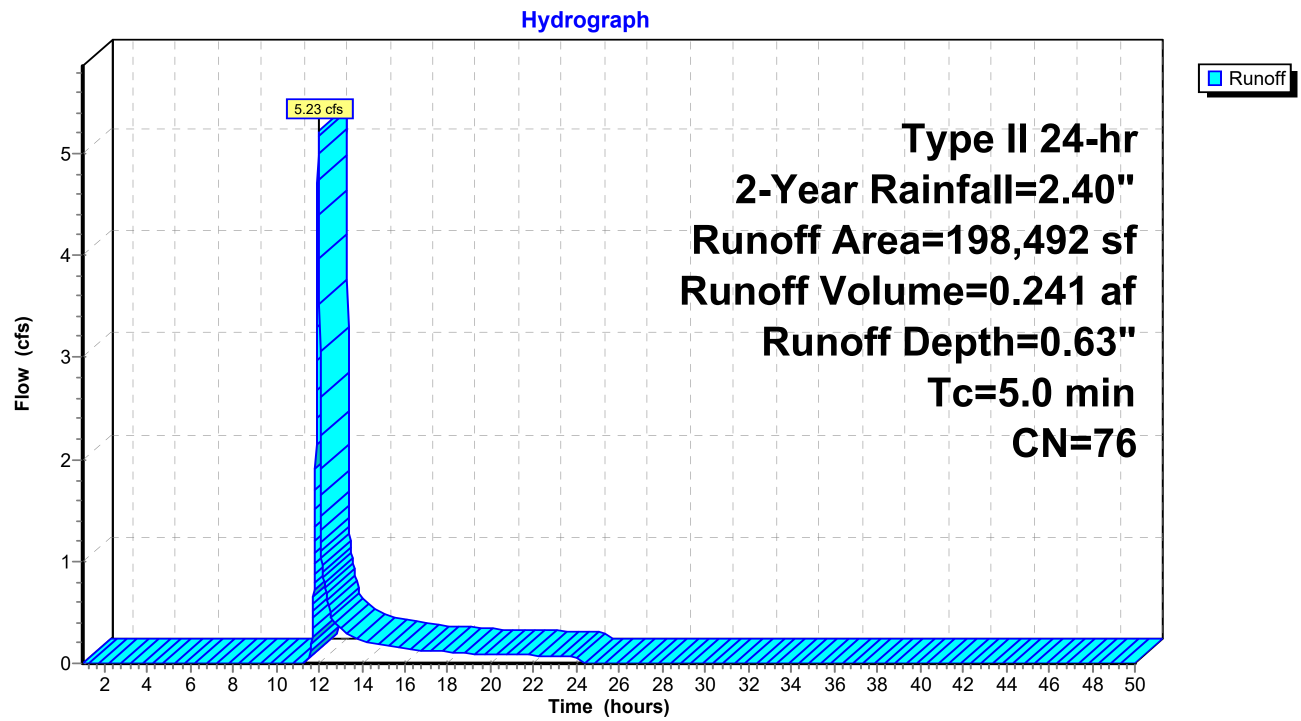
Runoff = 5.23 cfs @ 11.97 hrs, Volume= 0.241 af, Depth= 0.63"
Routed to Pond WNO : WEST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 14NO: 1-4



Summary for Subcatchment 56NO: 5-6

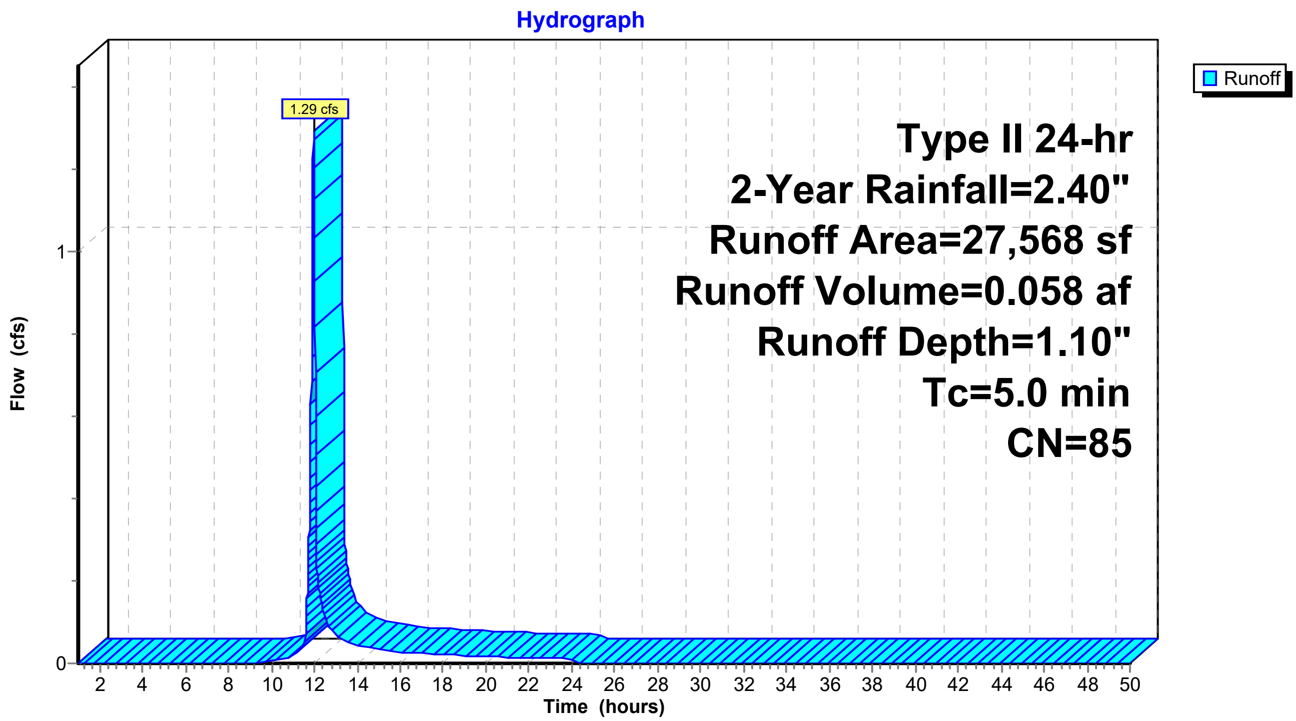
Runoff = 1.29 cfs @ 11.96 hrs, Volume= 0.058 af, Depth= 1.10"
Routed to Pond ENO : EAST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 56NO: 5-6



Summary for Subcatchment EX1-3: EX 1-3

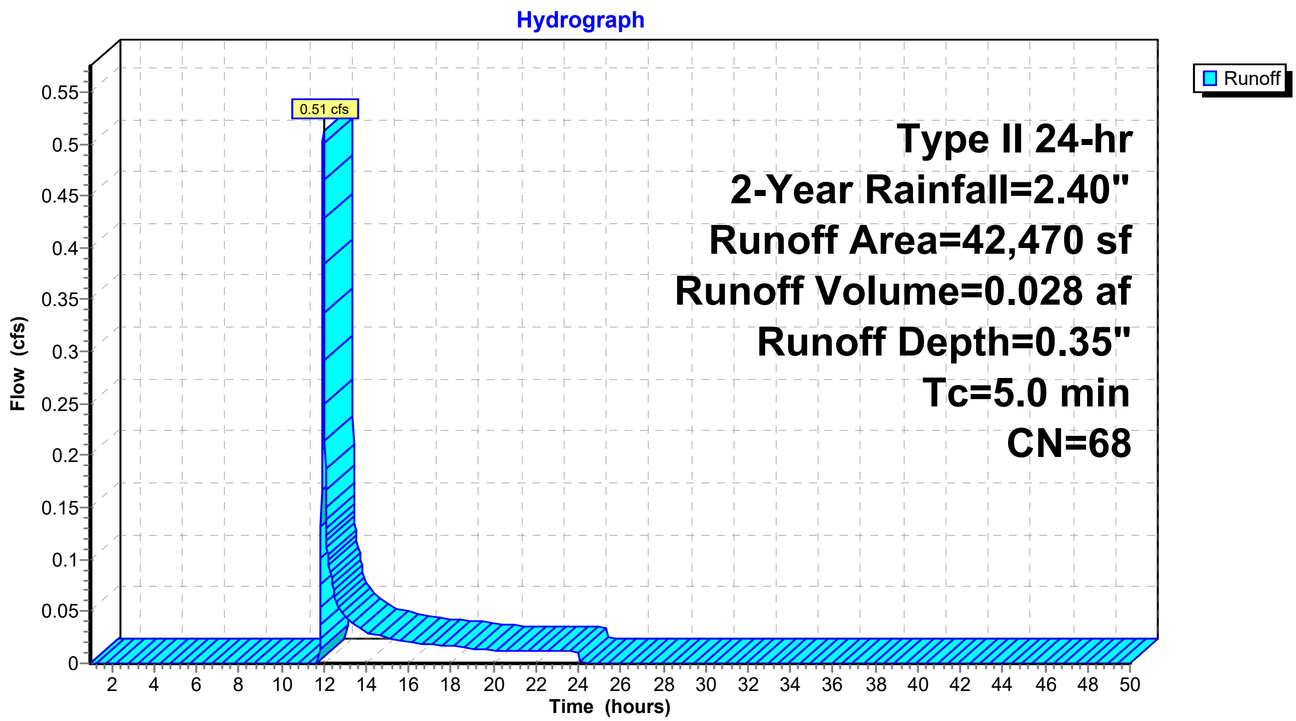
Runoff = 0.51 cfs @ 11.98 hrs, Volume= 0.028 af, Depth= 0.35"
Routed to Pond EXVS : EX VEG SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	42,470	68	
	42,470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX1-3: EX 1-3



Summary for Subcatchment EX8: EX 8

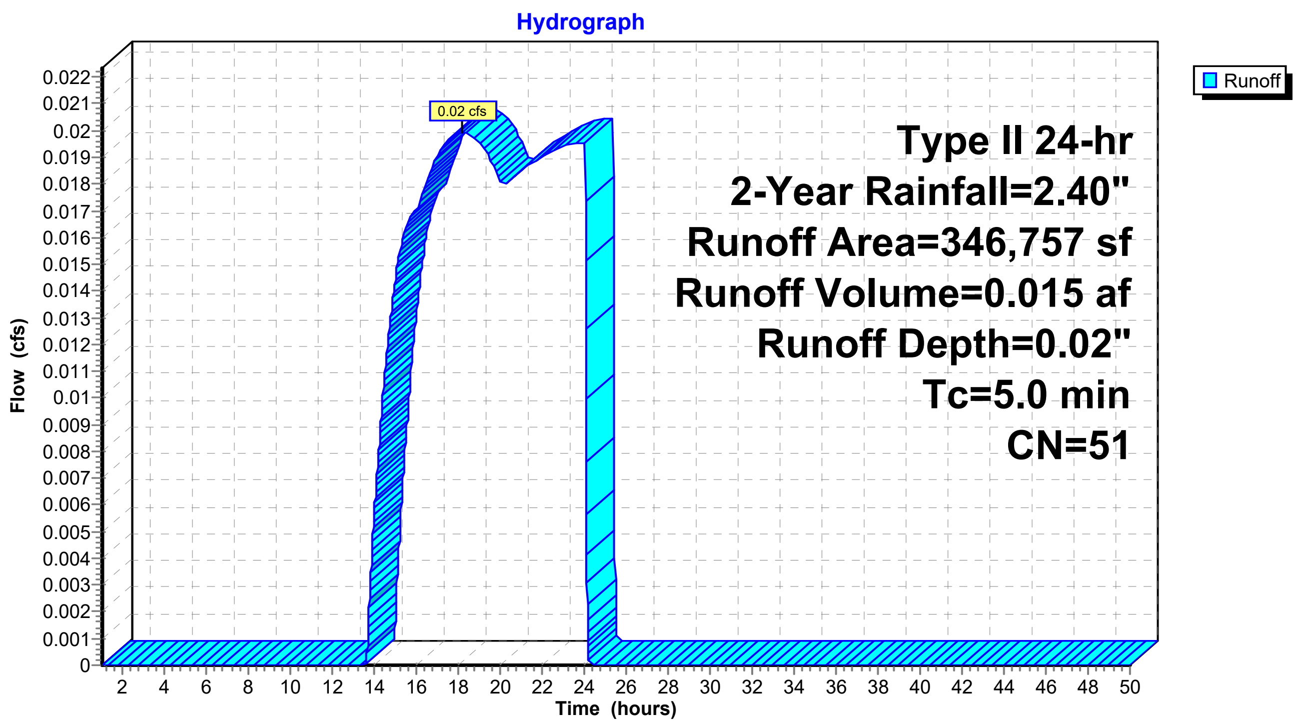
Runoff = 0.02 cfs @ 18.15 hrs, Volume= 0.015 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	346,757	51	
	346,757		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX8: EX 8



Summary for Subcatchment EX9: EX 9

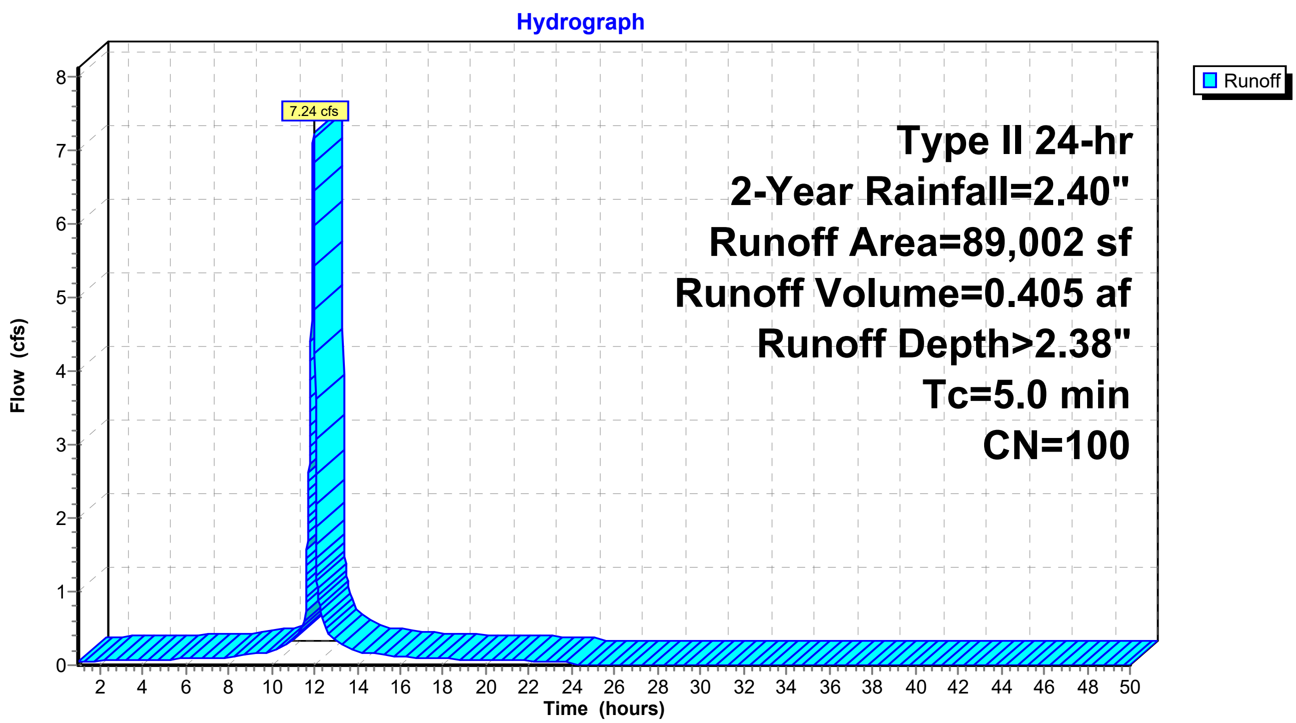
Runoff = 7.24 cfs @ 11.96 hrs, Volume= 0.405 af, Depth> 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-Year Rainfall=2.40"

	Area (sf)	CN	Description
*	89,002	100	
	89,002		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX9: EX 9



Summary for Pond EBMP: EAST BMP

Inflow Area = 1.258 ac, 0.00% Impervious, Inflow Depth = 1.12" for 2-Year event
Inflow = 1.95 cfs @ 11.97 hrs, Volume= 0.117 af
Outflow = 0.39 cfs @ 12.28 hrs, Volume= 0.117 af, Atten= 80%, Lag= 18.8 min
Discarded = 0.28 cfs @ 12.28 hrs, Volume= 0.111 af
Primary = 0.11 cfs @ 12.28 hrs, Volume= 0.006 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 20.90' @ 12.28 hrs Surf.Area= 2,158 sf Storage= 1,574 cf

Plug-Flow detention time= 49.5 min calculated for 0.117 af (100% of inflow)
Center-of-Mass det. time= 49.4 min (882.9 - 833.5)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

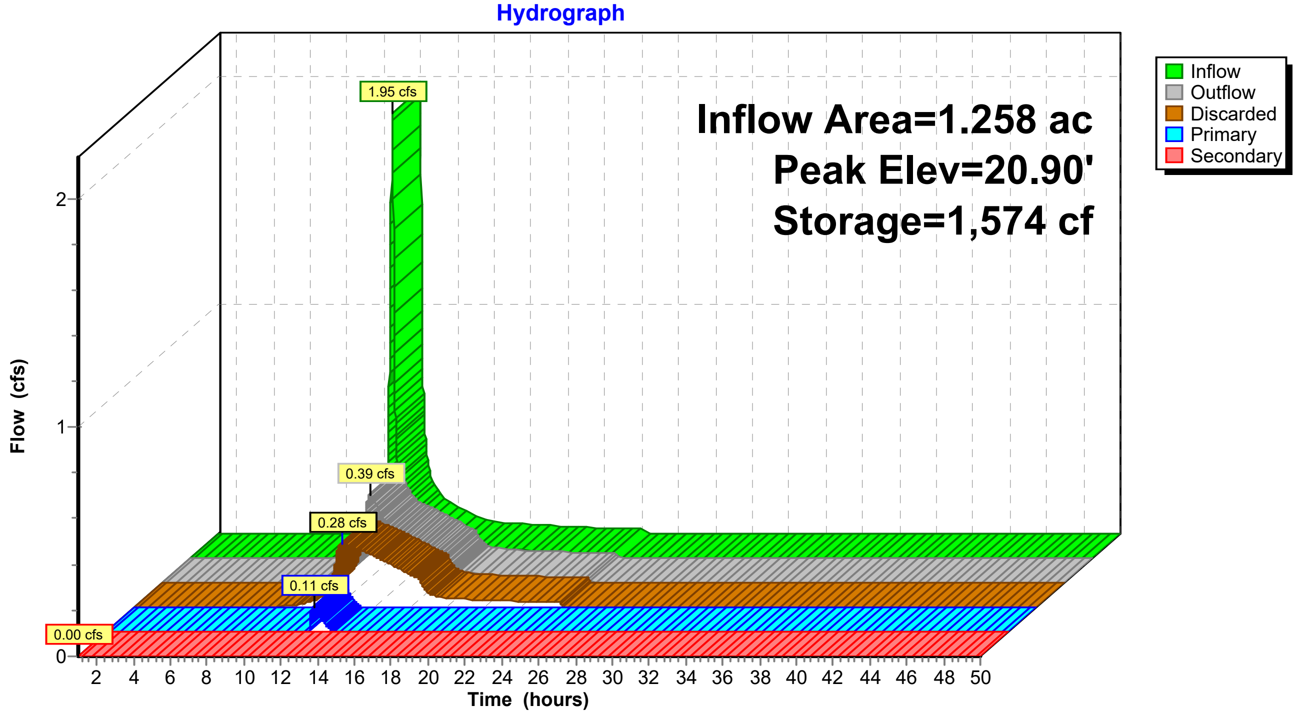
Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	19.81'	**6.0" Round Culvert** L= 92.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 19.81' / 19.35' S= 0.0050 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#3	Device 2	20.70'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.28 cfs @ 12.28 hrs HW=20.90' (Free Discharge)
└─**4=Exfiltration** (Controls 0.28 cfs)

Primary OutFlow Max=0.11 cfs @ 12.28 hrs HW=20.90' (Free Discharge)
└─**2=Culvert** (Passes 0.11 cfs of 0.59 cfs potential flow)
  └─**3=Orifice/Grate** (Orifice Controls 0.11 cfs @ 1.51 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond EBMP: EAST BMP



Summary for Pond ENO: EAST NO OUTLET

Inflow Area = 1.258 ac, 0.00% Impervious, Inflow Depth = 1.11" for 2-Year event
Inflow = 1.95 cfs @ 11.97 hrs, Volume= 0.116 af
Outflow = 0.28 cfs @ 12.37 hrs, Volume= 0.116 af, Atten= 85%, Lag= 24.0 min
Discarded = 0.28 cfs @ 12.37 hrs, Volume= 0.116 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 20.93' @ 12.37 hrs Surf.Area= 2,192 sf Storage= 1,637 cf

Plug-Flow detention time= 55.5 min calculated for 0.116 af (100% of inflow)
Center-of-Mass det. time= 55.4 min (890.8 - 835.4)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

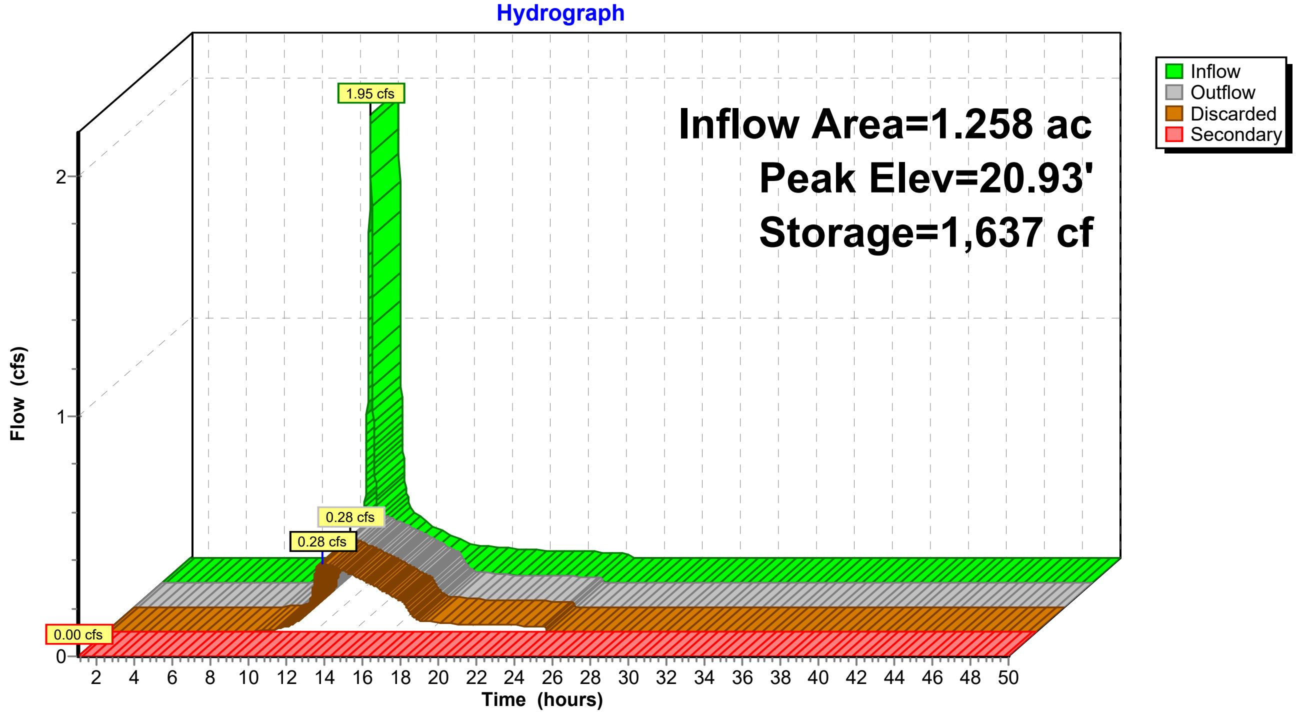
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.28 cfs @ 12.37 hrs HW=20.93' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.28 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond ENO: EAST NO OUTLET



Summary for Pond EXVS: EX VEG SWALE

Inflow Area = 0.975 ac, 0.00% Impervious, Inflow Depth = 0.35" for 2-Year event
Inflow = 0.51 cfs @ 11.98 hrs, Volume= 0.028 af
Outflow = 0.12 cfs @ 12.14 hrs, Volume= 0.028 af, Atten= 77%, Lag= 9.2 min
Discarded = 0.12 cfs @ 12.14 hrs, Volume= 0.028 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 18.64' @ 12.14 hrs Surf.Area= 980 sf Storage= 215 cf

Plug-Flow detention time= 14.0 min calculated for 0.028 af (100% of inflow)
Center-of-Mass det. time= 14.0 min (923.9 - 909.9)

Volume	Invert	Avail.Storage	Storage Description
#1	18.20'	36,604 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

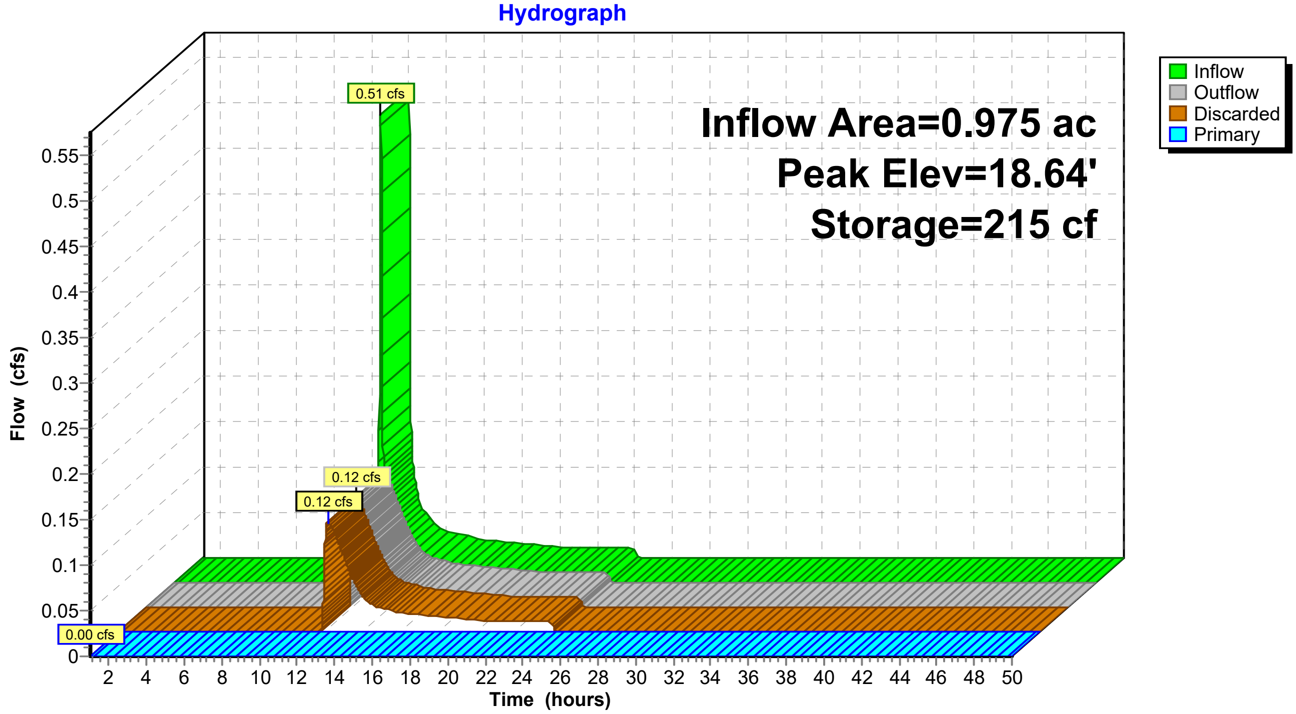
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.20	0	0	0
19.00	1,791	716	716
20.00	3,474	2,633	3,349
21.00	5,191	4,333	7,681
22.00	6,970	6,081	13,762
23.00	12,905	9,938	23,699
24.00	12,905	12,905	36,604

Device	Routing	Invert	Outlet Devices
#1	Primary	16.13'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.13' / 16.00' S= 0.0052 '/' Cc= 0.900 n= 0.130, Flow Area= 0.35 sf
#2	Device 1	19.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.00' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.12 cfs @ 12.14 hrs HW=18.64' (Free Discharge)
└─**3=Exfiltration** (Controls 0.12 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.20' (Free Discharge)
└─**1=Culvert** (Passes 0.00 cfs of 0.30 cfs potential flow)
  └─**2=Orifice/Grate** (Controls 0.00 cfs)

Pond EXVS: EX VEG SWALE



Summary for Pond S: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 1.37" for 2-Year event
Inflow = 1.57 cfs @ 11.96 hrs, Volume= 0.071 af
Outflow = 0.71 cfs @ 11.99 hrs, Volume= 0.071 af, Atten= 55%, Lag= 1.7 min
Discarded = 0.04 cfs @ 12.06 hrs, Volume= 0.012 af
Primary = 0.67 cfs @ 11.99 hrs, Volume= 0.059 af
Routed to Pond EBMP : EAST BMP
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.00' @ 12.06 hrs Surf.Area= 1,733 sf Storage= 649 cf

Plug-Flow detention time= 20.1 min calculated for 0.071 af (100% of inflow)
Center-of-Mass det. time= 20.1 min (839.1 - 819.0)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

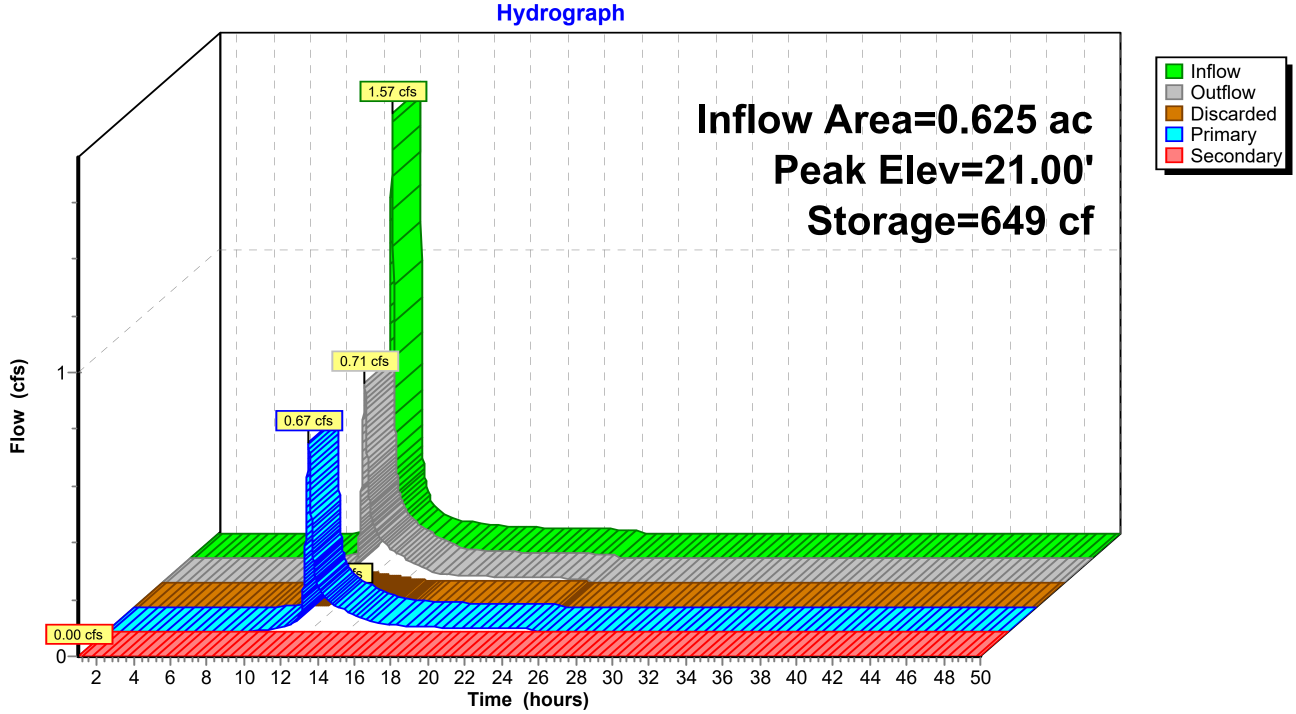
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.04 cfs @ 12.06 hrs HW=21.00' (Free Discharge)
└─**3=Exfiltration** (Controls 0.04 cfs)

Primary OutFlow Max=0.63 cfs @ 11.99 hrs HW=20.94' TW=20.64' (Dynamic Tailwater)
└─**2=Culvert** (Outlet Controls 0.63 cfs @ 2.16 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond S: SWALE


Hydrograph
1.57 cfs
0.71 cfs
0.67 cfs
0.00 cfs
Inflow Area=0.625 ac
Peak Elev=21.00'
Storage=649 cf
Inflow
Outflow
Discarded
Primary
Secondary
Flow (cfs)
1
0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
Time (hours)

Summary for Pond SNO: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 1.37" for 2-Year event
Inflow = 1.57 cfs @ 11.96 hrs, Volume= 0.071 af
Outflow = 0.71 cfs @ 11.99 hrs, Volume= 0.071 af, Atten= 55%, Lag= 1.7 min
Discarded = 0.04 cfs @ 12.06 hrs, Volume= 0.013 af
Primary = 0.67 cfs @ 11.99 hrs, Volume= 0.059 af
Routed to Pond ENO : EAST NO OUTLET
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.00' @ 12.06 hrs Surf.Area= 1,733 sf Storage= 649 cf

Plug-Flow detention time= 23.2 min calculated for 0.071 af (100% of inflow)
Center-of-Mass det. time= 23.2 min (842.2 - 819.0)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

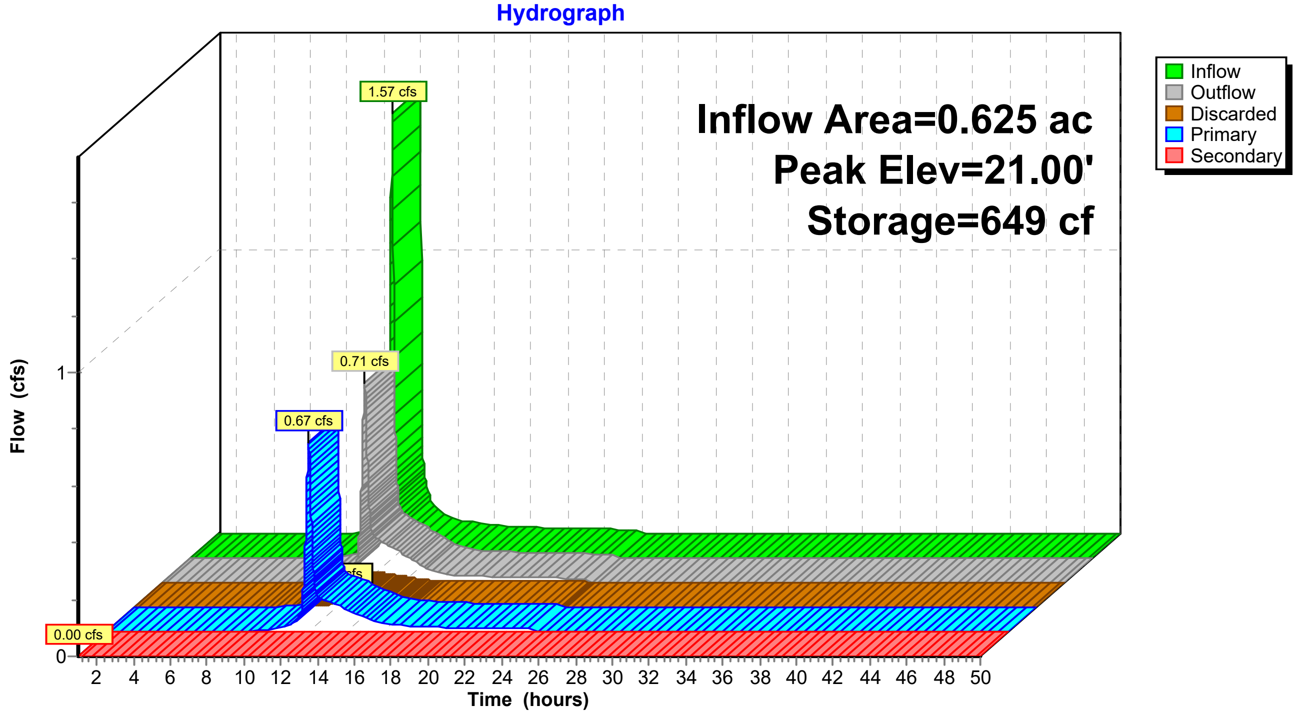
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.04 cfs @ 12.06 hrs HW=21.00' (Free Discharge)
└—**3=Exfiltration** (Controls 0.04 cfs)

Primary OutFlow Max=0.63 cfs @ 11.99 hrs HW=20.94' TW=20.64' (Dynamic Tailwater)
└—**2=Culvert** (Outlet Controls 0.63 cfs @ 2.16 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
└—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond SNO: SWALE



Summary for Pond WBMP: WEST BMP

Inflow Area = 4.557 ac, 0.00% Impervious, Inflow Depth = 0.63" for 2-Year event
Inflow = 5.23 cfs @ 11.97 hrs, Volume= 0.241 af
Outflow = 2.68 cfs @ 12.05 hrs, Volume= 0.239 af, Atten= 49%, Lag= 4.7 min
Discarded = 0.44 cfs @ 12.05 hrs, Volume= 0.029 af
Primary = 2.24 cfs @ 12.05 hrs, Volume= 0.210 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 18.93' @ 12.05 hrs Surf.Area= 4,178 sf Storage= 1,600 cf

Plug-Flow detention time= 11.4 min calculated for 0.239 af (99% of inflow)
Center-of-Mass det. time= 7.0 min (877.3 - 870.3)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	44,177 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

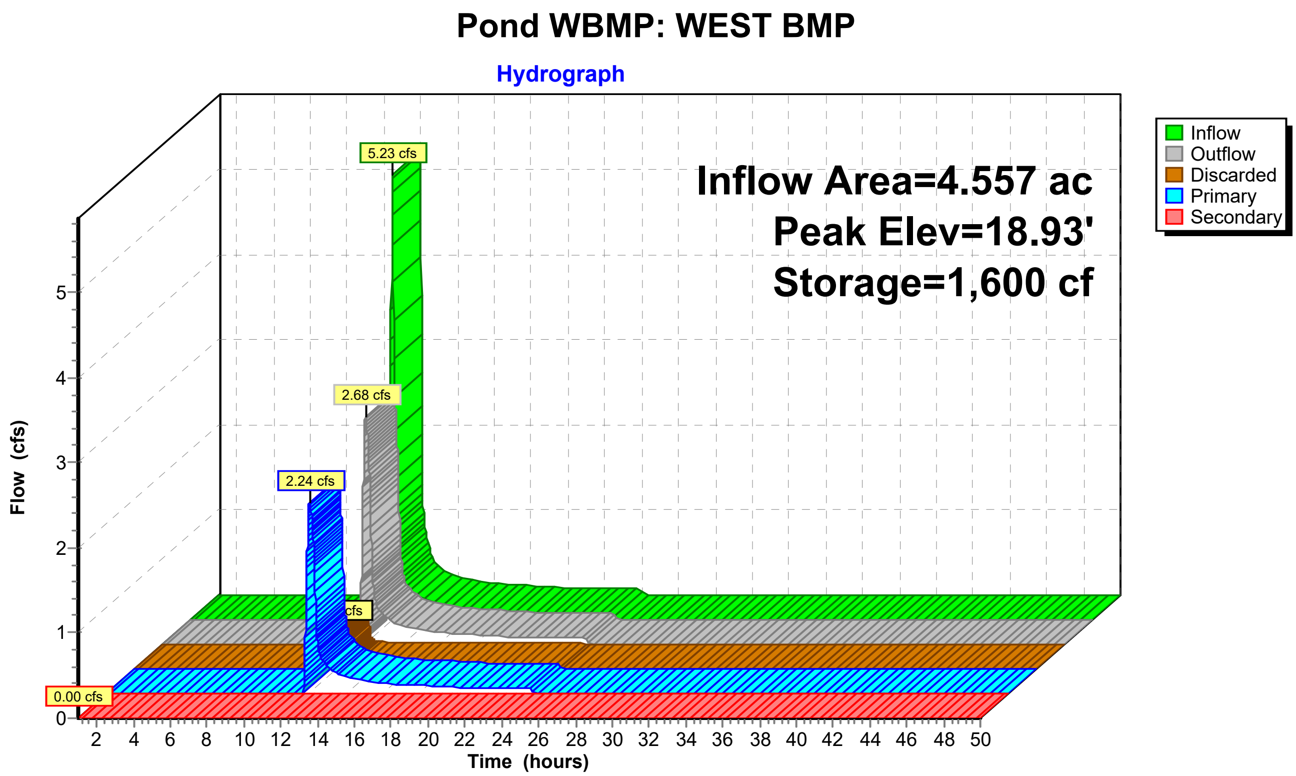
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,448	399	399
19.00	4,645	1,523	1,922
19.50	6,024	2,667	4,589
20.00	7,369	3,348	7,938
20.50	8,707	4,019	11,957
21.00	10,033	4,685	16,642
21.50	11,358	5,348	21,989
22.00	12,674	6,008	27,997
22.50	14,024	6,675	34,672
23.00	23,997	9,505	44,177

Device	Routing	Invert	Outlet Devices
#1	Primary	16.17'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.17' / 16.00' S= 0.0068 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#2	Device 1	18.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 667 sf
#4	Secondary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.44 cfs @ 12.05 hrs HW=18.93' (Free Discharge)
└**3=Exfiltration** (Controls 0.44 cfs)

Primary OutFlow Max=2.24 cfs @ 12.05 hrs HW=18.93' (Free Discharge)
└**1=Culvert** (Passes 2.24 cfs of 2.50 cfs potential flow)
  └**2=Orifice/Grate** (Orifice Controls 2.24 cfs @ 4.10 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)



Summary for Pond WNO: WEST NO OUTLET

Inflow Area = 4.557 ac, 0.00% Impervious, Inflow Depth = 0.63" for 2-Year event
Inflow = 5.23 cfs @ 11.97 hrs, Volume= 0.241 af
Outflow = 0.66 cfs @ 12.37 hrs, Volume= 0.239 af, Atten= 87%, Lag= 23.8 min
Discarded = 0.66 cfs @ 12.37 hrs, Volume= 0.239 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 19.32' @ 12.37 hrs Surf.Area= 5,536 sf Storage= 3,416 cf

Plug-Flow detention time= 65.3 min calculated for 0.239 af (99% of inflow)
Center-of-Mass det. time= 61.6 min (932.0 - 870.3)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	43,777 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

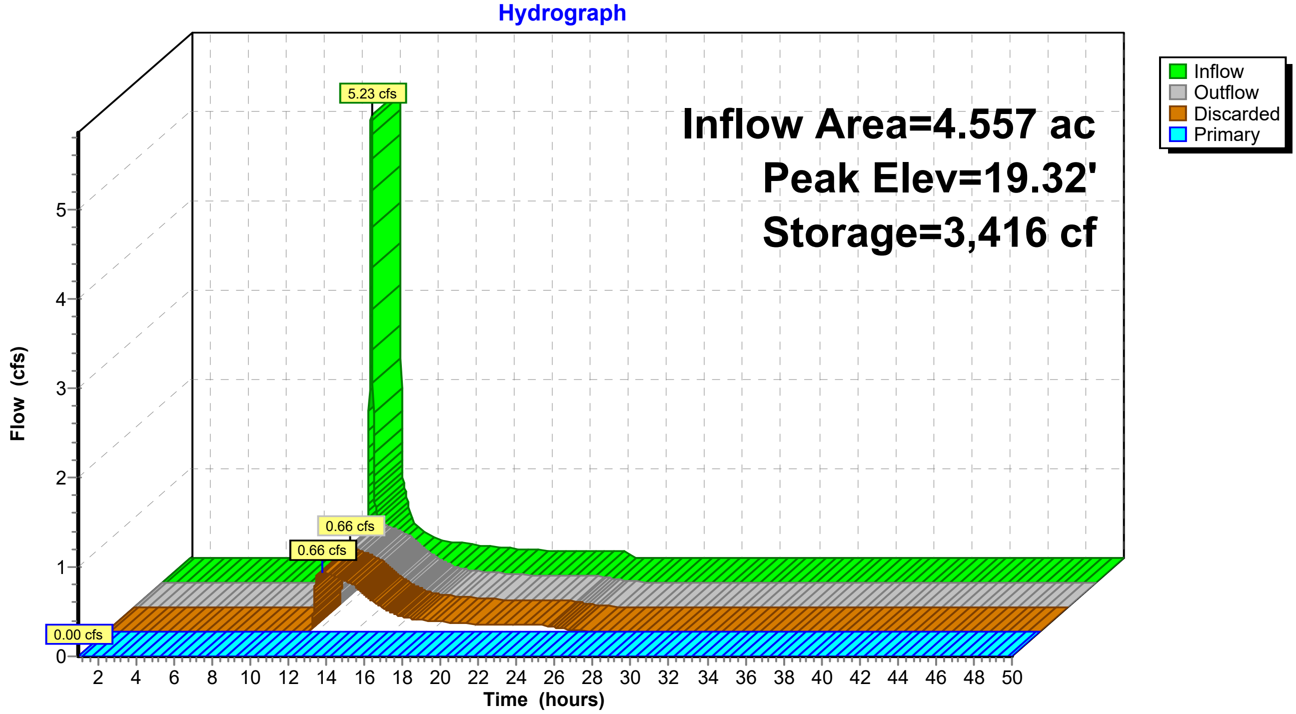
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,148	324	324
19.00	4,645	1,448	1,772
19.50	6,024	2,667	4,439
20.00	7,369	3,348	7,788
20.50	8,707	4,019	11,807
21.00	10,033	4,685	16,492
21.50	11,358	5,348	21,839
22.00	12,674	6,008	27,847
22.50	14,024	6,675	34,522
23.00	22,997	9,255	43,777

Device	Routing	Invert	Outlet Devices
#1	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 547 sf
#2	Primary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.66 cfs @ 12.37 hrs HW=19.32' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.66 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond WNO: WEST NO OUTLET



Time span=1.00-50.00 hrs, dt=0.01 hrs, 4901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1-4: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=0.95"
Tc=5.0 min CN=76 Runoff=7.99 cfs 0.360 af

Subcatchment5-6: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=1.50"
Tc=5.0 min CN=85 Runoff=1.76 cfs 0.079 af

Subcatchment7: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=1.81"
Tc=5.0 min CN=89 Runoff=2.05 cfs 0.094 af

Subcatchment7NO: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=1.81"
Tc=5.0 min CN=89 Runoff=2.05 cfs 0.094 af

Subcatchment8: 8 Runoff Area=173,721 sf 0.00% Impervious Runoff Depth=0.43"
Tc=5.0 min CN=64 Runoff=2.62 cfs 0.141 af

Subcatchment9: 9 Runoff Area=51,272 sf 100.00% Impervious Runoff Depth>2.87"
Tc=5.0 min CN=100 Runoff=5.04 cfs 0.282 af

Subcatchment9C-E: 9C-E Runoff Area=47,511 sf 100.00% Impervious Runoff Depth>2.87"
Tc=5.0 min CN=100 Runoff=4.67 cfs 0.261 af

Subcatchment14NO: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=0.95"
Tc=5.0 min CN=76 Runoff=7.99 cfs 0.360 af

Subcatchment56NO: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=1.50"
Tc=5.0 min CN=85 Runoff=1.76 cfs 0.079 af

SubcatchmentEX1-3: EX 1-3 Runoff Area=42,470 sf 0.00% Impervious Runoff Depth=0.58"
Tc=5.0 min CN=68 Runoff=0.96 cfs 0.047 af

SubcatchmentEX8: EX 8 Runoff Area=346,757 sf 0.00% Impervious Runoff Depth=0.09"
Tc=5.0 min CN=51 Runoff=0.09 cfs 0.060 af

SubcatchmentEX9: EX 9 Runoff Area=89,002 sf 100.00% Impervious Runoff Depth>2.87"
Tc=5.0 min CN=100 Runoff=8.75 cfs 0.489 af

Pond EBMP: EAST BMP Peak Elev=21.05' Storage=1,927 cf Inflow=2.45 cfs 0.158 af
Discarded=0.30 cfs 0.136 af Primary=0.30 cfs 0.022 af Secondary=0.00 cfs 0.000 af Outflow=0.60 cfs 0.158 af

Pond ENO: EAST NO OUTLET Peak Elev=21.14' Storage=2,126 cf Inflow=2.45 cfs 0.154 af
Discarded=0.32 cfs 0.154 af Secondary=0.00 cfs 0.000 af Outflow=0.32 cfs 0.154 af

Pond EXVS: EX VEG SWALE Peak Elev=18.86' Storage=483 cf Inflow=0.96 cfs 0.047 af
Discarded=0.19 cfs 0.047 af Primary=0.00 cfs 0.000 af Outflow=0.19 cfs 0.047 af

Pond S: SWALE Peak Elev=21.16' Storage=996 cf Inflow=2.05 cfs 0.094 af
Discarded=0.06 cfs 0.016 af Primary=0.69 cfs 0.079 af Secondary=0.00 cfs 0.000 af Outflow=0.74 cfs 0.094 af

Pond SNO: SWALE Peak Elev=21.16' Storage=1,002 cf Inflow=2.05 cfs 0.094 af
Discarded=0.07 cfs 0.020 af Primary=0.69 cfs 0.075 af Secondary=0.00 cfs 0.000 af Outflow=0.74 cfs 0.094 af

Pond WBMP: WEST BMP Peak Elev=19.22' Storage=3,015 cf Inflow=7.99 cfs 0.360 af
Discarded=0.60 cfs 0.047 af Primary=2.65 cfs 0.312 af Secondary=0.00 cfs 0.000 af Outflow=3.25 cfs 0.358 af

Pond WNO: WEST NO OUTLET Peak Elev=19.72' Storage=5,833 cf Inflow=7.99 cfs 0.360 af
Discarded=0.85 cfs 0.359 af Primary=0.00 cfs 0.000 af Outflow=0.85 cfs 0.359 af

Total Runoff Area = 28.864 ac Runoff Volume = 2.348 af Average Runoff Depth = 0.98"
85.06% Pervious = 24.553 ac 14.94% Impervious = 4.311 ac

Summary for Subcatchment 1-4: 1-4

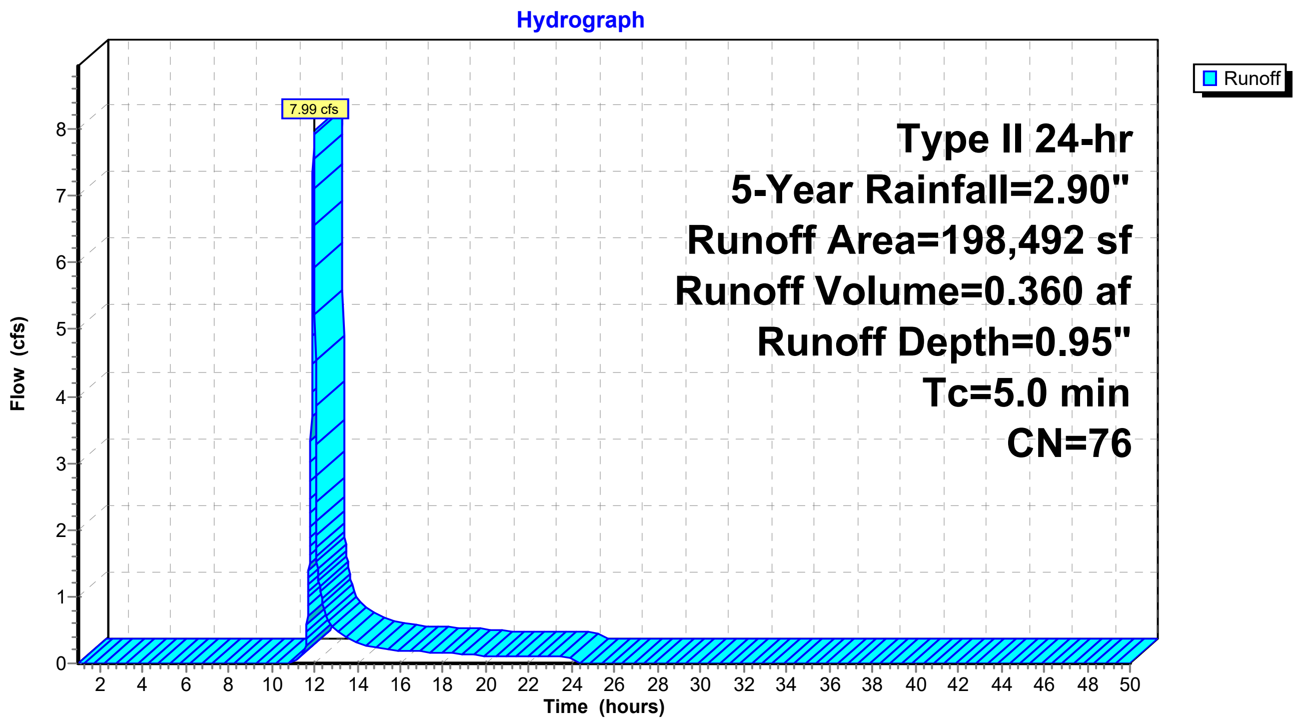
Runoff = 7.99 cfs @ 11.97 hrs, Volume= 0.360 af, Depth= 0.95"
Routed to Pond WBMP : WEST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1-4: 1-4



Summary for Subcatchment 5-6: 5-6

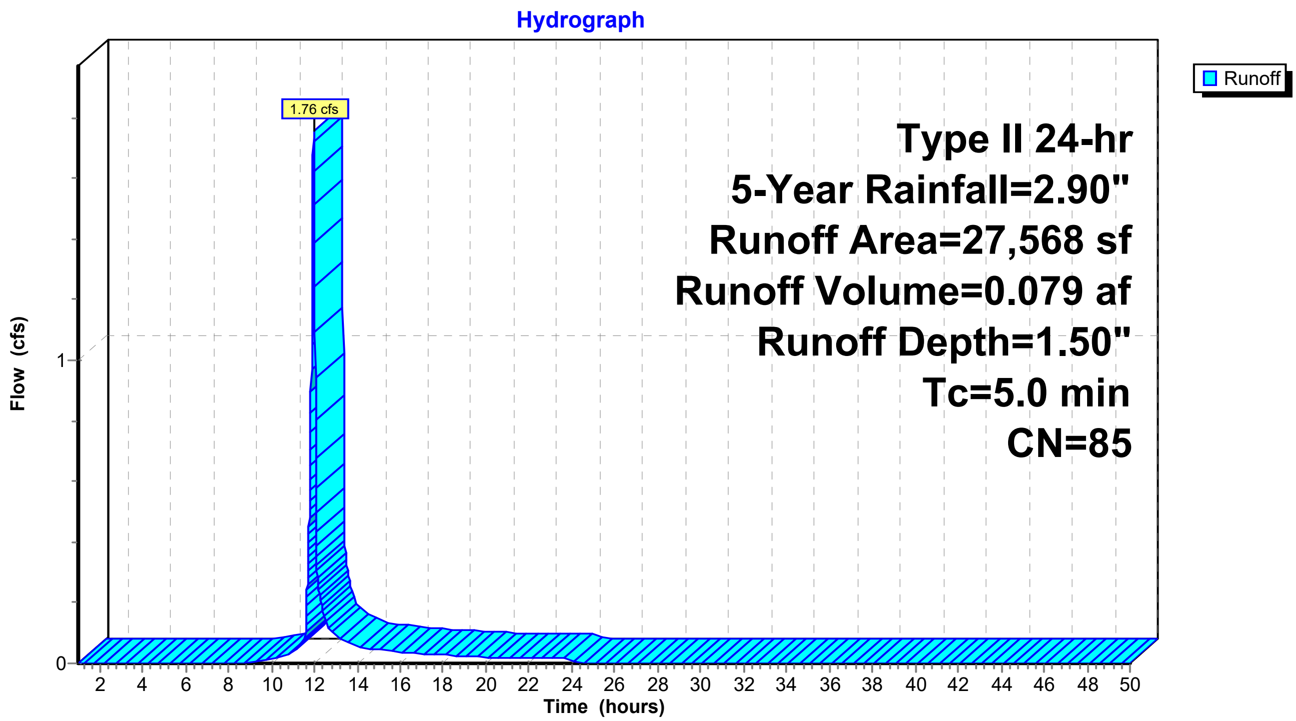
Runoff = 1.76 cfs @ 11.96 hrs, Volume= 0.079 af, Depth= 1.50"
Routed to Pond EBMP : EAST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5-6: 5-6



Summary for Subcatchment 7: 7

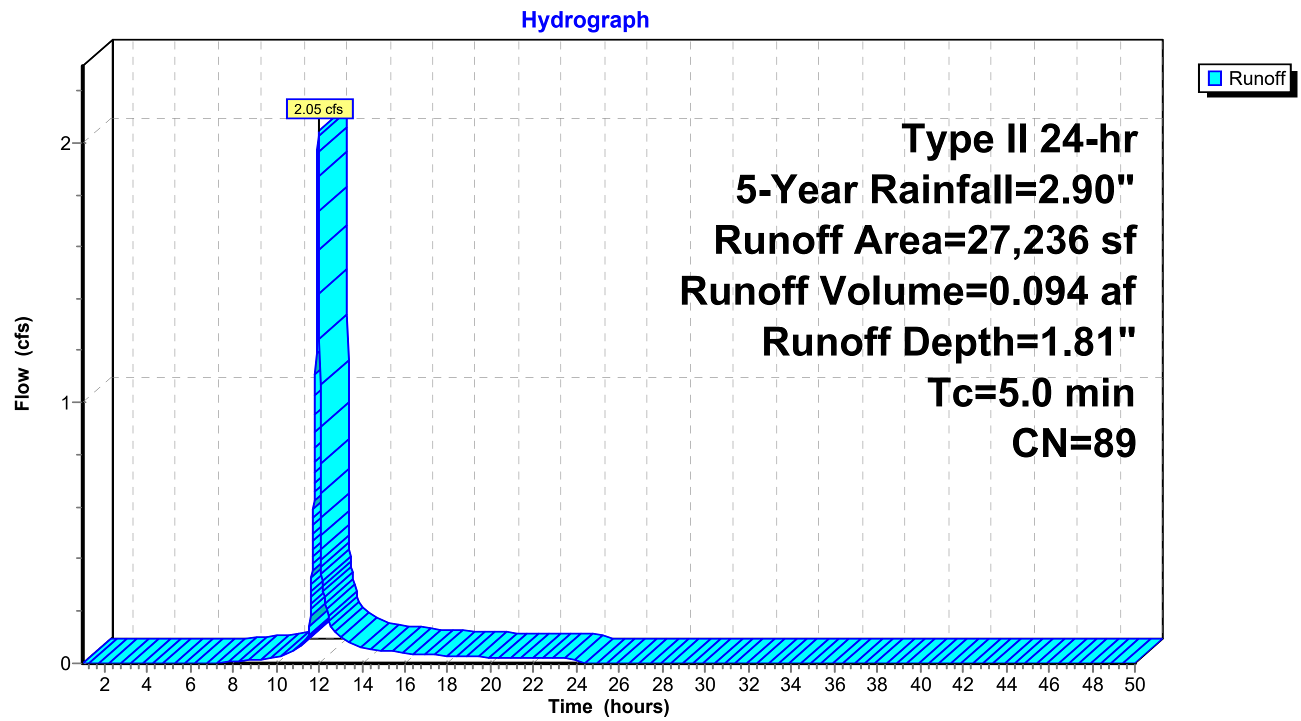
Runoff = 2.05 cfs @ 11.96 hrs, Volume= 0.094 af, Depth= 1.81"
Routed to Pond S : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7: 7



Summary for Subcatchment 7NO: 7

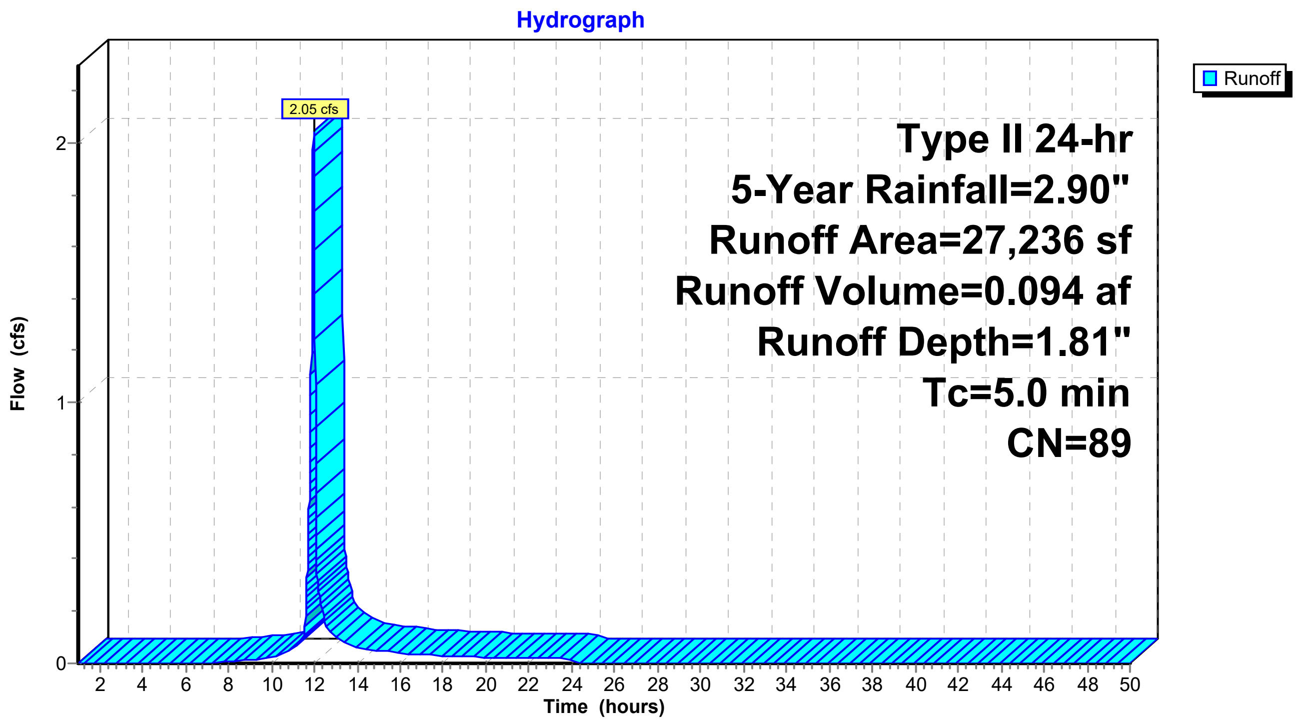
Runoff = 2.05 cfs @ 11.96 hrs, Volume= 0.094 af, Depth= 1.81"
Routed to Pond SNO : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7NO: 7



Summary for Subcatchment 8: 8

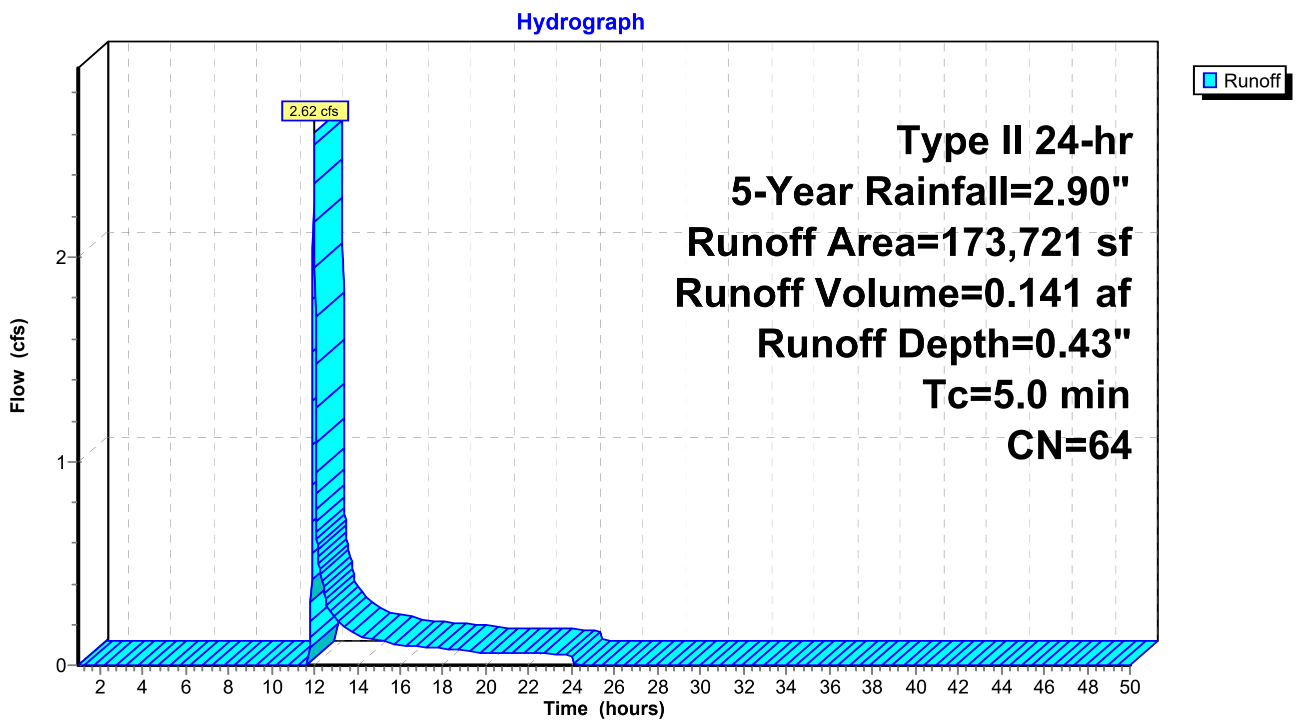
Runoff = 2.62 cfs @ 11.98 hrs, Volume= 0.141 af, Depth= 0.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	173,721	64	
	173,721		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 8: 8



Summary for Subcatchment 9: 9

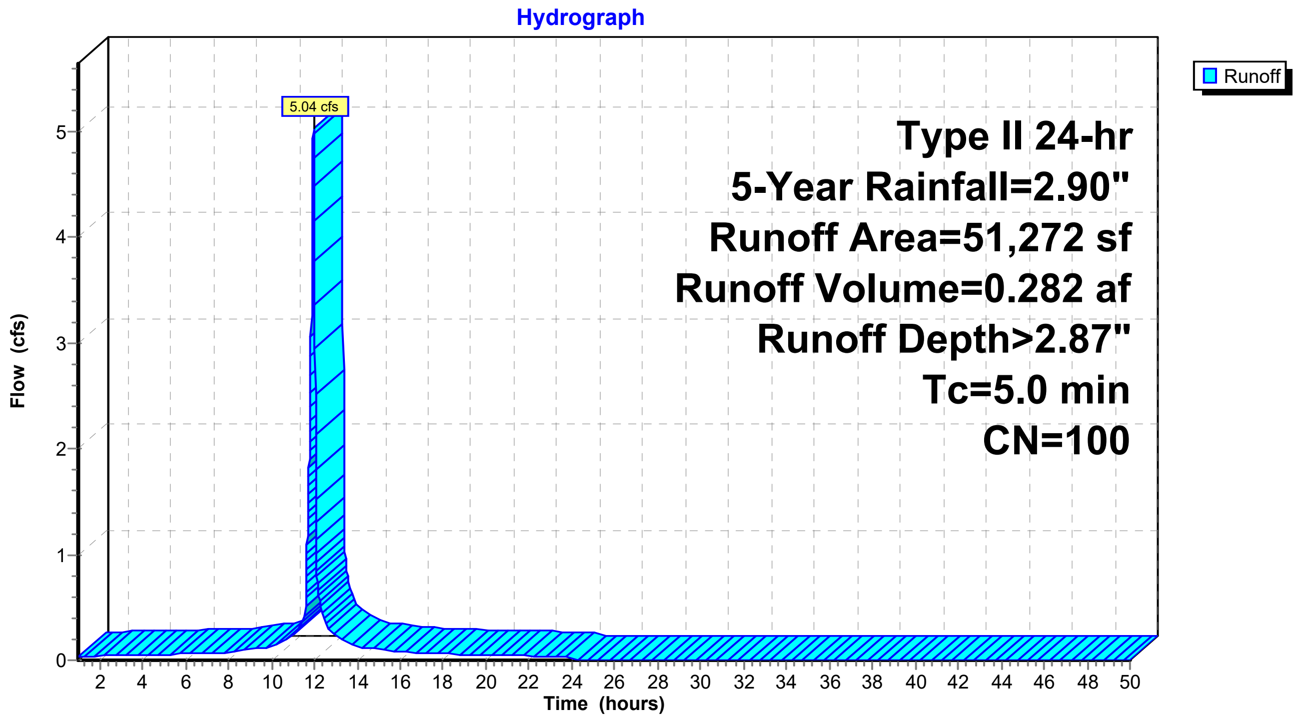
Runoff = 5.04 cfs @ 11.96 hrs, Volume= 0.282 af, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	51,272	100	
	51,272		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9: 9



Summary for Subcatchment 9C-E: 9C-E

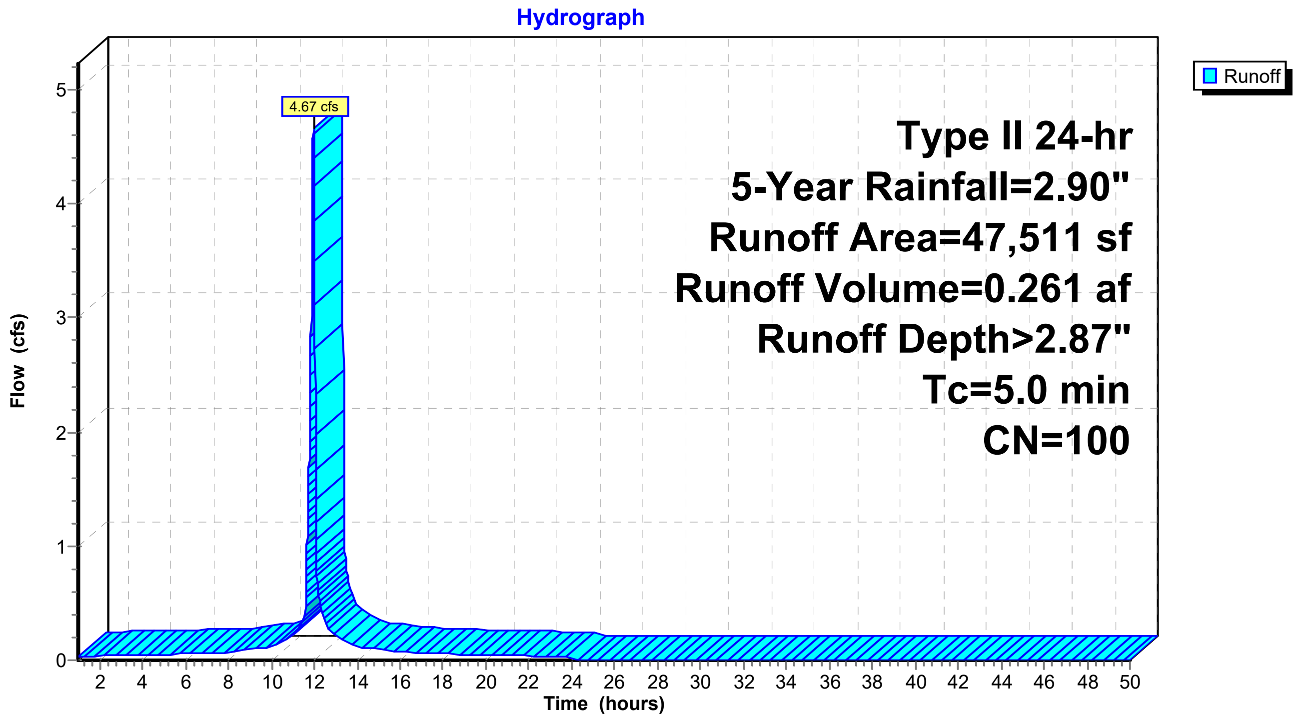
Runoff = 4.67 cfs @ 11.96 hrs, Volume= 0.261 af, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	47,511	100	
	47,511		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9C-E: 9C-E



Summary for Subcatchment 14NO: 1-4

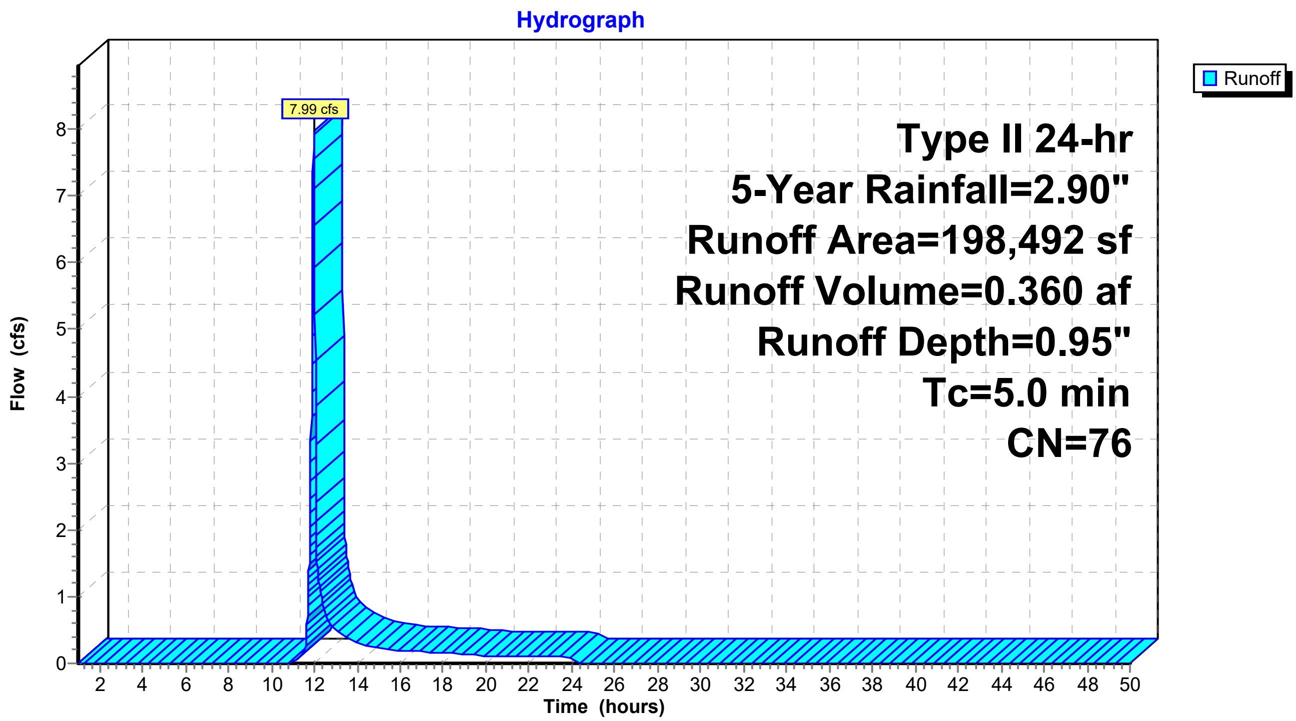
Runoff = 7.99 cfs @ 11.97 hrs, Volume= 0.360 af, Depth= 0.95"
Routed to Pond WNO : WEST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 14NO: 1-4



Summary for Subcatchment 56NO: 5-6

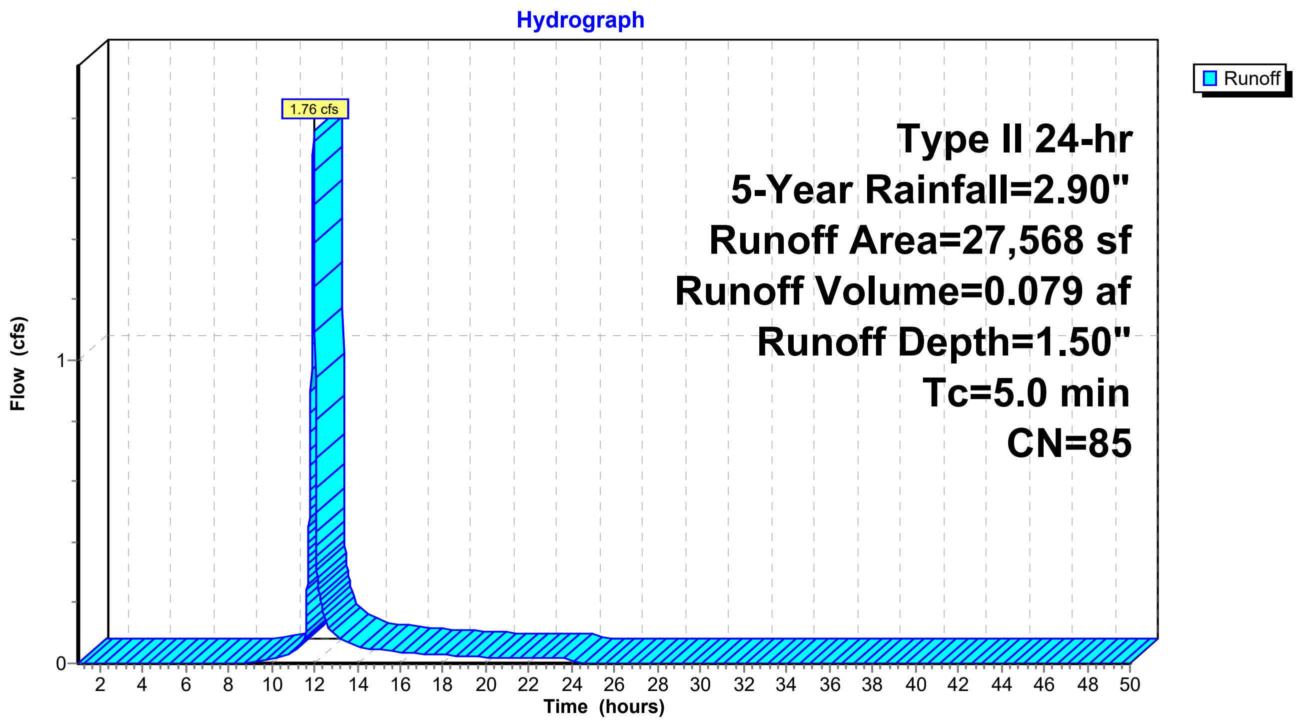
Runoff = 1.76 cfs @ 11.96 hrs, Volume= 0.079 af, Depth= 1.50"
Routed to Pond ENO : EAST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 56NO: 5-6



Summary for Subcatchment EX1-3: EX 1-3

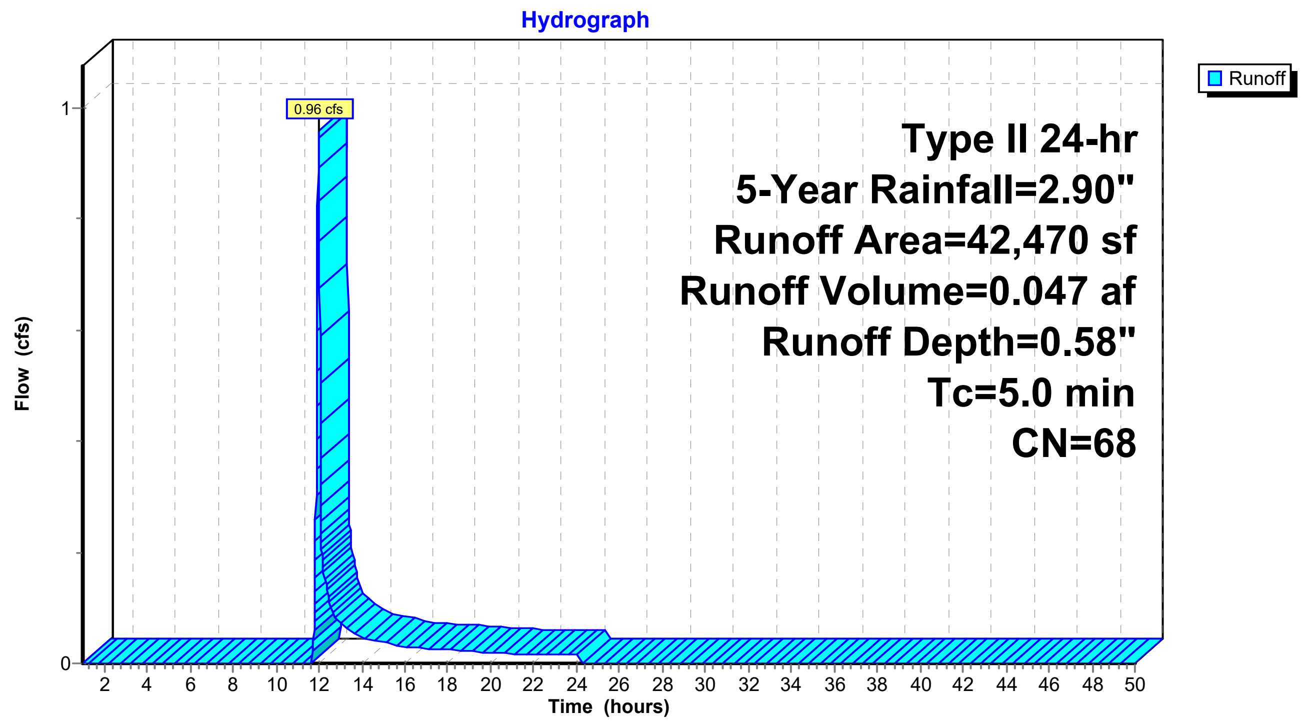
Runoff = 0.96 cfs @ 11.98 hrs, Volume= 0.047 af, Depth= 0.58"
Routed to Pond EXVS : EX VEG SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	42,470	68	
	42,470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX1-3: EX 1-3



Summary for Subcatchment EX8: EX 8

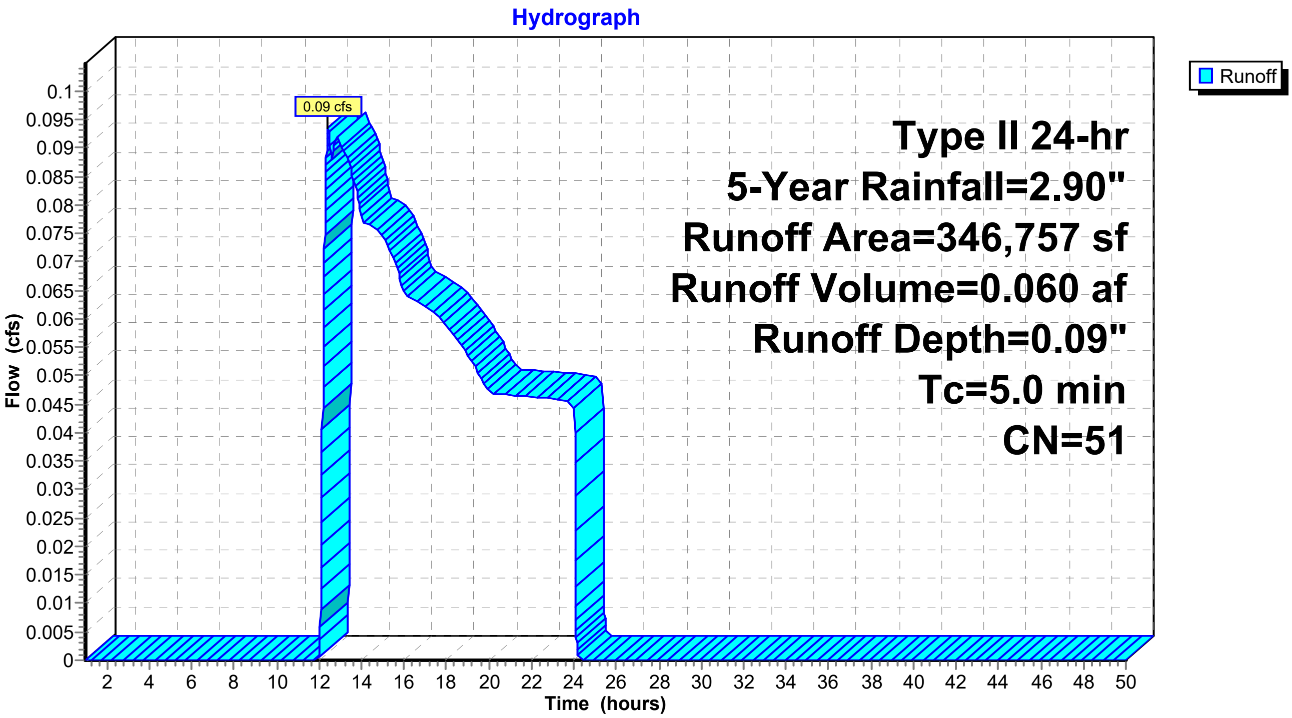
Runoff = 0.09 cfs @ 12.45 hrs, Volume= 0.060 af, Depth= 0.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	346,757	51	
	346,757		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX8: EX 8



Summary for Subcatchment EX9: EX 9

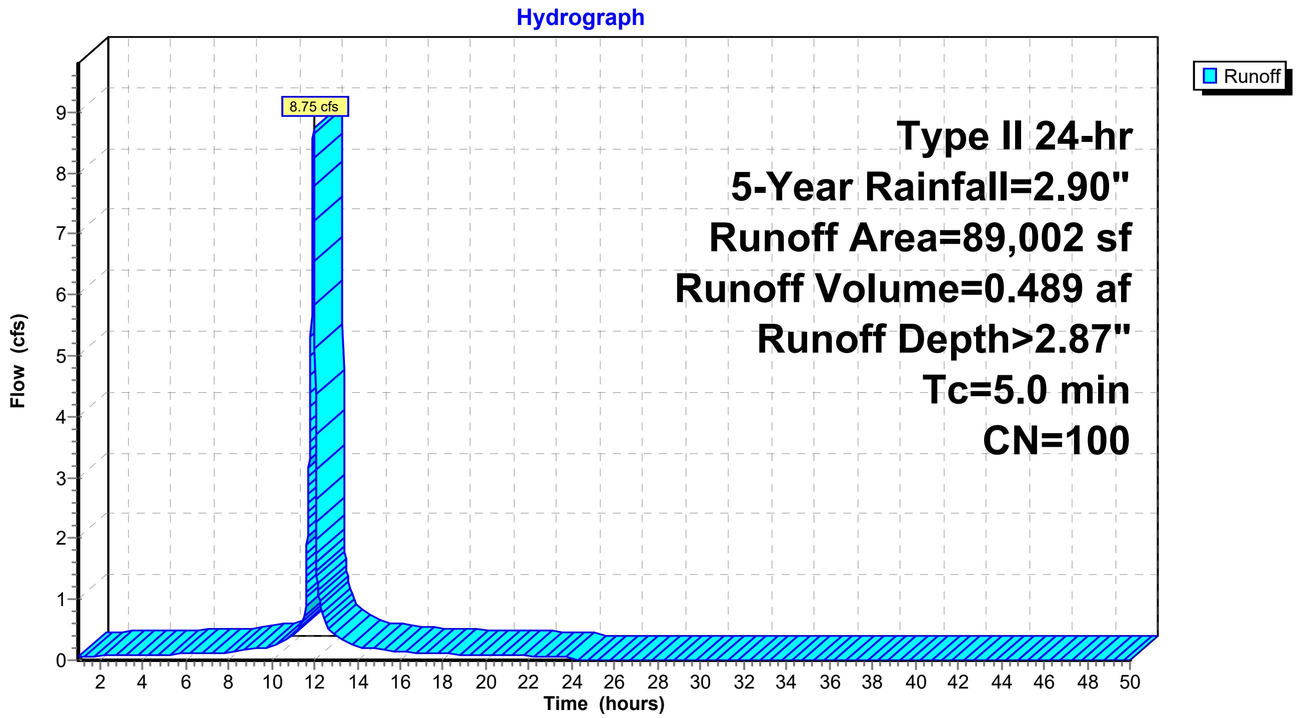
Runoff = 8.75 cfs @ 11.96 hrs, Volume= 0.489 af, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-Year Rainfall=2.90"

	Area (sf)	CN	Description
*	89,002	100	
	89,002		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX9: EX 9



Summary for Pond EBMP: EAST BMP

Inflow Area = 1.258 ac, 0.00% Impervious, Inflow Depth = 1.51" for 5-Year event
Inflow = 2.45 cfs @ 11.96 hrs, Volume= 0.158 af
Outflow = 0.60 cfs @ 12.21 hrs, Volume= 0.158 af, Atten= 75%, Lag= 14.8 min
Discarded = 0.30 cfs @ 12.21 hrs, Volume= 0.136 af
Primary = 0.30 cfs @ 12.21 hrs, Volume= 0.022 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.05' @ 12.21 hrs Surf.Area= 2,324 sf Storage= 1,927 cf

Plug-Flow detention time= 48.7 min calculated for 0.158 af (100% of inflow)
Center-of-Mass det. time= 48.7 min (876.6 - 828.0)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

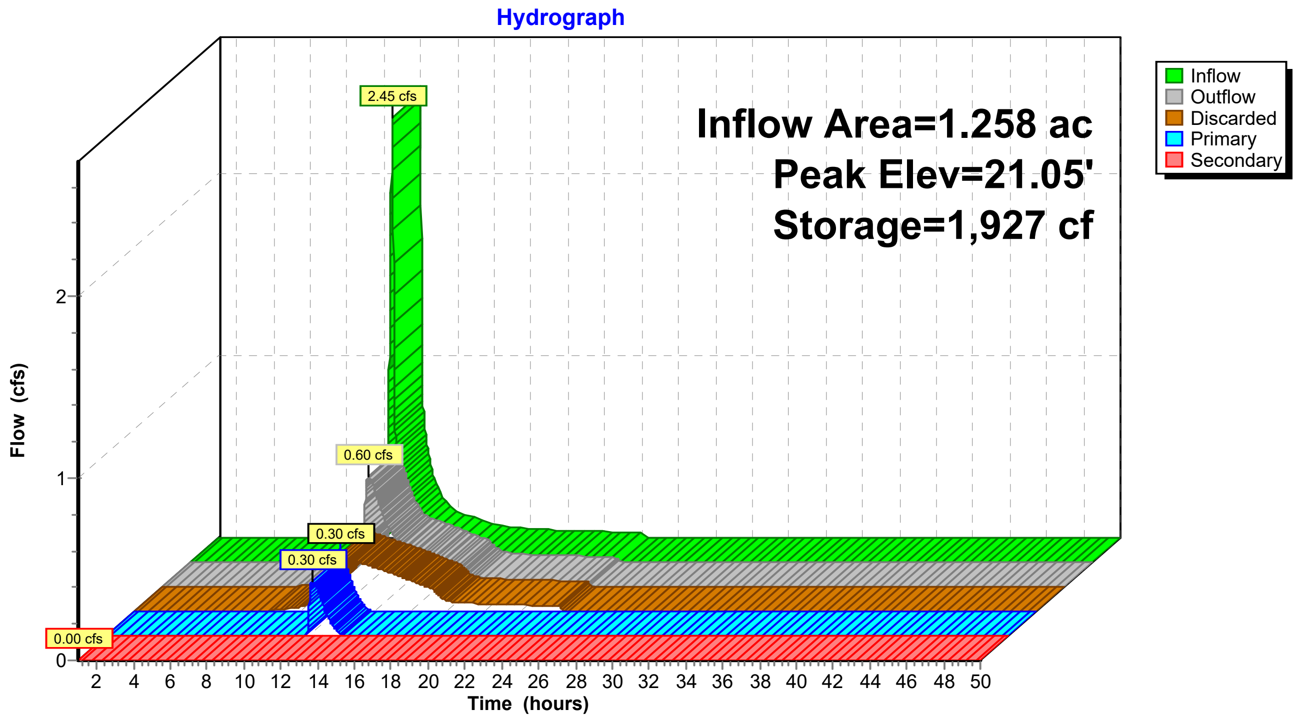
Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	19.81'	**6.0" Round Culvert** L= 92.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 19.81' / 19.35' S= 0.0050 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#3	Device 2	20.70'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.30 cfs @ 12.21 hrs HW=21.05' (Free Discharge)
└─**4=Exfiltration** (Controls 0.30 cfs)

Primary OutFlow Max=0.30 cfs @ 12.21 hrs HW=21.05' (Free Discharge)
└─**2=Culvert** (Passes 0.30 cfs of 0.64 cfs potential flow)
  └─**3=Orifice/Grate** (Orifice Controls 0.30 cfs @ 2.02 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond EBMP: EAST BMP



Summary for Pond ENO: EAST NO OUTLET

Inflow Area = 1.258 ac, 0.00% Impervious, Inflow Depth = 1.47" for 5-Year event
Inflow = 2.45 cfs @ 11.96 hrs, Volume= 0.154 af
Outflow = 0.32 cfs @ 12.40 hrs, Volume= 0.154 af, Atten= 87%, Lag= 26.3 min
Discarded = 0.32 cfs @ 12.40 hrs, Volume= 0.154 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.14' @ 12.40 hrs Surf.Area= 2,395 sf Storage= 2,126 cf

Plug-Flow detention time= 66.6 min calculated for 0.154 af (100% of inflow)
Center-of-Mass det. time= 66.6 min (901.3 - 834.7)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

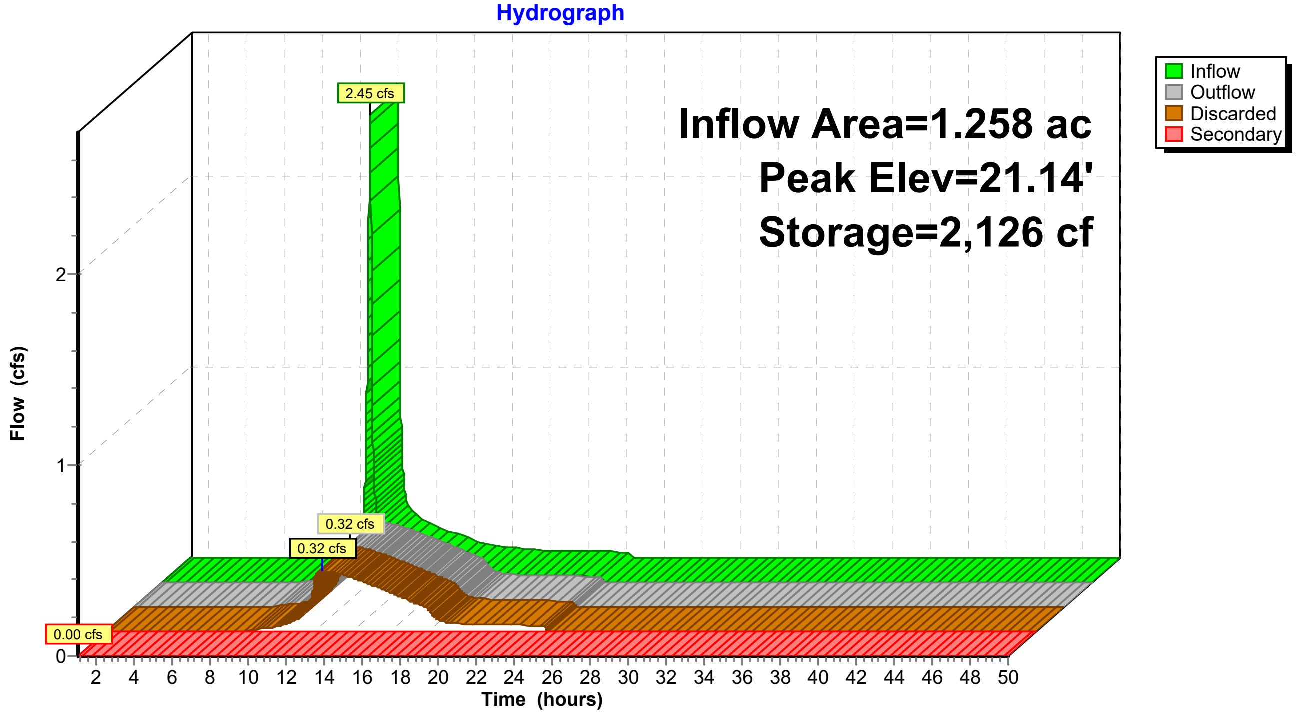
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.32 cfs @ 12.40 hrs HW=21.14' (Free Discharge)
└─**2=Exfiltration** (Controls 0.32 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond ENO: EAST NO OUTLET



Summary for Pond EXVS: EX VEG SWALE

Inflow Area =	0.975 ac,	0.00% Impervious,	Inflow Depth = 0.58"	for 5-Year event	
Inflow =	0.96 cfs @	11.98 hrs,	Volume=	0.047 af	
Outflow =	0.19 cfs @	12.15 hrs,	Volume=	0.047 af,	Atten= 81%, Lag= 10.8 min
Discarded =	0.19 cfs @	12.15 hrs,	Volume=	0.047 af	
Primary =	0.00 cfs @	1.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 18.86' @ 12.15 hrs Surf.Area= 1,470 sf Storage= 483 cf

Plug-Flow detention time= 22.7 min calculated for 0.047 af (100% of inflow)
Center-of-Mass det. time= 22.7 min (911.0 - 888.4)

Volume	Invert	Avail.Storage	Storage Description
#1	18.20'	36,604 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

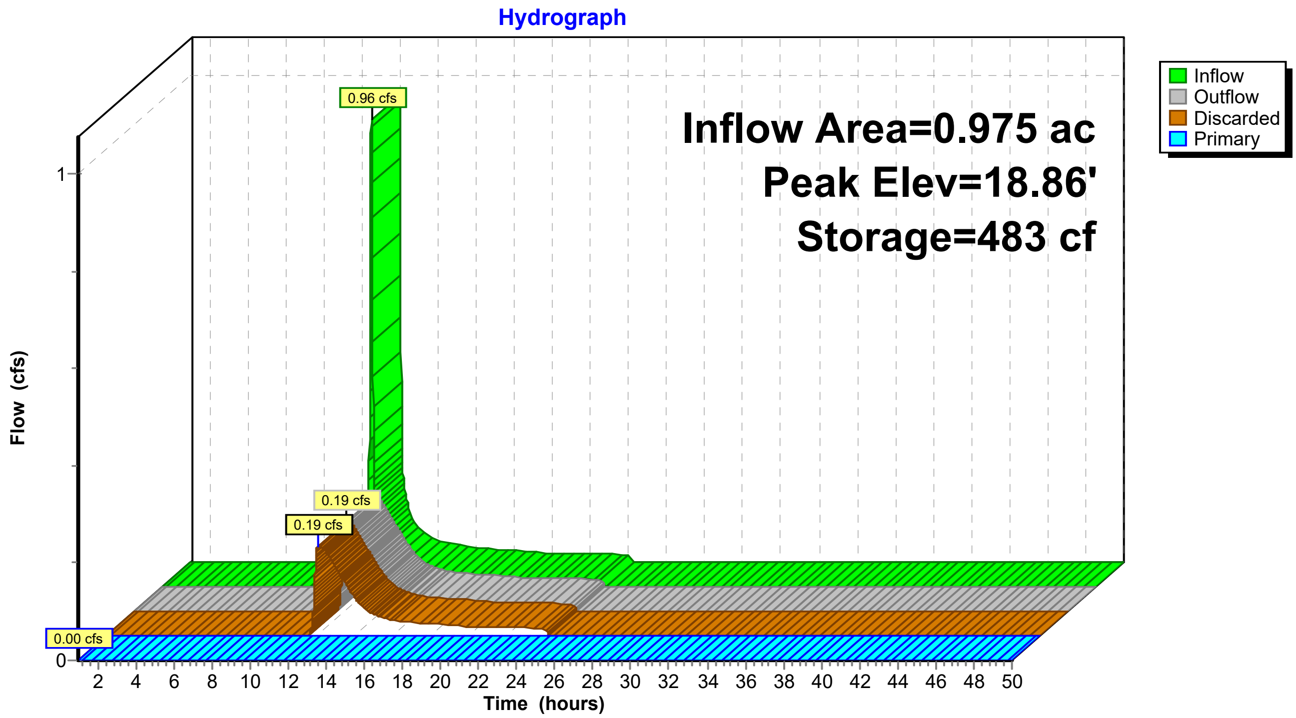
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.20	0	0	0
19.00	1,791	716	716
20.00	3,474	2,633	3,349
21.00	5,191	4,333	7,681
22.00	6,970	6,081	13,762
23.00	12,905	9,938	23,699
24.00	12,905	12,905	36,604

Device	Routing	Invert	Outlet Devices
#1	Primary	16.13'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.13' / 16.00' S= 0.0052 '/' Cc= 0.900 n= 0.130, Flow Area= 0.35 sf
#2	Device 1	19.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.00' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.19 cfs @ 12.15 hrs HW=18.86' (Free Discharge)
└─**3=Exfiltration** (Controls 0.19 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.20' (Free Discharge)
└─**1=Culvert** (Passes 0.00 cfs of 0.30 cfs potential flow)
  └─**2=Orifice/Grate** (Controls 0.00 cfs)

Pond EXVS: EX VEG SWALE



Summary for Pond S: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 1.81" for 5-Year event
Inflow = 2.05 cfs @ 11.96 hrs, Volume= 0.094 af
Outflow = 0.74 cfs @ 11.97 hrs, Volume= 0.094 af, Atten= 64%, Lag= 0.3 min
Discarded = 0.06 cfs @ 12.08 hrs, Volume= 0.016 af
Primary = 0.69 cfs @ 11.96 hrs, Volume= 0.079 af
Routed to Pond EBMP : EAST BMP
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.16' @ 12.08 hrs Surf.Area= 2,631 sf Storage= 996 cf

Plug-Flow detention time= 23.8 min calculated for 0.094 af (100% of inflow)
Center-of-Mass det. time= 23.8 min (834.8 - 811.1)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

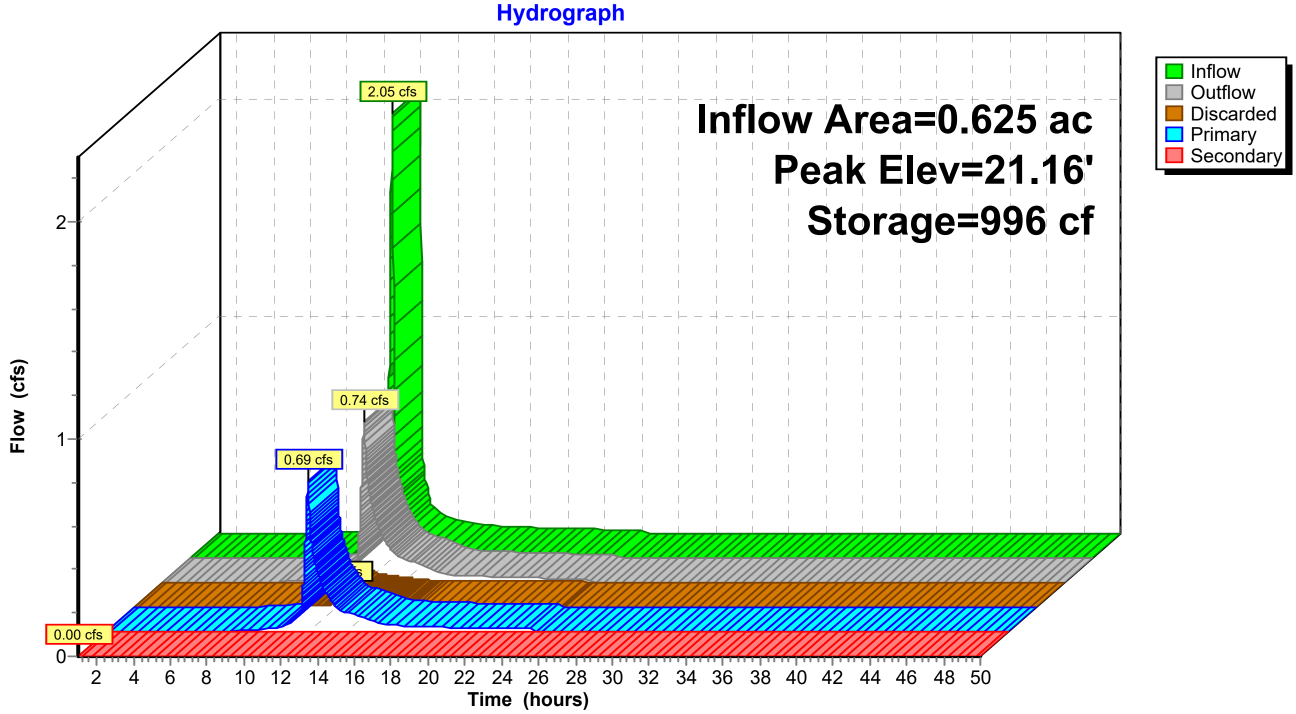
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.06 cfs @ 12.08 hrs HW=21.16' (Free Discharge)
└─**3=Exfiltration** (Controls 0.06 cfs)

Primary OutFlow Max=0.64 cfs @ 11.96 hrs HW=21.02' TW=20.76' (Dynamic Tailwater)
└─**2=Culvert** (Outlet Controls 0.64 cfs @ 2.01 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond S: SWALE


Hydrograph
Inflow Area=0.625 ac
Peak Elev=21.16'
Storage=996 cf
2.05 cfs
0.74 cfs
0.69 cfs
0.00 cfs
Inflow
Outflow
Discarded
Primary
Secondary
Flow (cfs)
Time (hours)
0
1
2
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

Summary for Pond SNO: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 1.81" for 5-Year event
Inflow = 2.05 cfs @ 11.96 hrs, Volume= 0.094 af
Outflow = 0.74 cfs @ 11.96 hrs, Volume= 0.094 af, Atten= 64%, Lag= 0.3 min
Discarded = 0.07 cfs @ 12.09 hrs, Volume= 0.020 af
Primary = 0.69 cfs @ 11.96 hrs, Volume= 0.075 af
Routed to Pond ENO : EAST NO OUTLET
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.16' @ 12.09 hrs Surf.Area= 2,644 sf Storage= 1,002 cf

Plug-Flow detention time= 35.7 min calculated for 0.094 af (100% of inflow)
Center-of-Mass det. time= 35.7 min (846.7 - 811.1)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

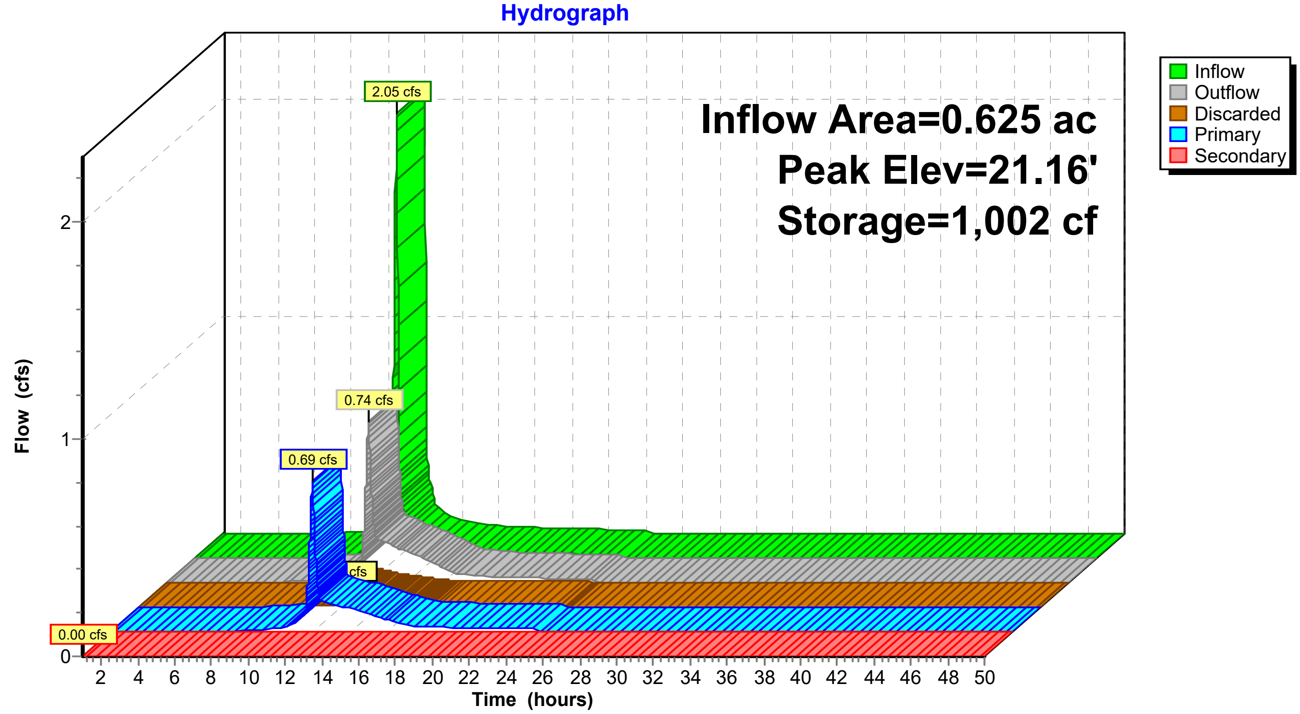
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.07 cfs @ 12.09 hrs HW=21.16' (Free Discharge)
└─**3=Exfiltration** (Controls 0.07 cfs)

Primary OutFlow Max=0.64 cfs @ 11.96 hrs HW=21.02' TW=20.76' (Dynamic Tailwater)
└─**2=Culvert** (Outlet Controls 0.64 cfs @ 2.01 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond SNO: SWALE



Summary for Pond WBMP: WEST BMP

Inflow Area = 4.557 ac, 0.00% Impervious, Inflow Depth = 0.95" for 5-Year event
Inflow = 7.99 cfs @ 11.97 hrs, Volume= 0.360 af
Outflow = 3.25 cfs @ 12.06 hrs, Volume= 0.358 af, Atten= 59%, Lag= 5.6 min
Discarded = 0.60 cfs @ 12.06 hrs, Volume= 0.047 af
Primary = 2.65 cfs @ 12.06 hrs, Volume= 0.312 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 19.22' @ 12.06 hrs Surf.Area= 5,254 sf Storage= 3,015 cf

Plug-Flow detention time= 11.1 min calculated for 0.358 af (99% of inflow)
Center-of-Mass det. time= 8.1 min (865.4 - 857.3)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	44,177 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,448	399	399
19.00	4,645	1,523	1,922
19.50	6,024	2,667	4,589
20.00	7,369	3,348	7,938
20.50	8,707	4,019	11,957
21.00	10,033	4,685	16,642
21.50	11,358	5,348	21,989
22.00	12,674	6,008	27,997
22.50	14,024	6,675	34,672
23.00	23,997	9,505	44,177

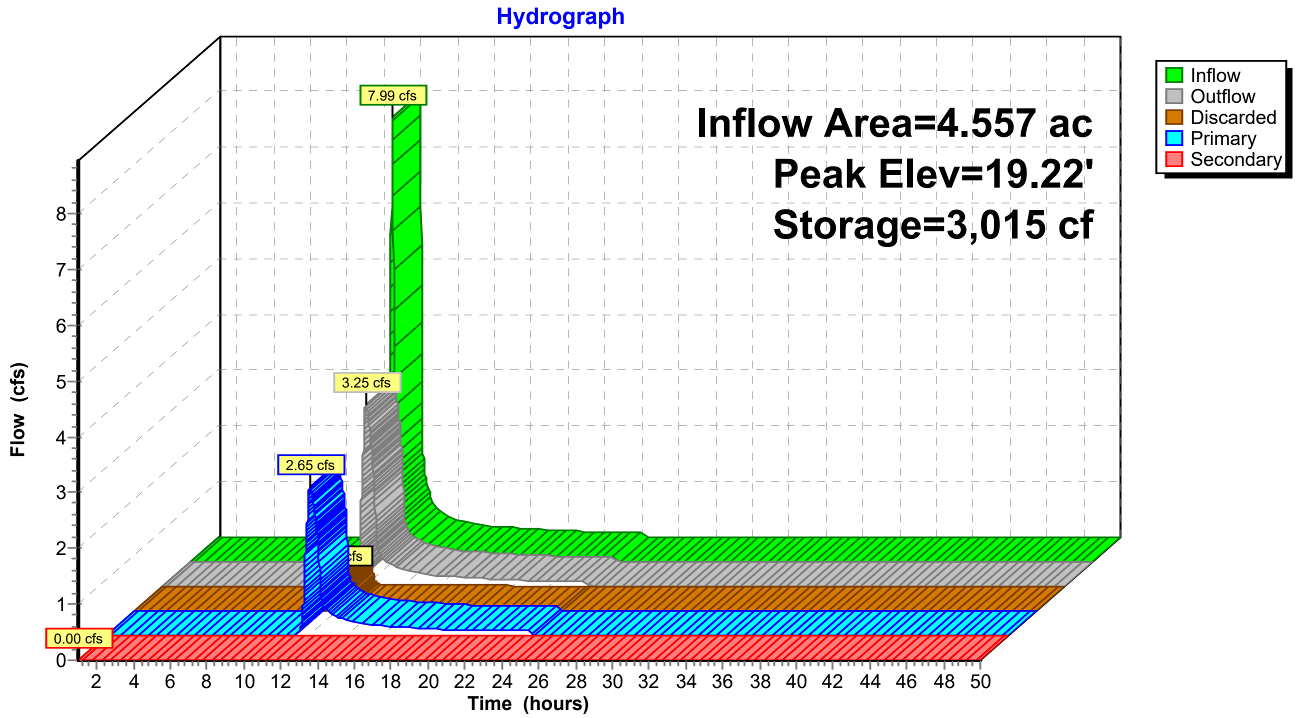
Device	Routing	Invert	Outlet Devices
#1	Primary	16.17'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.17' / 16.00' S= 0.0068 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#2	Device 1	18.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 667 sf
#4	Secondary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.60 cfs @ 12.06 hrs HW=19.22' (Free Discharge)
└─**3=Exfiltration** (Controls 0.60 cfs)

Primary OutFlow Max=2.65 cfs @ 12.06 hrs HW=19.22' (Free Discharge)
└─**1=Culvert** (Barrel Controls 2.65 cfs @ 7.60 fps)
  └─**2=Orifice/Grate** (Passes 2.65 cfs of 2.65 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond WBMP: WEST BMP



Summary for Pond WNO: WEST NO OUTLET

Inflow Area = 4.557 ac, 0.00% Impervious, Inflow Depth = 0.95" for 5-Year event
Inflow = 7.99 cfs @ 11.97 hrs, Volume= 0.360 af
Outflow = 0.85 cfs @ 12.43 hrs, Volume= 0.359 af, Atten= 89%, Lag= 27.9 min
Discarded = 0.85 cfs @ 12.43 hrs, Volume= 0.359 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 19.72' @ 12.43 hrs Surf.Area= 6,617 sf Storage= 5,833 cf

Plug-Flow detention time= 79.5 min calculated for 0.358 af (100% of inflow)
Center-of-Mass det. time= 76.9 min (934.2 - 857.3)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	43,777 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

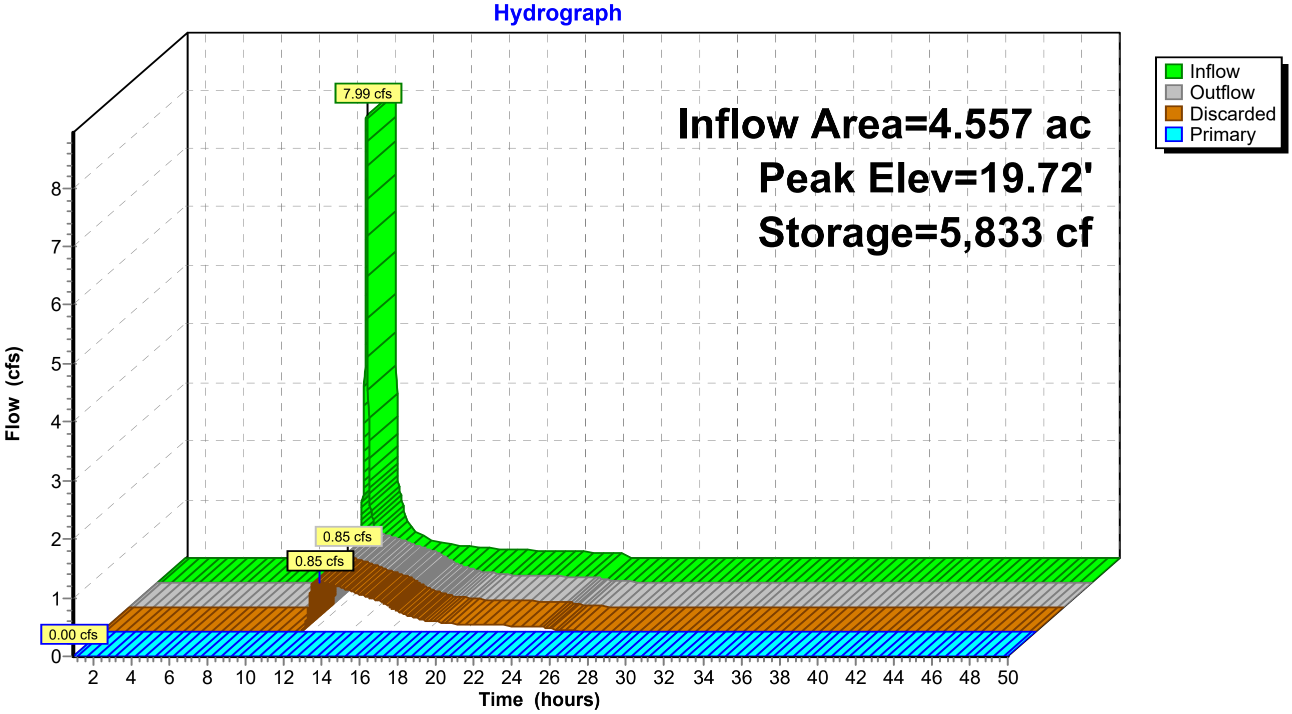
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,148	324	324
19.00	4,645	1,448	1,772
19.50	6,024	2,667	4,439
20.00	7,369	3,348	7,788
20.50	8,707	4,019	11,807
21.00	10,033	4,685	16,492
21.50	11,358	5,348	21,839
22.00	12,674	6,008	27,847
22.50	14,024	6,675	34,522
23.00	22,997	9,255	43,777

Device	Routing	Invert	Outlet Devices
#1	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 547 sf
#2	Primary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.85 cfs @ 12.43 hrs HW=19.72' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.85 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond WNO: WEST NO OUTLET



Time span=1.00-50.00 hrs, dt=0.01 hrs, 4901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1-4: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=1.29"
Tc=5.0 min CN=76 Runoff=10.97 cfs 0.491 af

Subcatchment5-6: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=1.93"
Tc=5.0 min CN=85 Runoff=2.24 cfs 0.102 af

Subcatchment7: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=2.26"
Tc=5.0 min CN=89 Runoff=2.54 cfs 0.118 af

Subcatchment7NO: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=2.26"
Tc=5.0 min CN=89 Runoff=2.54 cfs 0.118 af

Subcatchment8: 8 Runoff Area=173,721 sf 0.00% Impervious Runoff Depth=0.66"
Tc=5.0 min CN=64 Runoff=4.44 cfs 0.218 af

Subcatchment9: 9 Runoff Area=51,272 sf 100.00% Impervious Runoff Depth>3.37"
Tc=5.0 min CN=100 Runoff=5.91 cfs 0.330 af

Subcatchment9C-E: 9C-E Runoff Area=47,511 sf 100.00% Impervious Runoff Depth>3.37"
Tc=5.0 min CN=100 Runoff=5.48 cfs 0.306 af

Subcatchment14NO: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=1.29"
Tc=5.0 min CN=76 Runoff=10.97 cfs 0.491 af

Subcatchment56NO: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=1.93"
Tc=5.0 min CN=85 Runoff=2.24 cfs 0.102 af

SubcatchmentEX1-3: EX 1-3 Runoff Area=42,470 sf 0.00% Impervious Runoff Depth=0.84"
Tc=5.0 min CN=68 Runoff=1.47 cfs 0.069 af

SubcatchmentEX8: EX 8 Runoff Area=346,757 sf 0.00% Impervious Runoff Depth=0.20"
Tc=5.0 min CN=51 Runoff=0.87 cfs 0.131 af

SubcatchmentEX9: EX 9 Runoff Area=89,002 sf 100.00% Impervious Runoff Depth>3.37"
Tc=5.0 min CN=100 Runoff=10.26 cfs 0.573 af

Pond EBMP: EAST BMP Peak Elev=21.20' Storage=2,271 cf Inflow=2.87 cfs 0.200 af
Discarded=0.33 cfs 0.158 af Primary=0.47 cfs 0.042 af Secondary=0.00 cfs 0.000 af Outflow=0.80 cfs 0.200 af

Pond ENO: EAST NO OUTLET Peak Elev=21.32' Storage=2,565 cf Inflow=2.87 cfs 0.191 af
Discarded=0.34 cfs 0.191 af Secondary=0.00 cfs 0.000 af Outflow=0.34 cfs 0.191 af

Pond EXVS: EX VEG SWALE Peak Elev=19.07' Storage=838 cf Inflow=1.47 cfs 0.069 af
Discarded=0.25 cfs 0.069 af Primary=0.00 cfs 0.000 af Outflow=0.25 cfs 0.069 af

Pond S: SWALE Peak Elev=21.30' Storage=1,416 cf Inflow=2.54 cfs 0.118 af
Discarded=0.08 cfs 0.020 af Primary=0.67 cfs 0.098 af Secondary=0.00 cfs 0.000 af Outflow=0.72 cfs 0.118 af

Pond SNO: SWALE Peak Elev=21.33' Storage=1,513 cf Inflow=2.54 cfs 0.118 af
Discarded=0.09 cfs 0.029 af Primary=0.67 cfs 0.089 af Secondary=0.00 cfs 0.000 af Outflow=0.72 cfs 0.118 af

Pond WBMP: WEST BMP Peak Elev=19.54' Storage=4,852 cf Inflow=10.97 cfs 0.491 af
Discarded=0.75 cfs 0.068 af Primary=2.82 cfs 0.421 af Secondary=0.00 cfs 0.000 af Outflow=3.57 cfs 0.489 af

Pond WNO: WEST NO OUTLET Peak Elev=20.11' Storage=8,606 cf Inflow=10.97 cfs 0.491 af
Discarded=1.05 cfs 0.489 af Primary=0.00 cfs 0.000 af Outflow=1.05 cfs 0.489 af

Total Runoff Area = 28.864 ac Runoff Volume = 3.049 af Average Runoff Depth = 1.27"
85.06% Pervious = 24.553 ac 14.94% Impervious = 4.311 ac

Summary for Subcatchment 1-4: 1-4

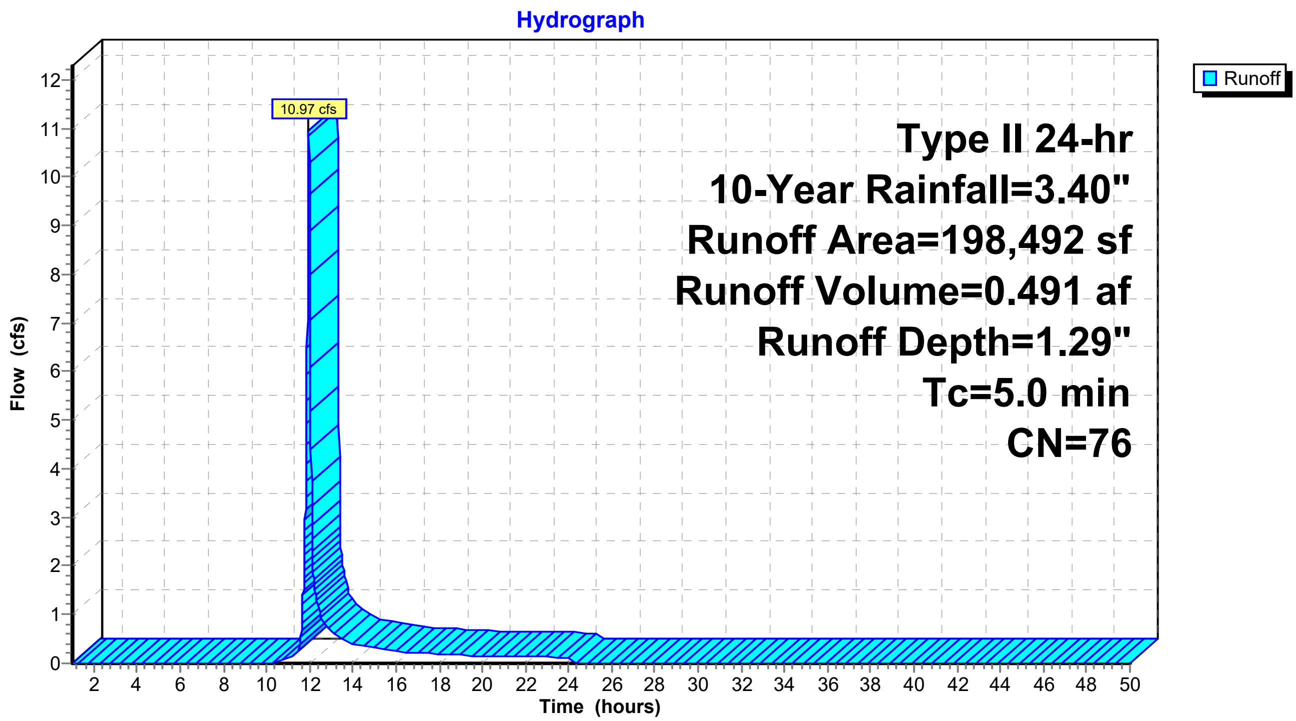
Runoff = 10.97 cfs @ 11.97 hrs, Volume= 0.491 af, Depth= 1.29"
Routed to Pond WBMP : WEST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1-4: 1-4



Summary for Subcatchment 5-6: 5-6

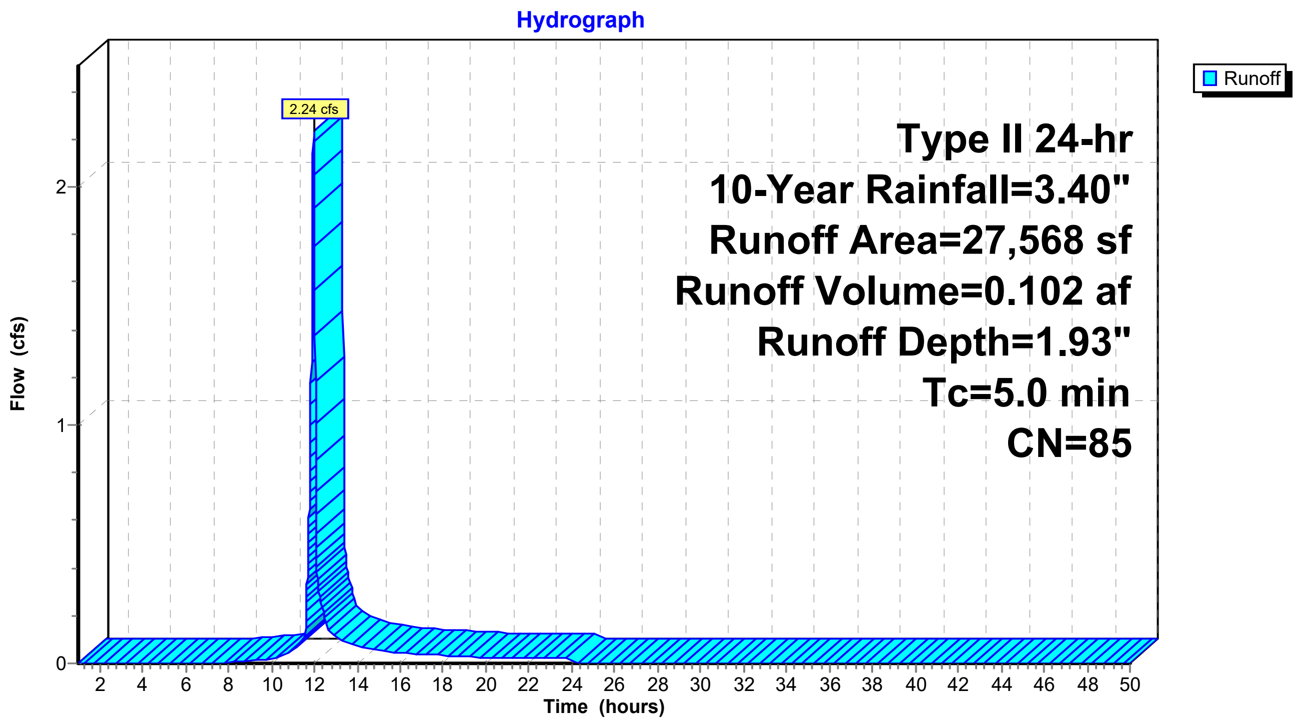
Runoff = 2.24 cfs @ 11.96 hrs, Volume= 0.102 af, Depth= 1.93"
Routed to Pond EBMP : EAST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5-6: 5-6



Summary for Subcatchment 7: 7

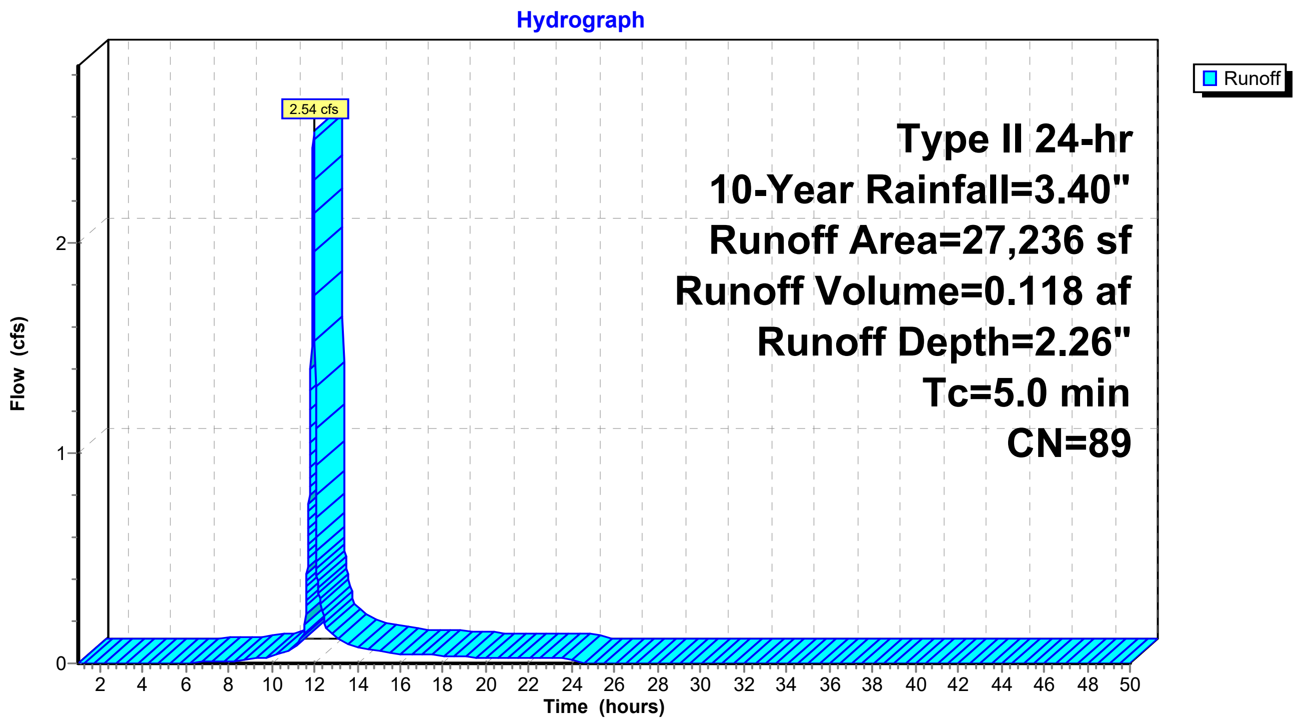
Runoff = 2.54 cfs @ 11.96 hrs, Volume= 0.118 af, Depth= 2.26"
Routed to Pond S : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7: 7



Summary for Subcatchment 7NO: 7

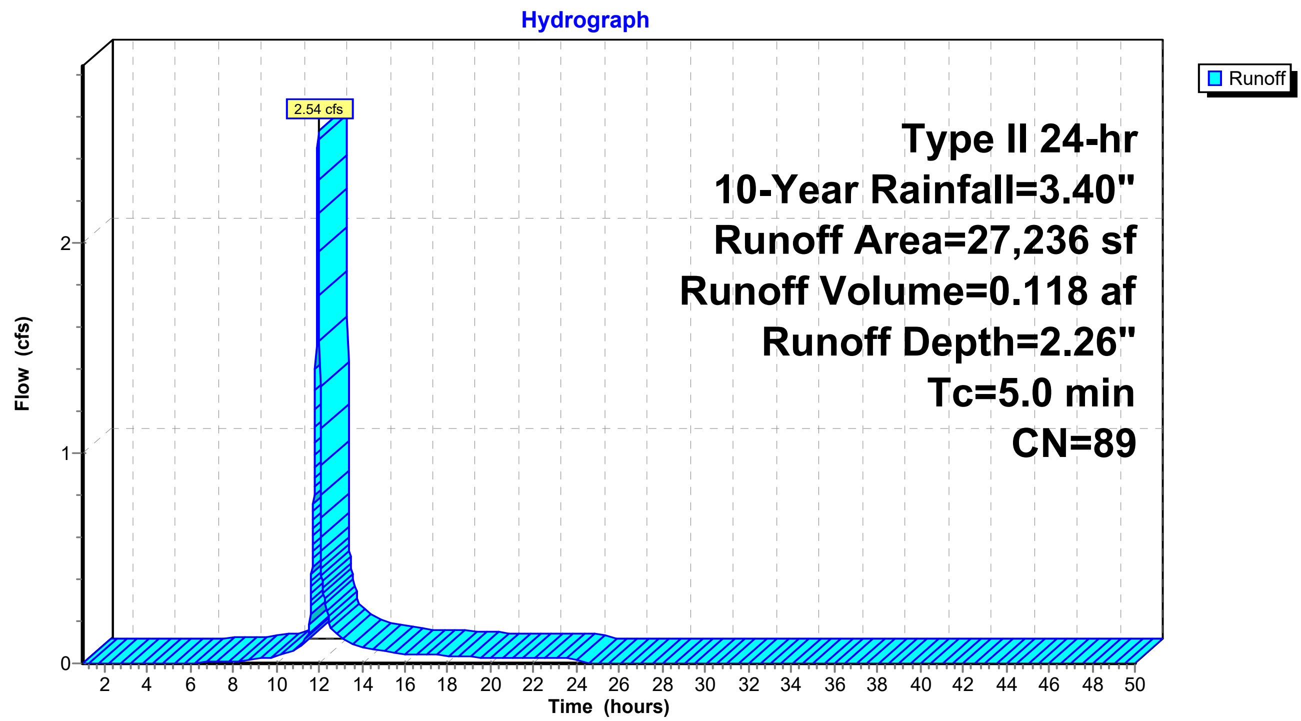
Runoff = 2.54 cfs @ 11.96 hrs, Volume= 0.118 af, Depth= 2.26"
Routed to Pond SNO : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7NO: 7



Summary for Subcatchment 8: 8

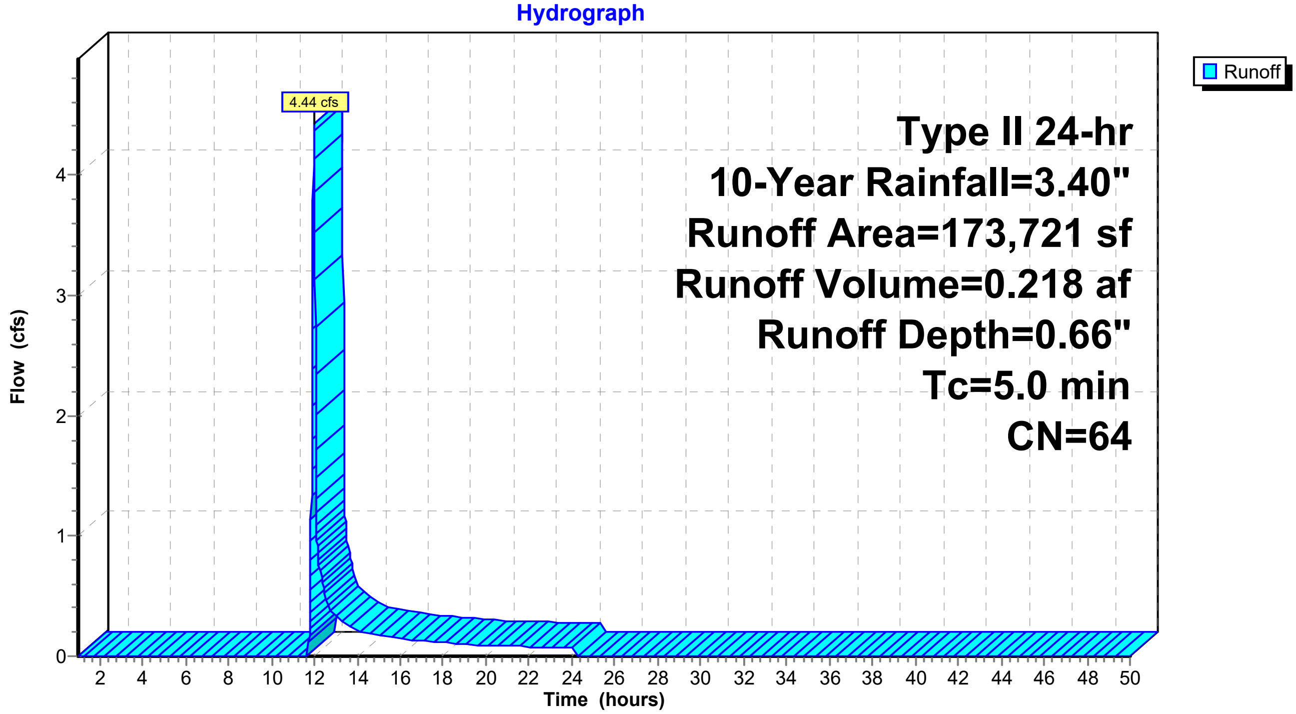
Runoff = 4.44 cfs @ 11.98 hrs, Volume= 0.218 af, Depth= 0.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	173,721	64	
	173,721		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 8: 8



Summary for Subcatchment 9: 9

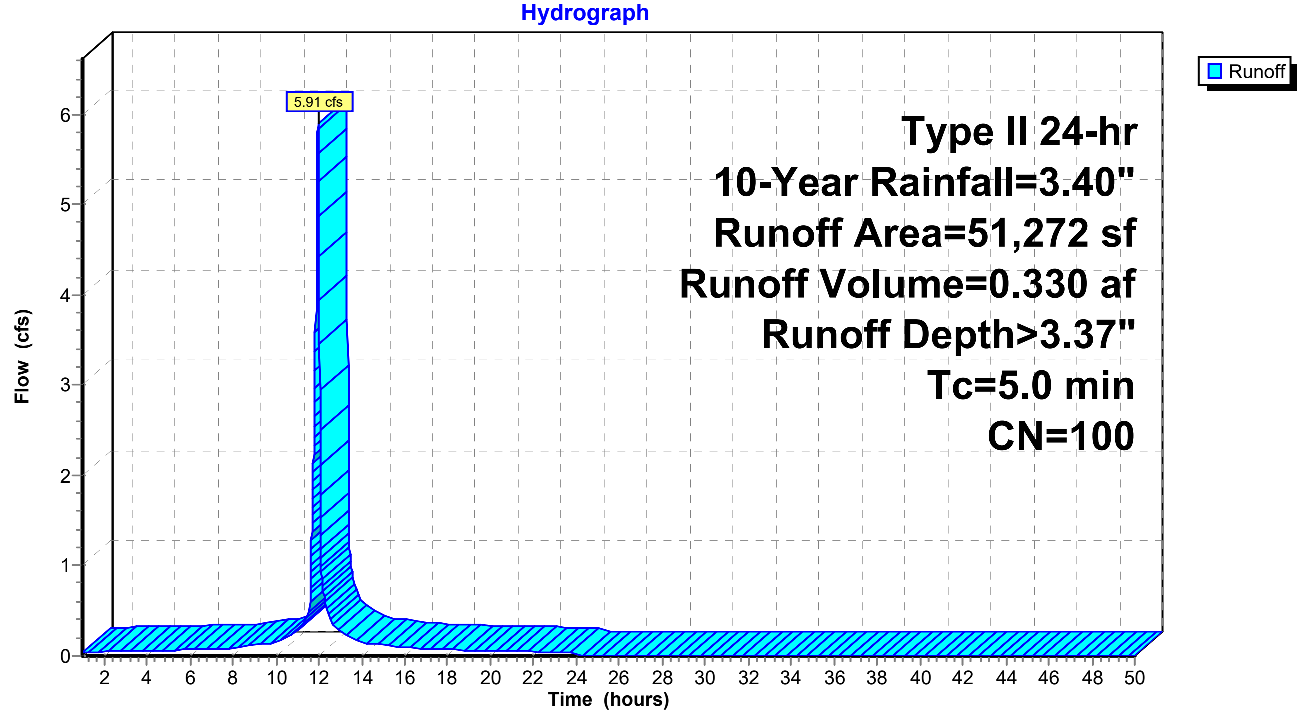
Runoff = 5.91 cfs @ 11.96 hrs, Volume= 0.330 af, Depth> 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	51,272	100	
	51,272		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9: 9



Summary for Subcatchment 9C-E: 9C-E

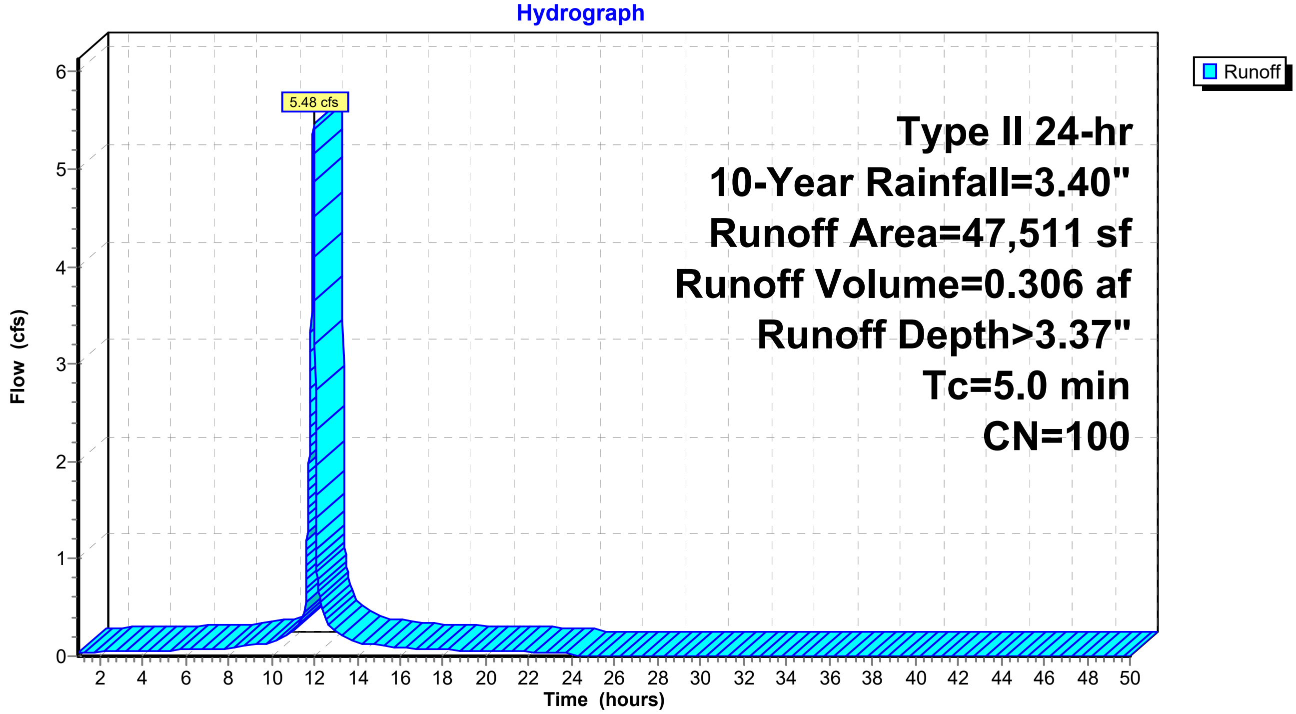
Runoff = 5.48 cfs @ 11.96 hrs, Volume= 0.306 af, Depth> 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	47,511	100	
	47,511		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9C-E: 9C-E



Summary for Subcatchment 14NO: 1-4

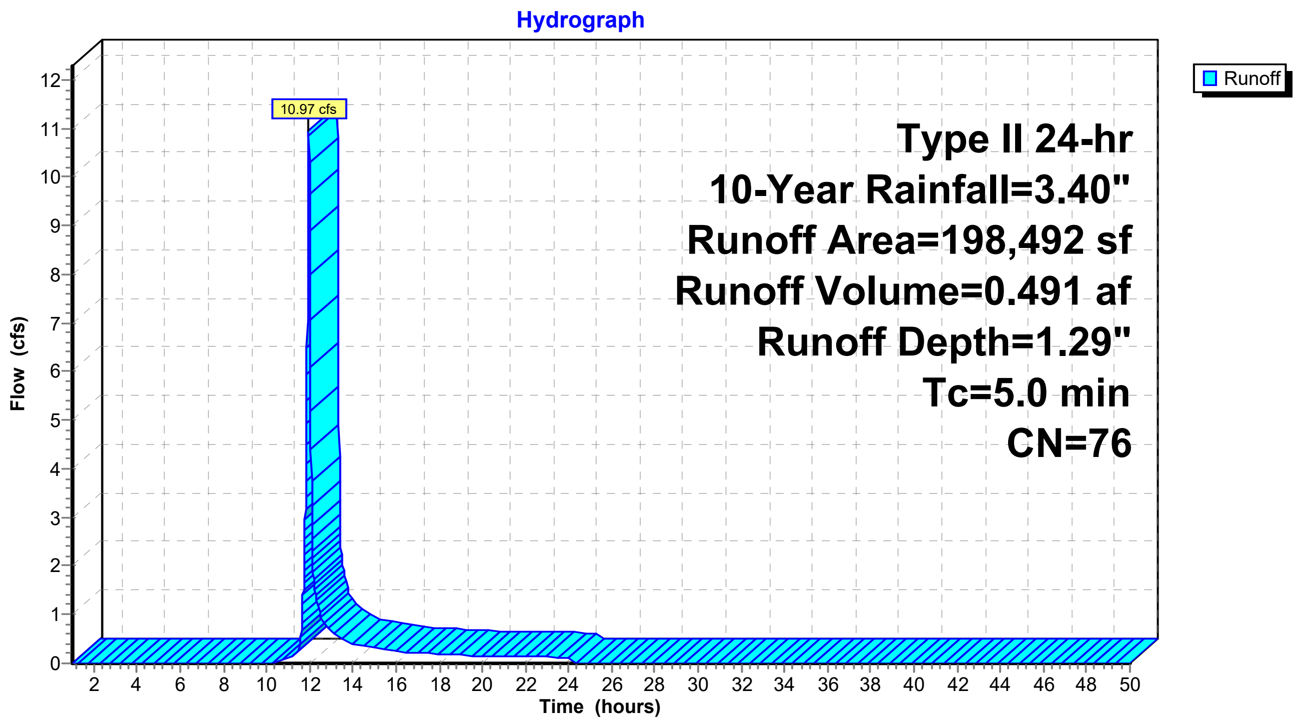
Runoff = 10.97 cfs @ 11.97 hrs, Volume= 0.491 af, Depth= 1.29"
Routed to Pond WNO : WEST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 14NO: 1-4



Summary for Subcatchment 56NO: 5-6

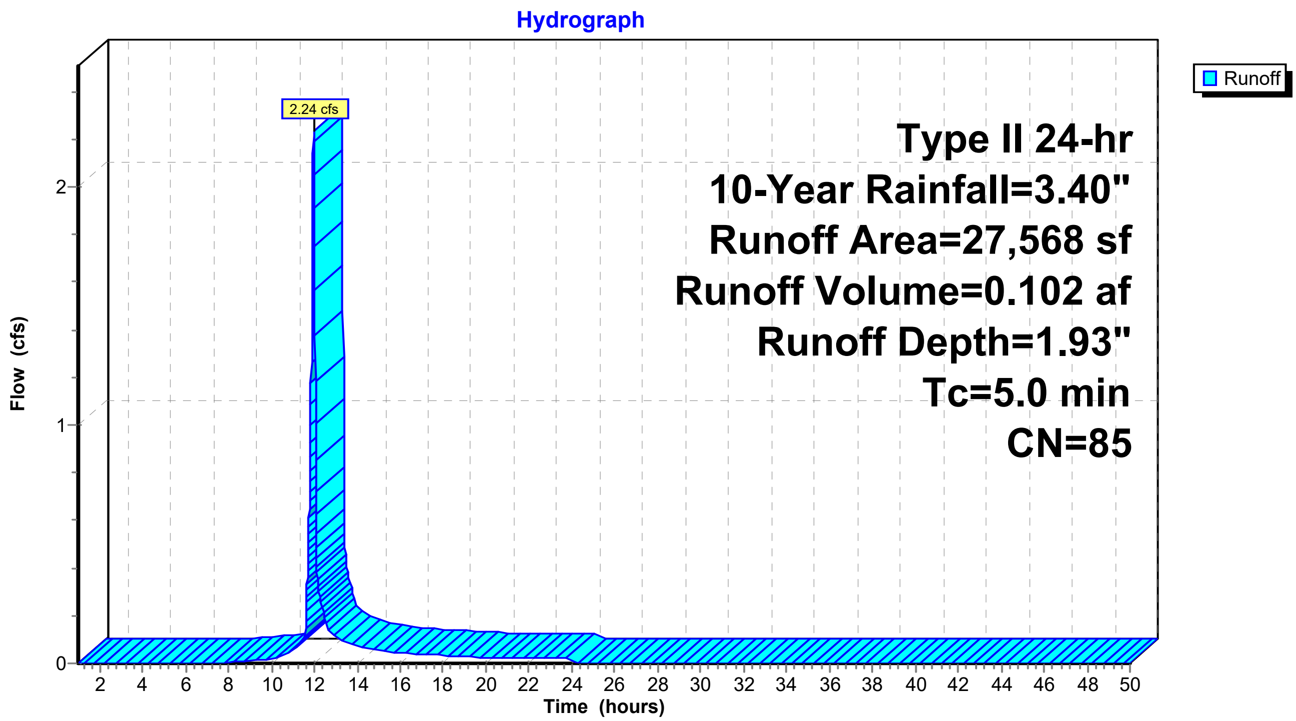
Runoff = 2.24 cfs @ 11.96 hrs, Volume= 0.102 af, Depth= 1.93"
Routed to Pond ENO : EAST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 56NO: 5-6



Summary for Subcatchment EX1-3: EX 1-3

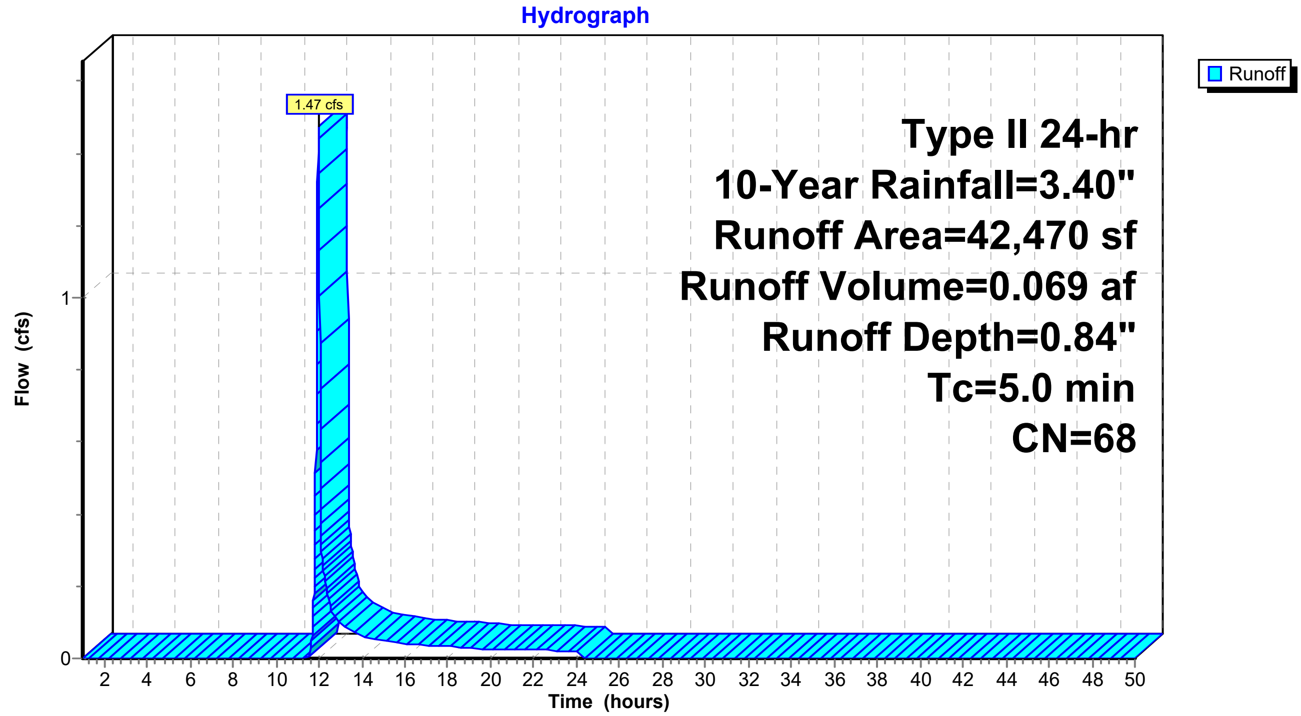
Runoff = 1.47 cfs @ 11.97 hrs, Volume= 0.069 af, Depth= 0.84"
Routed to Pond EXVS : EX VEG SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	42,470	68	
	42,470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX1-3: EX 1-3



Summary for Subcatchment EX8: EX 8

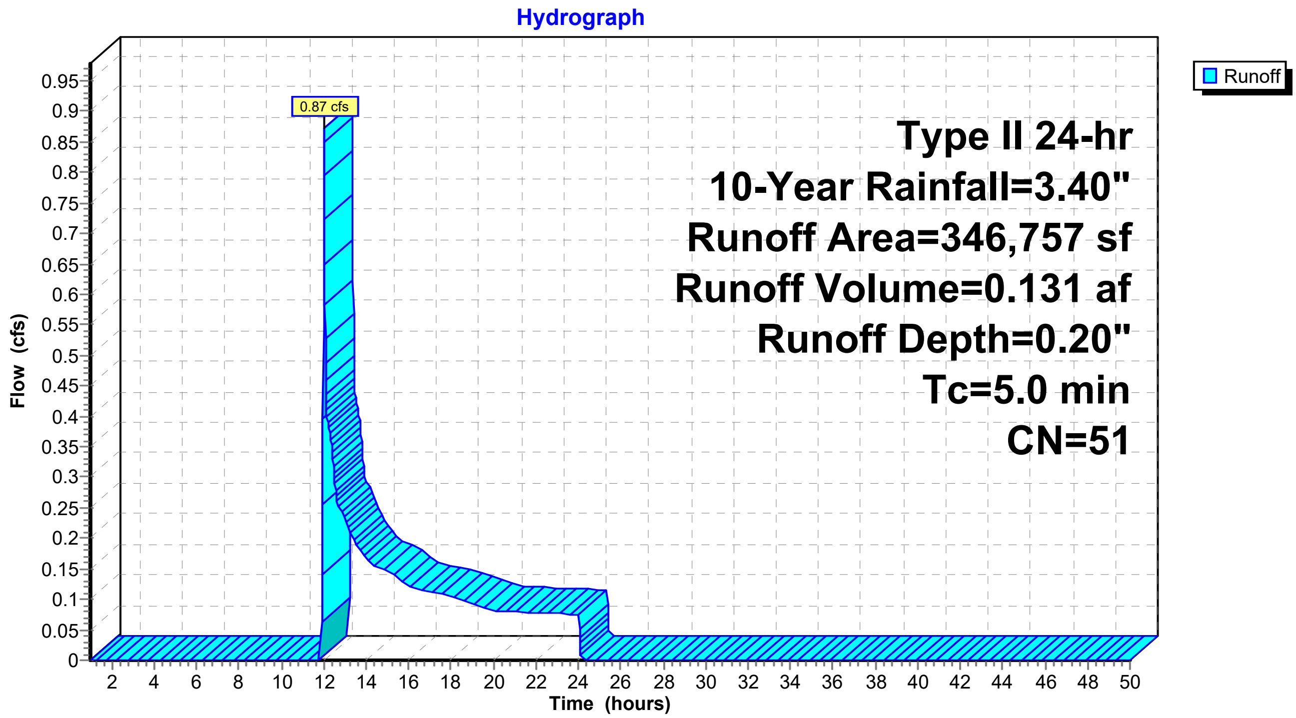
Runoff = 0.87 cfs @ 12.02 hrs, Volume= 0.131 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	346,757	51	
	346,757		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX8: EX 8



Summary for Subcatchment EX9: EX 9

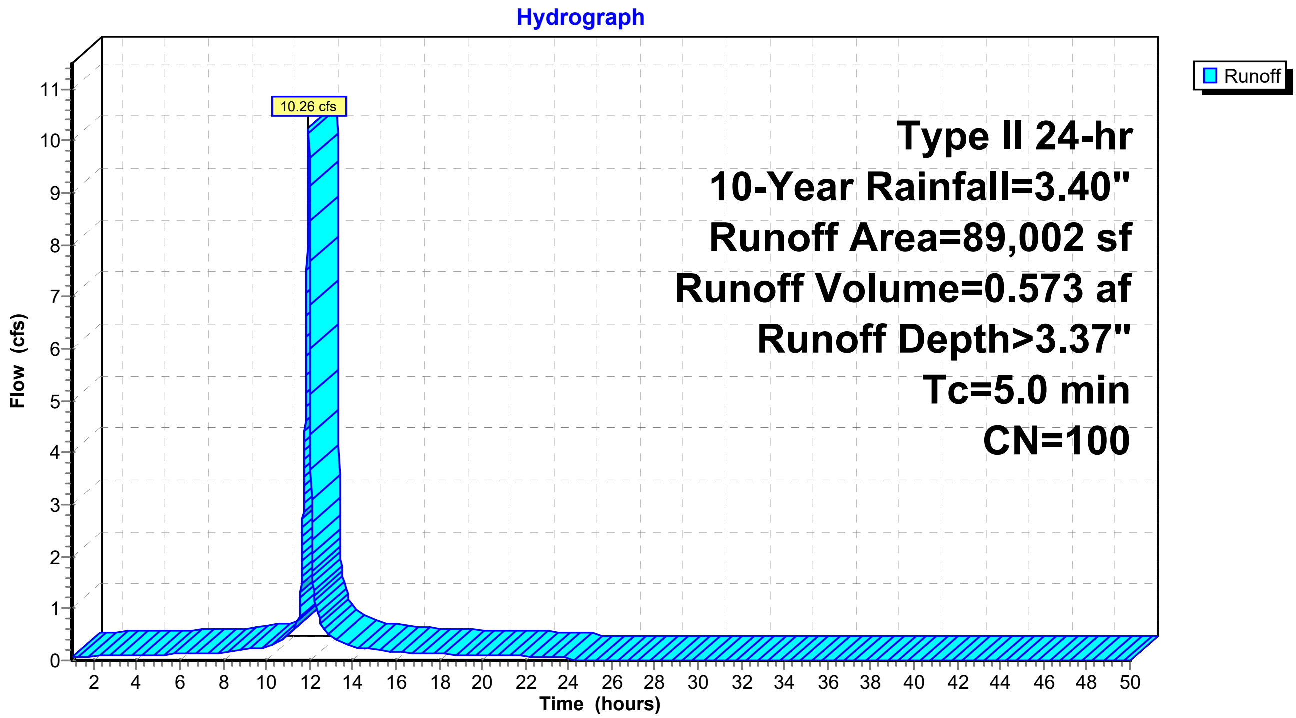
Runoff = 10.26 cfs @ 11.96 hrs, Volume= 0.573 af, Depth> 3.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-Year Rainfall=3.40"

	Area (sf)	CN	Description
*	89,002	100	
	89,002		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX9: EX 9



Summary for Pond EBMP: EAST BMP

Inflow Area = 1.258 ac, 0.00% Impervious, Inflow Depth = 1.91" for 10-Year event
Inflow = 2.87 cfs @ 11.95 hrs, Volume= 0.200 af
Outflow = 0.80 cfs @ 12.13 hrs, Volume= 0.200 af, Atten= 72%, Lag= 10.2 min
Discarded = 0.33 cfs @ 12.13 hrs, Volume= 0.158 af
Primary = 0.47 cfs @ 12.13 hrs, Volume= 0.042 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.20' @ 12.13 hrs Surf.Area= 2,445 sf Storage= 2,271 cf

Plug-Flow detention time= 47.5 min calculated for 0.200 af (100% of inflow)
Center-of-Mass det. time= 47.5 min (871.3 - 823.8)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

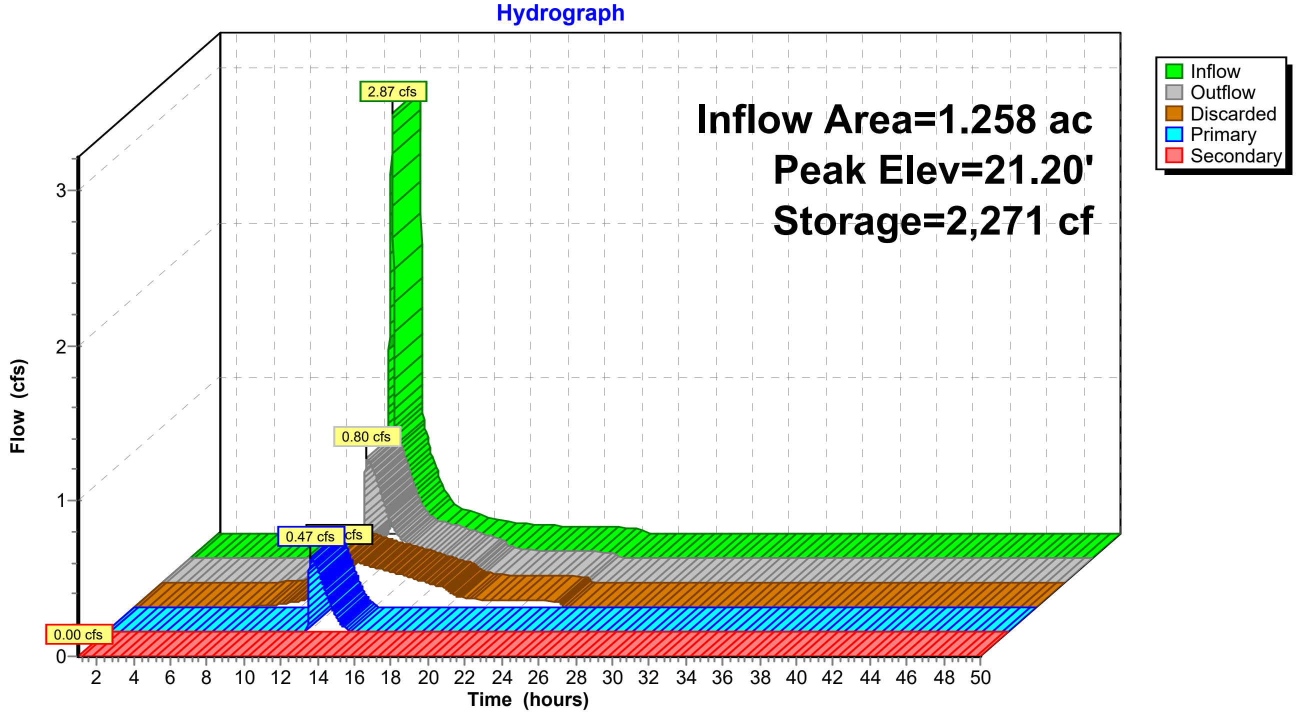
Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	19.81'	**6.0" Round Culvert** L= 92.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 19.81' / 19.35' S= 0.0050 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#3	Device 2	20.70'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.33 cfs @ 12.13 hrs HW=21.20' (Free Discharge)
└─**4=Exfiltration** (Controls 0.33 cfs)

Primary OutFlow Max=0.47 cfs @ 12.13 hrs HW=21.20' (Free Discharge)
└─**2=Culvert** (Passes 0.47 cfs of 0.67 cfs potential flow)
  └─**3=Orifice/Grate** (Orifice Controls 0.47 cfs @ 2.40 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond EBMP: EAST BMP



Summary for Pond ENO: EAST NO OUTLET

Inflow Area =	1.258 ac,	0.00% Impervious,	Inflow Depth = 1.82"	for 10-Year event
Inflow =	2.87 cfs @	11.95 hrs, Volume=	0.191 af	
Outflow =	0.34 cfs @	12.42 hrs, Volume=	0.191 af,	Atten= 88%, Lag= 27.9 min
Discarded =	0.34 cfs @	12.42 hrs, Volume=	0.191 af	
Secondary =	0.00 cfs @	1.00 hrs, Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.32' @ 12.42 hrs Surf.Area= 2,544 sf Storage= 2,565 cf

Plug-Flow detention time= 76.3 min calculated for 0.191 af (100% of inflow)
Center-of-Mass det. time= 76.2 min (912.1 - 835.9)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

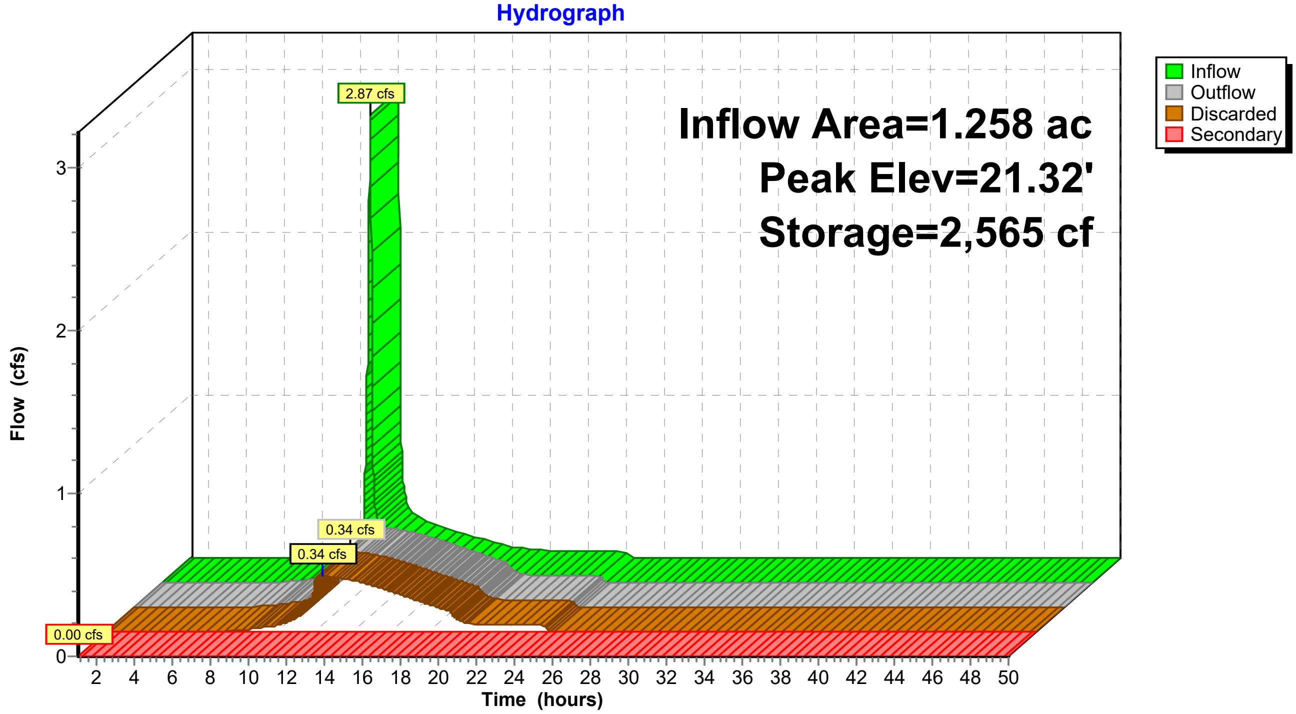
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.34 cfs @ 12.42 hrs HW=21.32' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.34 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond ENO: EAST NO OUTLET



Summary for Pond EXVS: EX VEG SWALE

Inflow Area =	0.975 ac,	0.00% Impervious, Inflow Depth = 0.84"	for 10-Year event
Inflow =	1.47 cfs @	11.97 hrs, Volume=	0.069 af
Outflow =	0.25 cfs @	12.18 hrs, Volume=	0.069 af, Atten= 83%, Lag= 12.7 min
Discarded =	0.25 cfs @	12.18 hrs, Volume=	0.069 af
Primary =	0.00 cfs @	1.00 hrs, Volume=	0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 19.07' @ 12.18 hrs Surf.Area= 1,902 sf Storage= 838 cf

Plug-Flow detention time= 31.3 min calculated for 0.069 af (100% of inflow)
Center-of-Mass det. time= 31.3 min (905.6 - 874.3)

Volume	Invert	Avail.Storage	Storage Description
#1	18.20'	36,604 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

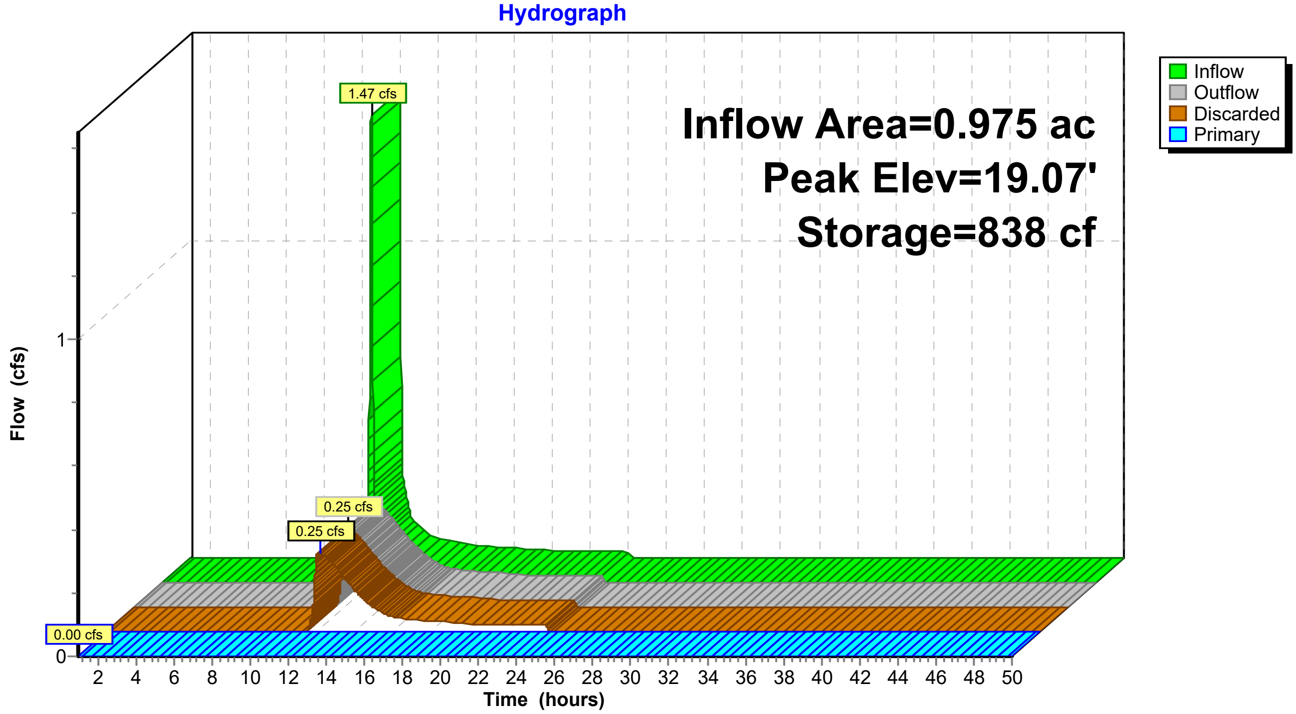
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.20	0	0	0
19.00	1,791	716	716
20.00	3,474	2,633	3,349
21.00	5,191	4,333	7,681
22.00	6,970	6,081	13,762
23.00	12,905	9,938	23,699
24.00	12,905	12,905	36,604

Device	Routing	Invert	Outlet Devices
#1	Primary	16.13'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.13' / 16.00' S= 0.0052 '/' Cc= 0.900 n= 0.130, Flow Area= 0.35 sf
#2	Device 1	19.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.00' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.25 cfs @ 12.18 hrs HW=19.07' (Free Discharge)
└─**3=Exfiltration** (Controls 0.25 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.20' (Free Discharge)
└─**1=Culvert** (Passes 0.00 cfs of 0.30 cfs potential flow)
  └─**2=Orifice/Grate** (Controls 0.00 cfs)

Pond EXVS: EX VEG SWALE



Summary for Pond S: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 2.26" for 10-Year event
Inflow = 2.54 cfs @ 11.96 hrs, Volume= 0.118 af
Outflow = 0.72 cfs @ 11.93 hrs, Volume= 0.118 af, Atten= 72%, Lag= 0.0 min
Discarded = 0.08 cfs @ 12.11 hrs, Volume= 0.020 af
Primary = 0.67 cfs @ 11.93 hrs, Volume= 0.098 af
Routed to Pond EBMP : EAST BMP
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.30' @ 12.11 hrs Surf.Area= 3,416 sf Storage= 1,416 cf

Plug-Flow detention time= 27.3 min calculated for 0.118 af (100% of inflow)
Center-of-Mass det. time= 27.3 min (832.0 - 804.7)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

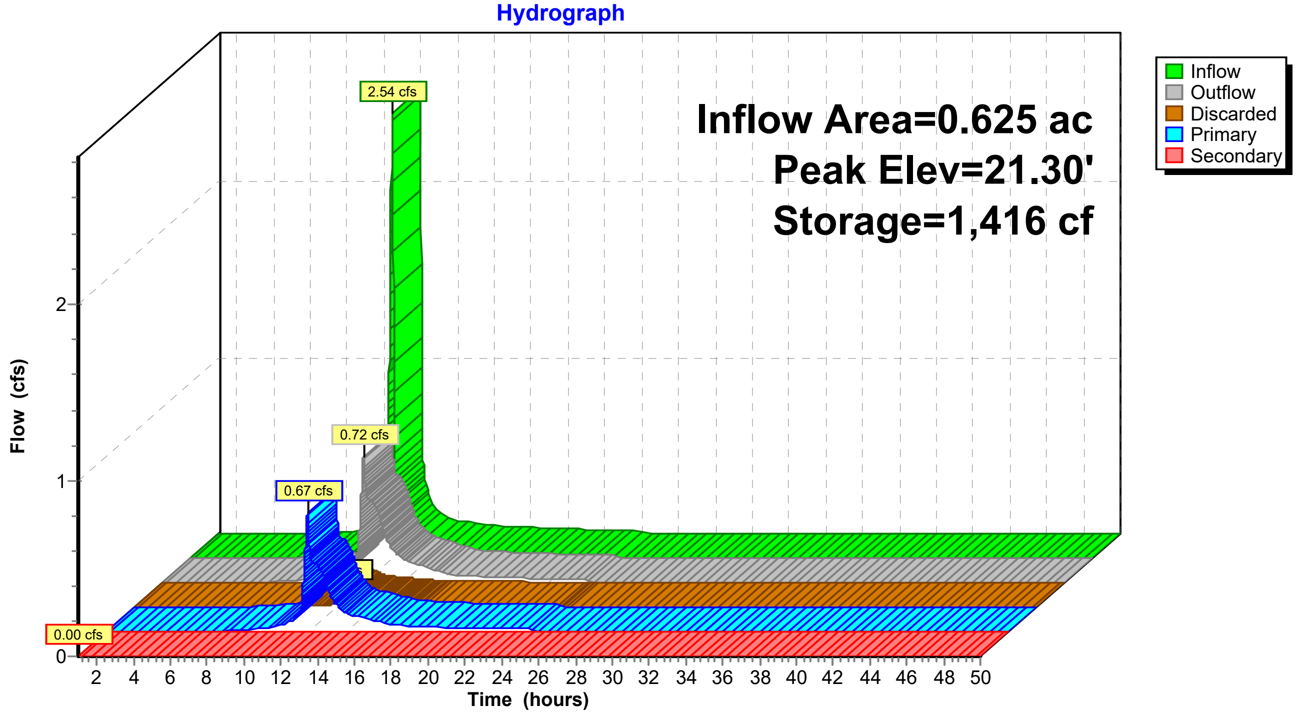
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.08 cfs @ 12.11 hrs HW=21.30' (Free Discharge)
└—**3=Exfiltration** (Controls 0.08 cfs)

Primary OutFlow Max=0.62 cfs @ 11.93 hrs HW=21.04' TW=20.81' (Dynamic Tailwater)
└—**2=Culvert** (Outlet Controls 0.62 cfs @ 1.89 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
└—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond S: SWALE


Hydrograph
Inflow Area=0.625 ac
Peak Elev=21.30'
Storage=1,416 cf
Inflow
Outflow
Discarded
Primary
Secondary
2.54 cfs
0.72 cfs
0.67 cfs
0.00 cfs
Flow (cfs)
0
1
2
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
Time (hours)

Summary for Pond SNO: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 2.26" for 10-Year event
Inflow = 2.54 cfs @ 11.96 hrs, Volume= 0.118 af
Outflow = 0.72 cfs @ 11.93 hrs, Volume= 0.118 af, Atten= 72%, Lag= 0.0 min
Discarded = 0.09 cfs @ 12.44 hrs, Volume= 0.029 af
Primary = 0.67 cfs @ 11.93 hrs, Volume= 0.089 af
Routed to Pond ENO : EAST NO OUTLET
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.33' @ 12.44 hrs Surf.Area= 3,571 sf Storage= 1,513 cf

Plug-Flow detention time= 50.1 min calculated for 0.118 af (100% of inflow)
Center-of-Mass det. time= 50.1 min (854.8 - 804.7)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

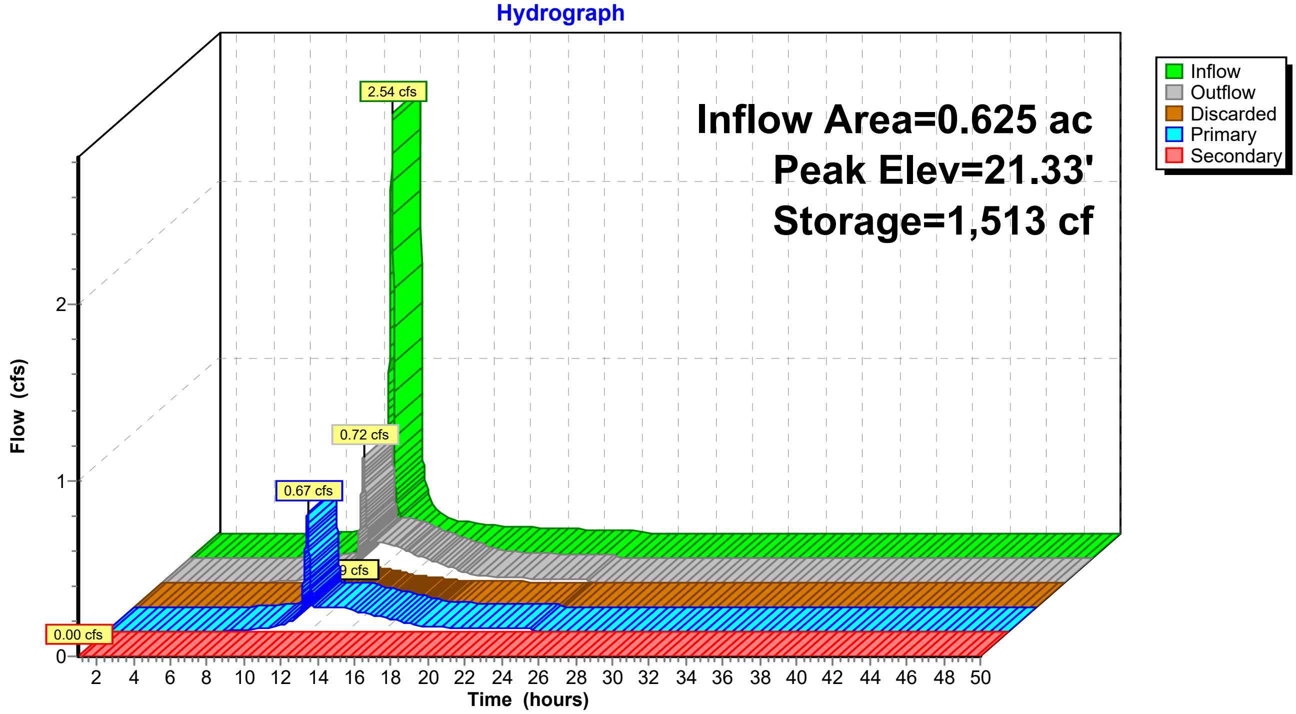
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.09 cfs @ 12.44 hrs HW=21.33' (Free Discharge)
↑—**3=Exfiltration** (Controls 0.09 cfs)

Primary OutFlow Max=0.62 cfs @ 11.93 hrs HW=21.04' TW=20.81' (Dynamic Tailwater)
↑—**2=Culvert** (Outlet Controls 0.62 cfs @ 1.89 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond SNO: SWALE



Summary for Pond WBMP: WEST BMP

Inflow Area = 4.557 ac, 0.00% Impervious, Inflow Depth = 1.29" for 10-Year event
Inflow = 10.97 cfs @ 11.97 hrs, Volume= 0.491 af
Outflow = 3.57 cfs @ 12.07 hrs, Volume= 0.489 af, Atten= 67%, Lag= 6.5 min
Discarded = 0.75 cfs @ 12.07 hrs, Volume= 0.068 af
Primary = 2.82 cfs @ 12.07 hrs, Volume= 0.421 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 19.54' @ 12.07 hrs Surf.Area= 6,140 sf Storage= 4,852 cf

Plug-Flow detention time= 12.5 min calculated for 0.489 af (100% of inflow)
Center-of-Mass det. time= 10.2 min (858.0 - 847.8)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	44,177 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,448	399	399
19.00	4,645	1,523	1,922
19.50	6,024	2,667	4,589
20.00	7,369	3,348	7,938
20.50	8,707	4,019	11,957
21.00	10,033	4,685	16,642
21.50	11,358	5,348	21,989
22.00	12,674	6,008	27,997
22.50	14,024	6,675	34,672
23.00	23,997	9,505	44,177

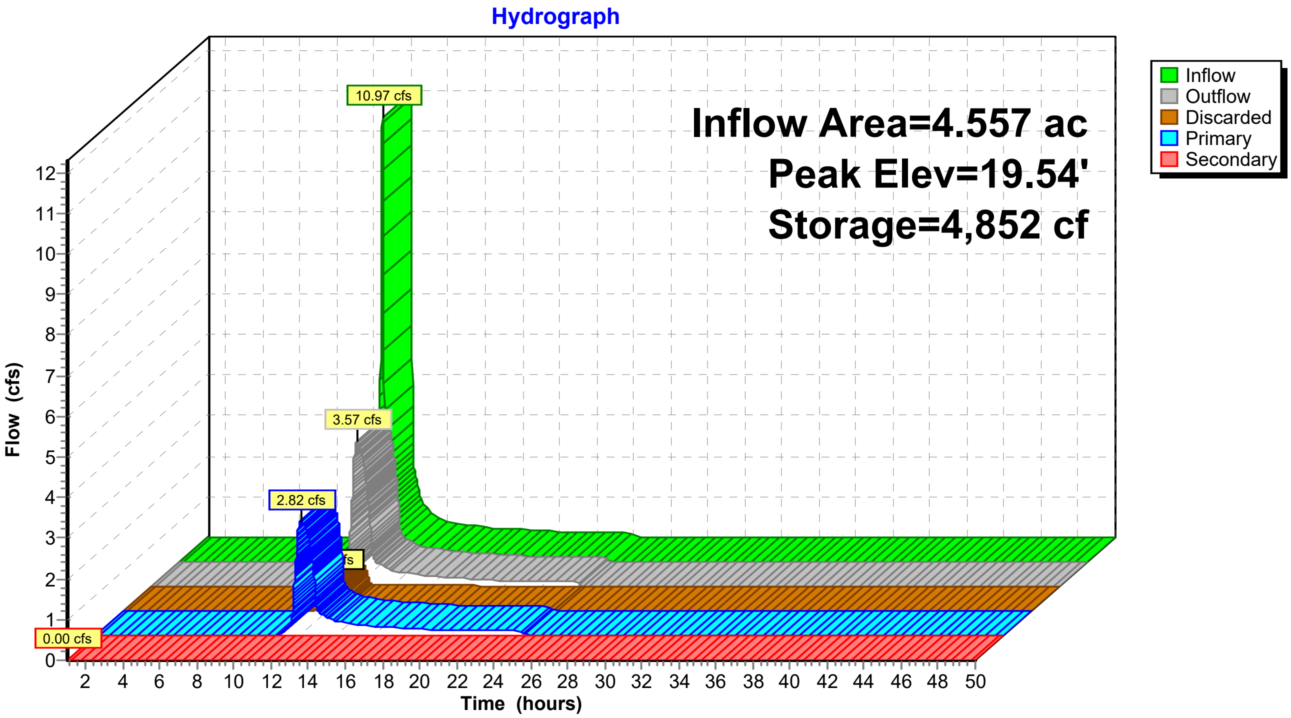
Device	Routing	Invert	Outlet Devices
#1	Primary	16.17'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.17' / 16.00' S= 0.0068 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#2	Device 1	18.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 667 sf
#4	Secondary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.75 cfs @ 12.07 hrs HW=19.54' (Free Discharge)
└─**3=Exfiltration** (Controls 0.75 cfs)

Primary OutFlow Max=2.82 cfs @ 12.07 hrs HW=19.54' (Free Discharge)
└─**1=Culvert** (Barrel Controls 2.82 cfs @ 8.06 fps)
  └─**2=Orifice/Grate** (Passes 2.82 cfs of 3.04 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond WBMP: WEST BMP



Summary for Pond WNO: WEST NO OUTLET

Inflow Area =	4.557 ac,	0.00% Impervious, Inflow Depth = 1.29" for 10-Year event		
Inflow =	10.97 cfs @	11.97 hrs, Volume=	0.491 af	
Outflow =	1.05 cfs @	12.47 hrs, Volume=	0.489 af,	Atten= 90%, Lag= 30.2 min
Discarded =	1.05 cfs @	12.47 hrs, Volume=	0.489 af	
Primary =	0.00 cfs @	1.00 hrs, Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 20.11' @ 12.47 hrs Surf.Area= 7,661 sf Storage= 8,606 cf

Plug-Flow detention time= 94.7 min calculated for 0.489 af (100% of inflow)
Center-of-Mass det. time= 92.8 min (940.6 - 847.8)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	43,777 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

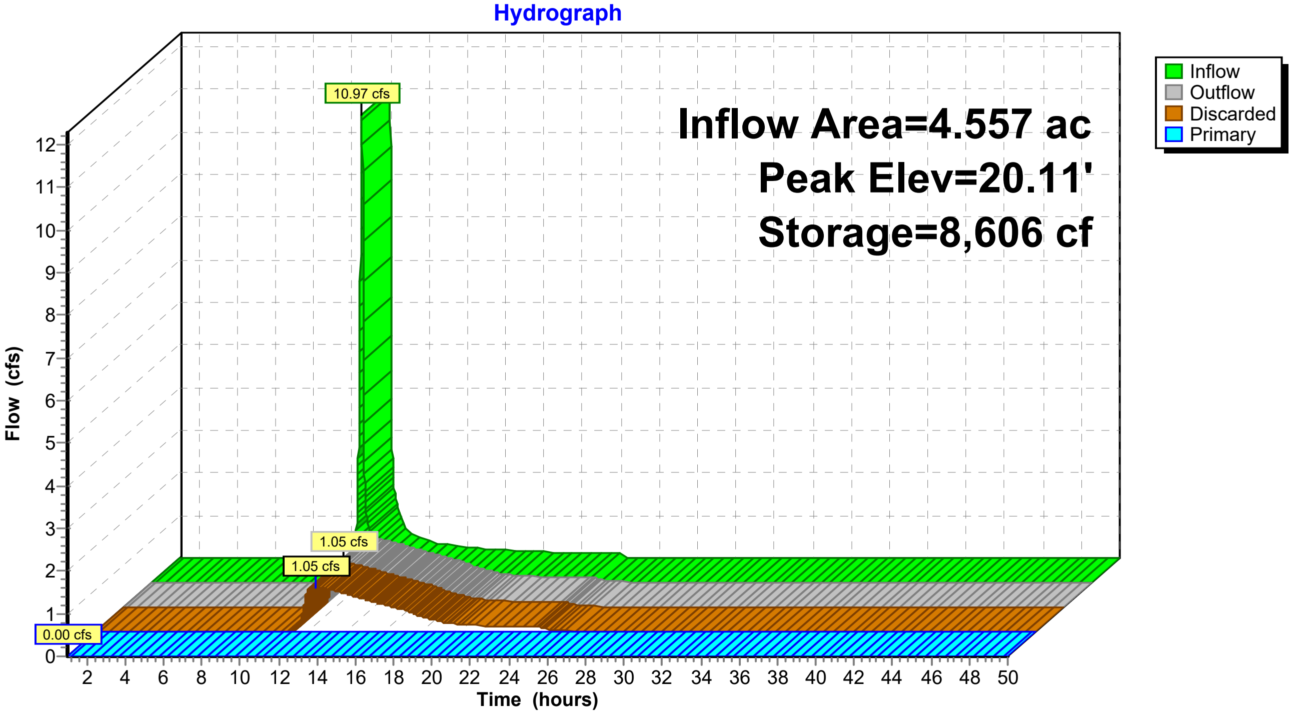
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,148	324	324
19.00	4,645	1,448	1,772
19.50	6,024	2,667	4,439
20.00	7,369	3,348	7,788
20.50	8,707	4,019	11,807
21.00	10,033	4,685	16,492
21.50	11,358	5,348	21,839
22.00	12,674	6,008	27,847
22.50	14,024	6,675	34,522
23.00	22,997	9,255	43,777

Device	Routing	Invert	Outlet Devices
#1	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 547 sf
#2	Primary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=1.05 cfs @ 12.47 hrs HW=20.11' (Free Discharge)
↑—**1=Exfiltration** (Controls 1.05 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond WNO: WEST NO OUTLET



Time span=1.00-50.00 hrs, dt=0.01 hrs, 4901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1-4: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=1.66"
Tc=5.0 min CN=76 Runoff=14.11 cfs 0.631 af

Subcatchment5-6: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=2.37"
Tc=5.0 min CN=85 Runoff=2.73 cfs 0.125 af

Subcatchment7: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=2.73"
Tc=5.0 min CN=89 Runoff=3.02 cfs 0.142 af

Subcatchment7NO: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=2.73"
Tc=5.0 min CN=89 Runoff=3.02 cfs 0.142 af

Subcatchment8: 8 Runoff Area=173,721 sf 0.00% Impervious Runoff Depth=0.92"
Tc=5.0 min CN=64 Runoff=6.49 cfs 0.305 af

Subcatchment9: 9 Runoff Area=51,272 sf 100.00% Impervious Runoff Depth>3.86"
Tc=5.0 min CN=100 Runoff=6.78 cfs 0.379 af

Subcatchment9C-E: 9C-E Runoff Area=47,511 sf 100.00% Impervious Runoff Depth>3.86"
Tc=5.0 min CN=100 Runoff=6.28 cfs 0.351 af

Subcatchment14NO: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=1.66"
Tc=5.0 min CN=76 Runoff=14.11 cfs 0.631 af

Subcatchment56NO: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=2.37"
Tc=5.0 min CN=85 Runoff=2.73 cfs 0.125 af

SubcatchmentEX1-3: EX 1-3 Runoff Area=42,470 sf 0.00% Impervious Runoff Depth=1.14"
Tc=5.0 min CN=68 Runoff=2.04 cfs 0.093 af

SubcatchmentEX8: EX 8 Runoff Area=346,757 sf 0.00% Impervious Runoff Depth=0.34"
Tc=5.0 min CN=51 Runoff=2.81 cfs 0.224 af

SubcatchmentEX9: EX 9 Runoff Area=89,002 sf 100.00% Impervious Runoff Depth>3.86"
Tc=5.0 min CN=100 Runoff=11.77 cfs 0.658 af

Pond EBMP: EAST BMP Peak Elev=21.35' Storage=2,647 cf Inflow=3.26 cfs 0.243 af
Discarded=0.35 cfs 0.180 af Primary=0.60 cfs 0.063 af Secondary=0.00 cfs 0.000 af Outflow=0.94 cfs 0.243 af

Pond ENO: EAST NO OUTLET Peak Elev=21.47' Storage=2,976 cf Inflow=3.24 cfs 0.228 af
Discarded=0.37 cfs 0.228 af Secondary=0.00 cfs 0.000 af Outflow=0.37 cfs 0.228 af

Pond EXVS: EX VEG SWALE Peak Elev=19.26' Storage=1,229 cf Inflow=2.04 cfs 0.093 af
Discarded=0.30 cfs 0.090 af Primary=0.11 cfs 0.002 af Outflow=0.41 cfs 0.093 af

Pond S: SWALE Peak Elev=21.43' Storage=1,893 cf Inflow=3.02 cfs 0.142 af
Discarded=0.10 cfs 0.024 af Primary=0.64 cfs 0.118 af Secondary=0.00 cfs 0.000 af Outflow=0.69 cfs 0.142 af

Pond SNO: SWALE Peak Elev=21.48' Storage=2,141 cf Inflow=3.02 cfs 0.142 af
Discarded=0.11 cfs 0.039 af Primary=0.64 cfs 0.103 af Secondary=0.00 cfs 0.000 af Outflow=0.69 cfs 0.142 af

Pond WBMP: WEST BMP Peak Elev=19.87' Storage=7,002 cf Inflow=14.11 cfs 0.631 af
Discarded=0.91 cfs 0.095 af Primary=2.97 cfs 0.534 af Secondary=0.00 cfs 0.000 af Outflow=3.88 cfs 0.629 af

Pond WNO: WEST NO OUTLET Peak Elev=20.48' Storage=11,633 cf Inflow=14.11 cfs 0.631 af
Discarded=1.24 cfs 0.630 af Primary=0.00 cfs 0.000 af Outflow=1.24 cfs 0.630 af

Total Runoff Area = 28.864 ac Runoff Volume = 3.806 af Average Runoff Depth = 1.58"
85.06% Pervious = 24.553 ac 14.94% Impervious = 4.311 ac

Summary for Subcatchment 1-4: 1-4

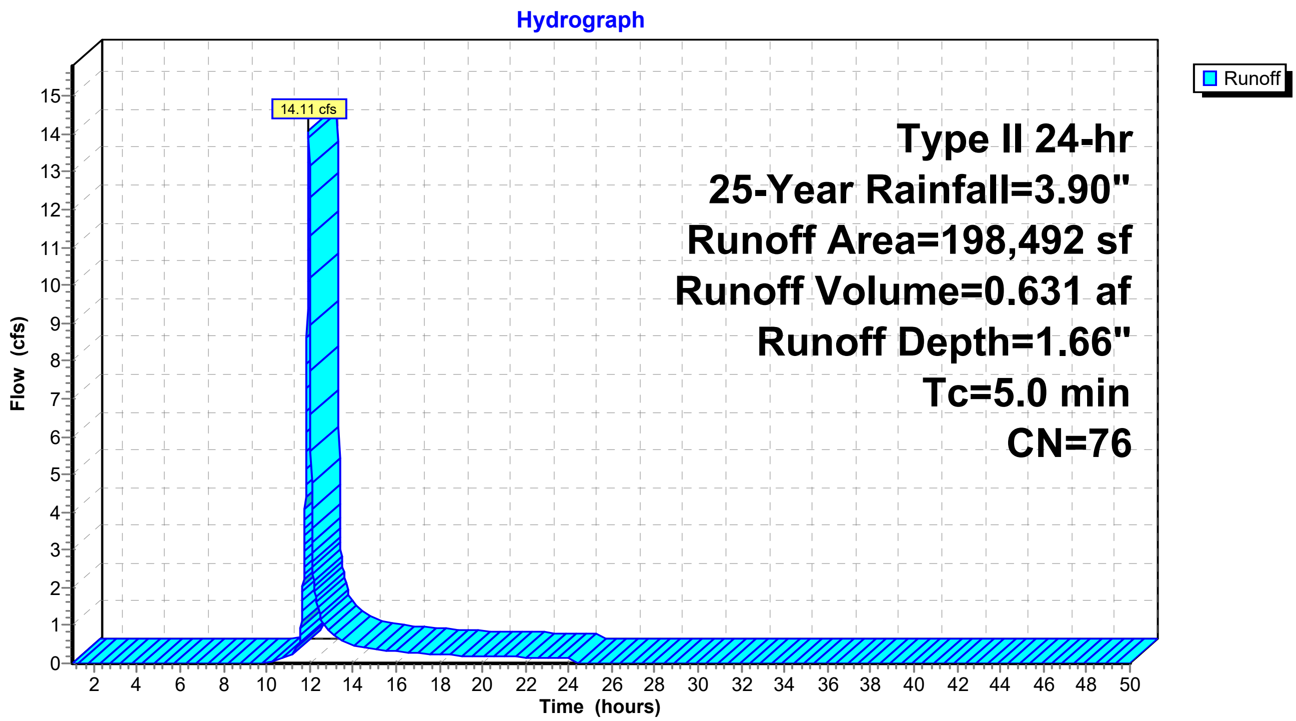
Runoff = 14.11 cfs @ 11.96 hrs, Volume= 0.631 af, Depth= 1.66"
Routed to Pond WBMP : WEST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1-4: 1-4



Summary for Subcatchment 5-6: 5-6

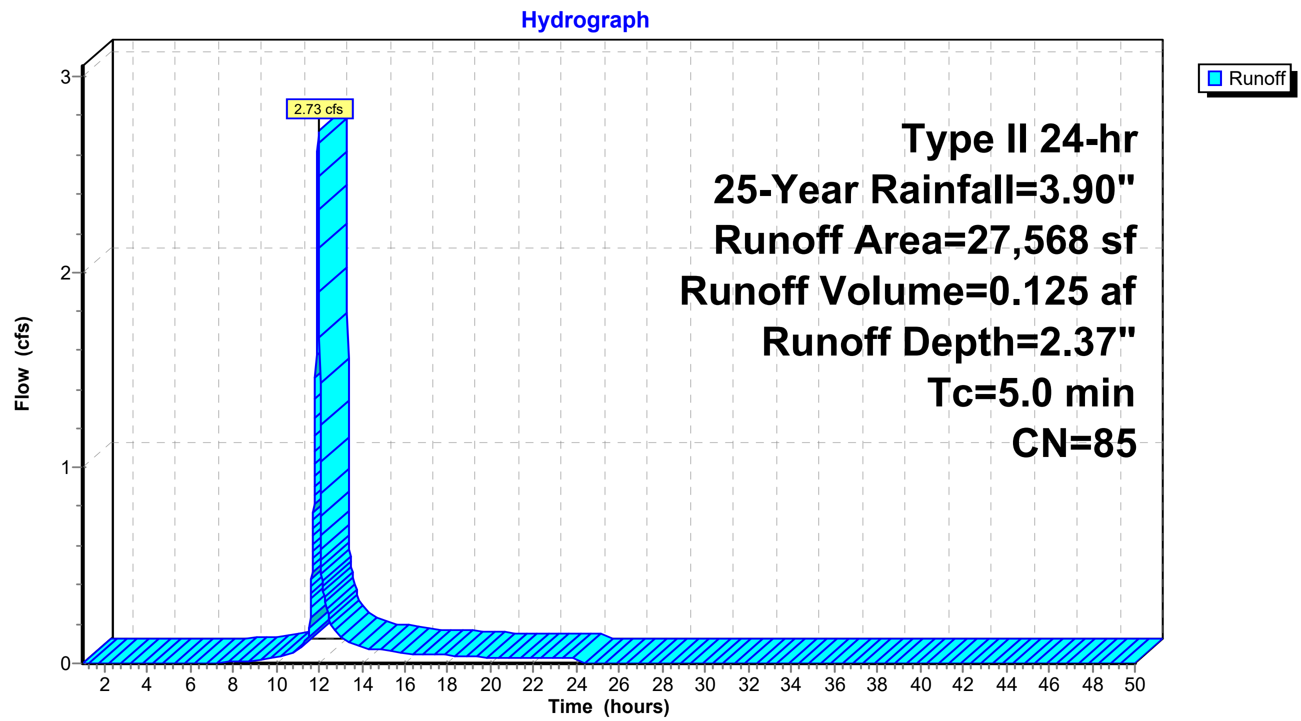
Runoff = 2.73 cfs @ 11.96 hrs, Volume= 0.125 af, Depth= 2.37"
Routed to Pond EBMP : EAST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5-6: 5-6



Summary for Subcatchment 7: 7

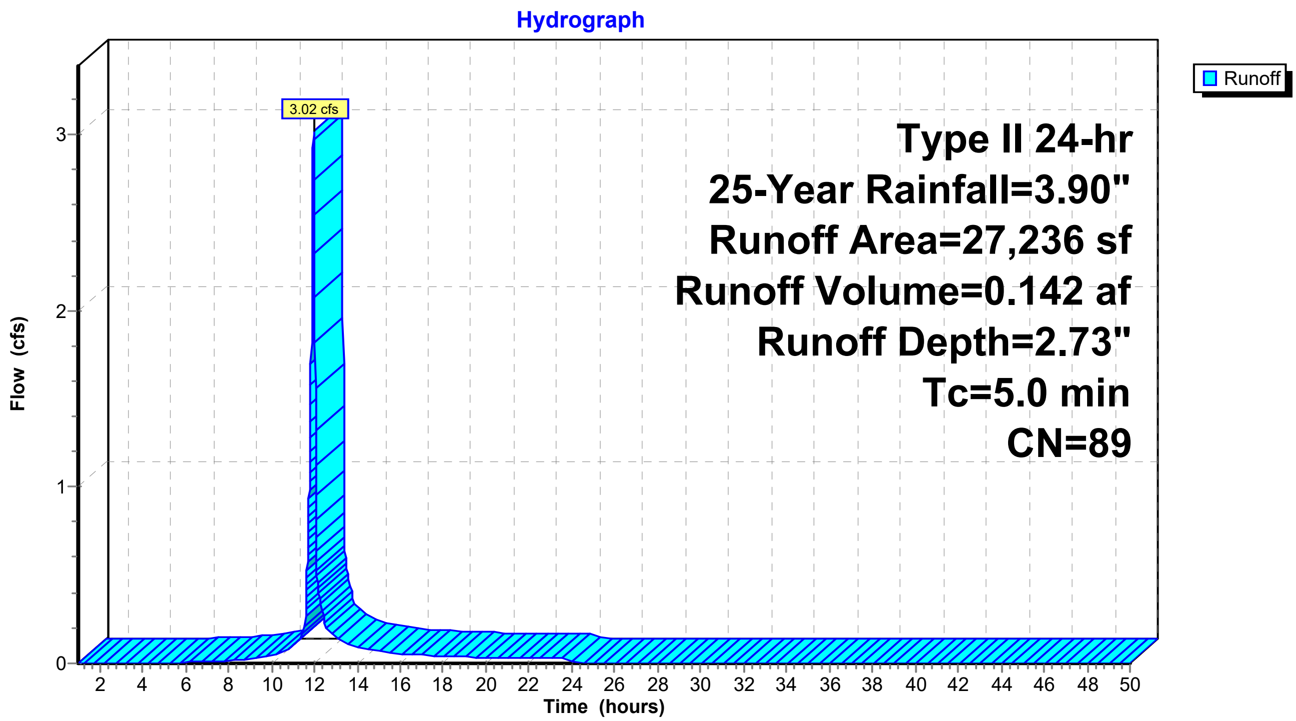
Runoff = 3.02 cfs @ 11.96 hrs, Volume= 0.142 af, Depth= 2.73"
Routed to Pond S : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7: 7



Summary for Subcatchment 7NO: 7

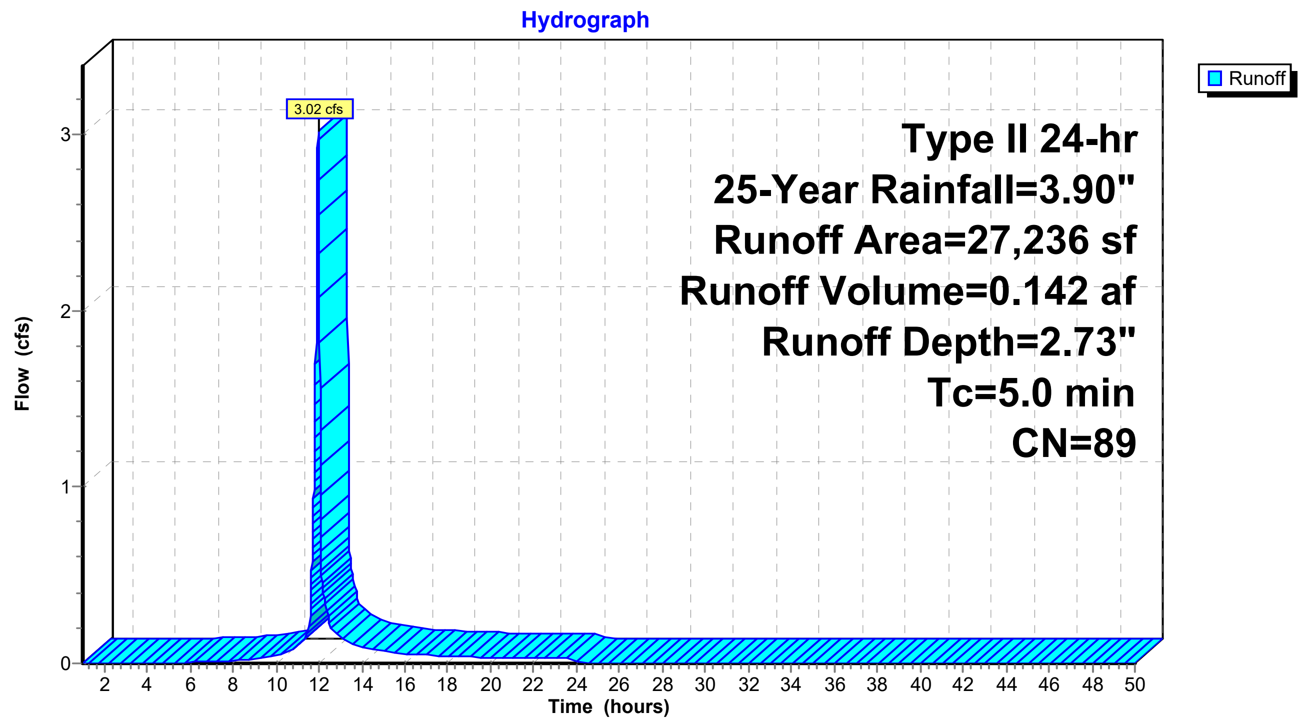
Runoff = 3.02 cfs @ 11.96 hrs, Volume= 0.142 af, Depth= 2.73"
Routed to Pond SNO : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7NO: 7



Summary for Subcatchment 8: 8

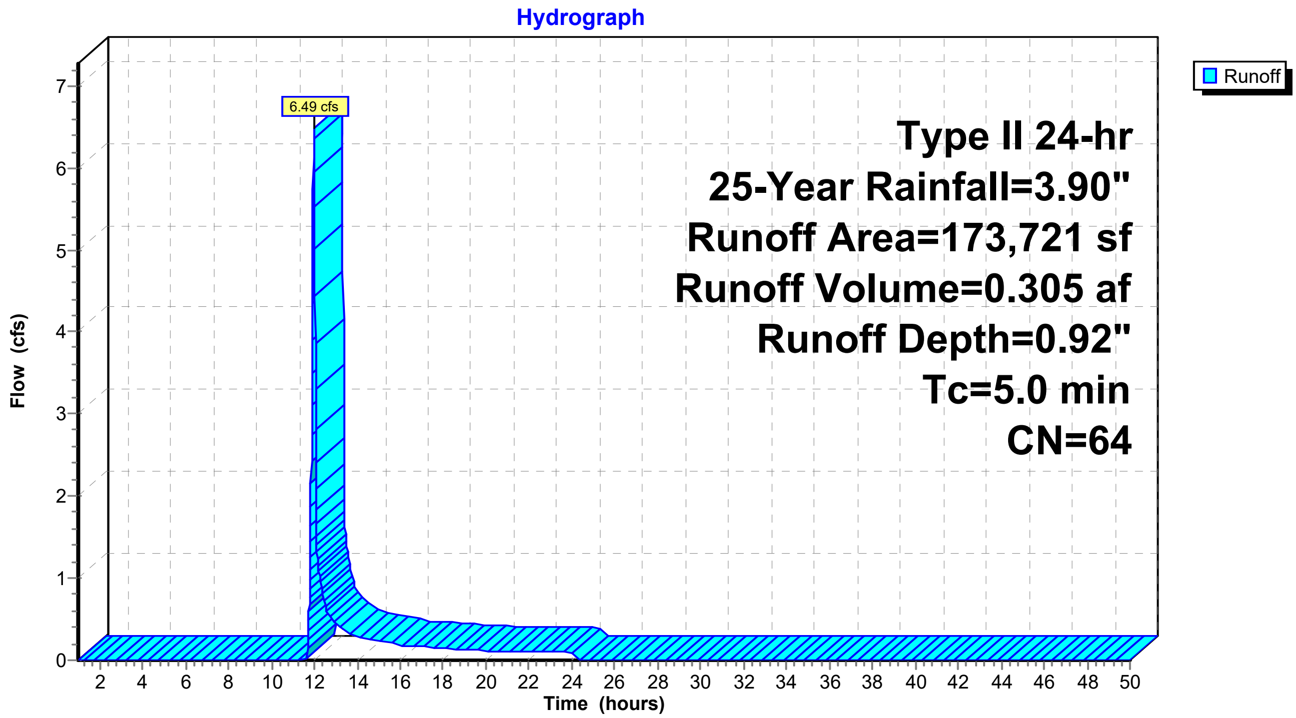
Runoff = 6.49 cfs @ 11.97 hrs, Volume= 0.305 af, Depth= 0.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	173,721	64	
	173,721		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 8: 8



Summary for Subcatchment 9: 9

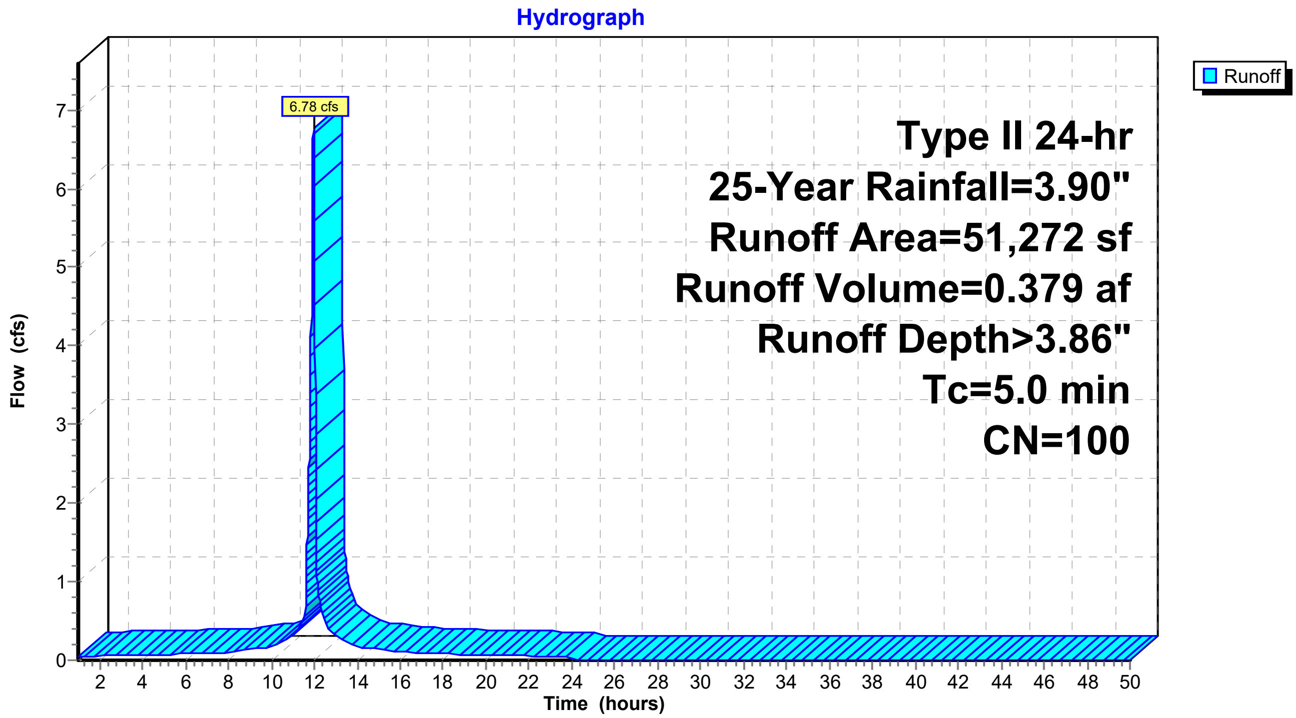
Runoff = 6.78 cfs @ 11.96 hrs, Volume= 0.379 af, Depth> 3.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	51,272	100	
	51,272		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9: 9



Summary for Subcatchment 9C-E: 9C-E

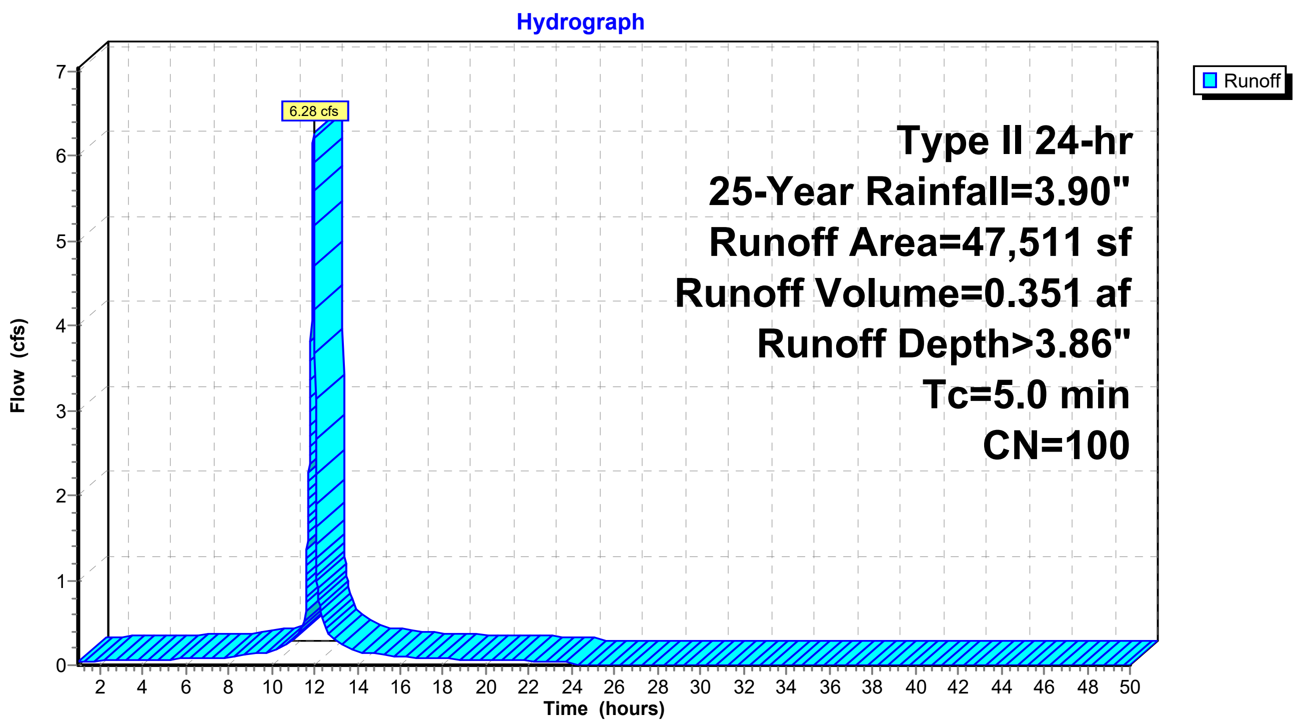
Runoff = 6.28 cfs @ 11.96 hrs, Volume= 0.351 af, Depth> 3.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	47,511	100	
	47,511		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9C-E: 9C-E



Summary for Subcatchment 14NO: 1-4

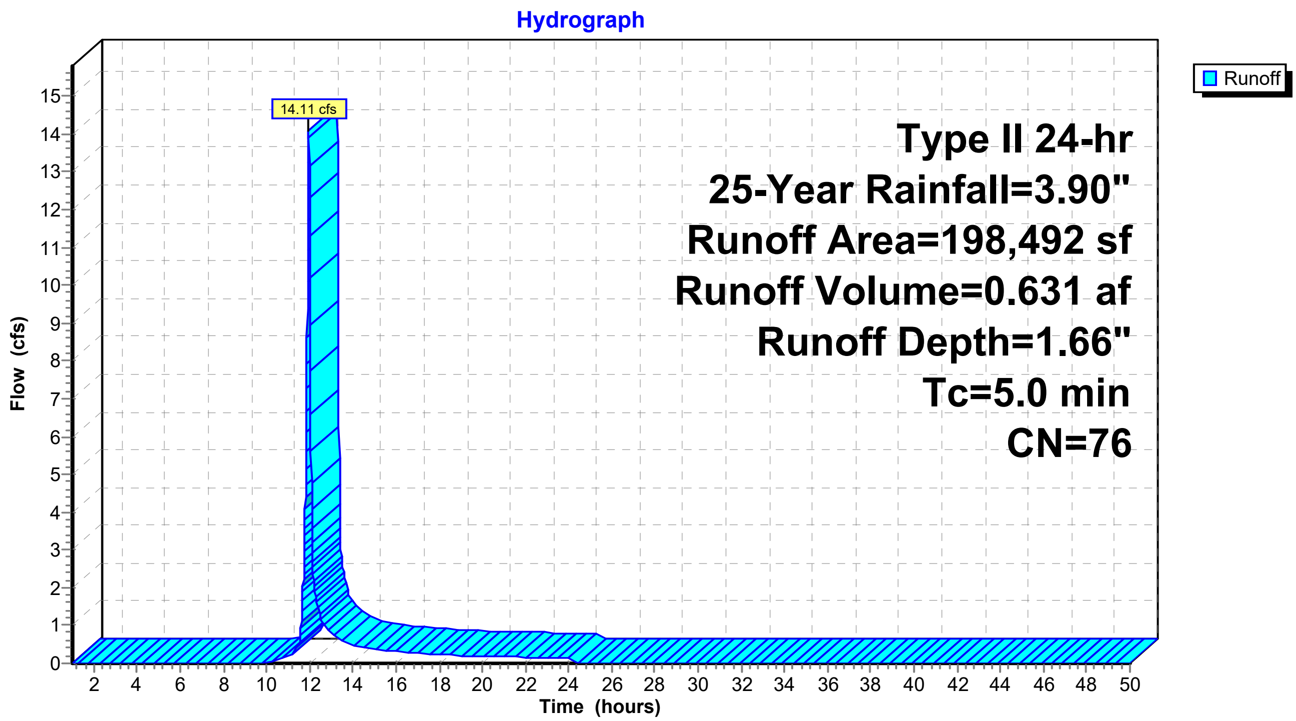
Runoff = 14.11 cfs @ 11.96 hrs, Volume= 0.631 af, Depth= 1.66"
Routed to Pond WNO : WEST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 14NO: 1-4



Summary for Subcatchment 56NO: 5-6

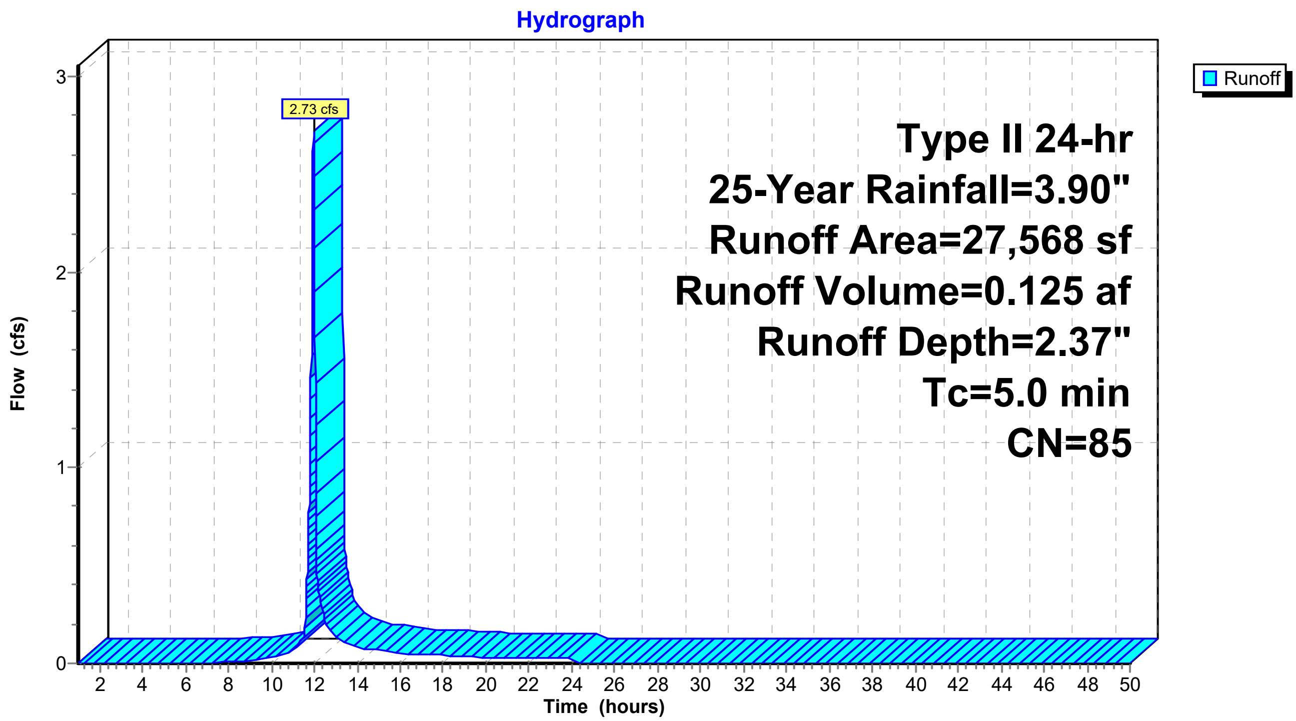
Runoff = 2.73 cfs @ 11.96 hrs, Volume= 0.125 af, Depth= 2.37"
Routed to Pond ENO : EAST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 56NO: 5-6



Summary for Subcatchment EX1-3: EX 1-3

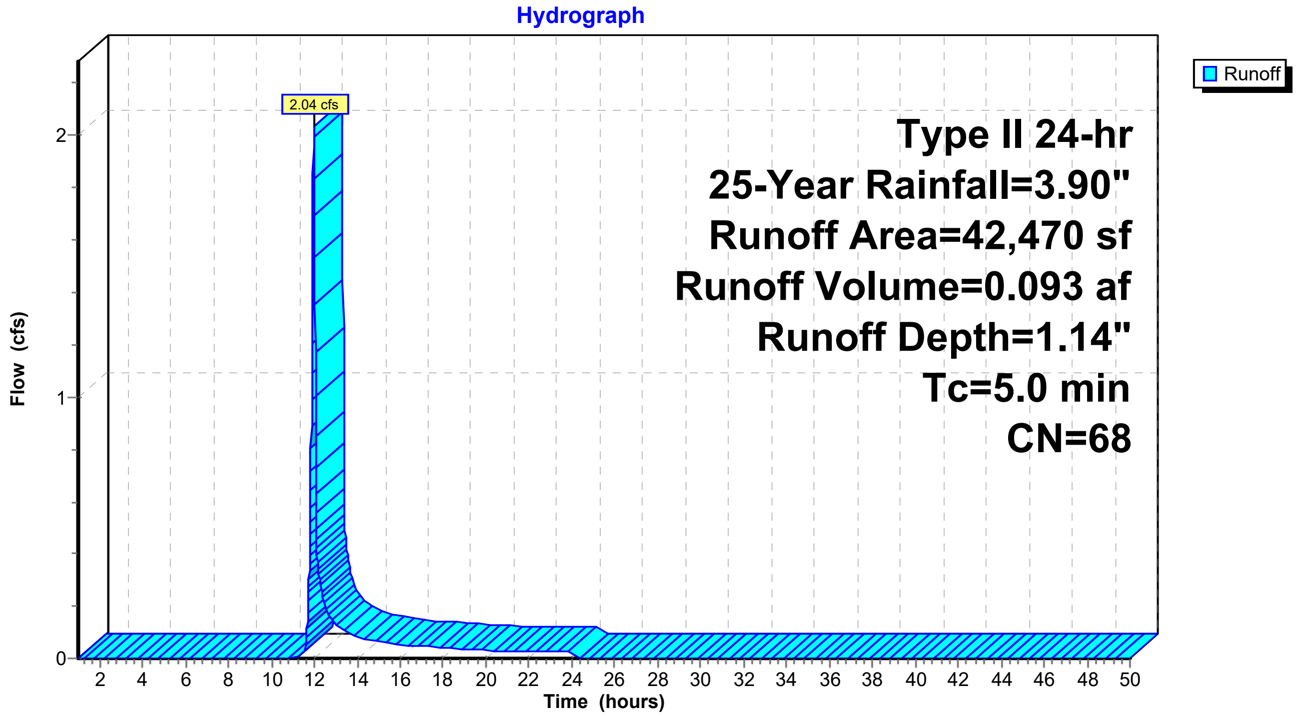
Runoff = 2.04 cfs @ 11.97 hrs, Volume= 0.093 af, Depth= 1.14"
Routed to Pond EXVS : EX VEG SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	42,470	68	
	42,470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX1-3: EX 1-3



Summary for Subcatchment EX8: EX 8

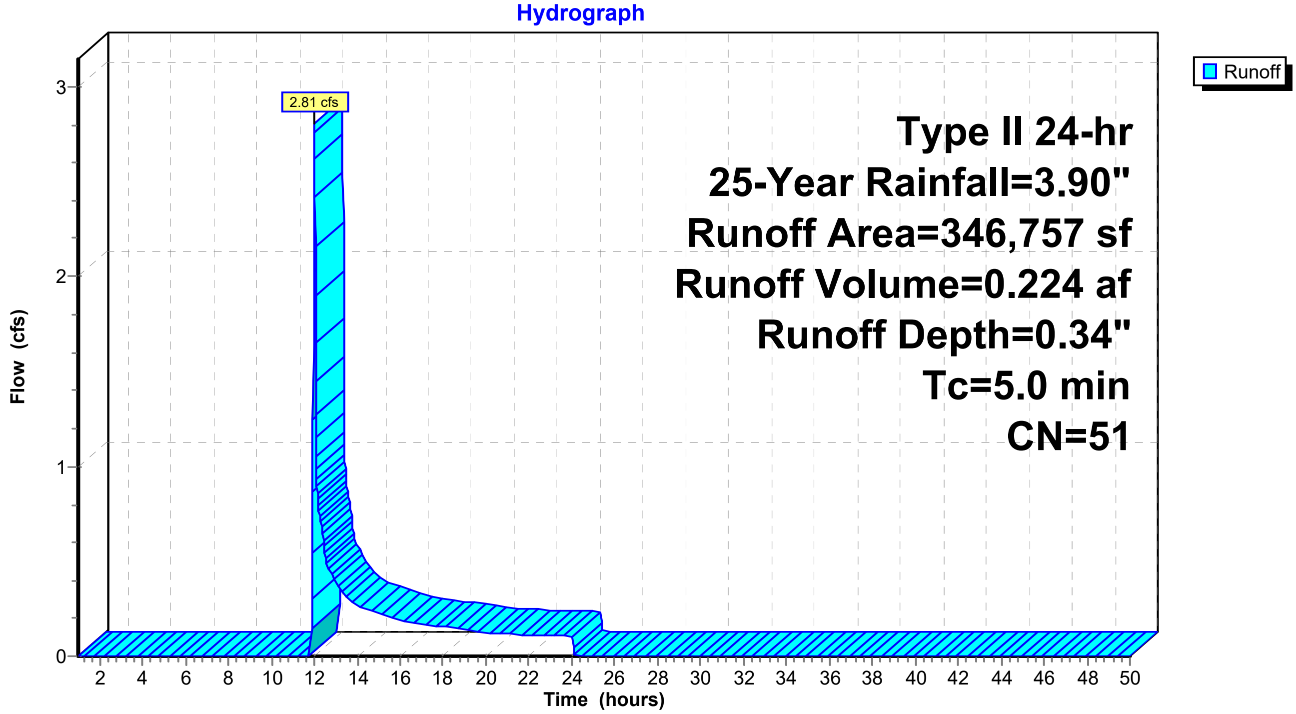
Runoff = 2.81 cfs @ 12.00 hrs, Volume= 0.224 af, Depth= 0.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	346,757	51	
	346,757		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX8: EX 8



Summary for Subcatchment EX9: EX 9

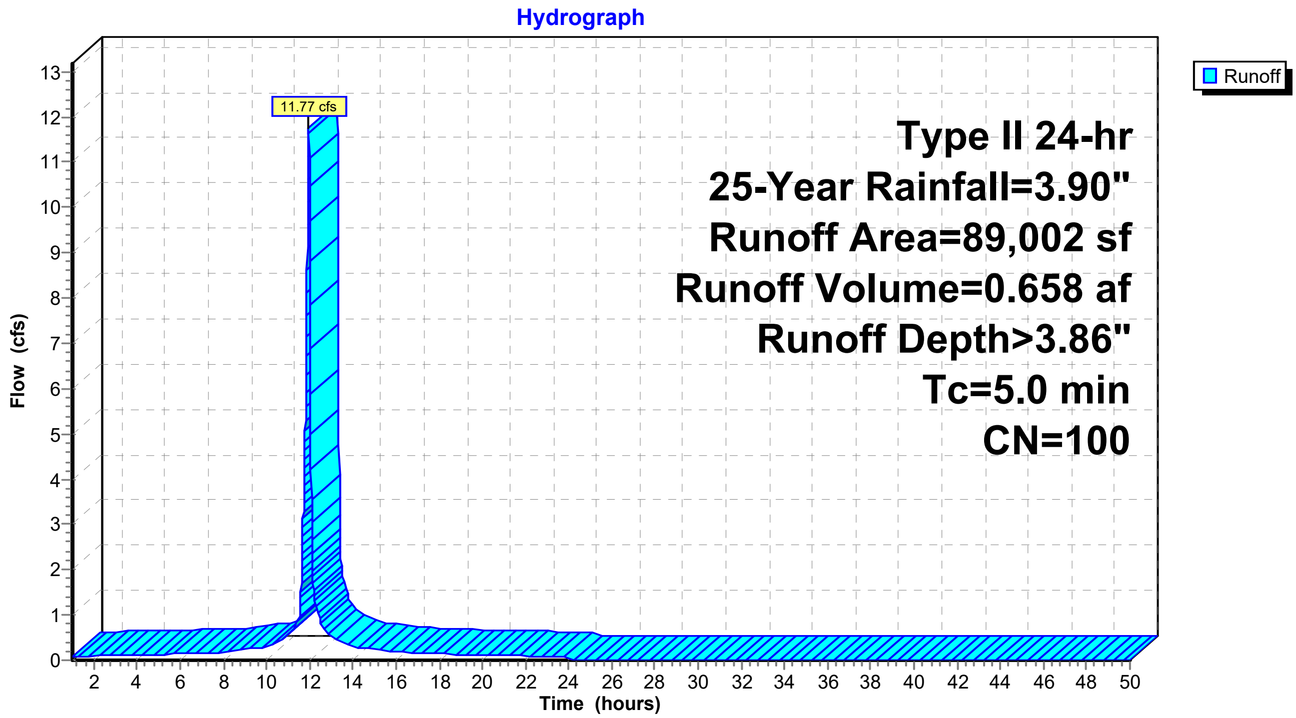
Runoff = 11.77 cfs @ 11.96 hrs, Volume= 0.658 af, Depth> 3.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-Year Rainfall=3.90"

	Area (sf)	CN	Description
*	89,002	100	
	89,002		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX9: EX 9



Summary for Pond EBMP: EAST BMP

Inflow Area =	1.258 ac,	0.00% Impervious, Inflow Depth = 2.32"	for 25-Year event
Inflow =	3.26 cfs @ 11.96 hrs,	Volume=	0.243 af
Outflow =	0.94 cfs @ 12.10 hrs,	Volume=	0.243 af, Atten= 71%, Lag= 8.5 min
Discarded =	0.35 cfs @ 12.10 hrs,	Volume=	0.180 af
Primary =	0.60 cfs @ 12.10 hrs,	Volume=	0.063 af
Secondary =	0.00 cfs @ 1.00 hrs,	Volume=	0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.35' @ 12.10 hrs Surf.Area= 2,571 sf Storage= 2,647 cf

Plug-Flow detention time= 47.0 min calculated for 0.243 af (100% of inflow)
Center-of-Mass det. time= 47.0 min (867.8 - 820.8)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

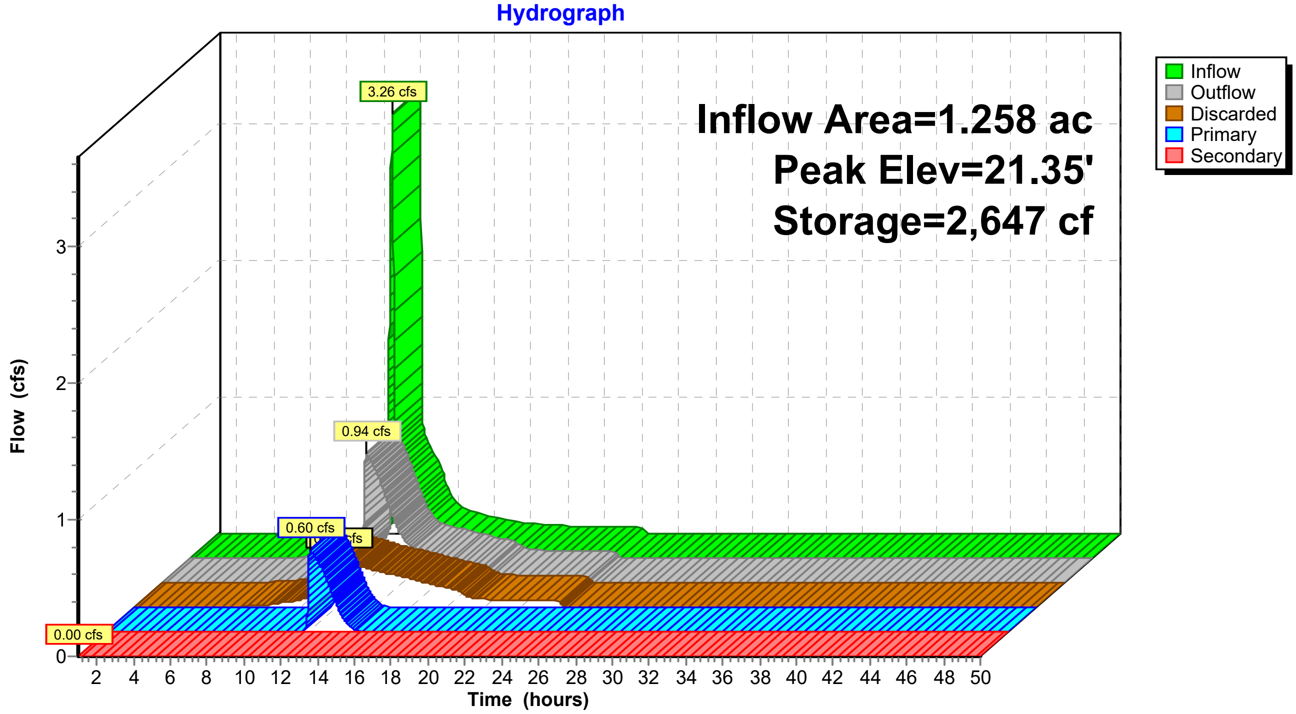
Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	19.81'	**6.0" Round Culvert** L= 92.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 19.81' / 19.35' S= 0.0050 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#3	Device 2	20.70'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.35 cfs @ 12.10 hrs HW=21.35' (Free Discharge)
└─**4=Exfiltration** (Controls 0.35 cfs)

Primary OutFlow Max=0.60 cfs @ 12.10 hrs HW=21.35' (Free Discharge)
└─**2=Culvert** (Passes 0.60 cfs of 0.71 cfs potential flow)
  └─**3=Orifice/Grate** (Orifice Controls 0.60 cfs @ 3.04 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond EBMP: EAST BMP



Summary for Pond ENO: EAST NO OUTLET

Inflow Area = 1.258 ac, 0.00% Impervious, Inflow Depth = 2.17" for 25-Year event
Inflow = 3.24 cfs @ 11.96 hrs, Volume= 0.228 af
Outflow = 0.37 cfs @ 12.44 hrs, Volume= 0.228 af, Atten= 89%, Lag= 29.0 min
Discarded = 0.37 cfs @ 12.44 hrs, Volume= 0.228 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.47' @ 12.44 hrs Surf.Area= 2,677 sf Storage= 2,976 cf

Plug-Flow detention time= 84.8 min calculated for 0.228 af (100% of inflow)
Center-of-Mass det. time= 84.8 min (922.7 - 838.0)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

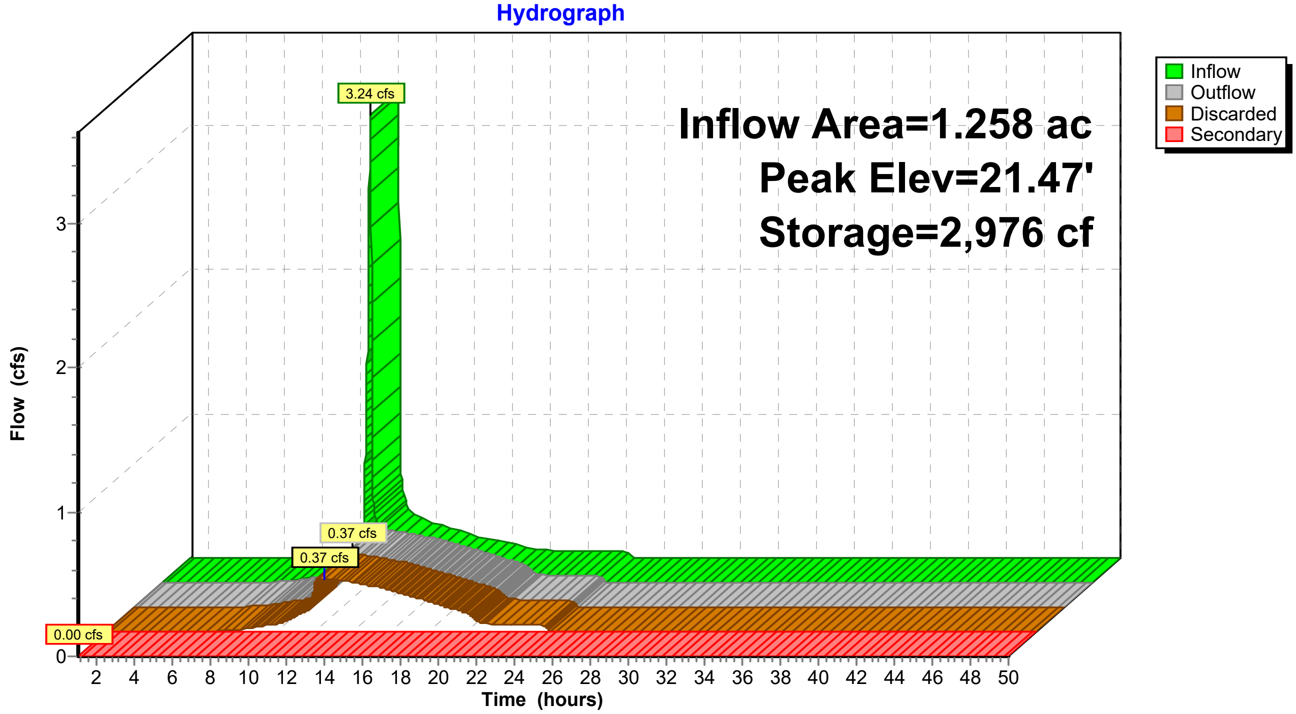
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.37 cfs @ 12.44 hrs HW=21.47' (Free Discharge)
└─**2=Exfiltration** (Controls 0.37 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond ENO: EAST NO OUTLET



Summary for Pond EXVS: EX VEG SWALE

Inflow Area = 0.975 ac, 0.00% Impervious, Inflow Depth = 1.14" for 25-Year event
Inflow = 2.04 cfs @ 11.97 hrs, Volume= 0.093 af
Outflow = 0.41 cfs @ 12.13 hrs, Volume= 0.093 af, Atten= 80%, Lag= 9.4 min
Discarded = 0.30 cfs @ 12.13 hrs, Volume= 0.090 af
Primary = 0.11 cfs @ 12.13 hrs, Volume= 0.002 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 19.26' @ 12.13 hrs Surf.Area= 2,221 sf Storage= 1,229 cf

Plug-Flow detention time= 37.7 min calculated for 0.093 af (100% of inflow)
Center-of-Mass det. time= 37.7 min (901.8 - 864.1)

Volume	Invert	Avail.Storage	Storage Description
#1	18.20'	36,604 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

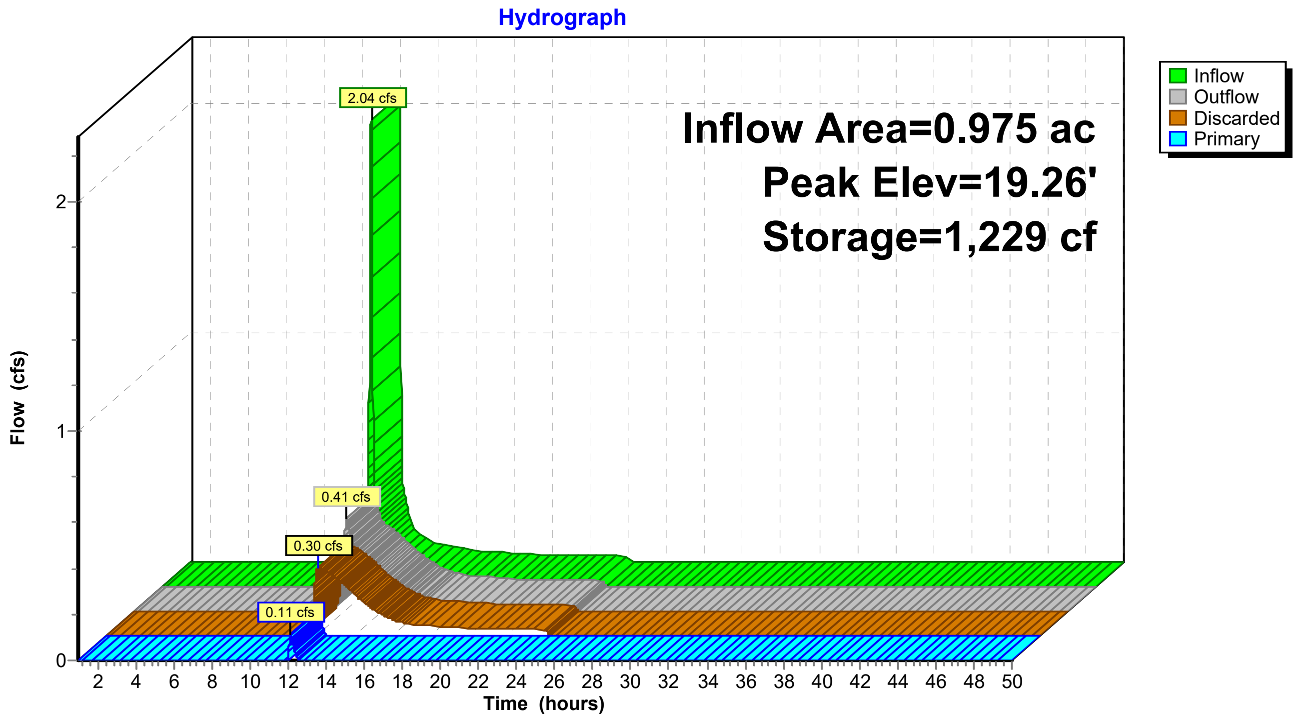
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.20	0	0	0
19.00	1,791	716	716
20.00	3,474	2,633	3,349
21.00	5,191	4,333	7,681
22.00	6,970	6,081	13,762
23.00	12,905	9,938	23,699
24.00	12,905	12,905	36,604

Device	Routing	Invert	Outlet Devices
#1	Primary	16.13'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.13' / 16.00' S= 0.0052 '/' Cc= 0.900 n= 0.130, Flow Area= 0.35 sf
#2	Device 1	19.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.00' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.30 cfs @ 12.13 hrs HW=19.26' (Free Discharge)
└─**3=Exfiltration** (Controls 0.30 cfs)

Primary OutFlow Max=0.11 cfs @ 12.13 hrs HW=19.26' (Free Discharge)
└─**1=Culvert** (Passes 0.11 cfs of 0.39 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 0.11 cfs @ 0.77 fps)

Pond EXVS: EX VEG SWALE



Summary for Pond S: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 2.73" for 25-Year event
Inflow = 3.02 cfs @ 11.96 hrs, Volume= 0.142 af
Outflow = 0.69 cfs @ 11.90 hrs, Volume= 0.142 af, Atten= 77%, Lag= 0.0 min
Discarded = 0.10 cfs @ 12.14 hrs, Volume= 0.024 af
Primary = 0.64 cfs @ 11.90 hrs, Volume= 0.118 af
Routed to Pond EBMP : EAST BMP
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.43' @ 12.14 hrs Surf.Area= 4,129 sf Storage= 1,893 cf

Plug-Flow detention time= 31.4 min calculated for 0.142 af (100% of inflow)
Center-of-Mass det. time= 31.4 min (830.8 - 799.4)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

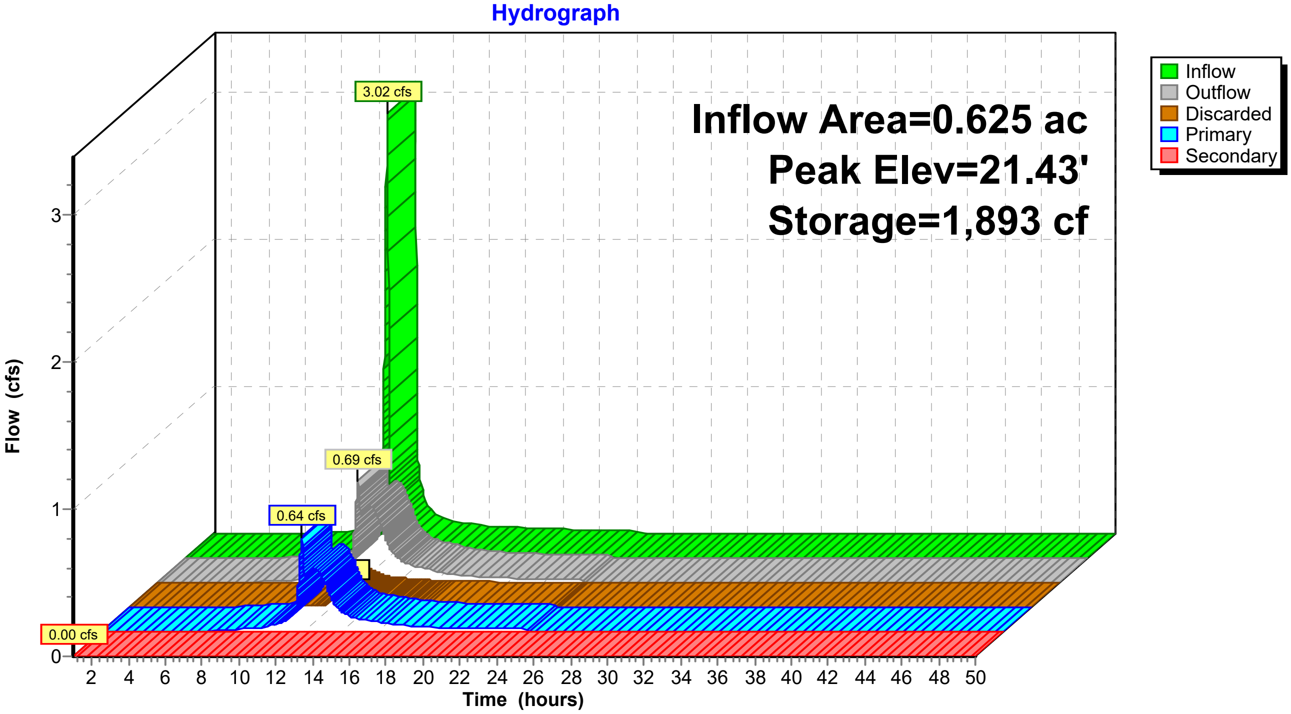
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.10 cfs @ 12.14 hrs HW=21.43' (Free Discharge)
└─**3=Exfiltration** (Controls 0.10 cfs)

Primary OutFlow Max=0.59 cfs @ 11.90 hrs HW=21.05' TW=20.84' (Dynamic Tailwater)
└─**2=Culvert** (Outlet Controls 0.59 cfs @ 1.78 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond S: SWALE


Hydrograph
3.02 cfs
0.69 cfs
0.64 cfs
0.00 cfs
Inflow Area=0.625 ac
Peak Elev=21.43'
Storage=1,893 cf
Inflow
Outflow
Discarded
Primary
Secondary
Flow (cfs)
0
1
2
3
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
Time (hours)

Summary for Pond SNO: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 2.73" for 25-Year event
Inflow = 3.02 cfs @ 11.96 hrs, Volume= 0.142 af
Outflow = 0.69 cfs @ 11.90 hrs, Volume= 0.142 af, Atten= 77%, Lag= 0.0 min
Discarded = 0.11 cfs @ 12.48 hrs, Volume= 0.039 af
Primary = 0.64 cfs @ 11.90 hrs, Volume= 0.103 af
Routed to Pond ENO : EAST NO OUTLET
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.48' @ 12.48 hrs Surf.Area= 4,455 sf Storage= 2,141 cf

Plug-Flow detention time= 66.1 min calculated for 0.142 af (100% of inflow)
Center-of-Mass det. time= 66.0 min (865.4 - 799.4)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

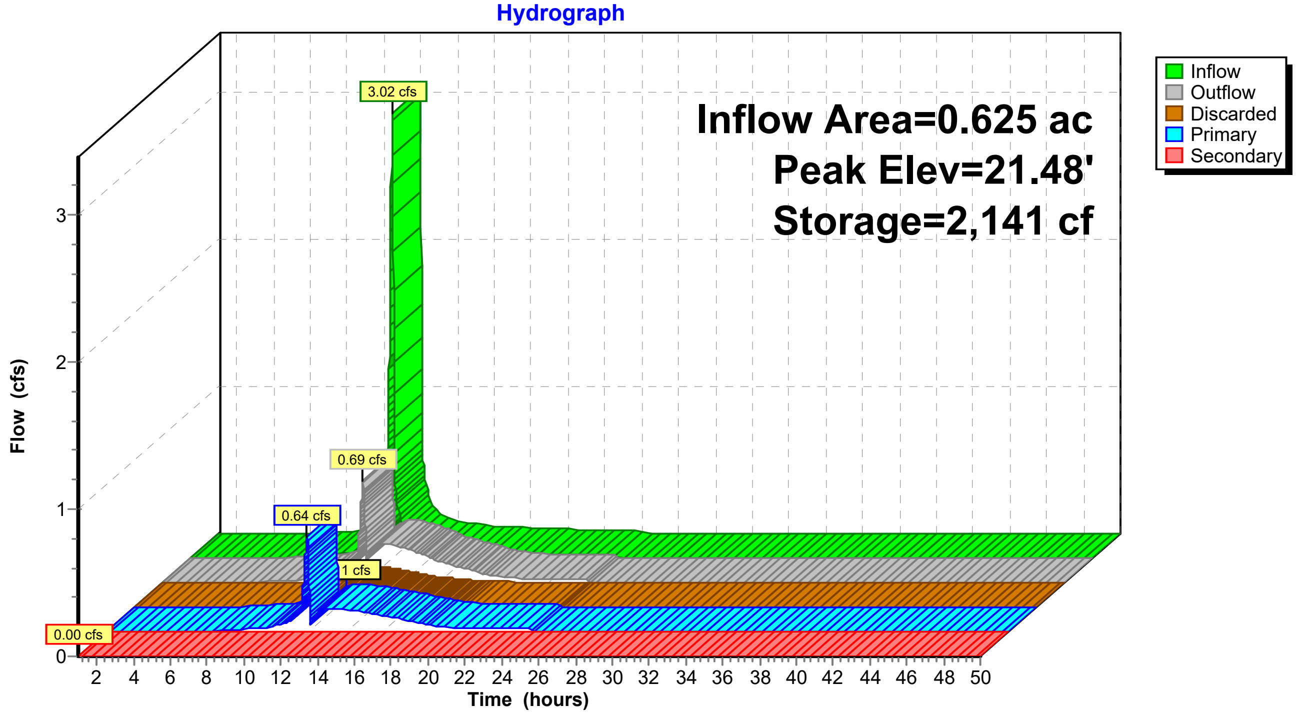
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.11 cfs @ 12.48 hrs HW=21.48' (Free Discharge)
└─**3=Exfiltration** (Controls 0.11 cfs)

Primary OutFlow Max=0.59 cfs @ 11.90 hrs HW=21.04' TW=20.84' (Dynamic Tailwater)
└─**2=Culvert** (Outlet Controls 0.59 cfs @ 1.78 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond SNO: SWALE



Summary for Pond WBMP: WEST BMP

Inflow Area = 4.557 ac, 0.00% Impervious, Inflow Depth = 1.66" for 25-Year event
Inflow = 14.11 cfs @ 11.96 hrs, Volume= 0.631 af
Outflow = 3.88 cfs @ 12.08 hrs, Volume= 0.629 af, Atten= 72%, Lag= 7.2 min
Discarded = 0.91 cfs @ 12.08 hrs, Volume= 0.095 af
Primary = 2.97 cfs @ 12.08 hrs, Volume= 0.534 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 19.87' @ 12.08 hrs Surf.Area= 7,019 sf Storage= 7,002 cf

Plug-Flow detention time= 14.7 min calculated for 0.629 af (100% of inflow)
Center-of-Mass det. time= 12.9 min (853.3 - 840.4)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	44,177 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,448	399	399
19.00	4,645	1,523	1,922
19.50	6,024	2,667	4,589
20.00	7,369	3,348	7,938
20.50	8,707	4,019	11,957
21.00	10,033	4,685	16,642
21.50	11,358	5,348	21,989
22.00	12,674	6,008	27,997
22.50	14,024	6,675	34,672
23.00	23,997	9,505	44,177

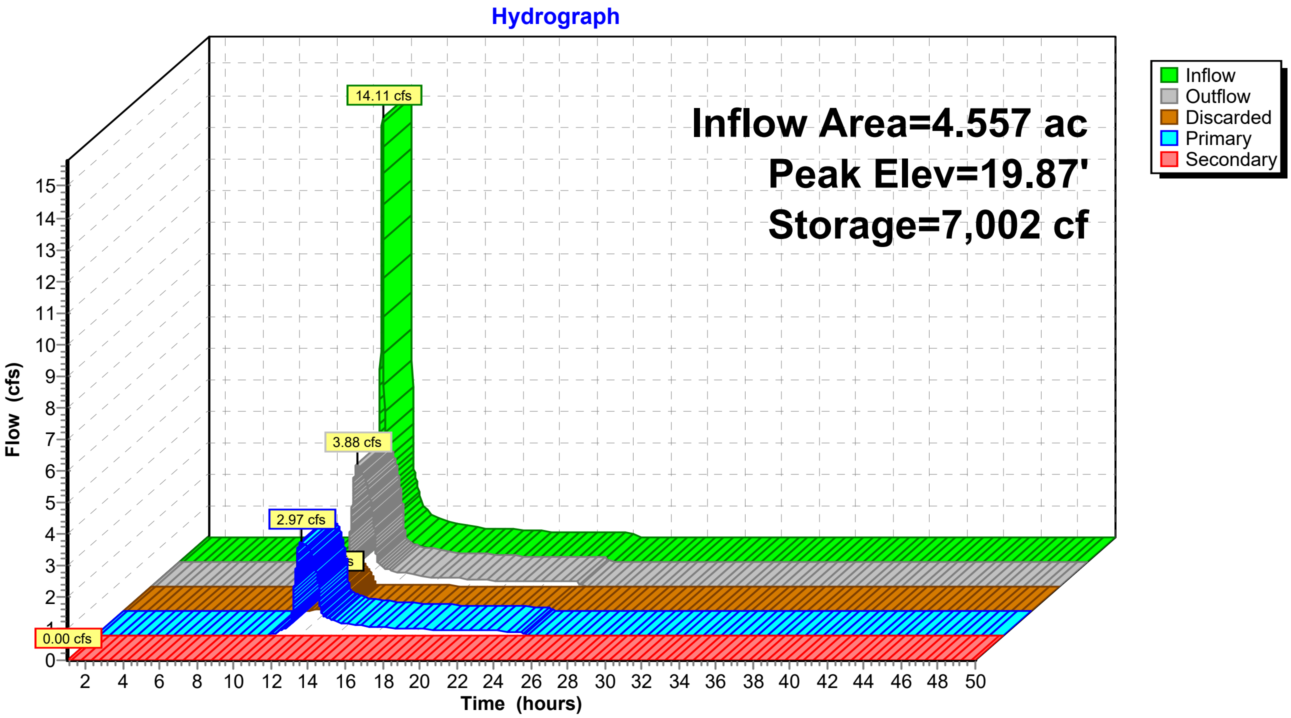
Device	Routing	Invert	Outlet Devices
#1	Primary	16.17'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.17' / 16.00' S= 0.0068 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#2	Device 1	18.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 667 sf
#4	Secondary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.91 cfs @ 12.08 hrs HW=19.87' (Free Discharge)
└─**3=Exfiltration** (Controls 0.91 cfs)

Primary OutFlow Max=2.97 cfs @ 12.08 hrs HW=19.87' (Free Discharge)
└─**1=Culvert** (Barrel Controls 2.97 cfs @ 8.51 fps)
  └─**2=Orifice/Grate** (Passes 2.97 cfs of 3.39 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond WBMP: WEST BMP



Summary for Pond WNO: WEST NO OUTLET

Inflow Area = 4.557 ac, 0.00% Impervious, Inflow Depth = 1.66" for 25-Year event
Inflow = 14.11 cfs @ 11.96 hrs, Volume= 0.631 af
Outflow = 1.24 cfs @ 12.49 hrs, Volume= 0.630 af, Atten= 91%, Lag= 31.8 min
Discarded = 1.24 cfs @ 12.49 hrs, Volume= 0.630 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 20.48' @ 12.49 hrs Surf.Area= 8,653 sf Storage= 11,633 cf

Plug-Flow detention time= 109.1 min calculated for 0.630 af (100% of inflow)
Center-of-Mass det. time= 107.5 min (947.8 - 840.4)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	43,777 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

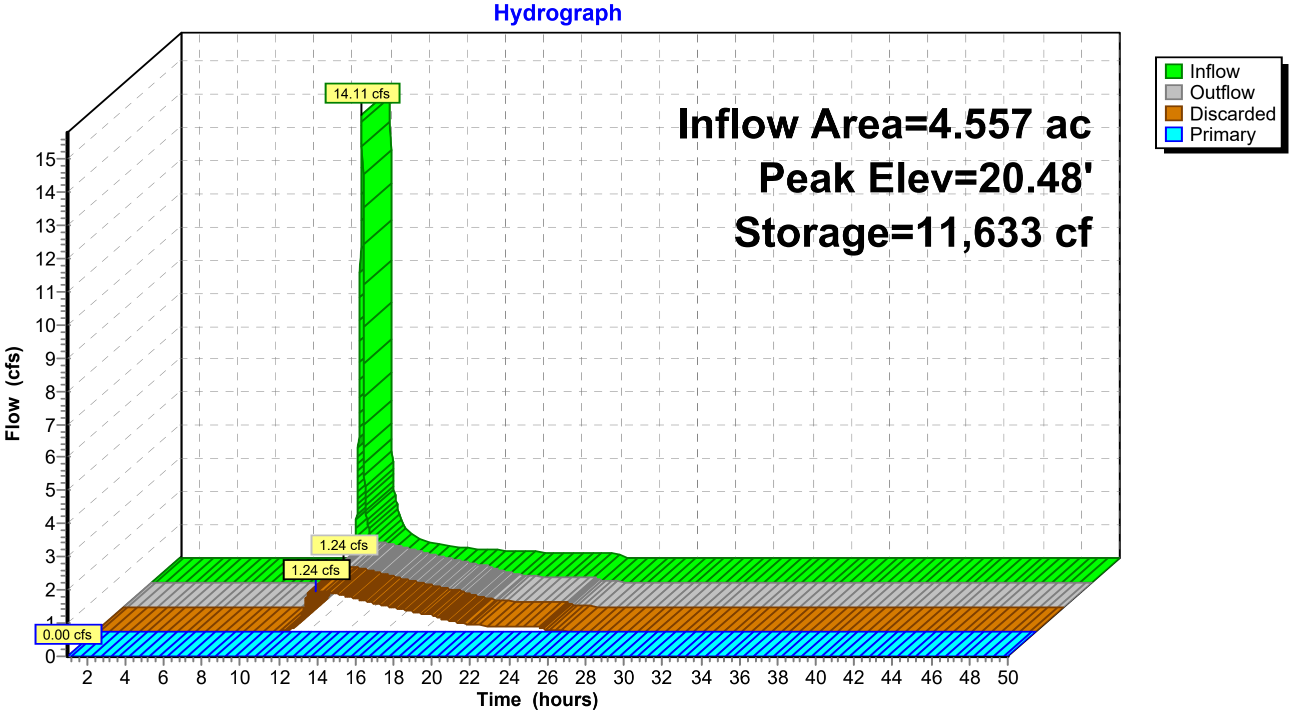
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,148	324	324
19.00	4,645	1,448	1,772
19.50	6,024	2,667	4,439
20.00	7,369	3,348	7,788
20.50	8,707	4,019	11,807
21.00	10,033	4,685	16,492
21.50	11,358	5,348	21,839
22.00	12,674	6,008	27,847
22.50	14,024	6,675	34,522
23.00	22,997	9,255	43,777

Device	Routing	Invert	Outlet Devices
#1	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 547 sf
#2	Primary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=1.24 cfs @ 12.49 hrs HW=20.48' (Free Discharge)
└─**1=Exfiltration** (Controls 1.24 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond WNO: WEST NO OUTLET



Time span=1.00-50.00 hrs, dt=0.01 hrs, 4901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1-4: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=2.05"
Tc=5.0 min CN=76 Runoff=17.37 cfs 0.779 af

Subcatchment5-6: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=2.82"
Tc=5.0 min CN=85 Runoff=3.22 cfs 0.149 af

Subcatchment7: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=3.20"
Tc=5.0 min CN=89 Runoff=3.51 cfs 0.167 af

Subcatchment7NO: 7 Runoff Area=27,236 sf 0.00% Impervious Runoff Depth=3.20"
Tc=5.0 min CN=89 Runoff=3.51 cfs 0.167 af

Subcatchment8: 8 Runoff Area=173,721 sf 0.00% Impervious Runoff Depth=1.21"
Tc=5.0 min CN=64 Runoff=8.74 cfs 0.401 af

Subcatchment9: 9 Runoff Area=51,272 sf 100.00% Impervious Runoff Depth>4.36"
Tc=5.0 min CN=100 Runoff=7.65 cfs 0.427 af

Subcatchment9C-E: 9C-E Runoff Area=47,511 sf 100.00% Impervious Runoff Depth>4.36"
Tc=5.0 min CN=100 Runoff=7.09 cfs 0.396 af

Subcatchment14NO: 1-4 Runoff Area=198,492 sf 0.00% Impervious Runoff Depth=2.05"
Tc=5.0 min CN=76 Runoff=17.37 cfs 0.779 af

Subcatchment56NO: 5-6 Runoff Area=27,568 sf 0.00% Impervious Runoff Depth=2.82"
Tc=5.0 min CN=85 Runoff=3.22 cfs 0.149 af

SubcatchmentEX1-3: EX 1-3 Runoff Area=42,470 sf 0.00% Impervious Runoff Depth=1.47"
Tc=5.0 min CN=68 Runoff=2.64 cfs 0.119 af

SubcatchmentEX8: EX 8 Runoff Area=346,757 sf 0.00% Impervious Runoff Depth=0.51"
Tc=5.0 min CN=51 Runoff=5.44 cfs 0.337 af

SubcatchmentEX9: EX 9 Runoff Area=89,002 sf 100.00% Impervious Runoff Depth>4.36"
Tc=5.0 min CN=100 Runoff=13.28 cfs 0.742 af

Pond EBMP: EAST BMP Peak Elev=21.49' Storage=3,029 cf Inflow=3.67 cfs 0.286 af
Discarded=0.37 cfs 0.201 af Primary=0.70 cfs 0.085 af Secondary=0.00 cfs 0.000 af Outflow=1.07 cfs 0.286 af

Pond ENO: EAST NO OUTLET Peak Elev=21.62' Storage=3,383 cf Inflow=3.62 cfs 0.264 af
Discarded=0.39 cfs 0.264 af Secondary=0.00 cfs 0.000 af Outflow=0.39 cfs 0.264 af

Pond EXVS: EX VEG SWALE Peak Elev=19.40' Storage=1,563 cf Inflow=2.64 cfs 0.119 af
Discarded=0.33 cfs 0.105 af Primary=0.40 cfs 0.014 af Outflow=0.73 cfs 0.119 af

Pond S: SWALE Peak Elev=21.54' Storage=2,424 cf Inflow=3.51 cfs 0.167 af
Discarded=0.12 cfs 0.029 af Primary=0.61 cfs 0.138 af Secondary=0.00 cfs 0.000 af Outflow=0.66 cfs 0.167 af

Pond SNO: SWALE Peak Elev=21.63' Storage=2,832 cf Inflow=3.51 cfs 0.167 af
Discarded=0.13 cfs 0.052 af Primary=0.60 cfs 0.115 af Secondary=0.00 cfs 0.000 af Outflow=0.65 cfs 0.167 af

Pond WBMP: WEST BMP Peak Elev=20.19' Storage=9,383 cf Inflow=17.37 cfs 0.779 af
Discarded=1.07 cfs 0.126 af Primary=3.12 cfs 0.651 af Secondary=0.00 cfs 0.000 af Outflow=4.19 cfs 0.777 af

Pond WNO: WEST NO OUTLET Peak Elev=20.83' Storage=14,867 cf Inflow=17.37 cfs 0.779 af
Discarded=1.43 cfs 0.777 af Primary=0.00 cfs 0.000 af Outflow=1.43 cfs 0.777 af

Total Runoff Area = 28.864 ac Runoff Volume = 4.610 af Average Runoff Depth = 1.92"
85.06% Pervious = 24.553 ac 14.94% Impervious = 4.311 ac

Summary for Subcatchment 1-4: 1-4

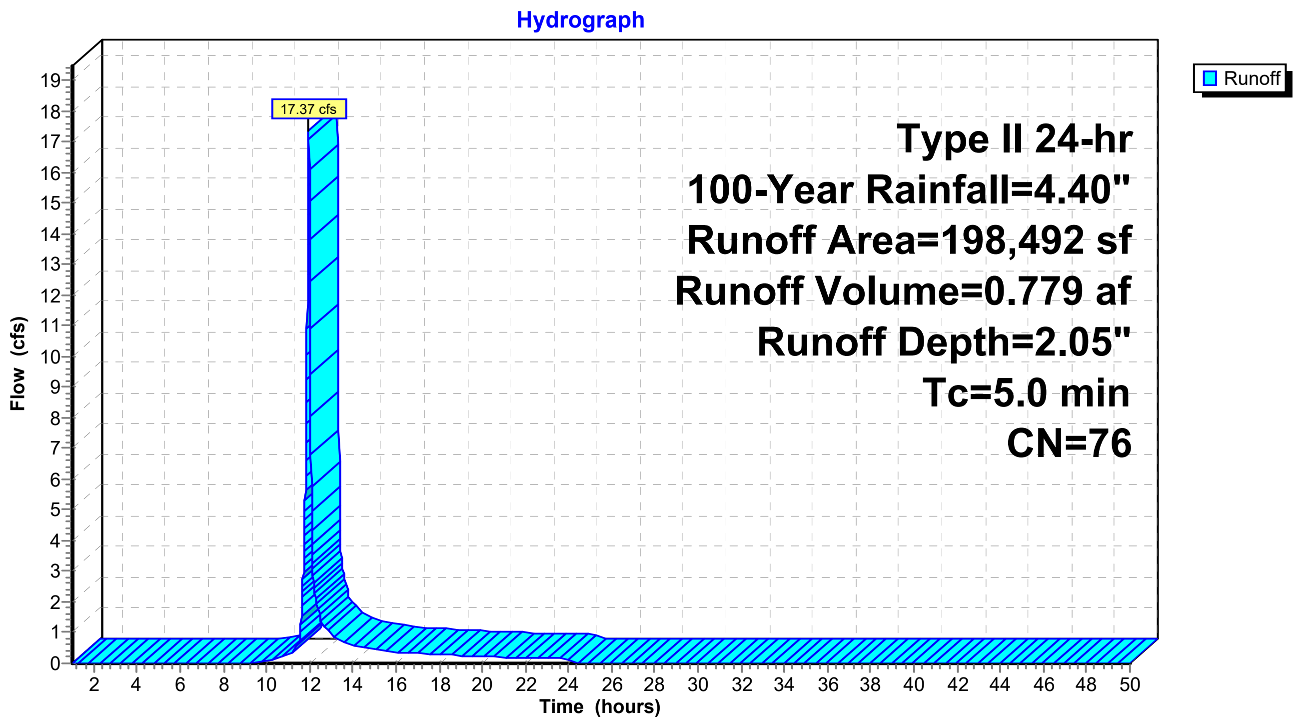
Runoff = 17.37 cfs @ 11.96 hrs, Volume= 0.779 af, Depth= 2.05"
Routed to Pond WBMP : WEST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 1-4: 1-4



Summary for Subcatchment 5-6: 5-6

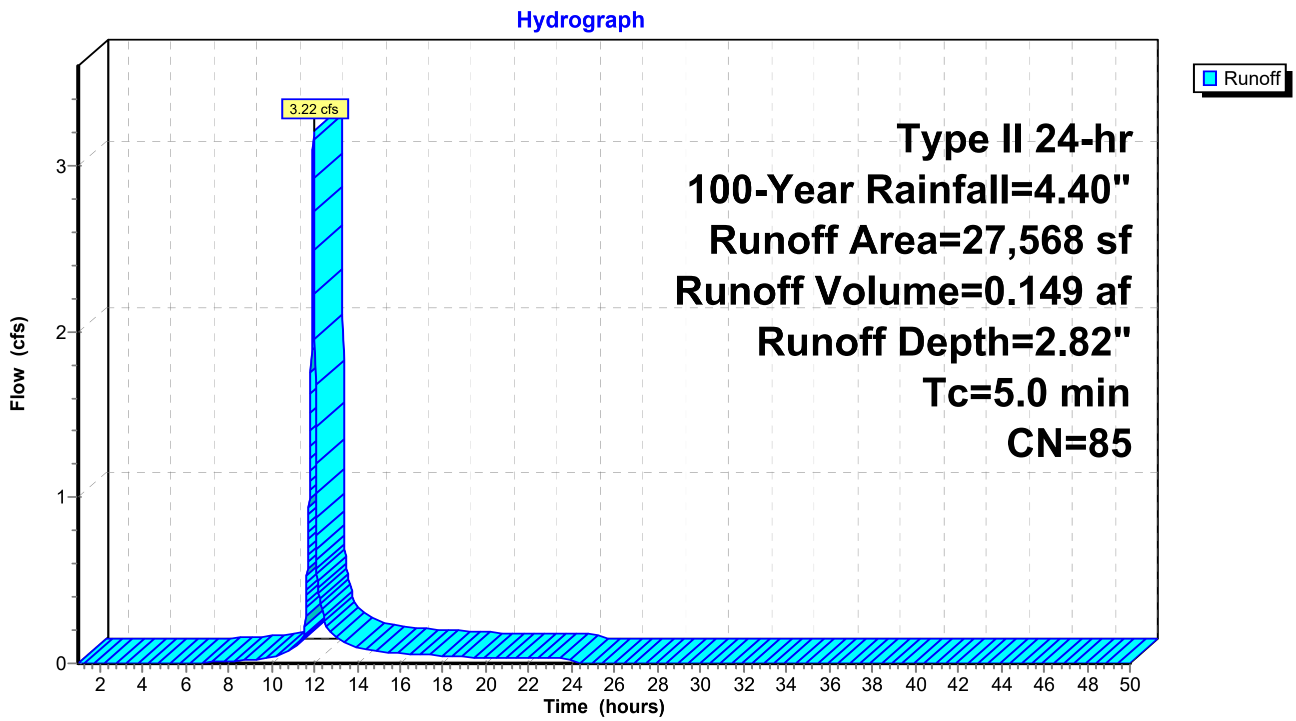
Runoff = 3.22 cfs @ 11.96 hrs, Volume= 0.149 af, Depth= 2.82"
Routed to Pond EBMP : EAST BMP

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 5-6: 5-6



Summary for Subcatchment 7: 7

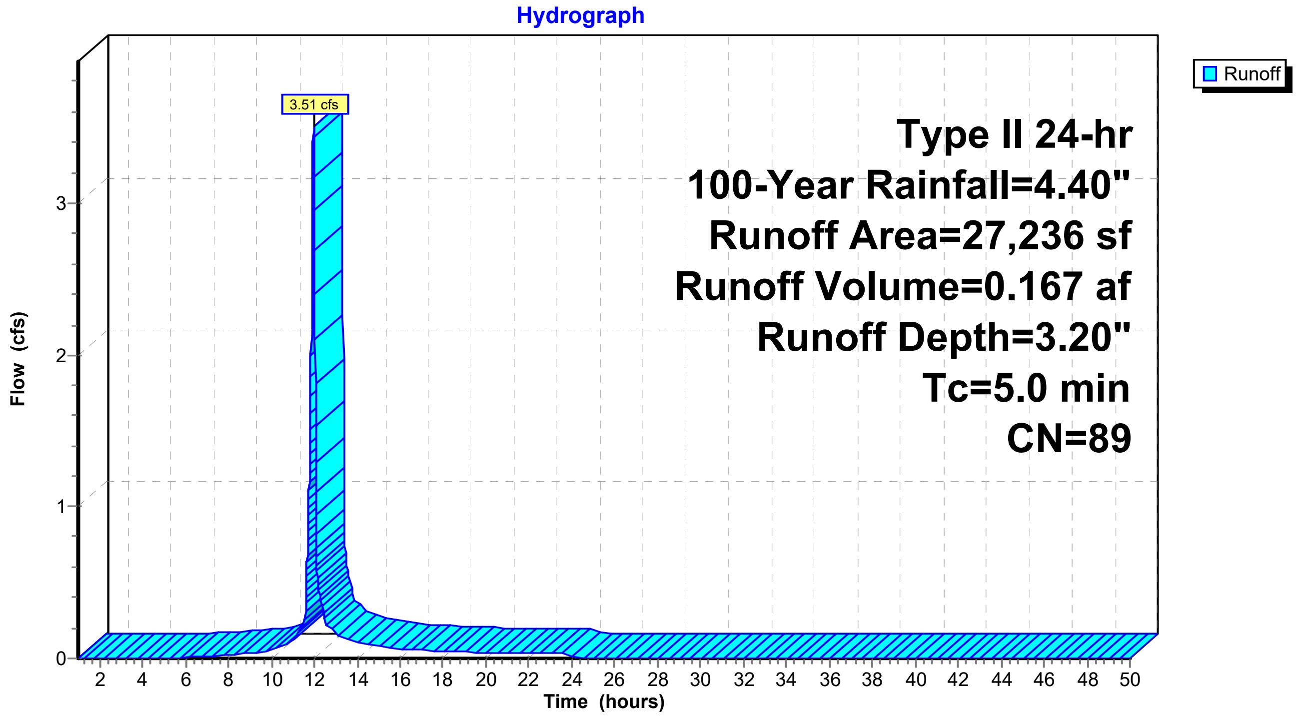
Runoff = 3.51 cfs @ 11.96 hrs, Volume= 0.167 af, Depth= 3.20"
Routed to Pond S : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7: 7



Summary for Subcatchment 7NO: 7

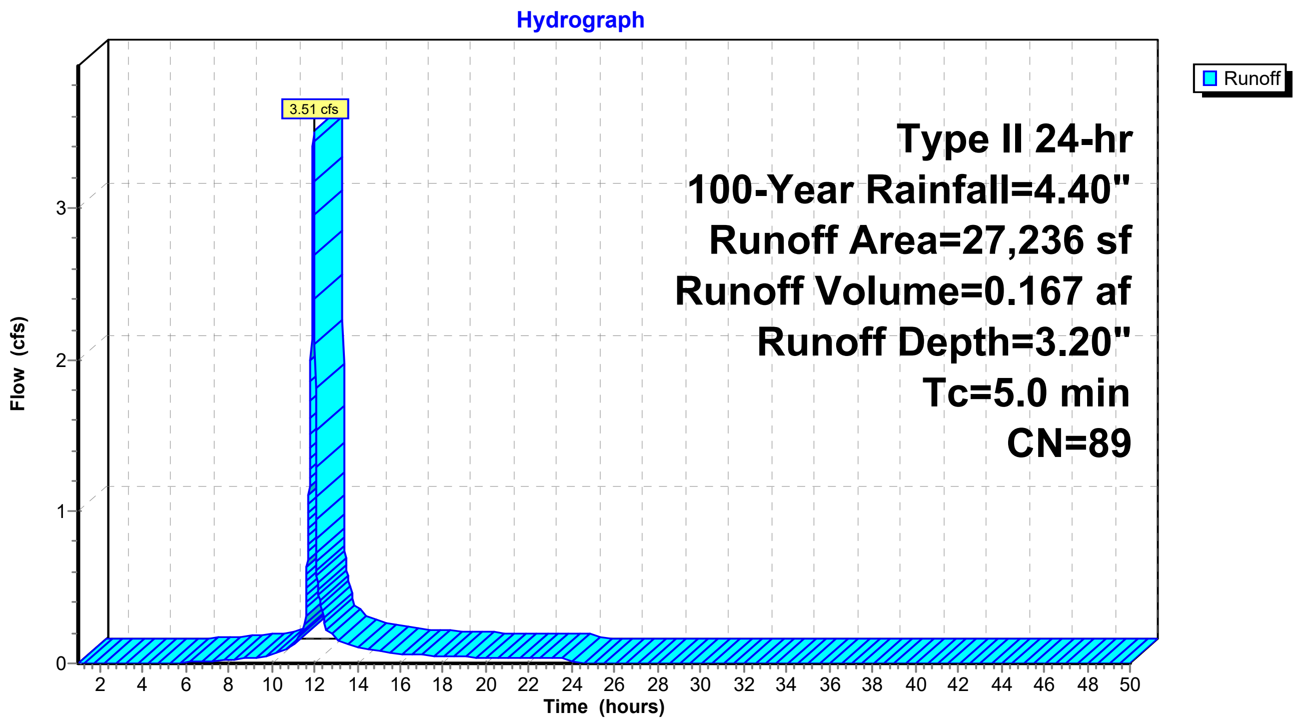
Runoff = 3.51 cfs @ 11.96 hrs, Volume= 0.167 af, Depth= 3.20"
Routed to Pond SNO : SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	27,236	89	
	27,236		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 7NO: 7



Summary for Subcatchment 8: 8

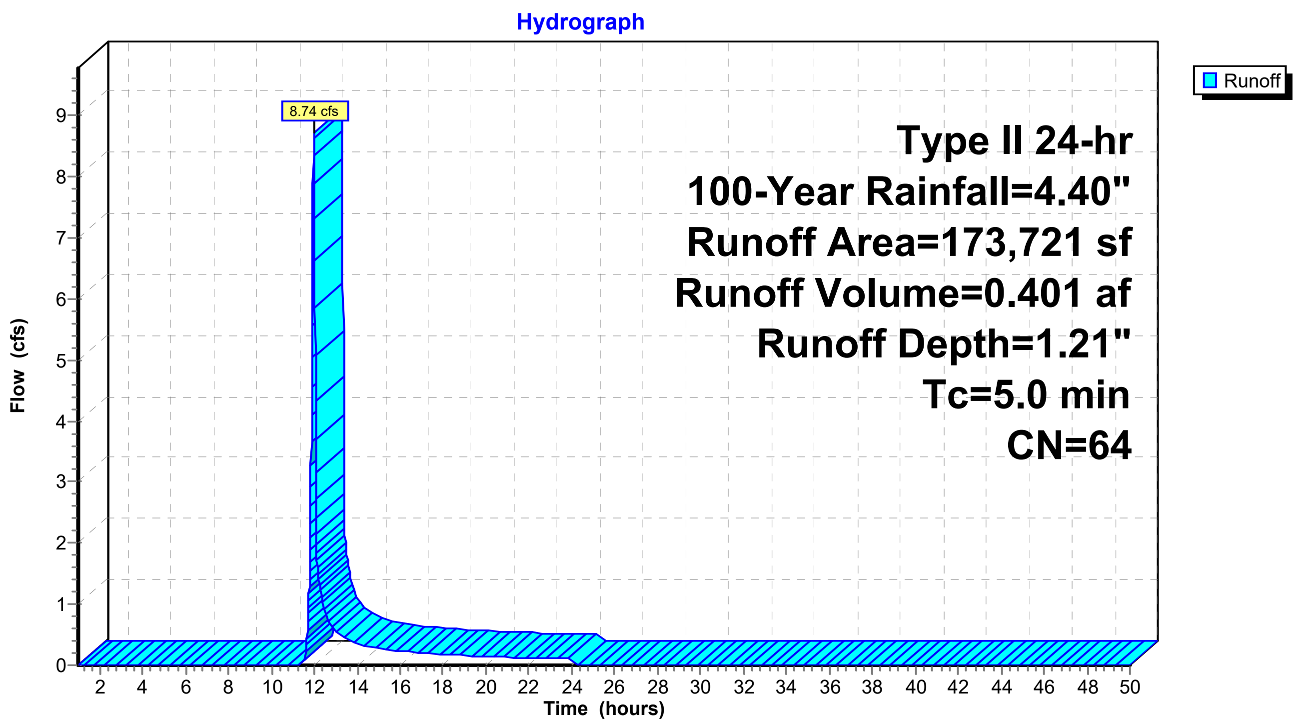
Runoff = 8.74 cfs @ 11.97 hrs, Volume= 0.401 af, Depth= 1.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	173,721	64	
	173,721		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 8: 8



Summary for Subcatchment 9: 9

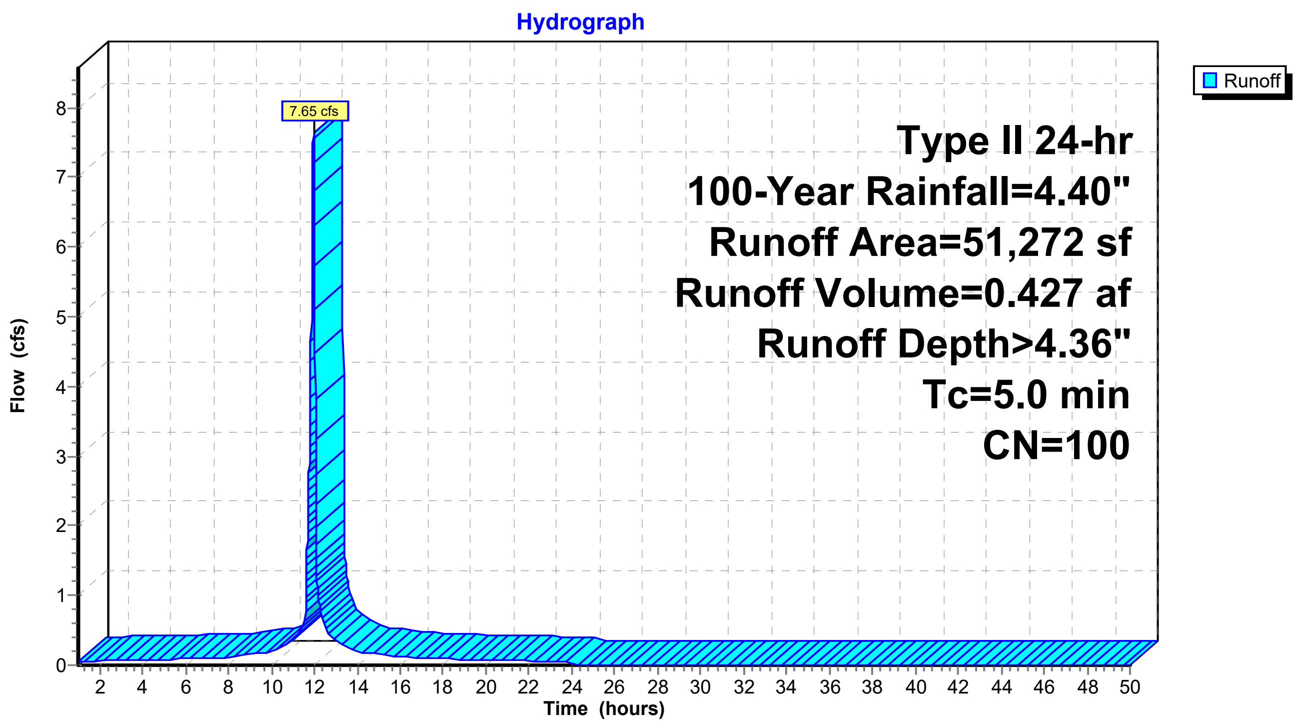
Runoff = 7.65 cfs @ 11.96 hrs, Volume= 0.427 af, Depth> 4.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	51,272	100	
	51,272		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9: 9



Summary for Subcatchment 9C-E: 9C-E

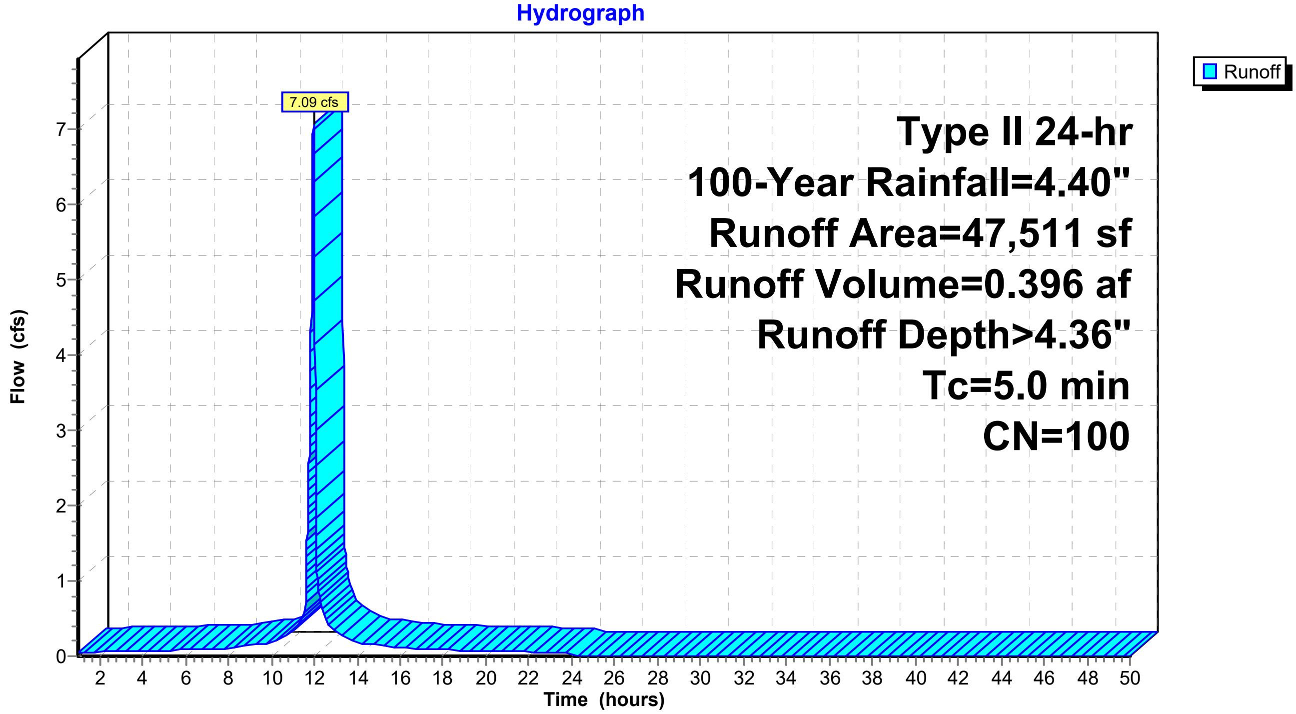
Runoff = 7.09 cfs @ 11.96 hrs, Volume= 0.396 af, Depth> 4.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	47,511	100	
	47,511		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9C-E: 9C-E



Summary for Subcatchment 14NO: 1-4

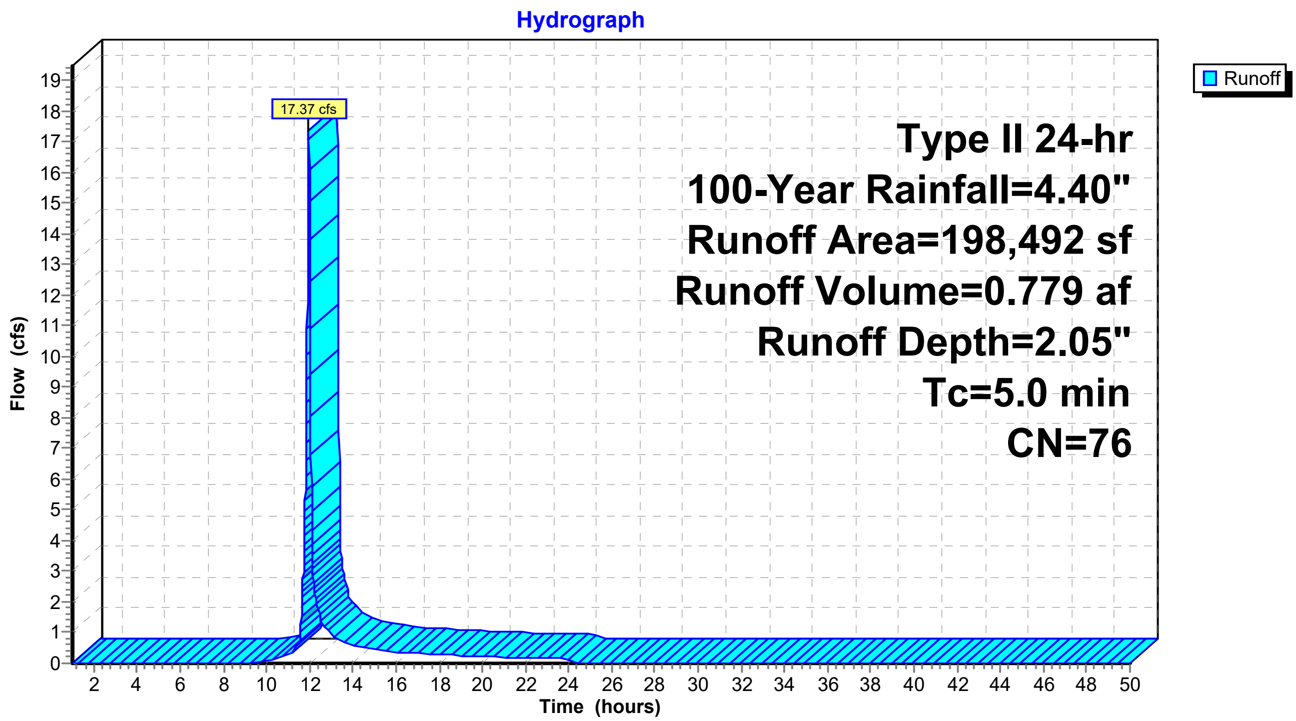
Runoff = 17.37 cfs @ 11.96 hrs, Volume= 0.779 af, Depth= 2.05"
Routed to Pond WNO : WEST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	198,492	76	
	198,492		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 14NO: 1-4



Summary for Subcatchment 56NO: 5-6

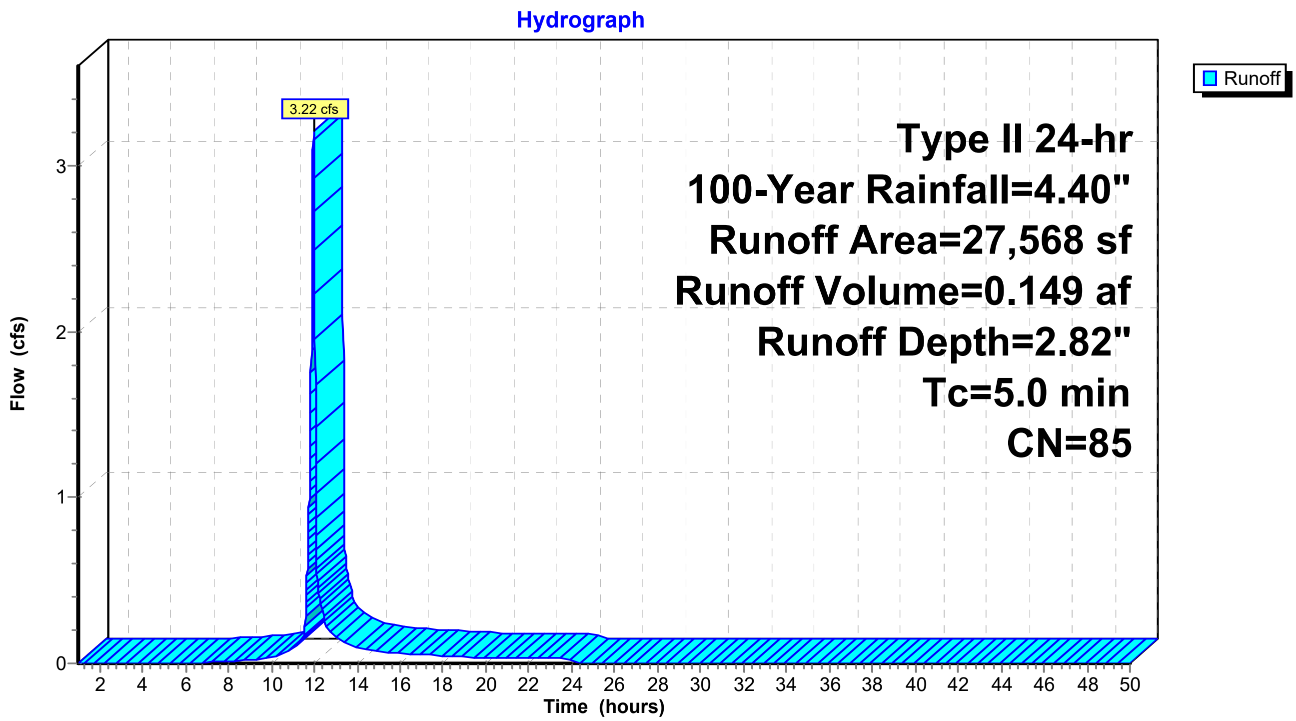
Runoff = 3.22 cfs @ 11.96 hrs, Volume= 0.149 af, Depth= 2.82"
Routed to Pond ENO : EAST NO OUTLET

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	27,568	85	
	27,568		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 56NO: 5-6



Summary for Subcatchment EX1-3: EX 1-3

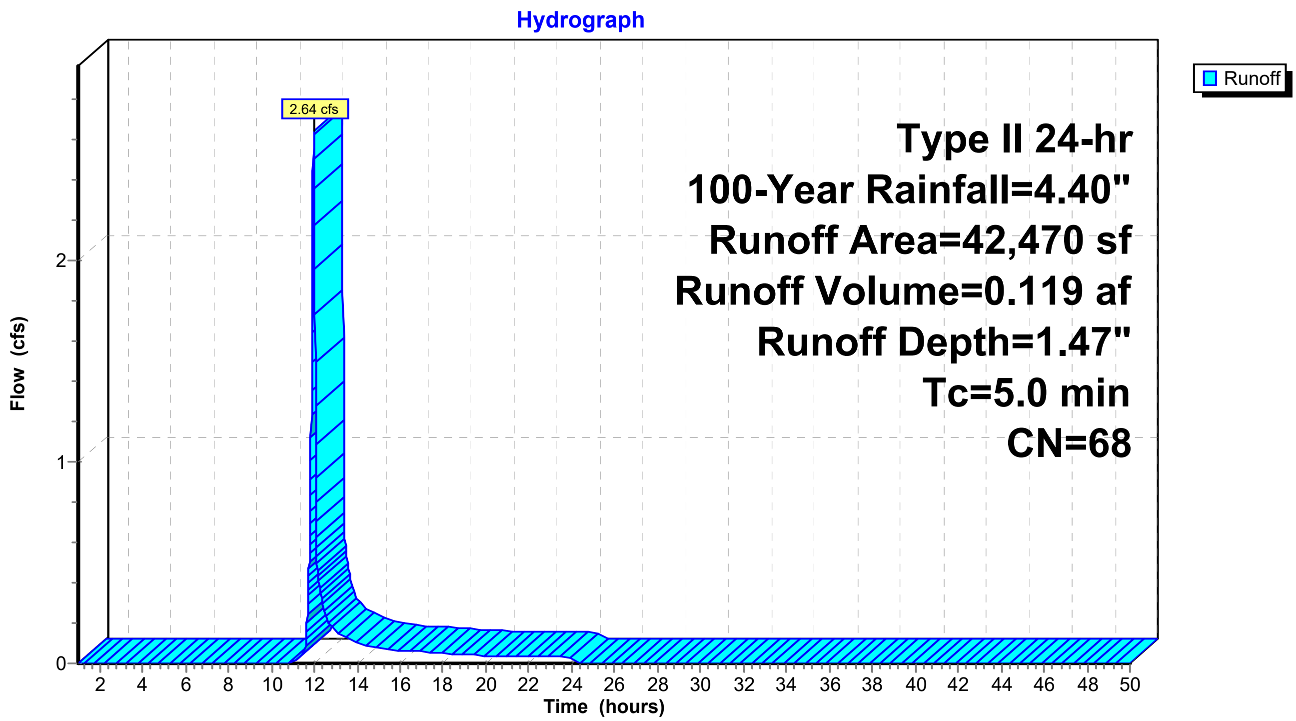
Runoff = 2.64 cfs @ 11.97 hrs, Volume= 0.119 af, Depth= 1.47"
Routed to Pond EXVS : EX VEG SWALE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	42,470	68	
	42,470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX1-3: EX 1-3



Summary for Subcatchment EX8: EX 8

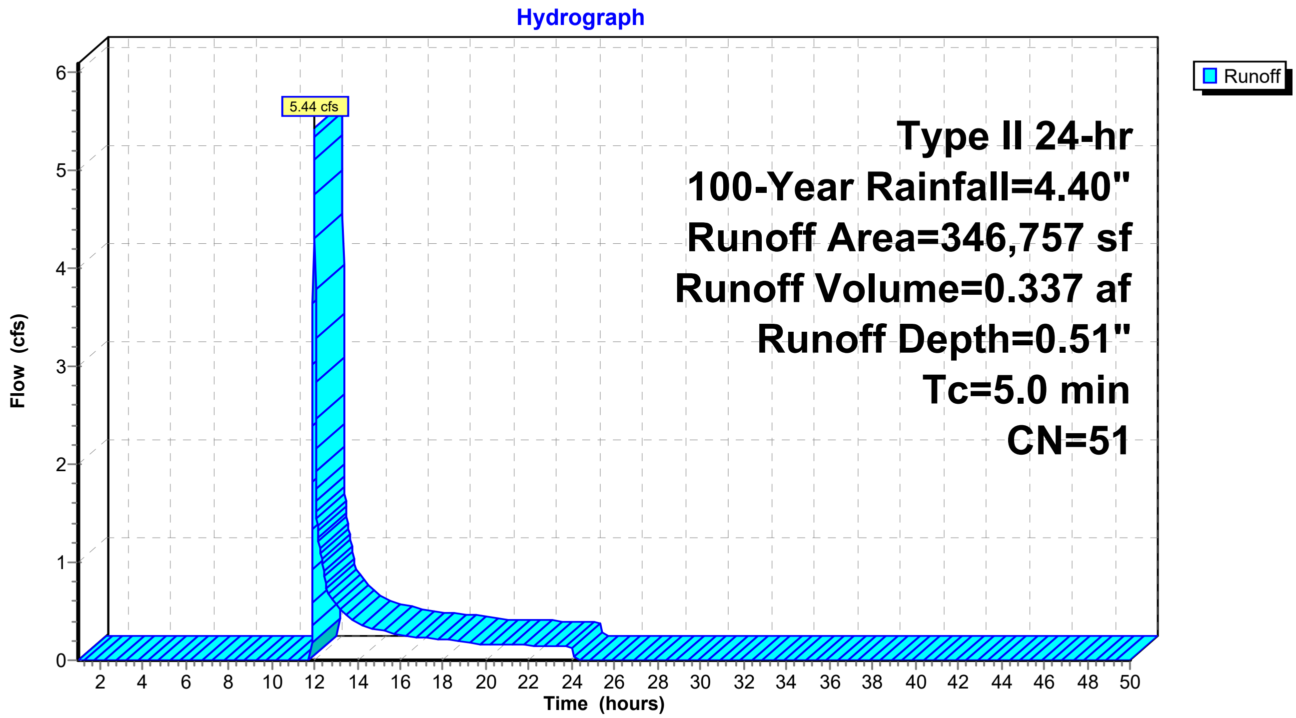
Runoff = 5.44 cfs @ 11.99 hrs, Volume= 0.337 af, Depth= 0.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	346,757	51	
	346,757		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX8: EX 8



Summary for Subcatchment EX9: EX 9

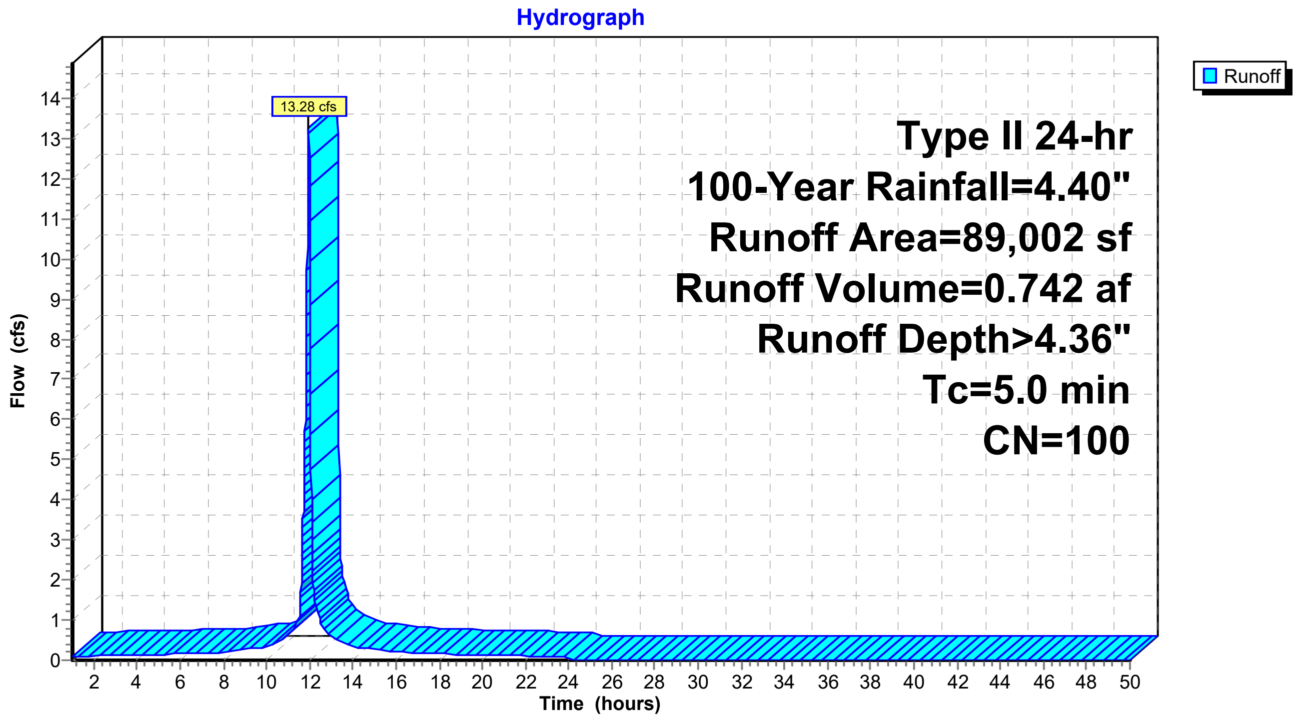
Runoff = 13.28 cfs @ 11.96 hrs, Volume= 0.742 af, Depth> 4.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-Year Rainfall=4.40"

	Area (sf)	CN	Description
*	89,002	100	
	89,002		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment EX9: EX 9



Summary for Pond EBMP: EAST BMP

Inflow Area = 1.258 ac, 0.00% Impervious, Inflow Depth = 2.73" for 100-Year event
Inflow = 3.67 cfs @ 11.96 hrs, Volume= 0.286 af
Outflow = 1.07 cfs @ 12.09 hrs, Volume= 0.286 af, Atten= 71%, Lag= 7.8 min
Discarded = 0.37 cfs @ 12.09 hrs, Volume= 0.201 af
Primary = 0.70 cfs @ 12.09 hrs, Volume= 0.085 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.49' @ 12.09 hrs Surf.Area= 2,693 sf Storage= 3,029 cf

Plug-Flow detention time= 47.0 min calculated for 0.286 af (100% of inflow)
Center-of-Mass det. time= 47.0 min (865.7 - 818.7)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

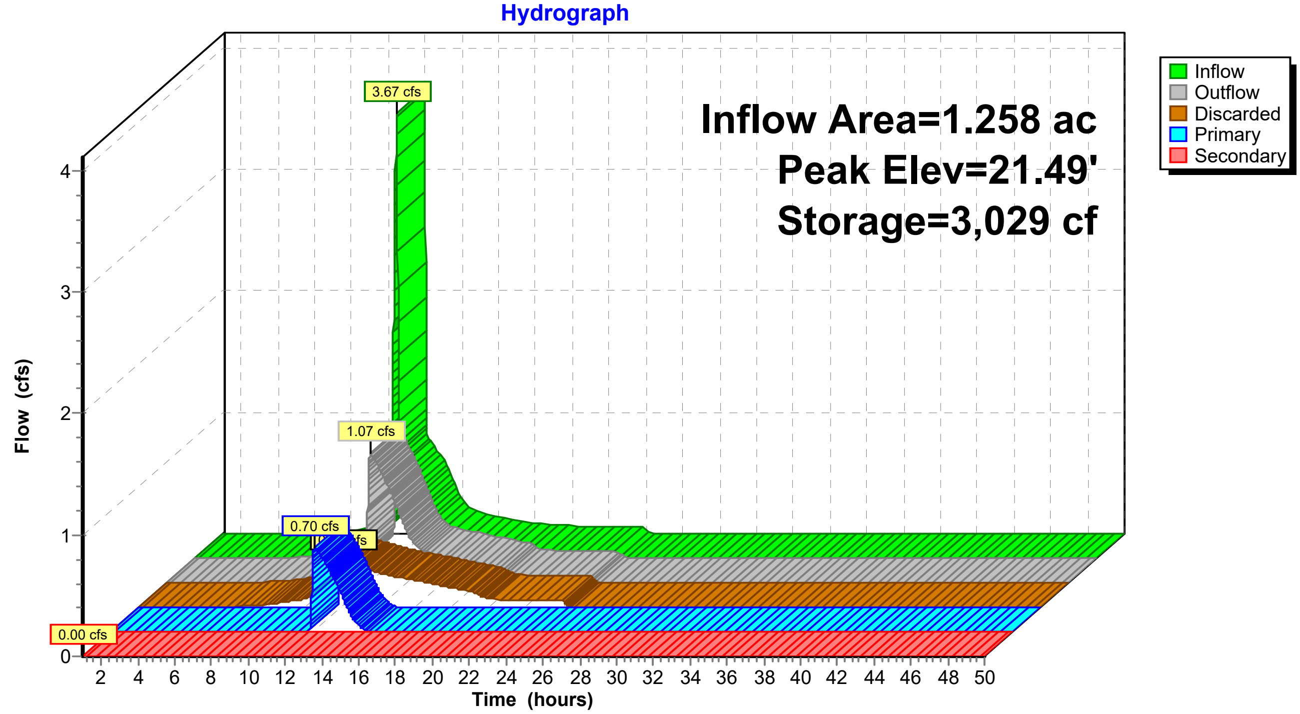
Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	19.81'	**6.0" Round Culvert** L= 92.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 19.81' / 19.35' S= 0.0050 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf
#3	Device 2	20.70'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.37 cfs @ 12.09 hrs HW=21.49' (Free Discharge)
└─**4=Exfiltration** (Controls 0.37 cfs)

Primary OutFlow Max=0.70 cfs @ 12.09 hrs HW=21.49' (Free Discharge)
└─**2=Culvert** (Passes 0.70 cfs of 0.74 cfs potential flow)
  └─**3=Orifice/Grate** (Orifice Controls 0.70 cfs @ 3.55 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond EBMP: EAST BMP



Summary for Pond ENO: EAST NO OUTLET

[80] Warning: Exceeded Pond SNO by 0.05' @ 12.08 hrs (0.27 cfs 0.006 af)

Inflow Area = 1.258 ac, 0.00% Impervious, Inflow Depth = 2.52" for 100-Year event
Inflow = 3.62 cfs @ 11.95 hrs, Volume= 0.264 af
Outflow = 0.39 cfs @ 12.24 hrs, Volume= 0.264 af, Atten= 89%, Lag= 17.2 min
Discarded = 0.39 cfs @ 12.24 hrs, Volume= 0.264 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.62' @ 12.24 hrs Surf.Area= 2,801 sf Storage= 3,383 cf

Plug-Flow detention time= 92.5 min calculated for 0.264 af (100% of inflow)
Center-of-Mass det. time= 92.5 min (933.0 - 840.5)

Volume	Invert	Avail.Storage	Storage Description
#1	19.80'	7,622 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

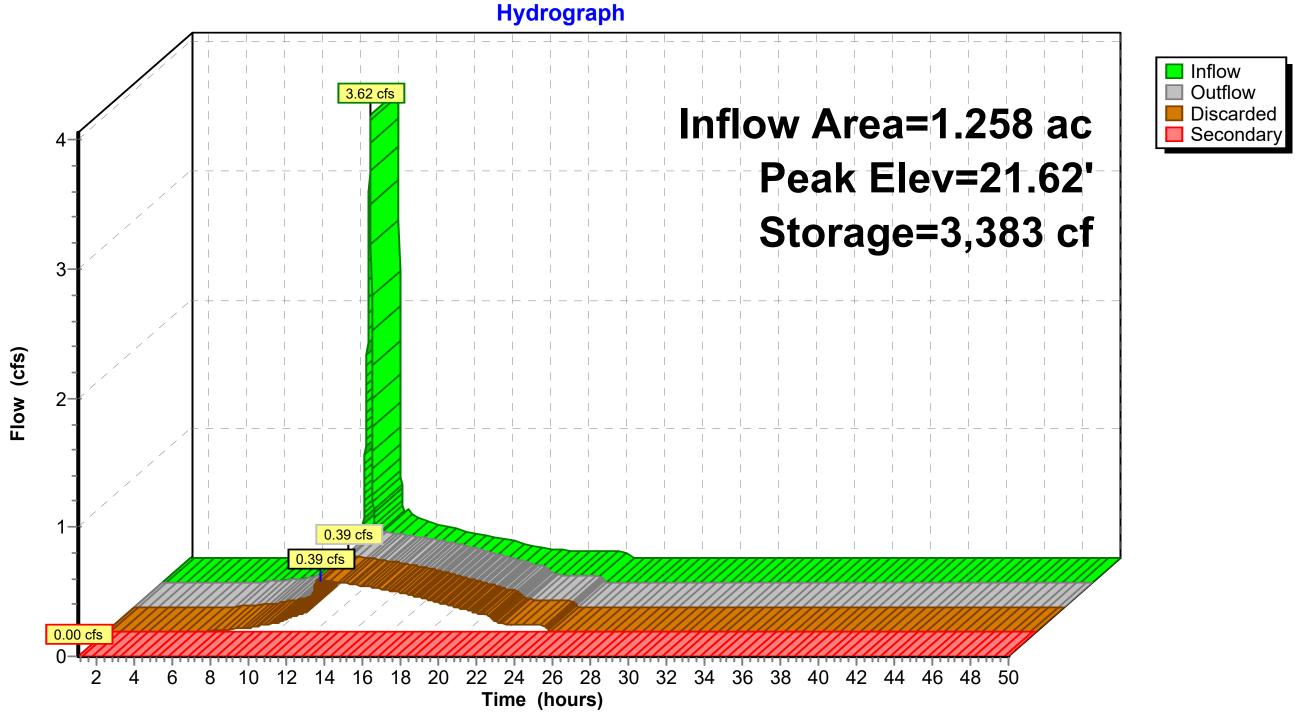
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
19.80	0	0	0
20.00	1,107	111	111
21.00	2,279	1,693	1,804
22.00	3,119	2,699	4,503
23.00	3,119	3,119	7,622

Device	Routing	Invert	Outlet Devices
#1	Secondary	21.75'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Discarded	19.81'	**5.000 in/hr Exfiltration over Surface area from 19.81' - 21.60'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 55 sf

Discarded OutFlow Max=0.39 cfs @ 12.24 hrs HW=21.62' (Free Discharge)
└─**2=Exfiltration** (Controls 0.39 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=19.80' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond ENO: EAST NO OUTLET



Summary for Pond EXVS: EX VEG SWALE

Inflow Area =	0.975 ac,	0.00% Impervious,	Inflow Depth = 1.47"	for 100-Year event
Inflow =	2.64 cfs @	11.97 hrs, Volume=	0.119 af	
Outflow =	0.73 cfs @	12.09 hrs, Volume=	0.119 af,	Atten= 72%, Lag= 7.2 min
Discarded =	0.33 cfs @	12.09 hrs, Volume=	0.105 af	
Primary =	0.40 cfs @	12.09 hrs, Volume=	0.014 af	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 19.40' @ 12.09 hrs Surf.Area= 2,461 sf Storage= 1,563 cf

Plug-Flow detention time= 36.5 min calculated for 0.119 af (100% of inflow)
Center-of-Mass det. time= 36.5 min (892.7 - 856.1)

Volume	Invert	Avail.Storage	Storage Description
#1	18.20'	36,604 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

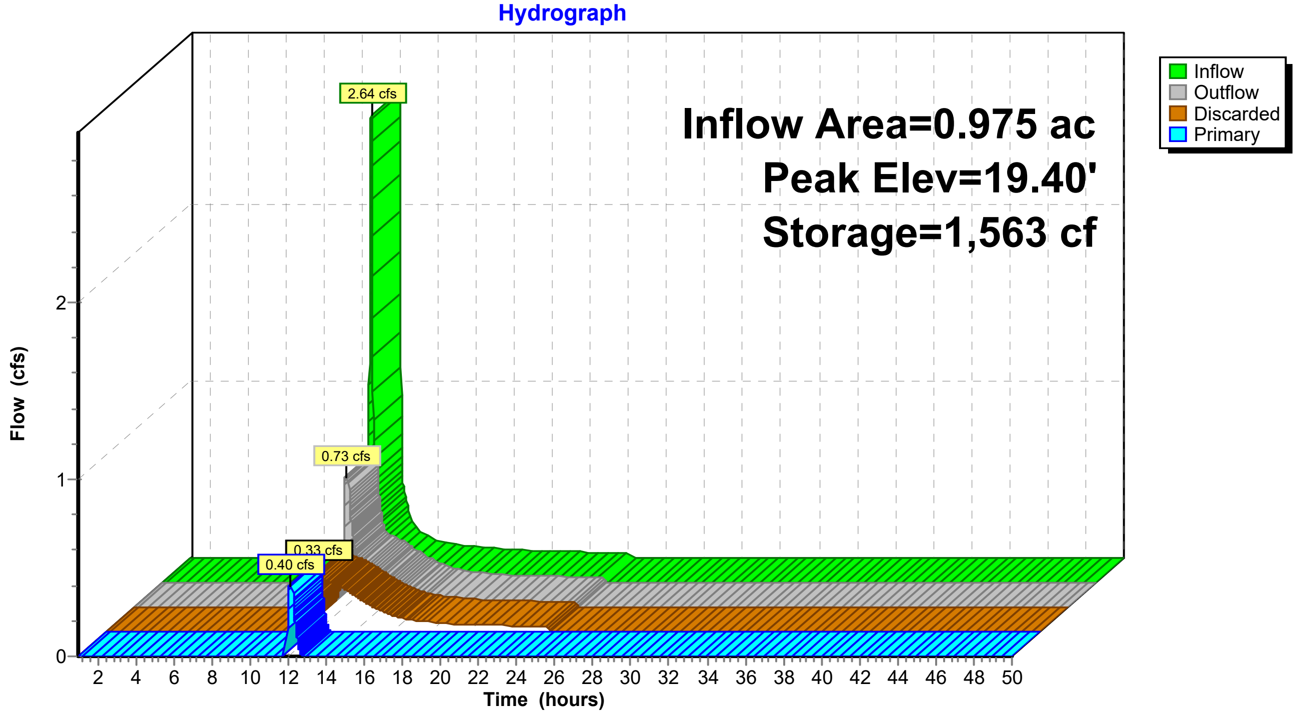
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.20	0	0	0
19.00	1,791	716	716
20.00	3,474	2,633	3,349
21.00	5,191	4,333	7,681
22.00	6,970	6,081	13,762
23.00	12,905	9,938	23,699
24.00	12,905	12,905	36,604

Device	Routing	Invert	Outlet Devices
#1	Primary	16.13'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.13' / 16.00' S= 0.0052 '/' Cc= 0.900 n= 0.130, Flow Area= 0.35 sf
#2	Device 1	19.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.00' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.33 cfs @ 12.09 hrs HW=19.40' (Free Discharge)
└──**3=Exfiltration** (Controls 0.33 cfs)

Primary OutFlow Max=0.40 cfs @ 12.09 hrs HW=19.40' (Free Discharge)
└──**1=Culvert** (Barrel Controls 0.40 cfs @ 1.14 fps)
  └──**2=Orifice/Grate** (Passes 0.40 cfs of 0.75 cfs potential flow)

Pond EXVS: EX VEG SWALE



Summary for Pond S: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 3.20" for 100-Year event
Inflow = 3.51 cfs @ 11.96 hrs, Volume= 0.167 af
Outflow = 0.66 cfs @ 11.87 hrs, Volume= 0.167 af, Atten= 81%, Lag= 0.0 min
Discarded = 0.12 cfs @ 12.18 hrs, Volume= 0.029 af
Primary = 0.61 cfs @ 11.87 hrs, Volume= 0.138 af
Routed to Pond EBMP : EAST BMP
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.54' @ 12.18 hrs Surf.Area= 4,801 sf Storage= 2,424 cf

Plug-Flow detention time= 36.0 min calculated for 0.167 af (100% of inflow)
Center-of-Mass det. time= 36.0 min (830.8 - 794.9)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

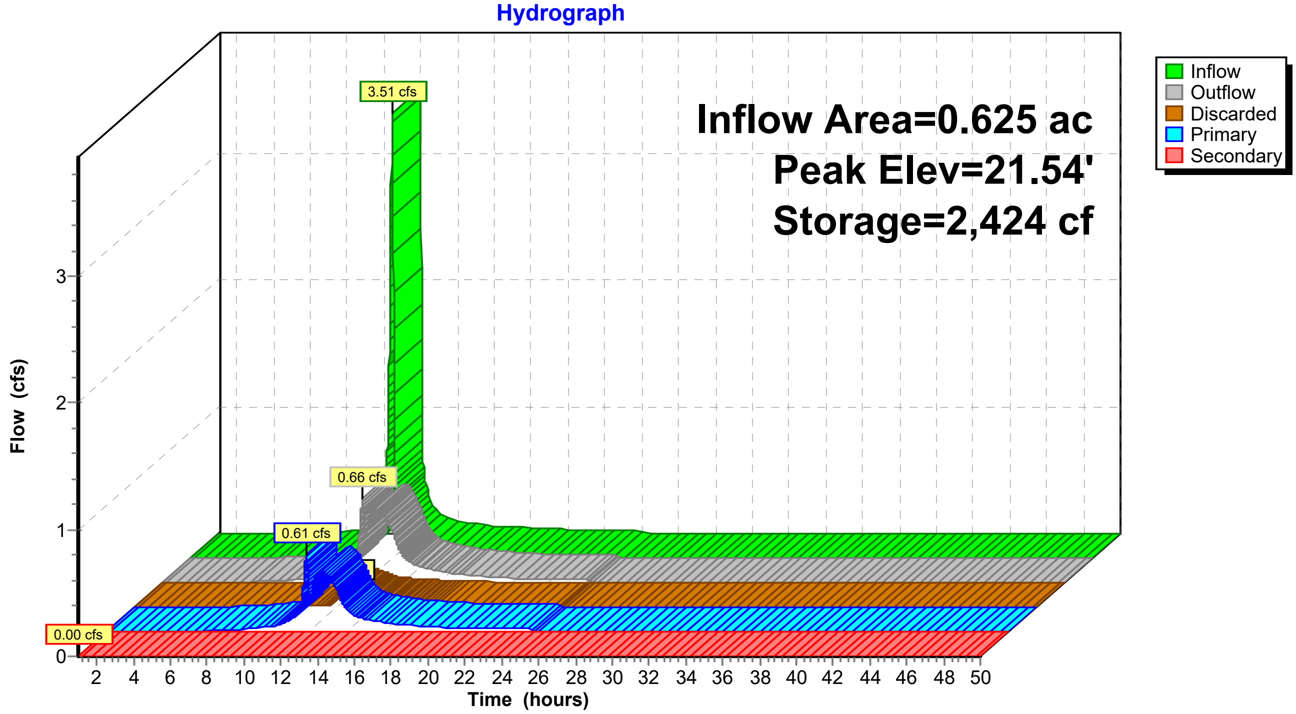
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.12 cfs @ 12.18 hrs HW=21.54' (Free Discharge)
└─**3=Exfiltration** (Controls 0.12 cfs)

Primary OutFlow Max=0.55 cfs @ 11.87 hrs HW=21.05' TW=20.87' (Dynamic Tailwater)
└─**2=Culvert** (Outlet Controls 0.55 cfs @ 1.67 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond S: SWALE


Hydrograph
Inflow Area=0.625 ac
Peak Elev=21.54'
Storage=2,424 cf
Inflow
Outflow
Discarded
Primary
Secondary
3.51 cfs
0.66 cfs
0.61 cfs
0.00 cfs
Flow (cfs)
Time (hours)
0
1
2
3
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

Summary for Pond SNO: SWALE

Inflow Area = 0.625 ac, 0.00% Impervious, Inflow Depth = 3.20" for 100-Year event
Inflow = 3.51 cfs @ 11.96 hrs, Volume= 0.167 af
Outflow = 0.65 cfs @ 11.87 hrs, Volume= 0.167 af, Atten= 81%, Lag= 0.0 min
Discarded = 0.13 cfs @ 12.52 hrs, Volume= 0.052 af
Primary = 0.60 cfs @ 11.87 hrs, Volume= 0.115 af
Routed to Pond ENO : EAST NO OUTLET
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 21.63' @ 12.52 hrs Surf.Area= 5,260 sf Storage= 2,832 cf

Plug-Flow detention time= 82.8 min calculated for 0.167 af (100% of inflow)
Center-of-Mass det. time= 82.8 min (877.7 - 794.9)

Volume	Invert	Avail.Storage	Storage Description
#1	20.25'	17,631 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.25	0	0	0
21.00	1,725	647	647
22.00	7,374	4,550	5,196
23.00	17,496	12,435	17,631

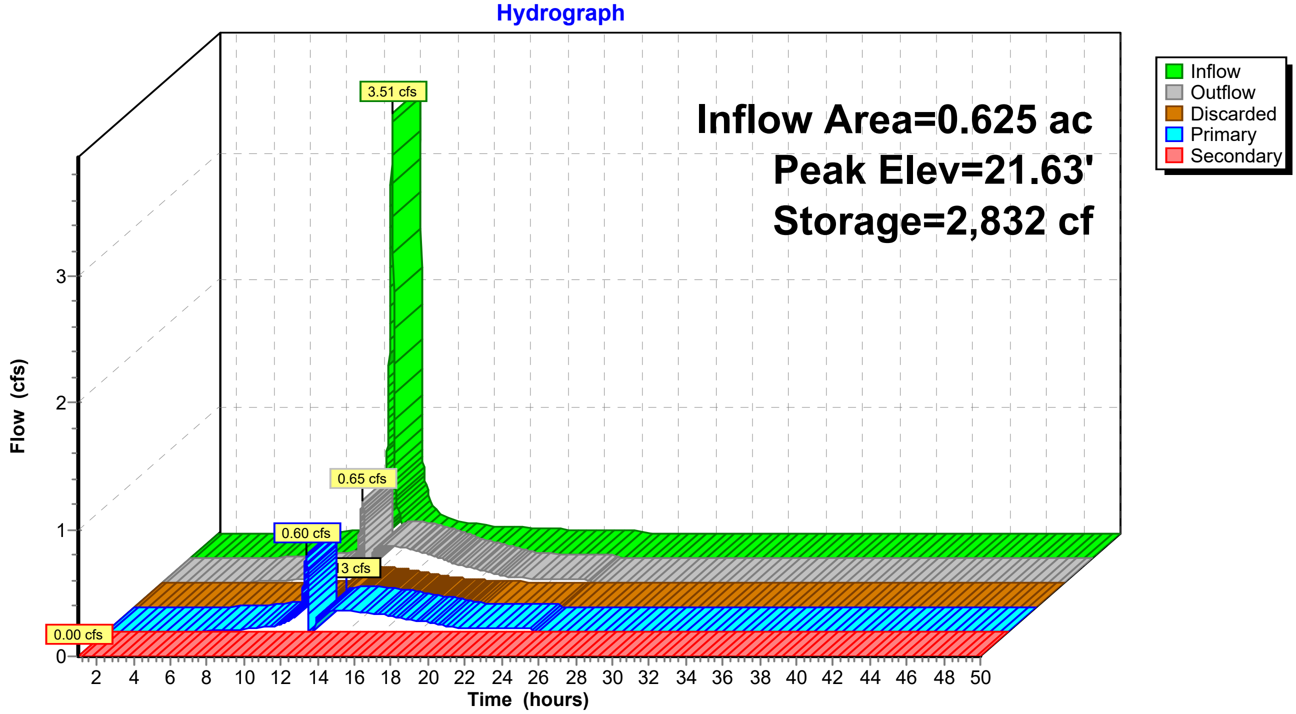
Device	Routing	Invert	Outlet Devices
#1	Secondary	22.05'	**10.0' long + 10.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64
#2	Primary	20.25'	**8.0" Round Culvert** L= 74.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 20.25' / 19.92' S= 0.0045 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Discarded	20.25'	**1.000 in/hr Exfiltration over Surface area from 20.25' - 22.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 0 sf

Discarded OutFlow Max=0.13 cfs @ 12.52 hrs HW=21.63' (Free Discharge)
└─**3=Exfiltration** (Controls 0.13 cfs)

Primary OutFlow Max=0.55 cfs @ 11.87 hrs HW=21.04' TW=20.86' (Dynamic Tailwater)
└─**2=Culvert** (Outlet Controls 0.55 cfs @ 1.67 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=20.25' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond SNO: SWALE



Summary for Pond WBMP: WEST BMP

Inflow Area =	4.557 ac,	0.00% Impervious, Inflow Depth = 2.05"	for 100-Year event
Inflow =	17.37 cfs @	11.96 hrs, Volume=	0.779 af
Outflow =	4.19 cfs @	12.09 hrs, Volume=	0.777 af, Atten= 76%, Lag= 7.8 min
Discarded =	1.07 cfs @	12.09 hrs, Volume=	0.126 af
Primary =	3.12 cfs @	12.09 hrs, Volume=	0.651 af
Secondary =	0.00 cfs @	1.00 hrs, Volume=	0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 20.19' @ 12.09 hrs Surf.Area= 7,877 sf Storage= 9,383 cf

Plug-Flow detention time= 17.4 min calculated for 0.777 af (100% of inflow)
Center-of-Mass det. time= 15.9 min (850.2 - 834.3)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	44,177 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,448	399	399
19.00	4,645	1,523	1,922
19.50	6,024	2,667	4,589
20.00	7,369	3,348	7,938
20.50	8,707	4,019	11,957
21.00	10,033	4,685	16,642
21.50	11,358	5,348	21,989
22.00	12,674	6,008	27,997
22.50	14,024	6,675	34,672
23.00	23,997	9,505	44,177

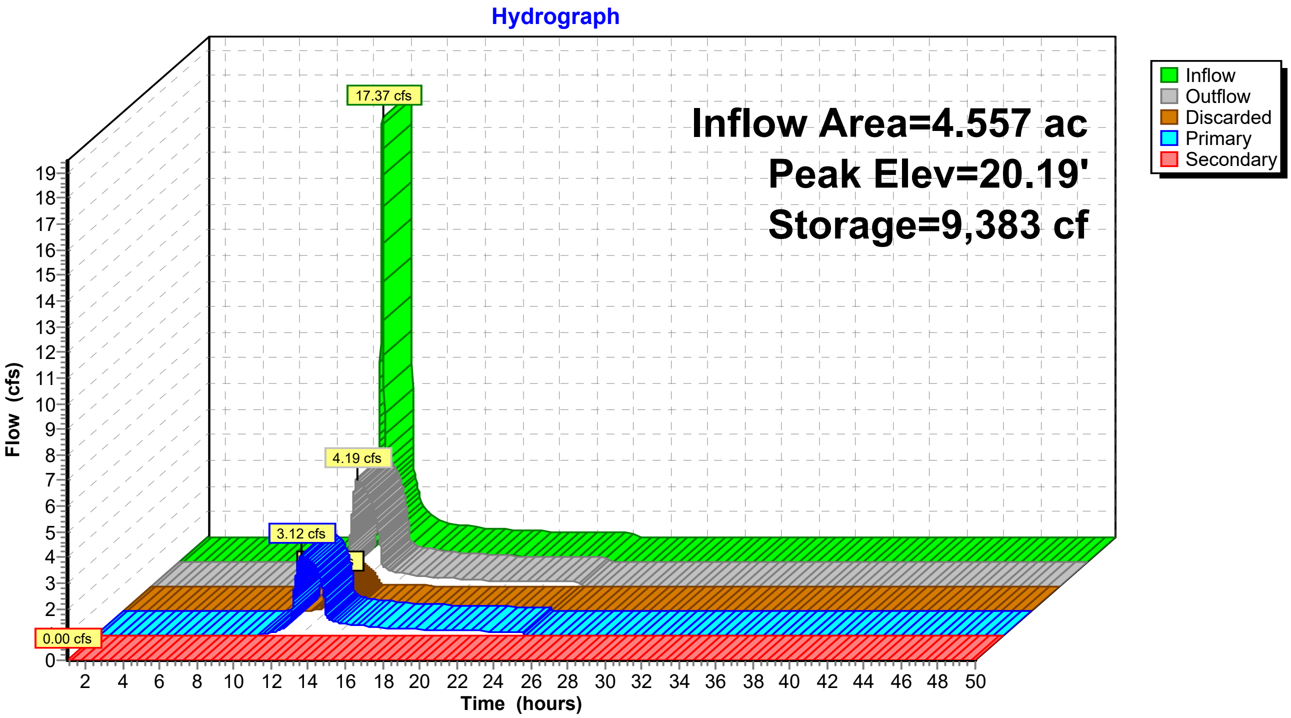
Device	Routing	Invert	Outlet Devices
#1	Primary	16.17'	**8.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.17' / 16.00' S= 0.0068 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#2	Device 1	18.20'	**10.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 667 sf
#4	Secondary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=1.07 cfs @ 12.09 hrs HW=20.19' (Free Discharge)
└─**3=Exfiltration** (Controls 1.07 cfs)

Primary OutFlow Max=3.12 cfs @ 12.09 hrs HW=20.19' (Free Discharge)
└─**1=Culvert** (Barrel Controls 3.12 cfs @ 8.93 fps)
  └─**2=Orifice/Grate** (Passes 3.12 cfs of 3.70 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond WBMP: WEST BMP



Summary for Pond WNO: WEST NO OUTLET

Inflow Area =	4.557 ac,	0.00% Impervious,	Inflow Depth = 2.05"	for 100-Year event
Inflow =	17.37 cfs @	11.96 hrs, Volume=	0.779 af	
Outflow =	1.43 cfs @	12.51 hrs, Volume=	0.777 af,	Atten= 92%, Lag= 33.0 min
Discarded =	1.43 cfs @	12.51 hrs, Volume=	0.777 af	
Primary =	0.00 cfs @	1.00 hrs, Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-50.00 hrs, dt= 0.01 hrs
Peak Elev= 20.83' @ 12.51 hrs Surf.Area= 9,594 sf Storage= 14,867 cf

Plug-Flow detention time= 122.0 min calculated for 0.777 af (100% of inflow)
Center-of-Mass det. time= 120.8 min (955.1 - 834.3)

Volume	Invert	Avail.Storage	Storage Description
#1	18.00'	43,777 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

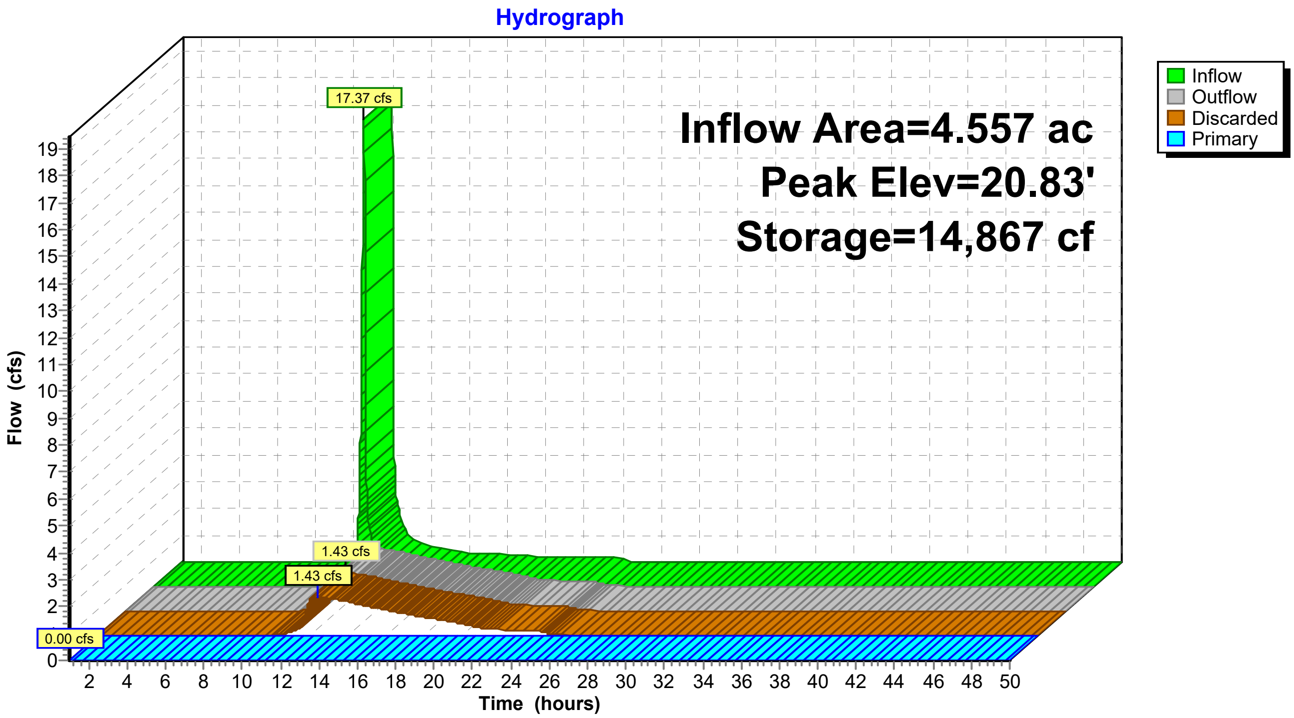
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
18.00	147	0	0
18.50	1,148	324	324
19.00	4,645	1,448	1,772
19.50	6,024	2,667	4,439
20.00	7,369	3,348	7,788
20.50	8,707	4,019	11,807
21.00	10,033	4,685	16,492
21.50	11,358	5,348	21,839
22.00	12,674	6,008	27,847
22.50	14,024	6,675	34,522
23.00	22,997	9,255	43,777

Device	Routing	Invert	Outlet Devices
#1	Discarded	18.20'	**5.000 in/hr Exfiltration over Surface area from 18.20' - 23.00'** Conductivity to Groundwater Elevation = 15.00' Excluded Surface area = 547 sf
#2	Primary	22.70'	**10.0' long + 10.0 '/' SideZ x 20.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=1.43 cfs @ 12.51 hrs HW=20.83' (Free Discharge)
↑—**1=Exfiltration** (Controls 1.43 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=18.00' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond WNO: WEST NO OUTLET

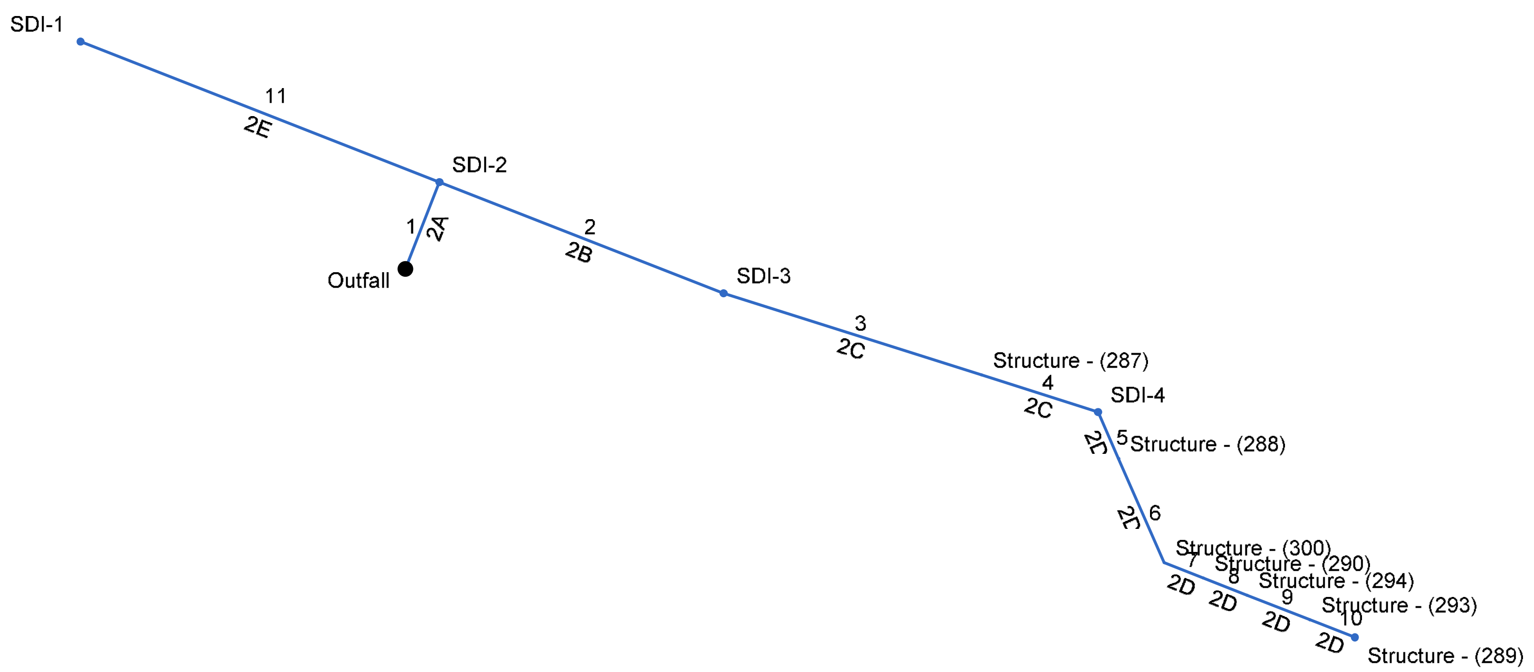


Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan

NORTH SYSTEM 25 - Year

ATTACHMENT H:

Hydroflow Model Data



Project File: PDX Storm Sewers_N_IDF.stm	Number of lines: 11	Date: 12/8/2023

Storm Sewers v2022.00

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	36.071	-68.607	DrGrt	0.00	0.19	0.72	5.0	19.00	2.36	19.85	15	Cir	0.013	1.50	22.60	2A
2	1	117.944	90.000	DrGrt	0.00	0.51	0.87	5.0	19.85	0.30	20.20	15	Cir	0.013	0.50	22.67	2B
3	2	104.585	-3.776	None	0.00	0.00	0.00	0.0	20.44	0.30	20.75	12	Cir	0.013	0.15	21.92	2C
4	3	47.245	0.000	DrGrt	0.00	0.08	0.87	5.0	20.75	0.30	20.89	12	Cir	0.013	1.19	23.43	2C
5	4	19.701	48.776	None	0.00	0.00	0.00	0.0	21.24	0.46	21.33	8	Cir	0.013	0.15	22.08	2D
6	5	43.938	0.000	None	0.00	0.00	0.00	0.0	21.33	0.48	21.54	8	Cir	0.013	0.75	22.29	2D
7	6	16.250	-45.000	None	0.00	0.00	0.00	0.0	21.54	0.43	21.61	8	Cir	0.013	0.15	22.36	2D
8	7	18.250	0.000	None	0.00	0.00	0.00	0.0	21.61	0.49	21.70	8	Cir	0.013	0.15	22.45	2D
9	8	26.000	0.000	None	0.00	0.00	0.00	0.0	21.70	0.46	21.82	8	Cir	0.013	0.15	22.57	2D
10	9	18.750	0.000	DrGrt	0.00	0.14	1.00	5.0	21.82	0.48	21.91	8	Cir	0.013	1.00	22.66	2D
11	1	149.000	-90.000	DrGrt	0.00	0.49	0.72	5.0	19.78	0.50	20.52	12	Cir	0.013	1.00	22.81	2E

Project File: PDX Storm Sewers_N_IDF.stm | Number of lines: 11 | Date: 12/8/2023

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
1	15	2.48	19.00	19.68	0.68	0.62	3.64	0.25	19.93	0.000	36.071	19.85	20.48 j	0.63**	0.62	4.00	0.25	20.73	0.000	0.000	n/a	1.50	0.37
2	15	1.51	19.85	20.48	0.63	0.62	2.44	0.09	20.57	0.214	117.944	20.20	20.76	0.56	0.53	2.84	0.13	20.89	0.321	0.268	0.316	0.50	0.06
3	12	0.56	20.44	20.82	0.38	0.28	1.98	0.06	20.88	0.244	104.585	20.75	21.11	0.36	0.25	2.20	0.08	21.18	0.325	0.285	0.298	0.15	0.01
4	12	0.59	20.75	21.13	0.38*	0.27	2.17	0.07	21.20	0.296	47.245	20.89	21.27	0.38	0.27	2.18	0.07	21.34	0.300	0.298	0.141	1.19	0.09
5	8	0.41	21.24	21.57	0.33*	0.17	2.33	0.08	21.66	0.457	19.701	21.33	21.66	0.33	0.17	2.34	0.09	21.75	0.459	0.458	0.090	0.15	0.01
6	8	0.42	21.33	21.67	0.34	0.18	2.33	0.08	21.76	0.443	43.938	21.54	21.87	0.33	0.17	2.43	0.09	21.97	0.492	0.467	0.205	0.75	0.07
7	8	0.43	21.54	21.94	0.40	0.22	1.96	0.06	22.00	0.278	16.250	21.61	21.98	0.37	0.20	2.16	0.07	22.05	0.357	0.317	0.052	0.15	0.01
8	8	0.44	21.61	21.99	0.38	0.21	2.13	0.07	22.06	0.339	18.250	21.70	22.05	0.35	0.18	2.40	0.09	22.14	0.468	0.403	0.074	0.15	0.01
9	8	0.45	21.70	22.06	0.36	0.19	2.36	0.09	22.15	0.437	26.000	21.82	22.17	0.35	0.19	2.42	0.09	22.26	0.466	0.452	0.117	0.15	0.01
10	8	0.46	21.82	22.19	0.37	0.20	2.36	0.09	22.27	0.430	18.750	21.91	22.26	0.35	0.19	2.45	0.09	22.36	0.478	0.454	0.085	1.00	0.09
11	12	1.17	19.78	20.48	0.70	0.35	1.97	0.06	20.54	0.148	149.000	20.52	20.97	0.45**	0.35	3.34	0.17	21.15	0.590	0.369	n/a	1.00	n/a

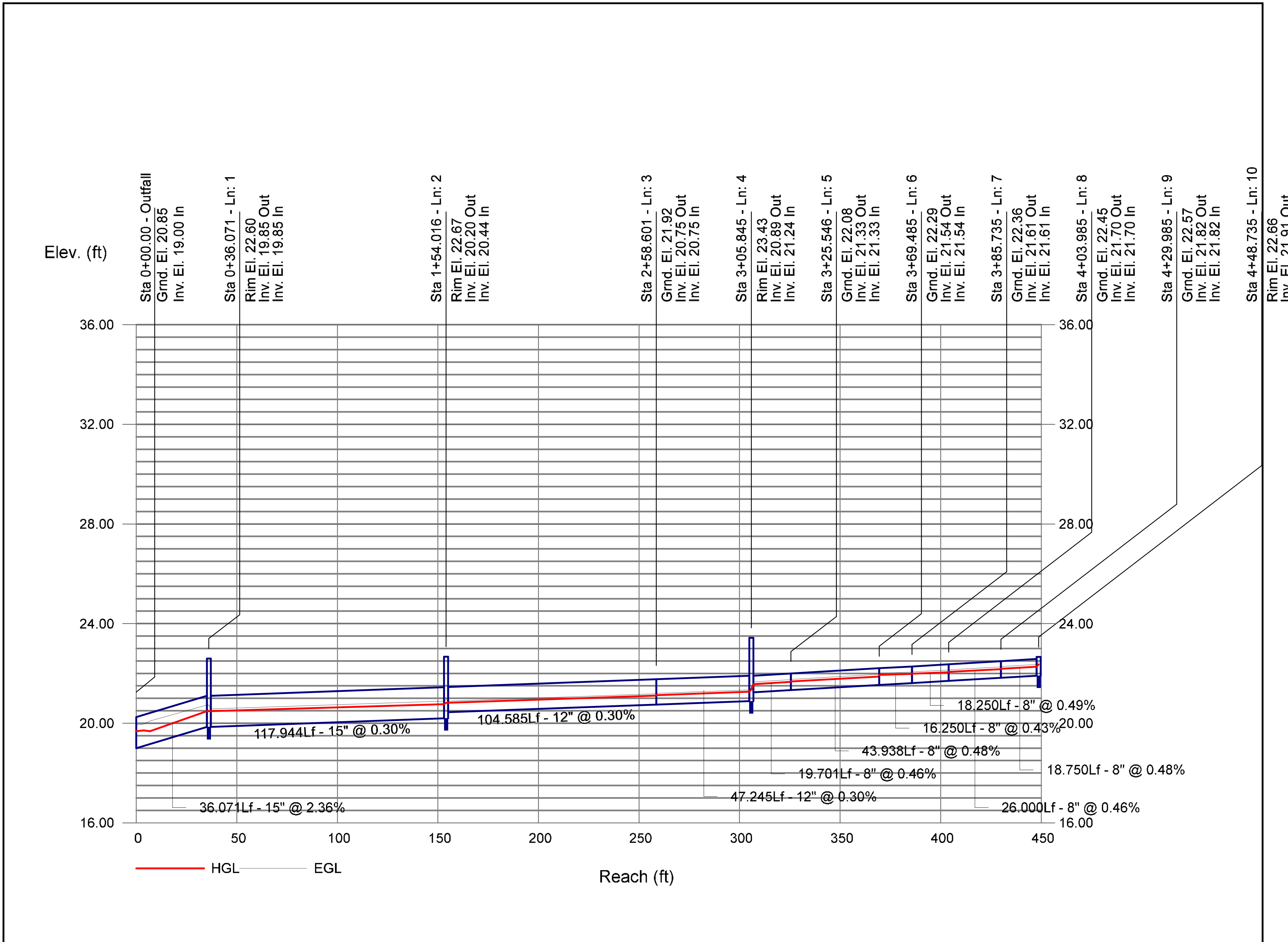
Project File: PDX Storm Sewers_N_IDF.stm	Number of lines: 11	Run Date: 12/8/2023

Notes: * Normal depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Storm Sewer Profile

25 - Year

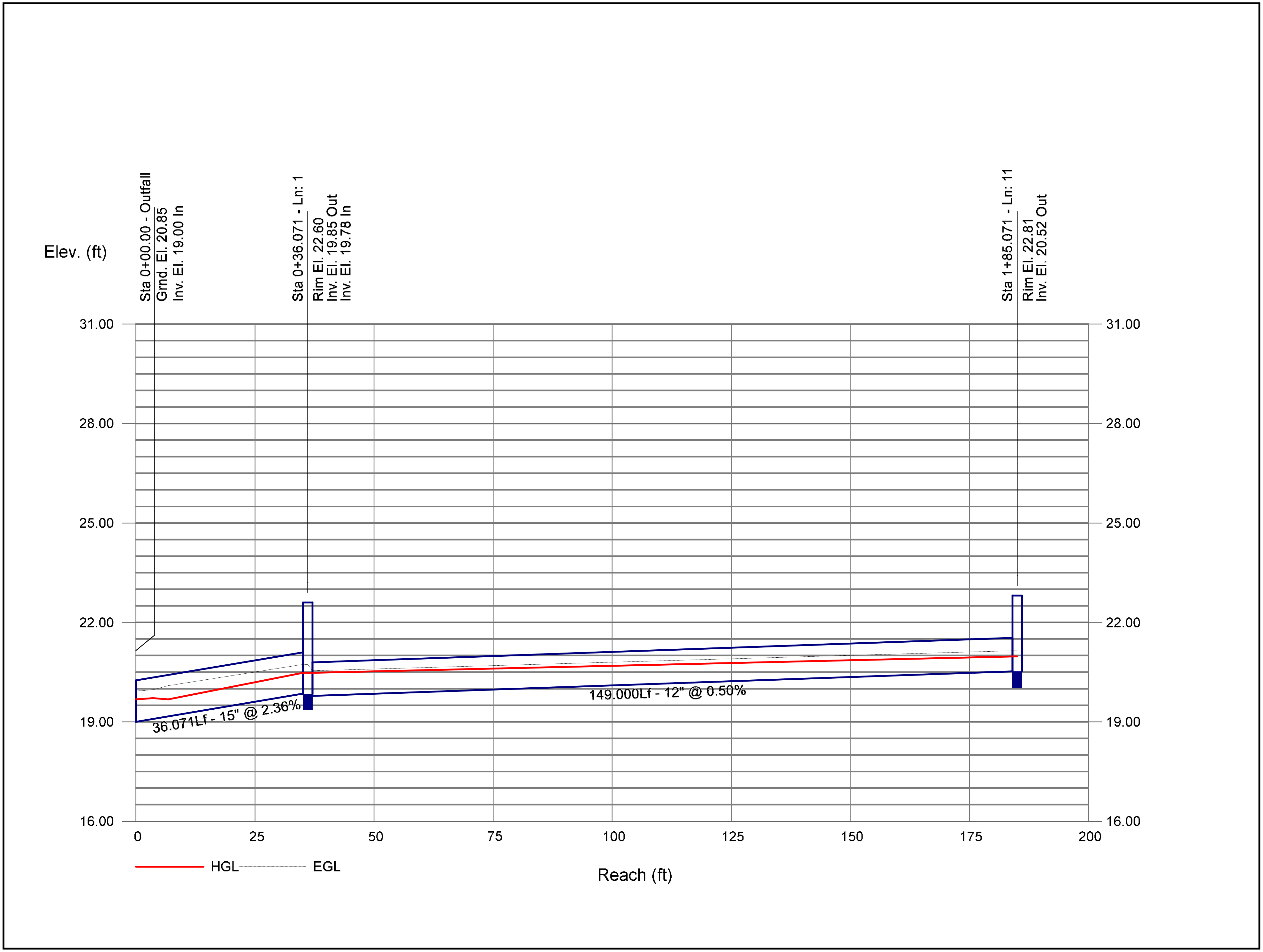
Proj. file: PDX Storm Sewers_N_IDF.stm



Storm Sewer Profile

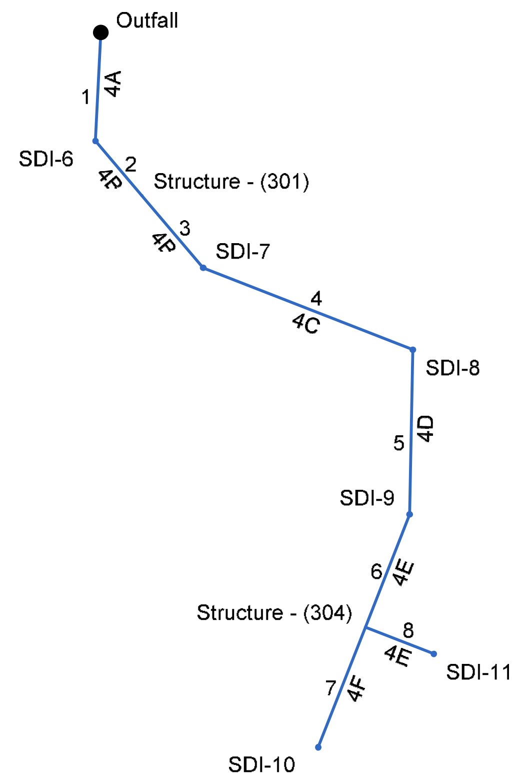
25 - Year

Proj. file: PDX Storm Sewers_N_IDF.stm



Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan

SOUTH SYSTEM 25 - Year



Project File: PDX Storm Sewers_S_IDF.stm	Number of lines: 8	Date: 12/8/2023

Storm Sewers v2022.00

Storm Sewer Inventory Report

25 - Year

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	59.252	92.844	DrGrt	0.00	0.39	0.66	5.0	18.86	0.29	19.03	18	Cir	0.013	1.09	21.92	4A
2	1	39.000	-43.155	None	0.00	0.00	0.00	0.0	19.03	0.31	19.15	18	Cir	0.013	0.15	20.87	4B
3	2	51.668	0.000	DrGrt	0.00	0.72	0.80	5.0	19.15	0.31	19.31	18	Cir	0.013	0.79	22.07	4B
4	3	122.489	-28.296	DrGrt	0.00	0.18	0.87	5.0	19.56	0.30	19.93	15	Cir	0.013	1.42	22.26	4C
5	4	89.793	69.717	DrGrt	0.00	0.12	0.80	5.0	19.93	0.30	20.20	15	Cir	0.013	0.60	23.29	4D
6	5	66.007	20.283	None	0.00	0.00	0.00	0.0	20.44	0.29	20.63	12	Cir	0.013	1.00	21.80	4E
7	6	70.382	0.000	DrGrt	0.00	0.22	0.87	5.0	20.63	0.31	20.85	12	Cir	0.013	1.00	23.25	4F
8	6	40.000	-90.000	DrGrt	0.00	0.17	0.87	5.0	20.63	0.30	20.75	12	Cir	0.013	1.00	23.35	4E

Project File: PDX Storm Sewers_S_IDF.stm | Number of lines: 8 | Date: 12/8/2023

Hydraulic Grade Line Computations

25 - Year

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)	(K)	(ft)
1	18	3.16	18.86	20.01	1.15	1.46	2.16	0.07	20.08	0.102	59.252	19.03	20.06	1.03	1.30	2.43	0.09	20.15	0.134	0.118	0.070	1.09	0.10
2	18	2.64	19.03	20.16	1.13	1.43	1.84	0.05	20.21	0.074	39.000	19.15	20.18	1.03	1.30	2.03	0.06	20.25	0.093	0.084	0.033	0.15	0.01
3	18	2.70	19.15	20.19	1.04	1.31	2.06	0.07	20.26	0.095	51.668	19.31	20.23	0.92	1.14	2.37	0.09	20.32	0.135	0.115	0.060	0.79	0.07
4	15	1.49	19.56	20.30	0.74	0.76	1.97	0.06	20.36	0.123	122.489	19.93	20.50	0.57	0.54	2.74	0.12	20.62	0.295	0.209	0.256	1.42	0.17
5	15	1.20	19.93	20.66	0.73	0.75	1.60	0.04	20.70	0.081	89.793	20.20	20.75	0.55	0.52	2.29	0.08	20.83	0.211	0.146	0.131	0.60	0.05
6	12	0.99	20.44	20.95	0.51*	0.40	2.45	0.09	21.04	0.288	66.007	20.63	21.14	0.51	0.40	2.46	0.09	21.23	0.289	0.288	0.190	1.00	0.09
7	12	0.63	20.63	21.23	0.60	0.50	1.27	0.03	21.26	0.068	70.382	20.85	21.29	0.44	0.34	1.87	0.05	21.35	0.189	0.129	0.091	1.00	0.05
8	12	0.49	20.63	21.23	0.60	0.50	0.98	0.02	21.25	0.041	40.000	20.75	21.24	0.49	0.39	1.25	0.02	21.27	0.077	0.059	0.024	1.00	0.02

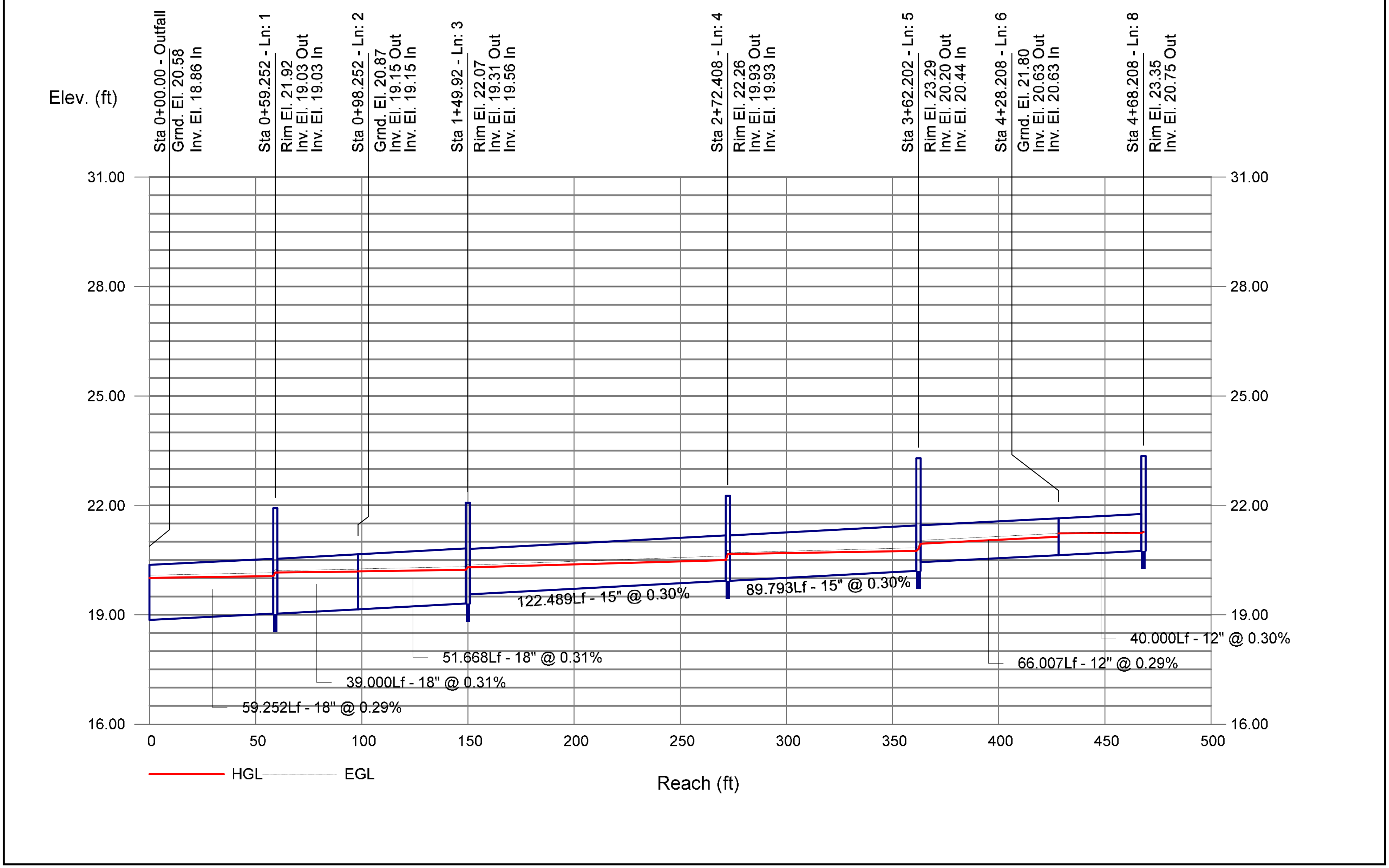
Project File: PDX Storm Sewers_S_IDF.stm | Number of lines: 8 | Run Date: 12/8/2023

Notes: * depth assumed ; c = cir e = ellip b = box

Storm Sewer Profile

25 - Year

Proj. file: PDX Storm Sewers_S_IDF.stm



ATTACHMENT I-1 (Pipe Velocity):

APPENDIX F: VARIANCE REQUEST APPLICATION FORM

This form shall be included as a cover sheet along with each Variance Request submitted to the Port at the Preliminary Design Milestone. Along with this form, the designer must submit required supporting documentation as described in Chapter 3 of the DSM. Designers shall inform the Port as soon as possible when the need for a Variance Request is first identified, and shall coordinate on the Port in advance of this submittal, if possible, to facilitate Port review.

Project Name and Number: PDX Facility Improvements - Phase II

Port Facility / Project Location: PDX Fuel Farm Tenant Improvements / 5000 NE Marine Dr, Portland, OR 97218

Designer Contact: (Name, Company, E-mail) Michael Greufe, Burns & McDonnell, mgreufe@burnsmcd.com
Sealer: Stacy Wagner, Burns & McDonnell, swagner@burnsmcd.com

Date Submitted: 12/21/2023

Total Area Disturbed (Acres): Approx. 9.29 AC

Acres Treated onsite (if applicable):

Check One of the following:	To be completed by the reviewing Port official: Approved	Denied
☐ Off-site mitigation to meet water quality SWM standard	☐	☐
☐ Implement a new Underground Injection Control (UIC) system serving non-roof areas	☐	☐
☒ Modify an activity-specific source control requirement	☐	☐
☐ Deviate from conveyance or BMP design criteria in Chapters 5, 6, or the BMP Fact Sheets	☐	☐
☐ Implement a BMP type other than those defined in the BMP Fact Sheets (BMPs must be certified under the Washington State Department of Ecology Technology Assessment Protocol (TAPE) program).	☐	☐

Reason for making the variance request:

A variance is requested to allow storm water pipe to be installed at a minimum 0.3% slope due to site constraints. The minimum slopes and velocities are due to multiple reasons one main driver being the crossing of the existing Kinder Morgan fuel pipeline. The flatness of the site, other existing utility constraints and trying to minimize the overall impact area also drive these constraints. Most of the pipes velocities are just slightly lower than 3 ft/s. The actual roughness coefficient of HDPE pipe is also less (0.012) than what was modeled (0.013). This decrease in friction would increase the velocity bringing them even closer to the requirement than what is calculated.

To be completed by the reviewing Port official

Port Comments:

ADS N-12® WT IB PIPE (PER AASHTO) SPECIFICATION

Scope

This specification describes 4- through 60-inch (100 to 1500 mm) ADS N-12 WT IB pipe (per AASHTO) for use in gravity-flow land drainage applications.

Pipe Requirements

ADS N-12 WT IB pipe (per AASHTO) shall have a smooth interior and annular exterior corrugations.

- 4- through 10-inch (100 to 250 mm) pipe shall meet AASHTO M252, Type S.
- 12- through 60-inch (300 to 1500 mm) pipe shall meet AASHTO M294, Type S or ASTM F2306.
- Manning's "n" value for use in design shall be 0.012.

Joint Performance

Pipe shall be joined using a bell & spigot joint meeting the requirements of AASHTO M252, AASHTO M294, or ASTM F2306. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.

Fittings

Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306. Bell and spigot connections shall utilize a welded bell and valley or saddle gasket meeting the watertight joint performance requirements of AASHTO M252, AASHTO M294, or ASTM F2306.

Field Pipe and Joint Performance

To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM F2487. Appropriate safety precautions must be used when field-testing any pipe material. Contact the manufacturer for recommended leakage rates.

Material Properties

Material for pipe and fitting production shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch (100 to 250 mm) diameters, and 435400C for 12- through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The 12- through 60-inch (300 to 1500 mm) pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306 respectively.

Installation

Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot. (0.3 m) and for 60-inch (1500 mm) diameter the minimum cover shall be 2 ft. (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1 (compacted), Class 2 (minimum 90% SPD) or Class 3 (minimum 95%) material. Maximum fill heights depend on embedment material and compaction level; please refer to Technical Note 2.01. Contact your local ADS representative or visit our website at www.ads-pipe.com for a copy of the latest installation guidelines.

Pipe Dimensions

	Nominal Diameter, in (mm)											
Pipe I.D. in (mm)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	15 (375)	18 (450)	24 (600)	30 (750)	36 (900)	42 (1050)	48 (1200)	60 (1500)
Pipe O.D.* in (mm)	4.8 (122)	6.9 (175)	9.1 (231)	11.4 (290)	14.5 (368)	18 (457)	22 (559)	28 (711)	36 (914)	42 (1067)	48 (1219)	54 (1372)	67 (1702)

*Pipe O.D. values are provided for reference purposes only, values stated for 12 through 60-inch are ±1 inch. Contact a sales representative for exact values

ATTACHMENT I-2 (Storm Depth):

APPENDIX F: VARIANCE REQUEST APPLICATION FORM

This form shall be included as a cover sheet along with each Variance Request submitted to the Port at the Preliminary Design Milestone. Along with this form, the designer must submit required supporting documentation as described in Chapter 3 of the DSM. Designers shall inform the Port as soon as possible when the need for a Variance Request is first identified, and shall coordinate on the Port in advance of this submittal, if possible, to facilitate Port review.

Project Name and Number: PDX Facility Improvements - Phase II

Port Facility / Project Location: PDX Fuel Farm Tenant Improvements / 5000 NE Marine Dr, Portland, OR 97218

Designer Contact: (Name, Company, E-mail) Michael Greufe, Burns & McDonnell, mgreufe@burnsmcd.com
Sealer: Stacy Wagner, Burns & McDonnell, swagner@burnsmcd.com

Date Submitted: 12/21/2023

Total Area Disturbed (Acres): Approx. 9.29 AC

Acres Treated onsite (if applicable):

	To be completed by the reviewing Port official	
Check One of the following:	Approved	Denied
☐ Off-site mitigation to meet water quality SWM standard	☐	☐
☐ Implement a new Underground Injection Control (UIC) system serving non-roof areas	☐	☐
☒ Modify an activity-specific source control requirement	☐	☐
☐ Deviate from conveyance or BMP design criteria in Chapters 5, 6, or the BMP Fact Sheets	☐	☐
☐ Implement a BMP type other than those defined in the BMP Fact Sheets (BMPs must be certified under the Washington State Department of Ecology Technology Assessment Protocol (TAPE) program).	☐	☐

Reason for making the variance request:

A variance is requested to allow storm water pipe to be installed at a minimum 12" of cover at the upstream inlet. The minimal cover is due to multiple reasons one main driver being the crossing of the existing Kinder Morgan fuel pipeline. The flatness of the site, other existing utility constraints and trying to minimize the overall impact area also drives this constraint. See attached for recommendation that this pipe can be installed with 1 foot of cover. Lastly, the inlets were located to be out of main traffic patterns and located along roadways out of driving paths and in parking spaces as much as possible.

To be completed by the reviewing Port official

Port Comments:

ADS N-12® WT IB PIPE (PER AASHTO) SPECIFICATION

Scope
This specification describes 4- through 60-inch (100 to 1500 mm) ADS N-12 WT IB pipe (per AASHTO) for use in gravity-flow land drainage applications.

Pipe Requirements
ADS N-12 WT IB pipe (per AASHTO) shall have a smooth interior and annular exterior corrugations.

- 4- through 10-inch (100 to 250 mm) pipe shall meet AASHTO M252, Type S.
- 12- through 60-inch (300 to 1500 mm) pipe shall meet AASHTO M294, Type S or ASTM F2306.
- Manning's "n" value for use in design shall be 0.012.

Joint Performance
Pipe shall be joined using a bell & spigot joint meeting the requirements of AASHTO M252, AASHTO M294, or ASTM F2306. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.

Fittings
Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306. Bell and spigot connections shall utilize a welded bell and valley or saddle gasket meeting the watertight joint performance requirements of AASHTO M252, AASHTO M294, or ASTM F2306.

Field Pipe and Joint Performance
To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM F2487. Appropriate safety precautions must be used when field-testing any pipe material. Contact the manufacturer for recommended leakage rates.

Material Properties
Material for pipe and fitting production shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch (100 to 250 mm) diameters, and 435400C for 12- through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The 12- through 60-inch (300 to 1500 mm) pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306 respectively.

Installation
Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot. (0.3 m) and for 60-inch (1500 mm) diameter the minimum cover shall be 2 ft. (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1 (compacted), Class 2 (minimum 90% SPD) or Class 3 (minimum 95%) material. Maximum fill heights depend on embedment material and compaction level; please refer to Technical Note 2.01. Contact your local ADS representative or visit our website at www.ads-pipe.com for a copy of the latest installation guidelines.

Pipe Dimensions

	Nominal Diameter, in (mm)											
Pipe I.D. in (mm)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	15 (375)	18 (450)	24 (600)	30 (750)	36 (900)	42 (1050)	48 (1200)	60 (1500)
Pipe O.D.* in (mm)	4.8 (122)	6.9 (175)	9.1 (231)	11.4 (290)	14.5 (368)	18 (457)	22 (559)	28 (711)	36 (914)	42 (1067)	48 (1219)	54 (1372)	67 (1702)

*Pipe O.D. values are provided for reference purposes only, values stated for 12 through 60-inch are ±1 inch. Contact a sales representative for exact values

ATTACHMENT I-3 (Oil Stop Valve):

APPENDIX F: VARIANCE REQUEST APPLICATION FORM

This form shall be included as a cover sheet along with each Variance Request submitted to the Port at the Preliminary Design Milestone. Along with this form, the designer must submit required supporting documentation as described in Chapter 3 of the DSM. Designers shall inform the Port as soon as possible when the need for a Variance Request is first identified, and shall coordinate on the Port in advance of this submittal, if possible, to facilitate Port review.

Project Name and Number: PDX Facility Improvements - Phase II

Port Facility / Project Location: PDX Fuel Farm Tenant Improvements / 5000 NE Marine Dr, Portland, OR 97218

Designer Contact: (Name, Company, E-mail) Michael Greufe, Burns & McDonnell, mgreufe@burnsmcd.com
Sealer: Stacy Wagner, Burns & McDonnell, swagner@burnsmcd.com

Date Submitted: 12/21/2023

Total Area Disturbed (Acres): Approx. 9.29 AC

Acres Treated onsite (if applicable):

Check One of the following:	To be completed by the reviewing Port official Approved	 Denied
☐ Off-site mitigation to meet water quality SWM standard	☐	☐
☐ Implement a new Underground Injection Control (UIC) system serving non-roof areas	☐	☐
☒ Modify an activity-specific source control requirement	☐	☐
☐ Deviate from conveyance or BMP design criteria in Chapters 5, 6, or the BMP Fact Sheets	☐	☐
☐ Implement a BMP type other than those defined in the BMP Fact Sheets (BMPs must be certified under the Washington State Department of Ecology Technology Assessment Protocol (TAPE) program).	☐	☐

Reason for making the variance request:

The Port's Stormwater Design Standards Manual (DSM) references the City of Portland's Source Control Manual (SCM) in section 4.6.2.1. This reference states that fuel dispensing facilities and surrounding traffic areas as well as aboveground storage of liquid materials, including tank farms, implement the source control measures in accordance with the SCM. We are applying for a variance to this reference in the Port's DSM for the use an oil water separator specified in paragraph 6.6.2.2 and Figure 6-6 of the SCM. See more detail in the attached documents.

To be completed by the reviewing Port official

Port Comments:

<u>Variance Request:</u>

Paragraph 6.6.2.2 of the SCM (under Treatment BMPs) states: A*ll discharges to the sanitary and storm systems from areas associated with stationary fuel transfer and dispensing areas must be treated with an oil-water separator* (OWS). Figure 6-6 from the SCM also shows the storm drainage around these areas to drain to an OWS and then to the storm drainage system.

For this project, we are applying for a variance to use an oil stop valve (OSV) in lieu of the suggested oil water separator. This oil stop valve uses specific gravity and a ballasted float to automatically close the system and prevent oil from discharging to the storm system, which meets the intent of the SCM requirement. This automatic closing also gives the operator a visual indication that a spill has occurred and needs to be cleaned up.

The OSV will be located in an inlet and drain to a water quality BMP downstream. The inlet will be the only drain to collect stormwater for the area outside of the fueling canopy. This area will be hydraulically isolated via curb and gutter.

See below images of the SCM Figure 6-6 and an example OSV detail. The following page depicts the extents of where the OSV would be used and the hydraulically isolated area that drains to it.

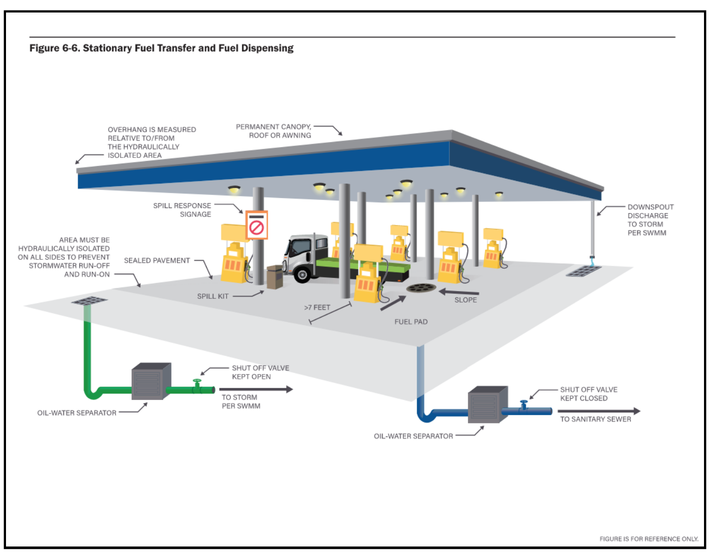
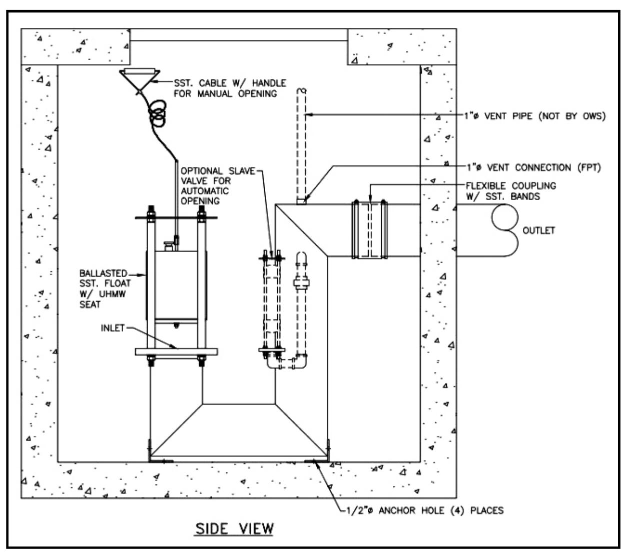


FIGURE 6-6



EXAMPLE OIL STOP VALVE DETAIL

ATTACHMENT I-4 (OWS Discharge):

APPENDIX F: VARIANCE REQUEST APPLICATION FORM

This form shall be included as a cover sheet along with each Variance Request submitted to the Port at the Preliminary Design Milestone. Along with this form, the designer must submit required supporting documentation as described in Chapter 3 of the DSM. Designers shall inform the Port as soon as possible when the need for a Variance Request is first identified, and shall coordinate on the Port in advance of this submittal, if possible, to facilitate Port review.

Project Name and Number: PDX Facility Improvements - Phase II

Port Facility / Project Location: PDX Fuel Farm Tenant Improvements / 5000 NE Marine Dr, Portland, OR 97218

Designer Contact: (Name, Company, E-mail) Michael Greufe, Burns & McDonnell, mgreufe@burnsmcd.com
Sealer: Stacy Wagner, Burns & McDonnell, swagner@burnsmcd.com

Date Submitted: 12/21/2023

Total Area Disturbed (Acres): Approx. 9.29 AC

Acres Treated onsite (if applicable):

Check One of the following:	To be completed by the reviewing Port official Approved	 Denied
☐ Off-site mitigation to meet water quality SWM standard	☐	☐
☐ Implement a new Underground Injection Control (UIC) system serving non-roof areas	☐	☐
☒ Modify an activity-specific source control requirement	☐	☐
☐ Deviate from conveyance or BMP design criteria in Chapters 5, 6, or the BMP Fact Sheets	☐	☐
☐ Implement a BMP type other than those defined in the BMP Fact Sheets (BMPs must be certified under the Washington State Department of Ecology Technology Assessment Protocol (TAPE) program).	☐	☐

Reason for making the variance request:

The Port's Stormwater Design Standards Manual (DSM) references the City of Portland's Source Control Manual (SCM) in section 4.6.2.1. This reference states that fuel dispensing facilities and surrounding traffic areas as well as aboveground storage of liquid materials, including tank farms, implement the source control measures in accordance with the SCM. We are applying for a variance to this reference in the Port's DSM for the use of a valve on the downstream side of an oil water separator. Since the separator only receives flow from a pump and there are sensors that will shut the pump down in case of a spill / or full OWS, discharge will not freely flow to the OWS in the event of a spill, thus negating its need.

To be completed by the reviewing Port official

Port Comments:

ATTACHMENT J:
Containment Calculations (Tanks)

Design Notes

Designed By: **WBB**
Checked By: **MRG**
Date: Dec-23

FUEL STORAGE TANKS CONTAINMENT VOLUME CALCULATIONS

Portland International Airport (PDX) Fuel Facility Improvements

for Portland Fuel Facilities Corporation (PFFC), Portland, Oregon

Objective:

References:

- NFPA 30 Flammable and Combustible Liquids Code
- 40 CFR 112
- City of Portland Source Control Manual
- International Fire Code (IFC)

Known:

- The two new tanks will be 110-foot diameter by 36-feet high and the existing tank is 95-foot diameter by 32-foot high. The foundation of each tank is estimated to be a 4" above surrounding grade.
- Three storage tanks will be constructed with there own separate containment area. The interior of the containment area will be constructed with steel containment a concrete floor and a small portion of Flexible Membrane Liner (FML) to connect the two and to provide adequate secondary containment.
- Each individual tank containment area will be sloped to containment drain inlets. Each tank containment area will have a lockable post indicator valve outside the dike area. The gravity drains will discharge to a gravity sewer system.
- The containment area will be sized to contain, at a minimum, the volume of 110% the largest tank located within the diked enclosure.
  - Largest Tank in Diked Enclosure = 64,000 BBL (nominal volume; ~ 64,000 BBL shell volume)
  - 110% of Largest Tank Volume Controls or 10 percent of the total volume of product stored, whichever is larger (City of Portland Source Control Manual - 1.9.1)
  (110% governs since each tank has its own containment)

Assumptions:

- A proposed ring wall height of 12" from the bottom of the containment area was used for calculations.

Calculations:

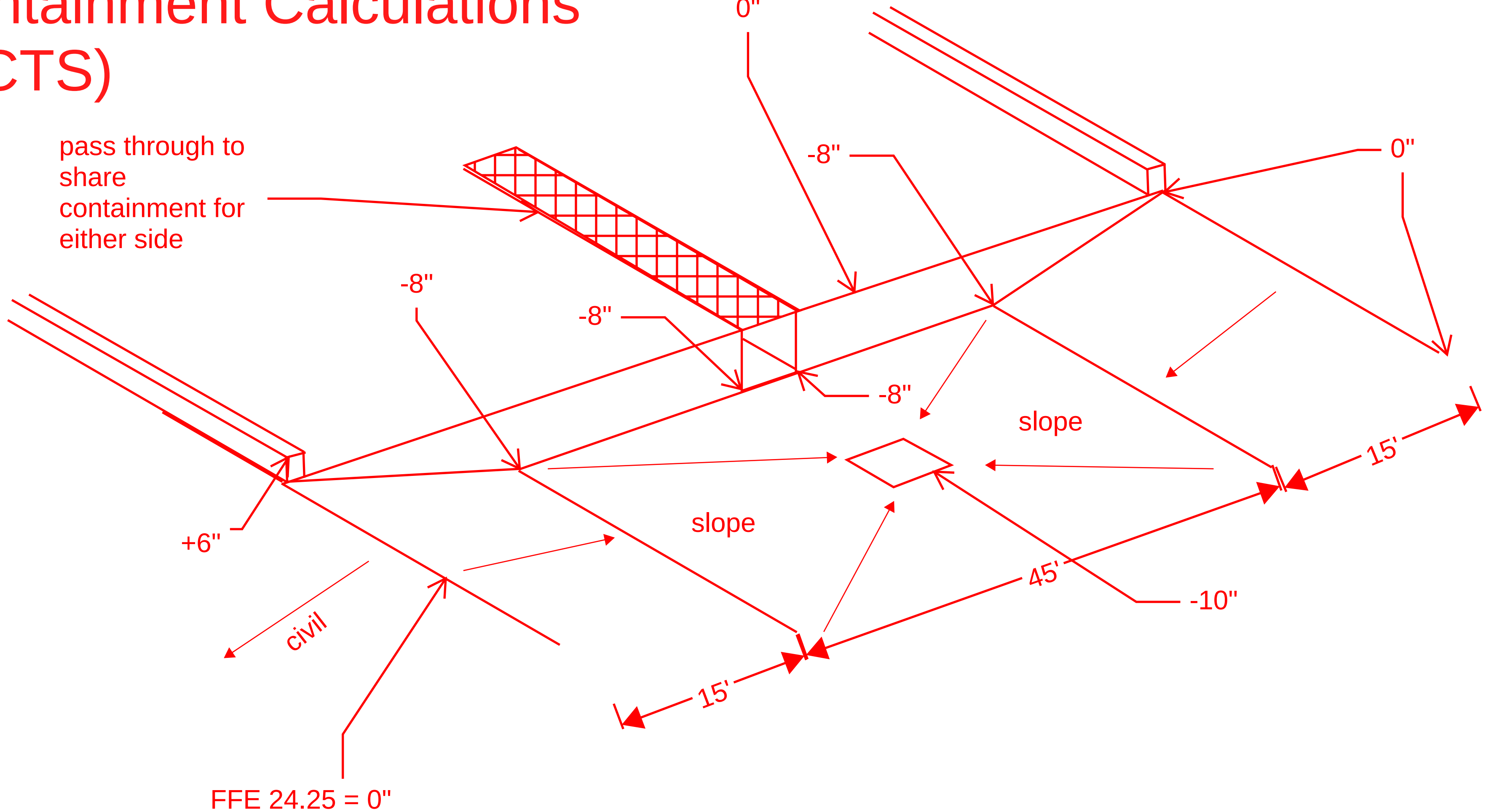
Containment Volume Requirement

Controlling Requirement	110% of Largest Tank			(City of Portland Source Control Manual - 1.9.1)
Largest Tank Shell Volume		342,119	cubic feet	
		2,559,224	gallons	
		60,934	barrels	
Rainfall Depth	N/A		inches	(25-year, 24-hour)
Containment Footprint Area		39,213	square feet	
Rainfall Area	N/A		square feet	(includes top of perimeter wall/berm)
Rainfall Volume	N/A		cubic feet	
Required Containment Volume		376,331	cubic feet	

Required Wall Height

Dike Floor Area (SF)	*15,836*	
Tanks Displacement (SF)	-	
Displacement Volume (CF)	*229*	*(approx. volume of piping and structures within containment)*
Required Wall Height (ft)	***23.94***	

ATTACHMENT J: Containment Calculations (HCTS)



Calcs

No Slope: (8/12)*(45' Long)*(15' Wide) = 450 CF

Sloped: 0.5*(8/12)*(15' Long)*(15' Wide)*(2) = 150 CF

600 CF * (2 Drive lanes) = 1200 CF storage

1200 CF *7.48 = 8,976 gal

APPENDIX I: PROJECT O&M FORM

Project Title:	PDX Facility Improvements - Phase II
Project Number:	BMcD #153929
Location: (Port Facility)	PDX Fuel Farm Tenant Improvements / 5000 NE Marine Dr, Portland, OR 97218
Designer Contact: (Name, Company, E-mail)	Michael Greufe, Burns & McDonnell, mgreufe@burnsmcd.com

Summary Narrative – Required Components and Attachments

- Stormwater management facilities description
- Operational considerations, procedures, and schedule
- Maintenance considerations, procedures, and schedule
- Inspection and monitoring considerations, procedures, and schedule
- Decision tree(s) on trouble shooting operations
- Decision tree(s) for when to perform irregular maintenance and inspections
- Record-keeping recommendations
- Monitoring recommendations
- Equipment and personnel hours and expertise required to perform tasks
- Location map for each stormwater management facility
- Vendor information if applicable

The proposed bioretention BMP's are intended to be passive and require minimal maintenance. The BMP's will be part of the general site grading and will be mowed with the surrounding areas, except as needed to prevent overgrowth within the BMP's (which may attract wildlife). Otherwise maintenance will only be required if excess sediment builds up in the bottom of the BMP's and prevents the area from draining within 48 hours after each rain event.

See documentation attached to Stormwater Narrative for more information about the proposed biorention BMP's.

Table 1: Summary of Stormwater Management Facilities

Stormwater management facilities include BMPs as well as major BMP components. The functions and locations of the stormwater management facilities shall be summarized in the table below and if needed or required by the Port additional information shall be provided within the narrative or attachments.

Facility Number/Descriptor	Description (Size, Source of SW, Discharge Point)	Function (Treatment Capabilities, either Flow or Volume, and Storage Capabilities)	Location	Drawing Number
Vegetated Swale (Storm Water West BMP)	Drainage area DA-1, 2, 3, & 4 to downstream wetland ditch	Filtration, Flow/Volume Infiltration and Detention	Northeast of Ex Tank 3 west side of site	CG102/3
Bioretention BMP (Storm Water East BMP)	Drainage area DA-5, 6, & 7 to existing port drainage	Filtration, Flow/Volume Infiltration and Detention	Northeast of Tank 5 east side of site	CG104

Table 2: Summary of Stormwater Management Facilities Operations

The operations of the stormwater management facilities shall be summarized in the table below and if needed or required by the Port additional information shall be provided within the narrative or attachments.

Facility Number/Descriptor	Operation	Operation Frequency	Required Personnel and Equipment to Operate Facility	Attachment(s) or Subsequent Section(s)
Vegetated Swale (Storm Water West BMP)	Passive	Continuous	Normal Facility Operations Staff	
Bioretention BMP (Storm Water East BMP)	Passive	Continuous	Normal Facility Operations Staff	

Table 3: Summary of Stormwater Management Facility Maintenance Tasks

The maintenance tasks of the stormwater management facilities shall be summarized in the table below and if needed or required by the Port additional information shall be provided within the narrative or attachments.

Facility Number/Descriptor	Maintenance Task	Maintenance Triggers	Required Personnel and Equipment for Maintenance Task	Maintenance Task Frequency	Attachment(s) or Subsequent Section(s)
Vegetated Swale (Storm Water West BMP)	Clean Out Bottom or Inlet/outlet pipes	Visible Sediment, Draining Slowly, Pipe Clogged	Normal Facility Operations Staff	As Needed	
Vegetated Swale (Storm Water West BMP)	Mowing	Vegetation growing more than surrounding area	Normal Facility Operations Staff	As Needed	
Bioretention BMP (Storm Water East BMP)	Clean Out Bottom or Inlet/outlet pipes	Visible Sediment, Draining Slowly, Pipe Clogged	Normal Facility Operations Staff	As Needed	
Bioretention BMP (Storm Water East BMP)	Mowing	Vegetation growing more than surrounding area	Normal Facility Operations Staff	As Needed	

Table 4: Summary of Stormwater Management Facility Monitoring and Inspection Tasks

The monitoring and inspections tasks of the stormwater management facilities shall be summarized in the table below and if needed or required by the Port additional information shall be provided within the narrative or attachments.

Facility Number/Descriptor	Required Monitoring and/or Inspection Task	Monitoring and/or Inspection Task Frequency	Required Personnel and Equipment for Monitoring and/or Inspection Task	Attachment(s) or Subsequent Section(s)
Vegetated Swale (Storm Water West BMP)	Monitor Drainage Rate	After Large Rain Events	Normal Facility Operations Staff	
Bioretention BMP (Storm Water East BMP)	Monitor Drainage Rate	After Large Rain Events	Normal Facility Operations Staff	

APPENDIX E: DSM COORDINATION CHECKLIST

As introduced in Chapter 3, the purpose of the DSM Coordination Checklist is to provide a method of documenting the project stormwater management design compliance toward SWM Standards, design criteria, and other regulations. This Checklist should be maintained throughout the project and used as a basis for coordination with the Port at design meetings. It is also required to be submitted along with each required design milestone submittal. The following sections ask the designer to document compliance with the following:

- SWM Standards:
  - Low-Impact Development
  - Infiltration
  - Water Quantity Control
  - Water Quality – Capture and Treat
  - Source Controls
  - Hazardous Wildlife Attractants
  - Floodway and Natural Resource Protection
  - Erosion and Sediment Control
- Design criteria within Chapter 5 and Chapter 6
- Variance Requests

E.1 Project Specific Information

Project: PDX Facility Improvements - Phase II

Designer Contact: Michael Greufe, Burns & McDonnell, mgreufe@burnsmcd.com
(Name, Company, E-mail)

Project Location: PDX Fuel Farm Tenant Improvements / 5000 NE Marine Dr, Portland, OR 97218

Date: December 2023

Project Milestone:

- ☒ Preliminary Design Milestone(s) – Specify percent complete: 90%
- ☐ Final Design Milestone

E.2 Low-Impact Development

Designers shall complete the following portion of the Coordination Checklist to demonstrate the consideration and implementation of LID strategies and the supporting practices into project designs, where applicable. Where LID strategies were considered but found to be not applicable, designers shall provide justification based on project or site constraints, as discussed in Chapter 4 of the DSM. Responses to the LID questions shall incorporate a summary of direction or decisions provided by the Port during project planning or as part of the design review and coordination process.

E.2.1 Strategy 1: Minimize Disturbance of Sensitive Areas (Site Selection and Layout)

- Description: Design the project to preserve or minimize disturbance of buffers, floodplains, wetlands, natural resources, and natural or undeveloped areas that may be especially susceptible to impacts from stormwater runoff (See DSM Chapter 4). Practices supporting this strategy include:

  ☐ Site the development to avoid natural resource areas.
  ☒ Minimize disturbance of natural or undeveloped areas.
  ☒ Minimize disturbance of areas that may be highly susceptible to erosion.

- Was strategy incorporated into the project design? ☒Yes ☐No

- Describe practices used to incorporate strategy into project design (if demonstration is provided within drawings or attached documentation, please indicate below).

The extent of new construction and associated ground disturbance was limited as much as possible while still adding upgrade functionality of facility. Slopes are minimal as the existing site is flat.

- Describe project or site constraints or other applicability considerations that limited the incorporation of this strategy into the project design (if justification is provided within drawings or attached documentation, please indicate below).

The new construction is limited by existing grades and layout. The flat site restricts options for daylighting to grade or connecting to existing stormwater infrastructure.

E.2.2 Strategy 2: Minimize the Impact of Development (Footprint Minimization)

- Description: Design project to result in compact development, in a way that reduces the footprint and minimizes the disturbance area (area of clearing and grading or exposed soil). (See DSM Chapter 4). Practices supporting this strategy include:

  ☒ Minimize development footprint.
  ☒ Minimize compaction of soil in specially designated areas.
  ☒ Minimize clearing and grading and changes to natural drainage pattern.
  ☒ Reduce extent of effective impervious areas.

- Was strategy incorporated into the project design? ☒Yes ☐No

- Describe practices used to incorporate strategy into project design (if demonstration is provided within drawings or attached documentation, please indicate below).

The extent of new construction was limited as much as possible while still adding upgrade functionality of facility. Disturbed unsurfaced areas will not be compacted before re-seeding. The existing drainage patterns will be maintained except for BMPs as required by the DSM. Aggregate surfaced areas not designated as driveways will be a thinner, well-drained aggregate section to reduce impervious areas.

- Describe project or site constraints or other applicability considerations that limited the incorporation of this strategy into the project design (if justification is provided within drawings or attached documentation, please indicate below).

The new construction is limited by existing grades and layout. The flat site makes daylighting to grade or connecting to existing stormwater infrastructure difficult.

E.2.3 Strategy 3: Manage Runoff from Disturbed Areas (GI and Runoff Management)

- Description: Incorporate measures into the project design to manage the quality and quantity of runoff from disturbed areas to minimize the potential for impacts to receiving waters. Place an emphasis on GI practices that contribute to mimicking pre-development hydrologic functions and promote infiltration, evapotranspiration, or stormwater reuse (See DSM Chapter 4). Practices supporting this strategy include:

  ☒ Disconnect impervious areas to direct runoff from impervious areas into pervious areas that are designed to promote infiltration.

  ☒ Implement green infrastructure to collect, treat, and infiltrate runoff from developed areas.

- Was strategy incorporated into the project design? ☒Yes ☐No

- Describe practices used to incorporate strategy into project design (if demonstration is provided within drawings or attached documentation, please indicate below).

Grading of most new impervious areas is designed to shed runoff to onsite BMP's as much as possible, or to adjacent pervious areas where any ponding will spread out and infiltrate. For the drainage area containing most of the proposed development, an east and west BMP will be used to treat runoff, infiltrate, and direct it to existing stormwater infrastructure.

- Describe project or site constraints or other applicability considerations that limited the incorporation of this strategy into the project design (if justification is provided within drawings or attached documentation, please indicate below).

Some field adjustments to pipes and the BMP's may be required once existing utility elevations are verified by the contractor. Variance requests for the minimum pipe velocity and depth of cover are included in the Stormwater Design Package (Attachment I).

E.3 Infiltration

Designers shall complete the following portion of the Coordination Checklist to demonstrate the selection and implementation of the Infiltration Strategy. Designers shall provide justification for the selection of the Infiltration Strategy based on project or site constraints, as discussed in Chapter 4 of the DSM.

☒ Completed screen for infiltration feasibility based on historical data.

Provide the current understanding of the following parameters for the project design.

- Field infiltration rate: 10 inch per hour per Geotechnical Report
  - ☒ Based on historical data screen ☒ From project field investigations
- Design infiltration rate: 5 in/hr, conservative estimate
  - ☐ Based on historical data screen ☒ From project field investigations
- Depth to groundwater: 10' below existing grade (elev ~12.5')
  - ☐ Based on historical data screen ☒ From project field investigations
- Groundwater separation from the bottom of BMP(s): 5.7-7.3' below lowest BMP elevs

- ☐ There is no known contamination of groundwater or soil column.
- ☒ There is known contamination of groundwater or soil column that has the potential to migrate into groundwater. Describe the findings (if information is provided within attached documentation, please indicate)

> PFAS contamination may occur in soil at the site. The site is also a DEQ ECSI site for historical jet fuel releases. A contaminated media management plan is being prepared for this project and should be utilized to handle any contamination of groundwater or soil at the site.

Selected infiltration strategy:

- ☒ Infiltration Strategy #1: Full Infiltration of the Water Quality Design Storm (Design infiltration capacity = WQ_V or WQ_F)
- ☐ Infiltration Strategy #2: Partial Infiltration of the Water Quality Design Storm (Design infiltration capacity < WQ_V or WQ_F)
- ☐ Infiltration Strategy #3: No Reliance on Infiltration

Describe the selected BMP(s) to meet the infiltration strategy:

BMP	Design Infiltration Capacity (specify units)	Portion of Total WQ_V or WQ_F	Drawdown Time of Surface Ponding (Hours)
Vegetated Swale (Storm Water West BMP)	0.57 cfs	WQf = 0.57 CFS (100%+)	12
Bioretention BMP (Storm Water East BMP)	1,173 cf	WQv = 1095 CF (100%+)	12

E.4 Water Quantity Control

Designers shall complete the following portion of the DSM Coordination Checklist to demonstrate compliance with the water quantity objectives. Designers shall also provide brief discussion of the model results.

- ☒ 10-year, 24-hour storm event – The model results demonstrate that the max water surface elevations (MWSEs) do not exceed the elevation of pavement surfaces.
- ☒ 100-year, 24-hour storm event – The model results MWSEs do not reach buildings and are in compliance with City freeboard requirements and all applicable freeboard requirements.
- ☒ Drainage system design (collection and conveyance) is in compliance with the ponding allowances identified in Chapter 5.

Identify any pre-existing capacity issues affecting the design. Discuss any capacity concerns or any area where the objectives cannot be met. Explain any changes (increases or decreases) in the max water surface elevation (MWSE). Document any Port feedback on results. If this discussion is included in an attached document please specify.

Identify the BMPs or controls needed to meet the objectives. Provide the following information.

BMP/Control	Surface Elevation of Lowest Spot on Pavement (NAVD88 Ft.)	MWSE With/Without Control During 10-year Design Storm (NAVD88 Ft.)	Surface Elevation of Lowest Freeboard Requirement for Buildings Nearby (NAVD88 Ft.)	MWSE With/Without Control During 100-year Design Storm (NAVD88 Ft.)	Drawdown Time (Hours)
Vegetated Swale (Storm Water West BMP)	22.80	Without: 20.11 With: 19.25	22.06	Without: 20.83 With: 20.19	12
Bioretention BMP (Storm Water East BMP)	21.55	Without: 21.32 With: 21.04	22.40	Without: 21.62 With: 21.49	12
		Without: With:		Without: With:	
		Without: With:		Without: With:	
		Without: With:		Without: With:	

E.5 Water Quality – Capture and Treat

Designers shall complete the following portion of the DSM Coordination Checklist to demonstrate compliance with this SWM Standard. Designers shall also provide the necessary BMP information to communicate the level of treatment provided by each BMP.

Provide the total project disturbance area and calculation for WQ_F and/or WQ_V, as appropriate for treatment approach (if information is provided within attached documentation, please indicate).

9.80 acres was used as the drainage area and for WQf and WQv calculations (Total project disturbance area = 9.29 acres)

See Narrative for WQf and WQv calculations.

List out project-specific POCs requiring treatment, based on coordination with the Port (if information is provided within attached documentation, please indicate).

Sediment, Jet fuel

Identify the BMPs selected to comply with this SWM Standard. Provide the following information.

BMP	Flow/Volume Based	Portion of Total WQ_F or WQ_V	Addressed POCs	Drawdown Time (Hours)
Vegetated Swale (Storm Water West BMP)	0.57 cfs	WQf = 0.57 CFS (100%+)	Sediment	12
Bioretention BMP (Storm Water East BMP)	1,173 cf	WQv = 1095 CF (100%+)	Sediment	12

Identify any POCs requiring treatment that are not addressed by the above BMPs, as determined through coordination with the Port. If provided within an attached documentation, please indicate.

Potential exposure of stormwater to jet fuel is handled by existing structural (secondary containment) and operational (SPCC) controls as outlined in Section III.E of the Narrative.

E.6 Source Controls

Designers shall complete the following portion of the Coordination Checklist to demonstrate compliance with this SWM Standard.

List below the POCs, based on coordination with the Port, that require source control (if provided within an attached documentation, please indicate).

Jet fuel

List below any potential existing or new operational source control activities that may be appropriate for implementation, based on coordination with the Port (if provided within an attached documentation, please indicate).

See Stormwater Narrative, Section III.E (Source Controls).

Identify below applicable Activity Specific Source Control Requirements and if design complies with the requirements within Appendix M. If design does not comply, please confirm that a Variance Request has been submitted under the Variance Request portion of this checklist.

Removed in 2017 Edition of DSM

Activity	Applicable to Project	Design Complies with Appendix M Requirements
Solid Waste Storage Areas, Containers, and Trash Compactors	☐	☐
Material Transfer Areas/Loading Docks	☐	☐
Fuel Dispensing Facilities and Surrounding Traffic Areas	☐	☐
Aboveground Storage of Liquid Materials, Including Tank Farms	☒	☐
Equipment and Vehicle Washing Facilities	☐	☐
Covered and Uncovered Vehicle Parking Area	☐	☐
Exterior Storage and/or Processing of Bulk Materials	☐	☐
Water Reclaim and Reuse Systems	☐	☐

☒ Design does not expose any restricted material to stormwater.
☐ Check if the project site is within the Columbia South Shore Well Field WHPA.

Identify any POCs requiring source controls that are not addressed by the above source controls, as determined through coordination with the Port. If provided within an attached documentation, please indicate.

E.7 Hazardous Wildlife Attractants

Designers shall complete the following portion of the Coordination Checklist to demonstrate compliance with this SWM Standard, FAA requirements, and the WHMP.

Project design includes a BMP or potential hazardous wildlife attractant within the following Hazardous Wildlife Attractant Zone (please check one):

- ☒ Primary Zone
- ☐ Intermediate Zone
- ☐ Secondary Zone
- ☐ Five-Mile

☒ Project design is in compliance with this SWM Standard, FAA requirements, and the PDX WHMP.

Please describe the identified potential hazard(s) in the design and the measure(s) taken to reduce the attractiveness of the BMP or potential hazardous wildlife attractant (if demonstration is provided within an attached documentation, please indicate).

Multiple infiltration BMP's directing runoff to existing infrastructure was designed to minimize the likelihood of standing water and address the water quality flow rate. The BMP's will have relatively short vegetation and small footprints to reduce attractiveness to wildlife, and is designed to drain completely within 12 hours after rainfall events. Standing water on the airport is required to drain within 48 hours.

E.8 Floodway and Natural Resource Protection

Designers shall complete the following portion of the DSM Coordination Checklist to demonstrate compliance with this SWM Standard.

☒ Project design is in compliance with all applicable federal, state, regional, and City of Portland floodway and natural resource regulations.

Flood Hazard Areas

☒ Design avoids construction within flood hazard areas.
☐ Design includes construction within flood hazard areas.

- Identify applicable required reviews, approvals, and permits associated with construction within the identified flood hazard area(s).

Greenway Overlay Zones

☒ Design avoids construction within greenway overlay zones.
☐ Design includes construction within greenway overlay zones.

- Identify applicable required reviews, approvals, and permits associated with construction within the identified greenway overlay zone(s).

Environmental Overlay Zones

☒ Design avoids construction within environmental overlay zones.
☐ Design includes construction within environmental overlay zones.

- Identify applicable required reviews, approvals, and permits associated with construction within the identified greenway overlay zone(s).

E.9 Erosion and Sediment Control

Designers shall complete the following portion of the Coordination Checklist to demonstrate compliance with this SWM Standard.

☒ Stormwater management design is in compliance with City of Portland Code Title 10 and the *Erosion and Sediment Control Manual.*

☒ Designers have incorporated the Port's technical specification "015713 – Temporary Erosion, Sediment, & Pollution Control" into project design documents.

☒ A DEQ construction permit is applicable toward the project and coverage under a permit is either already completed or is being sought.

- ☐ 1200-CA is applicable toward the project and designers have coordinated with the Port on permit requirements
- ☒ 1200-C is applicable and designers are coordinating or have already coordinated with the Port on the required permit application

☒ The project consists of ground-disturbing activities 500 square feet or greater in area and is a permitted development project, or the site is located on steep slopes, in an environmental overlay zone, or in a greenway overlay zone

- ☐ The Erosion, Sediment, and Pollutant Control Plan (ESPCP) has been developed and submitted to the City.
- ☒ The ESPCP has been developed and submitted to DEQ as part of the 1200-C application, or if covered under the 1200-CA permit, a copy has been developed and will be retained on-site during construction.

Identify applicable required reviews, approvals, and permits associated with construction.

E.10 Design Criteria in Chapter 5 and Chapter 6

Designers shall complete the following portion of the DSM Coordination Checklist to demonstrate compliance with the design criteria for drainage system design (Chapter 5) and BMP design (Chapter 6 and BMP Fact Sheets).

☐ Design of the drainage system is in compliance with the design criteria within Chapter 5. Please provide a summary demonstrating compliance with design criteria for the drainage system design (if summary is provided within an attached documentation, please indicate). If design does not comply, please confirm that a Variance Request has been submitted under the Variance Request portion of this checklist.

The design incorporates multiple stormwater systems:

Pipes are sized to convey the 100-year storm with no surcharge.

See Attachment I-1 and I-2 for variance requests related to storm drains (velocity and slope and depth of cover).

See Stormwater Narrative and attached calculations.

☒ Design of the drainage system is in compliance with the design criteria within Chapter 6 and BMP Fact Sheets. Please provide a summary demonstrating compliance with design criteria for BMPs (if summary is provided within an attached documentation, please indicate). If design does not comply, please confirm that a Variance Request has been submitted under the Variance Request portion of this checklist.

The design incorporates on FS6- Vegetated Swale and one FS4- Bioretention per the DSM. The BMP's address runoff from the drainage areas 1-7 for the new impervious surfacing. It serves as water quality treatment and is intended to control peak flows and reduce stormwater volume leaving the site by allowing infiltration to occur, while still directing runoff to the existing stormwater conveyance system to minimize standing water.

See Stormwater Narrative and attached calculations.

E.11 Identification of Variance Requests

Designers are required to submit completed Variance Requests to the Port at the Preliminary Design Milestone(s), as applicable. This allows the Port to review discrepancies from DSM requirements, provide feedback to designers, and adjust project course as needed before proceeding to the Final Design phase. Designers are encouraged to discuss and submit Variance Requests to the Port earlier in the design process, as they are identified. This portion of the DSM Coordination Checklist is used to track the potential need for a Variance Request or to track any outstanding Variance Requests. Please see Appendix F for the Variance Request Application Form that must be submitted to the Port along with supporting documentation.

Variance Request	Brief Description of Variance Request	Submitted Variance Request
Off-Site mitigation to meet water quality SWM Standard (See Chapter 4)		☐
Implement of a new Underground Injection Control (UIC) system serving non-roof areas (See Chapter 4)		☐
Modify an activity-specific source control requirement (See Chapter 4 and Appendix M)	Request variances from the required oil water separator and valving due to physical site constraints and simplicity of system. See Attachments I	☒
Deviate from conveyance or BMP design criteria (See Chapter 5, Chapter 6, and the BMP Fact Sheets)	Request variances from the required minimum depth of cover and velocity for stormwater pipes due to physical site constraints. See Attachments I	☒
Implement a BMP type other than those defined in the BMP Fact Sheets (BMPs must be certified under the Washington State Dept. of Ecology TAPE program)		☐

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

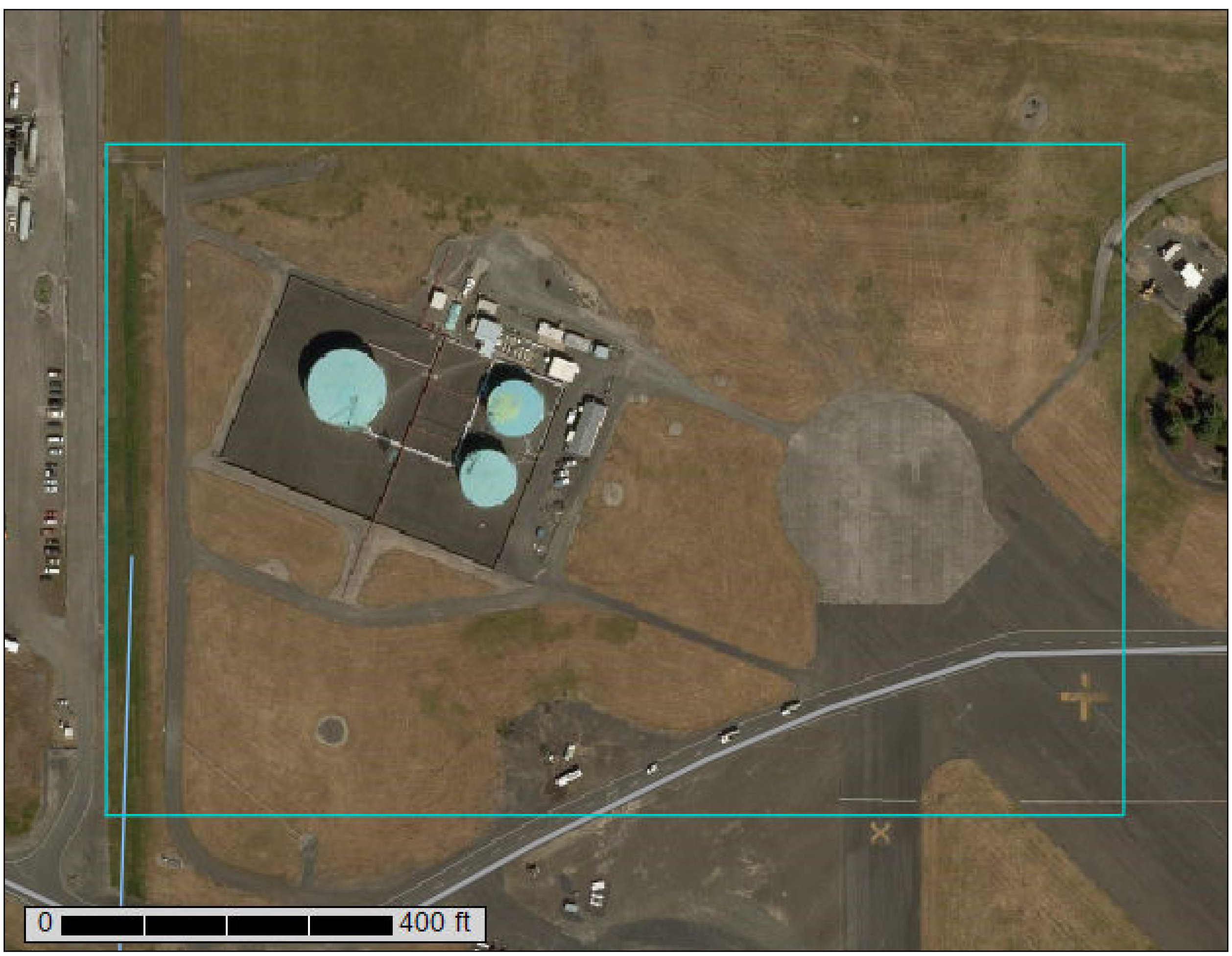
A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Multnomah County Area, Oregon

Portland International AirportPDX Facility Upgrade

APPENDIX B:
Web Soil Survey Report



October 21, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

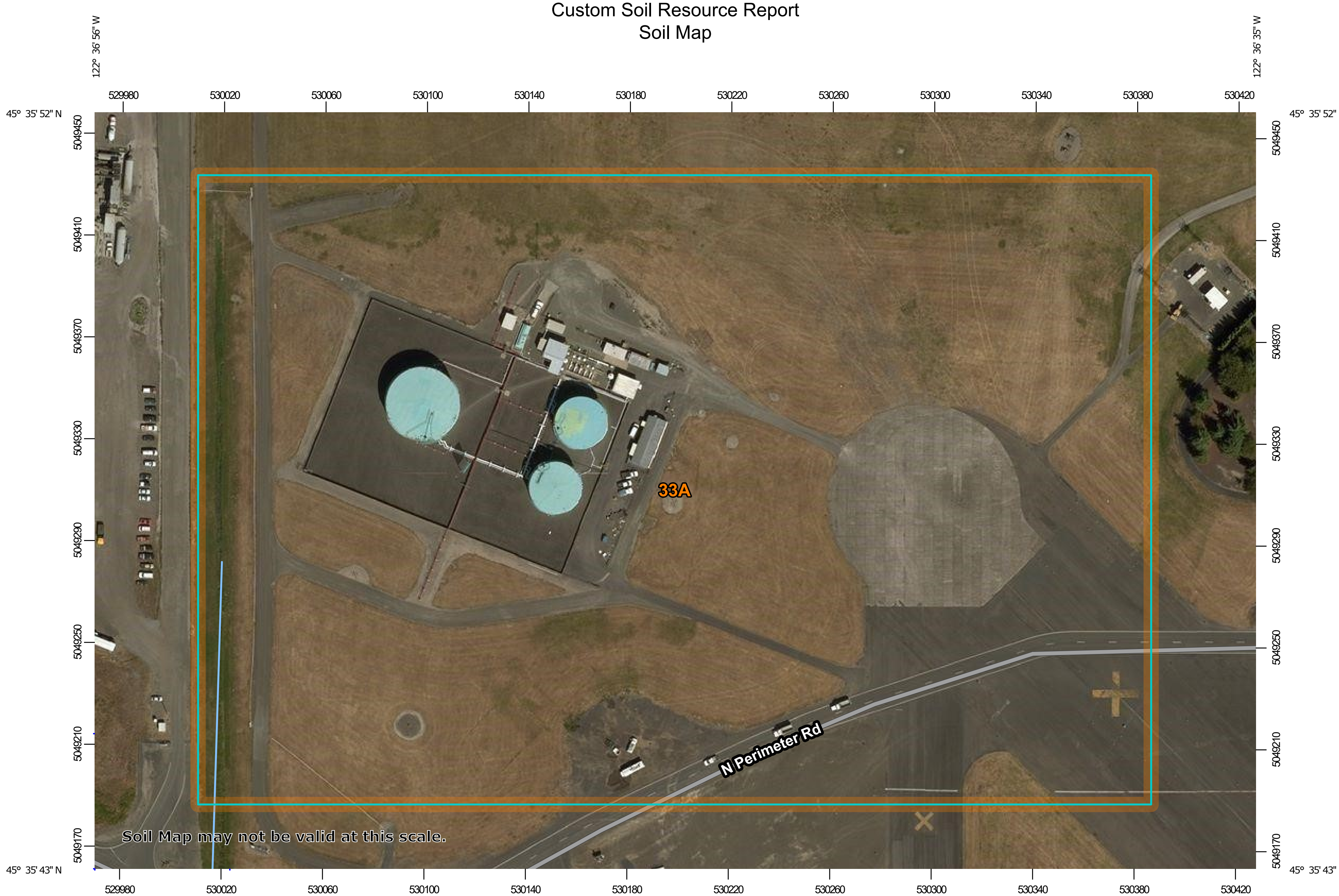
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:2,090 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 30, 60, 120, 180

Feet: 0, 100, 200, 400, 600

N

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Multnomah County Area, Oregon
Survey Area Data: Version 17, Sep 10, 2019

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
33A	Pilchuck-Urban land complex, 0 to 3 percent slopes	23.0	100.0%
Totals for Area of Interest		**23.0**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Multnomah County Area, Oregon

33A—Pilchuck-Urban land complex, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 229v
Elevation: 0 to 30 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 165 to 210 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Pilchuck and similar soils: 50 percent
Urban land: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pilchuck

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium

Typical profile

H1 - 0 to 12 inches: sand
H2 - 12 to 60 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water storage in profile: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Forage suitability group: Well drained < 15% Slopes (G002XY002OR)
Hydric soil rating: No

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Moag

Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

Rafton

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Faloma

Percent of map unit: 3 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

Sauvie

Percent of map unit: 2 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX C:
Facility ICP

PDX - Base #520
Portland International Airport
Portland, Oregon

Integrated Contingency Plan

Prepared By:

Advanced Remediation Technologies, Inc
690 NW 1st AVENUE, SUITE 104
CANBY, OREGON 97013 503-266-2122

Effective Date of Plan:
November 2016

Record of Amendments to the ICP

Date Change Proposed (If applicable)	Effective Date of Change	Certified Reviewer	Initialed	Section Modified	Modifications/Changes	Regulatory Notification/Date
	01/2004	Lance A. Downs, PE		Modification to "One Plan" entire plan	Incorporation of SPCC, FRP, and ERA into "One Plan" format.	Oregon DEQ 12/31/03
	11/2006	Bruce Kelly, PE		Update to Revised Regulation	Mobile refueller parking	
	01/2011	Lance A. Downs, PE		5 year update	South Load Rack relocation	
	08/2012	Lance A Downs, PE		Comments from Port/DEQ	Corrected numbers and pipeline operator	
	11/2016	Lance A Downs, PE		5 year update	O/W separator installed	
	04/10/18	Lance A. Downs, PE		Sec. 2.4.6 & 2.4.7	North Fueling Rack AST's	

The following pages include all of the certifications necessary for compliance with 40 CFR 112 and 40 CFR 122.

ICP CERTIFICATION AND APPROVAL SIGNATURES

I, Lance A. Downs, a Registered Professional Engineer, have examined the Portland Fuel Facility Consortium /Menzies Aviation (PFFC/Menzies) facilities and certify that this Integrated Emergency Response/Pollution Prevention Plan has been prepared in accordance with the following: good engineering practices, including consideration of applicable industry standards, U.S. Environmental Protection Agency Oil and Hazardous Substance Site Spill Prevention Control and Countermeasures (SPCC) regulations (40 CFR 112), Hazardous Waste regulations (40 CFR 264, 265), Underground Storage Tank requirements (40 CFR 280), and The National Pollutant Discharge Elimination System regulations (40 CFR 122, 125). Procedures for inspections and testing have been established within the plan and the plan is adequate for the facility as it is currently described.

Signature: ______________________ Date: ______________________

P.E. Registration No. 18510PE

State: Oregon

I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. The Integrated Contingency Plan (ICP) was approved by the management of the PFFC/Menzies and will be implemented at the facility as described herein. I have reviewed the terms of this plan and will to the best of my ability, oversee the implementation of the plan's provisions. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: ______________________ Date: ______________________

Name: Scott Baker
Title: Facility Manager

Facility Name: Portland Fuel Facility Consortium Fuel Storage and Distribution

Menzies Aviation	Fuel Storage and Distribution Facility
8133 Air Trans Way	5000 NE Marine Drive
Portland, Oregon 97218	Portland, Oregon 97218

Maximum storage capacity: 3,360,000 gallons of Jet A fuel

CERTIFICATION OF SUBSTANTIAL HARM DETERMINATION FORM

Operator Name: Menzies Aviation
4900 Diplomacy Road
Fort Worth, Texas 76155

Facility Name: Portland Fuel Facility Consortium Fuel Storage and Distribution

Menzies Aviation	Fuel Storage and Distribution Facility
8133 Air Trans Way	5000 NE Marine Drive
Portland, Oregon 97218	Portland, Oregon 97218

1. Does the facility have a maximum storage capacity greater than or equal to 42,000 gallons and do the operations include over water transfers of oil to or from vessels?

YES________________NO____X____________

2. Does the facility have a maximum storage capacity greater than or equal to one million gallons and is the facility without secondary containment for each aboveground storage area sufficiently large to contain the capacity of the largest aboveground storage tank within the storage area?

YES________________NO____X____________

3. Does the facility have a maximum storage capacity greater than or equal to one million gallons and is the facility located at a distance (as calculated using the appropriate formula in Attachment C-III or an alternative formula considered acceptable by the RA) such that a discharge from the facility could cause injury to an environmentally sensitive area defined in Appendix D?*

YES___X____________NO________________

4. Does the facility have a maximum storage capacity greater than or equal to one million gallons and is the facility located at a distance (as calculated using the appropriate formula in Attachment C-III or an alternative formula considered acceptable by the RA*) such that a discharge from the facility would shut down a public drinking water intake?

YES________________NO____X____________

5. Does the facility have a maximum storage capacity greater than or equal to one million gallons and within the past five years has the facility experienced a reportable spill in an amount greater than or equal to 10,000 gallons?

YES________________NO____X____________

**From 40 CFR 112. If an alternative formula is used, documentation of the reliability and analytical soundness of the alternative formula must be attached to this form.*

CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document; and that based on my inquiry of those individuals responsible for obtaining this information, I believe that the submitted information is true, accurate, and complete.

______________________________	______________________________
Signature	Date
Scott Baker	Facility Manager
Name (Please type or print)	Title

Table of Contents

List of Figures, Reports, and Forms

List of Tables

List of Acronyms

AST	Aboveground Storage Tank
BMP	Best Management Practices
CERCLA	Comprehensive, Environmental, Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
EC	Emergency Coordinator
EPA	Environmental Protection Agency
FRP	Facility Response Plan
GSE	Ground Service Equipment
ICP	Integrated Contingency Plan
IRT	Installation Response Team
ISCP	Installation Spill Contingency Plan
LEPC	Local Emergency Planning Committee
LQG	Large Quantity Generator
Menzies	Menzies Aviation
MSDS	Material Safety Data Sheet
NPDES	National Pollution Discharge Elimination System
NAICS	North American Industry Classification System
OAR	Oregon Administrative Rules
OERS	Oregon Emergency Response System
OR DEQ	Oregon Department of Environmental Quality
ORPDES	Oregon Pollutant Discharge Elimination System
ORS	Oregon Revised Statues
OSC	On-Scene Coordinator
IOSC	Installation On-Scene Coordinator
PDX	Portland International Airport
PFFC	Portland Fuel Facility Consortium
POC	Point of Contact
POL	Petroleum, Oil or Lubricant
POTW	Publicly Owned Treatment Works
PPE	Personal Protection Equipment
QI	Qualified Individual
RCRA	Resource Conservation and Recovery Act
SIC	Standard Industrial Code
SOP	Standard Operating Procedures
SPCC	Spill Prevention Control and Countermeasure
SPCCP	Spill Prevention Control and Countermeasure Plan
SQG	Small Quantity Generator
SWPPP	Storm Water Pollution Prevention Plan
TSD	Treatment, Storage and Disposal
UL	Underwriters Laboratories
USF	Used Sump Fuel
UST	Underground Storage Tank

1.0 PLAN INTRODUCTION

1.1 General Facility Identification Information

Facility name:	Portland Fuel Facility Consortium (PFFC) Fuel Storage and Distribution
Owner/operator/agent:	Port of Portland/PFFC/Menzies Aviation
Physical address:	Fuel Storage Facility & Distribution 5000 NE Marine Drive Portland, Oregon 97218
Mailing address:	Menzies Aviation 8133 Air Trans Way Portland, Oregon 97218

Facility Manager and other persons qualified to implement ICP:

Primary Contact:	Scott Baker, Facility Manager
Phone Number:	(503) 752-1726, work (360) 619-2589, cellular
Secondary Contact:	John Rausch, General Manager, Into Plane Fueling
Phone Number:	(503) 249-4565, work (310) 467-8556, cellular

Facility fax number: Menzies: (503) 280-9831

Other identifying information:

Latitude: 45°35’50”
Longitude: 122°36’45”

Multnomah County, Oregon

Directions to the facility:

Coming from the south (heading north) on I-205 take exit number 24A, and proceed west on NE Airport way. Turn left onto Highway 213 (NE 82nd Ave.) and proceed south to the intersection of NE Alderwood Rd. Turn right onto NE Alderwood Rd., and then turn right onto NE Cornfoot. Proceed on NE Cornfoot to NE Air Trans Way, Turn right onto NE Air Trans Way.

Coming from the north (heading south) on I-205 take exit number 24 and follow directions above.

1.2 Purpose & Scope

The purpose of the Integrated Contingency Plan (ICP) is the generation of a best management practices (BMP) and functional emergency response plan for the PFFC fuel storage and distribution system. Its intent is to protect human health and provide a single set of procedures and guidance for preventing, controlling and responding to releases or potential releases of pollutants to the environment. This ICP synthesizes the required planning elements of the following federal Environmental Protection Agency (EPA) and State of Oregon, as applicable to the PFFC, thereby eliminating the need for separate plans.

- **Resource Conservation and Recovery Act (RCRA) Contingency Planning requirements (40 CFR 264 and 265)**
- **Spill Prevention Control and Countermeasure Plan (SPCCP) (40 CFR 112)**
- **Facility Response Plan (FRP) (40 CFR 112)**
- **Oil & Hazardous Materials Emergency Response Requirement (OAR Div 142, ORS 468B)**

The format of the ICP is adapted from the guidance recommended by the National Response Team published on June 5, 1996, in the Federal Register. The ICP is intended to substantiate conformance with the guidance and satisfy the requirements of the referenced regulations.

The ICP is a user-friendly tool to protect natural resources by establishing an effective prevention and response program. The ICP identifies potential sources of harmful discharges of oil and hazardous substances that have the possibility to contaminate the environment (groundwater, surface water, air, land, etc.) through uncontrolled releases. It evaluates each source's pollutant release potential and describes current BMPs to prevent and control potential releases. It also serves as a basis for training personnel in preventing releases and implementing appropriate countermeasure actions.

Copies of the ICP must be kept at the facility and with local emergency responders whose assistance may be necessary in the event of an emergency incident.

1.3 Regulatory Applicability

The applicable federal and State of Oregon regulations referenced above are satisfied in the ICP. The following subsections present regulatory applicability of the component plans.

1.3.1 Spill Prevention Control and Countermeasures Plan and Installation Spill Contingency Plan Applicability

<u>SPCCP Requirements</u>

The development of a SPCCP is required under Title 40, Code of Federal Regulations (CFR), Part 112. Under Federal Regulation 40 CFR 112.1(d), a SPCCP must be written when one of the following requirements is met:

(1) Due to its location, the facility has a reasonable potential to discharge oil into or upon navigable waters of the United States; or

(2) Meets at least one of the following criteria:
   a. The total aboveground oil storage capacity at the facility is greater than 1,320 gallons; or
   b. The total underground oil storage capacity is greater than 42,000 gallons.

If the facility meets the federal criteria, a Self-Certification Statement of the applicability of substantial harm criteria must be completed and signed by the Responsible person. The criteria are designed to identify a facility that has the potential to cause substantial harm to the environment, specifically by discharging into navigable waters or adjacent shorelines. It should be noted that a yes answer to any of the questions would trigger a requirement to prepare a facility response plan. The Self-Certification Statement precedes the Introduction.

The PFFC meets the first and second criteria for the development of a SPCC under 40 CFR 112.1(d) because it contains three ASTs with a total capacity of 3,360,000 gallons (two ASTs with a capacity of 840,000 gallons each and one AST with a 1,680,000-gallon capacity) used to store Jet A fuel. The amount of hazardous materials stored at the facility exceeds "consumer quantities."

> Note: (1) - The term "navigable waters" has been modified several times over the years, each modification expanding the previous definition to include smaller streams, tributaries, and accumulations of water, such that now virtually all "waters of the U.S." are included.

1.3.2 Resource Conservation and Recovery Act Contingency Plan

Under 40 CFR 262.34(a)(4), owners and operators of facilities that generate hazardous wastes are required to comply with the Interim Status Treatment, Storage, and Disposal (TSD) Facility Standards listed under 40 CFR Part 265.30 (Subpart C) and 265.50 (Subpart D). Small Quantity Generators (SQG) must comply with Subpart C, while LQGs must comply with both Subparts C and D.

Subpart C (Preparedness and Prevention) presents the requirements a facility must implement to prevent or minimize an emergency situation involving fire, explosion, or a release of hazardous waste into the environment.

Subpart D lists the requirements for development of a contingency plan and the procedures a facility should follow in the case of an emergency such as a fire, explosion, or any unplanned sudden or non-sudden release of hazardous waste constituents to air, soil, or surface water at the facility. In addition to presenting contingency plan content requirements, Subpart D provides:

- Record keeping and amendment requirements for the plans; and
- Detailed emergency procedures and record keeping and reporting requirements during emergencies.

PFFC/Menzies does not generate hazardous waste, currently. The facility is considered to be exempt from most hazardous waste management requirements. PFFC/Menzies, however, is required to determine which wastes are hazardous, and treat or dispose of wastes onsite or deliver wastes to an offsite TSD facility that meets standards under 40 CFR Parts 265 and 270. If the quantity of hazardous waste at PFFC/Menzies increases such that the above-listed quantities are exceeded (but do not trigger full-regulatory status as a LQG), the facility will lose its conditionally exempt status and will be considered a SQG.

As a conditionally exempt small quantity generator (CESQG), PFFC/Menzies is not required to develop and maintain a Hazardous Waste Contingency Plan.

1.4 Plan Implementation

At least one copy of the plan will kept at the Menzies Maintenance office and accessible at any time by the incident commander or spill response manager named in accordance with OAR 340-141-0140(7). At least one copy of the plan will be kept at the Fuel Storage Facility covered by the plan and kept it in a conspicuous and accessible location.

In addition to personnel responsible for emergency response (see Section 2.1), representatives Menzies headquarters in Fort Worth, Texas are responsible for ensuring the plan is effectively implemented. These individuals are discussed below.

Menzies Aviation Headquarters

Menzies Aviation Headquarters has overall program management responsibility for ensuring the ICP is effectively implemented at the PDX PFFC/Menzies facilities. Menzies's Corporate responsibilities include:

- Providing oversight and guidance to the facility to assist in the plan's implementation;
- Assuring compliance with permit conditions, if appropriate
- Conducting or contracting facility comprehensive site compliance evaluations (see Section 2.4.7) and assuring necessary proper corrective actions are initiated;
- Developing employee training as required by the plan;
- Reviewing annually and updating the ICP.

Facility Manager

The Facility Manager is responsible for ensuring that day-to-day operations are conducted in accordance with the ICP. The Facility Manager at PFFC/Menzies is Scott Baker. The individual responsible for spill or incident response at PFFC/Menzies is Scott Baker. His duties include:

- Conducting routine facility inspections and implementing necessary corrective actions following discussion with the facility manager;
- Assisting in revision of the plan, including modifying or developing new BMPs;
- Scheduling team meetings on at least an annual basis to discuss issues related to the plan, including spill incidents, effectiveness of BMPs, and recommended plan modifications;
- Modifying existing or developing new BMP alternatives;
- Coordinating employee training as required by the plan, including reviewing training records;
- Conducting or otherwise providing annual and new employee training as required by the plan.

1.5 Commitment of Manpowern and Equipment

In the event of an emergency incident, Menzies will use whatever manpower, equipment, and materials necessary to safely respond to the incident in the minimum time, with minimal environmental damage and maximum recovery of the released material as practicable. At no time will personnel safety be jeopardized nor will environmental protection take precedence over personnel safety. In the event of worst case spill, the primary manpower and equipment resources will be as follows;

Cowlitz Clean Sweep (Primary)
9420 NW St. Helens Road
Portland, Oregon 97231

Terra Hydr, Inc. (Secondary)
P.O. Box 3616.
Portland, Oregon 97208

1.6 Documentation of Plan Review and Modification Process

The ICP must be amended whenever there is a change in facility design, construction, operation, or maintenance that materially affects (i.e., increases or decreases) the facility's potential to discharge oil or a hazardous material or waste into the environment. In addition, facility owners or operators are required to review and evaluate the ICP at least once every five years from the time the facility becomes subject to SPCC regulation. Following this review and evaluation, the ICP must be amended within six months of the review to include more effective prevention and control technology if:

- Such technology will significantly reduce the likelihood of a spill or release event from the facility; and
- The technology has been field-proven at the time of the review.

In order to satisfy the requirements of 40 CFR 112.5, SPCCP related amendments must be certified by a Professional Engineer. Interim amendment certification will be incorporated into the plan in addition to the five-year certification.

This plan will be reviewed and/or modified under the following circumstances:

- Once every five years;
- After the release of more than 1,000 gallons of oil or if two reportable spills (greater than 42 gallons each) occur within a 12-month period;
- If there is a change in facility design, construction, operation, or maintenance that materially affects (i.e., increases or decreases) the facility's potential to discharge oil or a hazardous material or waste into the environment;
- If applicable regulations are revised;
- If the ICP fails in an emergency;
- If the Emergency Coordinator (EC) changes[1];
- If the list of emergency equipment changes;
- If the Regional Administrator requires an amendment;[2]
- If the Comprehensive Site Compliance Evaluation (required at least once per year by the storm water regulations) is performed, and the results require changes to the description of potential pollutant sources and pollution prevention measures and controls. Note that the revisions must be made to the ICP within two weeks of the evaluation and implementation of any changes to the ICP must be in a timely manner, but in no case more than 12 weeks after evaluation.[1]

A record of amendments or modifications will be kept with the ICP.

The Oregon Department of Environmental Quality requires notification in writing as soon as possible and within 24 hours of any significant change that could affect implementation of this plan, including a significant decrease in available spill response equipment or personnel. A schedule for the prompt return of the plan to full operational status will also be given.

After the occurrence of an emergency incident, the following questions will be asked of facility emergency response personnel, under the direction of the EC:

- How might the emergency response execution be improved? Does the Emergency Response Structure need modification?
- What lessons were learned? Did existing procedures contribute to the cause of an incident?

[1] A PE re-certification is not required because this amendment is not related to 40 CFR 112.5.

[2] Within 30 days from receipt of the amendment notice the facility may submit written information, views, and arguments on the amendment. After reviewing the relevant material the Regional Administrator shall notify the facility of any amendment required or shall rescind the notice. The amendment is to become part of the Plan 30 days after such notice. The amendment of the Plan should be implemented as soon as possible but, not later than six months after the amendment becomes part of the plan, unless the Regional Administrator specified another date. The facility may appeal a decision made by the Regional Administrator requiring an amendment. This appeal is to be made to the administrator of the USEPA and must be made in writing within 30 days of receipt of the notice requiring the amendment.

- Was there any feedback from external agencies or responders that may improve response planning?
- What changes, if any, might be made to the ICP to improve emergency response planning?

After the preceding questions are answered, it may be necessary to modify the ICP. A record of the modifications will be noted in the table on Page i located at the beginning of the ICP.

Personnel to contact for plan review and maintenance is:

Menzies: Scott Baker, Facility Manager

1.7 Organization of the ICP

The ICP is organized into three primary sections: the Plan Introduction, the Core Plan, and the Annexes.

- **The Introduction** consists of general facility identification information, description of ICP review procedures, and the regulatory cross-reference matrix. The matrix is a tool that allows facility personnel and regulators to cross-reference required regulatory components with their locations in the ICP.
- **The Core Plan** consists of a description of the facility, emergency response procedures, an inventory and description of potential sources of pollution, and storm water management procedures.
- **The Annexes** include detailed supporting information on specific response techniques, such as procedures to address specific kinds of common spills and releases. It also includes BMPs as they pertain to the site. The BMPs include inspection procedures and degree of training required to maintain regulatory compliance. Necessary documentation used to demonstrate regulatory compliance and checklists that can be used to ensure compliance and promote good housekeeping are included in the Annexes.

1.8 Regulatory Cross-Reference Matrix

The matrix below can be used to reference required components of a SPCCP, a FRP, and a Hazardous Waste Contingency Plan to their locations in the ICP.

SPCCP (40 CFR 112)

FRP (40 CFR 112)

Hazardous Waste Contingency Plan (40 CFR 265, Subpart D)

Oregon Oil Spill Contingency Planning (OAR 141-340)

2.0 CORE PLAN

The Core Plan consists of a description of emergency response procedures for both major and minor incidents. It is followed by a description of the facility, its history, and potential sources of pollution. Finally, storm water management is discussed.

2.1 Emergency Response

2.1.1 Objectives and Goals

Emergency response procedures are developed to ensure that emergency incidents are responded to quickly, safely and effectively, and are properly reported and documented. Emergency incidents include pollutant releases to the environment resulting from spills, as well as explosions, fires and other dangerous incidents. Releases may be more or less severe. Some will require emergency assistance, while facility personnel can handle others.

The immediate goals of response to an emergency incident are to preserve human safety and health and to prevent, to the maximum extent practicable, harm to the environment. PFFC/Menzies will ensure, by all necessary approved means, the availability of resources necessary for facility personnel and the EC to meet these goals and to prepare for worst case scenarios for an emergency incident.

Menzies personnel are not required to make major efforts or risk personnel safety to clean up spills. When an incident is beyond the capability of facility personnel to complete emergency response, the appropriate action is to make required notifications and then assist outside personnel in completing security of the site and containment of spilled material, whether those outside personnel be other public officials or response companies contracted by Menzies management.

Emergency response DOES NOT include cleanup of the site unless within the capabilities of facility personnel and completed as an "incidental release." Cleanup beyond the capabilities of facility personnel will be coordinated by the EC.

2.1.2 Response Management Structure

This section provides an overview of the response management structure. Throughout the response to an emergency incident, there are several persons who hold responsibility for carrying out appropriate and complete response measures. Figure 2-1 illustrates the Installation Response Team (IRT) command Structure and identifies key members and phone numbers.

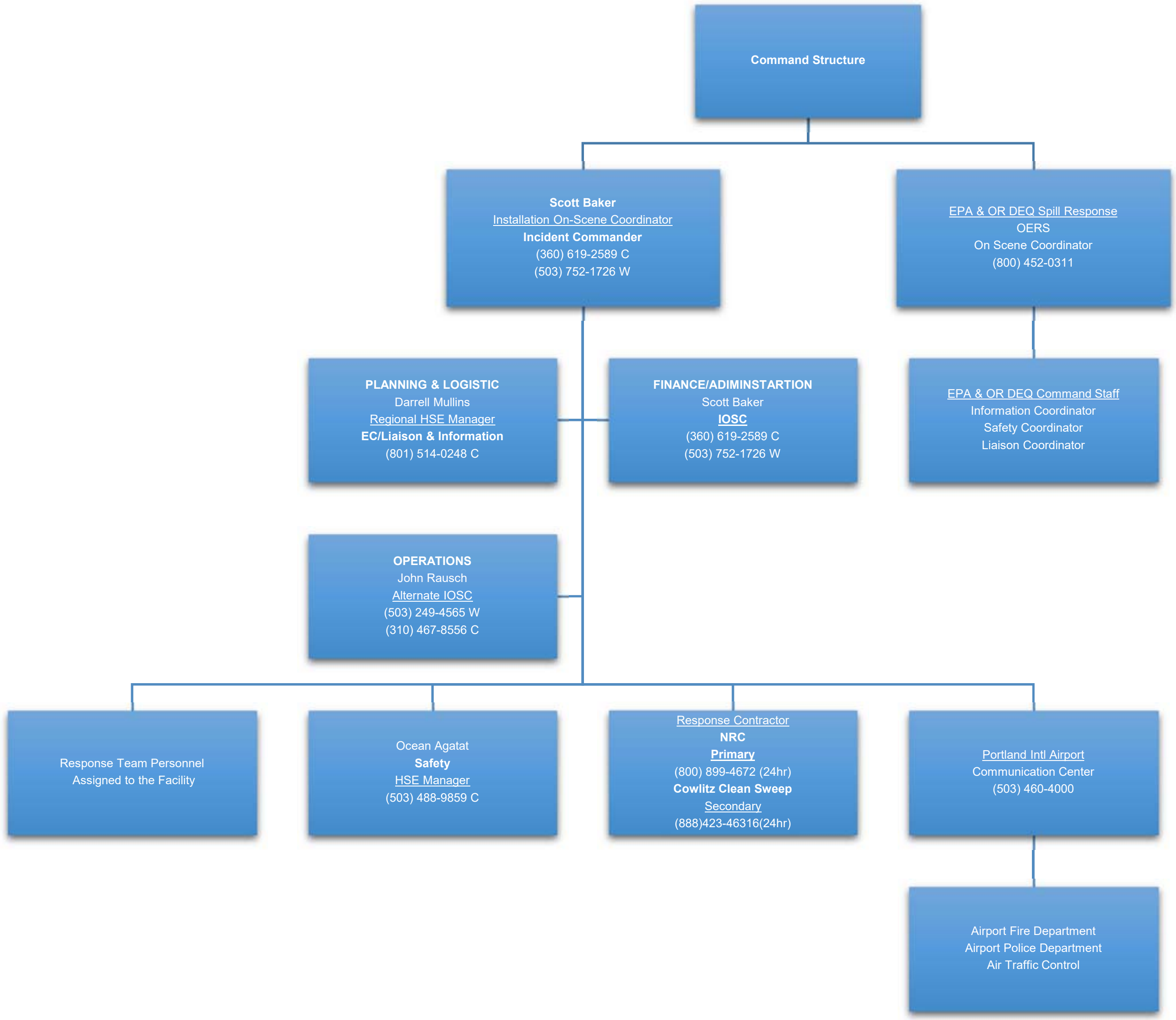


Figure 2-1: Installation Response Team Command Structure

EC Responsibilities

The EC will serve as a resource to the Installation On-Scene Coordinator (IOSC)/Qualified Individual (QI) and the OR DEQ On-Scene Coordinator (OSC). The primary responsibilities of the EC are to assist in emergency response and notification, if possible, clean up environmental contamination, restore the site (if needed), and assist in reporting to appropriate regulatory agencies. Upon notification (after a release of a "reportable quantity"), the EC will notify appropriate federal, state and local agencies (see Section 2.1.4), if not already done by the IOSC/QI. Additionally, the EC will:

- Take all reasonable measures necessary to ensure that emergency incidents do not occur, reoccur, or spread throughout the facility;
- Assess the possible direct and indirect hazards to human health and the environment (e.g., harmful effects of gases generated by the incident, maximum exposure limits, or harmful effects to the environment caused by chemical agents or surface water run-off). Identify areas of economic importance and environmental sensitivity. Such areas may require extraordinary response consideration;
- Perform site cleanup and contract/project management for large spills subsequent to the initial response provided by local emergency responders or other public agencies.

IOSC/QI Responsibilities

Emergency response is initiated when notification is made to the IOSC/QI, who is responsible for initiating immediate response to the incident for this facility, as described below:

- The IOSC/QI will utilize the IRT and other available assets of the facility if the required response is within the capabilities of facility personnel. The IOSC/QI will then use facility equipment to provide security and initiate containment and cleanup. The IOSC/QI must also provide telephonic and written notification to the EC (see ***EC Responsibilities*** above).
- If a "reportable quantity" or amount of material beyond the capability of the facility to provide appropriate response has been released, the IOSC/QI will immediately call (503) 460-4000 to obtain local assistance from PDX Communication Center.
- If a "reportable quantity" has been released, the IOSC/QI must notify the EC telephonically, either directly during normal working hours or during after hours, in order to obtain site restoration services and ensure that required notifications to regulatory agencies has been completed.
- State law requires notification of "reportable quantities" to the Oregon Emergency Response System (OERS) immediately of the incident by calling 1-800-452-0311. This will be accomplished by the EC if coordination of the incident has been made by the IOSC/QI. If the EC has not been notified, the IOSC/QI must notify OERS. A call to OERS activates a notification system to all potentially affected public agencies. This requirement is not met by calling 911.
- All spills, even those not of a "reportable quantity" and those that are adequately cleaned up by facility personnel, must be reported by the IOSC /QI to the EC within 24 hours or the first working day after the incident, and a completed copy of Spill Incident Report must be faxed to Menzies Corporate Headquarters within 72 hours of the incident.

When an incident occurs, the IOSC/QI will follow the steps described below.

1. **EXECUTE** Spill Response Requirements (see Section 2.1.3).
2. **CHARACTERIZE** the Spill:
   - What was spilled?
   - How much was spilled?
   - Was a "Reportable Quantity" spilled?
   - Has surface water been impacted?
3. **CONTACT** the Facility Manager (and, if necessary, PDX Communication Center and ORES) immediately.
4. **NOTIFY** (see Section 2.1.4) if a "Reportable Quantity" was spilled. This is necessary to ensure regulatory agencies are notified, financial liability of those who caused the spill is protected, and necessary support for cleanup is obtained.
   a. Call IOSC Scott Baker, 360-619-2589.
   b. Call Regional HS&E Darrell Mullins, 801-514-0248.
   c. Call OERS (1-800-452-0311) immediately if either of the above cannot be contacted.

1. **CONTAIN or CLEAN UP** any spill within the unit's capability with available materials and equipment. Do not over-task personnel. Pursue all actions safely.
2. **REQUEST** immediate assistance, if required, to contain or clean up the spill, especially if water is impacted. Call 911, if required. Coordinate with responders or other public officials, as necessary:
3. **REPORT** all POL or hazardous material spills to Menzies Corporate Headquarters.
   a. Complete an Menzies Spill Incident Report (see Annex 3.8).
   b. Verbal Report to Menzies's Regional and Corporate HS&E within 24 hours, if "reportable quantity" and not previously notified.
   c. Written report to Menzies Corporate within 72 hours (or next normal working day).

Upon notification, the IOSC/QI characterizes the release by evaluating the type of material, size, location, and potential hazard of the spill. Pertinent information that must be conveyed to the EC by the IOSC/QI includes:

- Nature of the incident (fire, explosion, release, etc.);
- Location of the incident;
- Number of injured personnel and nature of the injuries, if any;
- Substance(s) released;
- Amount released (estimated);
- Status of release (e.g., shut off, still discharging, reached storm sewer);
- Rate substance currently releasing (estimated);
- Time incident occurred;
- Direction and extent of flow (release);
- Any other pertinent information (other potential hazards).

The IOSC/QI has the responsibility to manage and direct all response operations until relieved by the commander of the local fire department or other public official, if local emergency response assistance has been requested. Facility personnel will then assume subordinate roles to the local responders. When called to a facility, the senior local fire department official will serve as Incident Commander and will execute response procedures. The IOSC/QI will serve in a subordinate response capacity, but does not relinquish authority or control of the IRT. The IOSC/QI retains the responsibility of conducting ongoing incident assessment until the emergency portion of the event is terminated. (Local police departments, fire departments, and state and local emergency response teams are required to have current copies of the ICP. Local hospitals are required to have been notified of the hazardous materials and waste contained at the facility.) When the emergency portion of the event is terminated, the IOSC/QI must coordinate with the EC to initiate cleanup and restoration of the site.

IRT Responsibilities

The IRT works under the direction of the IOSC/QI and is the first level of defense against expansion and aggravation of the incident until arrival of outside assistance, if such assistance is required. The IRT members are personnel who are responsible for controlling spills and hazardous materials/wastes releases.

Table 2-1. Installation Response Team

Name	Response Expertise	Responsibilities
Scott Baker	Safety and spill cleanup supervisor.	Installation On-Scene Coordinator Makes final decision on local level. Maintains communication with PDX, Response Contractors, and regulatory OSC
John Rausch	Provide absorbent material, shovels. Contain spill.	Alternate Installation On-Scene Coordinator
Facility Personnel	Turn off power to POL area, provide containment material, contain spill. Position fire extinguishers and prevent fire or explosion. Enforce safety zone, keep spectators a safe distance away.	IRT member

The IRT will attempt to prevent spills from entering streams, drainage ditches or other bodies of water using methods such as ditching, diking or covering with sand, soil or other absorbent material. If response by the fire department or other HAZMAT team is obtained, the IRT may assist in that effort by providing materials and equipment as practicable and within capabilities, but does not fall under the control or answer directly to anyone but the IOSC/QI.

2.1.3 Emergency Response Actions

When an emergency incident occurs, PFFC/Menzies personnel will follow the sequence of steps as illustrated in Figure 2-2.

Discovery and Initial Response

The initial observer to a spill or emergency incident should first take action to protect themselves and other personnel from harm and then immediately notify his/her supervisor or the IOSC/QI. Personnel not trained in spill response should not enter the spill area unless they are familiar with the material spilled and the safety precautions required.

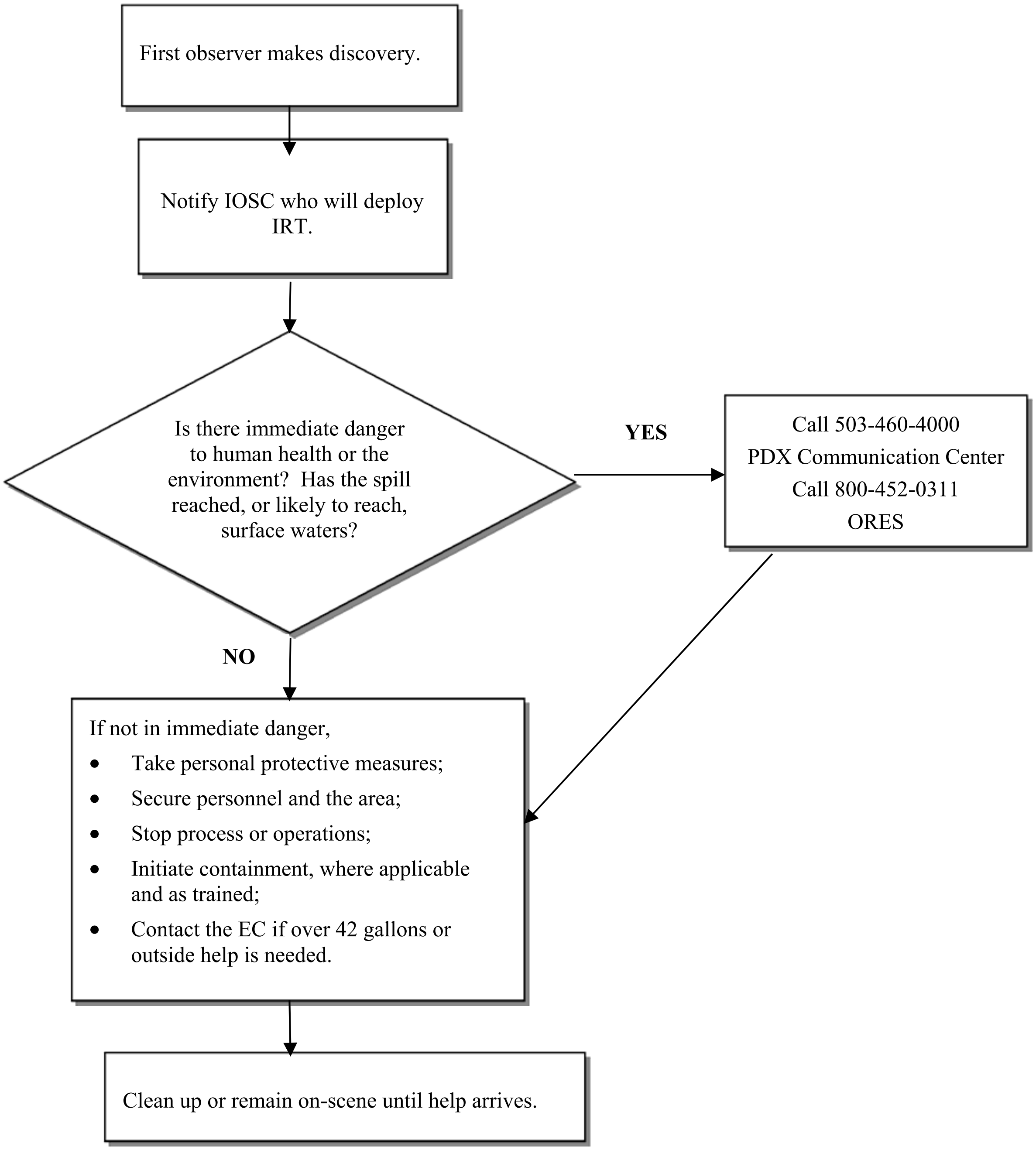


Figure 2-2: Initial Response to Spill Incident / Emergency

Spill Response Guide

1. **ANY EMPLOYEE** creating or observing a POL or hazardous material spill must **Notify the Installation On-Scene Coordinator IMMEDIATELY**, regardless of the type of material or the amount spilled. (IOSC/QI will notify the IRT and contact the EC, if necessary.)
2. Call 503-460-4000 (PDX Communication Center) if there is an imminent danger to human life and/or the environment and the IOSC/QI cannot be contacted.
3. **IOSC/QI SPILL RESPONSE REQUIREMENTS:**
   a. **IDENTIFY** the spilled material and evaluate the existing hazards at the site.
   b. **SECURE** personnel. SAFETY is the first priority. Resist the urge to rush into dangerous areas. If in doubt, stay out! Notify the Facility Manager (and, if necessary, the Airport Control Center) and seek help. The Regional and Corporate HS&E should be contacted if any of the criteria described in Section 2.1.4 are met, or if help from the corporate headquarters is necessary. Cooperate with public officials who happen upon the scene.
   c. **SECURE** the area. Set up an adequate perimeter. Limit access to the spill area. Keep observers and personnel not responding to the spill out of the contaminated area or other areas of possible exposure. If not in immediate danger, stop the flow after obtaining appropriate personal protective equipment. If possible, stop processes and operations that cause or contribute to the incident. Use common sense measures. Contain the release. Ensure that a mat covers floor drains. Shovel dirt, floor sweeping compound, absorbent material, etc., into the path of the release to contain it.
   d. **PROHIBIT** smoking, the use of lighters, matches, or other sparking devices in the area, and vehicles from entering the immediate area.
   e. **CONTAIN** the spill without unnecessarily exposing personnel to hazards, if possible. Use available materials and equipment. Spill kits may be located on vehicles hauling POL. Enter spill areas from upwind, uphill, or upstream.
   f. **PREVENT** spills from flowing into drainage ditches, storm drains, and bodies of water, if possible, using readily available materials. Use sand or soil as absorbent. Construct berms with soil or filled sand bags to restrict the flow.
   g. **CLEAN UP** all spills within the capabilities of the facility, no matter how small. Seek immediate response assistance if the spill is beyond your capability. Coordinate cleanup beyond your capability with the Facility Manager. **AND REMAIN ON SCENE** until additional help arrives, if outside help has been summoned.

Figure 2-3: Spill Response, Small Spill

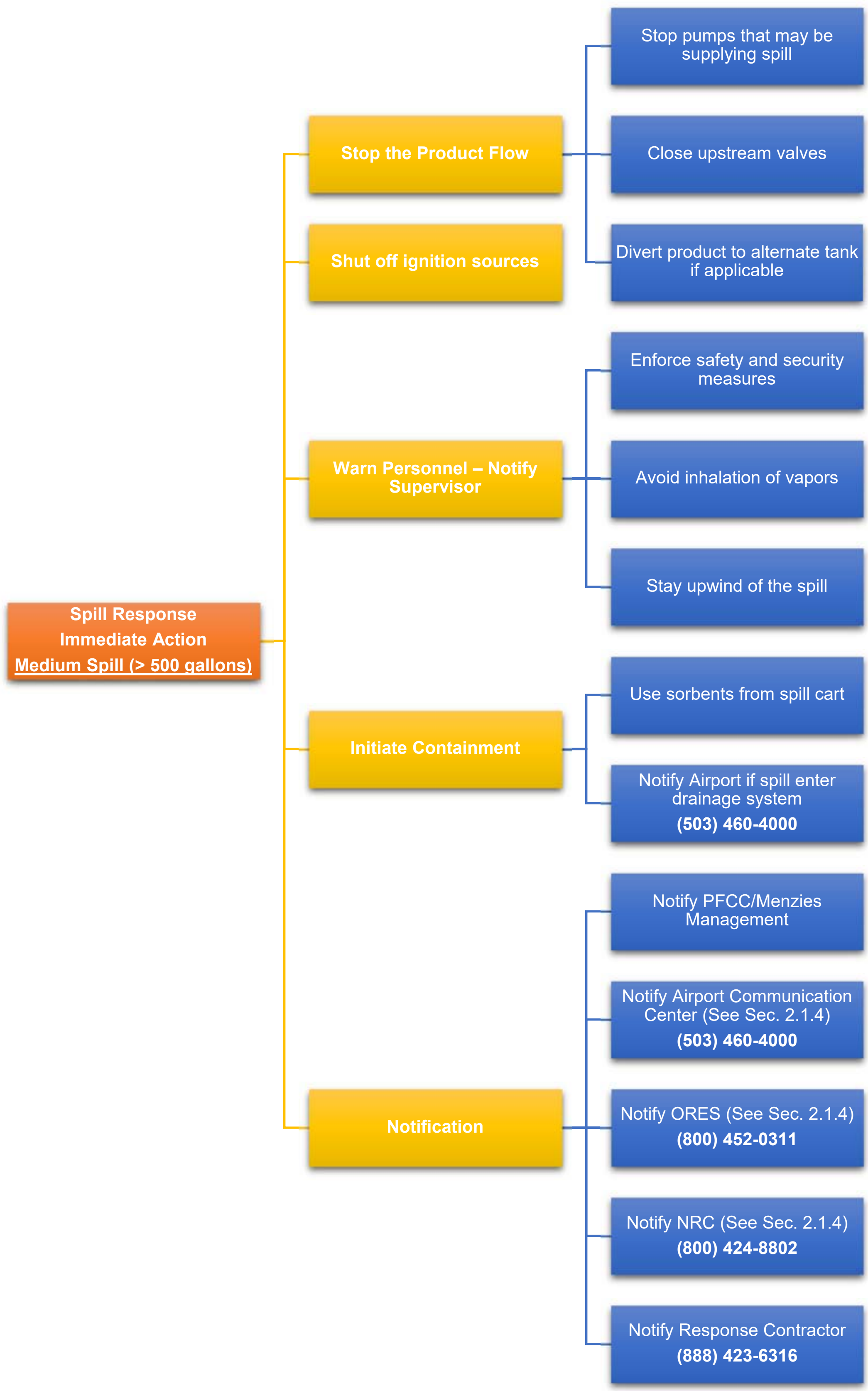


Figure 2-4: Spill Response, Medium Spill

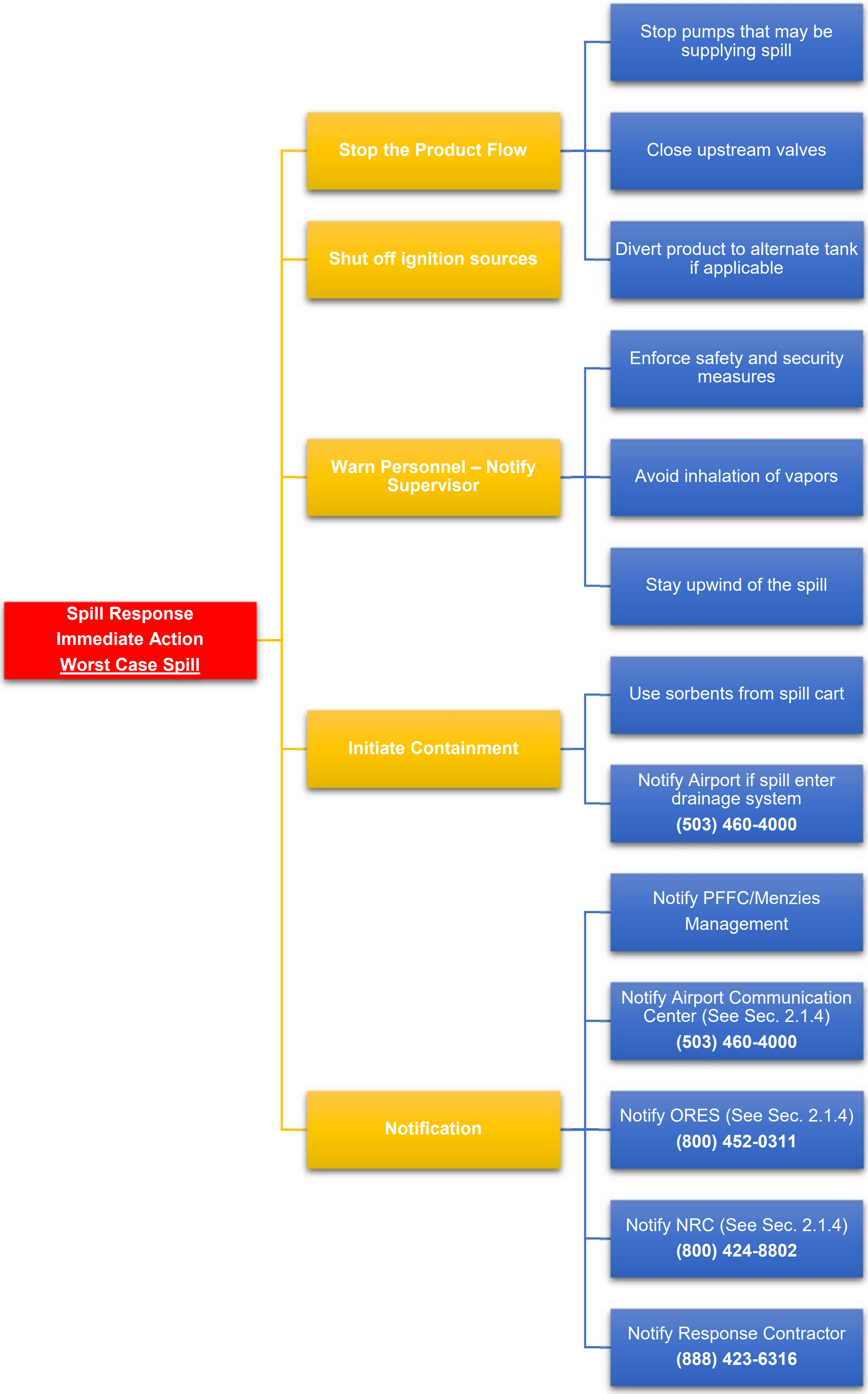


Figure 2-5: Spill Response, Worst Case Spill

2.1.4 Notification and Notification Procedures

<u>Internal Notification Procedures</u>

PFFC/Menzies is equipped with a radio system that can be used to activate the IRT in the case of incidents that can be handled by facility personnel (if outside assistance is needed, see ***External Notification Procedures*** under this subsection).

The IOSC/QI will contact the EC if a spill or incident meets any of the following criteria:

- Equal to or greater than the "reportable quantity" of the spilled material;
- Is considered to be a "harmful" discharge (a harmful discharge is defined as a discharge of a hazardous material or hazardous waste that reaches surface water and affects the water quality standards, or causes a film, sheen or discoloration of the water or adjoining shorelines);
- If cleanup assistance is required (oral notification to EC within one hour of the spill event or discovery).

A completed Corporate Spill Incident Report and all supporting information must be submitted to the EC within 24 hours of, or on the first working day after, a spill event. The form can be found in Annex 3.8.

Copies of the Site Evacuation Drawings are placed throughout the PFFC/Menzies facilities and are only referenced within the ICP.

<u>External Notification Procedures</u>

The IOSC/QI is responsible for notifying the fire department, if its assistance is needed for a spill or release. In case of fire, Airport Operations notifies the tower, which in turn notifies the airport fire department. The IOSC/QI is also responsible for notifying the OERS at (800) 452-0311 immediately of the incident *if* the EC cannot be contacted and either a reportable spill has occurred or assistance is required.

The IOSC/QI is responsible for notifying appropriate local authorities (including the applicable official identified by the Regional Contingency Plan, or if unavailable, the National Response Center (NRC) at (800) 424-8802) if an emergency incident could threaten human health or the environment outside of the facility or if evacuation of the local area is necessary.

Notifying the proper authorities depends upon the magnitude, possible environmental impact, and the possible effect upon human health and safety of an incident. The names listed in this section provide additional detail and are listed by functions within the nearby local community, the State of Oregon, and the federal government.

<u>Community</u>

ALL EMERGENCIES:	**CALL 503-460-4000 (PDX Communication Center) FIRE DEPARTMENT**
Police Department:	**911**
Ambulance Service:	**911**
Hospital	**911**
Providence Medical Center	**(503) 215-6000**

Contracts currently exist with local emergency response agencies/organizations or private contractors. .

NRC Environmental Services (primary)	**(800) 899-4672**
Cowlitz Clean Sweep. (secondary)	**(888) 423-6316**

State

The following release scenarios require notification to the State of Oregon:

(1) If spilled into waters of the state, or escape into waters of the state, is likely, any quantity of oil that would produce a visible oily slick, oily solids, or coat aquatic life, habitat or property with oil;

(2) If spilled on the surface of the land, any quantity of oil over one barrel (42 gallons); and

(3) An amount equal to or greater than the quantity listed in 40 CFR Part 302 -- Table 302.4 (List of Hazardous Substances and Reportable Quantities) and amendments adopted prior to July 1, 2002.

The State of Oregon requires immediate verbal notification to the OERS if any of the above applies for an incident.

Oregon State Emergency Response System (24 hours) **(800) 452-0311**
(*only if* EC or IOSC/QI cannot be reached)

OERS will contact other government agencies as appropriate (do not contact the Oregon Department of Environmental Quality [OR DEQ] directly).

The spill or release need not be reported to OERS if it occurs on public or private property and is known to the person owning or having control over oil or hazardous material or their designated representative; if it occurs on a surface impervious to the oil or hazardous material spilled or released and it is fully contained; and if it is completely cleaned up without further incident, including fixing or repairing the cause of the spill or release.

If a discharge in excess of 1,000 gallons occurs in a single event, or if two discharges (equal to or greater than 42 gallons of oil per event) occur in "harmful quantities" within a twelve month period, a copy of the ICP will be submitted to the EPA Region 10.

Federal

The enactment of the Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA) created a listing of hazardous substances designated for special consideration under other major environmental legislative enactments (such as the Clean Air Act), as well as other substances that may present substantial danger to human health and the environment. Reportable quantities were established for specific hazardous substances and waste streams. A spill to the environment of any of the identified substances in quantities greater than its assigned reportable quantity must be immediately reported to the NRC by the EC.

National Emergency Response Center (24 hour) **(800) 424-8802**
(only if EC cannot be reached)

2.1.5 Local Communication

The communications system to be used during spill or release incidents will involve primary cellular telephones. The communication net will be supplemented with the use of the land base radio system utilized for communication with Menzies/PFFC personnel and PDX traffic control center. For spill or releases within the fuel storage terminal, communication will be supplemented with intrinsically safe radios utilized by the response contractor. Following is a communication list for command structure personnel

.

Basic Local Communication Information		
Assignment	**Name**	**Method of Contact (P: phone #, C: cellular #, R: radio frequency, P: pager #)**
IOSC/QI	Scott Baker	C: (360) 619-2589
Alternate IOSC/QI	John Rausch	C: (310) 467-8556
EC, Liaison & Information	Darrell Mullins	C: (801) 514-0248
Health & Safety	Ocean Agatat	C: (503) 488-9859
Initial Response Team (IRT)	Facility personnel	R: 451.9250
Response Contractor	NRC Environ Services	P: (800) 899-4672
	Spill Command	R: 158.445 output 150.9800 receiving
	Spill Path 1	R: 154.585 output 159.4800 receiving
PDX Communication Center	Fire & Police,	P: (503) 460-4000
PDX Ground Traffic Control	Ground Traffic	R: 121.9000
Oregon Emergency Response	State Fire & Police	P: (800) 452-0311
Public Water System	Portland Water Bureau	P: (503) 823-4874
PDX Weather	NOAA Portland Office	P: (503) 261-9246
KATU Television Station	Public Notification	P: (503) 231-4264
KPDX Television Station	Public Notification	P: (503) 906-1249

2.1.6 Mobilization of Resources

Both the IRT and the IOSC/QI will proceed to the incident location immediately. In case of fire, the facility will be evacuated. Emergency response equipment is available at various locations on the facility. If necessary, a command post to be used in coordinating spill control activities will be established at PDX Communication Center, phone (503) 460-4000. Emergency response equipment lists are located in the Emergency Equipment Inventory (Table 3-1) in Annex 3-2. The facility responders have been trained to know the location and proper use of all response equipment. The IOSC/QI's assessment will be ongoing as containment continues, until the incident has been terminated. Internal and external responders, if present, will integrate their capabilities under the direction of the IOSC/QI and the regulatory Incident Commander designated by the OERS. During the response period, the IOSC/QI will ensure that facility personnel properly follow emergency response procedures. In order to limit exposure to site hazards, the number of facility emergency responders will be limited to those who actively perform emergency operations. The primary response contractor is:

NRC Environmental Services (NCR Env) Response Contractor (24 hour) (800) 899-4672
6211 N Ensign Street
Portland, Oregon 97217

2.1.7 Mitigating Actions

Actions taken to respond to an emergency event will be sufficient to address varying magnitudes of incident scenarios. Some incidents may be contained and terminated solely as a result of facility response. Other incidents may require supplementary assistance from external responders. If an incident occurs that is considered being "worst-case," the response will attempt to minimize destruction to the environment and will protect human health.

See Annex 3-3 "Spill Specific Procedures" for descriptions of actions to be taken in response to releases or spills of four distinct types of hazardous materials and/or wastes applicable to Menzies's operations. As with any spill, response time is critical to the effectiveness of containment, control and cleanup of the spill.

Following is the response time of the command personnel and support response contractors for a most probable discharge event.

Response Time

Name	**Phone**[1]	**Response Time**	**Responsibility**	**Response Training**
Scott Baker	360 619-2589	Immediate on-site < 1 hour off-site	IOSC/QI	40-hour HAZWOPER
John Rausch	310 467-8556	Immediate on-site < 1 hour off-site	Alternate IOSC/QI/HS&E	24-hour HAZWOPER
Darrell Mullins	801 514-0248	< 12 hours	IRT/HS & E/EC	24-hour HAZWOPER
Facility Personnel	Radio System	Immediate on-site	IRT	8-hour HAZWOPER
Notes: [1] – phone number to be used when person is not on-site				
Contractor	**Phone**	**Response Time**	**Contract Responsibility**	
NRC Env	800-899-4672	< 1 hour	15,000 barrels/day Follow the direction of the IOSC/QI. For example, contractor may be responsible to remove fuel spill with a vacuum truck, and based on volume and condition of fuel (i.e. contamination) may put the fuel back into an active fuel storage tank for non-contaminated jet fuel, or if necessary transport to a petroleum recycling center or possibly to a waste facility.	
Cowlitz Clean Sweep	888-423-6316	< 1 hour	15,000 barrels/day	
Terra Hydr, Inc	503-625-4000	< 1 hour	15,000 barrels/day	

2.1.8 Termination and Follow-up Actions

The emergency incident will be considered terminated when emergency response action is no longer necessary to provide containment of the spilled material. "Termination" means that containment will have been successfully executed, and the causal factors will have been eliminated.

EC's responsibilities

The responsibilities of the EC include:

- Seeking appropriate funding authority and initiating cleanup activities;
- Executing appropriate contracting and/or purchasing documents for required cleanup and other required services;
- Directing cleanup activities of the environment, facility, and equipment until all regulatory requirements have been met;
- Notifying local, state, and federal agencies that an incident has occurred. The EC will verbally notify OERS immediately of the incident if such notification has not been made by the IOSC/QI or the Facility Commander. Notification protocol for different types of emergency incidents are described in detail in Section 2.1.4.

Released materials and materials used to absorb or contain the materials will be collected, contained, and treated, if necessary. These materials will be stored in a manner such that they will not be able to contaminate storm water and their containers will not leak. Containers of released materials will be removed or isolated so that incompatibilities with other treated or stored waste will be removed until cleanup procedures are completed. The EC will determine if samples of residual material need to be taken and will evaluate what disposal options are best for the generated waste. Waste materials will be transported to an approved facility for recycling, treatment, or disposal. Emergency equipment will be cleaned and fit for its intended use before operations resume.

After an incident, the EC, facility personnel, and external responders, if appropriate, will review the quality of the emergency response. A notation will be made in Section 2.2.4, Table 2-2, Incident History. A review of the ICP will also be made to evaluate the internal procedures, the integration between internal and external response teams, and the performance of the response personnel. Section 1.6 provides details of the critique of the response and guidelines for plan review and modification.

2.2 Evacuation Plan

PFFC/Menzies has developed a facility-wide evacuation plan to evacuate parts of the facility that are at a high risk of exposure in the event of a spill or other release. Evacuation routes are posted in each facility. The following considerations have been given in developing these evacuation plans:
(1) Location of stored jet fuel;

Refer to Figure 3-2A, Facility Site Plan for Jet A fuel storage tank locations.

(2) Hazard imposed by spilled material;

Refer to MSDS Sheet for hazard information on jet fuel.

Summary of hazards includes:

COMBUSTIBLE LIQUID - JET FUEL
RUPTURED TANKS MAY CONTAIN FLAMMABLE OR EXPLOSIVE VAPORS
INHALATION OF VAPORS/MIST MAY CAUSE RESPIRATORY SYSTEM IRRITATION, DIZZINESS, NAUSEA, LOSS OF CONSCIOUSNESS, SKIN CONTACT MAY CAUSE IRRITATION AND DERMATITIS
FIRE FIGHTERS MUST USE SELF-CONTAINED BREATHING APPARATUS

(3) Spill Flow Direction;

Refer to Figure 3-3, **Facility Drainage Plan**.

PFFC/Menzies has determined the general spill flow direction during accidental release of jet fuel to be as follows. In case of accidental discharge into the storm drains at PDX the product would travel west inside the storm drains down towards the Columbia Slough.

(4) Prevailing Wind Direction and Speed;
Call (503 284-6771 for a recording of hour by hour wind information at the airport tower.
Call (503) 261-9246 for the Weather Bureau that services the airport, as a history of the wind.

(5) Arrival route of emergency response personnel and response equipment;

PFFC/Menzies IRT personnel and their contractors shall arrive via gate NA-71 off of Marine Drive for the Bulk Storage Facility, and via N.E. Air Trans Way for the Maintenance facility.

The fire department shall arrive by traveling approximately 1/2 mile west on Taxiway “I”.

The airport police shall arrive by sending dispatched patrol car(s) from the airport to PFFC/Menzies by the most direct route possible.

(6) Evacuation routes;

Refer to Figure 3-2A, **Facility Site Plan**

Always use good judgment in deciding evacuation routes. Personal safety is always first!

Use alternate routes of evacuation if the designated routes of evacuation are unsafe due to spilled jet fuel, fire hazard, tank or pipeline failure, or any other hazard that may jeopardize personal safety.

PFFC/Menzies or regulatory agencies in charge may instruct workers, contractors, and visitors to use alternative routes of evacuation in time of emergency. Always follow instructions from the Incident Commander during a jet fuel spill, release, or fire.

(7) Transportation of injured personnel to the nearest emergency medical facility;

Refer to Figure 3-4, **Hospital Route**

(8) Centralized check-in area for evacuation validation (roll call):

8133 Air Trans Way, Menzies Maintenance Shop and Offices.

(9) Location of shelter at the facility as an alternative to evacuation.

8133 Air Trans Way, Menzies Maintenance Shop and Offices.

2.3 Industrial Activity Description

2.3.1 Site Location and Industrial Operations

Description of facility location in relation to nearest city:

The PFFC is located at the Portland International Airport, Portland, Oregon. Portland International Airport is located along the banks of the Columbia River to the north and adjacent to the Columbia Slough to the south. The facility is approximately 6 miles northeast of downtown Portland and the Willamette River.

Primary purpose:

The facility provides Jet A fuel for all commercial aircraft at PDX. The facility SIC code is 5171 and the NAICS code is 424710. The PFFC storage and distribution system is comprised of three operations (fuel storage, hydrant delivery system, and ground service equipment [GSE] fueling stations). Operations at the fuel storage include receiving Jet A fuel by pipeline (Kinder Morgan Pipeline), fuel storage, fuel quality control, filtration and pumping to the hydrant system. The operations of the hydrant system is to deliver Jet A through hydrant pits through hydrant servicers to aircraft, and tanker/refueller reloading for fueling aircraft at non-hydrant gates at two reload racks (North and South). The GSE operations include two fueling stations, one located on the north side of the airport and one on the south. The south refueling station includes one 12,000-gallon UST for storage of automotive gasoline. The north refueling station includes one 10,000-gallon AST for storage of automotive gasoline and one 10,000-gallon AST for storage of diesel. The normal daily throughput at the facility is 500,000 gallons per day of Jet A fuel.

Structures:

Menzies's maintenance shop is an approximate 2,000–sq-ft structure with offices. Other structures include an approx. 400-sq-ft metal roof structure with POL storage located on the southwest side of the maintenance shop.

The facility is relatively flat. The majority of the facility is paved with asphalt. Square storm water catch basins collect surface runoff from the asphalt surfaces. A system of storm water drain conduits transfers storm water to a detention pond. The detention pond eventually discharges to the Columbia Slough.

Aboveground Storage Tanks:

Located in the northwest corner of the airport property is the Jet A fuel aboveground storage tanks facility. The AST storage facility consist of two Jet A ASTs (Tank #1, and #2) with a 840,000-gallon capacity (each), and one Jet A AST (Tank #3) with a 1,680,000-gallon capacity. The two 840,000-gallon ASTs are field–erected steel tanks with epoxy-coated interiors and painted exteriors constructed in 1972 and retro-fitted in 1996 with double bottoms and secondary containment. Tank #3 is a field-erected steel tank with epoxy-coated interior installed in 1996.

Tank # 1A

Tank #2A

Tank #3

The three ASTs are contained within concrete dike structures fitted with high-density polyethylene containment membrane. The secondary containment structures provide in excess of 110 percent of the single largest AST including a 25-year rainfall event and fire suppression.

<u>40 CFR Subparagraph 112.8(c)(3)(i) through (iv)</u>. Drainage of rainwater from containment areas into a storm drain should be treated unless the bypass valve is normally sealed closed, inspections of run-off rainwater ensure compliance with applicable water quality standards, the bypass valve is opened and sealed under supervision, and adequate records are kept.

Rainwater collects in the tank dike area. This area is monitored daily, the dike area post indictor valve is opened manually to drain any accumulated clean water. The water is visually inspected for a sheen by an authorized personnel before the discharge is permitted. Water is discharge through a 500-gallon oil/water separator prior to release to the airports storm water drainage system.

Secondary Containment for Tank #1 and #2 showing drain in foreground.

A 10,000-gallon sump fuel AST is also located at the fuel storage facility. The sump fuel AST is a double walled self-contained steel tank. Airline quality assurance practices require that all tanks and filters be checked for water at least daily by drawing a sample. This practices is called sumping. The sumping of tanks, filters, and transport trucks generates approximately 40 gallons of sump fuel per day. Sump fuel is stored in unusable sump tank and is periodically picked up by a licensed used oil recycler for processing off-site.

Sump fuel AST (USF).

Jet A is received by the facility from an underground pipeline owned and operated by Kinder Morgan Pipeline Company. Fuel is received at a rate of 600-gallons per minute at a pressure of 40 psig. The pipeline receiving filtration and control valves are owned and operated by Kinder Morgan. The pipeline operation is not covered under this plan.

<u>40 CFR Subparagraph 112.8(d)(1)</u>. Provide protective pipe coating or wrapping for buried piping installed after August 16, 2002. Corrosion protection by cathodic protection or other equivalent means must be installed as well.

All underground piping at this facility installed after August 16, 2002 is coated or wrapped and is cathodically protected to prevent corrosion. The cathodic protection system is tested annually; records are filed in accordance with normal business practices.

<u>40 CFR Subparagraph 112.8(d)(2)</u>. Cap or blank-flange any piping not in service or in standby service for an extended time.

The facility has no piping that is not in service or in standby service for an extended time. At such time that any piping at this facility should fall into this category the piping shall be capped or blank-flanged at the terminal point and marked as to the origin.

<u>40 CFR Subparagraph 112.8(d)(3)</u>. Properly design pipe supports.

All the pipe supports at this facility appear to be in good condition and appear to have been designed to minimize pipe abrasion and corrosion and allow for pipe expansion and contraction. At such time that any pipe supports are observed to be abrading or corroding any piping, the pipe support in question shall be correctly immediately.

<u>40 CFR Subparagraph 112.8(d)(4)</u>. Regularly inspect all aboveground valves, piping and appurtenances. Conduct integrity testing of all buried pipe at the time of installation, modification, construction, relocation, or replacement.

Regular site inspections of the facility's aboveground valves, pumps, piping and appurtenances are performed in accordance with ATA 103 and local regulations. These inspections include daily, monthly, quarterly and yearly checks. Integrity testing shall be performed at the time of installation, modification, construction, relocation or replacement of any piping at this facility in accordance with 40 CFR 112, API 570 and all applicable codes, rules and regulations.

Additionally, the hydrant system (and other underground piping) is leak tested 1.) annually in accordance with API 1110, 2). weekly with a high precision leak detection system, and undergoes daily monitoring of the system's pressure log for behavior consistent with loss of piping integrity. Daily monitoring of the pump pressure recorder is performed to ensure prompt action should a loss of pipe integrity be suspected.

<u>40 CFR Subparagraph 112.8(d)(5)</u>. Warn all vehicles entering the facility to be sure that no vehicle will endanger aboveground piping or other oil transfer operations.

The facility is equipped with posted warning and informational signs and placards to inform of hazards and safety precautions as listed in, but not limited to, this section of the rule.

Reload Racks:

There are two (2) fully automated Jet A load racks located within the secured area of the airport. One is located east of Concourse E, south of Runway 10L-28R. The second load rack is located north of the cargo ramp south of Runway 28L-10R and east of Runway 20. The load racks are equipped with standard bottom loading/unloading connections, deadman controls, Scully grounding, and overfill protection systems. Fuel flow into the refuellers is controlled by a deadman device that is held by the operator while continually observing the fuel transfer. The load racks themselves have preset meters that stop the flow automatically when a pre-determined amount of fuel has passed through the meter.

North Reload Rack

The north reload rack is a temporary facility. Daily inspection are conducted for capture of rainwater/oily water from a Poly-Star secondary containment. Containment outlet valves are kept closed until inspection have been made. Outlet valves are attached to "mini-O/W" separators that are only opened after inspection and discharge to impervious surface that is collected by the airports storm water drainage system.

South Reload Rack

The south reload rack is equipped with a spill control pit (approximately 8,000-gallon storage capacity) equipped with a post indicator valve (that is in the normally closed position) and connected to a 1,000-gallon oil/water separator. Storm water at the reload rack is collected and passed through pit then the oil/water separator prior to discharge to the airports storm water drainage system. A 2000-gallon temporary drain tank is used for routine maintenance of the rack system, fuel in the dispensing pipes and meters is drain to this tank and then removed, it is kept empty when in normal operation.

<u>40 CFR Subparagraph 112.8(c)(11)</u>. Mobile tanks should be staged to avoid a release to navigable waters.

Typically, the refuellers are parked at Menzies Maintenance Shop when not being used, and are parked with full fuel tanks to avoid the build up of condensation in the fuel tanks (see Section 3; Figure 3-2C).

Refueller trucks (and mobile tanks) are parked with adequate clearance between vehicles and away from other vehicles to immediately address a discharge. No refueller truck is parked closer than 50 feet from any building and all mobile tank parking areas meet NFPA and FAA requirements. To prevent a discharge from reaching navigable waters, all mobile refueller trucks have an on board spill kit, which contains enough spill response supplies to control a discharge of 5 gallons. The IOSC/QI has confirmed that adequate quantities of spill clean up items are on site and appropriately positioned to immediately address a discharge of the capacity listed above.

Refuellers parked on sloped asphalt.

Ground Service Equipment Fueling Stations:

There are two (2) fully automated card lock auto gas dispensing stations located within the secured area of the airport. One is located east of Concourse E, south of Runway 10L-28R adjacent to the Jet A North Reload Rack. The second load rack is located north of the cargo ramp south of Runway 28L-10R and east of Runway 20. Both fueling stations are continuously monitored with a Veeder-Root TLS-350 monitoring system that records daily fuel volume dispensed for each vehicle, fuel volume in the AST, and dispenser meter reading. The system also reconciles with fuel deliveries for inventory control. Each fueling stations has a 12,000-gallon double-wall fiberglass AST installed in 1994. The GSE Fueling Stations utilize card-access to control the pumps. The airport is a restricted access site and is completely fenced and monitored 24/7. Fuel deliveries are received by transport tanker trucks. Each delivery is approximately 8,000-gallons, with approximately 6 loads delivered per month.

North Fueling Station

South Auto Gas Fueling Station

2.3.2 Security

The PFFC/Menzies facilities are located inside the secured area of the PDX and are manned 24 hours per day 7 days per week. All Menzies employees working at this facility have been issued airport ID badges. These badges must be worn at all times while on duty and in the airport secured area.

2.3.3 Permit Status of the PFFC/Menzies

PFFC/Menzies is covered under Port of Portland's NPDES for storm water discharge: 101647, file #107220
PFFC North Fueling Station UST Operating Permit: 26-11866-1998-OPER
PFFC South Fueling Station UST Operating Permit: 26-11865-1998-OPER

2.3.4 Site History of Spills or Releases

There has been one release or emergency incidents (i.e., federal or state-reportable release quantities) that have occurred at the PFFC/Menzies operations. Table 2-2 provides a listing of emergency incidents that occurred at this facility. It also provides a description of each incident, corrective actions taken, and plans for preventing recurrence for each event.

Table 2-2: Incident History for PFFC/Menzies					
Date	**Location in Facility**	**Date of Investigation**	**Incident Description/Quantity**	**Causal Factors**	**Corrective Action/ Recommendations**
Jan. 26, 2001	Perimeter road, SE corner of PDX	Jan. 26, 2001	Refueller overturn/ 1,400-gallons	Icy road conditions Freezing Fog	Immediately cleaned up./diver education
Mar. 16, 2009	Overfill of tanker during reloading	Mar. 16, 2009	Overfill during transfer between tankers, > 30 gallons	Overflow protection system failure, cable out of adjustment	Immediately cleaned up additional personnel to monitor loading from top of tanker
July 23, 2014	Valve Vault #13	July 23, 2014	Flange gasket failure in containment vault/ estimated 12,000 gallons contained	Valve inadvertently left closed resulting in system surge and gasket failure	Immediately isolated line and drained containment vault. Opened valve and checked all system flange connections for tightness.

2.3.5 Hazardous and Non-Hazardous Waste Generation

Hazardous Waste

Hazardous wastes are solid wastes that exhibit ignitability, corrosivity, reactivity, or toxicity characteristics, or are identified on any of the hazardous waste lists described in 40 CFR 261. Steps that should be taken to determine waste characteristic are the following:

- Determine if the material is a solid waste. Solid waste can be a solid, liquid, or contained gas. Under RCRA a solid waste is any material that you will no longer be using for its originally intended purpose and will be discarded, reclaimed, or processed, before use.
- Determine whether the waste is exempted or excluded from the hazardous waste regulations. Petroleum-contaminated media and debris that fail the test for the Toxicity Characteristic of CFR Title 40 Part 261.24 (Hazardous Waste Codes D018 through D043 only) and are subject to the corrective action regulations under part 280 of this chapter are exempted as hazardous waste.
- Determine if the waste is a listed waste. Hazardous waste from non-specific sources (F-listed waste), hazardous waste form specific sources (K-listed wastes), and discarded commercial chemical products, off-specification species, container residues, and spill residues thereof (P- and U-listed wastes. As discussed above the most likely solid waste created during a spill event would be exempted and not a listed hazardous waste.
- Determine if the waste is a characteristic hazardous waste. Characteristic hazardous waste are those waste that exhibit ignitability, corrosivity, reactivity, or toxicity.

PFFC/Menzies does not currently generate hazardous waste at this facility based on generator knowledge and documentation through material safety data sheets and that it can be classified as a CESQG.

Contaminated spill response media should be handle with care, stored in compatible containers for storage and transportation. Contaminated spill response media and/or soil should be profiled for disposal or recycling as described above. Personnel should utilize appropriate personal protective equipment when handling contaminated spill response media in accordance with 29 CFR 1910 OSHA subpart H 1910.120.

Non-Hazardous Solid Wastes

Non-hazardous solid wastes are materials that are abandoned, recycled, or considered inherently waste-like (all discarded materials). Some discarded materials are excluded from being wastes by 40 CFR 261.

2.4 Potential Pollutant Sources

Locations within the PFFC/Menzies operations that are potential pollutant sources of environmental contamination are listed below:

- Materials stored within Maintenance Shop;
- Jet A ASTs storage area;
- Used Oil AST storage area;
- Tanker/Refueller parking yard;
- Refueling operations at the Gates.
- Jet A Reload Racks
- GSE Fueling Stations

A more detailed narrative of each identified potential pollutant source is discussed in the upcoming subsections. Table 2-3, located at the end of Section 2.3.8, provides a summary of these locations, including substances of concern present and approximate quantity, likelihood of pollutant release to the environment and pathway, and subsection discussed. The likelihood of pollutant release to the environment, presented in the table, is ranked according to the potential for a spill or leak to reach the environment (remote, low, and high). The ranking serves to identify areas where facility personnel must pay particular attention to ensure that proper BMPs are followed to prevent a release and to identify sites where structural modifications may be needed.

2.4.1 Materials stored within Maintenance Shop

The Maintenance Shop contains the POL storage room which has secondary containment. The POL storage is within a building with a secondary containment floor located in the Menzies Maintenance Shop. It is used for storing oil and lubricants in two (2) 120-gallons and one (1) 240-gallon ASTs. The maximum anticipated amount of oil that could be released is 240 gallons; however, the potential for release is low because of the secondary containment.

POL storage building with secondary containment.

BMPs are to be implemented in accordance with baseline BMPs (Annex 3.4.1) and activity-specific BMPs for Aboveground Storage Tanks (Annex 3.4.4) and BMPs for Indoor Storage Facilities (Annex 3.4.3).

2.4.2 Jet A ASTs Storage Area

Two 840,000-gallon and one 1,680,000 tanks contain Jet A fuel used to fill commercial aircraft. They are made of steel, with double bottoms. A concrete containment structure that has a 110 percent capacity surrounds each tank. The tanks are equipped with automatic shut-off devices to prevent overfilling. The potential for release is low. A release from the containment structure would be directed to the storm sewer system. The potential for release as a result of containment failure is remote; however, if a release occurs due to containment failure, the fuel would flow into the storm sewer system and eventually into the Columbia Slough and possible downstream into the Columbia River.

Secondary containment for ASTs.

A 10,000-gallon AST used for collecting sumping fuel is also located at the PFFC Bulk Storage Terminal. The Sump Fuel AST is double-walled and built to UL 142 standards. The audible high-level alarm for the Sump Fuel AST is connected to the control room at the AST Bulk Storage Facility. The control room is constantly attended. The tank also is fitted with a visual gauge for inspecting volume stored in the AST. The maximum anticipated amount of sump fuel that could be released is 5,000-gallons; however, the potential for release is low because of the secondary containment provided by the AST.

10,000-gallon Sump Fuel AST.

BMPs are to be implemented in accordance with baseline BMPs (Annex 3.4.1) and activity-specific BMPs for Aboveground Storage Tanks (Annex 3.4.4), BMPs for Motor Pools and Mobile Fuel Storage (Annex 3.4.7), and BMPs for Fueling Stations (Annex 3.4.8).

2.4.3 Used Oil AST Storage Area

A 300-gallon used oil tank is located at the Maintenance Shop along the south fence. The tank sits under a metal structure, with a roof. The tank is on a secondary containment pallet. Used oil from servicing facility is stored in this tank. The used oil tank relies upon direct vision thru the opaque container and is constantly monitored during transfer. The Maintenance Shop is constantly attended by personnel. The used oil is recycled via contract. There is spill response materials located next to the tank. The maximum anticipated amount of oil that could be released is 300-gallons; however, the potential for release is low because of the secondary containment provided by the pallets. A release would flow onto the concrete pad and onto the asphalt apron towards the north until collected by catch basin in the parking area. The catch basins are connected to an oil/water separator fitted with a flostop valve to prevent discharge to the storm sewer.

Used oil and sump fuel ASTs with secondary containment pallet adjacent waste fuel drums.

BMPs are to be implemented in accordance with baseline BMPs (Annex 3.4.1), activity-specific BMPs for Aboveground Storage Tanks (Annex 3.4.4), and BMPs for Outdoor Storage Facilities (Annex 3.4.6).

2.4.4 Tanker/Refueller Parking Yard

A asphalt parking yard is located to the west and north of the Menzies Maintenance Shop. Menzies parks refuellers with full load of Jet A in order to keep water out of the tanks to keep their filters and seals wet. The maximum stored Jet A within the parking yard is 72,800-gallons within twelve loaded refuellers. The capacities of the refuellers are 1 with 11,500-gallons, 2 with 10,000-gallons each, 2 with 8,000-gallons each, 3 with 5,000-gallons each, 3 with 2,200-gallons, and 1 with 2,500-gallons. One 1,200-gallon multi-product (Mogas and Diesel) refueller is stationed near the cargo terminal. Anticipated types of failures that may cause spills include mechanical failure during fuel transfers from tanker to tanker, ruptures, leaks, and tank corrosion. There are spill materials available at the south end of the parking yard. The potential for release for the refuellers is high because the vehicles are typically parked within the curbed asphalt yard with sloped surfaces directed towards two catch basins. Each catch basin has a drain matted located nearby in the event of a release from the loaded refuellers and would act as secondary containment. Additionally the catch basins are connected to an oil/water separator (approx. 2,000-gal storage) with a flostop valve prior to discharging into the storm sewer. In the event of a release to the storm sewer, the flostop valve will close, preventing spill material from entering the storm sewer. The maximum anticipated amount of oil that could be released is 11,500-gallons.

Loaded refuellers in the parking yard.

BMPs are to be implemented in accordance with baseline BMPs (Annex 3.4.1) and activity-specific BMPs for Aboveground Storage Tanks (Annex 3.4.4) BMPs for Fueling Stations/Reload Racks (Annex 3.4.8) and BMPs for Motor Pools and Mobile Fuel Storage (Annex 3.4.7).

2.4.5 Refueling Operations at the Gates

The majority of Jet A fuel is delivered from the hydrant system to the aircraft by the use of nine (9) hydrant servicers that connect a high pressure hose to the hydrant pit and another high pressure hose to the aircraft. This system serves 46 gates located at PDX's main terminal buildings. There are a total of 80 hydrant pits located at these gates. Jet A is pumped into the system via one or more of five (5) 1,000-gallon per minute pumps. Flow and pressure in the system is controlled at the AST Bulk Storage Facility by flow metered and pressure sensors. Its status in continuously monitored by a computer and displayed on a terminal located at the in the operations building control room.

Hydrant pit (typical).

Refueller delivered fuel uses only one hose connected to the aircraft. Standard under wing fueling nozzles are used to connect the aircraft. Fuel flow for both the hydrant servicers and the refuellers are controlled by a deadman device held by the fuelers. Standard under wing fueling nozzles are used to connect to the aircraft. Fuel flow from the refueller is controlled by a deadman device held by the operator. The operator continuously observes the aircraft's fuel gauges at the fueling connection to ensure overfilling does not occur. In the event of a problem, the operator immediately stops the fuel flow by releasing the deadman device. There is no secondary containment on the aprons, and spills would follow the slight slope of the apron to the catch basins located throughout the apron and connected to the storm sewer system. Spill kits are stored on the apron in case of a small release. The possibility of a spill occurring is low.

Hydrant servicer fueling aircraft.

Refueller fueling aircraft.

BMPs are to be implemented in accordance with baseline BMPs (Annex 3.4.1) and activity-specific BMPs for Aboveground Storage Tanks (Annex 3.4.4).

2.4.6 Jet A Reload Racks

There are two (2) fully automated Jet A load racks located within the secured area of the airport. One is located east of Concourse E, south of Runway 10L-28R. The second load rack is located south of the cargo ramp south of Runway 28L-10R and east of Runway 20. The potential for release as a result of containment failure is remote; however, if a release occurs due to containment failure, the fuel would flow across the pavement into catch basins connected to an oil/water separators prior to discharging into the storm sewer system. The reload areas are equipped with emergency stops that will shut down flows to the rack within 20 seconds, therefore the potential maximum release would be approximately 116 gallons at 350 gpm. Personnel are stationed with a deadman control attached during fueling operations which once released immediately stop flow. The potential for release during fueling operations is low because of the secondary containment and the oil/water separators.

North Reload Rack.

South Reload Rack.

BMPs are to be implemented in accordance with baseline BMPs (Annex 3.4.1) and activity-specific BMPs for Fueling Stations/Reload Racks (Annex 3.4.8).

2.4.7 GSE Fueling Stations

PFFC/Menzies operates two GSE fueling stations. The South GSE fueling station has one 12,000-gallon underground storage tank that is used to store unleaded gasoline. The North GSE Fueling station has one 10,000-gallon unleaded AST and one 10,000-gallon diesel AST. The GSE Fueling Stations utilize card-access to control the pumps. The airport is a restricted access site and is completely fenced and monitored 24/7. All Menzies personnel are issued access badges which control access. The USTs are made of fiberglass, double-walled and built to Underwriters Laboratories Standard). The USTs are equipped with automatic shut-off devices to prevent overfilling. When filling vehicles at the fueling station, an automatic shut-off switch controls fuel flow. There is a manually operated lever to activate the fuel pump. The potential for release as a result of containment failure is remote; however, if a release occurs due to containment failure, the fuel would flow across the pavement into catch basins connected to an oil/water separators prior to discharging into the storm sewer system. The GSE fueling stations are similar the reload racks in that personnel are stationed to observe if a release occurs; the dispensing nozzle serves as the deadman control. The GSE station has an emergency stop for immediate shut down of the flow to the dispensers. Therefore, the maximum probable spill at the GSE fueling station would be 20 to 40 gallons, based on 20 gpm flow. The potential for release during fueling operations is low because of the secondary containment and the oil/water separators.

North GSE fueling station.

South GSE fueling station.

BMPs are to be implemented in accordance with baseline BMPs (Annex 3.4.1) and activity-specific BMPs for Fueling Stations/Reload Racks (Annex 3.4.8).

Table 2-3: Summary of Potential Pollutant Sources and Incident Prediction for PFFC/Menzies				
Potential Pollutant Sources	**Pollutants of Concern Present**	**Approximate Quantity Stored or Maximum Storage Capacity (gallons)**	**Potential for Pollutant Release to Environment/Rate and Direction of Flow(*)**	**Section Discussed**
Maintenance Shop	Motor oil, transmission oil, paint, solvents, grease, lubricants, adhesives, cleaners, sealing compound, anti-corrosives	Various quantities, maximum 240 gallons	Low - flow is to the floor at a variable rate reflecting quantities stored if released or into secondary containment for ASTs.	Section 2.4.1
Jet A ASTs Storage	Jet A	2- 840,000 gallons ea. 1- 1,680,000 gallons	Remote – ASTs equipped with secondary containment, flow is to secondary containment if release occurs during fuel transfer; flow is to the apron storm sewer system if there is containment failure.	Section 2.4.2
Used Oil AST	Used oil	300-gallons	Remote – AST is equipped with secondary containment pallet, flow is to secondary containment if release occurs during fuel transfer; flow is to the pavement then to storm sewer system if there is containment failure.	Section 2.4.3
Tanker/Refuellers Parking Yard	Jet A	72,800	Low – flow is through an oil/water separator equipped with a flow stop valve then to the storm water sewer system.	Section 2.4.4
Refueling Operations at the Gates	Jet A	Up to 1,000 gallons per minute	high – no secondary containment; flow would follow the slope of the apron to the storm sewer system.	Section 2.4.5

Table 2-3(cont): Summary of Potential Pollutant Sources and Incident Prediction for PFFC/Menzies				
Potential Pollutant Sources	**Pollutants of Concern Present**	**Approximate Quantity Stored or Maximum Storage Capacity (gallons)**	**Potential for Pollutant Release to Environment/Rate and Direction of Flow(*)**	**Section Discussed**
Jet A Reload Racks	Jet A	Up to350-gallons per minute	low – flow is diverted to a containment pit in the event of a release on the containment pad for the south reload rack, otherwise storm water flow is diverted through an oil/water separator prior to discharge to the storm water sewer system.	Section 2.4.6
GSE Fueling Stations	Unleaded Gasoline and Diesel	Up to 20-gallons per minute	low – in the event of a release on the containment pad flow is diverted through an oil/water separator prior to discharge to the storm water sewer system..	Section 2.4.7

Note: (*) - depending on quantity and location, all releases have potential to contaminate groundwater or storm water, unless otherwise noted.
remote - highly unlikely for a release as adequate structural containment provisions and/or storage tank designs are present to contain any spill or leak. For example, a waste storage building with secondary containment or a double-walled AST.
low - minimal potential for release, as containment provisions are in place to contain most spills/leaks, unless of significant quantity. For example, drums of waste liquid stored on a concrete pad with no berms. The pad would be sufficient to contain small spills, but larger spills, if not quickly cleaned up, could flow off pad and onto grounds.
high - strong potential for release as there are no structural containment provisions to contain a spill. For example, drums of liquid material stored outdoors directly on the ground or an unpaved vehicle fueling area.

3.0 ANNEXES

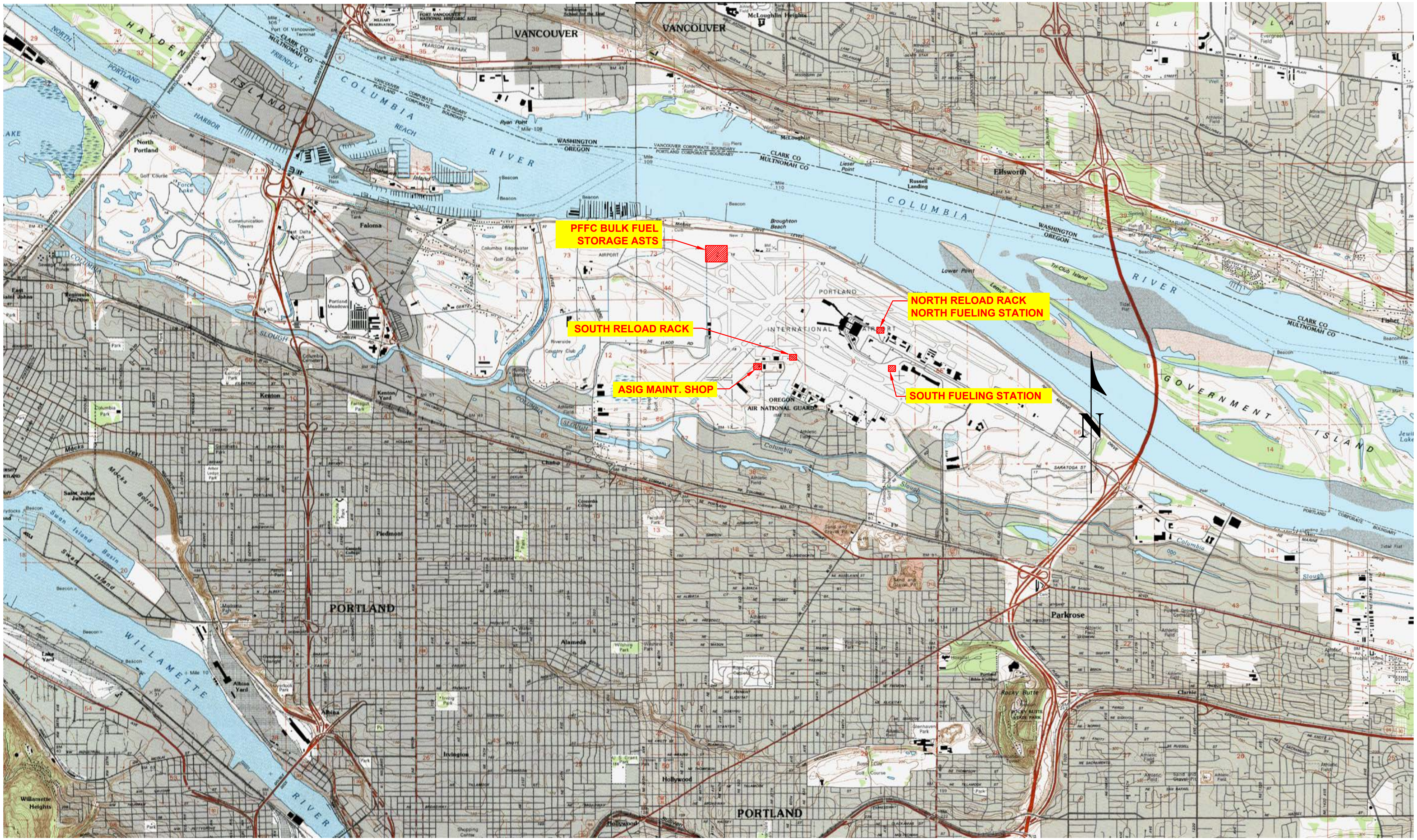
The content of the annexes supplements the material presented in the Core Plan. The annexes include facility maps and detailed supporting information on specific response techniques, such as procedures to address specific kinds of common spills and releases. It also includes BMPs as they pertain to activities at the site. Several sections address general operational BMPs, including inspections, training, and record keeping. Necessary documentation used to demonstrate regulatory compliance and checklists that can be used to ensure compliance and promote good housekeeping are included in the Annex 3.8.

3.1 Facility Maps and Drawings

The following maps and drawings are included in the ICP:

- A map showing the topography of the facility (Site Topographic Map);
- A drawing illustrating the structures, AST, reload racks, etc., on the facility (Site Facility Drawing) as well as general evacuation;
- A drawing illustrating the route of storm water runoff from the facility (Site Drainage Drawing); and
- A map showing the Hospital routes from the airport (Hospital Route)

Figure 3-1: Site Topographic Drawing



0 2,000 4,000 8,000

SCALE IN FEET

BASE MAP FROM USGS 7.5' QUADS; MT TABOR, OREGON 1990, AND PORTLAND, OREGON 1990

REVISION INFORMATION		
MILESTONE	DATE	REVIEWING AGENCY
FRP-ICP		

"PARTNERS IN SERVICE"

Advanced Remediation Technologies, Inc

690 NW 1st AVENUE, SUITE 104
CANBY, OREGON 97013
503-266-2122

MENZIES AVIATION

PFFC - PORTLAND INTL AIRPORT

PORTLAND, OREGON

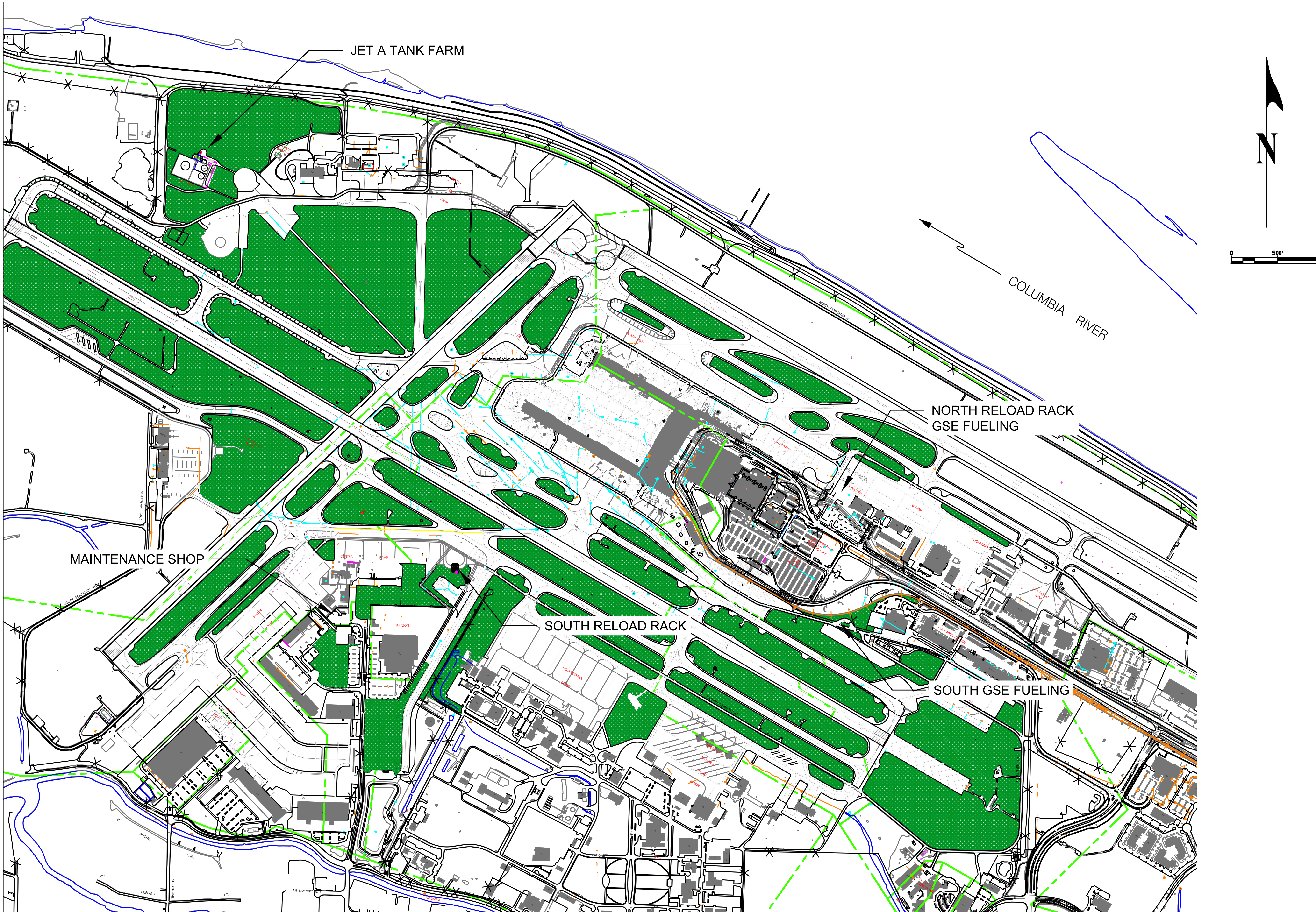
SITE TOPOGRAPHIC MAP, FIGURE 3-1

DATE	11/28/16
DRAWN	LAD
DESIGN	LAD
CHECK	KAD
SCALE	1"=20'

SITE PLAN

SHEET **1** OF **1**

Figure 3-2: Site Facilities Drawing



REVISION INFORMATION

MILESTONE	DATE	REVIEWING AGENCY
ICP–FRP	11/2016	

"PARTNERS IN SERVICE"

Advanced Remediation Technologies, Inc
690 NW 1st AVENUE, SUITE 104
CANBY, OREGON 97013
503-266-2122

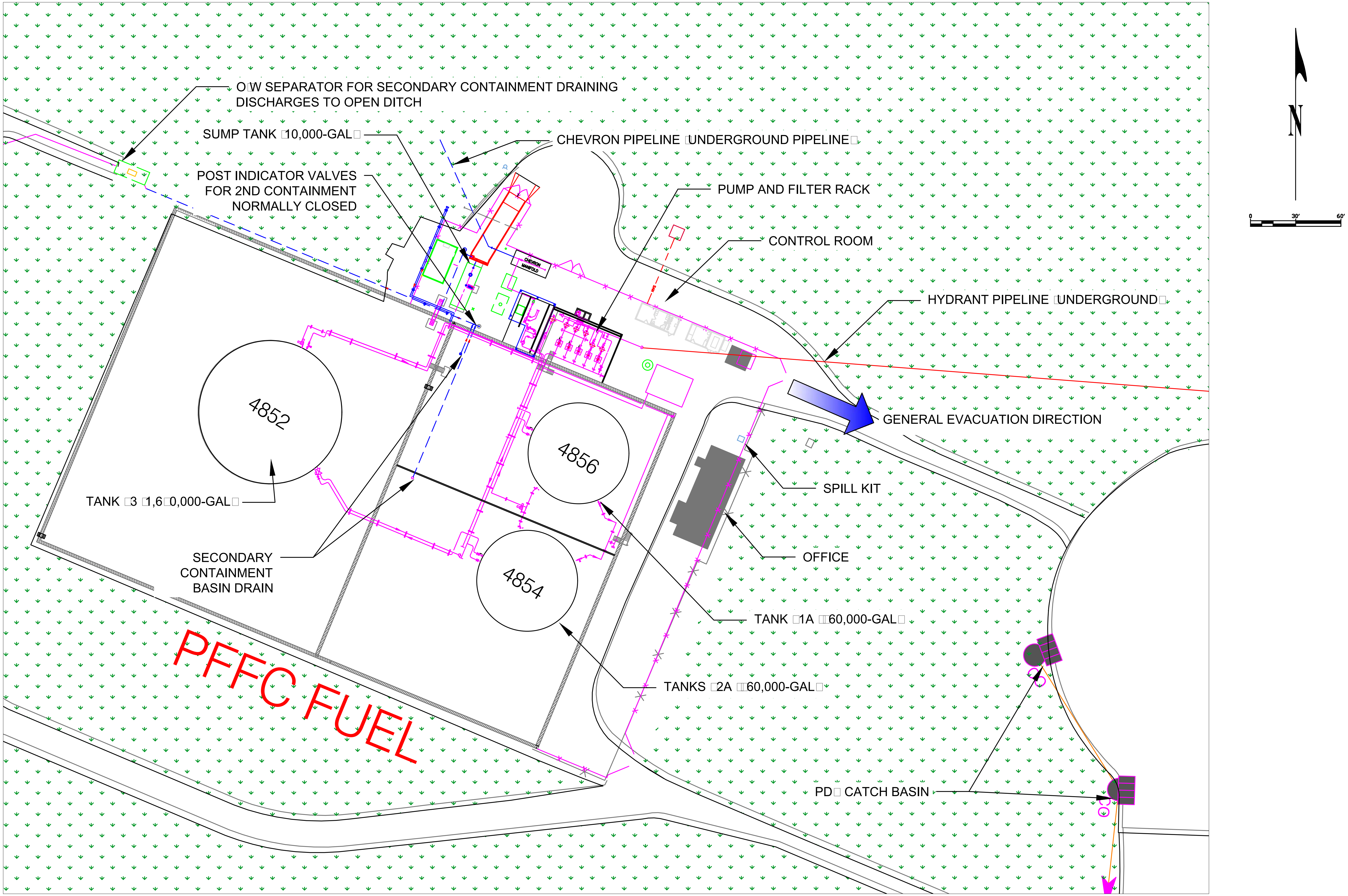
MENZIES AVIATION
PFFC – PORTLAND INTL AIRPORT
PORTLAND, OREGON

FACILITIES LOCATION, FIGURE 3–2

DATE	11/28/16
DRAWN	LAD
DESIGN	LAD
CHECK	KAD
SCALE	

SITE PLAN

SHEET 1 OF 1



REVISION INFORMATION

MILESTONE	DATE	REVIEWING AGENCY
ICP-FRP	11/2016	

"PARTNERS IN SERVICE"

Advanced Remediation Technologies, Inc

AIRCRAFT SERVICE INTL GROUP

PFFC – PORTLAND INTL AIRPORT

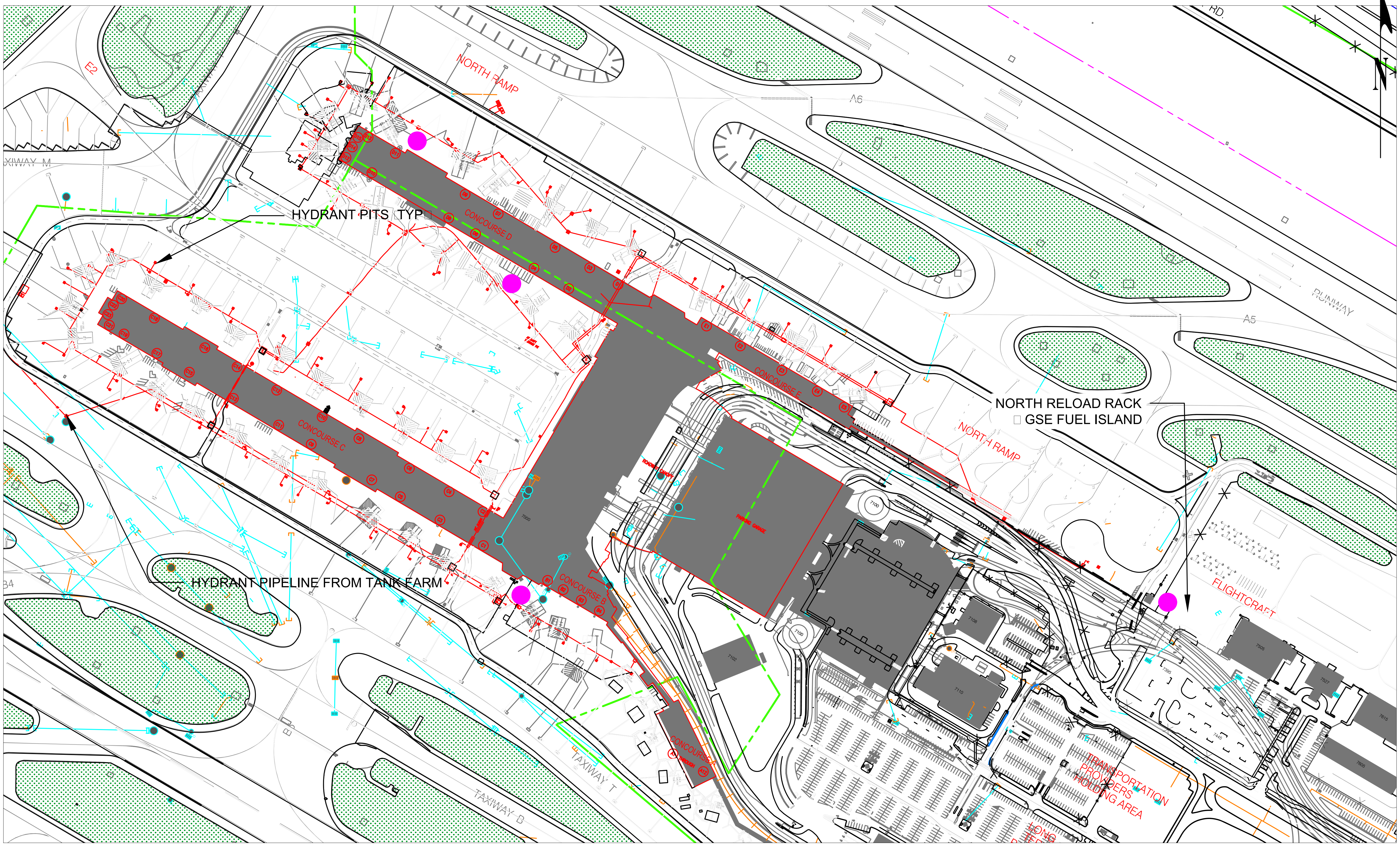
PORTLAND, OREGON

JET-A TANK FARM, FACILITY PLAN, FIGURE 3-2A

DATE	11/28/16
DRAWN	LAD
DESIGN	LAD
CHECK	KAD
SCALE	

SITE PLAN

SHEET 1 OF 1



● SPILL KIT OR CART LOCATION

REVISION INFORMATION

MILESTONE	DATE	REVIEWING AGENCY
ICP–FRP	11/2016	

"PARTNERS IN SERVICE"

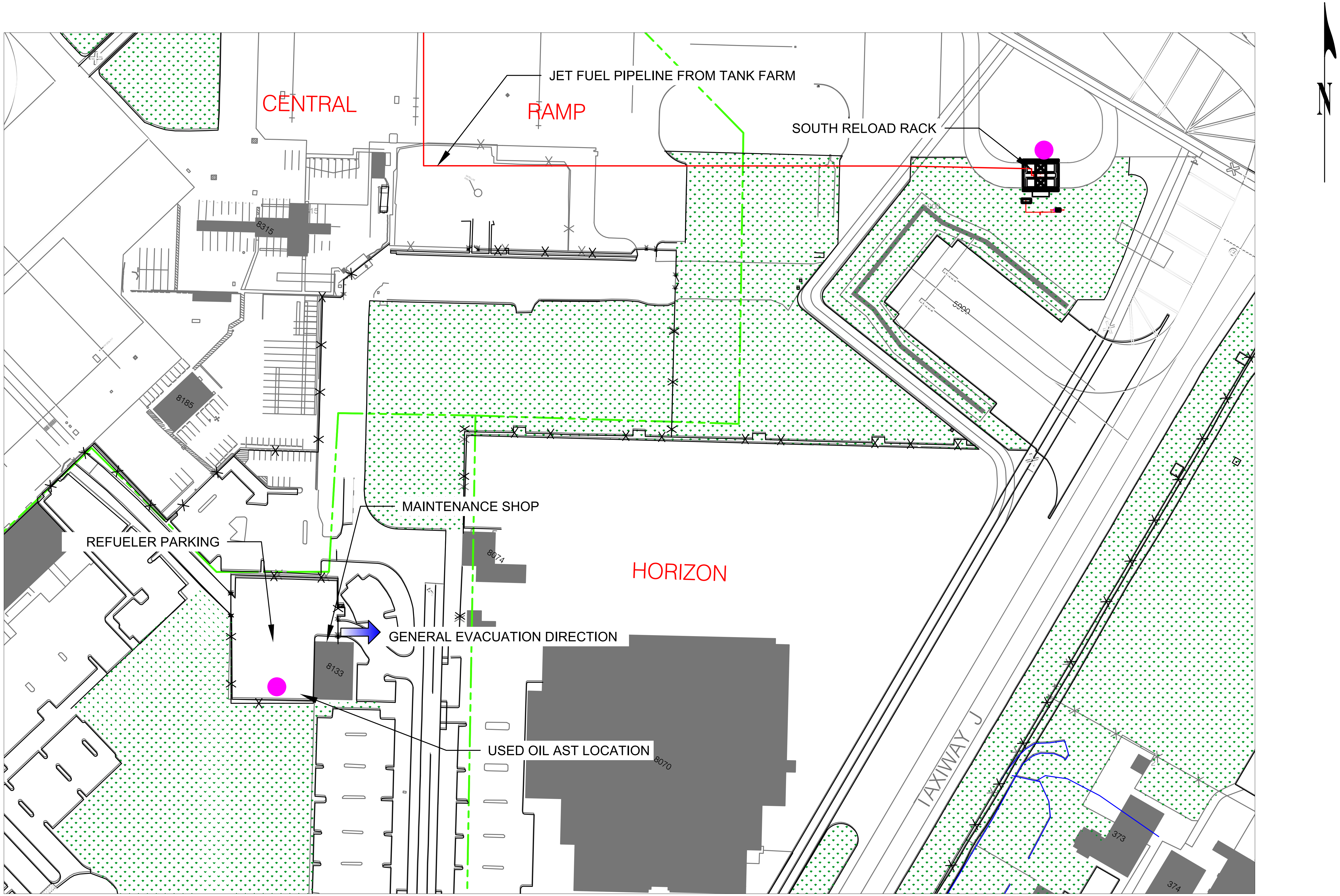
Advanced Remediation Technologies, Inc

MENZIES AVAITION
PFFC – PORTLAND INTL AIRPORT
PORTLAND, OREGON
TERMINAL & NORTH RELOAD, FIGURE 3–2B

DATE	11/28/16
DRAWN	LAD
DESIGN	LAD
CHECK	KAD
SCALE	1" = 250'

SITE PLAN

SHEET 1 OF 1



SPILL KIT OR CART LOCATION

REVISION INFORMATION		
MILESTONE	DATE	REVIEWING AGENCY
ICP–FRP	11/2016	

"PARTNERS IN SERVICE"

Advanced Remediation Technologies, Inc
690 NW 1st AVENUE, SUITE 104
CANBY, OREGON 97013
503-266-2122

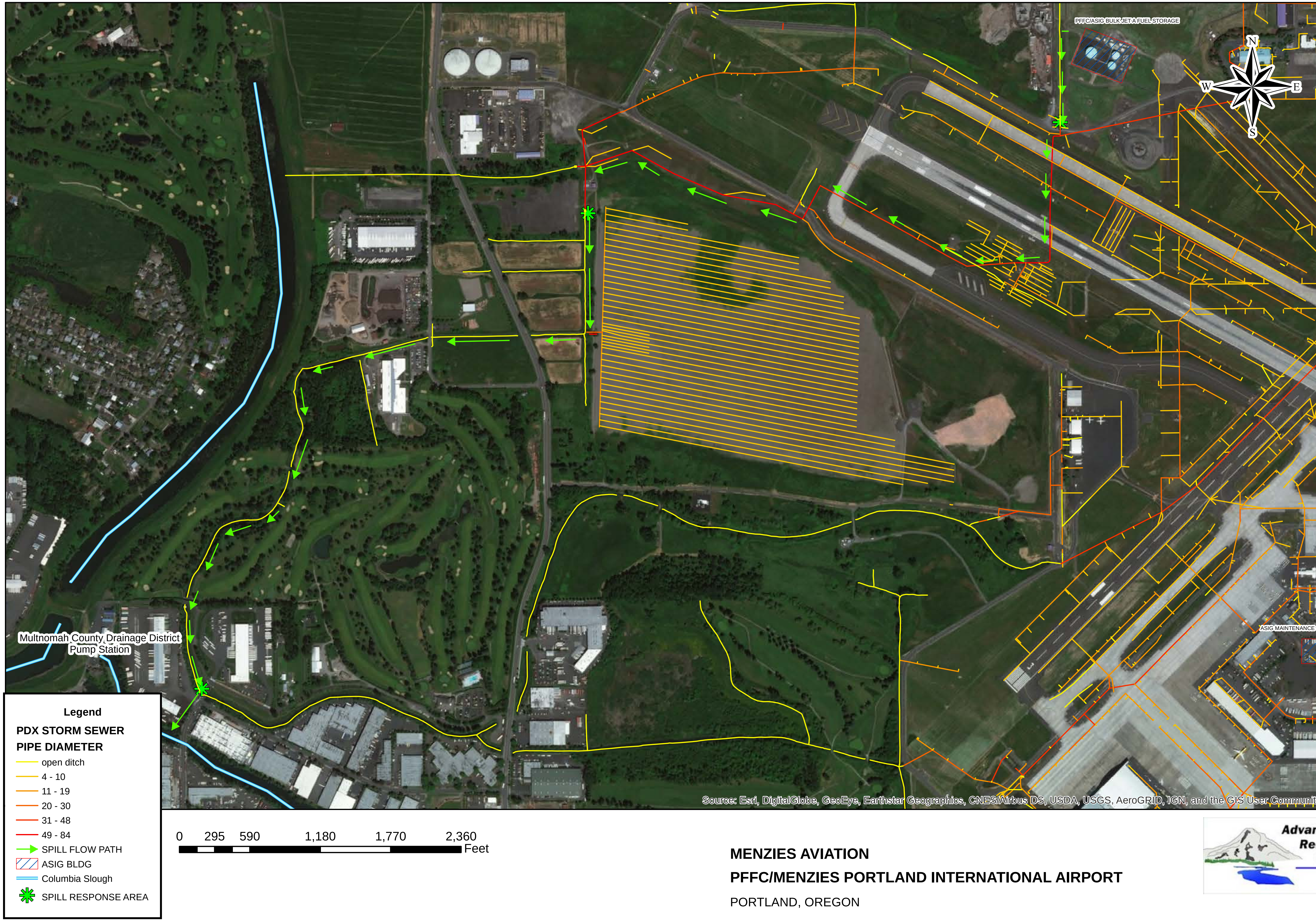
MENZIES AVIATION
PFFC – PORTLAND INTL AIRPORT
PORTLAND, OREGON
MAINTENANCE SHOP & S. RELOAD, FIGURE 3–2C

DATE	11/28/16
DRAWN	LAD
DESIGN	LAD
CHECK	KAD
SCALE	1" = 150'

SITE PLAN

SHEET 1 OF 1

Figure 3-3: Site Drainage/Spill Response



MENZIES AVIATION

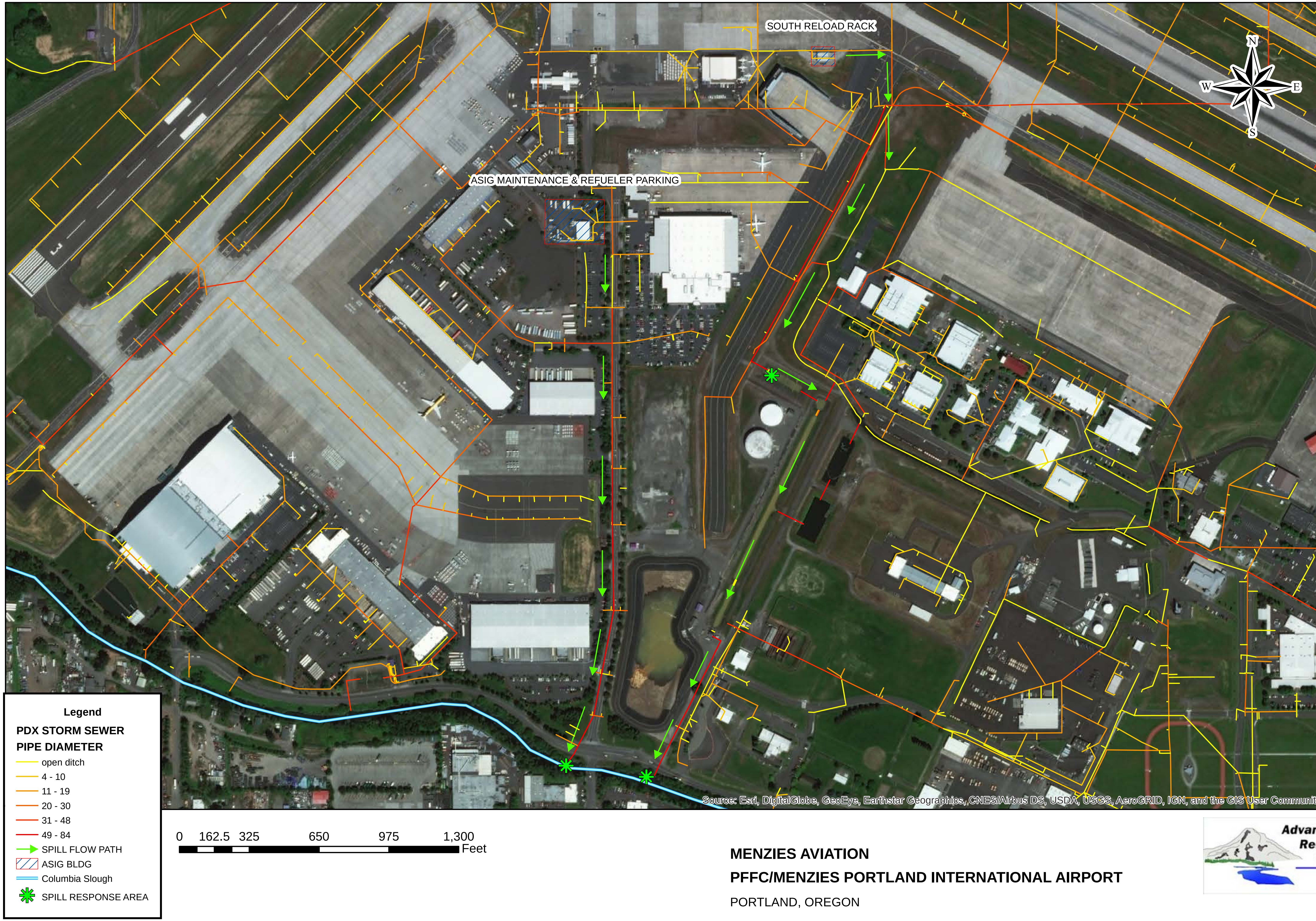
PFFC/MENZIES PORTLAND INTERNATIONAL AIRPORT

PORTLAND, OREGON

SPILL RESPONSE SITE DRAINAGE, AST FUEL STORAGE FACILITY

Advanced Remediation Technologies, Inc

FIGURE 3-3A



Advanced Remediation Technologies, Inc

MENZIES AVIATION

PFFC/MENZIES PORTLAND INTERNATIONAL AIRPORT

PORTLAND, OREGON

SPILL RESPONSE SITE DRAINAGE, SOUTH RELOAD REFUELLER PARKING

FIGURE 3-3B

Legend

PDX STORM SEWER PIPE DIAMETER

- open ditch
- 4 - 10
- 11 - 19
- 20 - 30
- 31 - 48
- 49 - 84
- SPILL FLOW PATH
- ASIG BLDG
- Columbia Slough
- SPILL RESPONSE AREA

0 205 410 820 1,230 1,640 Feet

Advanced Remediation Technologies, Inc

MENZIES AVIATION

PFFC/MENZIES PORTLAND INTERNATIONAL AIRPORT

PORTLAND, OREGON

SPILL RESPONSE SITE DRAINAGE, NORTH RELOAD & GSE FUEL ISLANDS

FIGURE
3-3C

Legend

PDX STORM SEWER PIPE DIAMETER

- open ditch
- 4 - 10
- 11 - 19
- 20 - 30
- 31 - 48
- 49 - 84
- SPILL FLOW PATH
- ASIG BLDG
- Columbia Slough
- SPILL RESPONSE AREA

0 280 560 1,120 1,680 2,240 Feet

Advanced Remediation Technologies, Inc

MENZIES AVIATION

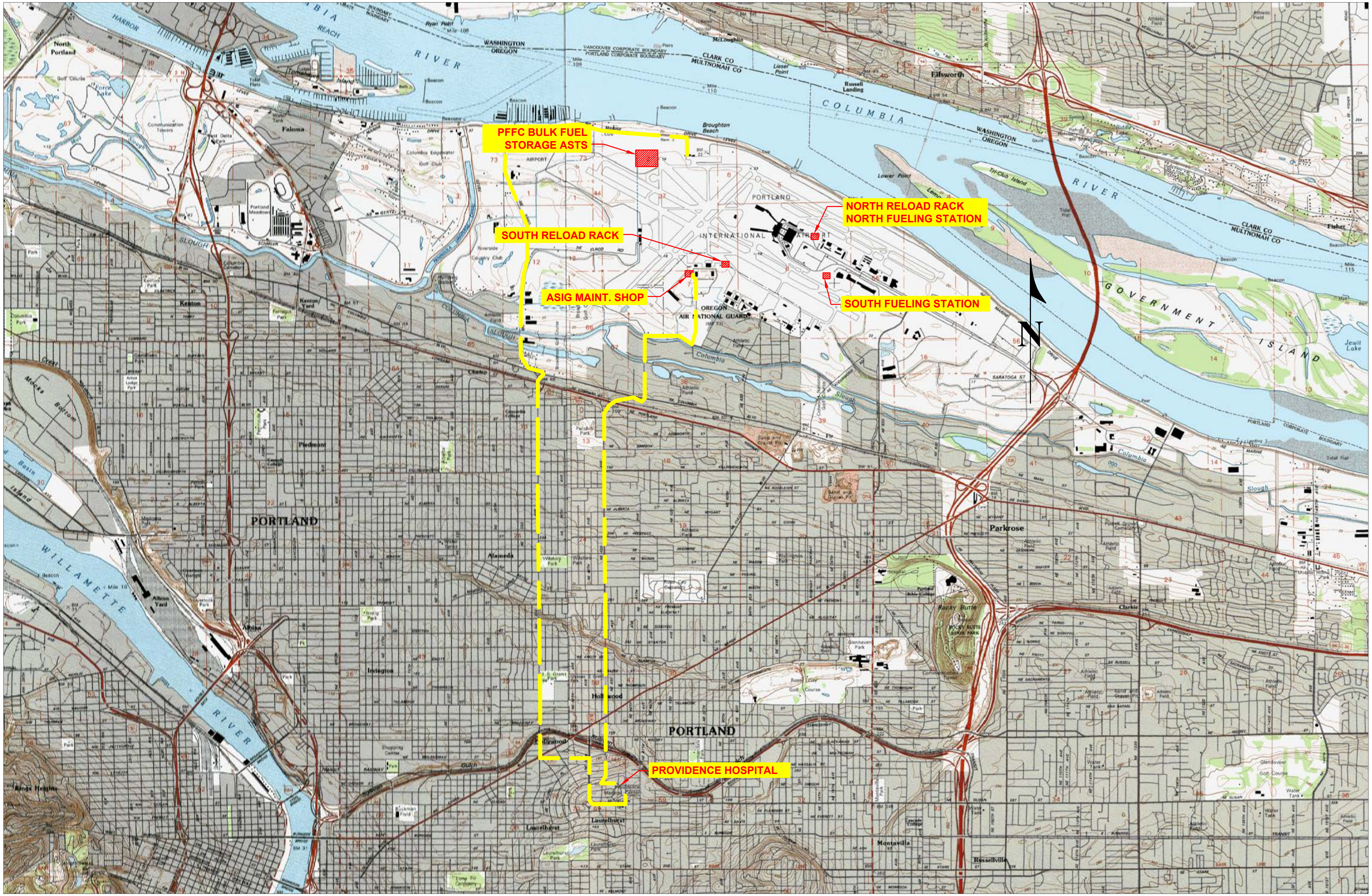
PFFC/MENZIES PORTLAND INTERNATIONAL AIRPORT

PORTLAND, OREGON

SPILL RESPONSE SITE DRAINAGE,MAINTENANCE SHOP, N & S RELOAD & GSE FUEL ISLANDS

FIGURE 3-3D

Figure 3-4: Hospital Route



BASE MAP FROM USGS 7.5' QUADS; MT TABOR, OREGON 1990, AND PORTLAND, OREGON 1990

0 2,000 4,000 8,000

SCALE IN FEET

REVISION INFORMATION		
MILESTONE	DATE	REVIEWING AGENCY
FRP-ICP		

"PARTNERS IN SERVICE"

Advanced Remediation Technologies, Inc

690 NW 1st AVENUE, SUITE 104
CANBY, OREGON 97013
503-266-2122

MENZIES AVIATION

PFFC - PORTLAND INTL AIRPORT

PORTLAND, OREGON

HOSPITAL ROUTES, FIGURE 3-4

DATE	11/28/16
DRAWN	LAD
DESIGN	LAD
CHECK	KAD
SCALE	1"=20'
SITE PLAN	

SHEET **1** OF **1**

3.2 Emergency Equipment Inventory

The following table includes all emergency equipment kept at the PFFC/Menzies operations, listed by location:

Table 3-1: On-Site Emergency Equipment Inventory

Type of Equipment	Location	Response Time
Spill Carts (4)	Gates D1, D3, D6, B1, C23, and Cargo (FEDEX)	15 minutes
Spill Kits (3)	Bulk Fuel Storage Facility, North and South Reload Racks	15 minutes
Vacuum Truck (1,500-gallon)	Bulk Fuel Storage Facility	15 minutes
Drain covers (2- 36"x36")	Maintenance Shop	15 minutes
Absorbent pads	Maintenance Shop and Bulk Fuel Storage Facility	15 minutes
Brooms	Maintenance Shop	15 minutes
Dry absorbents/floor dry	Maintenance Shop	15 minutes
Fire Extinguishers	Throughout PFFC/Menzies	15 minutes

Equipment	Contents (minimum)	Quantity
Spill Cart (each)	55-gallon recovery drum	1
	Personnel Protective Equip (2-pair gloves, 2-safety goggles, 2-tyvek suites, 1 roll duct tape)	1
	Absorbent Pads (16" x 18") bales (100 ea bale)	2
	Absorbent Booms (10' x 4")	2
	Absorbent 40-lbs bags	8
	Squeegee	1
	Absorbent socks (3" x 48")	6
	Shovel (spark resistant)	1
	Push Broom	1
	Heavy Duty Plastic Bags (4-10 mil thick)	12
Spill Kit (each)	Personnel Protective Equip (2-pair gloves, 2-safety goggles, 2-tyvek suites, 1 roll duct tape)	1
	Absorbent Pads (16" x 18") bales (100 ea bale)	2
	Absorbent Booms (10' x 4")	4
	Absorbent 40-lbs bags	4
	Absorbent Socks (3" x 48")	6
	Shovel (spark resistant)	1
	Push Broom	1
	Heavy Duty Plastic Bags (4-10 mil thick)	12

All equipment will be cleaned after use and made suitable for response events. All equipment will be maintained according to manufacturer's specifications, including periodic calibration, if applicable.

Mobile Safety Truck

Spill Cart Gate D1

Spill Cart and Super Sopper Gate D6

Spill Kit Bulk Storage Facility

Spill Materials Supplies Maintenance Shop

1,500-gallon Vacuum Truck

Additionally, emergency response contractors (NRC Env or Cowlitz Clean Sweep or Terra Hydra) can respond to major spill events with equipment capable of handling up to 15,000 barrels per day within one hour of the incident.

3.3 Spill Specific Procedures

Procedures for response to any type of spill that could occur at PFFC/Menzies are specified in this section. Four categories of spills that could potentially occur at the facility are identified. Each category identifies the various types of materials explained within. Therefore, the facility personnel responding to an incident need to categorize the type of spill and respond accordingly.

Waste Fuel and Fuel Products Spill Procedures

This category includes fuel type materials in both bulk (ASTs) and small containers in storage (i.e., gasoline, fuel tanks, diesel fuel, waste diesel, and diesel fuel additives).

SPILL CONTAINMENT

Attempt to halt the spill or leak by:

- Closing off connecting valves.
- Plugging the hole(s) with wood or any other available materials. Care must be taken to use spark retardant tools.
- Repositioning the fuel pod, tank truck, or drum so that the leak is slowed or stopped.
- Position some type of container/trash can under the leak or rupture.
- Enclose the spilled fuel with a dike of clay absorbent or an absorbent sock.

CLEAN-UP

Use enough absorbent to soak up all the spilled liquid. Since most organic liquids are very flammable, avoid all sources of ignition or sparking. Scoop up spent solid absorbent with a non-sparking shovel with a long handle. Place absorbent in 55-gallon drums labeled "WASTE SPILL MATERIAL," "DIESEL," "JET A" or "AUTO GAS," depending on the contaminant. Recovered product for medium and large spill can be temporarily stored in the sump fuel AST. For worst case spill, secondary containment should be sufficient to contain spill. Recovered product can be temporarily stored in other ASTs and recovery equipment until appropriate disposal and/or treatment is arranged.

PERSONAL PROTECTIVE EQUIPMENT

Personnel involved in cleaning up a fuel/fuel product spill must wear the following Personal Protection Equipment (PPE):

- Tyvek coverall
- Nitrile gloves
- Goggles/safety glasses
- Boots with chemical-resistant overshoes

Fire Extinguishers to be used: water, dry chemical, or carbon dioxide.

Battery Acid and Other Corrosives Spill Procedures

This category includes corrosives mainly found in small quantities in batteries or storage areas: batteries (sulfuric acid, mercury (Hg), nickel/cadmium (Ni/Cd), lithium (Li), alkali), phosphoric acid (rust remover), and potassium hydroxide.

SPILL CONTAINMENT & NEUTRALIZATION

Enclose spilled acid with a dike of absorbent. Add sodium bicarbonate to a liquid acid spill or add ascorbic acid to a liquid alkaline spill until it is completely covered.

CLEAN-UP

Add absorbent until the acid or alkaline spill is absorbed. Scoop up spent solid absorbent material and place spent waste in a plastic drum.

PERSONAL PROTECTIVE EQUIPMENT

Personnel involved in cleaning up an acid/corrosive spill must wear the following PPE:

- Rubber or neoprene 18” gauntlet gloves
- Rubber or neoprene apron
- Rubber hightop boots or overshoes
- Long sleeve shirt
- Face shield/splash-resistant goggles

Wash all clothing after use.

Fire Extinguishers to be used: water, dry chemical, or carbon dioxide.

Used Oil and Oil Products Spill Procedures

This category includes oil type materials mainly in small quantities located in storage cabinets and maintenance facilities: lube oil, oil/solvent, used oil, oil product (such as motor oil, gear oil, and engine oil), brake and transmission fluids, hydraulic fluids, grease, and fuel pump tester calibration fluid.

SPILL CONTAINMENT

Enclose spilled oil with a dike of absorbent rolls or clay absorbent. Other recovered spilled oil can be stored in sump fuel AST

CLEAN-UP

Use enough absorbent to soak up all the spilled liquid. Avoid all sources of ignition or sparking. Scoop up spent solid absorbent with a non-sparking shovel with a long handle. Place absorbent in a 55-gallon drum labeled "WASTE SPILL MATERIAL – OIL."

PERSONAL PROTECTIVE EQUIPMENT

Personnel involved in cleaning up an oil product spill must wear the following PPE:

- Tyvek coverall
- Nitrile or rubber gloves
- Goggles/safety glasses
- Boots with chemical-resistant overshoes

Fire Extinguisher to be used: carbon dioxide.

Paints, Thinners, and Other Organic Materials Spill Procedures

This category contains materials that are generally in containers smaller than 55 gallons and are stored in flammable cabinets and other storage areas. *Paint type materials* include: paint thinner (including methylene chloride products), waste paint, paint product, stain, mineral spirits, MEK, carbon tetrachloride, polyurethane, and lacquer. *Other materials* include: ethylene glycol (including antifreeze and windshield cleaner), isopropanol, linseed oil, methanol, coating compounds, de-icer, toner and dispersant, and isocanes.

SPILL CONTAINMENT

Enclose spilled organic liquid with a dike of absorbent material or sweeping compound.

CLEAN-UP

Use enough absorbent to soak up all the spilled liquid. Since most organic liquids are very flammable, avoid all sources of ignition or sparking. Scoop up spent solid absorbent with a non-sparking shovel with a long handle. Place absorbent in 55-gallon metal drum labeled "WASTE SPILL MATERIAL – PAINT PRODUCTS."

PERSONAL PROTECTIVE EQUIPMENT

Personnel involved in cleaning up an organic material spill must wear the following PPE:

- Tyvek coverall
- Nitrile gloves
- Goggles/safety glasses
- Boots with chemical-resistant overshoes

Fire Extinguisher to be used: carbon dioxide and dry chemical type.

3.4 Operating Procedures and Best Management Practices

This annex presents facility operating procedures and BMPs. The PFFC/Menzies has developed BMPs to prevent and control pollutant releases to the environment (i.e., storm water, groundwater, surface water, soil, and air) and from endangering human health. These BMPs are designed based on industry standards and are applicable to the potential pollutant sources identified in Section 2.3. BMPs are defined as:

- Baseline BMPs; and
- Activity-specific BMPs.

3.4.1 Baseline BMPs

Baseline BMPs are cost effective and easily implemented measures that are applicable facility-wide. Many of these BMPs have been used in the past or are currently being used (for example) for product loss prevention, worker health and safety, or to comply with other environmental regulations. The following presents a discussion of the baseline BMPs.

Spill Prevention and Response

As discussed in Section 2.1, PFFC/Menzies implements emergency response procedures to effectively respond to and clean up spills. In addition, spill response equipment is available onsite and is listed in the Emergency Equipment Inventory (Table 3-1) in Annex 3.2. Spill preventative measures are addressed within the baseline and activity-specific BMPs, including inspections to promote early discovery of an incident that would require emergency response, spill prevention and response training, and procedures for appropriate management and containment of containers, tanks and storage areas.

Good Housekeeping

Good housekeeping practices are designed to maintain a clean and orderly work environment and involve the following control practices implemented at the facility:

- Quantities of stored products are kept as small as possible while still maintaining an adequate supply;
- Only compatible materials are stored together;
- Products are kept in their original containers with original label;
- Product and waste containers will be well organized and placed so the label can be read without moving it;
- Any detected spill will be attended to immediately;
- Leaking containers will be repaired, recontainerized or placed in overpack containers immediately upon discovery;
- Spill cleanup materials and equipment will be readily accessible and all personnel will be knowledgeable in their location and proper use;
- All lids on garbage dumpsters will be closed to prevent storm water accumulation and contamination;
- Garbage and waste material will be picked up on a regular basis;
- All work areas will be "policed" at least once a day;
- Scrap metal and empty containers (drums) exposed to precipitation will be wiped clean of any residue;
- Scrap metal or containers that show signs of rust or corrosion, or are stored outdoors for extended periods of time, will be covered with plastic or tarp;

- Empty containers and equipment will be stored on pallets and covered with plastic or a tarp where enclosed outdoor areas are not available. Another option is to store empty containers on their side to prevent rainwater accumulation; and
- Used oil, hydraulic fluid, solvent degreasing material, stripped paint, etc., will be disposed of properly and in accordance with applicable state and federal regulations.

3.4.2 Activity-Specific Best Management Practices

Whereas baseline BMPs can be applied facility wide, activity-specific BMPs are particular to an identified potential pollutant source. Activity-specific BMPs incorporate some of the baseline BMPs where applicable. The following subsections present activity-specific BMPs that are implemented at the facility.

3.4.3 BMPs for Indoor Storage Facilities

This section deals specifically with indoor storage of hazardous materials in designated rooms, cabinets, or shelves.

Storage Procedures

- An inventory of materials stored will be maintained to insure that the stored products are compatible.
- Containers will be arranged to provide 2 feet of aisle space between rows to allow adequate access for inspection and emergency response. All storage rooms will be evaluated to determine the capability to provide secondary containment for the stored materials. The volume of the largest containers, presence or absence of floor drains, vents near the floor, expansion joints, holes in the floor, slope of the floor, etc., are points that will to be considered in the evaluation. Frequently, a storage room will provide sufficient secondary containment. In some cases, a concrete berm can be installed in front of the door and along the walls to increase the containment volume provided by the room. Small sheds used as storage rooms can be placed on curbed pads. Floor drains should be closed in rooms designated for hazardous material storage.
- Drip pans will be placed beneath all dispensing taps that are used to fill other containers.
- Emphasis will be placed on good housekeeping. Workers will clean up after themselves. Spillage from leaking containers or equipment will be attended to immediately and/or reported to supervisors.
- The name and phone number of the person to notify in the event of a spill will be posted near the entrance to the storage area. In the case of a room storing large quantities (i.e., > 250 gallons), a copy of the appropriate spill response procedures should be conspicuously posted.
- All personnel who use the storage rooms will be trained in proper handling, containment, cleanup, and reporting procedures.
- Stacked containers will be limited in height so they are stable and secure.
- The storage room will be locked except when materials are being added or removed.
- Spill containment and cleanup equipment, appropriate for the materials stored, will be readily accessible.
- Adequate ventilation will be provided in areas storing flammable materials, and no smoking rules will be enforced (i.e., posting of signs).
- Bulk drums of flammable liquids will be grounded.

Unloading and Loading Procedures

- Activities will be conducted in areas where appropriate containment or diversionary structures are present to contain a spill. If none are present, temporary provisions such as portable berms may be provided.
- At least two persons will be present at all times during operations; one person will be responsible for directing the driver.
- Materials will not be stored in the designated unloading/loading area.
- Spill containment equipment will be readily accessible.
- When feasible, outdoor operations will not be performed during rain events.
- All delivery vehicles will use emergency brakes, and vehicles will be shut off when not in use.
- All container lids will be checked prior to loading/unloading to ensure they are secure.

Visual Inspections

The storage areas and containers will be informally observed daily, and formally inspected weekly to ensure that leakage has not occurred.

3.4.4 BMPs for Aboveground Storage Tanks

ASTs at PFFC/Menzies are used to store Jet A fuel, sump fuel, and waste liquids such as vehicle waste oil. The following is a discussion of procedures to minimize the potential for release from an AST.

AST Operational Standards

ASTs at the facilities are subject to the Federal Standards outlined in 40 CFR 112 and 40 CFR 279. These include requirements for secondary containment and periodic tightness testing.

Secondary Containment

In accordance with SPCCP requirements outlined in 40 CFR 112.7 and used oil storage requirements outlined in 40 CFR 279.22, all ASTs must be provided with some form of secondary containment to prevent a release. The containment used is generally a function of the size of the tank, its contents, and its location. Containment systems may consist of concrete, asphalt, or compacted earth bases with berms, dikes, or curbing, drainage systems leading to a sump, diversion or retention pond. Alternatively, the containment may be a sheet metal enclosure (as with double-walled tanks) or any system that will contain the flow from the primary storage tank in the event of a leak.

There are specific secondary containment requirements for tanks with capacities greater than 660 gallons and used oil tanks that are 15 years of age or older outlined in 40 CFR 112.7(e)(2)ii and 40 CFR 279.22, respectively. Specifically, secondary containment for these tanks is designed to contain at least 100% of the tank's product volume. If numerous ASTs are co-located, a larger containment system can be provided but must be constructed to contain at least 100% of the largest tank's volume plus sufficient freeboard to contain precipitation. In areas that receive large amounts of precipitation, overhead protection may be present to exclude precipitation from the secondary containment structure. This is accomplished with a cover such as a roof or awning. Cover structures are designed and constructed with sufficient strength to prevent interference with normal operations in and around the tank system.

Facility Procedures

Physical Damage & Vandalism Controls

Because of their typical use in vehicle maintenance areas, ASTs are vulnerable to damage incurred from vehicle collisions and vandalism. For example, a collision could result in an instantaneous release of a large volume of material if the tank were to rupture. Posting signs and enforcing ground-guide procedures (i.e., guide present to direct vehicle when backing up) discourages damage to ASTs from vehicle collisions. In addition, physical barriers such as fences, concrete/steel posts, and guardrails may be installed around vulnerable areas of the tank to protect tanks from collision. Fences, signs, padlocks, lighting, and security personnel deter vandals.

If physical damage or vandalism occurs, regardless of the extent, it is immediately reported to the Facility Manager. The tank is immediately inspected to survey the damage and repairs are initiated, if necessary.

Drainage of Collected Storm Water

Large-volume containment systems are designed to allow for drainage of collected precipitation. This usually consists of a drainage valve. Drainage of rainwater from the containment area is in accordance with 40 CFR 112.7(e)(2)iii. The following procedures must be followed:

- The release valve is normally kept locked;
- Accumulated water is only released upon verification that the water is free of contamination. This consists of observance of visible oil sheen;
- The drainage valve is resealed following drainage;
- Records will be kept of testing and discharge of accumulated precipitation;
- A log will be maintained of all drainage release events (see Form 3-2).

Other Facility Preventative Procedures

Preventative operational measures that are employed in addition to those listed above include:

- Supervision of all product delivery and removal to ensure that there is no spillage (e.g., from dislodged or broken delivery hose);
- Maintain records of all preventative measures, including inspections, and containment drainage discharge for a period of three years.

3.4.5 BMPs for Outdoor Storage Facilities

This section primarily addresses spill prevention procedures for outdoor storage facilities that are used for either materials (product) or waste storage. These storage areas include designated housed structures as well as open segregated areas within the grounds. ASTs are not addressed in this section (see section 3.4.4). BMPs discussed address storage areas of both new products and waste materials. Most of the recommended practices are applicable to both types of storage areas. Where practices are specific to one type of storage, it is noted accordingly.

Outdoor storage is discouraged due to the high potential for environmental contamination from spills. At a minimum, all hazardous materials and wastes should be stored under a canopy or inside a designated structure to provide protection from the elements. Outdoor storage should be a temporary last resort to management of hazardous materials and wastes.

Storage Procedures

General

- Hazardous materials and wastes will be segregated according to chemical compatibility. An inventory of materials stored will be maintained to insure that the stored products are compatible.
- Containers will be arranged to provide 2 feet of aisle space between rows to allow adequate access for inspection and emergency response.

- Stacked containers will be limited in height so they are stable and secure.
- Temperature extremes can cause containers to bulge and leak. Move containers to more protected areas, if necessary, to prevent mishaps.
- All containers stored in the open must be kept tightly closed to exclude rainwater.
- If former product drums are used to store waste products, the original labels must be obliterated and the type of waste to be held must be stenciled or marked on the drums.
- The levels of waste material in satellite waste accumulation drums will be monitored frequently to ensure that they are not overfilled. Careful pouring of the waste material into the storage containers will be emphasized in annual training to avoid contaminating the exterior of the container and the surrounding ground. If funnels are used, they will be removed after use and the containers will be closed.
- Environmental laws require that bungs be kept in the containers to exclude rainwater and prevent the contents from pouring out if they are inadvertently tipped over.
- The storage room will be locked except when materials are being added or removed.
- Drip pans will be placed beneath all dispensing taps that are used to fill other containers.
- All containers will have legible labels on them identifying the contents. The containers should be oriented so the labels may be read without having to move the containers. Hazardous waste containers will be labeled in accordance with federal and state hazardous waste regulations for regulated waste generators and will include the contents and the date the waste entered storage.
- Adequate ventilation will be provided in areas storing flammable materials and no smoking rules will be enforced (i.e., posting of signs).
- Bulk drums of flammable liquids will be grounded and bonded to containers during dispensing.
- Leaking containers will be repaired, replaced, or placed in overpack containers immediately upon their discovery.
- Emphasis will be placed on good housekeeping. Workers will clean up after themselves. Spillage from leaking containers or equipment will be attended to immediately and/or reported to supervisors.
- The name and phone number of the person to notify in the event of a spill will be posted near the entrance to the storage area. In the case of a room storing large quantities (i.e., > 250 gallons), a copy of the appropriate spill response procedures should be conspicuously posted.
- All personnel who use the storage rooms will be trained in proper handling, containment, cleanup, and reporting procedures.
- Spill containment and cleanup equipment appropriate for the materials stored will be readily accessible.
- Contaminated material and soil should be cleaned up and disposed of in accordance with applicable regulations. The Menzies Corporate Office will coordinate and/or contract for the disposal of all contaminated material and soil. Therefore, the Menzies Corporate Environmental Coordinator should be contacted prior to cleanup activities for instructions regarding the appropriate containers, labels and methods to use.

Secondary Containment

- All outdoor material and waste storage facilities will be designed to provide protection from the elements and secondary containment to minimize the potential for a spill to reach the environment. This includes:

- Outdoor storage sheds not equipped with containment provisions will be located on a concrete pad with a berm around the walls and the front entrance.
- Drums or containers of materials/waste stored in the open will not be stored directly on the ground. They will be stored on pallets or on a concrete pad. Where feasible, materials will be stored within a containment area (such as a lined bermed area).
- Drums or containers not stored in a building/shed or roofed area will be covered with a tarp or plastic sheeting that is tied down and/or anchored with rocks.

Drainage of Rainwater

- The following procedures will be adhered to when drainage of any accumulated rainwater within containment areas is required:
  - The release valve is normally kept locked.
  - Accumulated water is only released upon verification that the water is free of contamination of stored product. This consists of observance of visible oil sheen.
  - The drainage valve is resealed following drainage.
  - Records will be kept of discharge of accumulated precipitation.

Unloading and Loading Procedures

- Activities will be conducted in areas where appropriate containment or diversionary structures are present to contain a spill. If none are present, temporary provisions such as portable berms may be provided.
- At least two persons will be present at all times during operations; one person will be responsible for directing the driver.
- Materials will not be stored in the designated unloading/loading area.
- Spill containment equipment will be readily accessible.
- When feasible, outdoor operations will not be performed during rain events.
- All delivery vehicles will use emergency brakes and vehicles will be shut-off when not in use.
- All container lids will be checked prior to loading/unloading to ensure they are secure.

Visual Inspections

- The material and equipment storage areas will be informally observed daily, and formally inspected weekly to insure that leakage has not occurred
- Waste storage areas must be routinely inspected. Walkthrough inspections should be performed daily and thorough inspections must occur weekly to ensure that leakage has not occurred. The weekly inspections must also be documented at large and small quantity generator sites.

3.4.6 BMPs for Mobile Fuel Storage

This section deals with vehicles parked in "motor pools" for maintenance or for mobile fuel storage vehicles. These mobile units refer to refuellers, trucks, and trailers, used to transport products for delivery to other vehicles, aircraft, and storage tanks. BMPs are as follows:

Motor Pool Practices

- Where feasible, all vehicles will be parked on a concrete or paved area to prevent any leaks contaminating the grounds.

- All parked vehicles will be inspected on a daily basis for evidence of fuel leaks, and prompt action will be taken if a leak is detected. Buckets or drip pans will be placed under all leaks immediately upon detection.
- Due to the nature of activities, unpaved motor pools can be prone to erosion. Therefore, walkthroughs of the motor pool, focusing on evidence of erosion areas, will be performed during vehicle inspections outlined above. Where erosion is detected, appropriate corrective measures will be taken. This can include refilling areas with gravel.
- Absorbent materials will be readily available to contain and clean up any spills.

Mobile Storage Units

- Vehicles (such as Refuellers) storing fuel will be parked, if feasible, within an area that would not permit spilled material to get into storm or natural drainage systems.
- Fuel transportation vehicle operators will be trained on vehicle spill prevention and control procedures. Operators will be trained on notification procedures, spill containment measures, and the use of rudimentary spill response supplies typically located on vehicles and at storage terminals. Written procedures for spill prevention and contingency actions will be kept on each vehicle.
- Absorbent materials, shovels, and brooms must be available nearby to allow quick cleanup of accidental spills that may occur during dispensing procedures.
- Fuel transfer personnel will be required to remain with equipment during fuel transfers and will follow BMPs for receiving (bulk fueling) and dispensing fuel for fueling. No "topping-off" of fuel when dispensing fuel from tanker trucks to vehicles.

3.4.7 BMPs for Fueling Stations/Reload Racks

Fuel Stations refer to designated fixed locations for fueling of vehicles and/or refueller trucks. The following BMPs address general spill prevention and control measures and three operations, receiving, dispensing, and bulk fueling.

General Spill Prevention and Control Measures

- Adequate lighting will be present at the fuel point areas.
- Signs will be posted with instructions in the event of a spill, including names and numbers of emergency notification personnel.
- Absorbent material will be readily available in all cases.
- Fuel point operators will be familiar with this plan and be properly trained in spill prevention and control.
- The fueling area will be inspected daily for evidence of leaks (fuel stains) and any damage or cracks in the concrete containment area.
- All piping will be inspected and maintained according to 40 CFR 112.7(e)(3).

Receiving

- One Menzies personnel will always be present and attentive during receiving operations.
- The receiving tank will be gauged before and after delivery, as a matter of inventory control.

Dispensing

Dispensing is the delivery of fuel to the operational gas tank of a vehicle or equipment, or to other containers. It is usually accomplished by an electric service station pump, which delivers 10 to 25 gallons per minute (gpm). The pump discharges through a wire-reinforced synthetic rubber hose, and a compound lever-type nozzle. The nozzle usually has an automatic shutoff mechanism. If it has a lock-on, latch-open device which permits unattended operation, this feature should be disabled so the lever must be manually held open, in effect making the nozzle a deadman shutoff valve.

- The pump will be padlocked whenever it is not in use or under the direct supervision of the responsible person. The electrical pump switches should be located inside a securable building, or be securable themselves.
- Fueling operations will be conducted on a concrete pad with adequate provisions for secondary containment. This can include a fixed concrete berm, sandbags, or a sump with an oil/water separator.
- Care will be taken to prevent a spill from overfilling during fueling. Therefore topping off tanks is not permitted.

Bulk Fueling

Bulk fueling racks have larger pump hoses than service stations and pumping rates may range as high as 350 gpm.

- As with receiving operations, a Menzies personnel will always be present.
- To prevent the receiving truck from departing before disconnecting the fuel line, preventative measures such as posting reminder signs or having the operator hold the keys will be utilized.
- Pumps and electrical switches will be locked to prevent unauthorized use.

3.5 Preventative Maintenance and Inspection Procedures

The established preventative maintenance program focuses on maintenance and inspection of systems and equipment identified as potential pollutant sources and includes storm water management devices (oil/water separators, catch basins and outfalls).

The supervisors, during their normal daily routine, are responsible for inspecting the areas under their control for compliance with this plan. The Standard Operating Procedures (SOP) used at PFFC/Menzies state that the facility will be inspected for implementation of proper security measures and elimination of potential fire/operational hazards at the close of each workday. A weekly review is also conducted to ensure the facility is operating properly and no problems exist. In addition, periodic inspections will be made by the Facility Manager/Facility Supervisor. Checklists that may be used to document periodic inspections are provided in Annex 3.8. The following is a general guideline for inspecting facilities.

- Facility inspections are required to follow written procedures. The written inspection procedures and record of inspections, signed by the inspector, are maintained for a period of three years.
- Spill response inspections are required annually, at a minimum.

The following areas must be inspected:

Shop Maintenance Area

The work area must be clean and well maintained. All hazardous material, when not in use, must be covered and returned to designated storage areas.

Hazardous Material Containers

All containers must be clearly marked with their contents. They must be closed and made of suitable material for their contents. At no time will food containers be used to store hazardous material or waste.

Hazardous Waste Containers

As a CEQSG, PFFC/Menzies is required to determine which of its wastes are hazardous, and treat or dispose of wastes onsite or deliver wastes to an offsite, permitted treatment, storage, or disposal facility. All hazardous waste containers must either be marked HAZARDOUS WASTE or with words that identify the contents of the container. All containers must be inspected to ensure they are clean, free of leaks, and in good condition. Waste containers must be closed when not in use. Containers located in an uncontrolled area must be sealed or locked to prevent mixing of wastes. Currently, PFFC/Menzies generates no hazardous waste.

Spill Containment

Whenever possible, materials should be stored on an impermeable surface such as concrete and secondary containment should be provided. Secondary containment may include a diked containment area, storage lockers with spill containment, or spill pallets. Inspect secondary containment to ensure it has the capacity to contain the largest possible spill. Determine if spill kits or equipment are present, easy to locate, and readily accessible. Inspect the spill kit to determine if it contains the types and quantities of material necessary to contain any potential spill. Fire extinguishers must be suitable for the types of materials stored and must be maintained and readily accessible.

Accumulation Areas

CESQGs may accumulate hazardous waste onsite, but if at any time more than 1,000 kilograms (2,205 pounds) of hazardous waste, one kilogram of acute hazardous waste, or 100 kilograms of acute hazardous waste spill cleanup debris is accumulated, all of the wastes become subject to full regulation.

Exempt Wastes

Exempt wastes must be stored separately from non-exempt wastes. Section 268.50(d-e) of the RCRA regulations describes the storage requirements of exempt wastes. Section 261 defines what a hazardous waste is and how a waste may become exempt. Used oil that meets burn standards and the requirements of an exempt oil as per RCRA 261.4(12) (i.e. oil recovered from transportation practices), and is to be used for energy recovery, can be held in excess of the holding time restrictions. These drums or ASTs should be clearly marked USED OIL, and should include a sampling date if it is required. If sampling is required, results should be attached to the drum when they are obtained. In all cases, these exempt wastes should be stored separately from RCRA hazardous wastes.

Waste Segregation

Storage areas must be clearly marked with the types of material they are permitted to contain. Kits and packages containing incompatible materials must be separated when not in use. Examples of potentially incompatible wastes can be found in Appendix V of RCRA Part 265.

Drains

Drains must be inspected to ensure some form of control is in place to prevent contamination from reaching the environment or a wastewater system. Various control measures include oil/water separators, positive elevation (the drain is at a higher elevation then the material), and valves. Any system or valve must be inspected to see that it is working and in use.

The following areas are considered to be part of a storm water management inspection. At a minimum, they should be included in all routine inspections, on a monthly basis.

Ditches and Waterways

Ditches, ponds, waterways, and drainage pipes around facilities and work areas will be inspected for evidence of leaks or spills.

Overland Flow

The flow of storm water runoff must be controlled to minimize its contact with potential pollutants. Ditches and barriers should be established to prevent the flow of surface water through areas with potential pollutants. Inspect areas to determine if excessive storm runoff is occurring. Inspect the runoff barriers to determine if they are in good condition and functioning properly.

Material Storage

Material should be stored to minimize contact with storm water. Hazardous material should be covered or stored in a shelter. Ensure hazardous material containers stored outdoors are clean and in a well drained area.

Aboveground Storage Tanks

Tank Integrity Testing

40 CFR Subparagraph 112.8(c)(6). Aboveground tanks must be subject to regular integrity testing and whenever repairs are made and should be frequently inspected for signs of deterioration or accumulation of oil inside diked areas. Visual inspection must be combined with another testing technique and comparison record must be kept. The tank's supports and foundations must also be inspected.

Regular site inspections of the facility are performed in accordance with ATA 103 and local regulations. These inspections include daily, monthly, quarterly and yearly checks encompassing both analytical and visual inspections. Integrity testing shall be performed at the time of installation, modification or repair of any aboveground storage tank at this facility in accordance with 40 CFR 112, a nationally recognized and industry accepted standard and all applicable codes, rules and regulations. All field-erected tanks at this facility are tested on a regular schedule in accordance with API 653 and frequent inspections outside the tank are performed to detect signs of deterioration and discharges, to confirm the integrity of the tank foundation and supports and to monitor the dike area. Specifically, daily and monthly inspections for all aboveground storage tanks are conducted by facility personnel as follows:

- Daily checks consist of visually inspecting tank surfaces and equipment for corrosion and paint condition. Routine exterior maintenance, such as spot or touch-up painting, is performed by facility personnel. Tank equipment and gauges are checked for proper operation and they will be repaired by facility personnel, unless special technical skill or equipment requires an outside contractor. Extensive exterior maintenance, such as sandblasting, painting of tanks, interior surface maintenance, and required integrity testing is performed by outside contractors. Visual inspections for leaks are made during scheduled rounds of the facility. Should emergency repairs be necessary, they will be undertaken immediately. Inspection records are maintained at the facility.
- Exterior surfaces of tanks for leaks, cracks, areas of wear, thinning, maintenance, operating practices, settling of structures, separation or swelling of seams, malfunctioning equipment, and structural or foundation weakness;
- Proper functioning of tank gauging leak detection systems, cathodic protection equipment, and monitoring and warning systems.

For field-erected tanks with a capacity of 10,000 gallons or more, a detailed 10-year inspection must be performed in accordance with API 653. The inspection must consist of the following:

- Cleaning the tank and difficult to reach areas within the tank in accordance with generally accepted practices;
- Removal, transportation, and disposal of sludge as required by law;

- Inspecting tank shell for soundness, testing all welds and seams on tank bottom for porosity and tightness; work performed consistent with generally accepted industry testing and inspection practices;
- Visual inspection of the internal surface of the tank and difficult to reach areas for corrosion or failure;
- Inspection of internal coatings for any signs of failure such as cracks, bubbles, blisters, peeling, curling, or separation;
- A tightness test of any connecting underground pipes.
- A formal API 653 inspection report is kept on file and to be used to schedule the next inspection date.

More frequent inspections and additional cleaning may be required when changing type of product stored or when major maintenance or repairs are needed. Immediate corrective measures will be taken if any leaks are identified, including notifying the IOSC/QI immediately upon detection.

3.6 Employee Training

The training program will be performed as a classroom course or as an on-the-job training program. Periodic briefings will also be provided under this training program. All facility personnel are to be instructed by Menzies personnel, who must be trained in hazardous waste management, spill prevention and control procedures, and storm water pollution prevention procedures. Training will be conducted using the ICP, and the trainer will ensure that all employees are familiar with its contents. In particular, the Facility Manager of PFFC/Menzies will ensure that the duties and responsibilities of the IRT are understood by facility personnel (see Section 2.1). The training will also provide instruction in applicable pollution control laws, rules, and regulations. The content of training courses will be modified to incorporate changes in operational procedures resulting from post-incident investigations. The training will also provide the following:

- Procedures for effectively responding to spill and emergency incidents (contingency planning);
- Familiarization with emergency procedures, emergency equipment, and emergency systems (e.g., communication/alarm systems, response to fire or explosion, response to groundwater contamination incidents, and procedures for use, inspection, and repair of emergency and monitoring equipment);
- Good housekeeping and material management practices;
- Operation and maintenance of equipment to prevent spills or incidents requiring emergency response;
- Descriptions of known spill events or failures, malfunctioning equipment/components, and recently developed precautionary measures;
- Onsite pollution prevention requirements; and
- Management/Procedures for fueling, used oil, spent solvent, painting, and used batteries.

Training is provided on, at least, an annual basis. This does not include periodic briefings. Facility personnel will be trained within six months of hire, assignment to the facility, or to a new position at the facility, as required by 29 CFR 1910.38 and 1910.119.

All training given to individuals must be documented. The following records must be maintained at the facility:

- Name and job title of employee trained;
- Written job description for each position;
- Written description of the type and amount of both introductory and continuing education that will be given to each employee; and
- Records of training completed by personnel.

Training records must be maintained on current personnel until the closure of the facility. Training records on former employees must be kept for at least three years from the last day of employment at the facility.

In addition to the general annual training discussed above, the facility shall ensure that adequate training is provided to all employees who participate, or are expected to participate, in emergency responses and storm water pollution prevention. Emergency response training consists of two levels that correspond to different personnel responsibilities.

Full Time Personnel

Full time personnel shall meet the requirements of the first responder awareness level as described in 29 CFR 1910.120(q)(6). These employees will most likely be the first to discover a spill or emergency incident. Their responsibility is to initiate the first response sequence by notifying the proper authorities. They must be trained in the following areas:

a. An understanding of what hazardous substances are and the risks associated with them in an accident;
b. An understanding of the potential results associated with hazardous material and waste emergencies;
c. The ability to recognize the presence of hazardous substances in an emergency;
d. The ability to identify hazardous substances, if possible;
e. An understanding of the role of the first responder awareness individual in the employer's emergency response plan including site security and control and U.S. Department of Transportation's Emergency Response Guidebook;
f. The ability to realize the need for additional resources, and to make appropriate notification to the communication center.

IOSC/QI

The IOSC/QI shall meet the requirements of the first responder operations level as described in 29 CFR 1910.120(q)(6). These employees will respond to releases or potential releases of hazardous substances to protect nearby persons, property, or the environment from the effects of the spill. This level must have received eight hours of training or demonstrate competency in the following areas, in addition to the areas listed above, for the first responder awareness level:

a. Knowledge of basic hazard and risk assessment techniques;
b. How to select and use proper personal protective equipment;
c. Knowledge of basic hazardous materials terms;
d. How to control basic control, containment and/or confinement operations;
e. How to implement basic decontamination procedures;
f. Knowledge of the relevant SOP and termination procedures.

3.7 Planning Drills and Training Exercises

Menzies shall meet the requirements of 40 CFR 112.21 Subpart D for self-inspection, drill/exercises, and response training through simulation of most probable to worst case spill scenarios. It is recommended that the training program be based on the USCG's Training Elements for Oil Spill Response, as applicable to facility operations. Menzies must notify the OR DEQ at least 60days before a full deployment exercise and tabletop drills, and 10 days prior to equipment deployment.

Tabletop exercises involve key personnel discussing hypothetical scenarios in an informal setting. This type of exercise can be used to assess oil spill contingency plans, policies, and procedures or to assess the ICP structure to guide the response to, and recovery from a pollution incident. Tabletop's typically are aimed at facilitating understanding of concepts, identifying strengths and shortfalls, and achieving changes in the approach to a particular situation. Participants are encouraged to discuss issues in depth and develop decisions through slow-paced problem solving, rather than the rapid, spontaneous decision making that occurs under actual or simulated emergency conditions. The effectiveness of a tabletop is derived from the energetic involvement of participants and their assessment of recommended revisions to current policies, procedures and plans.

For a typical exercise, the situation is established by the scenario. It describes a pollution event or spill incident and brings discussion participants up to the simulated present time. Personnel apply their knowledge and skills to a list of problems presented by the leader; problems are discussed as a group; and the leader generally agrees on and summarizes the resolutions.

Drill/exercises represent the next level of the exercise training cycle. They are used to validate the plans, policies, agreements and procedures solidified in discussion-based exercises. Operations-based exercises include drills and full-scale exercises with response deployment. They can clarify roles and responsibilities, identify gaps in resources needed to implement plans and procedures and improve individual and team performance. Operations-based exercises are characterized by actual reaction to an oil spill or pollution incident, response to emergency conditions; mobilization of equipment, resources, and/or networks; and commitment of personnel, usually over an extended period of time.

A drill/exercise is a coordinated, supervised activity usually employed to validate a single specific operation. Drill/exercises are commonly used to provide training on ICP, verify oil spill contingency plans, or practice and maintain current skills. Drill/exercises are also an effective training ground for lessons learned from previous spills or exercises. Drill/exercises at the operational-base size should be completed annually. Typical attributes of drills include but are not limited to:

- A plan holder oil spill contingency plan
- Lessons learned
- A realistic incident scenario which would address environmental, cultural, economic impacts
- Address public concerns regarding human health and wildlife impacts

Menzies shall submit a post drill report summary to OR DEQ within 60 days of completion of the drill or exercise. Menzies shall retain records of tabletop and drill/exercises for at least three (3) years and make available upon request by OR DEQ and/or USEPA.

3.8 Health and Safety Policies

Menzies's health and safety policies were established to protect personnel from the hazards posed by fieldwork. The procedures developed as part of the policies are intended to minimize the potential for exposure to hazardous materials, accidents, or physical injury during daily field activities or under adverse conditions. The procedures also specifies emergency measures that may be required during medium to worst case spill/release events.

The procedures must be observed by the Menzies personnel. Subcontractors participating in fieldwork at the Menzies sites or on off-site properties are required to prepare and maintain their own health and safety procedures. Personnel working in control zones will meet the medical surveillance, personal protection, respirator fit test, and hazardous waste operations training requirements specified by the federal Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120). Menzies maintains a basic Health and Safety Plan (HASP) for Menzies first responder personnel. Fieldwork observers must also comply with the safety requirements of Menzies's corporate procedures. Menzies field participants, observers, and subcontractors must read the HASP and sign an agreement to comply with its conditions.

3.9 Recordkeeping and Internal Reporting Procedures

A facility's ability to remain in compliance depends upon proper documentation that serves as a foundation for effectively preventing the occurrence of a spill or release. The facility will maintain the following records onsite:

- Onsite training records of all individuals, including initial and annual refresher training and any other pertinent offsite training certification;
- Preventative Maintenance Logs;
- Sampling data, including permit monitoring;

- Include the following records as part of the ICP as they occur:
    - Description of spill or other discharges;
    - Descriptions of the quality and quantity of storm water discharges;
    - All inspection and maintenance activities.
- Maintain for three years written internal inspection procedures, records of the inspection (scope on inspection, inspection personnel, inspection dates, major observations, actions resulting from inspection) performed at the facility, and incidents of noncompliance. An appropriate supervisor or inspector must sign these records. If no incidents of noncompliance are identified, the ICP shall include a certification that the facility is in compliance;
- Records of all events where rainwater from a diked area drains into a storm drain or an effluent discharge that ultimately empties into an open water course, lake, or pond, thus bypassing the in-plant treatment system;
- Note in the operating record the time, date, and details of any emergency incident that requires implementing the ICP;
- Maintain all employee training records summarized in the Training section of this plan;
- Maintain written procedures on spill notification at potential spill sites or at the main office;
- If a spill occurs where more than 1,000 gallons of oil reach navigable waters, or if harmful quantities reach navigable waters in two spill events occurring within a 12 month period, the facility must submit to the Regional Administrator within 60 days of the spill the following information:
    - Name of facility;
    - Facility owner or operator name(s);
    - Facility location;
    - Date and year of initial facility operation;
    - Maximum storage or handling capacity of the facility and normal daily throughput;
    - Facility description, including maps, flow diagrams, and topographical maps;
    - SPCCP with all amendments;
    - Cause(s) of such spill, including a failure analysis of system or subsystem in which the failure occurred;
    - Corrective actions and/or countermeasures taken, including an adequate description of equipment repairs and/or replacements;
    - Additional preventative measures taken or contemplated to minimize the possibility of recurrence.
- Within 15 days of an emergency incident that requires implementing the ICP, a written report must be submitted on the incident to the Regional Administrator, state, and local administrator. The report must include:
    - Name, address, and telephone number of the facility owner or operator;
    - Name, address, and telephone number of the facility;
    - Date, time, and type of incident;
    - Name and quantity of materials involved;
    - The extent of injuries, if any;
    - An assessment of actual or potential hazards to human health or the environment;
    - Estimated quantity and disposition of recovered material that resulted from the incident.

In addition, the following information will also be maintained at the facility:

- Material Safety Data Sheets (MSDSs) must be available for all materials. All hazardous material or waste storage areas must maintain copies of MSDSs for all materials in these areas in a location that is readily available to all employees;
- A list of names and contact numbers of the EC, the alternate and emergency responders must be posted at each satellite accumulation point, accumulation point, and telephone. The fire extinguisher and fire alarm need to be clearly visible (40 CFR 262.34 (d)(5)(ii)).

3.10 Forms

This annex includes forms that may be used as records of incidents and inspections that provide the necessary documentation to maintain regulatory compliance. These records should be completed as necessary. All forms identified in the ICP as being an integral part of the plan should be kept with the ICP, as directed in the text.

- Aboveground Storage Tank Monthly Inspection
- Menzies Incident/Accident Report
- Initial Spill Notification
- DEQ Spill/Release Report Form
- Form 3-1: Record of Annual SPCCP Inspection
- Form 3-2: Record of Storm Water Discharge
- Form 3-3: Letter of Agreement between PFFC/Menzies and Community Emergency Responders
- Form 3-4: Monthly Storm Water Inspection Checklist
- Form 3-5: Exercise Documentation Forms

ABOVE-GROUND STORAGE TANK
MONTHLY INSPECTION

Facility ______________________________ **Year** ____________

Tank Location ______________________________ **Tank Size** ____________ **gal**

Month	Overall Condition	ANY RUST?	TANK, PIPES, GAUGES, ETC. LEAKING?	Containment Valve Closed?	Water in Secondary Containment?	Water Discharge Documented?	Spills Around Facility?	Fire Extinguisher Present?	Comment # (Back of Page)
January									
February									
March									
April									
May									
June									
July									
August									
September									
October									
November									
December									

COMMENT 1: ____

COMMENT 2: ____

COMMENT 3: ____

COMMENT 4: ____

COMMENT 5: ____

COMMENT 6: ____

COMMENT 7: ____

COMMENT 8: ____

COMMENT 9: ____

COMMENT 10: ____

COMMENT 11: ____

COMMENT 12: ____

COMMENT 13: ____

COMMENT 14: ____

COMMENT 15: ____

COMMENT 16: ____

COMMENT 17: ____

COMMENT 18: ____

SPILL INCIDENT REPORT FORM

This advisement is first notice to Corporate Claims and the HS&E Department. A complete Accident/Incident report is to be forwarded to Corporate Claims within 5 business days. Addendum reports can be added any time.

TO: CLAIMS & INSURANCE **FROM**:

Menzies ☐

Six Digit Base Code: Dept. Phone #:

IATA Airport/City Code: Department:

Date of Incident/Accident: Time of Incident/Accident:

If known, Estimate of Damage: (US Dollars)

Type

☐Aviation Liability ☐Auto ☐Environmental ☐Property ☐FYI Incident

Employee Injury

Report to Travelers: 1-800-832-7839 Claim Number:

Non-Employee Injuries: ☐Yes ☐No ☐Unsure

Ambulance Needed: ☐Yes ☐No

Description of Injury:

Company Property Involved or Damaged: ☐Yes ☐No

☐Company Automobile and Asset Number:

☐Company Mobile/Ground Equipment: Type: Asset Number:

☐Company Other:

☐Company Buildings

Non-COMPANY Property Involved or Damaged: ☐Yes ☐No

☐Aircraft If Aircraft, Note Type of Aircraft: Tail #

☐Auto ☐Building ☐Other, specify:

☐Company Mobile/Ground Equipment: Type:

Owner of Non-Company Property, if known:

Brief Description of Injury or Property:

Description of Incident/Accident:

SPILL INCIDENT REPORT FORM

Spill Response Notification Form

Reporter's Last Name	First Name	Middle Initial
Position:	Phone: Day:	Phone: Evening:

Company:	Organization Type:

Address:	City:	State:	Zip:

Were Materials Discharge? (Y / N)	Confidential? (Y / N)
Meeting Federal Obligations to Report? (Y / N)	Date Called:
Calling for Responsible Party? (Y / N)	Time Called:

Incident Description

Source and /or Cause of Incident:	
Date of Incident:	Time of Incident: AM/PM
Incident Address Location:	
Nearest City:	State:
Distance from City:	Units of Measure: Gals/Bbls
Direction from City:	Section:
Container Type:	Tank Fuel Storage:
Capacity:	Units of Measure: Gals/Bbls
Facility Fuel Storage Capacity:	Units of Measure: Gals/Bbls

Facility Latitude:	Degrees:	Minutes:	Seconds:
Facility Longitude:	Degrees:	Minutes:	Seconds:

Materials

CAS Code:	Discharged Quantity:	Unit of Measure: Gals/Bbls
Material Discharged in Water:	Quantity:	Unit of Measure: Gals/Bbls

Response Action

Actions Taken to Correct, Control or Mitigate Incident:

Response Action Cont.

Were there Evacuations? (Y / N)	Number Evacuated:
Was there any Damage? (Y / N)	Damage in Dollars (approx.)”
Medium Affected:	
Description:	
More information About Medium:	

Additional Information

Any information about the incident not recorded elsewhere in the report:

Caller Notifications

EPA? (Y / N)	USCG? (Y / N)	State? (Y / N)
Other? (Y / N)		
Describe:		

Impact

Number of Injuries:	Number of Deaths:

SPILL/RELEASE REPORT

State of Oregon
Department of Environmental Quality

1 - GENERAL INFORMATION **OERS No. ____________**

a. Company/Individual Name: ________________________________

b. Address: ____

____

c. Company Contact Person: ________________________________

d. Phone Number(s): ____

e. Specific on-site location of the release (and address if different from above):

____

____

____

Please provide a map of the site showing area(s) where the release occurred, any sample collection locations, location of roads/ditches/surface water bodies, etc.

2 - RELEASE INFORMATION

a. Date/Time Release started: __________________ Date/Time stopped: _________________

b. Release was reported to (specify Date/Time/Name of Person contacted where applicable):

ODEQ ____

OERS ____

NRC ____

Other (describe): ____

c. Person(s) reporting release: ____

d. Name, quantity and physical state (gas, liquid, solid or semi-solid) of material(s) released:

____

____

Please attach copies of material safety data sheets (MSDS) for released material(s).

e. The release affected: ____Air ____Groundwater ____Surface Water ____Soil ____Sediment

f. Name and distance to nearest surface water body(s), even if unaffected (include locations of creeks, streams, rivers and ditches that discharge to surface water on maps):

____

Has the release reached the surface water identified above?: ____Yes ____No

Could the release potentially reach the surface water identified above? ____Yes ____No

Explain: ____

____

g. Depth to nearest aquifer/groundwater: _____________

Is nearest aquifer/groundwater potable (drinkable)? ____Yes ____No

Has the release reached the nearest aquifer/groundwater? ____Yes ____No

Explain: ____

____

State of Oregon Department of Environmental Quality

h. Release or potential release to the air occurred? ____Yes ____No
Explain:____

____

i. Was there a threat to public safety? ____Yes ____No
j. Is there potential for future releases? ____Yes ____No
Explain:____

____

k. Describe other effects/impacts from release (emergency evacuation, fish kills, etc.):

____

____

____

l. Describe how the release occurred. Include details such as the release source, cause, contributing weather factors, activities occurring prior to or during the release, dates and times of various activities, first responders involved in containment activities, etc.:

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

3 - SITE INFORMATION

a. Adjacent land uses include (check all that apply and depict on site maps):
____Residential ____Commercial ____Light Industrial ____Heavy Industrial ____Agricultural
____Other (describe):____
b. What is the population density surrounding the site:_______________
c. Is the site and/or release area secured by fencing or other means? ____Yes ____No
d. Soil types (check all that apply): ____alluvial ____ bedrock ____ clay ____sandy
____silt ____ silty loam ____artificial surface (cement/asphalt/etc.)
e. Describe site topography:____

____

____

SPILL/RELEASE REPORT

State of Oregon
Department of
Environmental
Quality

4 - CLEANUP INFORMATION

a. Was site cleanup performed? ____Yes ____No

If No, explain:____

____

b. Who performed the site cleanup?

Company Name: ___________________________

Address: ___________________________________

____

Cleanup Supervisor: ________________________

Phone Number(s): ___________________________

c. Has all contamination been removed from the site? ____Yes ____No

If No, explain:____

____

d. Estimated volume of contaminated soil removed:______________

e. Estimated volume of contaminated soil left in place:______________

f. Was a hazardous waste determination made for cleanup materials? ____Yes ____No

g. Based on the determination, are the cleanup materials hazardous wastes?

____Yes ____No If Yes, list all waste codes:________________________________

h. Was contaminated soil or water disposed of at an off-site location? ____Yes ____No

If yes, attach copies of receipts/manifests/etc., and provide the following information:

Facility Name:______________________________

Address: ___________________________________

____

Facility Contact: ______________________________

Phone Number(s): _____________________________

i. Is contaminated soil or water being stored and/or treated on-site? ____Yes ____No
If yes, please describe the material(s), storage and/or treatment area, and methods utilized (attach additional sheets if necessary):

____

____

____

____

j. Describe cleanup activities including what actions were taken, dates and times actions were initiated and completed, volumes of contaminated materials that were removed, etc. (attach additional sheets or contractor reports if necessary or more convenient):

____

____

____

____

____

5 - SAMPLING INFORMATION

Attach copies of all sample data and indicate locations of sample collection on maps.

a. Were samples of contaminated soil collected? ____Yes ____No ____N/A
b. Were samples of contaminated water collected? ____Yes ____No ____N/A
c. Were samples collected to show that all contamination had been removed?
____Yes ____No ____N/A
d. Describe sampling activities, results and discuss rationale for sampling methods:

____
____
____
____
____
____
____
____
____
____
____
____
____
____
____
____

6 - SPILL REPORT CHECKLIST

To ensure that you have gathered all the information requested by the Department in this Spill/Release Report, please complete the following checklist:

____ Map(s) of the site showing buildings, roads, surface water bodies, ditches, waterways, point of the release, extent of contamination, areas of excavation and sample collection locations attached.

____ Material Safety Data Sheet (MSDS) for released material(s) attached. **Note: an MSDS is not required for motor fuels.**

____ Sampling data/analytical results attached.

____ Receipts/manifests (if any) for disposal of cleanup materials attached.

____ Contractor reports (if any) attached.

If you would like to submit your report by e-mail it can be submitted electronically to:
DOSPILLS@deq.state.or.us

Form 3-1: Record of Annual SPCCP Inspection

This inspection record documents annual inspections conducted in accordance with 40 CFR 112. The facility inspection record must be kept for a period of three years.

Date	Review Supervisor And Title	Modifications/Changes to Facility Operations (as a result of the inspection)

Form 3-2: Record of Storm Water Discharge

As required by 40 CFR 112, any time that storm water is discharged from a firewall or dike, a record of inspection, discharge, and oil removal is to be maintained. PFFC/Menzies maintains dikes for secondary containment of the Jet A Bulk Storage ASTs. The following table will be used as a discharge record from the dike.

Tank ID	Date of Discharge	Quantity Discharged	Oil Sheen Present?	Supervisor's Signature	Comments

Form 3-3: Letter of Agreement Between PFFC/Menzies and Community Emergency Responders

From:	______________________________
Facility name	Portland Fuel Facility Consortium Fuel Storage and Distribution
Facility address	5000 NE Marine Drive, Portland Oregon
Latitude	45°35'50"
Longitude	122°36'45"
Facility POC	______________________________
To:	______________________________
Organization name	______________________________
Organization address	______________________________
Organization POC	______________________________
Date	______________________________

This letter serves as an agreement between the __________________(organization) and the ________________ (facility) with regard to emergency response for Jet-A (petroleum) releases. The facility stores a maximum of 3,360,000 gallons of Jet A in three aboveground storage tanks.

The ________________________ (organization) has received a copy of the _____________________ (facility) Integrated Contingency Plan (ICP). The ICP is a document that defines response procedures for emergency incidents occurring at the _______________________ facility. The _________________________ (organization) has responsibilities in the emergency response process. The appropriate personnel at the _______________________ (organization) are aware of their responsibilities as they relate to emergency response and have been appropriately trained.

If changes need to be made concerning the applicability or implementation of this agreement, please contact the facility representative listed above. A signed copy of this agreement will be kept with the ICP at the facility.

____ __________________________________
Name of Organization Representative Date

____
Signature of Organization Representative

Form 3-4: Monthly Storm Water Inspection Checklist

	YES	NO	NA
Are dikes free of leaks and rainwater accumulation?			
Are ditches, ponds, waterways, and drainage pipes around the facility free of leaks and spills?			
Do any areas on the facility show evidence of excessive erosion?			
Are erosion control methods in good condition and operating properly?			
Do any of the areas show evidence of receiving excessive storm water runoff?			
Are barriers to runoff in good condition and operating properly?			
Are materials stored to minimize their contact with storm water?			
Are all storm water BMPs being implemented?			

COMMENTS:

Form 3-5: PFFC/Menzies
Integrated Contingency Plan
EXERCISE DOCUMENTATION Forms

Qualified Individual Notification Drill Logs

Drill Log:		
Date:		
Company:		
Qualified Individual(s):		
Emergency Scenario:		
Evaluation:		
Changes to be Implemented:		
Time Table for Implementation:		

Spill Management Team Tabletop Exercise Logs

Tabletop Exercise Log:		
Date:		
Company:		
Qualified Individual(s):		
Emergency Scenario:		
Evaluation:		
Changes to be Implemented:		
Time Table for Implementation:		

3.11 Hazard Identification Tanks

The fuel facilities store primarily Jet A fuel which has an approximate flashpoint range of 100-150 degrees Fahrenheit. Jet A is classified as a non-persistent petroleum fuel according to 40 CFR 112 appendix E.

HAZARD IDENTIFICATION - TANKS

Date of Last Update: July 2003

Tank No.	Substance Stored (Oil and Hazardous Substance)	Quantity Stored (gallons)	Tank Type/Year	Maximum Capacity (gallons)	Failure/ Cause
Aboveground Storage Tanks (AST)					
1A	Jet Fuel A	840,000	Fixed roof/1972	840,000	None
2A	Jet Fuel A	840,000	Fixed roof/1972	840,000	None
3	Jet Fuel A	1,680,000	Fixed roof/1996	1,680,000	None
USF	Jet Fuel A	5,000	Double wall steel/1996	10,000	None
N. Autogas	Unleaded	10,000	Double wall steel/2017	10,000	None
N. Autogas	Diesel	10,000	Double wall steel/2017	10,000	None
Generator	Diesel	<500	Double wall steel/2003	500	None
Underground Storage Tanks (UST)					
S. Autogas	Unleaded	<10,000	Double wall fiberglass	12,000	None

SECONDARY CONTAINMENT CAPACITIES

Date of Last Update: July 2003

Secondary Containment No	Substance Stored in Tank	Maximum Quantity Stored in Tanks (gallons)	Surface Area/Year	Maximum Capacity of Secondary Containment (gallons)	Failure/ Cause	Largest Tank Capacity
1A	Jet A	840,000	37,369ft^2./1972	1,010,110	None	840,000
2A	Jet A	840,000	37,369ft^2./1972	1,010,110	None	840,000
3	Jet A	1,680,000	46,781ft^2./1996	1,941,271	None	1,680,00

Formula: L xW = Surface Area. Surface Area x Height (Dike Wall) = Cubic Feet. 1cu ft. = 7.48 gallons.
Note: Tank Diameter has been deducted. Tank 1A and 2A share same containment.

3.12 Vulnerability Analysis

In this section entitled vulnerability analysis, PFFC/Menzies addresses the potential effects of a fuel spill to human health, property, and the environment.

3.12.1 Planning Distance

If the ASTs were to rupture, most of the fuel would be contained within the diked area. Some fuel would infiltrate and could adversely impact soil and groundwater. Fuel released beyond the facility may occur due to dike failure, overspillage of the dike, or earthquake conditions.

Any release outside the diked area would drain west to the airport storm water drainage system that consist of ditches and sewers. The airport storm water sewer system discharges into the Columbia Slough. The airport discharge is near a levee and pump station. The pump station delivers the storm water runoff into the lower Columbia Slough. The lower Columbia Slough connects with Smith and Bybee Lake and eventually releases into the Willamette River which discharges into the Columbia River.

The vulnerability of environmental receptors downgradient of the facility is relatively small for the following reasons:

- The site drains into an airport drainage network with a large storage capacity.
- The airport drainage network releases into the upper Columbia Slough which is retained by a Multnomah County Drain Commission levee providing considerable storage capacity.
- Jet A fuel is a non-persistent petroleum substance and would naturally dissipate.

Planning distances are used to describe fuel transport to and in navigable waters. The planning distances for the site are as follows:

DI = Distance from the nearest opportunity for discharge, XI, to a storm drain or an open channel leading to navigable water.

D2 = Distance through the storm drain or open concrete channel to navigable water.

D3 = Distance downstream from the outfall within which fish and wildlife and sensitive environments could be injured or a public drinking water intake would be shut down as determined by the planning distance formula.

D4 = Distance from the nearest opportunity for discharge, X2, to fish and wildlife and sensitive environments not bordering navigable water.

DI = < 100 feet

D2 = 2.5 miles

D3 = 8-9 miles (Bybee Lake, Willamette River, Columbia River)

D4 = 2,000 feet (Columbia River over five foot flood levee)

Assuming a length of 13,200 feet (2.5 miles) from the point of discharge through a storm drain to navigable water, the travel times (distance/velocity) are:

8.8 hours at a velocity of 25 feet per second

73.3 hours at a velocity of 3 feet per second

110 hours at a velocity of 2 feet per second

Storm drains are located in close proximity to the facility and can provide a direct pathway to navigable waters. Since DI is less than or equal to 0.5 mile, a discharge from the facility could pose substantial harm because the time to travel the distance from the storm drain navigable water (D2).

Planning distance calculations and discussion was based in part on the following characteristics of the facility and immediate vicinity.

- The nearest body of navigable water is assumed to be the Columbia Slough and is located approximately 2.5 miles from the site.
- The topography near the tank farm is relatively flat with a mild slope towards the airport drainage system to the west. Any release from the subject site will travel through the airport storm sewers and unnamed drainage ditches on the airport property to the upper Columbia Slough.
- For planning distance calculations, it is assumed that a fuel release would overspill the levee, although highly unlikely.
- Conveyances are considered adequate to handle any flow released from the tank farm.
- Bybee and Smith Lake have fish and wildlife sensitive environments.

Generally, the groundwater flow would be towards the Columbia River. Any release at the facility has the capacity to infiltrate through the soil to groundwater. The City of Portland does not have any wellhead protection areas near the facility. Contaminated groundwater however, could flow to the Columbia River.

(1) Water intakes (drinking, cooling, or other);
None.

(2) Schools;

Woodlawn School is ½ mile from the Columbia Slough, although no impact is likely.

(3) Medical facilities;

None within reach of a release.

(4) Residential areas;

None, there are no nearby residences.

(5) Businesses;

Broadmoor Golf Course borders the airport drainage.

(6) Wetlands or other sensitive environmental;

Columbia Slough

(7) Fish and wildlife;

Bybee and Smith Lake, Ridgeland National Wildlife Preserve, 20 miles downstream.

(8) Lakes and streams;

Bybee and Smith Lake are on the Columbia Slough approximately 5 miles past the pump station levee

(9) Endangered flora and fauna;

Unknown.

(10) Recreational areas;

None

(11) Transportation routes (air, land, and water);

Portland International Airport, which provides air transportation for commercial domestic and international flights. Airport terminals are located approximately 3/4 mile east of the facility. Taxiway ''B' and 'I' are located within approximately 700 feet to 100 feet of the fuel storage facility.

Marine Drive runs east/west and is located approximately 1,000 feet mile north of the facility.

The Columbia River is located approximately 2,000 feet north of the facility.

(12) Utilities;

Gas, water, and electricity are provided to the PFFC/Menzies site.

Call Oregon Utilities Notification Center 1-800 332-2344 for precise locations of utilities.

(13) Other areas of economic importance (e.g. beaches, marinas) including terrestrially sensitive environments, aquatic environments, and unique habitats;

None

3.13 Analysis of the Potential for an Oil Spill

Because the facility handles fuel, the probability of an oil spill exists. However, spill prevention is the best method to protect the environment, public, PFFC/Menzies personnel and assets, and public property against the threat of a spill. This goal is achieved through personnel training, adherence to proper operational and safety procedures, and sound engineering practices.

The number of spills at this facility over the past several years shows that prevention, containment, and detection systems in place at the facility have been affective.

The following are considered the most likely risk probability for a spill location and event.

Location	Product	Quantity (gallons)	Probability	Likely Consequence	Impact
Valve/piping Integrity	Jet A	<50	low	Confined to secondary containment.	Slight
Hydrant System Integrity	Jet A	<50	low	Subsurface impact	Moderate
Earthquake AST Rupture	Jet A	1,680,000	low	Worst case discharge	Substantial
Overfilling	Jet A	<5,000	low	Spilled to ground	Moderate
Terrorist Act AST Rupture	Jet A	1,680,000	low	Worst case discharge	Substantial

3.14 Small/Average Most Probable Discharge

(2,100 gallons or less)

Date:	March 31, 2014
Time:	1600 hour
Weather:	Clear, wind from the SW at 5 mph
Temp:	55°

During filling a Tank 1-A, the terminal operator (TO) disengaged the high level alarm to squeeze a little more fuel into the tank. The TO then receives a phone call and forgets about the fuel levels in the tank. After hanging up the telephone, the TO glances outside and notices fuel coming out of the vents.

TIME	EVENT
1601	The TO shuts down the pipeline influent.
1603	The TO notices several puddles of fuel around the tank.
1615	The TO contains spill with absorbent pads and boom from the office to contain spill.
1620	The TO returns to the office. He estimates the spill volume to be 2,100 gallons and contacts the Facility Manager (FM). The FM instructs TO to begin notification procedures.
1650	The FM arrives on site (response time 35 minutes) and re-evaluates the severity of the spill. It is determined that a majority of the fuel remained near the tanks in the secondary containment.
1700	The terminal's spill response contractor, CCS, is notified of the incident and requested to respond with equipment and manpower to further evaluate the spill and start clean-up operations.
1705	Brad Keith (EC) of Menzies's Office of Environmental Affairs is contacted.
1740	State emergency response representative (ORES) arrives (1 hr and 10 minutes response time).
1830	Contractor personnel start to arrive at the terminal and following a brief safety meeting with Menzies, CCS personnel are directed to the spill area and permitted to start staging the clean-up operation, including removal of impacted soils (response time 2 hours).
1900	Contractor crews with protective clothing and organic vapor respirators manually start to remove the absorbent pads and boom.
2000	With the possibility of product reaching the groundwater, hourly monitoring of existing water monitoring wells will begin. Estimate that 100 gallons reached the groundwater through nearby drainage swales. In the event that product is detected, pumping of water wells will begin. Using two vacuum trucks obtained from IW, the product/water mixture will be pumped into available storage tanks.
2100	Following the soil removal, an estimated 1,000 gallons infiltrated the soil. Terminal personnel and local environmental agencies examine the exposed soil for evidence of saturation which requires additional soil removal. Following this evaluation, appropriate gas testing mobile equipment is supplied to start a more aggressive soil removal.

0600 State emergency response personnel On-Scene Coordinator (OSC) and FM/IOSC/QI agree that sufficient soil has been removed to eliminate any threat to the environment, pending follow up test results. All contaminated soil has been spread on visqueen until dump site disposal can be arranged, according to disposal program outlined in Integrated Contingency Plan (ICP).

1000 Following a review of clean-up operations and various test results taken by both state emergency response personnel and the clean-up contractor, it is agreed that a long term monitoring program needs to be set up and the clean-up contractor needs to make disposal arrangements for the contaminated soil.

A soil-gas venting system will be installed in the spill area. Also new monitoring wells and drilled around the perimeter of the spill area, a long term sampling and remediation program will be implemented, and the water from the new monitoring wells will be pumped and treated through a carbon filtration water treatment system.

An incident investigation is conducted. The results are reviewed with State emergency response personnel.

3.15 Medium/Maximum Most Probable Discharge

(between 2,100 and 36,000 gallons or 10 percent of the worst case discharge, whichever is less)

Date: July 10, 2014
Time: 1300 hour
Weather: Wind from the north, light rain
Temp: 65°

The Terminal is due to receive Jet A fuel in Tank No. 1A with a safe fill capacity of 840,000 gallons or 20,000 barrels. Facility Manager (FM) and Terminal Operator (TO) are on duty.

TIME EVENT

1305 The pipeline dispatcher calls Terminal, notifies FM that the receipt had started at 1240 and there had been a rise in the line pressure, then the pressure dropped and stabilized.

1310 FM has the TO investigate the phone call, TO notices that the inlet valve to Tank No. 1A is closed and the flange between the valve and pipeline has burst. TO immediately notifies FM to shut down receipt.

1312 FM notifies the pipeline dispatcher to shut down receipt. FM shuts down terminal operations.

1315 The FM, now assuming the position of the IOSC/QI has TO make the necessary notifications outlined in the Emergency Notification Procedures. Also, the clean-up contractor, CCS has been alerted.

1318 TO notifies FM/IOSC/QI that the proper notifications have been made, and estimates the spill to be 36,000 gallons or 857 barrels.

1320 Airport Fire and Police Dept. arrive (response time 5 minutes) a brief safety meeting is conducted.

1325 Fire Dept. begins to put a layer of foam on top of the spilled product. Police Dept. secures the entrance and exit gates.

1330 TO reports to FM/IOSC/QI and is instructed, to get all hose and the gasoline driven pump and proceed to the stairway going to Tank No 1A.

1335 State environmental personnel (OSC) arrives (response time 20 minutes) and are briefed in a meeting with the Superintendent, Fire Dept. and Police Dept.

1345 CCS arrives on site (response time 30 minutes). FM/IOSC/QI evaluates clean up options with the unified command (OSC, Fire, Police and CCS). It is determined that the area is fully contained and the area is covered with foam. Fire Dept. will continue to standby and monitor.

1355 Three vacuum trucks arrive, CCS starts staging for site clean-up, (600 gallons per minute recovery rate) begin removing product/water mixture and pump into the oil/water separator.

1400 With the possibility of product reaching the groundwater through the permeable secondary containment floor hourly monitoring of existing water monitoring wells will begin. In the event that product is detected, pumping of water wells will begin. Using two of the vacuum trucks already on site. Product/water mixture will be pumped into Oil/Water separator, and if test results warrant, a carbon filtration system will be installed to further treat water.

1630 A safety meeting is conducted by the Unified Command. Center vapor generation is minimal at this point and the Police and fire Dept. elect to leave the scene.

1730 Word is received that the Advanced Remediation Technologies, Inc (Environmental and Engineering Consultant) representatives are en-route and will be on site the following morning.

1900 CCS notifies Superintendent that the spilled product has been removed from the dike area around Tank No. 1A and soil removal will begin.

1930 The dike area around Tank No. 2 will be stripped of dirt and gravel and new fill will be installed. All contaminated soil from the impacted area will spread on visqueen until dump site disposal can be arranged. Any required permits will be obtained from the necessary state regulatory agencies.

DAY 2

0800 Advanced Remediation Technologies, Inc. representatives arrive on site. Meeting conducted with the IOSC/QI and OSC.

An incident investigation is conducted. The results are reviewed with State environmental personnel.

3.16 Worst Case Discharge

Three tanks with a total capacity of 3,360,000 gallons or 80,000 barrels are contained within secondary containment at the Portland, Oregon facility. The largest tank, No. 3 has a shell capacity of 1,680,000 gallons, or 40,000 barrels. This worst case discharge from the Portland terminal results from a catastrophic failure of that tank is due to a structural failure of the shell material. At the time of the rupture, the tank was containing Jet A fuel.

Nature and Cause of Spill

Date: September 15, 2014 Time: 3:30 PM

Weather: Warm, 30 mph winds, no rain for the past 15 days

Temp: 75°

There are three people on duty at the terminal, a Facility Manager, and two terminal operators. The terminal is in the process of receiving a product pipeline delivery. A loud thunderous noise is heard by the employees and they notice that Tank No. 1A has experienced a partial rupture of the side wall.

Immediate Actions

The Facility Manager (FM) is working in the office with one of the terminal operators (OP 1) when the noise is heard. After verifying the safety of OP 1 and his immediate environment, FM proceeds outside to check on the safety of the additional people on site while OP 1 assesses any damage to the office building, phone lines, electricity, and alarm systems. A visual inspection of the tank farm area by the FM reveals that a large amount of product is escaping from a rather large hole on the lower side wall on Tank No. 2A. Product is escaping at an estimated rate of 4,000 barrels per hour. Some product is forming into pools at various points around the tank and is spilling over the dike wall towards airport drainage ditches. All other tanks appear to be intact; however, dike surrounding Tank No. 3 has shifted, creating a slight separation at the northwest corner.

The FM shuts down terminal operations. OP 1 has determined that no apparent damage has occurred to the office building. A cellular phone and the Integrated Contingency Plan (ICP) is retrieved from the office by the FM and evacuation of the terminal site takes place through the main entrance gate. Everyone is accounted for on the Service Road outside the terminal.

OP 1 is instructed to begin making notifications using the ICP as a reference. OP 2 remains at the main entrance to control access, and the FM begins a further assessment of the situation. The FM, now assuming the position of the IOSC/QI, has determined that the services of CCS (primary response contractor), and Terra Hydr (secondary response contractor) are needed. The following order of calls are made: Airport Fire Department (911), Airport Communication System, and ORES. OP 1 then calls the National Response Center, EPA, and the remaining terminal personnel that are not on site. The Aviation Department temporarily closes air traffic.

At 3:47 p.m. the FM/IOSC/QI returns to the terminal and unlocks the gate to allow access to response personnel. Equipment staging sites are set up in the parking lot next to the terminal office building with a secondary site to be the vacant field next to the tank farm. Because of high levels of vapor concentrations being generated by the continuous flow of product, the FM/IOSC/QI determined that responders will need to wear SCBA, eye protection and protective clothing. Continued assessment and monitoring of the area will also be required. Wind is to the southeast and has the potential to send vapors to neighboring facilities and away from the remainder of the terminal. OP 1 is directed to contact these facilities and notify them of the incident.

Police arrive at 3:48 p.m. to secure the area.

The Airport Fire Department arrives at 3:48 p.m. and, equipped with appropriate PPE and explosion detection meters, enters the terminal site. After a brief safety meeting, it is determined that the Fire Department will secure the area and standby. The Fire Department is advised of the neighboring facilities and concern over the vapors traveling towards them. The Fire Department decides that evacuation of the adjacent properties is not necessary at this time. Assisted by the Fire Department HAZMAT team, OP 1 and OP 2, suit-up in PPE and begin gathering sorbent materials and shovels from the facility trailer for containment efforts at the facility. A team is sent out on to airport property to contain released fuel in airport drainage ditches and sewer. The FM/IOSC/QI is notified that Multnomah drain commission has sent someone to shut down pumps in the upper Columbia Slough.

Containment and Recovery Actions

After a brief safety meeting at 4:05 p.m., it is determined that an immediate response action will include transferring product from Tank No. 3 to available storage Tanks No. 1A and 2A (recovery rate of 84,000 gallons per hour). Airport Fire Department and Menzies employees leave the site to put sandbags on top of the upper Columbia Slough levee as an added precaution.

At 4:30 p.m. two other facility employees arrive at the scene and the FM/IOSC/QI sets up a command center in the terminal office. He meets with the Menzies employees and briefs them on his assessment and the PPE requirements for the area. The FM/IOSC/QI then requests that one facility employee coordinate with CCS and Terra Hydr.

A representative from a district office of the Environmental Protection Agency (EPA) arrives at 4:30 p.m. and meets with the FM/IOSC/QI and CCS to gather facts and to assess the situation. Another facility employee is instructed by the FM/IOSC/QI to begin working with the EPA to review current clean-up efforts and to develop a long term plan for any remediation work that may be needed.

EPA Region X has responded back to FM/IOSC/QI via telephone that they will arrive in 4 to 5 hours.

At approximately 5:30 p.m., CCS has arrived with three people, three vacuum trucks, and equipment to assist in containment and clean-up operations. It is determined by CCS and the FM/IOSC/QI to have the three vacuum trucks assist in recovering the product that has formed in various pools through-out the tank farm. In the event that they may be needed, CCS has been requested to provide additional vacuum trucks and pumps. CCS has access to several pump trucks in the Portland area. Due to the severity of the spill and the porosity of the soil, the FM/IOSC/QI requests that CCS contact a well drilling contractor for installation of a product recovery well system.

At 5:45 p.m. CCS personnel leave site to investigate impact on the Columbia Slough. Skimmers and booms are ready to be mobilized.

At 6:40 p.m. local terminal personnel continue to staff security, communications and field operations functions pending the arrival of additional members of the CCS team. The FM/IOSC/QI then determines additional staffing needs to accommodate shifts and activates additional personnel through CCS. The FM/IOSC/QI assigns the role of Safety Manager to a facility employee and coordinates with the section chiefs to address potentially hazardous and unsafe incident conditions. He determines the adequacy of PPE equipment by monitoring and helps to limit extent of entry by establishing exposure zones. An incident-specific safety plan, including emergency escape procedures, is developed.

At 7:15 p.m. CCS personnel indicate that most of the fuel released to the Columbia Slough has dissipated. They observed a sheen on the surface and mobilized absorbent booms to mitigate.

At 7:30 p.m. the trucks requested arrive, and begin loading (recovery rate of 88,000 gallons). Personnel arrive from CCS at approximately 9:00 p.m. and begin working with the FM/IOSC/QI to support and supplement the clean-up activities. A 12-hour shift rotation is established to relieve personnel. A Menzies employee is assigned the task of organizing lodging and catering arrangements with local businesses.

At 9:45 p.m. the FM/IOSC/QI directs a Menzies employee to work with appropriate agencies to ensure the protection of wildlife and environmentally sensitive areas. The major environmental resource concern is the potential of contamination in the Columbia Slough. Contamination has been effectively contained behind the levee of the upper Columbia Slough and removal of oil is underway. While all efforts are being made to contain and quickly remove accumulated product, due to the porosity of the soil, there is likely to be vertical migration at those exposed areas which are not impervious. Other resource concerns include the economic disturbance to businesses in the vicinity. The FM/IOSC/QI is directed to ensure that all funds required to carry out the response activities are in place.

Material and Storage Disposal

The petroleum product collected from the containment area is being pumped into available storage tanks on-site and into tank trucks. The non-liquid wastes are being stored in an established waste storage area in the parking area of the terminal, appropriately marked as hazardous materials and secured.

Notification

The OP 1 made the initial contacts; however, the FM/IOSC/QI maintains in contact for verbal updates to State and Federal agencies.

Volume of Material Recovered

In the first 12 hours 302,000 gallons (36%) have either been recovered or transferred to other tankage.

3:30 a.m., Tank No. 1A is completely empty.

The volume discharged was 554,000 gallons. The amount of product that was loaded on to trucks and returned to storage tanks, as well as the amount of product that was transferred from Tank No. 3 and put in to storage tanks was 302,400 gallons. Ultimate disposal of product at a later time will include any product that was contaminated by temporary storage in available storage tanks.

OTHER ACTIONS

The gross contamination is removed in four days of operation and remediation efforts are underway. The area surrounding the outside of the containment wall, the airport drain system, and ground water conditions in the vicinity will be monitored as required by state and federal regulations.

Within approximately 12 hours, a subcontractor arrives to install a recovery well system to recover product from the groundwater. A soil-gas venting system will also be installed in the spill area as part of the initial recovery system.

The Menzies Office of Environmental Affairs will work with the EPA to develop a sampling program, which will evaluate the extent of contamination in the soil and groundwater. The anticipated remediation program will be coordinated through the EPA.

FOLLOW UP

A post incident review meeting will take place within two weeks to evaluate the effectiveness of the facility's response plan and the status of all regulatory compliance issues. Discussions with the EPA will be ongoing during remediation and subsequent monitoring of environmental conditions.

3.17 DISCHARGE DETECTION SYSTEMS

Discharge Detection by Personnel

Terminal operators perform the following terminal inspections:

DAILY:

General condition of tank yard	Hoses, swivels, and nozzles
Security, fire and safety features	Ground reels, cables and clamps
Fuel leak evidence	Fire extinguishers
Storage tank sumps	Waste fuel tanks
Filter sumps	

MONTHLY:

Filtration testing	Floating suctions
Ground cable continuity	Fuel meter seals
Signs & placards	Fire extinguishers

SEMI-ANNUALLY:

Line strainers	Emergency shutdown system

ANNUALLY:

Storage tank interiors	Tank vents
Meter calibration	Tank high level controls

Pressure gauges	Cathodic protection
Filter Elements	Facility condition
Water Defense System	

Automated Discharge Detection

The terminal is equipped with high level and high-high level audible and visual alarms. The loading/unloading racks all have deadman devices, which will automatically stop flow if the attendant releases the handle.

3.18 Worksheet to Plan Volume of Response Resources For Worst Case Discharge

Part I	Background Information		
Step A	Calculate Worst Case Discharge in Barrels (Appendix D)		40,000
Step B	Oil Group[1] (Table 2 and section 1.2 of Appendix F)		1
Step C	Operating Area (choose one)		
	Nearshore/inland/Great Lakes ☐	Rivers and Canals ☒	
Step D	Percentage of Oil (Table 2)		

Percent Lost to Natural Dissipation	Percent Recovered Floating Oil	Percent Oil Onshore
80	10	10

Step E1	On Water Oil Recovery	Step D2 x Step 1	4,000
Step E1	Shoreline Recovery	Step D3 x Step 1	4,000
Step F	Emulsion factor (Table 3 of Appendix F)		1
Step G	On Water Oil Recovery Resource Mobilization Factor (Table 4 of Appendix F)		

Tier 1	Tier 2	Tier 3
0.30	0.40	0.60

1 A facility that handles, stores or transports multiple groups of oil must do separate calculations for each group on site except those oil groups that constitute 10 percent or less by volume of the total oil storage capacity at the facility. For purposes of this calculation the volumes of all products must be summed to determine the percentage of the facilities total oil storage.

Part II On-Water Oil Recovery Capacity (barrels/day)

Tier 1	Tier 2	Tier 3
1200	1600	2,400
Step E1 x Step F x Step G1	Step E1 x Step F x Step G2	Step E1 x Step F x Step G3

Part III Shoreline Cleanup Volume (barrels)

4,000

Step E2 x Step F

Part IV On Water Response Capacity by Operating Area

(Table 5 of Appendix F, amount needed to be contracted for in barrels/day)

Tier 1	Tier 2	Tier 3
1,500	3,000	6,000

Part V On Water Amount Needed to be Identified, but not Contracted for in Advance (barrels/day)

Tier 1	Tier 2	Tier 3
600	800	1,200
Part II Tier 1 – Step J1	Part II Tier 2 – Step J2	Part II Tier 3 – Step J3

Note: To convert from barrels/day to gallons/day, multiply the quantities in Parts II through V by 42 gallons/barrel.

3.19 FEDERAL FINANCIAL RESPONSIBILITY

Page Intentional Left Blank

3.20 Menzies Aviation PERSONNEL TRAINING LOG

Page Left Intentional Blank

3.21 REPONSE CONTRACTOR TRAINING LOG, EQUIPMENT LIST, AND AGREEMENT

Page Left Intentionally Blank

APPENDIX D: Report of Geotechnical Engineering Services

www.haleyaldrich.com

REPORT OF GEOTECHNICAL ENGINEERING SERVICES
PDX FUEL TANK DESIGN
PORTLAND INTERNATIONAL AIRPORT
PORTLAND, OREGON

by
Haley & Aldrich, Inc.
Portland, Oregon

for
Burns & McDonnell
Bloomington, Minnesota

File No. 0204679-001
December 2023

HALEY & ALDRICH, INC.
6420 S. Macadam Avenue
Suite 100
Portland, OR 97239-3517
503.620.7284

18 December 2023
File No. 0204679-001

Burns & McDonnell
8201 Norman Center Drive #500
Bloomington, Minnesota 55437

Attention: Reid Unke

Subject: Report of Geotechnical Engineering Services
PDX Fuel Tank Design
Portland International Airport
Portland, Oregon

Dear Reid Unke:

Enclosed is Haley & Aldrich, Inc.'s (Haley & Aldrich's) geotechnical engineering report for the proposed Portland International Airport (PDX) Fuel Tank Design (Project) in Portland, Oregon. The Project site is located within the property of PDX in Portland, Oregon, along the Columbia River.

We understand the Project includes the design and construction of a new truck offload facility, three new large fuel storage tanks, secondary tank containment walls, operations and fire protection buildings, pipelines and utility racks, and ancillary light poles. The project will also include demolition of existing fuel storage tanks and an existing operations building. The proposed improvements will interface with existing improvements, including a fuel pump and underground fuel piping.

This report contains the results of our research, explorations, and analyses, and provides recommendations for design and construction of the proposed Project. This report should be reviewed in conjunction with our Geotechnical Data Report (Haley & Aldrich, 2023b) and our Enhanced Seismic Design Considerations (Haley & Aldrich, 2023a) for the site.

The most significant geotechnical concerns regarding the proposed site development include the potential for very strong seismic shaking, seismic hazards including liquefaction and liquefaction-induced vertical settlements, and lateral spreading. These effects will cause instability of the nearby Columbia River riverbanks during an earthquake which can adversely affect the Project site. Ground improvement measures and/or deep foundations will be required to protect the proposed structures and other features which have seismic stability requirements.

We appreciate the opportunity to provide our services to you on this Project. If you have any questions, please call.

Sincerely yours,
HALEY & ALDRICH, INC.

Micah D. Hintz, P.E., G.E.
Technical Specialist, Geotechnical Engineer

Allison M. Pyrch, P.E., G.E.
Senior Associate, Geotechnical Engineer

Enclosures

c: JH Kelly, Attn.: Derek Koistinen

\\haleyaldrich.com\share\pdx_data\Notebooks\0204679-001_PDX_Fuel_Project_Tank_Design\Deliverables In-Basket\Geotech Report - Final\2023_1218_PDX_FuelTankDesign_GeotechReport_F.docx

HALEY & ALDRICH, INC.
6420 S. MACADAM AVENUE
SUITE 100
PORTLAND, OR 97239-3517
503.620.7284

SIGNATURE PAGE FOR

REPORT ON
PDX FUEL TANK DESIGN
PORTLAND INTERNATIONAL AIRPORT
PORTLAND, OREGON

PREPARED FOR
BURNS & MCDONNELL
BLOOMINGTON, MINNESOTA

PREPARED BY:

Kayla Ahrens, P.E.
Technical Specialist, Geotechnical Engineer
Haley & Aldrich, Inc.

Micah D. Hintz, P.E., G.E.
Project Manager, Geotechnical Engineer
Haley & Aldrich, Inc.

REVIEWED AND APPROVED BY:

Allison M. Pyrch, P.E., G.E.
Senior Associate, Geotechnical Engineer
Haley & Aldrich, Inc.

Daniel J. Trisler, P.E., G.E.
Principal, Geotechnical Engineer
Haley & Aldrich, Inc.

Table of Contents

Page

Table of Contents

List of Tables

List of Figures

1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich) is pleased to submit this report to Burns & McDonnell summarizing our geotechnical engineering services for the Portland International Airport (PDX) Fuel Project Tank Design (Project) at 4300 NE Marine Drive, located within the property of PDX in Portland, Oregon. We completed our work in general accordance with the scope of services included in the Incidental Service & Material Order issued by JH Kelly, executed 24 February 2023 (Agreement).

Burns & McDonnell plans on making facility improvements to the existing fueling facility located in the northwestern portion of the PDX property. We understand the proposed improvements project includes demolition of three existing above-ground fuel tanks (designated Tanks #1, #2, and #3) and associated piping and containment area walls as well as demolition of an existing operations building located east of the tanks. Proposed improvements include three new above-ground fuel tanks with dike walls, an operations building, a truck offload and Hazardous Cargo Transportation Security (HCTS) facility, and piping to connect the proposed fuel tanks to existing pipelines and facilities at the site. The proposed 110-foot-diameter fuel tanks (designated Tanks #5, #6, and #7) will be located to the south and east of the existing tanks. The proposed operations building will be roughly rectangular in shape with plan dimensions of about 50 by 70 feet. The proposed truck offload and HCTS facility will be rectangular in shape with a footprint area of about 75 by 85 feet. The project will also include construction of new pavements, above and below ground utilities (water, electricity, storm and sanitary sewer, etc.), and stormwater infiltration facilities.

Existing site structures and equipment pads to remain are understood to be supported on shallow mat foundations with bearing pressures on the order of 500 to 750 pounds per square foot (psf). These improvements include the following:

- Pump pad with footprint area of about 35 by 70 feet;
- Maintenance building with footprint area of about 20 by 25 feet;
- Testing lab with footprint area of about 10 by 30 feet;
- Generator pad with footprint area of about 20 by 30 feet;
- Power distribution center (PDC) with footprint area of about 30 by 45 feet; and
- Product tank with footprint area of about 10 by 35 feet.

Several Kinder Morgan-owned equipment pads and facilities are present at the site but are not within the scope of this project.

We understand the proposed improvements will be designed in accordance with the State of Oregon Department of Environmental Quality Fuel Tank Seismic Stability Rule 340-300, 2019 Oregon State Structural Code (OSSC), and American Society of Civil Engineers (ASCE) 7-16.

This report contains the results of our analyses and provides recommendations for design and construction of the proposed improvements. This report relies on the site data presented in the project Geotechnical Data Report, which includes detailed descriptions of the recent and historical field explorations, laboratory test results, and subsurface conditions (Haley & Aldrich, 2023b). This report also builds on the seismic evaluation presented in our report on Enhanced Seismic Design Considerations prepared for the project by Haley & Aldrich (2023a).

Figures are presented following the text. The location of the site is shown on Figure 1, Vicinity Map, and the site layout with recent and historical exploration locations is presented as Figure 2, Site Plan. A subsurface profile of the site is presented as Figure 3, Subsurface Cross Section A-A'. Pile design capacity plots are presented on Figures 4 through 6. Figures 7 and 8 present plots of estimated vertical and lateral displacements.

2. Scope of Services

The purpose of our services was to evaluate the subsurface conditions at the Project site and to provide geotechnical engineering recommendations for design and construction of the project elements. We completed the following tasks in general accordance with the Agreement:

- Performed a geotechnical exploration program at the site as presented and discussed in our Geotechnical Data Report (Haley & Aldrich, 2023b).
- Conducted engineering analysis to develop geotechnical design recommendations for seismic design criteria, foundations, excavations, and pavement design criteria.
- Prepared this report outlining our findings and recommendations, including information related to the following:
  - Subsurface soil and groundwater conditions;
  - Seismic hazards (e.g., liquefaction, settlement, and lateral spreading);
  - Site preparation and grading;
  - Utility trench construction;
  - Shallow and deep foundation design parameters;
  - Seismic design criteria; and
  - Slab and pavement design.
- Provided project management and support services, including coordinating staff and subcontractors and conducting telephone consultations and email communications with you and the design team, etc.

3. Subsurface Conditions

3.1 GENERAL

Subsurface soil and groundwater conditions interpreted from historical explorations and explorations advanced at the site as part of our current study, in conjunction with soil properties inferred from field and laboratory tests, formed the basis for the conclusions and recommendations in this report. Details of the explorations and laboratory testing completed at the project site are discussed in the site Geotechnical Data Report (Haley & Aldrich, 2023b). Our interpretations of the available subsurface data are provided in the following sections.

3.2 SOIL CONDITIONS

Generally, explorations encountered up to 7 to 16 feet of dredge sand fill overlying overbank deposits of Columbia River Sand Alluvium up to 50 feet below ground surface (bgs), which then overlies sand of the Columbia River Sand Aquifer to the base of the explorations. We divided the encountered soils into three engineering soil units (ESUs), which are grouped by similar geologic origin and/or engineering properties. Descriptions of these ESUs are provided below:

- ESU 1: Loose to Medium Dense Sand (Topsoil / Fill)
- ESU 2: Very Soft Silt (Overbank Deposits)
- ESU 3: Medium Dense to Dense Sand (Columbia River Sand)

These ESUs are discussed in detail in the following sections. A representative cross section is shown on Figure 3, Subsurface Cross Section A-A'.

3.2.1 ESU 1 – Loose to Medium Dense Sand (Topsoil / Fill)

This ESU consists of silty, poorly graded sand (SM to SP-SM) sand to a depth of approximately 7 to 16 feet bgs. The soils appeared to be brown, fine to medium grained, and poorly graded sand with a variable amount of silt. Based on observations taken during test pit excavation, fill sand generally has a loose to medium dense relative density. Groundwater table fluctuations are rarely expected to rise above the base of this ESU; however, this layer frequently appeared saturated in our explorations at depths greater than approximately 4 to 5 feet bgs, which we attribute to locally perched water conditions.

3.2.2 ESU 2 – Very Soft Silt (Overbank Deposits)

This ESU underlies the ESU 1 layer. This ESU consists of interbedded low plasticity clay (CL), silt (ML), and sandy silt to silty sand (SM) extending to depths varying between approximately 40 and 50 feet bgs. We performed soil index testing on undisturbed soil samples from this ESU taken between depths of 7.5 and 42 feet bgs. The plasticity index of samples within this ESU ranges from 0 to 52 with an average value of 17 and a standard deviation of 13. The water content (w_c) ranges from 33 to 83 percent with an average value of 51 percent and standard deviation of 12 percent. The liquid limit (LL) of the soil samples ranges from 0 to 103 (average value of 47) resulting in a w_c/LL value ranging from 0.8 to 1.2 (average value 1.0). According to the Bray and Sancio (2006) criteria, 64 percent of the tested soil samples are classified as susceptible to moderately susceptible to strength loss during cyclic loading and the other 36 percent of the tested soil samples are classified as non-susceptible. A minor amount of organic material was observed in these deposits, with organic content measured by loss on ignition ranging from 2 to 6 percent of the soil unit by mass.

No standard penetration test (SPT) blow counts (N-values) were measured in this ESU because the SPT sampler pushed into the soil due to the weight of hammer (equivalent to 0 blows per foot [bpf]). Field-collected pocket penetrometer readings ranged from 0 to 0.75 tons per square foot. This ESU is considered to be relatively weak and susceptible to liquefaction where saturated below the groundwater table.

3.2.3 ESU 3 – Medium Dense to Dense Sand (Columbia River Sand)

Underlying ESU 2, this ESU consists of fully saturated, poorly graded, micaceous, clean sand with traces of silt (SP to SP-SM) with fines contents ranging from 5 to 23 percent. SPT blow counts (N-values) in this ESU varied from 10 to 48 bpf indicating loose to dense, though typically medium dense to dense, relative density. Based on the normalized penetration resistance value (q_{c1N}) the clean-sand deposit is liquefiable (q_{c1N} <150) from a depth of 40 feet to a depth of at least 135 feet bgs (as observed at SCPT-5). We estimate the *in-situ* relative density (D_R) of this ESU ranges from 40 to 58 percent (loose to medium dense sand). For modeling purposes, we distinguish this ESU into three subgroups, namely ESU 3a (27 to 59 feet bgs), ESU 3b (59 to 97 feet bgs), and ESU 3c (greater than 97 feet bgs) to account for increasing relative density with depth. Each of the ESU 3 soils are considered to be relatively weak and susceptible to liquefaction and/or seismic strength loss.

This unit extends to depths of at least 150 feet bgs based on our exploration data, and likely terminates at a depth of approximately 180 feet bgs based on geophysical test results as described in the Geotechnical Data Report (Haley & Aldrich, 2023b). This unit is likely underlain by Troutdale Formation materials, followed by basalt bedrock at great depth.

3.2.4 Engineering Properties of ESUs

Estimated engineering soil properties for the three ESUs are provided in Table 1, Design Soil Profile, and Table 2, General Soil Properties. Table 1 indicates the name of the ESU, its general depth range, and representative $N1_{60}$ values, and Table 2 provides general engineering soil properties used in our analyses. Determination of these material properties were based on SPT relationships described in Bowles (1977) and our engineering judgement. Liquefied residual strength ratios and friction angles used for analysis of liquefiable conditions were generated from correlations by Robertson and Cabal (2010).

Table 1. Design Soil Profile

Soil Unit	Description	Typical Depths (Elevation[1]) (feet)	Average $N1_{60}$ (blows/foot)
ESU 1	Loose to Medium Dense Sand and Sandy Silt	0 to 16 (22 to 6)	15[2]
ESU 2	Very Soft Silt	16 to 27 (6 to –5)	0

Table 1. Design Soil Profile			
Soil Unit	**Description**	**Typical Depths (Elevation[1]) (feet)**	**Average $N1_{60}$ (blows/foot)**
ESU 3a	Medium Dense Interbedded Sand and Silt	27 to 59 (–5 to –37)	10
ESU 3b	Medium Dense Columbia River Sand	59 to 97 (–37 to –75)	21
ESU 3c	Medium Dense to Dense Columbia River Sand	97+ (-75 +)	26

Notes:

1. *The reference/assumed ground elevation at the site is 22 feet NAVD88.*
2. *SPT blow counts from this unit are not available due to "soft" digging during explorations. $N1_{60}$ is based on correlations with dynamic cone penetrometer tests.*

Table 2. General Soil Properties					
Parameter	**ESU 1**	**ESU 2**	**ESU 3a**	**ESU 3b**	**ESU 3c**
Total Unit Weight (pcf[a])	112	105	115	120	120
Friction Angle, ϕ' (degrees)	32	30	35	36	36
Liquefied Residual Shear Strength Ratio[1], s_r/σ'_{v0}	0.63	0.29	0.12	0.16	0.40
Liquefied Residual Friction Angle[1], ϕ'_r (degrees)	32	16	7	9	22

Notes:

1. *Liquefied Residual Shear Strength Ratio and Liquefied Residual Friction Angle values are provided for axial analyses and not intended for lateral pile analyses. Refer to Section 6.1.3 for lateral pile parameters.*

pcf = pounds per cubic foot

3.3 GROUNDWATER

Groundwater was encountered at depths ranging from approximately 5 to 14 feet bgs during our current and previous site explorations. Shallower measurements on the order of 5 to 7 feet bgs appear to represent a perched groundwater table within fill materials overlying the more fine-grained overbank deposits. Deeper groundwater level readings appear to be more indicative of the regional groundwater table. Cone penetration test pore pressure dissipation data collected during our current and previous site explorations indicate a regional groundwater level between approximately 10.5 to 14.5 feet bgs, as measured in June 2019 and February 2023. Historical groundwater elevations at the site reported by others were on the order of 8 to 10 feet mean sea level (MSL) in February 1999 (AGRA Earth & Environmental, Inc., 1999).

We anticipate that groundwater elevations will likely fluctuate over time based on the water level of the adjacent Columbia River. Fluctuations in groundwater levels may also occur due to variations in rainfall, temperature, seasons, and other factors. It is important that the contractor provide contingencies for addressing groundwater during construction on this project.

3.4 INFILTRATION TESTING

Three infiltration tests were conducted at the locations shown on Figure 2 labeled as IT-1, IT-2, and IT-3 in general accordance with the City of Portland's 2020 Stormwater Management Manual Section 2.3.2. Details surrounding the test procedure and collected infiltration data are presented in the Geotechnical Data Report (Haley & Aldrich, 2023b). Refer to Section 8.3, Infiltration Systems, of this report for a discussion of our findings and recommendations regarding the design of infiltration systems for this site.

4. Seismic Considerations

4.1 SEISMIC SETTING

Oregon is located near the contact between two large crustal tectonic plates. The Juan de Fuca Plate constitutes the floor of the Pacific Ocean off the northwestern coast of the United States and moves northeastward from its spreading ridge boundary with the Pacific Plate at an average rate of approximately 1.5 inches per year. As the Juan de Fuca Plate converges with continental North America, it subducts or dips below the North American Plate, forming a shallow, eastward-dipping contact interface. This boundary is referred to as the Cascadia Subduction Zone (CSZ) and is responsible for seismic activity in the western regions of Washington and Oregon. The CSZ gives rise to earthquakes associated with three types of source zones: subduction interface, subduction intraslab, and shallow crustal earthquakes.

The seismicity of the Pacific Northwest region is predominantly influenced by the CSZ. In this zone, the offshore Juan de Fuca Plate subducts beneath the continental North American Plate. Subduction zones typically exhibit three main types of earthquakes: crustal earthquakes, interface subduction earthquakes, and intraslab subduction earthquakes.

Intraslab and Interface Sources. A subduction zone is characterized by the interaction of a down-going oceanic plate, such as the Juan de Fuca Plate, and an overriding continental plate, such as the North American Plate. The displacement caused by the subduction of the Juan de Fuca Plate below the North American Plate does not generally manifest as slip between the two plates; rather, it is absorbed by compression of the North American Plate at the interface at relatively shallow depths. When the magnitude of the compression becomes large enough to overcome the stresses locking the plates together, the plates will suddenly rupture, causing an interface earthquake. Based on geologic and historical evidence, this compression is released about every 350 to 600 years on average in the form of magnitude 8.0 to 9.0 earthquakes.

The most recent CSZ interface event is thought to have occurred on 26 January 1700, based on paleoseismic evidence and historical records of an orphan tsunami along the Japanese coast (Atwater et al., 2005). Interface earthquakes (such as the 2011 magnitude 9.0 Tohoku earthquake in northern Japan) are some of the largest magnitude earthquakes on record. Characteristics of this type of earthquake may include very large ground accelerations, shaking durations in excess of 3 minutes, and particularly strong long-period ground motions, which may affect tall or long-period structures.

Intraslab earthquakes originate from a deeper zone of seismicity that is associated with bending and breaking of the subducting Juan de Fuca Plate. Intraslab earthquakes (such as the 2001 magnitude 7.0 Nisqually earthquake in west central Washington) occur at depths of 40 to 70 kilometers (130,000 to 230,000 feet) and can produce earthquakes with magnitudes greater than magnitude 7.0. Deep intraslab earthquakes tend to be felt over larger areas than shallower crustal events.

Crustal Sources. Shallow crustal faults are caused by cracking of the continental crust resulting from the stress that builds as the subduction zone plates remain locked together. Few surficial geologic traces exist of the shallow crustal faults in the Portland, Oregon area. The nearest series of known shallow crustal faults, including the Portland Hills Fault, East Bank Fault, Oatfield Fault, Lacamas Lake, and the Beaverton Fault Zone, have had their surface traces either eroded away or buried by ancient flood deposits, but have been mapped by seismic reflection and refraction studies and other geophysical methods. Therefore, less information is known about these faults than faults with distinct surface traces.

Crustal seismicity from known faults near the project site is generally dominated by the Portland Hills Fault, located approximately 6 miles from the project site. The Portland Hills, Oatfield, and East Bank faults run in a generally northwest-southeast direction through downtown Portland, and the Portland Hills Fault is generally believed to be capable of producing earthquake events with magnitude 7.0 or greater with a return period from 10,000 years to 20,000 years (Petersen et al., 2014). No estimates for the maximum expected earthquake magnitudes are available for the Beaverton Fault Zone and the Oatfield Fault (Peterson et. al., 2014); however, the East Bank Fault has a lower estimated slip rate and an expected maximum earthquake magnitude of 6.2. These faults and other crustal sources contribute significantly to the seismic hazard at all periods.

4.2 SEISMIC SITE CLASS

We determined the soil site class based on the foundation soil information following the guidelines of ASCE 7-16, as referenced by the current OSSC. The soil site class is determined by considering the soil characteristics and measured shear wave velocity data at the site up to a depth of 100 feet bgs. As presented in the Haley & Aldrich's Enhanced Seismic Design Considerations report (Haley & Aldrich, 2023a), the site is classified as seismic Site Class E, without accounting for the presence of liquefiable soils at the Project site. As a liquefaction hazard is determined to be present at the site, the site is classified as Site Class F and a site response analysis was completed.

4.3 DESIGN RESPONSE SPECTRA

A recommended surface response spectrum was developed based primarily on the results of the site response analysis, as discussed in Haley & Aldrich's Enhanced Seismic Design Considerations report (Haley & Aldrich, 2023a). The response spectrum is observed to be generally equal to or larger than the full ASCE 7-16 Chapter 21 code-based spectrum in the impulsive period range of interest. To facilitate design, the design earthquake (DE) spectrum is determined as 2/3 of the MCE_R spectrum. Tabular values for both the MCE_R and DE spectra are provided in Table 3. Additionally, the design acceleration parameters, S_{D1} and S_{DS}, are computed from the recommended design spectrum in accordance with Section 21.4 of ASCE 7-16. These design acceleration parameters are included in the notes section of Table 3. Refer to the Enhanced Seismic Design Considerations report for a full discussion of surface response spectrum development (Haley & Aldrich, 2023a).

Table 3. Recommended Surface Response Spectra

Period (seconds)	MCE_R (g)	DE (2/3 MCE_R) (g)
0.01	0.34	0.23
0.03	0.40	0.27
0.05	0.45	0.30
0.10	0.58	0.39
0.20	0.89	0.59
1.20	0.89	0.59
1.50	0.74	0.49

Table 3. Recommended Surface Response Spectra		
Period (seconds)	**MCE_R (g)**	**DE (2/3 MCE_R) (g)**
1.70	0.65	0.43
2.00	0.52	0.35
3.00	0.36	0.24
4.00	0.27	0.18
5.00	0.21	0.14
7.50	0.13	0.09
10.00	0.10	0.07

Note:
S_{DS} = 0.59g, S_{D1} = 0.74g

By utilizing the recommended design spectrum, along with the calculated design acceleration parameters, designers can appropriately incorporate the seismic loading considerations into the structural design process in accordance with ASCE 7-16 guidelines.

4.4 LIQUEFACTION

4.4.1 General

When cyclic loading occurs during an earthquake, the shaking can increase the pore pressure in loose to medium dense saturated sand and cause liquefaction. The rapid increase in pore water pressure reduces the effective normal stress between soil particles, resulting in the sudden loss of shear strength in the soil. Granular soils, which rely on interparticle friction for strength, are susceptible to liquefaction until the excess pore pressures can dissipate. Sand boils and flows observed at the ground surface after an earthquake are the result of excess pore pressures dissipating upwards, carrying soil particles with the draining water. In general, loose, saturated sand soils with low silt and clay contents are the most susceptible to liquefaction. Silty soils with low plasticity are moderately susceptible to liquefaction under relatively higher levels of ground shaking. For any soil type, the soil must be saturated for liquefaction to occur.

As presented in the Haley & Aldrich's Enhanced Seismic Design Considerations report (2023a), we performed simplified and more advanced two-dimensional (2D) numerical modeling to evaluate the liquefaction potential analysis of the site soils. Based on our analyses, we anticipate the saturated ESU 2 and ESU 3 soils are liquefiable to a depth of at least 150 feet bgs. The analyses estimate liquefaction-induced total vertical settlements at the site range from approximately 8 to 12 inches, with an average estimated total settlement of approximately 10 inches. An average estimated vertical settlement profile is presented as Figure 7, Estimated Vertical Seismic Settlement, and tabulated values for this profile are presented as Table 4, Tabulated Values for Estimated Liquefaction-Induced Vertical Settlement (attached). The recommended design liquefaction-induced differential settlement at the site can be taken as 5 inches over a distance of 50 feet, corresponding to about half of the estimated total seismic settlement.

4.4.2 Lateral Spreading

Lateral spreading commonly occurs on mildly sloping ground and involves lateral displacement caused by the accumulation of cyclic shear strain during earthquake. As the soil undergoes cyclic loading, excess pore pressure builds up, reducing the effective stress and gradually leading to a reduction in shear strength. This accumulation of shear strain ultimately results in permanent lateral deformation. Excessive lateral displacement resulting from lateral spreading can impact the fuel tank facility area by increasing the lateral force and displacement exerted on the tank foundation. Given the proximity of the project site to the Columbia River and the presence of liquefiable soil, we conducted an evaluation of the potential geotechnical impact on fuel tank facilities due to lateral deformation caused by liquefaction-induced lateral spreading during a design-level event. However, it is possible that the upslope geometry from the project site toward the levee may help reduce lateral displacement.

As presented in the Haley & Aldrich's Enhanced Seismic Design Considerations report (2023a), we used a free field 2D model to predict the behavior of the site under seismic loading. With respect to lateral deformation and spreading, seismic analyses performed on this model showed that the levee at the northern end of the PDX site experienced significant lateral deformation (more than 10 feet) due to high shear strain accumulation within the toe region. Considering a 2,475-year hazard level, the numerical model estimated that the existing fuel tank facilities area could experience lateral displacement, either toward the north or south direction, ranging from several inches to up to 6 feet, depending on the input ground motion selected; however, the average predicted lateral displacement using eleven input ground motions ranges from 18 inches at the northern end of the tank area to 32 inches at the southern end. Analyses indicate that the general trend for lateral spreading-induced movement is to the south in the direction away from the Columbia River, as topography at the site and in the surrounding area gently slopes towards the south.

4.4.3 Seismic Strength Loss

Our analyses, as presented in the Haley & Aldrich's Enhanced Seismic Design Considerations report (2023a), indicate site soils below the groundwater table will undergo liquefaction and cyclic softening and lose strength during the design level earthquake. This loss of strength was accounted for and factored into design parameters used in our global stability and foundation design analyses.

4.5 FAULT SURFACE RUPTURE

There are no mapped crustal faults are present at the site, with the closest known quaternary-age fault mapped approximately 5 miles to the southwest (Personius, 2019). Therefore, we consider the hazard from fault surface rupture at the site to be low, although unmapped or otherwise unknown faults may be present that could result in a higher hazard.

5. Discussion

Based on our review of subsurface information for the site, we have formulated geotechnical recommendations for use in project design. We offer the following general summary of our conclusions.

- Site soils generally consist of up to 7 feet of dredge sand fill overlying overbank deposits of Columbia River Sand Alluvium up to 50 feet bgs, which then overlies sand of the Columbia River Sand Aquifer to approximately 180 feet bgs. Shallow groundwater conditions are expected, with perched groundwater zones identified within the upper 5 feet bgs, and an estimated depth to the local groundwater table as shallow as about 10 to 12 feet bgs. Subsurface materials at the site to 180 feet are considered weak and susceptible to liquefaction and/or seismic strength loss where saturated.
- Near-surface soils may be prone to disturbance and loss of support under loading from heavy construction equipment such as pile drivers and cranes. Grading of working pads to support these loads should be expected. Wet soil grading methodologies may be appropriate for work during wet months.
- Due to presence of liquefaction and related hazards, there is a likelihood for excessive vertical and/or lateral movements of existing and proposed building foundations, utilities, and other site improvements. Proposed, critical, displacement-sensitive improvements should be designed to resist or account for these seismically induced ground movements. This could be achieved through support of proposed improvements on deep foundations designed to resist seismic loading. Shallow foundations may be considered for other cases. Ground improvement presents another viable alternative, though we understand the project team is not considering this approach at this time.
- Several existing structures on-site are supported on shallow foundations and may experience distress due to seismic ground deformations.
- Abrupt differential settlements may occur between improvements supported on deep foundations and those supported on shallow foundations and existing subgrade.

The remainder of this report presents our specific recommendations for foundations, pavements, drainage facilities, earthwork, and utilities.

6. Foundation Design Recommendations

This section of the report presents our conclusions and recommendations for the geotechnical aspects of design and construction of foundations for structures on the Project site. We have developed our recommendations based on our current understanding of the project and the subsurface conditions encountered by our explorations. We understand that the proposed fuel tanks, dike walls, operations building, truck offload and HCTS facility, and piping will all be above ground improvements supported on deep foundations. Non-critical improvements not designed per OSCC may potentially be supported on shallow foundations bearing on unimproved subgrade. Current designs do not include use of ground improvement for support of proposed improvements due to potential damage to existing facilities, though this approach is potentially feasible for this project.

If the nature or location of the facilities is different than we have assumed, we should be notified so we can change or confirm our recommendations.

6.1 DEEP FOUNDATIONS

6.1.1 General

Deep foundations are recommended for support of the proposed tank structures to mitigate the potential for large static total and differential settlements, to provide support for the proposed tanks under seismic shaking, and to supply resistance against seismic hazards including liquefaction-induced vertical settlements and lateral spreading.

In addition to conventional structure loads on the piles, additional soil-related loads will include seismically induced downdrag and lateral spreading forces. Deep foundations should be designed to resist a bearing capacity type failure while under downdrag caused by liquefaction-induced settlements. Lateral loads due to seismic lateral displacements of the ground, including the non-liquefied crust and deeper liquefied soils, will induce large moments and displacement in deep foundation elements. To support the structural and soil-related loads, we understand that pipe piles on the order of 18 inches in diameter are proposed.

Driven piles installed using vibratory methods or conventional drop hammers may induce development of elevated pore water pressures within the liquefiable soil layers at the site. This could lead to localized liquefaction occurring around each driven pile, resulting in significant ground settlements during construction. While the amount of settlement and the lateral distance from each pile to which the settlement will occur is not well understood, available analysis methods predict that settlements could be as high as several feet directly adjacent to the pile and may not taper out to less than 1 inch until a distance of several hundred feet from the pile is reached (Massarsch, 2004). These settlements may severely impact the performance of the existing buried pipelines and infrastructure at the site.

Where driving-induced settlements are a concern, piles may be installed using a torque-down method, which will greatly reduce the potential for pore water pressure buildup during installation.
Steel-encased torque-down piles perform similarly to conventional driven piles but are installed by screwing or torquing the pile into place using proprietary equipment, means, and methods. The piles are installed with a helical tip that allows the pile to advance through the subsurface through a combination of crowd pressure and torque. These piles are installed as full-displacement elements, similar to plugged

driven piles, causing soils surrounding the piles to densify during installation. Installation using this method also produces much less noise compared to conventional pile driving.

The recommendations provided in this section, including recommended pile capacities, apply to both conventional driven piles and those installed using a torque-down method.

6.1.2 Vertical Pile Resistance (Compressive and Uplift)

Vertical compressive loads to be supported by piles can be resisted by a combination of end bearing support at the tip (bottom) and side friction between the pile material and the soil along the axial length embedded into the bearing stratum. The ultimate uplift resistance of a pile is generally considered to be equal to the component of vertical resistance resulting from the friction of soil against the surface length embedded into the bearing stratum.

Our pile capacity analyses were conducted in general accordance with the methods contained in *Design and Construction of Driven Pile Foundations* (FHWA, 2016) using the computer program APile (ver. 2019.9.10) by Ensoft, Inc. We used the API RP2A method which is typically used for large diameter open-ended steel pipe piles bearing in cohesionless soil and relates soil density to a dimensionless bearing capacity factory, N_q.

The results of our vertical pile capacity analyses for 18-inch-diameter open-ended steel pipe piles are plotted on charts included on Figures 4 through 6. The charts show plots of ultimate resistance (capacity) versus length for various scenarios including static, liquefied, and post-liquefied conditions. These capacities are unfactored and appropriate resistance factors or factors of safety should be applied to the values. See Section 6.1.5.3, Quality Assurance/Quality Control (QA/QC) and Resistance Factors, for additional recommendations on this subject. We recommend that we work closely with the design team to discuss these factors depending upon the design methodology used.

For the liquefied condition, we recommend that bearing resistance be ignored within the upper 60 feet bgs to account for full liquefaction within the ESU 2 and 3a layers, as shown on Figure 5, 18-Inch-Diameter Pile Capacities Liquefied Condition. Portions of deep foundations embedded at depths greater than 60 feet bgs may gain support as shown on Figure 5, as soils at these depths are expected to undergo only partial liquefaction (see Enhanced Seismic Design Considerations report).

We recommend that design for the Extreme Event loading condition be performed considering the effects of post-seismic downdrag following the methodology presented for liquefaction-induced downdrag presented by Caltrans (2020), with minor modifications to account for increased settlement tolerances (between approximately 3 and 4 inches) for the proposed structures. The Caltrans methodology presents a settlement-based approach to determining minimum pile lengths to satisfy the axial bearing stability; however, it is acceptable to modify the analysis to account for increased settlement tolerances as applicable to the relevant site. The settlement profile presented on Figure 7, Estimated Vertical Seismic Settlement, should be used for determining ground settlements for this procedure. The strength of resettled liquefied soils may be taken as 50 percent of the static strength from 0 to 60 feet bgs. The full static strength should be used at depths greater than 60 feet bgs, based on the reduced Ru-max values in ESU 3b and 3c, indicating only partial liquefaction in these units (see Enhanced Seismic Design Considerations report). The axial loads corresponding to these recommendations are depicted graphically on Figure 6, 18-Inch-Diameter Pile Capacities Post-Liquefied Condition.

6.1.3 Lateral Deep Foundation Capacity

Lateral loads on the deep foundations are resisted primarily by the horizontal bearing support of near-surface soils adjacent to the pile. The lateral capacity of a pile depends on its length, stiffness in the direction of loading, and degree of fixity at the head, as well as on the engineering properties of the soils. The design lateral capacity of the deep foundations will depend largely on the allowable lateral deflection, shear, and moment of the shafts.

We performed analyses of the lateral capacity of the deep foundations completed using the 2D commercial code LPile 2019 by Ensoft, Inc. The LPile software computes deflection, shear, bending moment, and soil response due to lateral loads with respect to depth under several types of shaft-head loading conditions.

Table 5 shows recommended input parameters for performing LPile analyses for deep foundations.

Table 5. LPile Parameters for Analysis of Deep Foundations

Parameter	Engineering Soil Unit (ESU)				
	ESU 1	ESU 2	ESU 3a	ESU 3b	ESU 3c
Elevation (ft)	22 to 6	6 to –5	–5 to –37	–37 to –75	–75+
Static p-y Curve Type	API Sand	API Sand	API Sand	API Sand	API Sand
Static p-y Modulus, k (pci)	102	34.6	85.7	96.6	96.6
Static Friction Angle (°)	32	30	35	36	36
Liquefied p-y Curve Type	API Sand	Soft Clay (Matlock)	API Sand	API Sand	API Sand
Liquefied p-y Modulus, k (pci)	102	n/a	85.7	96.6	96.6
Liquefied p-multiplier[1]	--	--	0.10	0.60	0.72
Liquefied Friction Angle (°)	32	n/a	35	36	36
Undrained Shear Strength at Top of Layer (psf)	n/a	520	n/a	n/a	n/a
Undrained Shear Strength at Bottom of Layer (psf)		655			
Liquefied Strain Factor, ε_{50}	n/a	0.05	n/a	n/a	n/a
Effective Unit Weight (psf)	112 / 49.6[2]	42.6	52.6	57.6	57.6

Note:

1. *Lateral group p-multipliers should be combined with the liquefied p-multipliers as appropriate based on pile spacing.*
2. *Lower effective unit weight should be used for portions of ESU 1 beneath the design water table elevation of 10 feet.*

The proposed deep foundations supporting the structures and improvements will be subjected to large lateral displacements in the extreme limit state due to liquefaction-induced lateral spreading.
A relationship of average lateral displacements versus depth was developed as a result of 2D numerical model analyses, as summarized in our report on Enhanced Seismic Design Considerations (Haley &

Aldrich, 2023a). This lateral displacement will induce deflection and loading on the piles, which should be incorporated into lateral pile design. Recommended lateral displacement profiles for the northern, middle, and southern ends of the proposed facility are presented as Figure 8, Estimated Lateral Seismic Displacements.

6.1.4 Pile Corrosion Considerations

A suite of tests was completed as part of prior geotechnical work at the site (Hart Crowser, 2020) to evaluate the corrosion potential of the site soils. The results of the laboratory tests are provided within the Geotechnical Design Report (Haley & Aldrich, 2023b).

Based on the laboratory test results and comparisons to standards in the Ductile Iron Pipe Research Association (2006), we conclude that there is a low risk of corrosion to steel, iron, and concrete within the on-site fine- and coarse-grained soils. Additionally, the Soil Survey (USDA, 2023) indicates that there is a low risk of corrosion for both uncoated steel and concrete.

Based on the laboratory testing and guidance from the above documents, we consider it prudent to follow the guidelines set forth in Section 1.26.5 of Oregon Department of Transportation *Bridge Design Manual* (ODOT; 2020) for general corrosion protection measures due to the relatively low corrosive environment, which estimates an annual loss of steel of 0.001 inches/year. For open-ended piles, this loss of steel should be assumed to occur on the inside and outside of the pile (e.g., double the loss), whereas closed-ended piles only need to assume material loss on the pile exterior. ODOT (2020) indicates that corrosion can be controlled by relatively simple means, such as thicker walls or galvanizing steel. Use of Type I or II Portland cement for concrete is allowable.

6.1.5 Pile Installation Considerations

6.1.5.1 Driven Piles

We understand that driven piles, while feasible for use at this site, have the potential for inducing large settlements during pile driving, as described in Section 6.1.1. Should the design team elect to use driven piles, a pre-production indicator pile program with vibration and settlement monitoring should be formulated to establish action limits and strategies to mitigate excessive vibration and/or settlement.

Based on our explorations and experience with similar geologic units, excess pore pressure buildup is anticipated during pile installation using conventional driving. We recommend that after reaching the desired tip elevation under these conditions, piles should be allowed to “set up” for a minimum of 24 hours to allow for excess pore pressure dissipation. Following the set-up period, a restrike should occur and the restrike resistance should be verified in general accordance with Section 8.12.3 in the ODOT *Geotechnical Design Manual* (2023).

6.1.5.2 Torque-down Piles

Torque-down piles are typically installed using proprietary driving rigs capable of rotating closed-end pipe piles into place under variable crowd force. We recommend that the specialty contractor selected for this project provide a minimum of five references for previous installation of torque-down pile or equivalent type projects of similar length and diameter.

Deep foundations for this project are required to attain a minimum tip elevation to withstand seismic forces. Since torque-down piles are by necessity installed with closed-end tips without percussive force to hammer the piles into place, relatively dense soil conditions can cause torque-down piles to encounter refusal conditions; where driven open-ended piles would be able to advance. We recommend that the contractor independently assess the geotechnical data available for the site and attest to the capabilities of achieving minimum tip elevations using torque-down methods. Additionally, the contractor should propose a remedial action should an individual torque-down pile reach early refusal.

6.1.5.3 QA/QC and Resistance Factors

We recommend that a program of pile driving analysis be performed to verify the soil resistances and required depths of embedment, regardless of whether driven piles or torque-down piles are used. We recommend that load testing consist of static load testing for determination of compression and uplift resistances. Static load testing to determine lateral resistance may also be considered. Additionally, we recommend that at least 2 percent of production piles be tested using high-strain dynamic testing with signal matching (Pile Driving Analyzer® [PDA] and Case Pile Wave Analysis Program [CAPWAP]). Required driving resistances should include both anticipated structural loads and downdrag loads. Piles designed using this QA/QC approach may be designed using a Load and Resistance Factor Design resistance factor of as high as 0.80 for bearing resistance, and as high as 0.60 for uplift resistance, or an Allowable Stress Design factor of safety of 2.0 for uplift and compressive capacity.

6.2 SHALLOW FOUNDATIONS

6.2.1 General

Shallow foundations without ground improvement are generally not recommended for support of planned critical site improvements and those designed following OSSC, due to excessive predicted static and seismic settlements and lateral spread displacements. However, use of shallow foundations for support of improvements may be considered where the expected displacements have been accounted for in the facility design. Structures designed per OSSC must also meet the requirements of ASCE 7-16 Section 12.13. Shallow foundation systems should consist of elements structurally tied to each other, such as via a mat foundation system or via spread footings with grade beam ties.

Additionally, we understand that numerous existing, to-remain site improvements are supported on shallow foundations. Recommendations pertaining to new and existing shallow foundation supported structures and improvements are provided in this section.

6.2.2 New Shallow Foundations

Where shallow foundations are appropriate for support of select planned improvements, we recommend the following for design:

- Use a mat foundation or grid-style foundation to interlock all interior and perimeter footings. Use of isolated footings is not recommended.
- Design individual footings/strip footings for a maximum allowable bearing pressure of 1,500 psf. This represents a maximum pressure for any specific foundation element but does not consider consolidation settlements. The above bearing pressure values represent net bearing pressures; the weight of the footings and overlying backfill can be ignored in calculating footing sizes. The recommended allowable bearing pressures apply to the total of dead plus long-term live loads and may be increased by one-third for short term wind and seismic loads.

- Smaller structures (up to 75 kips total foundation load) supported on shallow foundations may experience about 2 inches of total static settlement due to consolidation of underlying compressible soils. This may result in about 1 inch of static differential settlement over a distance of 50 feet.
- Assume lateral ground displacement of 15 to 45 inches and vertical settlement of 8 to 12 inches as shown on Figures 7 and 8 for evaluation of ASCE-16, Section 12.13 criteria.

All shallow foundations should be underlain by 2 feet of medium dense granular material. This may consist of the on-site granular fill overlying the soft overbank deposits, imported structural fill, or a combination thereof.

6.2.2.1 Footing Dimension Recommendations

Structurally interconnected continuous wall footings and interior grade beams should be at least 18 and 12 inches wide, respectively. The bottom of exterior footings should be at least 18 inches below the adjacent finished exterior grade. Interior grade beams should be embedded at least 12 inches below the adjacent interior grade (e.g., base of slab).

6.2.2.2 Lateral Resistance

Lateral loads on footings can be resisted by passive earth pressures on the sides of footings and by friction on the bearing surface. We recommend that passive earth pressures be calculated using an equivalent fluid density of 250 pcf. We recommend using an ultimate friction coefficient of 0.30 for foundations placed on compacted, existing silty sand fill or 0.45 for foundations placed on an aggregate base subgrade. The passive earth pressure and friction components may be combined provided that the passive component does not exceed two-thirds of the total. The lateral resistance values do not include safety factors.

6.2.2.3 Uplift Resistance

Uplift forces on shallow foundations may be resisted using a combination of two methods. The first is to use the weight of the foundation element itself to resist uplift forces. Additionally, the weight of the overlying backfill soils may be used to assist in uplift resistance. Overlying soil weight may be calculated as a prism overlying the footing defined by a plane acting at 20 degrees from vertical extending from the upper perimeter of the foundation element. Assume the unit weight of the overlying soil is approximately 110 pcf.

6.2.2.4 Construction Considerations

Prior to the placement of reinforcing steel in the footing excavations, all loose or disturbed soils should be removed. If water infiltrates and pools in the excavation, the water, along with any disturbed soil, should be removed before placing the reinforcing steel. If construction is undertaken during periods of rain, we recommend that a concrete “rat slab” or “mud slab” or imported granular material be placed over the bases of footing excavations. The protective layer reduces subgrade disturbance from standing water and from foot traffic during forming and tying of reinforcing steel. Typically, 3 to 4 inches of concrete or granular material that is lightly compacted until well-keyed provides sufficient protection from disturbance.

6.2.3 Existing Shallow Foundations

Several existing site structures and equipment pads are reportedly supported on shallow mat foundations with bearing pressures on the order of 500 to 750 psf. These improvements include the following:

- Pump pad with footprint area of about 35 by 70 feet;
- Maintenance building with footprint area of about 20 by 25 feet;
- Testing lab with footprint area of about 10 by 30 feet;
- Generator pad with footprint area of about 20 by 30 feet;
- PDC with footprint area of about 30 by 45 feet; and
- Product tank with footprint area of about 10 by 35 feet.

These existing improvements are expected to experience large total vertical settlements averaging 8 to 12 inches resulting from liquefaction trigged by the design seismic event, with estimated vertical differential settlements averaging 5 inches over a distance of 50 feet. However, differential settlement equal to the total settlement (8 to 12 inches) should be anticipated between existing systems and proposed improvements supported on deep foundations. Seismic-induced lateral displacements averaging 15 to 45 inches are also anticipated and will result in lateral separation to varying degrees between existing and proposed improvements. These displacements should be considered in design.

6.3 BUILDING SLABS

We understand that nearly all new building slabs will be supported on deep foundations as opposed to slabs-on-grade. One slab adjacent to an existing hydrant pump pad will be supported on-grade. Building slabs, whether pile-supported on supported on-grade, may be constructed over new structural fills or native subgrade prepared in accordance with Section 9.0, Earthwork Recommendations, including reworking of the loose/soft surficial soils.

A minimum 6-inch-thick layer of aggregate base should be placed over the prepared subgrade to assist as a capillary break. Aggregate base material placed directly below the slab should be 3/4- to 1-inch maximum size. Flooring manufacturers often require vapor barriers to protect flooring and flooring adhesives. Many flooring manufacturers will warrant their product only if a vapor barrier is installed according to their recommendations. Selection and design of an appropriate vapor barrier, if needed, should be based on discussions among members of the design team.

6.3.1 Subdrainage Considerations

We generally recommend that slab-on-grade buildings with moisture sensitive interiors be constructed with a perimeter drain system to reduce the risk of future slab or below-grade wall moisture problems. Such intrusion may occur due to water perching in the near surface sands over the fine-grained overbank deposits or if the ground surface is not properly draining away from the building (e.g., trapped planters are present). Given the relatively flat grade and the presence of perched groundwater relatively close to ground surface in our explorations, the risk of water or moisture intrusion inside the building envelope is considered low to moderate. Provided that the surrounding ground surface is properly sloped away from the building (e.g., no trapped planters), a perimeter drainage system may be considered prudent but not required. However, the final decision whether to include a perimeter building drainage system should be based on what level of risk the owner and building designer is willing to accept.

Installation of perimeter drain system should consist of a minimum 2-foot-deep by 1-foot-wide trench filled with drainage material with a 4-inch-diameter perforated collection pipe. The drainage material should consist of a free draining, well-graded sand and gravel, such as ODOT Standard Specifications for Construction (OSS) Gravel Granular Drainage Blanket, Section 00360.11, with the additional criteria of containing less than 3 percentffines. All drainage pipes should be installed at least 1 foot beneath the adjacent floor slab subgrade and be sloped to drain away from the footings and be hydraulically connected to a suitable discharge outlet point. Cleanouts should be installed for maintenance purposes.

Roof and surface water runoff should not discharge into the perimeter drain system. Rather, these sources should discharge into separate tightline pipes and be routed away from the building to a storm drain or other appropriate location.

6.4 LIGHT POLE STRUCTURE FOUNDATIONS

We understand that luminaire structures will be constructed at various points around the site. We anticipate that these structures will typically be supported by square or round shafts that vary in diameter from 2.5 to 3 feet and in length from 6 to 11.5 feet, depending upon the configuration of the structure and soil strength. Design of luminaires is commonly controlled not by vertical capacity but by overturning and/or rotation of the pole. Due to the relatively short and wide nature of luminaire foundations, LPile analysis is generally not considered a valid method for design of luminaire foundations. Design of this type of foundation is more commonly performed using Broms method as presented in Design of Structural Supports for Highway Signs, Luminaires, and Traffic Signals (American Association for State Highway and Transportation Officials [AASHTO], 2011).

We understand that luminaire structures are not being designed to withstand the design seismic event. Recommendations provided in this section address static conditions only.

6.4.1 Lateral Capacity (Broms Method) Recommendations

The Broms Method outlined in AASHTO (2011) may be followed using the parameters listed in Table 6.

Table 6. Broms Method Soil Parameters

Parameter	Value
Effective Soil Unit Weight (γ') (above groundwater/below groundwater)	112 pcf/49.6 pcf
Soil Friction Angle (ϕ)	32
Lateral Bearing Coefficient (K_p)	3.3

Notes:

The values presented assume that the ground around the foundation is generally level (3H:1V or flatter)

Assume groundwater at a depth of 10 feet bgs.

A soil-to-foundation contact friction angle of 25 degrees may be used for torsional analysis.

6.4.2 Shaft Foundations

Shaft foundations may be designed using either a friction or end-bearing approach.

- **Friction-Based Design:** Vertical capacity may be derived by applying an allowable 250 psf skin friction in both the surficial sand and underlying overbank deposits for both compressive and uplift forces. Friction-based design should not be used for shaft foundations constructed using corrugated metal pipe or Sonotube forms below grade.
- **End-Bearing Based Design:** Vertical capacity may be derived using an end-bearing based approach using an allowable end bearing stress of 6 kips per square foot. If this approach is selected, shafts should be overdrilled a depth of 2 feet and 2 feet of stabilization material as defined in Section 9.5.4, Stabilization Material, should be placed at the base of the excavation prior to concrete placement.

6.4.3 Spread Footings

Alternatively, luminaires may be founded on shallow spread footings. Design for shallow foundations for luminaires should be performed using design parameters presented in Section 6.2, Shallow Foundations, of this report.

6.4.4 Construction Considerations

The bottoms of the drilled pier holes for luminaires should be free of debris and water before placing concrete. Concrete should be placed the same day the holes are drilled to limit relaxation of the supporting soil. As an alternative approach, concrete can be placed using tremie methods if water is present in the pier holes.

The sand layers at the site could cave during drilling. The contractor should plan for this condition and select the appropriate means and methods of drilling the pier holes and placing the reinforcing steel and concrete.

7. Pavement Design Recommendations

Paving for this project includes new flexible asphaltic concrete (AC) to be used for drive aisles and parking areas around the facility. Our design thicknesses assume that new pavements will be founded on the *in-situ* silty sand subgrade.

7.1 ASSUMPTIONS AND DESIGN PARAMETERS

We made the following assumptions regarding, and used the following parameters for, the design of the pavement.

- A 20-year design life of approximately 60,000 equivalent single-axle loads (ESALs). (These ESALs were calculated using ESAL factors provided in ODOT's Pavement Design Guide (ODOT, 2019) and traffic count values provided by Burns & McDonnell, as follows:
  - Tanker Truck (14k Gallons) – 2 per week
  - Ford F700 – 8 per day
  - Isuzu NPR – 8 per day
  - Ford F450 – 10 per day
  - Ford F150 – 15 per day
  - Utility Van – 15 per day
  - Vacuum Truck (5k Gallons) – 1 per week
  - Employee Vehicle – 20 per day
- A subgrade modulus of 10,000 pounds per square inch (psi) was assumed for a compacted *in-situ* fill subgrade.
- A resilient modulus of 20,000 psi was estimated for the base rock.
- Reliability and standard deviation of 85 and 0.45, respectively.
- Initial and terminal serviceability indices of 4.2 and 2.5, respectively.
- Structural coefficients of 0.42 and 0.10 for new asphalt and aggregate base layers, respectively.

7.2 PAVEMENT SECTION

Using the parameters provided above, we analyzed various pavement sections, including pavement constructed on *in-situ* fill material. If these or other assumptions are inaccurate, we should be contacted to develop updated recommendations. The recommended pavement section is provided in Table 7.

Table 7. Recommended Pavement Sections

Pavement Type	Pavement Thickness (inches)	Aggregate Base Thickness (inches)
Flexible Asphaltic Concrete	4	6
Aggregate Roadway	0	21

Notes:
1. *The aggregate base should be underlain by a separation geotextile unless pre-existing aggregate is exposed in the subgrade.*
2. *These values represent the minimum recommended material thicknesses.*

HALEY ALDRICH

7.3 PAVEMENT MATERIALS

7.3.1 Flexible Asphaltic Concrete

The AC should be Level 2, 12.5-millimeter, dense hot mix asphalt concrete according to OSS 00744, Minor Hot Mixed Asphalt Concrete Pavement.

The asphalt cement binder should be PG 64-22 Performance Grade Asphalt Cement. The minimum AC lift thickness for the base lift should be 2 inches. Subsequent lifts should be a minimum of 1.5 inches thick. The AC should be compacted to 91 percent of Rice Density of the mix, as determined in accordance with ASTM International (ASTM) D 2041.

7.3.2 Aggregate Base

Imported granular material used as base aggregate (base rock) should meet the criteria specified in Section 9.5, Structural Fill and Backfill, of this report. The base aggregate should be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D 1557. We recommend placement of a geotextile separation fabric beneath the aggregate base if the base is placed on existing sandy fill soils (as opposed to existing base rock). The geotextile should meet the specifications provided in OSS 02320.20, Geotextile Property Values, for soil separation. The geotextile should be installed in conformance with the specifications provided in OSS 00350, Geosynthetic Installation.

If the existing base rock that blankets the site is documented to be free of debris and other deleterious materials and is of sufficient thickness after site grading (at least 8 inches), the existing rock may be used to support new pavement. If sufficient rock thickness is not present, and if grades allow, additional rock can be placed atop the existing rock, otherwise the existing rock will need to be removed and new rock placed.

7.3.3 Subgrade

The pavement design assumes the soil subgrade consists of well compacted subgrade that has been stripped of organics. The subgrade should be compacted to a firm and unyielding condition and evaluated per the recommendations of Section 9, Earthwork Recommendations.

8. Drainage and Infiltration

8.1 TEMPORARY DRAINAGE

During demolition, stripping and mass grading at the site, the contractor should be made responsible for temporary drainage of surface water as necessary to prevent standing water and/or erosion at the working surface. During rough and finished grading of the building site, the contractor should keep all footing excavations, building pads, tank pads, and other subgrades free of water.

8.2 SURFACE DRAINAGE

The finished ground surface around buildings and tanks should be sloped away from the foundations at a minimum 2 percent gradient for a distance of at least 5 feet. Downspouts or roof scuppers should discharge into a storm drain system that carries the collected water to an appropriate stormwater system.

8.3 INFILTRATION SYSTEMS

The results of our field infiltration testing are described in the Geotechnical Data Report (Haley & Aldrich, 2023b). Infiltration rates in the near surface fill soils were found to be highly variable with silty fill materials having an infiltration rate of less than ¼ inches per hour, while sandy fill materials had an unfactored infiltration rate of approximately 10 to 20 inches per hour.

Perched groundwater was encountered in our explorations at depths as shallow as 5 feet bgs, corresponding to elevations of about 14.5 to 16.2 feet (North American Vertical Datum [NAVD] 88). These higher-elevation groundwater measurements likely represent zones of perched water, with the regional groundwater table at depths of approximately 10 to 12 feet bgs. Perched and regional groundwater could have a significant effect on design of stormwater disposal systems. Per the City of Portland 2020 Stormwater Management Manual, new surface infiltration facilities are required to have a minimum separation distance of 5 feet between the bottom of the facility and the seasonal high groundwater level unless otherwise approved by the City Bureau of Environmental Services.

Should surface infiltration features be permitted for use at the site, we recommend using a design unfactored infiltration rate of no greater than 10 inches per hour assuming that infiltration features encounter sandy fill materials. Due to extreme variability of infiltration rates in the fill, we recommend that supplemental field exploration be completed prior to completion of design to confirm soil conditions at the proposed locations of new infiltration systems, or that early in construction the soil conditions at proposed infiltration feature locations be assessed and that confirmation infiltration testing be conducted in the field during construction.

9. Earthwork Recommendations

We understand that mass grading across the site will generally be limited, with localized fill up to approximately 2 feet thick. All earthwork activities should be conducted in accordance with the OSS, particularly OSS 00330, Earthwork; OSS 00400,Drainage and Sewers; and OSS 02600, Aggregates, depending upon the application (ODOT, 2018).

9.1 DEMOLITION

Demolition should include complete removal of existing site improvements within areas to receive new pavements, structures, or engineered fill. Materials generated during demolition of existing improvements should be transported off-site for disposal or stockpiled in areas designated by the owner. In general, these materials will not be suitable for reuse as engineered fill. However, concrete, embankment fill, and base rock materials may be crushed and recycled for use as general fill. Such recycled materials should meet the specifications for imported granular material, as described in Section 9.5, Structural Fill and Backfill.

9.2 EXCAVATION

9.2.1 General

Excavations, shoring, and dewatering should be completed in accordance with the specifications provided in OSS 00330, Earthwork and OSS 00405, Trench Excavation, Bedding, and Backfill; the guidelines provided in Section 15.3.26, Temporary Shoring and Cut Slopes of the ODOT Geotechnical Design Manual (ODOT 2018); the City of Portland Standard Construction Specifications (Portland, 2020); and the City of Portland Stormwater Management Manual (Portland, 2020).

Site soils within expected excavation depths generally consist of sandy fill materials and silty alluvial materials. It is our opinion that conventional earthmoving equipment in proper working condition should be capable of making necessary general excavations. However, caving and/or sloughing conditions are likely to be present in the loose sands and soft silts.

The earthwork contractor should be responsible for providing equipment and following procedures as needed to excavate the site soils, as described in this report, while protecting the subgrade.

9.2.2 Temporary Open Cuts

Temporary soil cuts for site excavations that are more than 4 feet deep should be adequately sloped back to prevent sloughing and collapse, in accordance with Occupational Safety and Health Administration (OSHA) guidelines.

The stability and safety of cut slopes depend on a number of factors, including:

- Type and density of the soil;
- Presence and amount of groundwater seepage;
- Depth of cut;

- Proximity and magnitude of the cut to any surcharge loads, such as stockpiled material, traffic loads, or structures;
- Duration of the open excavation; and
- Care and methods used by the contractor.

Because of the variables involved, actual slope angles required for stability in temporary cut areas can only be estimated before construction. It is the responsibility of the contractor to ensure that the excavation is properly sloped or braced for worker protection, in accordance with OSHA guidelines. Most of the near-surface site soils generally consist of loose fill and very soft alluvial soils that would be classified as OSHA Class C for excavation purposes.

If site constraints do not allow proper excavation slopes for trenching, shoring may be used to support trench excavations. Shoring selection and design should be the responsibility of the contractor. If shored excavations are left open for extended periods of time, caving of the sidewalls may occur between the cut and shoring if voids between the shoring and cut are not filled. The presence of caved material will limit the ability to properly backfill cuts. The voids between box shoring and the sidewalls of cuts should be properly filled with sand or gravel before caving occurs. It should be the contractor's responsibility to employ trenching, excavation, and shoring methods that ensure proper compaction will be achieved and protect adjacent facilities.

9.3 SUBGRADE PREPARATION

The site should be rough graded to accommodate the proposed grading plan. In non-foundation areas that will receive new fills, building loads, and site improvements, such as pavements, sidewalks, and slabs, the exposed soil subgrade should be prepared by scarifying to a depth of at least 8 inches, moisture-conditioning to the optimum moisture content, and compacting to at least 90 percent relative compaction. In proposed building areas, subgrade preparation should extend at least 5 feet beyond the limits of the proposed building slabs and any adjoining flatwork. In exterior concrete slab and pavement areas, subgrade preparation should extend at least 2 feet beyond the limits of these improvements.

The near surface soils primarily consist of sands but include fine-grained layers that may be susceptible to disturbance during periods of wet weather. We recommend wet soil construction practices be implemented throughout construction. Wet soil construction practices include using equipment, such as smooth excavator buckets and tracked equipment, to limit subgrade disturbance. During wet weather or when the exposed subgrade is wet, the prepared subgrade should be evaluated by observing excavation activity and probing with a steel foundation probe. Observations and probing should be performed by Haley & Aldrich representatives.

Existing near-surface soils are not expected to provide a suitable working surface for heavy construction equipment including cranes and pile driving rigs, meaning that ground improvement or grading of a working platform will be required. Design of the working platform should be the responsibility of the contractor.

Outside of crane and pile driver working pad areas, the contractor may consider the use of granular haul roads and staging areas to reduce subgrade disturbance. Based on our experience, between 12 and 18 inches of imported granular material is generally required to provide stable staging and haul roads areas. However, the actual thickness will depend on the contractor's means and methods, and accordingly, should be the contractor's responsibility. Additionally, a geotextile separation fabric should be placed as a barrier between the subgrade and imported granular material in areas of repeated construction traffic. The granular material and geotextile separation fabric materials should conform to specifications provided in Section 9.5.4, Stabilization Material, of this report. If stabilized haul roads or staging areas are constructed, the contractor should verify if site restoration requirements require such features to be removed at the end of construction.

9.4 DEWATERING

Dewatering systems should be designed for the highest anticipated groundwater elevation during the construction period. Perched groundwater may be present as shallow as 5 feet bgs seasonally based on our explorations. These perched groundwater zones may produce a significant volume and flow rate of water into temporary excavations.

Construction of utilities that extend below groundwater will require dewatering or water control systems. Groundwater seepage rates into excavations may vary across the site, with high flow rates possible in areas with more granular soil layers. Pumping from sumps may only be effective in removing water from localized sections of trenches and open excavations. If excavations extend more than a few feet below a groundwater level or expose large areas below the groundwater, then large volumes, possibly combined with relatively high flow rates of water should be expected, and the use of well points or a robust series of collection trenches and sumps may be required. (This is particularly true for excavations that extend into the regional water table, generally expected to be found at a depth of 10 feet below the existing ground surface).

We note that dewatering of excavations with sump pumps will not prevent or reduce the greater risk of trench wall caving, sloughing, or basal instability caused by seepage.

Excavation or hauling equipment should not track below the groundwater table without dewatering systems in place. Also, fills, topsoil, etc. should not be placed in ponded water. Therefore, dewatering points or trenches may be required to prevent water from ponding in excavations during construction. The contractor should be made responsible for temporary drainage of surface water and groundwater as necessary to prevent standing water and/or erosion at the working surface or in excavations.

9.5 STRUCTURAL FILL AND BACKFILL

Structural fill should include fill intended to support structures, such as buried structures or new buildings, or which exist within the influence zone of structures. Structural fill should only be placed over a subgrade that has been prepared in conformance with the prior sections of this report. A variety of material may be used as structural fill. However, all material used as structural fill should be free of debris, clay balls, roots, organic matter, frozen soil, man-made contaminants, particles with greatest dimension exceeding 4 inches, and other deleterious materials and should meet the appropriate specification provided in OSS 00330.12, Borrow Material; 00330.13, Selected General Backfill; or 00330.14, Selected Granular Backfill.

Fill and backfill materials should be placed and compacted in lifts with maximum uncompacted thicknesses and relative densities as recommended in the table in Section 9.6, Fill Placement and Compaction of this report.

9.5.1 On-Site Soils

On-site soils encountered at shallow depths in our explorations consist of dredge sand with variable silt content used for the original construction of the airport. This fill material can be used as borrow material, provided it is properly moisture conditioned, free of organics, and has oversize materials removed. If earthwork is completed during periods of wet weather, then the excavated soil intended for reuse should be protected with plastic sheeting or other methods employed to maintain suitable moisture content. Even with these measures, such soils may be difficult or impossible to use during wet weather of it is wet at the time of placement.

Below the fill materials, native soils are fine-grained, very soft and wet. These fine-grained soils will not be suitable for reuse as fill.

9.5.2 Imported Select Structural Fill

Imported granular material used as structural fill should be pit or quarry run rock, crushed rock, or crushed gravel and sand and should meet the specifications provided in OSS 00330.14, Selected Granular Backfill; 00330.15, Selected Stone Backfill; or 00330.16, Selected Stone Embankment. The imported granular material should also be angular, fairly well graded between coarse and fine material, have less than 5 percent by dry weight passing the United States (U.S.) Standard Number (No.) 200 Sieve, and have at least two mechanically fractured faces.

9.5.3 Aggregate Base/Base Rock

Imported granular material used as aggregate base (base rock) beneath pavements or structures should be clean, crushed rock or crushed gravel and sand that is fairly well graded between coarse and fine. The base aggregate should meet the specifications provided in OSS 02630.10, Dense Graded Base Aggregate, depending upon application, with the exception that the aggregate has less than 5 percent by dry weight passing a U.S. Standard No. 200 Sieve, and at least two mechanically fractured faces. For use beneath abutment wall footings, the aggregate base should have a maximum particle size of 1.5 inches, while for use beneath pavements and sidewalks or other slabs (if needed) should have a maximum particle size of 1 inch.

9.5.4 Stabilization Material

If imported granular material is used to create haul roads for construction traffic or is required for stabilization of the bases of excavations, we recommend that material consist of pit or quarry run rock or crushed rock. The material should generally be sized between 2 and 6 inches, have less than 5 percent by dry weight passing the U.S. Standard No. 4 Sieve, and have at least two mechanically fractured faces. The material should be free of organic matter and other deleterious material. Material meeting the specifications of OSS 00330.15 - Stone Backfill Material is acceptable for use, excepting recycled glass shall not be used.

A geotextile should be placed as a barrier between the native soil subgrade and the stabilization material. The stabilization material should be placed in conformance with the specifications provided in OSS 00331, Subgrade Stabilization. The geotextile should meet the specifications provided in OSS 02320.20, Geotextile Property Values for soil separation. The geotextile should be installed in conformance with the specifications provided in OSS 00350, Geosynthetic Installation.

Stabilization material should be placed in lifts between 12 and 18 inches thick and be compacted to a well-keyed condition with appropriate compaction equipment without using vibratory action.

9.5.5 Drain Rock

Drain rock used for subsurface drainage systems should meet the specifications provided in OSS 0430.11, Granular Drain Backfill Material. The drain rock should be wrapped in a geotextile fabric that meets the specifications provided in OSS 02320, Geosynthetics for Drainage Geotextiles.

9.6 FILL PLACEMENT AND COMPACTION

Structural fill should be placed and compacted in accordance with OSS 00330.43, Earthwork Compaction requirements and the following guidelines.

- Place fill and backfill on a prepared subgrade that consists of firm, inorganic on-site soils or approved structural fill.
- Place fill or backfill in uniform horizontal lifts with a thickness appropriate for the material type and compaction equipment. Table 8 provides general guidance for uncompacted lift thicknesses.
- Do not place fill and backfill until the required tests and evaluation of the underlying materials have been made and the appropriate approvals have been obtained.
- Limit the maximum particle size within the fill to two-thirds of the loose lift thickness.
- Control the moisture content of the fill to within 3 percent of the optimum moisture content based on laboratory modified Proctor tests. The optimum moisture content corresponds to the maximum attainable modified Proctor dry density.

During structural fill placement and compaction, a sufficient number of in-place density tests should be completed by Haley & Aldrich to verify that the specified degree of compaction is being achieved. For structural fill with more than 30 percent retained on the 3/4-inch sieve, proper compaction should be verified with a proof roll or other performance methods.

Table 8. Guidelines for Uncompacted Lift Thickness

Compaction Equipment	Native Soils	Granular and Crushed Rock Maximum Particle Size ≤ 1½ inch	Crushed Rock Maximum Particle Size > 1½ inch
Plate Compactors and Jumping Jacks	4 to 8	4 to 8	Not Recommended
Rubber-Tire Equipment	6 to 8	8 to 12	6 to 8
Light Roller	8 to 10	8 to 12	8 to 10
Heavy Roller	10 to 12	12 to 18	12 to 16
Hoe Pack Equipment	12 to 16	18 to 24	12 to 16

Note:

The above table is based on our experience and is intended to serve as a guideline. The information provided in this table should not be included in the project specifications.

10. Additional Geotechnical Services

Before construction begins, we recommend that we review the final design plans and specifications to verify the geotechnical engineering recommendations have been properly interpreted and implemented into the design.

During the construction phase of the project, we recommend that we be retained to review contractor submittals and conduct the following activities:

- Observe subgrade preparation for foundations and pavements;
- Observe deep foundation installation;
- Observe load testing of deep foundations and review GRL WEAP analysis results;
- Review or provide PDA/CAPWAP data;
- Review contractor submittals for pile driving, dewatering, materials, and other geotechnically relevant items;
- Observe construction of pavements; and
- Perform confirmatory infiltration testing.

The purpose of these observations and services is to note compliance with the design concepts, specifications, or recommendations, and to allow design changes or evaluation of appropriate construction measures in the event that subsurface conditions differ from those anticipated prior to the start of construction.

11. Limitations

This report has been prepared for specific application to the proposed construction as understood at this time. In the event that changes in the nature, design, or location of the project are planned, the conclusions and recommendations contained in this report should not be considered valid, unless the changes are reviewed by Haley & Aldrich and the conclusions of this report modified or verified in writing.

The geotechnical analyses and recommendations are based, in part, upon the data obtained from the referenced subsurface exploration. The nature and extent of variations between explorations may not become evident until construction. If variations appear at that time, it may be necessary to re-evaluate the recommendations of this report.

This report is prepared for the exclusive use of Burns & McDonnell, JH Kelly, and their consultants in pursuit of the proposed PDX Fuel Tank Design in Portland, Oregon. There are no intended beneficiaries other than Burns & McDonnell, JH Kelly, and their consultants. Haley & Aldrich shall owe no duty whatsoever to any other person or entity on account of the Agreement or the report. Use of this report by any person or entity other than Burns & McDonnell, JH Kelly, and their consultants for any purpose whatsoever is expressly forbidden unless such other person or entity obtains written authorization from Burns & McDonnell, JH Kelly, and Haley & Aldrich. Use of this report by such other person or entity without the written authorization of Burns & McDonnell, JH Kelly, and Haley & Aldrich shall be at such other person's or entity's sole risk and shall be without legal exposure or liability to Haley & Aldrich.

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

References

1. AGRA Earth & Environmental, Inc., 1999. *Geotechnical Engineering Report, Engine Run-Up Facility, Portland International Airport, Portland, Oregon*. Report 9-61M-10089-0, dated February 1999.

2. American Association for State Highway and Transportation Officials (AASHTO), 2011. *Design of Structural Supports for Highway Signs, Luminaries, and Traffic Signals.*

3. American Society of Civil Engineers (ASCE)/Structural Engineering Institute, 2016. Minimum Design Loads for Buildings and Other Structures, ASCE 7-16.

4. Atwater, B.F, Satoko Musumi-Rokkaku, Kenji Satake, Yoshinobu Tsuji, Kazue Ueda, and David K. Yamaguchi, 2005. "The orphan tsunami of 1700—Japanese clues to a parent earthquake in North America." Professional Paper 1707. Geological Survey of Japan (National Institute of Advanced Industrial Science and Technology), the University of Tokyo, and the University of Washington.

5. Boulanger, R.W. and I.M. Idriss, 2014. *CPT and SPT Based Liquefaction Triggering Procedures*, University of California at Davis.

6. Bowles, J.E., 1977*. Foundation Analysis and Design*, McGraw-Hill, Inc., New York.

7. Bray, Jonathan D. and Sancio, Rodolfo B., 2006. "Assessment of the Liquefaction Susceptibility of Fine-Grained Soils." ASCE Journal of Geotechnical and Geoenvironmental Engineering, Volume 132, Issue 9.

8. Caltrans, 2020. Liquefaction-Induced Downdrag, Caltrans Geotechnical Manual. January 2020. https://dot.ca.gov/-/media/dot-media/programs/engineering/documents/geotechnical-services/202001-gm-downdrag-a11y.pdf.

9. Ductile Iron Pipe Research Association, 2006. The Design Decision Model for Corrosion Control of Ductile Iron Pipelines.

10. Ensoft, Inc. 2019. APile program, ver.2019.9.10.

11. Federal Highway Administration (FHWA) 2016. Design and Construction of Driven Pile Foundations, US Department of Transportation – FHWA, Publication FHWA-NHI-16-009, July.

12. Hart Crowser, 2020*. Revised Report of Geotechnical Engineering Services, PDX Fuel Facility Improvements, Portland, Oregon*. Project No. 154-118-001, dated 17 August.

13. Haley & Aldrich, Inc., 2023a. *Enhanced Seismic Design Considerations, PDX Fuel Tank Project, Portland International Airport, Portland, Oregon*. File No. 204679-001, dated 29 September.

14. Haley & Aldrich, Inc., 2023b. *Geotechnical Data Report, PDX Fuel Project Tank Design, Portland International Airport, Portland, Oregon*. Draft. File No. 204679-001, dated 21 July.

15. ICC, 2021. *2021 International Building Code*.

16. Massarsch, K.R., 2004. *Vibrations Caused by Pile Driving.* Deep Foundations, Summer.

17. Occupational Safety and Health Administration, 2023. “Section V: Chapter 2, Excavations: Hazard Recognition in Trenching and Shoring,” *Technical Manual*.

18. Oregon Department of Transportation (ODOT), 2018. *Oregon Standard Specifications for Construction*.

19. ODOT, 2019. *ODOT Pavement Design Guide*. January.

20. ODOT, 2020. *Bridge Design Manual*.

21. ODOT, 2023. *Geotechnical Design Manual*.

22. Oregon Structural Specialty Code (OSSC), 2019. *2019 Oregon Structural Specialty Code*, Building Codes Division, Department of Consumer and Business Services, State of Oregon.

23. Personius, S.F., compiler, 2019. Quaternary Fault and Fold Database of the United States, U.S. Geological Survey website: http://earthquakes.usgs.gov/regional/qfaults.

24. Petersen M. D., Moschetti M. P., Powers P., Mueller C. S., Haller K. M., Frankel A. D., Zeng Y., Rezaeian S., Harmsen S. C., Boyd O. L., Field N., Chen R., Rukstales K. S., Luco N., Wheeler R. L., Olsen A. H., 2014. Documentation for the 2014 National Seismic Hazard Maps U.S. Geological Survey Open-File Report, 2014-1091.

25. Portland (City of), 2020. “Chapter 2.3.6 – Infiltration and Soil Requirements,” *2020 Stormwater Management Manual*. https://www.portlandoregon.gov/bes/.

26. Portland (City of), 2020. City of Portland Standard Construction Specifications 2020. https://www.portland.gov/transportation/engineering/documents/2020-city-portland-standard-construction-specifications/download

27. Robertson, P.K., Cabal, K.I., 2010. *Guide to Cone Penetration Testing for Geotechnical Engineering*, 4th Edition, July.

28. U.S. Department of Agriculture, 2023. Web Soil Survey, http://websoilsurvey.sc.egov.usda.gov/.

\\haleyaldrich.com\share\pdx_data\Notebooks\0204679-001_PDX_Fuel_Project_Tank_Design\Deliverables In-Basket\Geotech Report - Final\2023_1218_PDX_FuelTankDesign_GeotechReport_F.docx

TABLE

TABLE 4

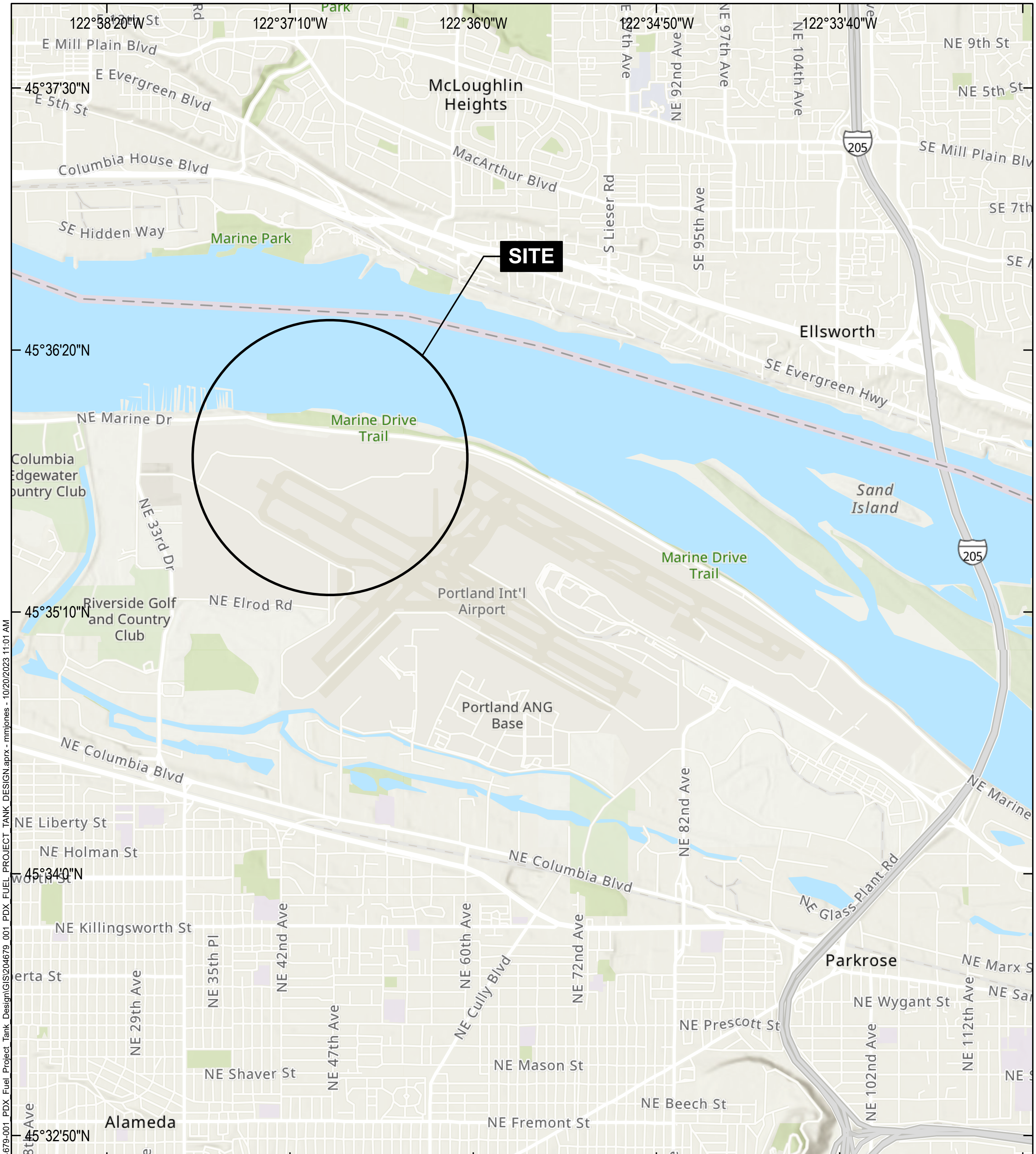
TABULATED VALUES FOR ESTIMATED LIQUEFACTION-INDUCED VERTICAL SOIL SETTLEMENT

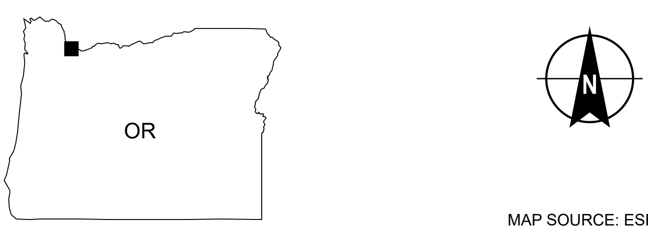
PDX Fuel Tank Design

Portland International Airport

Elevation (feet)	Settlement (inches)	Elevation (feet)	Settlement (inches)
21.3	10.2	-55.4	2.9
19.4	10.2	-57.2	2.8
17.5	10.1	-59.1	2.7
15.7	10.1	-61.0	2.7
13.8	10.1	-62.8	2.6
11.9	10.0	-64.7	2.5
10.1	10.0	-66.6	2.4
8.2	10.0	-68.4	2.3
6.3	9.9	-70.3	2.2
4.4	9.9	-72.2	2.0
2.6	9.8	-74.0	1.8
0.7	9.7	-75.9	1.7
-1.2	9.5	-77.8	1.6
-3.0	9.3	-79.6	1.5
-4.9	9.1	-81.5	1.5
-6.8	8.8	-83.4	1.4
-8.6	8.5	-85.3	1.4
-10.5	8.2	-87.1	1.3
-12.4	7.9	-89.0	1.3
-14.2	7.6	-90.9	1.2
-16.1	7.2	-92.7	1.2
-18.0	7.0	-94.6	1.2
-19.8	6.6	-96.5	1.1
-21.7	6.3	-98.3	1.1
-23.6	6.0	-100.2	1.0
-25.5	5.6	-102.1	1.0
-27.3	5.2	-103.9	0.9
-29.2	4.9	-105.8	0.9
-31.1	4.5	-107.7	0.8
-32.9	4.3	-109.6	0.7
-34.8	4.1	-111.4	0.7
-36.7	3.9	-113.3	0.6
-38.5	3.8	-115.2	0.6
-40.4	3.6	-117.0	0.5
-42.3	3.5	-118.9	0.5
-44.1	3.4	-120.8	0.4
-46.0	3.3	-122.6	0.4
-47.9	3.2	-124.5	0.3
-49.7	3.2	-126.4	0.3
-51.6	3.1	-128.2	0.2
-53.5	3.0	-130.1	0.2

FIGURES





MAP SOURCE: ESRI
SITE COORDINATES: 45°35'06"N, 122°35'39"W

HALEY ALDRICH

PDX FUEL TANK DESIGN
PORTLAND INTERNATIONAL AIRPORT
PORTLAND, OREGON

VICINITY MAP

APPROXIMATE SCALE: 1 IN = 1 MILE
OCTOBER 2023

FIGURE 1

GIS: \\haleyaldrich.com\share\pdx_data\Notebooks\0204679-001_PDX_Fuel_Project_Tank_Design\GIS\204679_001_PDX_FUEL_PROJECT_TANK_DESIGN.aprx - mmjones - 10/20/2023 11:01 AM

LEGEND

- CURRENT EXPLORATION (H&A, 2023)
- PREVIOUS EXPLORATION (GRI, 2017)
- PREVIOUS EXPLORATION (H&A, 2019)
- TEST PITS CURRENT EXPLORATION (H&A, 2023)
- CROSS SECTION
- BATHYMETRIC ELEVATION CONTOUR, 5-FT INTERVAL (NAVD 88)
- TOPOGRAPHIC ELEVATION CONTOUR, 5-FT INTERVAL (NAVD 88)

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. TOPOGRAPHY/BATHYMETRY SOURCE: US ARMY CORPS OF ENGINEERS, 2010.
3. AERIAL IMAGERY SOURCE: NEARMAP, 14 AUGUST 2022.
4. NORTH AMERICAN VCERTICAL DATUM OF 1988 (NAVD88)

N

0 800 1,600
SCALE IN FEET

HALEY ALDRICH

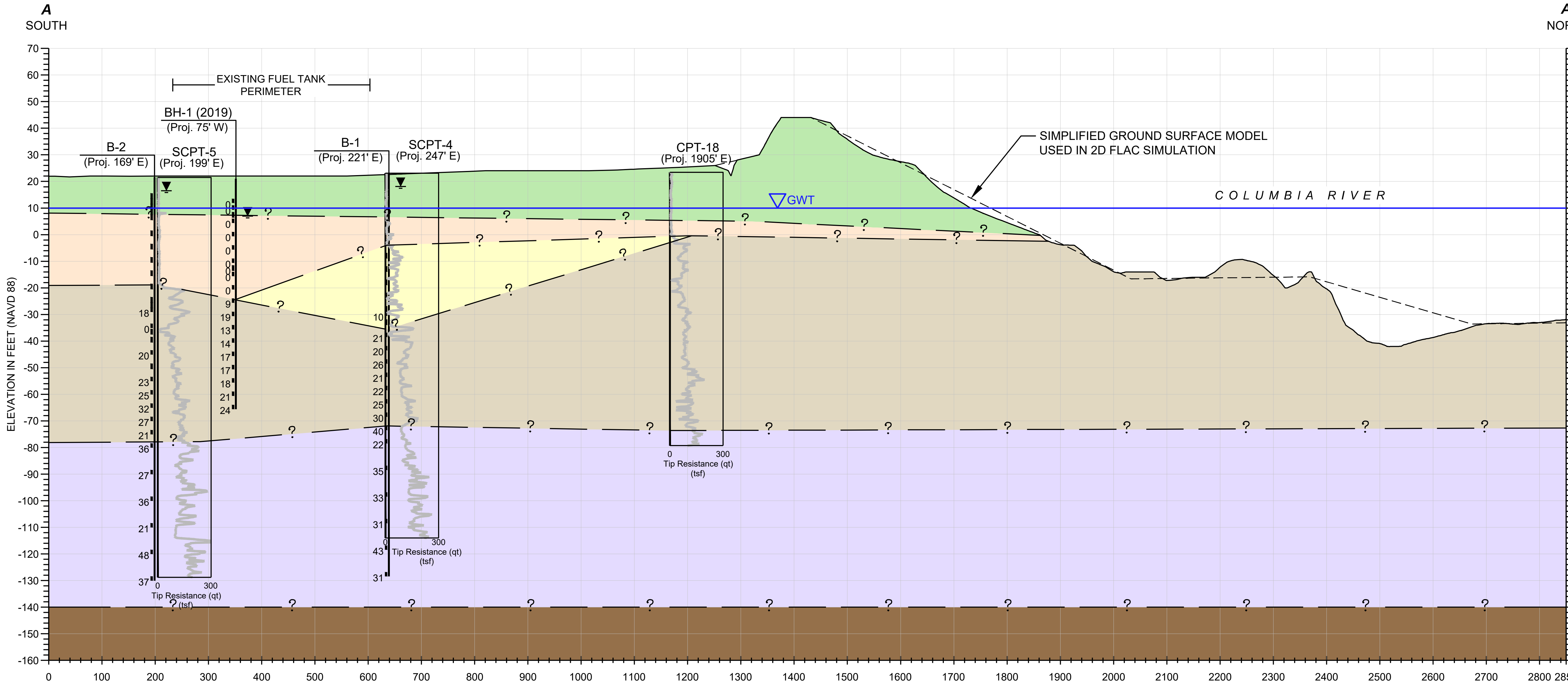
PDX FUEL TANK DESIGN
PORTLAND INTERNATIONAL AIRPORT
PORTLAND, OREGON

SITE PLAN

OCTOBER 2023

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\pdx_data\Notebooks\0204679-001_PDX_Fuel_Project_Tank_Design\GIS\204679_001_PDX_FUEL_PROJECT_TANK_DESIGN.aprx - USER: mmjones - LAST SAVED: 10/20/2023 10:53 AM



LEGEND

EXPLORATION

B-1
(Proj. 221' E)

STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT — 10, 21, 20

WATER LEVEL

USCS CLASSIFICATION — SP

T.D.= 151.5 — EXPLORATION DEPTH IN FEET

CPT EXPLORATION

CPT-18
(Proj. 1905' E)

0 300
Tip Resistance (qt)
(tsf)

ESU-1 - FILL & OVERBANK DEPOSIT (ABOVE G.W.T)

ESU-2 - OVERBANK DEPOSIT

ESU-3A - COLUMBIA RIVER SAND (DR =40%)

ESU-3B - COLUMBIA RIVER SAND (SP)(DR = 50%)

ESU-3C - COLUMBIA RIVER SAND (SP)(DR = 58%)

VERY DENSE SANDY GRAVEL (ELASTIC HALFSPACE VS = 1271 FT/SEC)

NOTES

1. CONTACTS BETWEEN SOIL UNITS ARE BASED UPON INTERPOLATION BETWEEN BORINGS AND REPRESENT OUR INTERPRETATION OF SUBSURFACE CONDITIONS BASED ON CURRENTLY AVAILABLE DATA.
2. PROFILE SURFACE CREATED FROM A DIGITAL ELEVATION MODEL (DEM) CREATED BY THE LOWER COLUMBIA ESTUARY PARTNERSHIP.

HORIZ. 0 200 400
VERT. 0 40 80
SCALE IN FEET

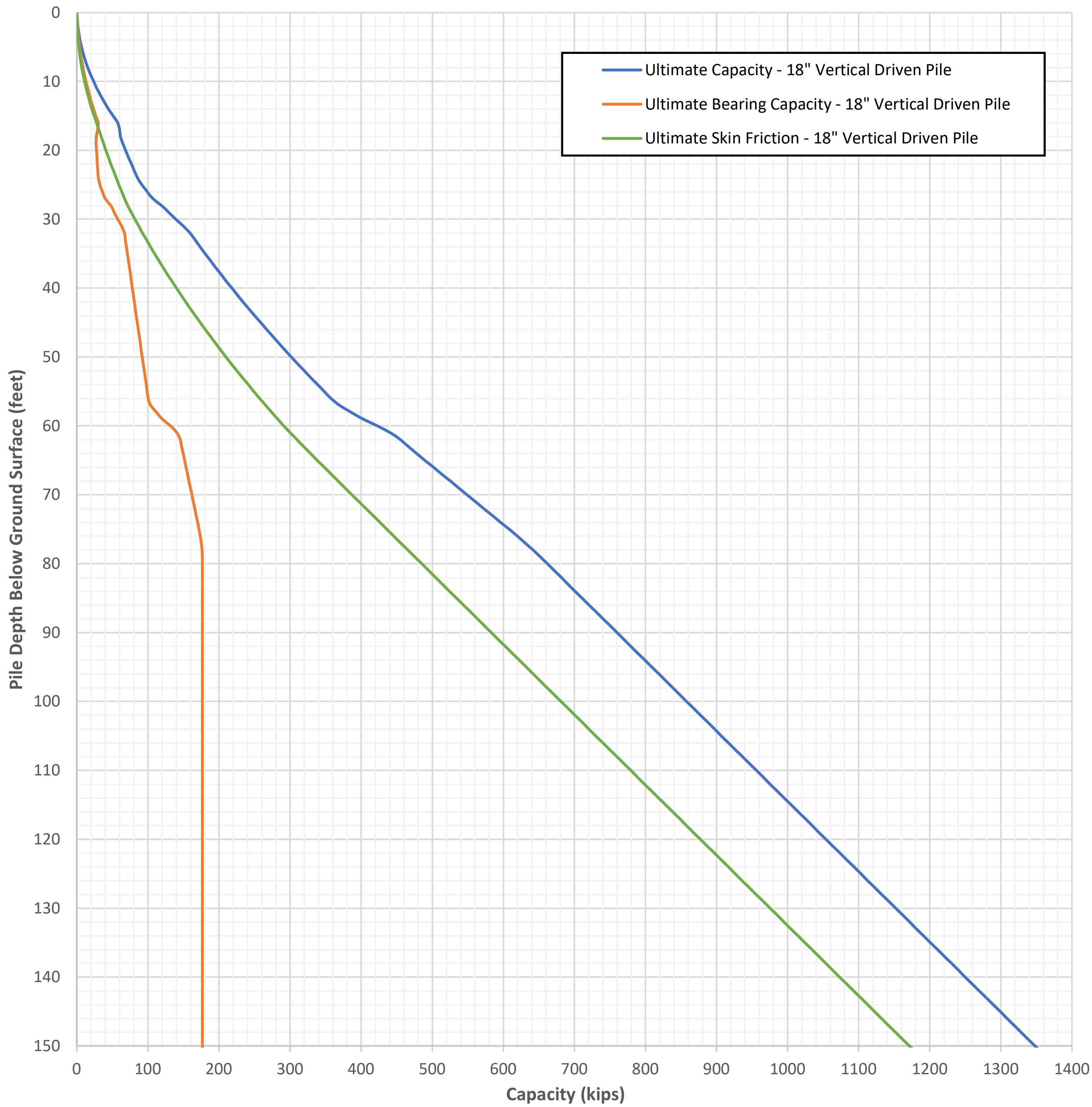
HALEY ALDRICH

PDX FUEL TANK - SEISMIC VULNERABILITY ASSESSMENT
PORTLAND INTERNATIONAL AIRPORT
5000 NE MARINE DRIVE
PORTLAND, OREGON 97218

SUBSURFACE CROSS SECTION A-A'

DECEMBER 2023

FIGURE 3



NOTES

1. PROVIDED CAPACITIES ARE ULTIMATE (UNFACTORED). DESIGNER IS RESPONSIBLE FOR APPLYING FACTORS OF SAFETY / RESISTANCE FACTORS APPROPRIATE FOR DESIGN METHOD.

2. END BEARING CAPACITY IS CALCULATED ASSUMING EITHER A PLUG IS FORMED (FOR DRIVEN OPEN-ENDED PIPE PILES) OR CLOSED-END CONDITIONS FOR TORQUE-DOWN PILES

3. RECOMMENDATIONS ARE FOR VERTICAL 18-INCH-DIAMETER STEEL PIPE PILES

4. GROUND SURFACE ELEVATION ASSUMED AS EL. 22 FT (NAVD88).

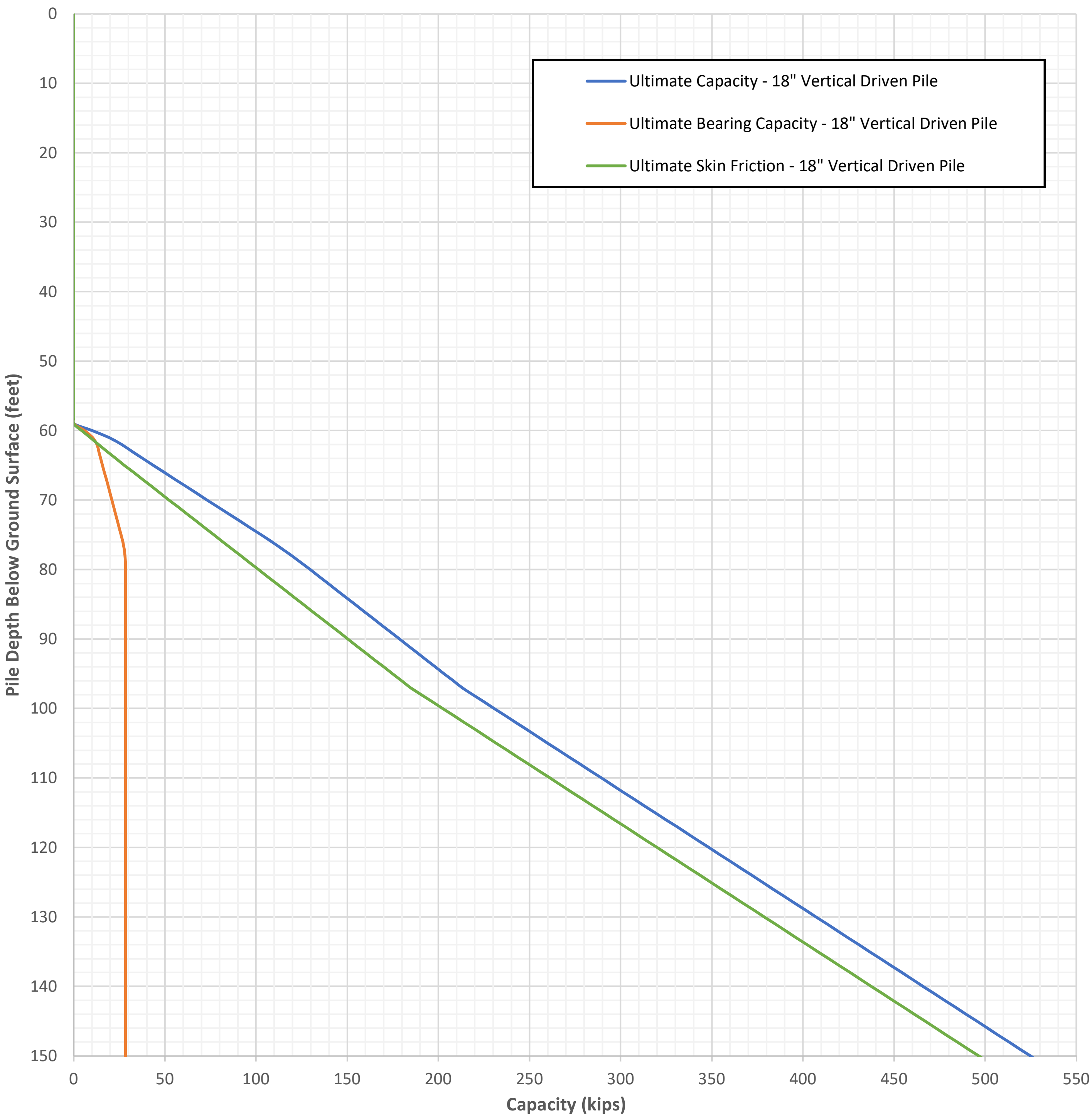
HALEY ALDRICH

PDX FUEL TANK DESIGN
PORTLAND INTERNATIONAL AIRPORT
PORTLAND, OREGON

18-INCH-DIAMETER PILE CAPACITIES
STATIC CONDITION

SCALE: AS SHOWN
DECEMBER 2023

FIGURE 4



NOTES

1. PROVIDED CAPACITIES ARE ULTIMATE (UNFACTORED). DESIGNER IS RESPONSIBLE FOR APPLYING FACTORS OF SAFETY / RESISTANCE FACTORS APPROPRIATE FOR DESIGN METHOD.

2. END BEARING CAPACITY IS CALCULATED ASSUMING EITHER A PLUG IS FORMED (FOR DRIVEN OPEN-ENDED PIPE PILES) OR CLOSED-END CONDITIONS FOR TORQUE-DOWN PILES

3. RECOMMENDATIONS ARE FOR VERTICAL 18-INCH-DIAMETER STEEL PIPE PILES

4. GROUND SURFACE ELEVATION ASSUMED AS EL. 22 FT (NAVD88).

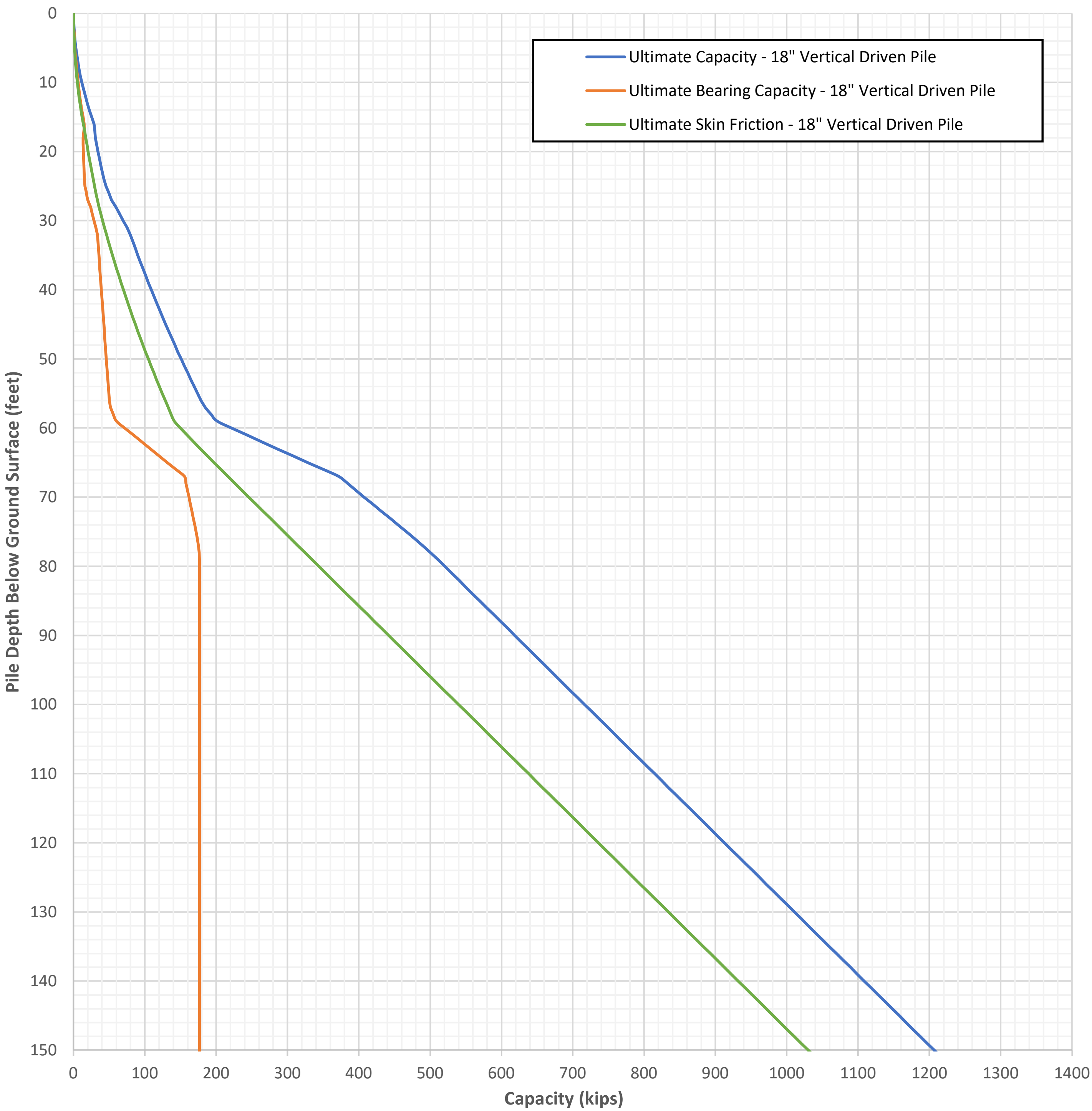
HALEY ALDRICH

PDX FUEL TANK DESIGN
PORTLAND INTERNATIONAL AIRPORT
PORTLAND, OREGON

18-INCH-DIAMETER PILE CAPACITIES
LIQUEFIED CONDITION

SCALE: AS SHOWN
DECEMBER 2023

FIGURE 5



NOTES

1. PROVIDED CAPACITIES ARE ULTIMATE (UNFACTORED). DESIGNER IS RESPONSIBLE FOR APPLYING FACTORS OF SAFETY / RESISTANCE FACTORS APPROPRIATE FOR DESIGN METHOD.

2. LIQUEFACTION-INDUCED DOWNDRAG ANALYSIS MUST BE PERFORMED WHEN USING VALUES ON THIS FIGURE. SEE REPORT SECTION 6.1.2.

3. END BEARING CAPACITY IS CALCULATED ASSUMING EITHER A PLUG IS FORMED (FOR DRIVEN OPEN-ENDED PIPE PILES) OR CLOSED-END CONDITIONS FOR TORQUE-DOWN PILES

4. RECOMMENDATIONS ARE FOR VERTICAL 18-INCH-DIAMETER STEEL PIPE PILES

5. GROUND SURFACE ELEVATION ASSUMED AS EL. 22 FT (NAVD88).

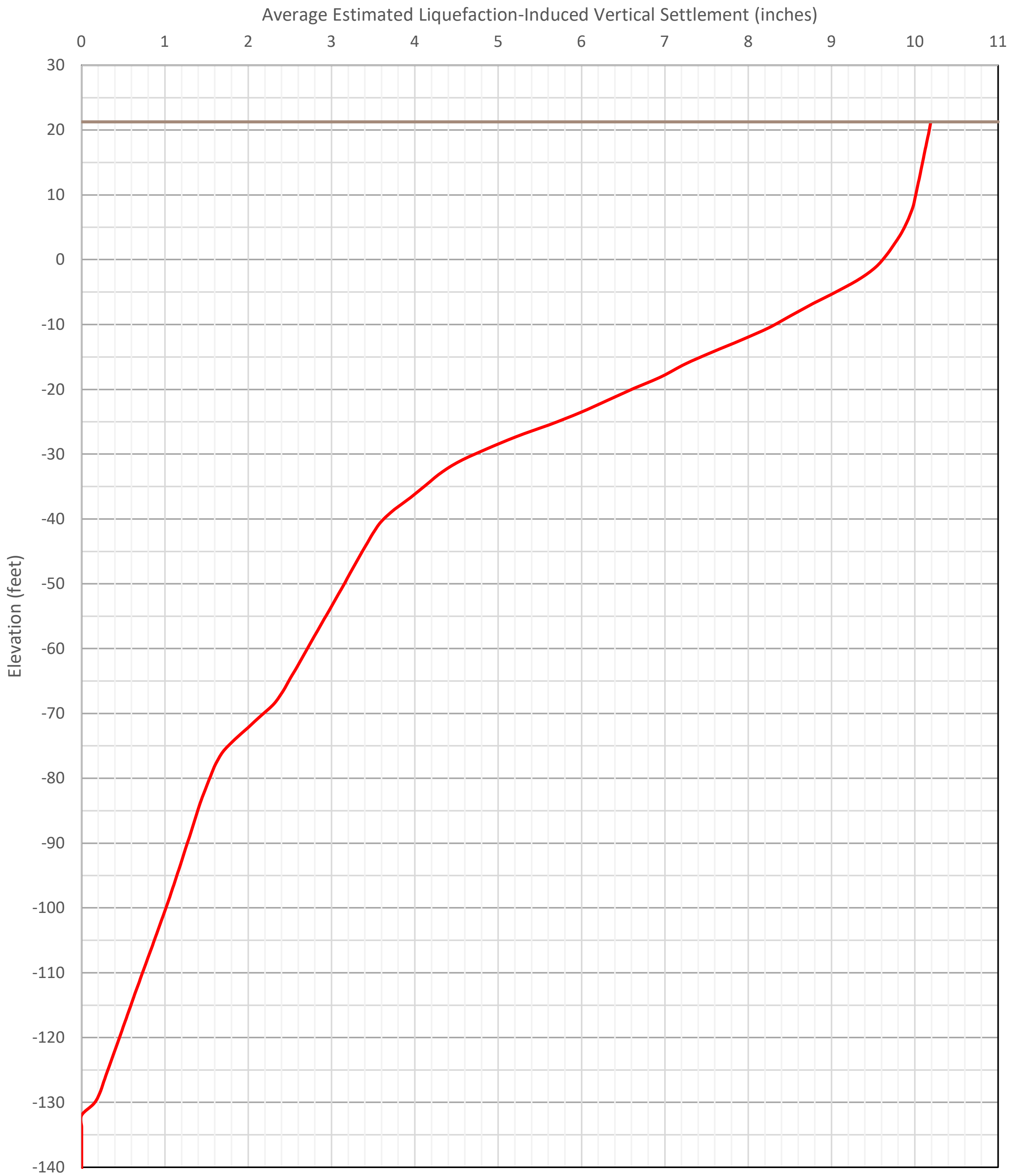
HALEY ALDRICH

PDX FUEL TANK DESIGN
PORTLAND INTERNATIONAL AIRPORT
PORTLAND, OREGON

18-INCH-DIAMETER PILE CAPACITIES
POST-LIQUEFIED CONDITION

SCALE: AS SHOWN
DECEMBER 2023

FIGURE 6



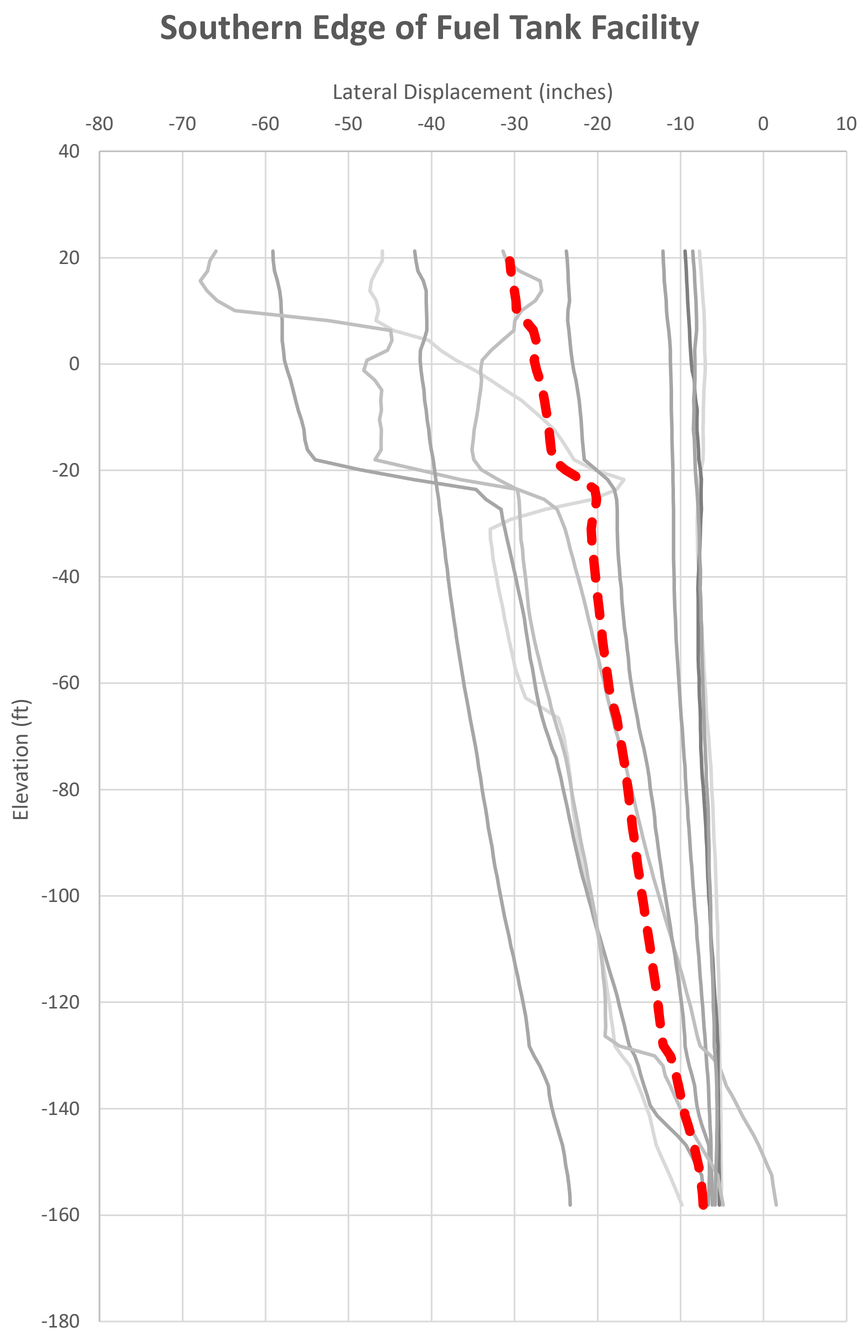
HALEY ALDRICH

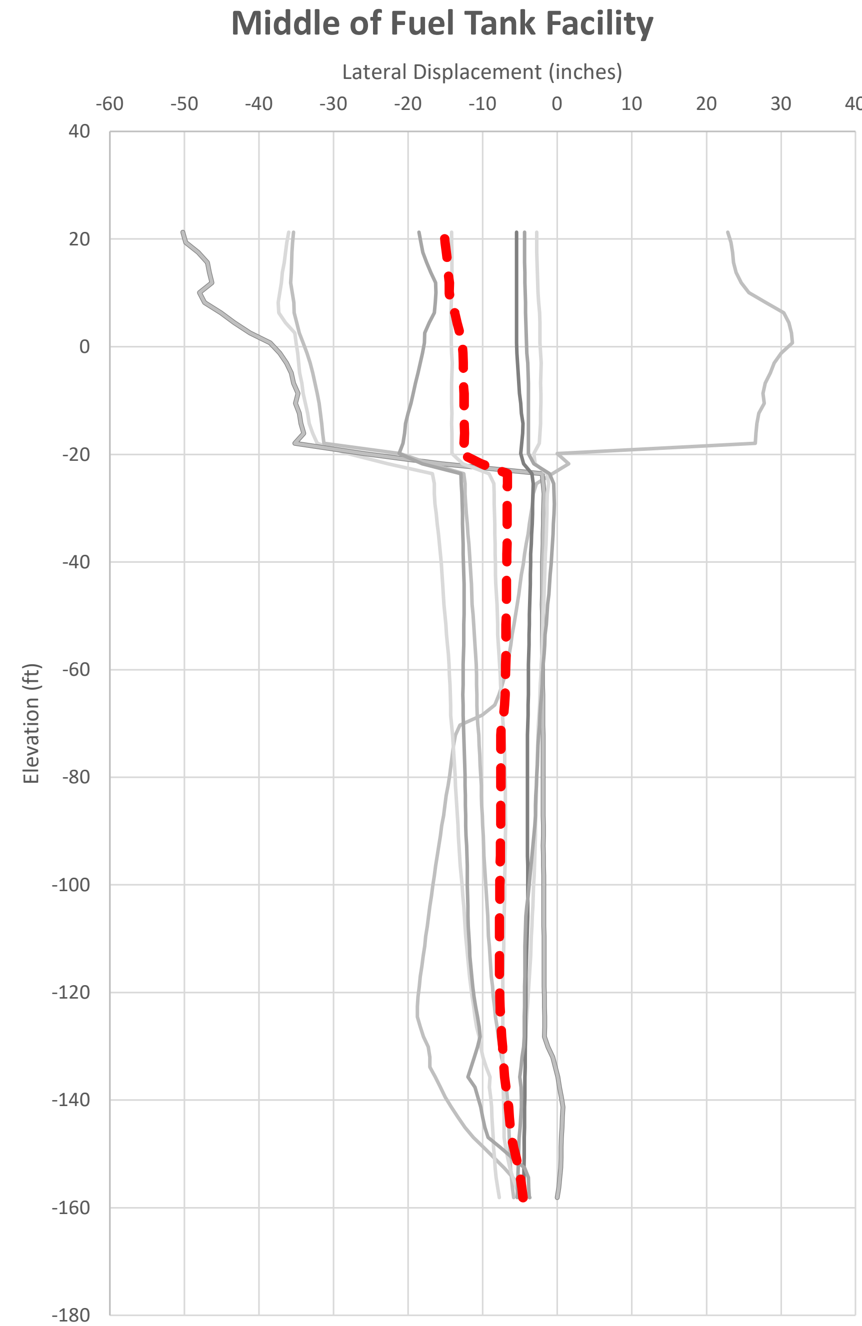
PDX FUEL TANK DESIGN
PORTLAND INTERNATIONAL AIRPORT
500 NE MARINE DRIVE
PORTLAND, OREGON 97218

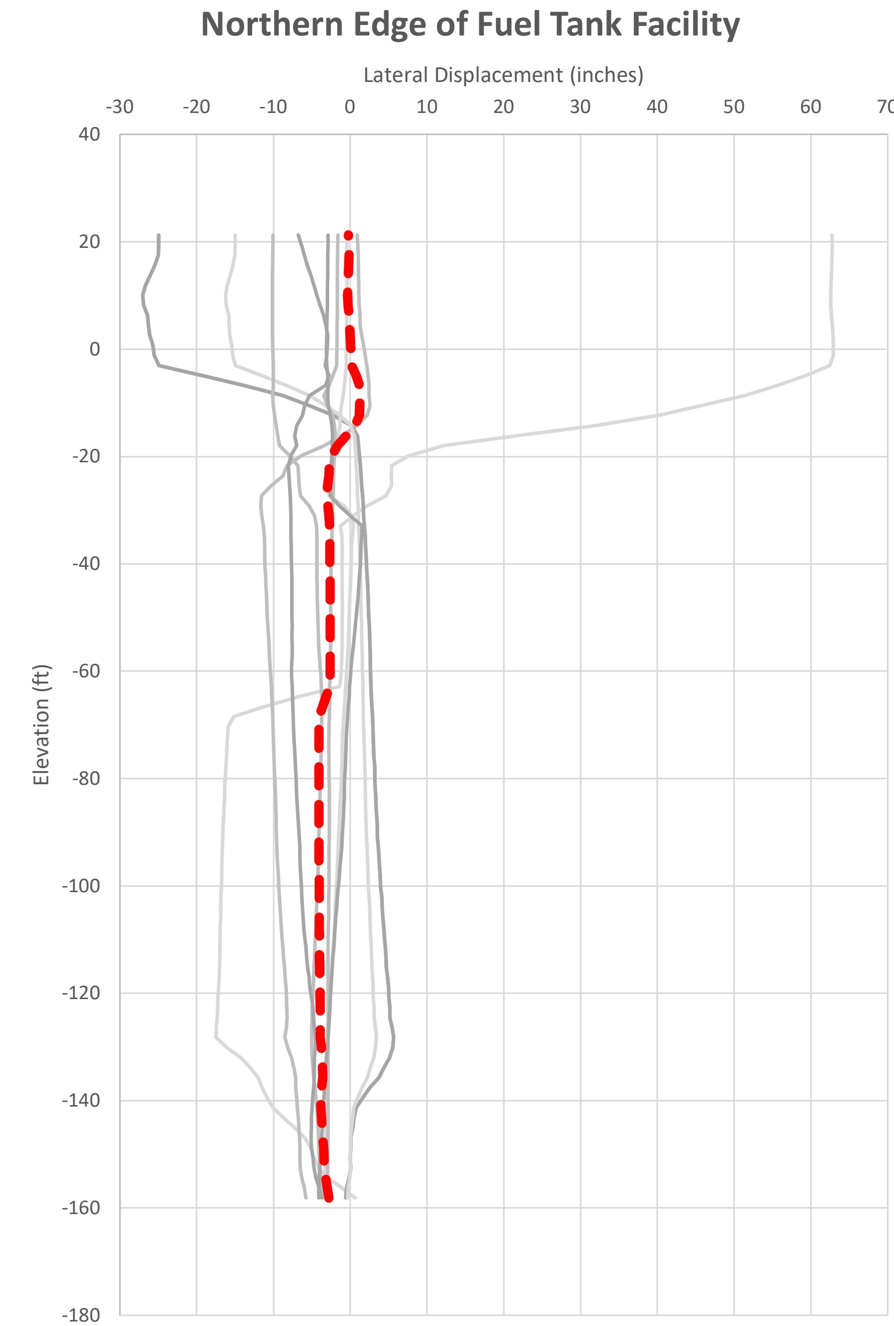
ESTIMATED VERTICAL SEISMIC SETTLEMENT

SCALE: AS SHOWN
DECEMBER 2023

FIGURE 7







LEGEND

- NGAsubRSN6001811_MET-EW
- RSN6887_DARFIELD_CBGSS01W
- NGAsubRSN4000035_522-NS
- RSN5478_IWATE_AKT023EW
- NGAsubRSN4000113_904-NS
- Recommended Design Average
- NGAsubRSN6001803_SLUC090
- NGAsubRSN4000040_527-NS
- RSN1197_CHICHI_CHY028-N
- NGAsubRSN2000001_OLY0086
- NGAsubRSN7006531_KAU080--E

HALEY ALDRICH

PDX FUEL TANK DESIGN
PORTLAND INTERNATIONAL AIRPORT
500 NE MARINE DRIVE
PORTLAND, OREGON 97218

ESTIMATED LATERAL SEISMIC DISPLACEMENTS

SCALE: AS SHOWN
DECEMBER 2023

FIGURE 8

\\haleyaldrich.com\share\pdx_data\Notebooks\0204679-001_PDX_Fuel_Project_Tank_Design\Analysis and Calcs\8 Deep Foundations\[2023_1025-Design_Lateral_Displacements.xlsx]PlotFig8 Tabular Average