St. Helens Riverwalk

Stormwater Drainage Report

Final Revised

Submitted to:

City of St. Helens
265 Strand Street
St. Helens, OR 97051

Prepared by:

Otak, Inc.
808 SW Third Avenue, Suite 800
Portland, OR 97204

January 24, 2024

Project No. 20028

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Section 1. Introduction

The St. Helens Riverwalk Phase 1 project includes pedestrian pathways, multiuse pavilion, and riverbank improvements in the existing Columbia View Park. Improvements will also extend approximately 150 feet into the Veneer Property directly south of the park. The one-acre site is located within tax lots 100 and 7500 of Columbia County Tax Map Section 3 Township 4N Range 1W. The stormwater management system for the project includes a StormFilter manhole, vegetated filterstrip and a flow through planter for water quality treatment, and a conveyance system that connects to an existing stormwater outfall to the Columbia River.

Vicinity Map

Existing Conditions

The approximately one-acre project is centered at Columbia View Park. The existing park and adjacent property are relatively flat and slope at 1% to 3% to the east. Along the eastern edge of the site the existing river bank slopes down at 1H:1.5V approximately 11 feet to ordinary high water (OHW) of the Columbia River.

Proposed Conditions

The project improvements at Columbia View Park include pedestrian paths and riverbank access improvements. From the existing amphitheater, the site will continue to slope downward to the east to a lawn that fronts the proposed multiuse pavilion. Runoff from this basin will be treated by a Stormfilter manhole. The playground and adjacent trails gently slope to a flow-through planter for water quality treatment. A seat wall will drain to a vegetated filterstrip for water quality treatment. Figure 1 shows the

proposed site layout and locations of each treatment facility. Treated stormwater runoff will be conveyed south to connect to the existing outfall to the Columbia River. Proposed basin delineations are shown in Figure 1 and summarized in Table 1.

Table 1 Proposed Project Drainage Basin Areas

Basin	Impervious Area (ac)	Pervious Area (ac)	Total Area (ac)
A (Playground)	0.23	0.24	0.47
B (Amphitheater)	0.14	0.28	0.42
C (Pavilion)	0.04	0.02	0.06
D (SeatWall)	0.01	0.00	0.01

Section 2. Design Approach

Design of the proposed stormwater system will meet the design criteria of the St. Helens Municipal Code. The code requires that the conveyance system contain the peak runoff from the 25-year design system. Water quality treatment is also required to remove pollutants from new impervious areas within the project site. The Oregon Department of Transportation (ODOT) hydraulics manual defines the water quality design storm as 50% of the 2-year 24-hour storm for this region of the state. Water quantity control is not required since the site discharges directly to the Columbia River which is considered a large water body with a greater than 100 square mile contributing watershed basin at the project outfall locations.

Peak runoff rates from the proposed basins for these design storms were modeled using the Santa Barbara Urban Hydrograph (SBUH) method in HydroCAD v10.0 using the parameters described below.

Hydrology

Rainfall depths for the storm events of interest were obtained from the ODOT isopluvial mapping and the St. Helens Draft Stormwater Masterplan (Keller, 2021). These depths, listed in Table 2, were applied to the Natural Resource Conservation Service (NRCS) Type 1A rainfall distribution in HydroCAD.

Table 2 ODOT Precipitation Depths for 24-Hour Duration Storm Event

Design Storm	Recurrence Interval	Precipitation Depth (in)
Treatment	50% of the 2-Year	1.0
Conveyance	25-Year	3.5

The Natural Resource Conservation Service (NRCS) Soil Survey for Columbia County, Oregon online soil survey was referenced to determine hydrologic soil types for the project location. The site is composed of Sauvie silt loam which is classified as hydraulic soil group (HSG) C/D with high runoff potential, (see soil map in Appendix A.)

Groundwater measurements were made through pore pressure dissipation testing in CPT probes in April 2021 (NV5, 2022). Groundwater was found to be about 20 feet below ground surface at the time. Infiltration testing was not conducted. Depth to groundwater is expected to correspond closely to the Columbia River level, which has an ordinary low water elevation of 2.9 feet and an ordinary high water (OHW) elevation of 14.6 feet.

Runoff Curve Numbers (CNs) for impervious and pervious areas were selected using Table 2-2c – Runoff Curve Numbers for Other Agricultural Lands and Table 2-2a – Runoff Curve Numbers for Urban Areas from *Technical Release 55: Urban Hydrology for Small Watersheds* (SCS, 1986). Table 3 provides a summary of the runoff curve numbers used for water quality and conveyance calculations.

Table 3 Runoff Curve Numbers

Category	Cover Type	Hydrologic Soil Group	Curve Number
Pervious Area	>75% Grass Cover, Good Condition	D	80
Impervious Area	Pavement, Roofs, Sidewalk	D	98

The time of concentration (Tc) represents the maximum time needed for all areas of a given drainage basin to contribute to the outflow hydrograph. The minimum allowable Tc for any drainage basin using this method is five minutes so this value was used as a conservative approach and was applied to all basins.

Water Quality

The City of St. Helens (City) requires mitigation for the impacts of new development on water quality. The pollutants of concern in stormwater for runoff from pedestrian and non-motorized vehicle use impervious surfaces include sediment, as well as pesticides and other nutrients (DEQ, 2021).

The proposed stormwater system will discharge to the Columbia River which is regulated by DEQ and U.S. EPA. While the City is not currently regulated under a municipal separate storm sewer (MS4) permit by the DEQ, the City will likely fall under a MS4 permit sometime in the future and is required to comply with TMDL requirements. The Columbia River (Frogmore Slough to Tide Creek) is 303(d) listed for arsenic inorganic, DDE 4,4', dioxin, PCBs, temperature, and total dissolved gas (DEQ, 2022). This project is not expected to increase levels of these listed pollutants.

The water quality approach prioritizes the use of vegetated facilities over proprietary filter cartridges. However, space constraints and elevation near the stage dictates the use of a filter manhole for Basins B and C. The filter cartridges were designed using runoff calculated from the defined water quality storm event, and a design flow rate of 15 gpm. The design is summarized in Table 4.

Table 4 Treatment Cartridge Sizing (Basins B and C)

Parameters	Filter Manhole
Water Quality Flow Rate (cfs)	0.04
Water Quality Flow Rate (gpm)	18
Treatment Cartridge per Capacity (gpm)	15
Number of Cartridges	2

The flow-through planter that will provide water quality treatment for Basin A was modeled using HydroCAD v10.00 to show that the peak water quality flow rate of 0.05 cfs can infiltrate through the water quality mix at a rate of two inches per hour (CWS, 2019) (see Appendix B). The planter has a 531-sf

footprint with a 6-inch maximum ponding depth and 6 inches of freeboard over the overflow. The water quality ponding depth for the contributing area is 4.3 inches. The facility has the treatment capacity to manage the runoff from Basin A if an additional 3,400 sf of pervious area were converted to hardscape. The seatwall in Basin D drains onto a minimum 18-inch swath of vegetated filterstrip for water quality treatment.

Conveyance Network

St. Helens Municipal Code requires that the conveyance system elements convey and contain the 25-year frequency, 24-hour duration design storm event. The City expressed concern for conveyance capacity and requested that the 100-year storm event be used. The City requires a minimum pipe diameter of 10 inches for catch basin laterals and 12 inches for main line. New pipe is proposed to convey stormwater to an existing 24-inch outfall to the Columbia River. HydroCAD was used to confirm adequate conveyance capacity of the 100-year 24-hour design storm in the most constricted sections of pipe (see Appendix C). Tailwater was not included in the calculations and the new pipe connects to the existing outfall above OHW.

Section 3. Operations and Maintenance

The proposed water quality facilities and conveyance system will be publicly owned and maintained by the City. Department of Public Works Supervisor is Dave Elder and the contact number is 503-397-3532. Operation and Maintenance Plans have been included for reference in Appendix D.

Section 4. Conclusion

The proposed St. Helens Riverwalk project will include a stormwater management system that follows the standards set forth by the St. Helens Municipal Code. Runoff from the proposed improvements at Columbia View Park will receive water quality treatment in a proprietary StormFilter® treatment manhole and flow-through planter before discharging to the Columbia River through an existing outfall. The project is exempt from water quantity control requirements as the Columbia River is considered a large water body, therefore no flow control will be provided with this project.

Section 5. References

CWS, 2019. *Design and Construction Standards for Sanitary Sewer and Surface Water Management*, Clean Water Services, December 2019

DEQ, 2021. *Section 401 Water Quality Certification*, State of Oregon Department of Environmental Quality, January 2021.

DEQ, 2022. *2022 Integrated Report*, State of Oregon Department of Environmental Quality, approved September 1, 2022.

Keller, 2021. *Draft Stormwater Master Plan Sections 2-5*, Keller Associates, May 14, 2021.

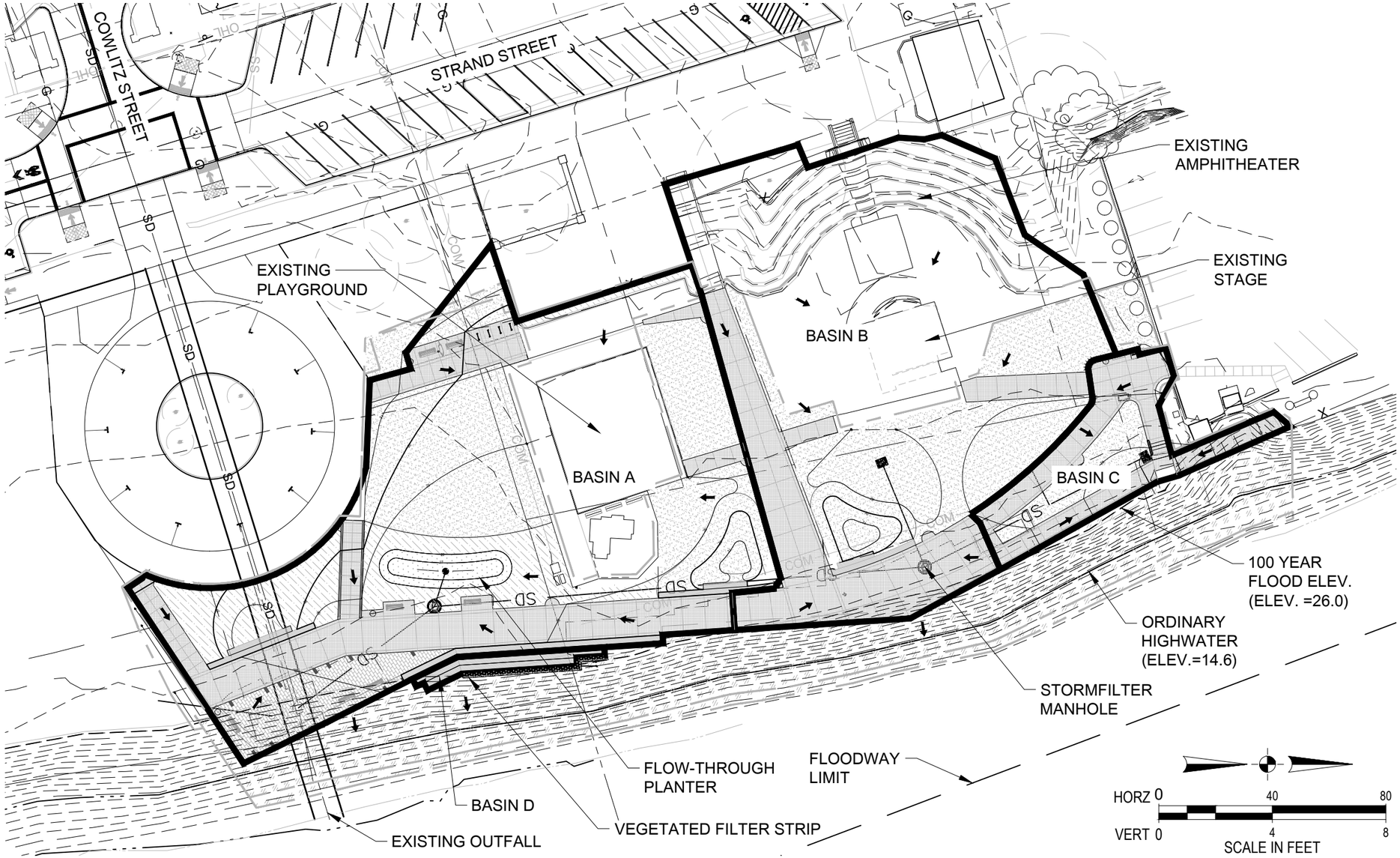
NV5, 2022. *Preliminary Report of Geotechnical Engineering Services,* NV5, February 2, 2022.

ODOT, 2014. *Hydraulics Design Manual*, Oregon Department of Transportation, April 2014.

SCS, 1986. *Technical Release 55: Urban Hydrology for Small Watersheds*, United States Department of Agriculture Soil Conservation Service, June 1986.

SHMC, 2012. *St. Helens Municipal Code*, City of St. Helens, November 6, 2012.

Figure



LEGEND

EXISTING MAJOR CONTOUR	PROJECT BOUNDARY
EXISTING MINOR CONTOUR	BASIN BOUNDARY
PROPOSED MAJOR CONTOUR	EXISTING STORM PIPE
PROPOSED MINOR CONTOUR	PROPOSED STORM PIPE
PROPOSED FLOW DIRECTION	PROPOSED CATCH BASIN
	PROPOSED STORM MANHOLE

FIGURE 1

Mayer/Reed

Mayer/Reed, Inc.
319 SW Washington St.
Suite 820
Portland, Oregon 97204
503.223.5953

Otak

Otak, Inc.
808 SW Third Avenue, Ste. 800
Portland, OR 97204
503. 287. 6825
www.otak.com

St. Helens Riverwalk
St. Helens, Oregon
Project Number: P-525A
PROPOSED CONDITIONS FIGURE

Project Managers: Jennifer Dimsho; John Walsh

PHASE
FINAL PLANS
DATE
07/21/2023

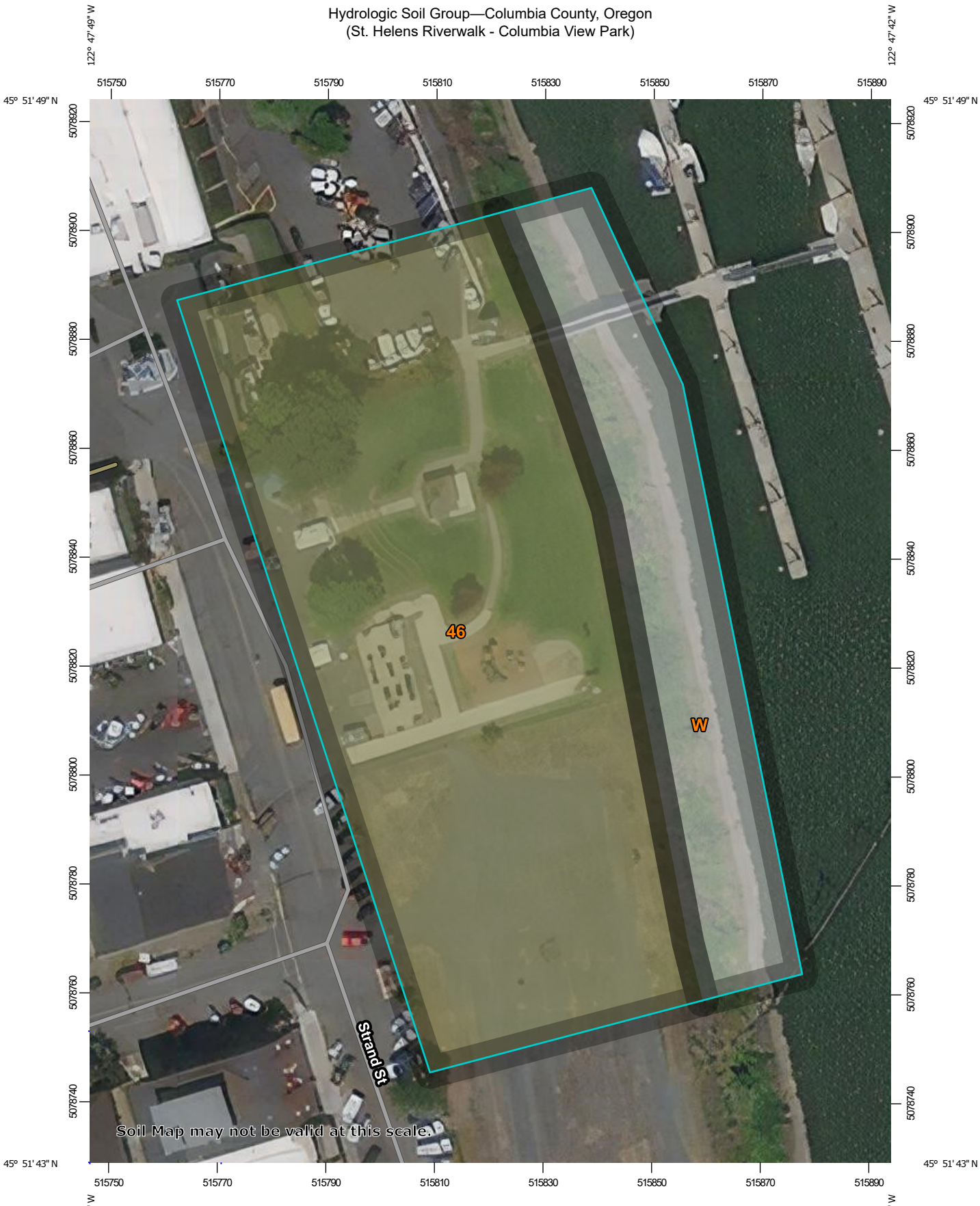
REVISIONS

NO.	DESC.	DATE
2	BID ADD 1	2023-08-16

Appendix A

NRCS Soil Survey

Hydrologic Soil Group—Columbia County, Oregon
(St. Helens Riverwalk - Columbia View Park)



Map Scale: 1:951 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 10 20 40 60

Feet
0 45 90 180 270

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

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

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

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

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: Columbia County, Oregon
Survey Area Data: Version 19, Oct 27, 2021

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

Date(s) aerial images were photographed: Sep 29, 2015—Sep 13, 2016

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
46	Sauvie silt loam	C/D	2.2	75.8%
W	Water		0.7	24.2%
Totals for Area of Interest			**2.9**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

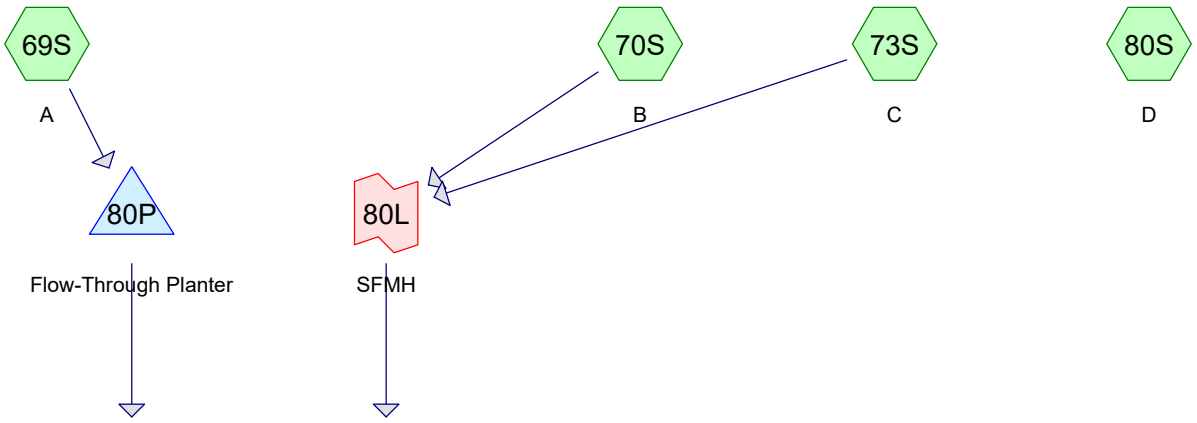
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix B

Water Quality



Subcat Reach Pond Link

Routing Diagram for 20028-WNR-Working
Prepared by Otak, Printed 1/23/2024

Summary for Subcatchment 69S: A

Runoff = 0.05 cfs @ 7.91 hrs, Volume= 0.017 af, Depth= 0.44"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Type IA 24-hr WQ Rainfall=1.00"

Area (sf)	CN	Description
10,199	98	Unconnected pavement, HSG D
10,258	80	>75% Grass cover, Good, HSG D
20,457	89	Weighted Average
10,258	80	50.14% Pervious Area
10,199	98	49.86% Impervious Area

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

Summary for Subcatchment 70S: B

Runoff = 0.03 cfs @ 7.91 hrs, Volume= 0.011 af, Depth= 0.32"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Type IA 24-hr WQ Rainfall=1.00"

Area (sf)	CN	Description
6,176	98	Unconnected pavement, HSG D
11,976	80	>75% Grass cover, Good, HSG D
18,152	86	Weighted Average
11,976	80	65.98% Pervious Area
6,176	98	34.02% Impervious Area

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

Summary for Subcatchment 73S: C

Runoff = 0.01 cfs @ 7.91 hrs, Volume= 0.003 af, Depth= 0.57"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Type IA 24-hr WQ Rainfall=1.00"

Area (sf)	CN	Description
1,966	98	Unconnected pavement, HSG D
864	80	>75% Grass cover, Good, HSG D
2,830	93	Weighted Average
864	80	30.53% Pervious Area
1,966	98	69.47% Impervious Area

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

Summary for Subcatchment 80S: D

Runoff = 0.00 cfs @ 7.91 hrs, Volume= 0.001 af, Depth= 0.79"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Type IA 24-hr WQ Rainfall=1.00"

Area (sf)	CN	Description
371	98	Unconnected pavement, HSG D
371	98	100.00% Impervious Area

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

Summary for Pond 80P: Flow-Through Planter

Inflow Area = 0.470 ac, 49.86% Impervious, Inflow Depth = 0.44" for WQ event
Inflow = 0.05 cfs @ 7.91 hrs, Volume= 0.017 af
Outflow = 0.02 cfs @ 8.99 hrs, Volume= 0.017 af, Atten= 67%, Lag= 64.8 min
Primary = 0.02 cfs @ 8.99 hrs, Volume= 0.017 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Peak Elev= 27.36' @ 8.99 hrs Surf.Area= 342 sf Storage= 103 cf

Plug-Flow detention time= 57.6 min calculated for 0.017 af (100% of inflow)
Center-of-Mass det. time= 57.4 min (802.1 - 744.7)

Volume	Invert	Avail.Storage	Storage Description
#1	27.00'	384 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
27.00	237	0	0
28.00	531	384	384

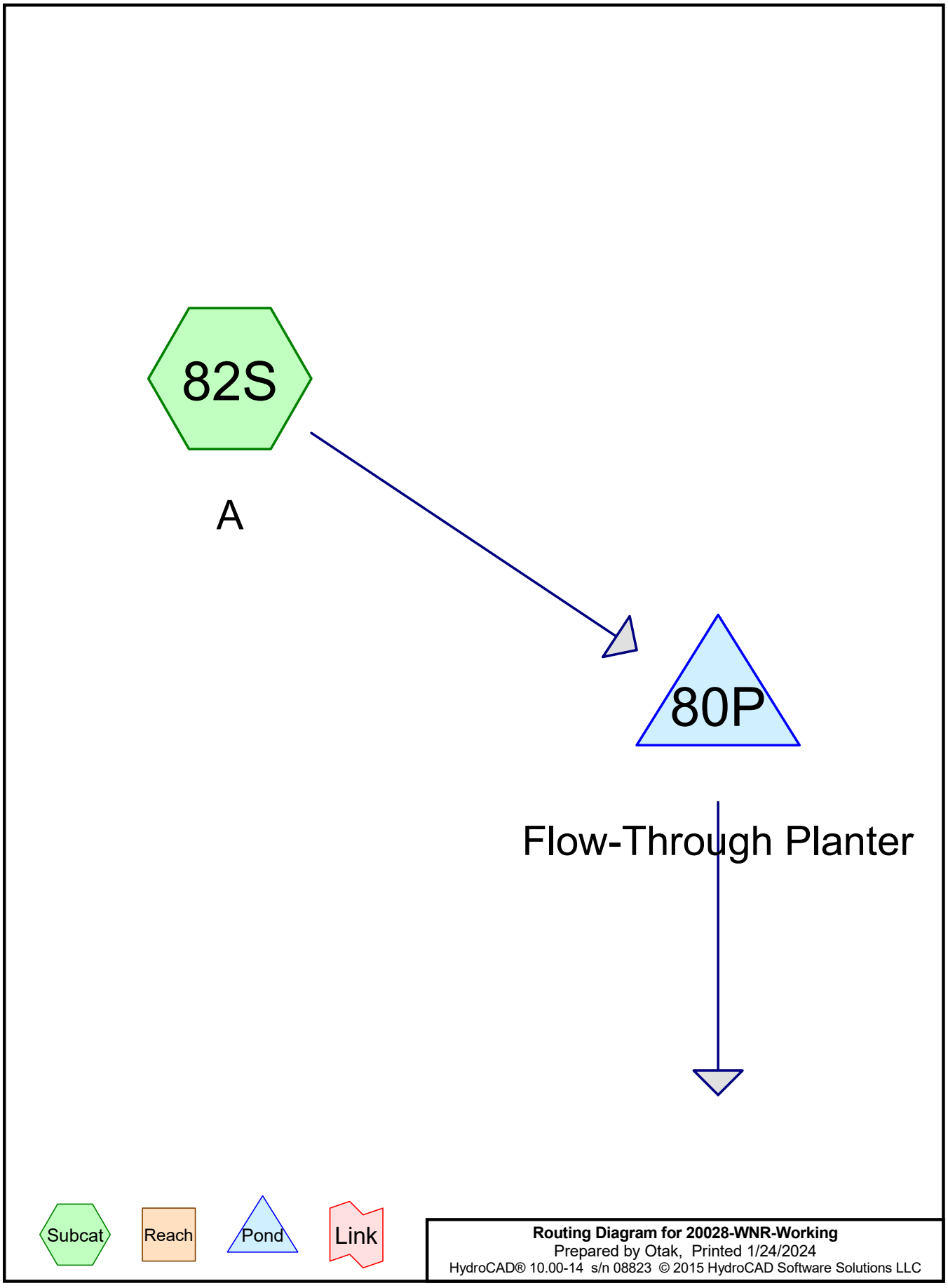
Device	Routing	Invert	Outlet Devices
#1	Primary	27.00'	**2.000 in/hr Exfiltration over Surface area** Phase-In= 0.10'
#2	Primary	27.50'	**4.8' long x 0.5' breadth Beehive Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.02 cfs @ 8.99 hrs HW=27.36' TW=18.90' (Dynamic Tailwater)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
└─**2=Beehive Weir** (Controls 0.00 cfs)

Summary for Link 80L: SFMH

Inflow Area = 0.482 ac, 38.80% Impervious, Inflow Depth = 0.36" for WQ event
Inflow = 0.04 cfs @ 7.91 hrs, Volume= 0.014 af
Primary = 0.04 cfs @ 7.91 hrs, Volume= 0.014 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs



Routing Diagram for 20028-WNR-Working
Prepared by Otak, Printed 1/24/2024

Summary for Subcatchment 82S: A

Runoff = 0.06 cfs @ 7.91 hrs, Volume= 0.022 af, Depth= 0.55"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Type IA 24-hr WQ Rainfall=1.00"

Area (sf)	CN	Description
10,199	98	Unconnected pavement, HSG D
6,858	80	>75% Grass cover, Good, HSG D
3,400	98	Unconnected pavement, HSG D
20,457	92	Weighted Average
6,858	80	33.52% Pervious Area
13,599	98	66.48% Impervious Area

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

Summary for Pond 80P: Flow-Through Planter

Inflow Area = 0.470 ac, 66.48% Impervious, Inflow Depth = 0.55" for WQ event
Inflow = 0.06 cfs @ 7.91 hrs, Volume= 0.022 af
Outflow = 0.02 cfs @ 8.89 hrs, Volume= 0.022 af, Atten= 65%, Lag= 58.9 min
Primary = 0.02 cfs @ 8.89 hrs, Volume= 0.022 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Peak Elev= 27.50' @ 8.89 hrs Surf.Area= 385 sf Storage= 157 cf

Plug-Flow detention time= 82.7 min calculated for 0.022 af (100% of inflow)
Center-of-Mass det. time= 82.7 min (812.5 - 729.8)

Volume	Invert	Avail.Storage	Storage Description
#1	27.00'	384 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

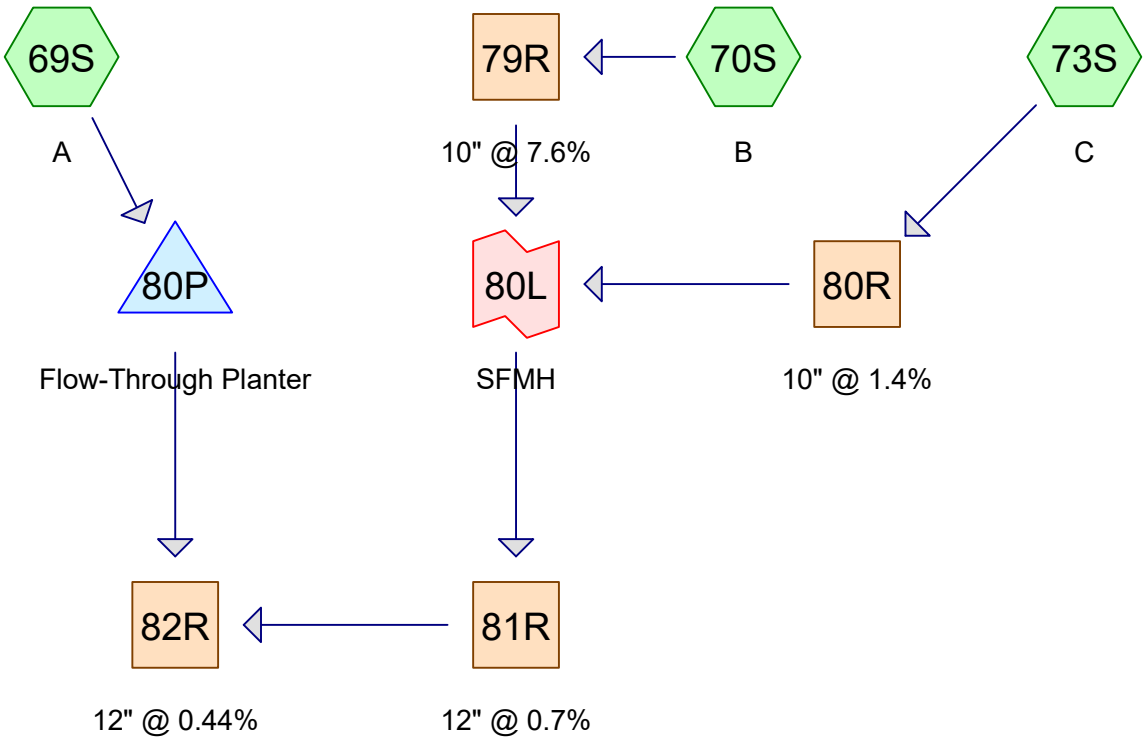
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
27.00	237	0	0
28.00	531	384	384

Device	Routing	Invert	Outlet Devices
#1	Primary	27.00'	**2.000 in/hr Exfiltration over Surface area** Phase-In= 0.10'
#2	Primary	27.50'	**4.8' long x 0.5' breadth Beehive Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.02 cfs @ 8.89 hrs HW=27.50' TW=18.90' (Dynamic Tailwater)
↑—**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
└—**2=Beehive Weir** (Weir Controls 0.00 cfs @ 0.19 fps)

Appendix C

Conveyance



Subcat Reach Pond Link

Routing Diagram for 20028-WNR-Working
Prepared by Otak, Printed 1/24/2024

Summary for Subcatchment 69S: A

Runoff = 0.33 cfs @ 7.92 hrs, Volume= 0.114 af, Depth= 2.90"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Type IA 24-hr 100-year Rainfall=4.00"

Area (sf)	CN	Description
10,199	98	Unconnected pavement, HSG D
10,258	80	>75% Grass cover, Good, HSG D
20,457	89	Weighted Average
10,258	80	50.14% Pervious Area
10,199	98	49.86% Impervious Area

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

Summary for Subcatchment 70S: B

Runoff = 0.26 cfs @ 7.93 hrs, Volume= 0.091 af, Depth= 2.63"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Type IA 24-hr 100-year Rainfall=4.00"

Area (sf)	CN	Description
6,176	98	Unconnected pavement, HSG D
11,976	80	>75% Grass cover, Good, HSG D
18,152	86	Weighted Average
11,976	80	65.98% Pervious Area
6,176	98	34.02% Impervious Area

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

Summary for Subcatchment 73S: C

Runoff = 0.05 cfs @ 7.90 hrs, Volume= 0.018 af, Depth= 3.24"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Type IA 24-hr 100-year Rainfall=4.00"

Area (sf)	CN	Description
1,966	98	Unconnected pavement, HSG D
864	80	>75% Grass cover, Good, HSG D
2,830	93	Weighted Average
864	80	30.53% Pervious Area
1,966	98	69.47% Impervious Area

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

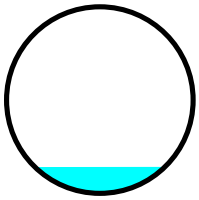
Summary for Reach 79R: 10" @ 7.6%

Inflow Area = 0.417 ac, 34.02% Impervious, Inflow Depth = 2.63" for 100-year event
Inflow = 0.26 cfs @ 7.93 hrs, Volume= 0.091 af
Outflow = 0.26 cfs @ 7.94 hrs, Volume= 0.091 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Max. Velocity= 5.57 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.13 fps, Avg. Travel Time= 0.2 min

Peak Storage= 2 cf @ 7.94 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 6.08 cfs

10.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 38.3' Slope= 0.0770 '/'
Inlet Invert= 25.50', Outlet Invert= 22.55'



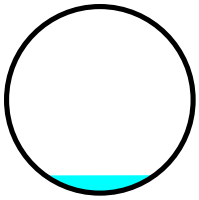
Summary for Reach 80R: 10" @ 1.4%

Inflow Area = 0.065 ac, 69.47% Impervious, Inflow Depth = 3.24" for 100-year event
Inflow = 0.05 cfs @ 7.90 hrs, Volume= 0.018 af
Outflow = 0.05 cfs @ 7.91 hrs, Volume= 0.018 af, Atten= 0%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Max. Velocity= 1.92 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.08 fps, Avg. Travel Time= 1.3 min

Peak Storage= 2 cf @ 7.91 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 2.66 cfs

10.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 85.6' Slope= 0.0147 '/'
Inlet Invert= 23.81', Outlet Invert= 22.55'



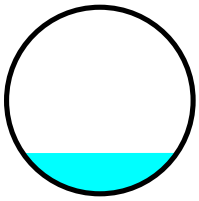
Summary for Reach 81R: 12" @ 0.7%

Inflow Area = 0.482 ac, 38.80% Impervious, Inflow Depth = 2.71" for 100-year event
Inflow = 0.32 cfs @ 7.93 hrs, Volume= 0.109 af
Outflow = 0.32 cfs @ 7.95 hrs, Volume= 0.109 af, Atten= 0%, Lag= 0.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.47 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 2.1 min

Peak Storage= 22 cf @ 7.95 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.99 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 173.3' Slope= 0.0070 '/'
Inlet Invert= 20.25', Outlet Invert= 19.03'



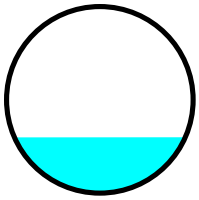
Summary for Reach 82R: 12" @ 0.44%

Inflow Area = 0.951 ac, 44.26% Impervious, Inflow Depth = 2.80" for 100-year event
Inflow = 0.65 cfs @ 7.94 hrs, Volume= 0.222 af
Outflow = 0.65 cfs @ 7.95 hrs, Volume= 0.222 af, Atten= 0%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Max. Velocity= 3.28 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.64 fps, Avg. Travel Time= 0.6 min

Peak Storage= 12 cf @ 7.95 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.33 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 59.7' Slope= 0.0087 '/'
Inlet Invert= 18.83', Outlet Invert= 18.31'



Summary for Pond 80P: Flow-Through Planter

Inflow Area = 0.470 ac, 49.86% Impervious, Inflow Depth = 2.90" for 100-year event
Inflow = 0.33 cfs @ 7.92 hrs, Volume= 0.114 af
Outflow = 0.33 cfs @ 7.94 hrs, Volume= 0.114 af, Atten= 0%, Lag= 1.2 min
Primary = 0.33 cfs @ 7.94 hrs, Volume= 0.114 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs
Peak Elev= 27.58' @ 7.94 hrs Surf.Area= 408 sf Storage= 187 cf

Plug-Flow detention time= 44.3 min calculated for 0.114 af (100% of inflow)
Center-of-Mass det. time= 44.1 min (752.9 - 708.8)

Volume	Invert	Avail.Storage	Storage Description
#1	27.00'	384 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
27.00	237	0	0
28.00	531	384	384

Device	Routing	Invert	Outlet Devices
#1	Primary	27.00'	**2.000 in/hr Exfiltration over Surface area** Phase-In= 0.10'
#2	Primary	27.50'	**4.8' long x 0.5' breadth Beehive Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=0.33 cfs @ 7.94 hrs HW=27.58' TW=19.13' (Dynamic Tailwater)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)
└─**2=Beehive Weir** (Weir Controls 0.31 cfs @ 0.80 fps)

Summary for Link 80L: SFMH

Inflow Area = 0.482 ac, 38.80% Impervious, Inflow Depth = 2.71" for 100-year event
Inflow = 0.32 cfs @ 7.93 hrs, Volume= 0.109 af
Primary = 0.32 cfs @ 7.93 hrs, Volume= 0.109 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

Appendix D

Operations and Maintenance Manual

Flow-Through Planter Operation and Maintenance Plan

Annual inspections are required. It is recommended that the facility is inspected on a monthly basis to ensure proper function. The plan below describes inspection and maintenance activities, and may be used as an inspection log. Contact the design engineer, Clean Water Services or City representative for more information.

Identified Problem	Condition to Check for	Maintenance Activity	Maintenance Timing	✔ Task Complete Comments
Sediment Accumulation in Treatment Area	Sediment depth exceeds 3 inches	Remove sediment from treatment area. Ensure planter is level from side to side and drains freely toward outlet; no standing water within 24 hours after any major storm (1-inch in 24 hours)	 Ideally in dry season	
Erosion	Erosion or channelization that impacts or effects the function of the facility or creates a safety concern	Repair eroded areas and stabilized using proper erosion control measures Establish appropriate vegetation as needed	 Inspect after major storm (1-inch in 24 hours)	
Standing Water	Standing water in the planter between storms that does not drain freely. Water should drain after 24 hours of dry weather.	Remove sediment or trash blockages. Grade out areas of mounding and improve end to end grade so there is no standing water.		
Flow Not Distributed Evenly	Flow unevenly distributed through planter width due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire planter width		
Obstructed Inlet/Outlet	Material such as vegetation, sediment, trash is blocking more than 10% of the inlet/outlet pipe	Remove blockages from facility	 Inspect after major storm (1-inch in 24 hours)	

Flow-Through Planter Operation and Maintenance Plan (continued)

Annual inspections are required. It is recommended that the facility is inspected on a monthly basis to ensure proper function. The plan below describes inspection and maintenance activities, and may be used as an inspection log. Contact the design engineer, Clean Water Services or City representative for more information.

Identified Problem	Condition to Check for	Maintenance Activity	Maintenance Timing	✔ Task Complete Comments
Poor Vegetation Coverage	80% survival of approved vegetation and no bare areas large enough to affect function of facility.	Determine cause of poor growth and correct the condition; replant with plugs or containerized plants per approved plans and applicable standards at time of construction. Remove excessive weeds and all invasive plants.	 Ideal time to plant is spring and fall seasons	
Invasive Vegetation as outlined in Appendix A	Invasive vegetation found in facility. Examples include: Himalayan Blackberry; Reed Canary Grass; Teasel, English Ivy, Nightshade, Clematis, Cattail, Thistle	Remove excessive weeds and all invasive plants. Attempt to control even if complete eradication is not feasible. Refer to Clean Water Services Integrated Pest Management Plan for appropriate control methods, including proper use of chemical treatment.		
Excessive Vegetation	Vegetation grows so tall it competes with or shades approved emergent wetland grass/shrubs; interferes with access or becomes a fire danger	Prune over-hanging limbs, if possible; remove brushy vegetation as needed. Prune emergent wetland grass/shrubs that have become overgrown.	 Ideal time to prune emergent wetland grass is spring	
Vector Control	Evidence of rodents or water flowing through facility via rodent holes. Harmful insects such as wasps or hornets present	Repair damage to facility. Remove harmful insects, call professional if needed. Refer to Clean Water Services Integrated Pest Management Plan for management options.	As Needed	

Flow-Through Planter Operation and Maintenance Plan (continued)

Annual inspections are required. It is recommended that the facility is inspected on a monthly basis to ensure proper function. The plan below describes inspection and maintenance activities, and may be used as an inspection log. Contact the design engineer, Clean Water Services or City representative for more information.

Identified Problem	Condition to Check for	Maintenance Activity	Maintenance Timing	✔ Task Complete Comments
Trash and Debris	Visual evidence of trash, debris or dumping.	Remove and dispose of trash and debris from facility. Dispose of properly		
Contamination and Pollution	Evidence of oil, gasoline, contaminants, or other pollutants. Look for sheens, odor or signs of contamination.	If contaminants or pollutants present, coordinate removal/cleanup with local jurisdiction.		
Outlet Structure Damaged	Grate or overflow structure is missing or only partially in place and may have missing or broken grate members.	Repair or replace outlet structure.	As Needed	

CONTECH®
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StormFilter Inspection and Maintenance Procedures

The Stormwater Management StormFilter®

Maintenance Guidelines

The primary purpose of the Stormwater Management StormFilter® is to filter and prevent pollutants from entering our waterways. Like any effective filtration system, periodically these pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness.

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site. Maintenance activities may be required in the event of a chemical spill or due to excessive sediment loading from site erosion or extreme storms. It is a good practice to inspect the system after major storm events.

Maintenance Procedures

Although there are many effective maintenance options, we believe the following procedure to be efficient, using common equipment and existing maintenance protocols. The following two-step procedure is recommended::

1. **Inspection**
   - Inspection of the vault interior to determine the need for maintenance.
2. **Maintenance**
   - Cartridge replacement
   - Sediment removal

Inspection and Maintenance Timing

At least one scheduled inspection should take place per year with maintenance following as warranted.

First, an inspection should be done before the winter season. During the inspection the need for maintenance should be determined and, if disposal during maintenance will be required, samples of the accumulated sediments and media should be obtained.

Second, if warranted, a maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather.

In addition to these two activities, it is important to check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/ maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

Maintenance Frequency

The primary factor for determining frequency of maintenance for the StormFilter is sediment loading.

A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media inside the cartridges. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. It may be possible to extend the usable span of the cartridges by removing sediment from upstream trapping devices on a routine as-needed basis, in order to prevent material from being re-suspended and discharged to the StormFilter treatment system.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions.

Regulatory requirements or a chemical spill can shift maintenance timing as well. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly after major storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual StormFilter system or site. It is recommended that the site owner develop a database to properly manage StormFilter inspection and maintenance programs..

Inspection Procedures

The primary goal of an inspection is to assess the condition of the cartridges relative to the level of visual sediment loading as it relates to decreased treatment capacity. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then typically large amounts of sediments will be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

Warning: In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct an inspection:

Important: Inspection should be performed by a person who is familiar with the operation and configuration of the StormFilter treatment unit and the unit's role, relative to detention or retention facilities onsite.

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to whether or not maintenance is needed.

Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. The following Maintenance Decision Tree should be used as a general guide. (Other factors, such as Regulatory Requirements, may need to be considered).

Please note Stormwater Management StormFilter devices installed downstream of, or integrated within, a stormwater storage facility typically have different operational parameters (i.e. draindown time). In these cases, the inspector must understand the relationship between the retention/detention facility and the treatment system by evaluating site specific civil engineering plans, or contacting the engineer of record, and make adjustments to the below guidance as necessary. Sediment deposition depths and patterns within the StormFilter are likely to be quite different compared to systems without upstream storage and therefore shouldn't be used exclusively to evaluate a need for maintenance.

1. Sediment loading on the vault floor.
   a. If >4" of accumulated sediment, maintenance is required.
2. Sediment loading on top of the cartridge.
   a. If >1/4" of accumulation, maintenance is required.
3. Submerged cartridges.
   a. If >4" of static water above cartridge bottom for more than 24 hours after end of rain event, maintenance is required. (Catch basins have standing water in the cartridge bay.)
4. Plugged media.
   a. While not required in all cases, inspection of the media within the cartridge may provide valuable additional information.
   b. If pore space between media granules is absent, maintenance is required.
5. Bypass condition.
   a. If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), maintenance is required.
6. Hazardous material release.
   a. If hazardous material release (automotive fluids or other) is reported, maintenance is required.
7. Pronounced scum line.
   a. If pronounced scum line (say ≥ 1/4" thick) is present above top cap, maintenance is required.

Maintenance

Depending on the configuration of the particular system, maintenance personnel will be required to enter the vault to perform the maintenance.

Important: If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flows is occurring.

Replacement cartridges can be delivered to the site or customers facility. Information concerning how to obtain the replacement cartridges is available from Contech Engineered Solutions.

Warning: In the case of a spill, the maintenance personnel should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct cartridge replacement and sediment removal maintenance:

1. If applicable, set up safety equipment to protect maintenance personnel and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.
5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

Method 1:

A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

   Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact Contech Engineered Solutions for suggested attachment devices.

B. Remove the used cartridges (up to 250 lbs. each) from the vault.

Important: Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner.

C. Set the used cartridge aside or load onto the hauling truck.

D. Continue steps a through c until all cartridges have been removed.

Method 2:

A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

B. Unscrew the cartridge cap.

C. Remove the cartridge hood and float.

D. At location under structure access, tip the cartridge on its side.

E. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.

F. Set the empty, used cartridge aside or load onto the hauling truck.

G. Continue steps a through e until all cartridges have been removed.

8. Remove accumulated sediment from the floor of the vault and from the forebay. This can most effectively be accomplished by use of a vacuum truck.
9. Once the sediments are removed, assess the condition of the vault and the condition of the connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used **empty** cartridges to Contech Engineered Solutions.

Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

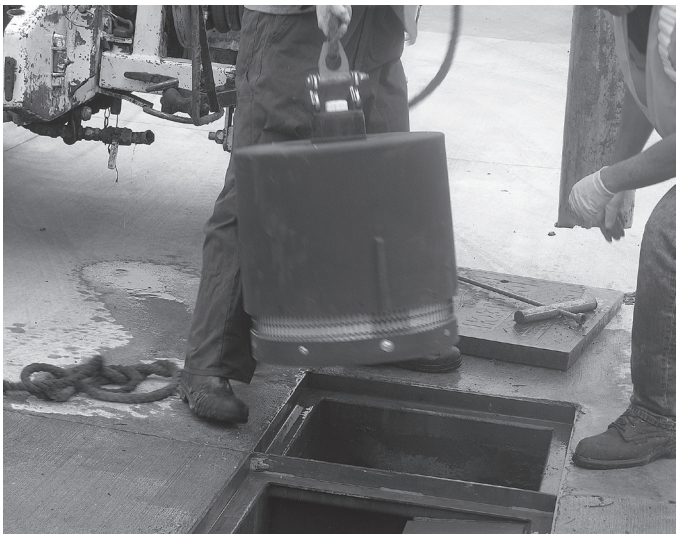
Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.

Related Maintenance Activities - Performed on an as-needed basis

StormFilter units are often just one of many structures in a more comprehensive stormwater drainage and treatment system.

In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities.

In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.



Inspection Report

Date: _____ Personnel: _____

Location: _____ System Size: _____ Months in Service: _____

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: _____

Sediment Thickness in Forebay: _____ Date: _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Estimated Flow from Drainage Pipes (if available): _____

Cartridges Submerged: Yes ☐ No ☐ Depth of Standing Water: _____

StormFilter Maintenance Activities (check off if done and give description)

☐ Trash and Debris Removal: _____

☐ Minor Structural Repairs: _____

☐ Drainage Area Report _____

Excessive Oil Loading: Yes ☐ No ☐ Source: _____

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: _____

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: _____

Items Needing Further Work: _____

Owners should contact the local public works department and inquire about how the department disposes of their street waste residuals.

Other Comments:

_____

_____

_____

_____

_____

_____

_____

_____

Review the condition reports from the previous inspection visits.

StormFilter Maintenance Report

Date: _____ Personnel: _____

Location: _____ System Size: _____

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: _____

List Safety Procedures and Equipment Used: _____

_____

_____

System Observations

Months in Service: _____

Oil in Forebay (if present): Yes ☐ No ☐

Sediment Depth in Forebay (if present): _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Drainage Area Report

Excessive Oil Loading: Yes ☐ No ☐ Source: _____

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: _____

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: _____

StormFilter Cartridge Replacement Maintenance Activities

Remove Trash and Debris: Yes ☐ No ☐ Details: _____

Replace Cartridges: Yes ☐ No ☐ Details: _____

Sediment Removed: Yes ☐ No ☐ Details: _____

Quantity of Sediment Removed (estimate?):

Minor Structural Repairs: Yes ☐ No ☐ Details: _____

Residuals (debris, sediment) Disposal Methods: _____

Notes:

_____

_____

_____

_____

_____

_____

_____

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