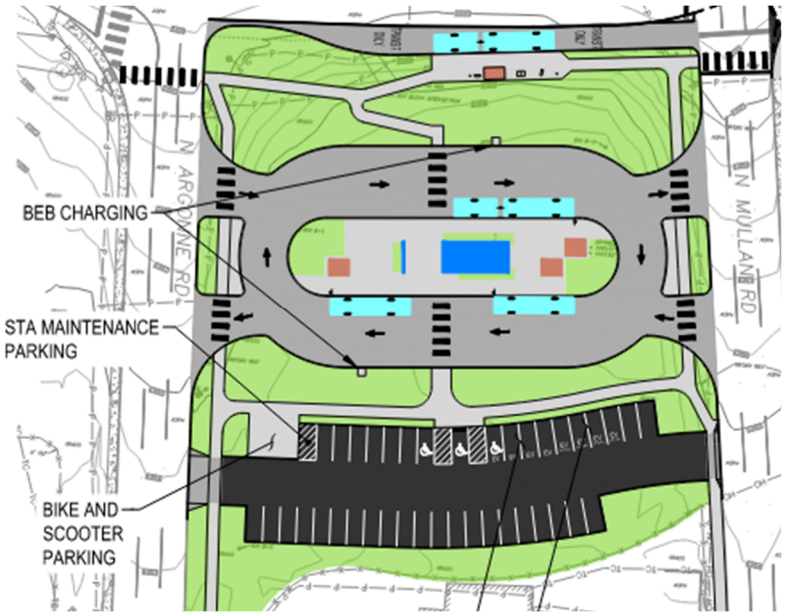
Attachment G
Stormwater Report



Argonne Station Park and Ride

Spokane Transit Authority

Draft Stormwater Report

June 2025 | Draft Report

kpff Consulting Engineers

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Spokane Transit Authority

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1. PROJECT OVERVIEW

Spokane Transit Authority's proposed Argonne Station Park and Ride is a 1.6 acre park and ride facility located in Spokane Valley, just south of Interstate 90 (I-90), between Argonne Road and Mullan Road. Proposed improvements to the project site include a 40 stall parking lot, transit-only bus loop, three bus bays with shelters, and an operations building. The project also includes an eastbound High Performance Transit (HPT) flyer stop and signal modifications for a new dedicated bus-only receiving lane on the eastbound I-90 on-ramp.

SITE LOCATION

The project site is between N Argonne Road and N Mullen Road, north of E Mission Ave and south of I-90 located within the City of Spokane Valley, Washington. The proposed park and ride site is situated south of the I-90 off and on ramps, between Argonne Road and Mullan Road, north of Mission Avenue. The proposed receiving lane for buses is located northeast of the park and ride site, added along the eastbound I-90 on ramp. The proposed project is located within Washington State Department of Transportation (WSDOT) right of way, which extends north of the project site to I-90. Parcels 45083.9003 and 45083.9018 are directly south of the park and ride site and contain a restaurant building with a 42-stall parking lot. The project location is shown in the vicinity map below.

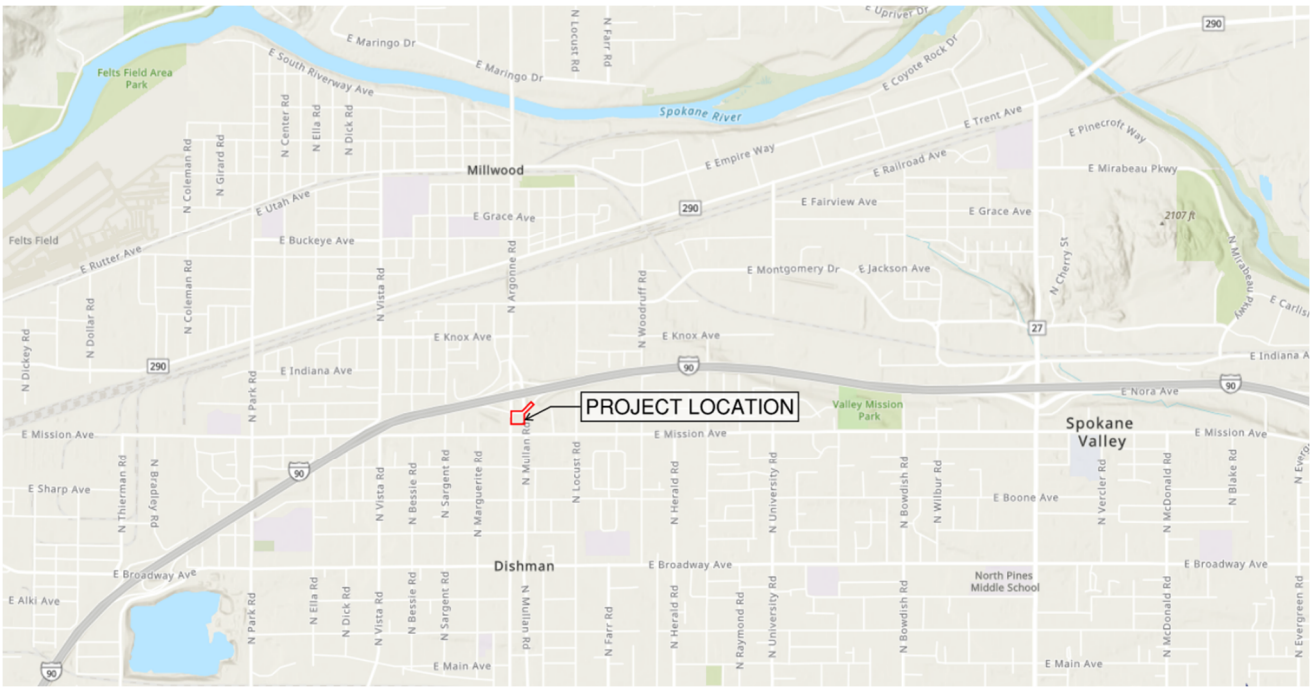


FIGURE 1-1 ARGONNE STATION PROJECT VICINITY MAP

SCOPE OF WORK

The Argonne Station Park and Ride project includes a 40-stall parking lot, transit only bus loop, containing three bus bays with shelters, and an operations building, an eastbound HPT flyer stop with an additional on ramp receiving lane, stormwater bioinfiltration ponds and drywells, and modifications to the eastbound off-ramp and on-ramp intersections to accommodate pedestrian

movements and the bus-only receiving lane. No off-site easements are needed for project development.

2. SITE CONDITIONS

THRESHOLD DISCHARGE AREAS (TDAS)

The project site consists of two distinct threshold discharge areas (TDAs). TDA 1 includes the main area that will develop into the park and ride site. TDA 2 is the area to the northeast consisting of a freeway on ramp that will include the receiving lane. Each TDA is broken out into basins to address the flows within the TDA for the Pre-Developed and Post-Developed Conditions Discharges and existing drainage patterns are illustrated in the TDA map located in Appendix A.2.

SOILS

The site contains three types of soils consisting of fill, topsoil, and coarse-grained soil. The silty gravel with sand fill is found within depths of 12 to 30 inches. Below the fill exists a 6 to 12 inch layer of topsoil. Coarse grained soil can be found under the topsoil layer. According to the Geotechnical Engineering Report, this native course ground soil is a suitable target layer for stormwater infiltration.

The Geotechnical Engineer Report was prepared for the Spokane Transit Authority Argonne Station by Budinger & Associates in 2025. See Appendix A-2 for the Geotechnical Engineering Report, which includes a map of soil testing locations and geologic cross sections at those locations.

PRE-DEVELOPMENT CONDITION

The pre-development condition for the existing main project site is primarily undeveloped with grass cover that slopes generally towards the center of site to an existing drywell. To the north of the existing site, the asphalt pavement of the roadway drains to the site and enters the site discharging stormwater flow into the existing drywell. Table 2-1 below shows a summary of the drainage basin areas in each TDA.

TABLE 2-1 PRE-DEVELOPMENT BASIN

	AREA (ACRES)	2-YR	10-YR	25-YR	50-YR	100-YR
TDA 1 - A	0.31	0.40	0.74	0.94	1.09	1.24
TDA 1 - B	1.75	0.74	1.37	1.74	2.01	2.29
TDA 2 -A	0.21	0.27	0.50	0.63	0.73	0.83
TDA 2 -B	0.04	0.03	0.06	0.08	0.09	0.10
TOTAL	**2.31**	**1.45**	**2.67**	**3.39**	**3.92**	**4.47**

The site includes one streetlight, eight signs and posts, and a signal mast arm structure at the northwest corner. Additionally, underground electrical utilities are present, supporting both the streetlight and signal mast arm structure.

The portion of the site that extends to the northeast that is currently a freeway on ramp contains three signs, one streetlight, sidewalk, and an ADA ramp with a pedestrian push button. No critical areas (wells, steep slopes, floodplains) exist on the park and ride site. The receiving lane site is located within a 1000' wellhead buffer per a Spokane Valley Rathdrum Prairie Aquifer map created by the City of Spokane Valley in 2006. See Appendix A-9 for the aquifer map and other information used to determine critical areas relevant to the project site.

EXISTING HYDRAULIC FEATURES

The main project site contains one double-depth drywell at the low point in the center of the main site which captures all stormwater flow from the TDA 1. An existing detention pond is located along the eastbound I-90 on ramp with the bus receiving lane, which is approx. 50 feet to 400 feet from the existing runoff on the south border as it disperses down the hill to the detention pond capturing stormwater flow from TDA 2.

EXISTING STORMWATER DISCHARGE POINT INVENTORY

Existing site stormwater discharge points include infiltration via drywell within the park and ride site and dispersion within the receiving lane site. The existing drywell WSDOT feature number is DRAI00057663 per the GIS inventory map titled "WSDOT – Stormwater Discharge Points" with data from the Stormwater Features Inventory Database.

EXISTING UTILITIES

Existing utilities onsite include underground power, junction boxes, one streetlight, two traffic signal structures, and one overhead power pole in the southeast corner of the site. The receiving lane site includes underground power and junctions for pedestrian crossing buttons and two traffic signal structures.

3. DESIGN STANDARDS

DESIGN FREQUENCY

Design storm frequencies and hydrologic methods to size conveyance systems were selected following Spokane Regional Stormwater Manual (2008), HRM Section 4-4 for Eastern Washington design criteria and WSDOT Hydraulics Manual (HM) chapters 3,4 and 6. Modeling outputs can be found in Appendix A-3.

STORMWATER MANAGEMENT GUIDELINES

The WSDOT HRM Stormwater Design Documentation spreadsheet was used in determination of the applicable Minimum Requirements (MR) for the project drainage. The completed spreadsheet can be found in Appendix A-1.

TDA 1 is required to comply with all WSDOT Minimum Requirements #1-9. The project proposes construction of new and replaced asphalt roadway surface (impervious pollutant generating surface) and areas of new landscaped area with sidewalks (new non-pollution generating new impervious surfaces.) The project proposes 47,460 square feet of combined new and replaced impervious surfaces and 101,150 square feet of land disturbing activity triggering the WSDOT HRM Minimum Requirements #1-4. The proposed 41,33 square feet of new impervious surfaces also triggers the WSDOT HRM Minimum Requirements #6-9. The BMP RT.04 – Biofiltration Swale will be used for TDA 1 onsite to capture the stormwater flow.

TDA 2 is required to comply with WSDOT Minimum Requirements #1-9 as it is currently considered part of one project. It is possible that MR# 6 does not apply to this area. BMP RT.02-Filter Strip is currently shown to be used to provide runoff treatment and flow control for TDA 2 to reduce the impact on the existing bioinfiltration pond to the east.

See Appendix A.1 for the WSDOT Stormwater Design Documentation Spreadsheet, and Appendix A.2 for Minimum Requirement flowcharts.

STORMWATER RETROFIT ANALYSIS

The existing drywell on the park and ride site will be removed as part of the development of the site and will not be retrofit to the new site. There are no other existing stormwater structures or facilities within the project site. An existing stormwater retention pond is located 50 feet from the end of the eastbound on-ramp receiving lane addition but will not be adversely impacted and will not be retrofitted.

OTHER REQUIREMENTS

Design for this project was completed using the 2008 Spokane Regional Stormwater Manual (SRSM), which meets or exceeds applicable criteria from the Washington State Department of Ecology's Stormwater Management Manual for Eastern Washington (SWMMEW) for underground injection and discharge to surface waters. Both TDA 1 and TDA 2 are required to comply with all of the SRSM's basic requirements (1-8).

HYDRAULICS MANUAL DEVIATIONS

No deviations from April 2024 WSDOT Hydraulics Manual were used during design.

HIGHWAY RUNOFF MANUAL DEVIATIONS

No deviations from April 2019 WSDOT Highway Runoff Manual were used during design.

PIPE ALTERNATIVES

Pipe used for construction of the stormwater conveyance system shall an 18-inches in diameter and polyvinyl chloride (PVC) material. Other accepted pipe materials include concrete (Class IV, and Class III).

DOWNSTREAM ANALYSIS

Current runoff patterns of flow will generally be maintained, and the stormwater will infiltrate into the existing soils then deposit into a drywell for higher flows as needed. The proposed stormwater system will generally maintain the pre-development flow patterns and use bioretention swales to capture stormwater flow and infiltrate runoff within the project limits. The BMP and conveyance systems designed will maintain existing drainage patterns during large storm events.

NEW STORMWATER DISCHARGE POINTS

Stormwater continues to infiltrate onsite in the post-development condition similarly to the pre-development condition. The proposed development includes seven bioinfiltration swales, each with a single-depth drywell, designed to treat and infiltrate stormwater runoff from both the park-and-ride site and the existing upstream flows from north. Stormwater runoff generated within the receiving lane site continues to sheet flow southeast off the on-ramp where it will naturally disperse, just as in the pre-development condition.

4. POST-DEVELOPMENT CONDITIONS

DRAINAGE BASINS

The post-development condition of the project does not impact TDA delineation. The developed project site consists of the same two distinct threshold discharge areas (TDAs). Table 4-1 below shows a summary of the drainage basin areas in each TDA.

TABLE 4-1 POST-DEVELOPMENT BASIN

	AREA (ACRES)	2-YR	10-YR	25-YR	50-YR	100-YR
TDA 1 - OFF1	0.19	0.25	0.45	0.58	0.67	0.76
TDA 1 - OFF2	0.18	0.23	0.43	0.55	0.64	0.72
TDA 1 - 1	0.05	0.01	0.03	0.03	0.04	0.04
TDA 1 - 2	0.25	0.25	0.45	0.58	0.67	0.76
TDA 1 - 3	0.34	0.29	0.54	0.69	0.80	0.91
TDA 1 - 4	0.23	0.22	0.41	0.52	0.60	0.68
TDA 1 - 5	0.13	0.13	0.23	0.30	0.34	0.39
TDA 1 - 6	0.10	0.09	0.16	0.20	0.23	0.26
TDA 1 - 7	0.60	0.57	1.06	1.34	1.55	1.77
TDA 2 - 1	0.25	0.30	0.56	0.71	0.82	0.93
TOTAL	**2.32**	**2.35**	**4.33**	**5.48**	**6.34**	**7.23**

TDA 1 includes the park and ride site that drains to onsite bioswales with single depth drywells. TDA 2 includes the I-90 on-ramp receiving lane site, to the northeast of the park and ride site. TDA 1 has seven (7) drainage basins that each drain to a pond within the basin. The adjacent roadway on either side of the site will continue to sheet flow to the south. See Appendix A.2 for TDA map and the Post-Development Basin map.

POST DEVELOPED DRAINAGE PATTERNS

Stormwater runoff generated within the new park and ride site will sheet flow to curb openings and catch basins, then flow to bioinfiltration swales with drywells via PVC pipe. The developed site contains seven (7) new bioinfiltration swales with single depth drywells to treat and infiltrate stormwater runoff.

Stormwater runoff generated within TDA 2 can continue to sheet flow southeast off the on-ramp where it will naturally disperse following to the existing stormwater swale to the east, just as in the predeveloped condition. BMP RT.02 - Filter Strip is currently shown to provide runoff treatment and flow control for TDA 2 to reduce the impact on the existing bioinfiltration pond to the east. Further calculations and inspection during the project design will determine if the Filter Strip is necessary.

5. HYDROLOGIC AND HYDRAULIC DESIGN

Conveyance systems to route stormwater flow were designed with the general knowledge of the existing stormwater patterns.

CALCULATIONS

TDA 1 will utilize bioinfiltration swales on the park and ride site. The slope of the seven proposed swales will meet the WSDOT HRM standard for a 1.5% slope along the pond bottom. The biofiltration swale will generally follow the calculations and requirements outlined in the 2019 HRM Chapter 5-4.1.3.

Mannings Equation

$$Q_{biofil} = \frac{1.49 A R^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad AR^{.67} = \frac{Q_{biofil}\ n}{1.49\ s^{0.5}}$$

Where: Q_{biofil} = width of natural dispersion in feet
A = area (ft^2)
R = hydraulic radius (ft)
s = slope (ft/ft)
n = Mannings coefficient

Natural dispersion is utilized for the existing stormwater flow pattern. The RT.02 – Vegetated Filter Strip will follow the calculations and requirements outlined in the 2019 HRM Chapter 5-4.1.3.

Natural Dispersion

$$LID = \frac{ACP}{\frac{K_s}{r_i} - 1}$$

Where: LID = width of natural dispersion in feet
ACP = width of roadway in feet
K_s = saturated hydraulic conductivity in inches per hour
r_i = rainfall intensity in inches per hour

The option to integrate the BMP RT.02 - Filter Strip is currently shown in the basin map to provide runoff treatment and flow control for TDA 2 to reduce the impact on the existing bioinfiltration pond to the east.

CONCLUSIONS AND RECOMMENDATIONS

Stormwater runoff generated within TDA 1 will be adequately treated and captured by the proposed seven (7) bioswales for the post-development project site. It is considered that onsite grading will generally grade towards the ponds as shown and all the ponds will be a minimum depth to accommodate the 1 foot of freeboard required. The drywells will be set at an elevation to allow time for water quality treatment and infiltration. All ponds are expected to drain and infiltrate within a 72-hour time period to meet requirements.

Stormwater runoff generated within TDA 2 will be adequately treated and captured by the I-90 on-ramp receiving lane. This will be accomplished by allowing the flows to disperse as in the pre-development condition or by adding a Filter Strip to the south of the shoulder.

6. PERMITS AND ASSOCIATED REPORTS

ENVIRONMENTAL ISSUES, FISH AND OTHER ENDANGERED HABITAT

No critical areas or fish passage issues were identified in the project area.

PERMITS/APPROVALS

No permits were required for storm drainage in this project.

EASEMENTS

No easements were required for storm drainage in this project.

ADDITIONAL REPORTS OR STUDIES

Geoengineers geotechnical report available. – See Appendix A-10

7. Inspection and Maintenance Summary

The project contains existing drainage conveyance systems and stormwater facilities. The proposed stormwater BMPs are low maintenance facilities and minimal maintenance is anticipated. Operational maintenance shall follow the guidelines of Table 5-11, 5-17, 5-18, and 5-19 of the WSDOT HRM.

Appendix A-1

Stormwater Design Documentation Spreadsheet

Project Title:	**I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride**
WSDOT Region:	Eastern
WIN:	
PIN(s):	
Design Manual Used:	Highway Runoff Manual
Manual Publication Year:	2019
Job Number:	STA WO# 10325-0007

2019 HRM Spreadsheet Version 6.3

Is this project in western Washington? **NO**

Existing Impervious Surface

Total Project Area (ft^2)	18,793
acres =	0.431

New Impervious Surface

Total Project Area (ft^2)	41,533
acres =	0.953

Conversion of Native Vegetation to Lawn or Landscaped

Total Project Area (ft^2)	N/A

Conversion of Native Vegetation to Pasture

Total Project Area (ft^2)	N/A

Replaced Impervious Surface

Total Project Area (ft^2)	5,927
acres =	0.136

Land Disturbing Activity

Total Project Area (ft^2)	101,150
acres =	2.322

Is this project a "non-road-related" project? (See HRM Glossary for definition) **YES**

>>>>>Enter replacement value of existing site here (Cell C31)-------> $300,000

>>>>>Enter cost of proposed improvements here (Cell C32)---------> $1,000,000

Set the box to the right to NO ----> NO

Description	Project Area	Threshold Area Triggers	HRM Figure 3-1 Step #	Decision Response	HRM Minimum Requirements
New and replace impervious surfaces added to Project	47,460	≥ 2,000 ft^2	2	YES	Apply MR 1-4 to the new and replaced impervious surfaces and land disturbed on the Project
Land disturbing activity for the Project	101,150	≥ 7,000 ft^2	2	YES	Apply MR 1-4 to new and replaced impervious surfaces and land disturbed on the Project
New impervious surface added to Project	41,533	≥ 5,000 ft^2	3	YES	Apply MR 6-9 for new impervious surfaces and converted pervious surfaces on the Project
Conversion of native vegetation to lawn or landscaped area	N/A	≥ 32,670 ft^2 (3/4 acres)	3	N/A	N/A
Conversion of native vegetation to pasture	N/A	≥ 108,900 ft^2 (2.5 acres)	3	N/A	N/A
New impervious surfaces add 50% or more to the existing impervious surfaces within the Project limit	N/A	New impervious ≥ 5,000 sq. ft AND (New Impervious surface) ≥ 1/2 (Exist Impervious surface)	4	N/A	Check non-road-related project theshold below
For non-road-related Projects, proposed value of improvements greater than replacement value	See HRM Figure 3-1 for complete threshold. Non-road-related project generally refers to rest area, ferry terminals, and maintenance facility Projects.	(New impervious + replaced impervious) ≥ 5,000 sq. ft AND (Proposed value of improvements) ≥ 1/2 (replacement value of existing site)	4	YES	Apply MR 6-9 to replaced impervious surfaces on the Project

Summary of All Minimum Requirements:

Apply MR 1-4 to New and Replaced impervious surfaces and land disturbed on the Project
Apply MR 6-9 to New impervious surfaces and Converted pervious surfaces on Project
Apply MR 6-9 to Replaced imperious surfaces on Project
Complete the Level of Retrofit Tab
Go To the 'Step 5 and 6' tab

MR #	Minimum Requirements	MR #	Minimum Requirements
1	Stormwater Planning	6	Flow Control (Quantity)
2	Construction Stormwater Pollution Prevention	7	Wetlands Protection
3	Source Control of Pollutants	8	Incorporating Approved Basin Plans into Stormwater Management
4	Maintaining the Natural Drainage System	9	Operation and Maintenance
5	Runoff Treatment (quality)		

Project Title: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride
WSDOT Region: Eastern
WIN:
PIN(s):
Design Manual Used: Highway Runoff Manual
Manual Publication Year: 2019
Job Number: STA WO# 10325-0007

2019 HRM Spreadsheet Version 6.3

Is this project in western Washington? NO

Existing PGIS

Total Project Area (ft^2)	18,793
acres =	0.431

New PGIS

Total Project Area (ft^2)	41,533
acres =	0.953

Conversion of Native Vegetation to PGPS

Total Project Area (ft^2)	N/A

Replaced PGIS

Total Project Area (ft^2)	5,927
acres =	0.136

Is this project a "non-road-related" project? (See HRM Glossary for definition) YES

>>>>>Replacement value of exisitng site -------> $300,000

>>>>>Cost of propsed improvements --------> $1,000,000

Description	Project Area (ft^2)	Threshold Area (ft^2)	HRM Figure 3-2 Step #	Decision Response	HRM Minimum Requirements
New PGIS added to Project	41,533	≥ 5,000	5	YES	Apply MR 5 for new PGIS and converted PGPS on the Project
Conversion of Native Vegetation to PGPS	NA	≥ 32,670 (3/4 acres)	5	N/A	N/A
New PGIS add 50% or more to the existing PGIS within the Project limit	N/A	New PGIS ≥ 5,000 AND (New PGIS) ≥ 1/2 (Exist PGIS)	6	N/A	Check non-road-related threshold below
For non-road-related Projects, proposed value of improvements greater than replacement value	See HRM Figure 3-1 for complete threshold. Non-road-related Project generally refers to rest area, ferry terminals, and maintenance facility projects.	(New PGIS + replaced PGIS) ≥ 5,000 AND (Proposed value of improvements) ≥ 1/2 (replacement value of existing site)	6	YES	Apply MR 5 to Replaced PGIS on Project

Summary of All Minimum Requirements:

Apply MR 5 to New PGIS and converted PGPS the on Project
Apply MR 5 to Replaced PGIS on the Project
Complete the Level of Retrofit Tab
Go to Step 7 RT tab

MR #	Minimum Requirements	MR #	Minimum Requirements
1	Stormwater Planning	6	Flow Control (Quantity)
2	Construction Stormwater Pollution Prevention	7	Wetlands Protection
3	Source Control of Pollutants	8	Incorporating Approved Basin Plans into Stormwater Management
4	Maintaining the Natural Drainage System	9	Operation and Maintenance
5	Runoff Treatment (quality)		

Project Title: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride
WSDOT Region: Eastern
WIN:

PIN(s):

Design Manual Used: Highway Runoff Manual
Manual Publication Year: 2019
Job Number: STA WO# 10325-0007

2019 HRM Spreadsheet Version 6.3

Refer to HRM Figure 3-3 Step 7

Are the replaced PGIS applicable to the project per HRM Figure 3-2 Step 6? YES
Are there any existing runoff treatment Stormwater BMPs within the project limits? NO

Is this project in western Washington? NO

Does the project have retrofit requirements for discharges to Puget Sound? NO

TDA Description	Description	New PGIS Area (ft^2)	Replaced PGIS Area (ft^2)	Non-Effective PGIS Area (ft^2)	Effective PGIS Area (ft^2)	Converted PGPS Area (ft^2)	RT needed for TDA based on Effective PGIS? *Flow Chart Step 7* (Yes/No)	RT needed for TDA based on PGPS? *Flow Chart Step 7* (Yes/No)	RT needed for TDA? PGIS Area (ft^2)	RT needed for TDA? Converted PGPS Area (ft^2)	If RT needed, what is ADT of roadway in TDA? (ADT)	Is Roadway inside Urban Growth Area? (Yes/No)	Does the Roadway Have Full or Partially Controlled Limited Access? (Yes/No)	Enhanced RT or Basic RT?	Oil Control (Yes/No)	Phosphorus Control? (Yes/No)	Comments
1	Park and Ride Site	41,533	0	0	41,533	0	YES	N/A	41,533	N/A	500	YES	NO	Basic RT	NO	NO	
2	On-Ramp	0	5,927	0	5,927	0	YES	N/A	5,927	N/A	8,600	YES	NO	Enhanced RT	YES	NO	
Area Totals for Project		**41,533**	**5,927**	**0**	**47,460**	**0**			**47,460**	**0**							

Project Title: **I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride**
WSDOT Region: Eastern
WIN:
PIN(s):
Design Manual Used: Highway Runoff Manual
Manual Publication Year: 2019
Job Number: STA WO# 10325-0007

2019 HRM Spreadsheet Version 6.3

Refer to HRM Figure 3-3 Step 8

Are the replaced Impervious surfaces applicable to the project per HRM Figure 3-1 Step 4? YES

Are there any existing flow control stormwater BMPs within the project limits? NO

Is this project in western Washington? NO

Does the project have retrofit requirements for discharges to Puget Sound? NO

TDA Description	Description	New Impervious Surface Area (ft^2)	Reverted Impervious Surface** Area (ft^2)	Net-New Impervious Surface Area (ft^2)	Replaced Impervious Surface Area (ft^2)	Non-Effective Impervious Surface Area (ft^2)	Effective Impervious Surface Area (ft^2)	Conversion of Native Vegetation to Lawn or Landscape per TDA Area (ft^2)	Increase of 0.15 cfs in 100-year Recurrence Interval Flow for TDA?*** (Yes/No)	FC Needed for TDA based on Effective Impervious surface threshold? (Yes/No)	FC needed for TDA based on Native Vegetation Conversion? (Yes/No)	FC needed for TDA based on 0.15 cfs increase in flow? (Yes/No)	FC needed for TDA? Effective Impervious Area (ft^2)	FC needed for TDA? Converted Pervious Surfaces Area (ft^2)	Comments
1	Park and Ride Site	41,533	0	41,533	0	0	41,533	-	-	YES	N/A	N/A	41,533	N/A	
2	On-Ramp	0	0	0	5,927	0	5,927	-	-	NO	N/A	N/A	0	N/A	
	Area Totals for Project	**41,533**	**0**	**41,533**	**5,927**	**0**	**47,460**	**0**					**41,533**	**0**	

**** Input zero into this column if the reverted impervious surface does not meet the reversion requirements per HRM 4-3.5.3.**

*****See Highway Runoff Manual 3-3.6.3 for MGSFlood modeling guidance.**

Project Title: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride
WSDOT Region: Eastern
WIN:
PIN(s):
Design Manual Used: Highway Runoff Manual
Manual Publication Year: 2019
Job Number: STA WO# 10325-0007

2019 HRM Spreadsheet Version 6.3

Is this a WSDOT project initiated by WSDOT (i.e., this isn't a project initiated by a developer, local agency, or other state agency)?**	NO	
Does any part of the project drain to Puget Sound AND does any TDA in the project exceed runoff treatment or flow control thresholds?		
Are the replaced Impervious surfaces applicable to the project per HRM Figure 3-2 Step 5?	YES	
Are the replaced PGIS applicable to the project per HRM Figure 3-2 Step 6?	YES	
Was there any retrofitting of existing impervious surfaces and/or existing PGIS done by the project (including offsite in-kind retrofitting)?	YES	
Choose the type of retrofit of existing impervious surfaces done by the project.	PROJECT TRIGGERED	
Choose N/A ---------->	N/A	
Choose N/A ---------->	N/A	

PROJECT TRIGGERED

How much area of replaced impervious was retrofitted onsite for flow control in the project? (PROJECT TRIGGERED)		acres
How much area of replaced PGIS was retrofitted onsite for runoff treatment in the project? (PROJECT TRIGGERED)		acres
How much area of existing impervious was retrofitted onsite for flow control in the project?	0.000	acres
How much area of existing PGIS was retrofitted onsite for runoff treatment in the project?	5.000	acres
Leave Blank ---------->		acres
Leave Blank ---------->		acres
How much area of existing impervious was fully reverted to a pervious surface?	0.00008	acres
Choose N/A ---------->	N/A	
Choose N/A ---------->	N/A	
Leave Blank ---------->		

Were any new permanent stormwater BMPs constructed by the project OR were any existing stormwater BMPs modified by the project? YES

Goto the 'BMPs_New_or_Modified' and 'BMPs_Removed_or_Modified' tabs and enter in the permenant stormwater BMP information.

Project Title:	**I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride**
WSDOT Region:	**Eastern**
CN WIN:	
PIN:	
Design Manual Used:	**Highway Runoff Manual**
Manual Publication Year:	**2019**
Job Number:	**STA WO# 10325-0007**
CN Contract Number:	
SubstantiallyCompleteOperationallyComplete Date:	
CNPhaseEndPlanned Date:	
CNPhaseEndActual Date:	
Is the project within the WSDOT NPDES permit area?	**YES**
CN PE:	

2019 HRM Spreadsheet Version 6.3

State Route	Begin MP	Begin Latitude** (in Decimal Degrees)	Begin Longitude** (in Decimal Degrees)	End MP	End Latitude** (in Decimal Degrees)	End Longitude** (in Decimal Degrees)	TDA Name	Stormwater BMP Type	Is this an existing BMP to be modified by project or is this a new BMP?	Will this BMP be owned and operated by WSDOT?	Will this BMP be maintained by WSDOT?	List the old WSDOT Feature Number*** (existing BMPs that will be modified by the project will be given a new Feature Number)	List the new WSDOT Feature Number*** (existing BMPs that will be modified by the project will be given a new Feature Number)	Is this BMP designed to full or partial HRM standards?****	List the amount of Effective Impervious Surface (flow control) mitigated by the new or modified BMP (Acres)	List the amount of Effective PGIS (runoff treatment) mitigated by the new or modified BMP (Acres)	If retrofitting existing impervious surfaces, list the amount of existing impervious surface mitigated by the new or modified BMP for flow control (Acres)	If retrofitting existing PGIS, list the amount of existing PGIS mitigated by the new or modified BMP for runoff treatment (Acres)	Comments
090	287.86	47.67	-117.28	287.86	47.67	-117.28	Park and Ride Site	Bioinfiltration Pond (EW only)	New	YES	NO	N/A		Full			N/A	N/A	
090	287.86	47.67	-117.28	287.86	47.67	-117.28	Park and Ride Site	Drywell	New	YES	NO	N/A		Full			N/A	N/A	

Project Title: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride
WSDOT Region: Eastern
CN WIN:
PIN:
Design Manual Used: Highway Runoff Manual
Manual Publication Year: 2019
Job Number: STA WO# 10325-0007
CN Contract Number:
SubstantiallyCompleteOperationallyComplete Date:
CNPhaseEndPlanned Date:
CNPhaseEndActual Date:
Is the project within the WSDOT NPDES permit area? YES
CN PE:

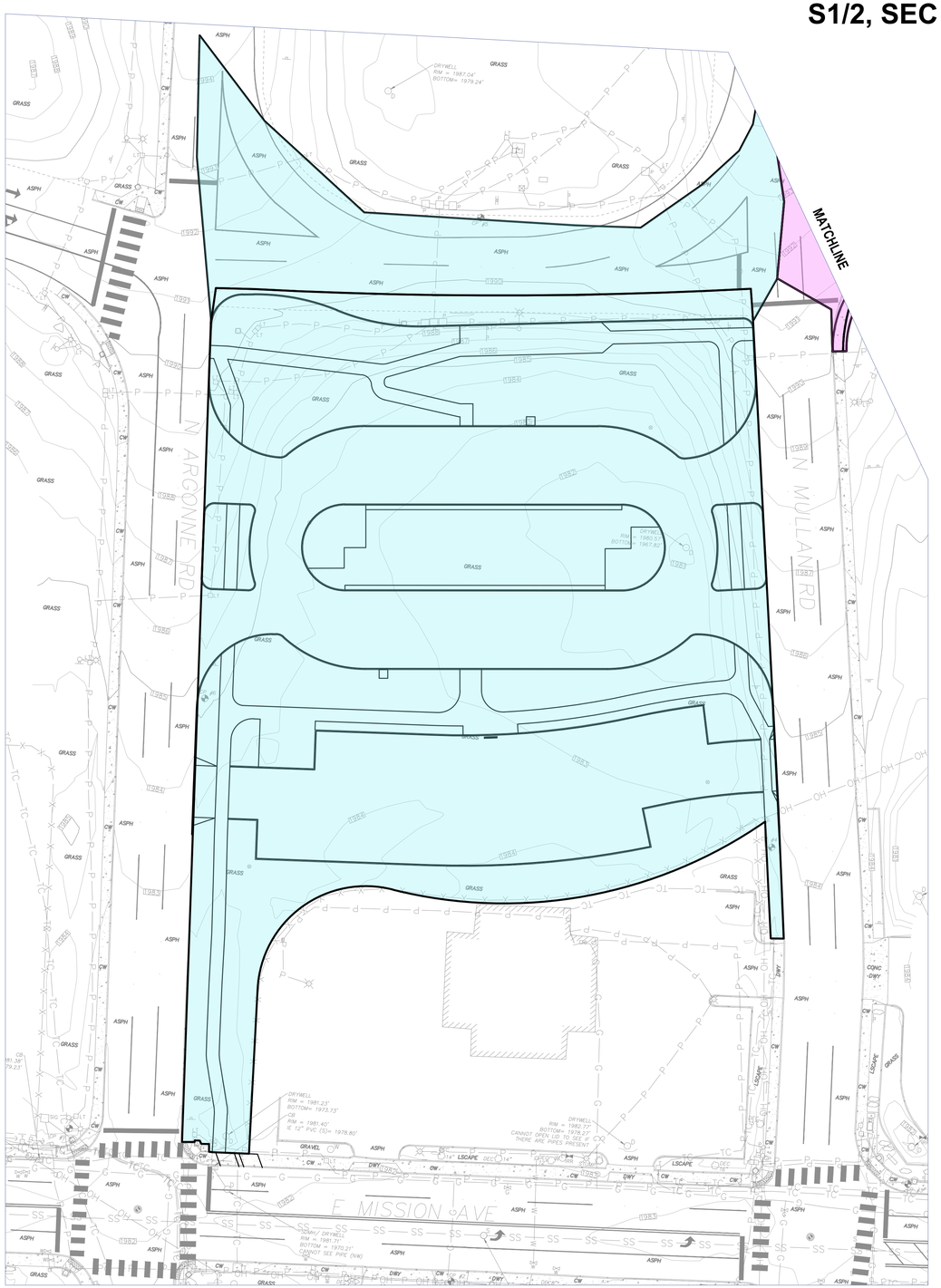
2019 HRM Spreadsheet Version 6.3

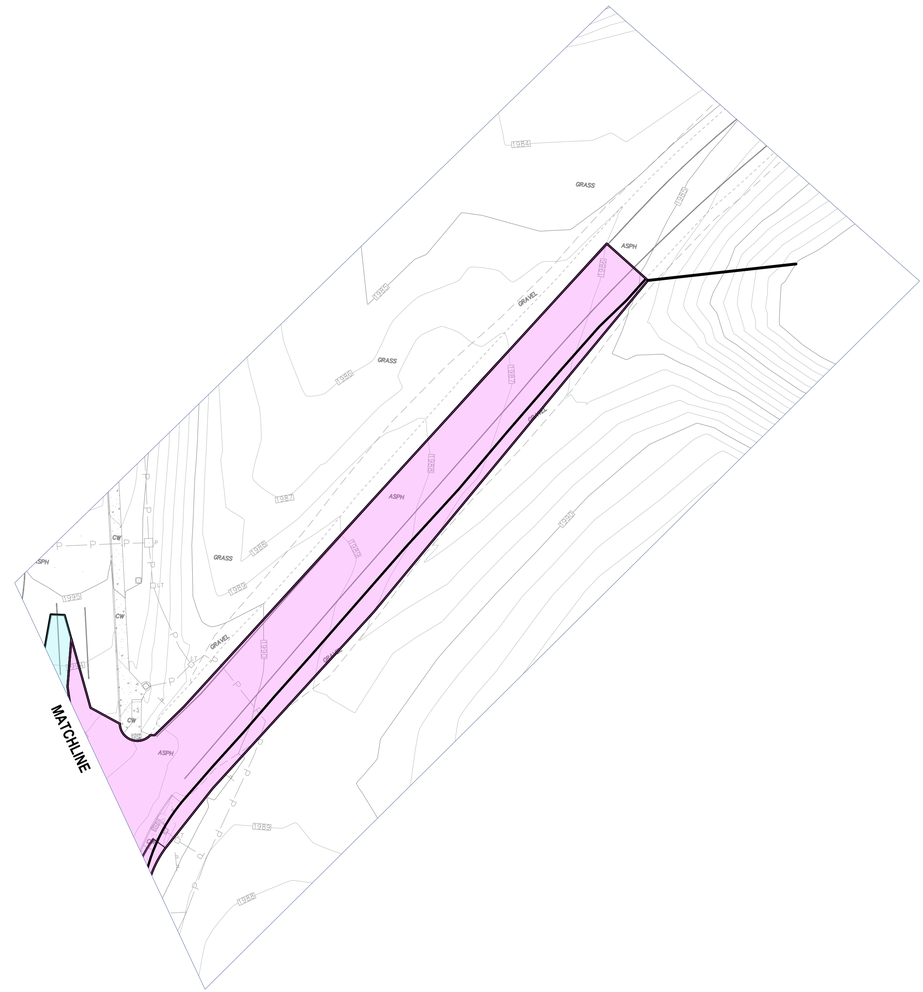
State Route	Begin MP	Begin Latitude** (in Decimal Degrees)	Begin Longitude** (in Decimal Degrees)	End MP	End Latitude** (in Decimal Degrees)	End Longitude** (in Decimal Degrees)	TDA Name	Existing Stormwater BMP Type	Is this an existing BMP going to be modified or completely removed by project?	Existing WSDOT Feature Number (See WSDOT HATS*** web application to determine Feature Number)	If this is an existing BMP being modified, please describe the proposed modification	List the amount of existing Impervious surface (flow control) mitigated by the existing BMP before the project (Acres)	List the amount of existing PGIS (runoff treatment) mitigated by the existing BMP before the project (Acres)	Is the amount of existing impervious surface and PGIS receiving treatment and flow control re-established by a new or modified BMP?	Comments
090	287.86	47.67	-117.28	287.86	47.67	-117.28	Park and Ride Site	Drywell	Completely Removed	DRAI00057663	N/A	0.000	0.000	YES	Drywell in low point of undeveloped project site

Appendix A-2

TDA Maps, Drainage Basin Maps, and Area Calculations

S1/2, SEC 07, T25N, R44E, WM





LEGEND

- TDA 1
- TDA 2

N

0 15' 30' 60'

1 inch = 30 feet

NO.	DATE	BY	CHD.	APPR.	REVISION

DRAWN BY: KSS | DESIGNED BY: CDZ
CHECKED BY: JRP | APPROVED BY: MAB
DATE: 05/27/2025
JOB No.: 2400399
SCALE: AS NOTED

CALL TWO BUSINESS DAYS BEFORE YOU DIG 1-800-424-5555

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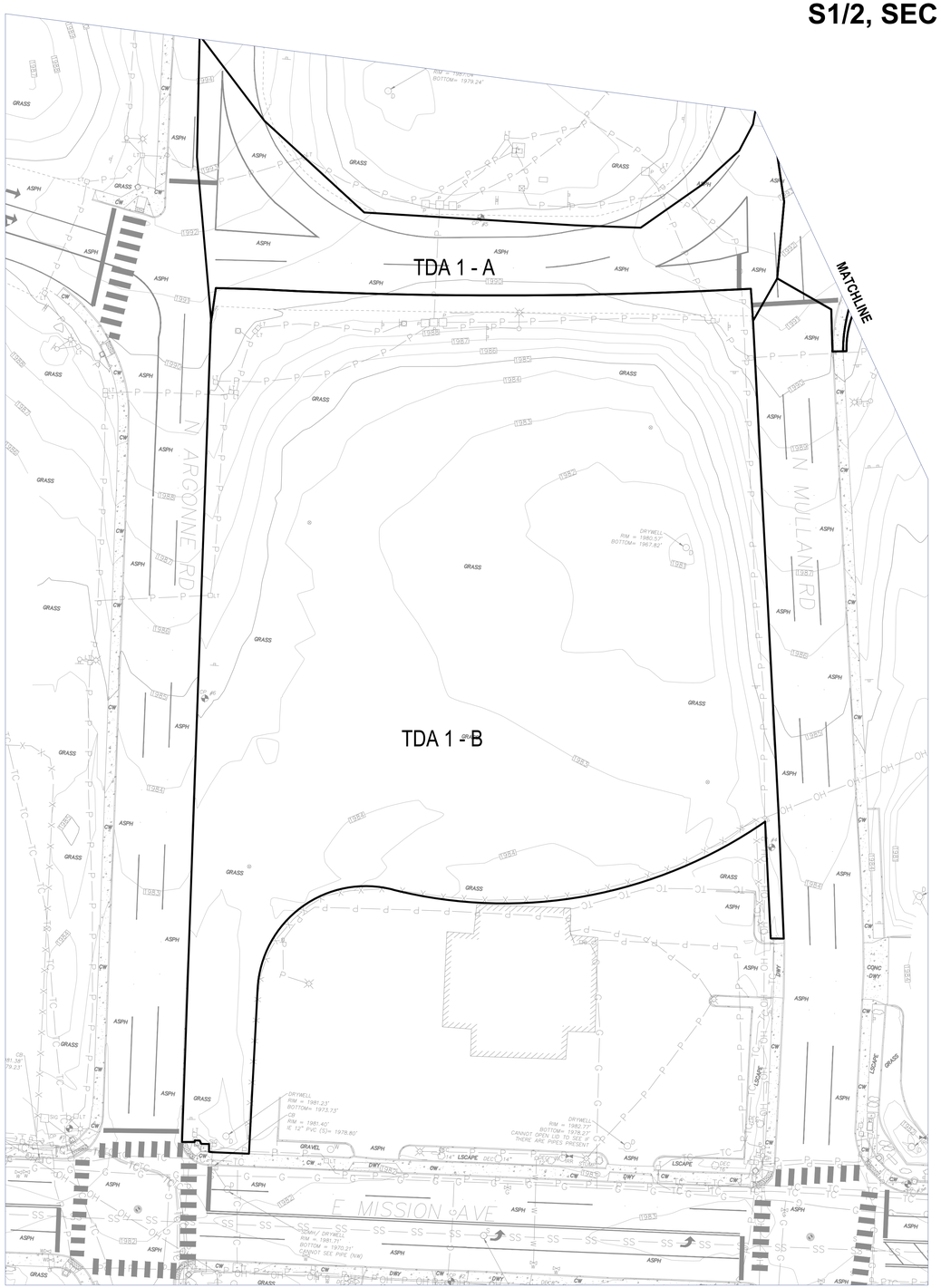
ARGONNE STATION PARK AND RIDE PROJECT
SPOKANE VALLEY, WA

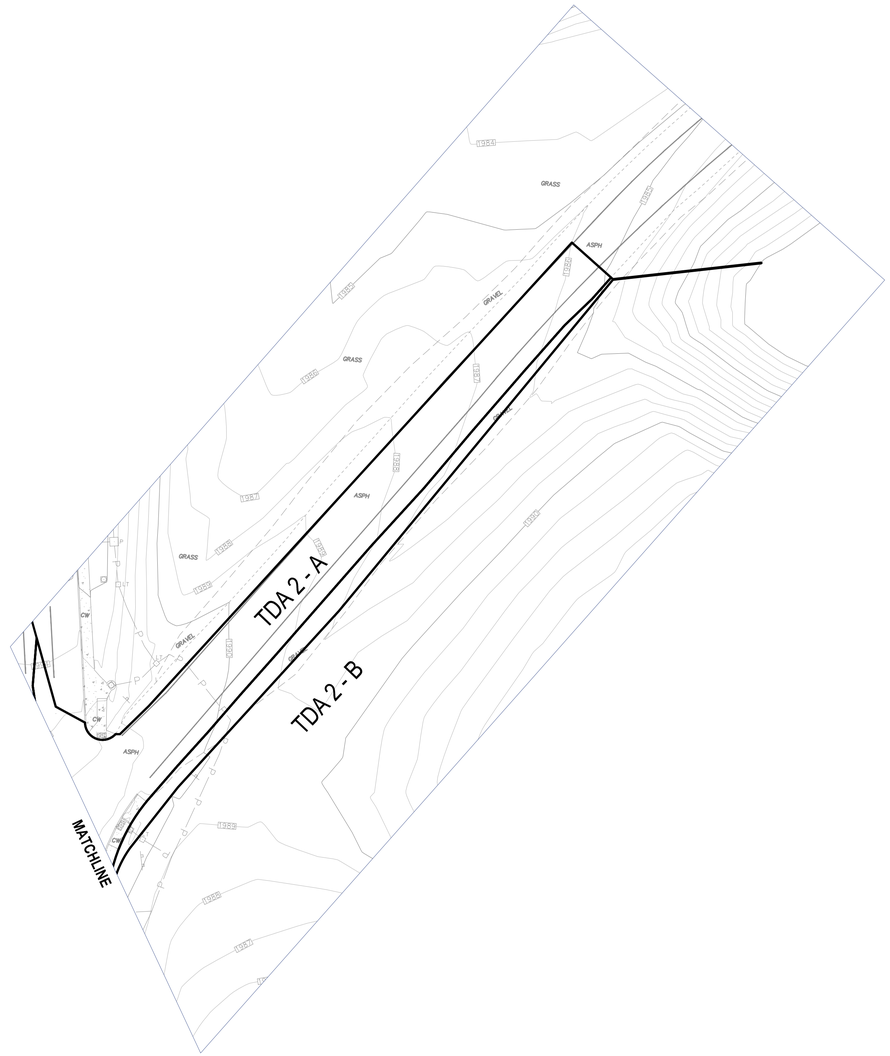
TDA MAP

SHEET
S 01

Jun 18, 2025 – 12:01pm ChonitZ Z:\2400001-2409999\2400399 STA I-90 Valley HPTC WO7 Argonne SV\CADD\Exhibits\2025 06 13 Drainage Report\ARC-DRAINAGE.dwg

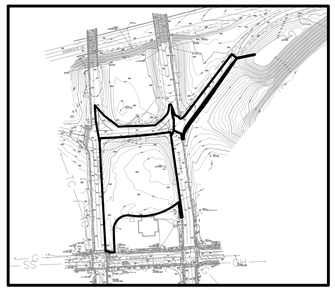
S1/2, SEC 07, T25N, R44E, WM





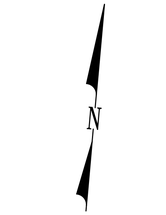
LEGEND

- TDA 1
- TDA 2



KEY MAP

SCALE: 1" = 250'



NO.	DATE	BY	CHD.	APPR.	REVISION

DRAWN BY: KSS | DESIGNED BY: CDZ
CHECKED BY: JRP | APPROVED BY: MAB
DATE: 05/27/2025
J O B No. : 2400399
S C A L E: AS NOTED

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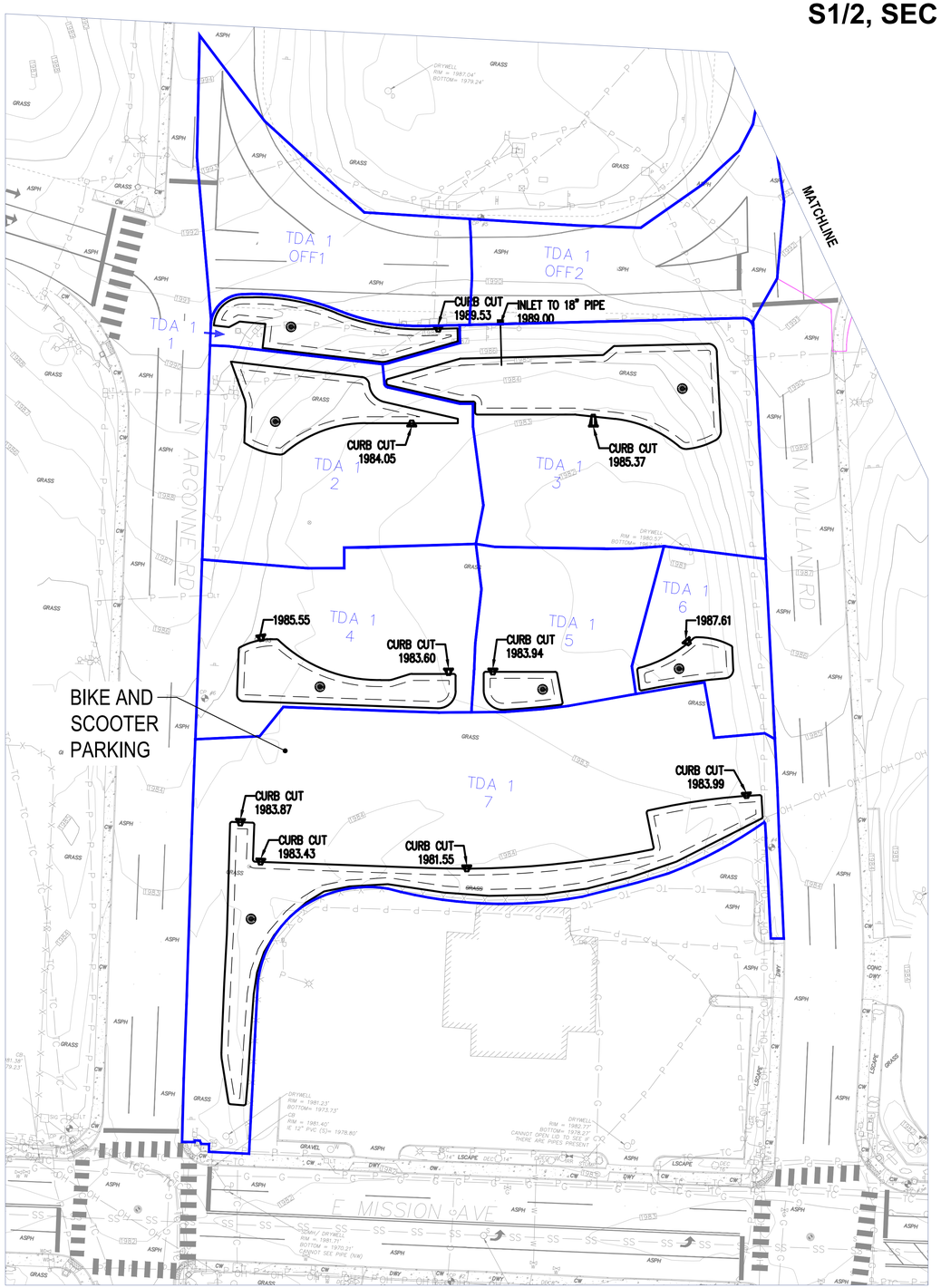
ARGONNE STATION PARK AND RIDE PROJECT
SPOKANE VALLEY, WA

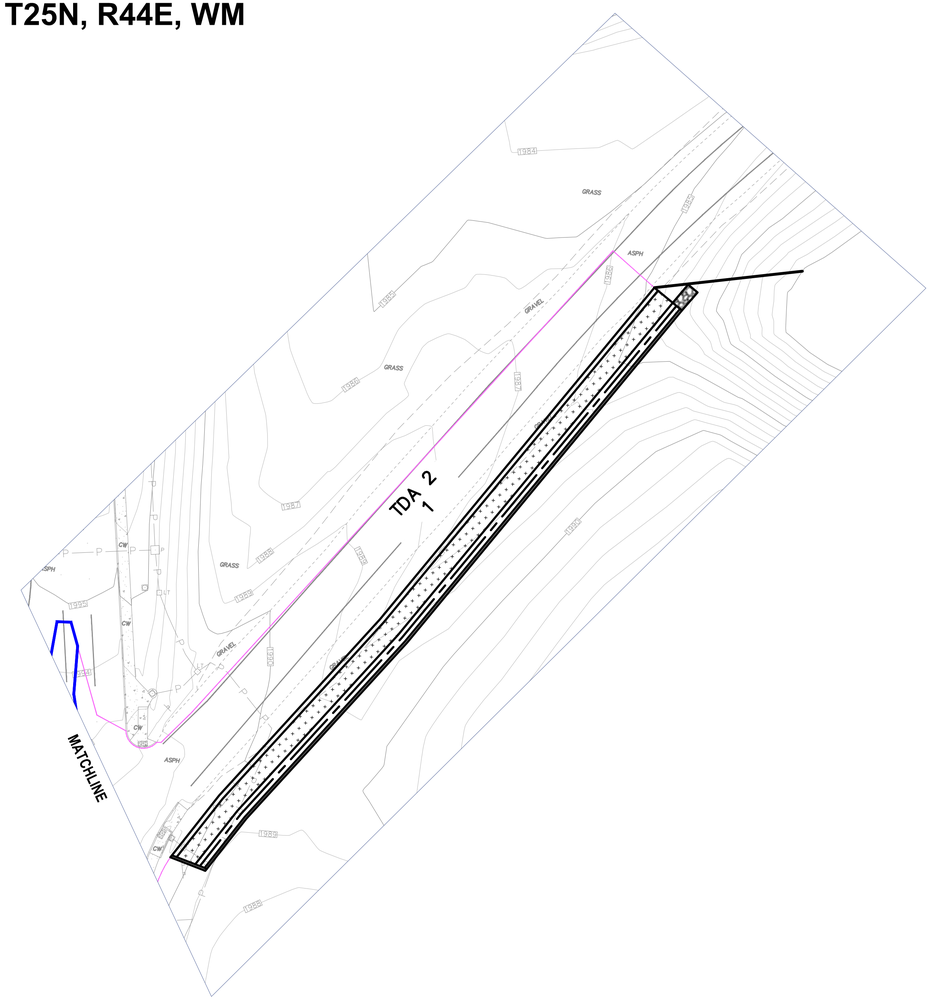
EXISTING BASINS

SHEET
S 02

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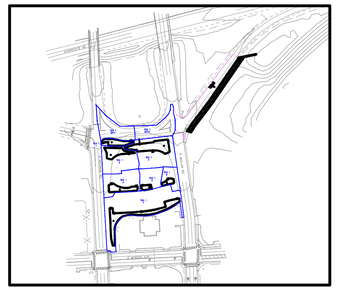
S1/2, SEC 07, T25N, R44E, WM





LEGEND

- TDA 1
- TDA 2
- BASINS



KEY MAP

SCALE: 1" = 250'

N

0 15' 30' 60'

1 inch = 30 feet

NO.	DATE	BY	CHD.	APPR.	REVISION

DRAWN BY: KSS | DESIGNED BY: KSS
CHECKED BY: JRP | APPROVED BY: MAB
DATE: 05/27/2025
J O B No. : 2400399
SCALE: AS NOTED

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SPOKANE VALLEY, WA

PROPOSED BASINS

SHEET
S 03

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Jun 18, 2025 - 12:21pm
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BASIN TABLES
RATIONAL METHOD

PROJECT: I-90 / ARGONNE RD & MULLAN RD INTERCHANGE - STA PARK & RIDE, SPOKANE VALLEY, WA
REVIEWER: JRP
DESIGNER: CDZ
DATE: 6/11/2025

BASIN INFORMATION TABLE		*"C" Value*									Q=CIA (cfs)				
		0.90	*0.90*	*0.90*	*0.90*	*0.15*	*0.30*	*0.55*	*Intensity (in/hr)*		*1.42*	*2.62*	*3.32*	*3.84*	*4.38*
Basin	**Total (sq ft)**	**Asphalt (sq ft)**	**Attached Concrete (sq ft)**	**Detached Concrete (sq ft)**	**Buildings / Roof (sq ft)**	**Grass / Landscape (sq ft)**	**Unimproved (sq ft)**	**Gravel (sq ft)**	**Combined "C"**	**Area (acres)**	**2 Year Storm**	**10 Year Storm**	**25 Year Storm**	**50 Year Storm**	**100 Year Storm**
PRE-DEVELOPMENT CONDITION															
TDA 1 - A	**13,691**	13,691	0	0	0	0	0	0	0.90	0.31	0.40	0.74	0.94	1.09	1.24
TDA 1 - B	**76,075**	0	0	0	0	0	76,075	0	0.30	1.75	0.74	1.37	1.74	2.01	2.29
TDA 2 -A	**9,185**	9,185	0	0	0	0	0	0	0.90	0.21	0.27	0.50	0.63	0.73	0.83
TDA 2 -B	**1,843**	0	0	0	0	0	0	1,843	0.55	0.04	0.03	0.06	0.08	0.09	0.10
PRE-DEVELOPMENT TOTALS	**100,794**	**22,876**	**0**	**0**	**0**	**0**	**76,075**	**1,843**	**0.44**	**2.31**	**1.45**	**2.67**	**3.39**	**3.92**	**4.47**
POST-DEVELOPMENT CONDITION															
TDA 1 - OFF1	**8,402**	8,402	0	0	0	0	0	0	0.90	0.19	0.25	0.45	0.58	0.67	0.76
TDA 1 - OFF2	**8,005**	8,005	0	0	0	0	0	0	0.90	0.18	0.23	0.43	0.55	0.64	0.72
TDA 1 - 1	**2,316**	0	0	120	0	2,196	0	0	0.19	0.05	0.01	0.03	0.03	0.04	0.04
TDA 1 - 2	**10,860**	4,860	0	3,036	0	2,964	0	0	0.70	0.25	0.25	0.45	0.58	0.67	0.76
TDA 1 - 3	**14,698**	4,820	0	4,300	0	5,578	0	0	0.62	0.34	0.29	0.54	0.69	0.80	0.91
TDA 1 - 4	**9,823**	4,420	0	2,637	0	2,766	0	0	0.69	0.23	0.22	0.41	0.52	0.60	0.68
TDA 1 - 5	**5,681**	2,754	0	1,318	0	1,609	0	0	0.69	0.13	0.13	0.23	0.30	0.34	0.39
TDA 1 - 6	**4,244**	2,050	0	609	0	1,585	0	0	0.62	0.10	0.09	0.16	0.20	0.23	0.26
TDA 1 - 7	**26,064**	13,390	0	4,800	0	7,874	0	0	0.67	0.60	0.57	1.06	1.34	1.55	1.76
TDA 2 - 1	**11,028**	9,185	0	0	0	0	0	1,843	0.84	0.25	0.30	0.56	0.71	0.82	0.93
POST-DEVELOPMENT TOTALS	**101,120**	**57,886**	**0**	**16,820**	**0**	**24,572**	**0**	**1,843**	**0.71**	**2.32**	**2.34**	**4.33**	**5.48**	**6.34**	**7.23**

PRE-DEVELOPMENT PGIS		**24,719 sq ft**
POST-DEVELOPMENT PGIS		**59,729 sq ft**
	NEW PGIS	**41,533 sq ft**
NEW AND REPLACED PGIS		**47,460 sq ft**

Appendix A-3

Calculations and Program Output

RT.04 - Basic Biofiltration Swale and Compost Amended Biofiltration Swale
Project: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride Designed By: CDZ
Description: Checked By:

BASIC BIOSWALE AND COMPOST AMENDED BIOSWALE SPREADSHEET VERSION 2.1

Design Steps

D-1 Determine runoff treatment design flow rate Q_{wq}

Q_{wq} 0.260 Runoff treatment design flow rate from MGS Flood OR SBUH; MGSFlood reports an online and offline flow rate, please enter the applicable design flow rate

D-2 Determine the biofiltration design flow rate (Q_{biofil})

Is the bioswale in eastern WA? Yes Qwq=Qbiofil

N/A

Is bioswale online or offline? online

Q_{biofil} 0.260 runoff treatment design flow rate

D-3 Determine the longitudinal slope of the proposed biofiltration swale (ft/ft)

s 0.015 ft/ft

D-4 Select a soil and vegetation cover suitable for the biofiltration swale

soil/veg Grass-legume mix on lightly compacted topsoil with 3-inch medium compost blanket (CABS) <--Use pull down box

Manning's n= 0.35 From HRM Table 5-3

D-5 Select the design depth of flow y (see HRM Table 5-4)

y 0.33 (ft) design depth of flow; for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-6 Select a trapezoidal swale cross-sectional shape.

D-7 Use Manning's Eq and first approximations relating hydraulic radius and dimensions to get width for trapezoidal cross section

$$Q_{biofil} = \frac{1.49 A R^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad AR^{.67} = \frac{Q_{biofil}\, n}{1.49\, s^{0.5}}$$

<--manning's changed

HRM Chapter 5 Equation E-11

Use Excel Solver

D-7a

Q_{biofil}	0.260	cfs - runoff treatment design flow rate
A	2.307	ft2 - wetted area
R	0.285	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	6.00	ft - bioswale bottom width
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow = maximum depth of flow

Q_{biofil} 0.521 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "b" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-7b If the swale calculations above give a swale width less than 2 feet wide, re-run calculations with 2 foot wide swale, solve for depth y Or if redesigning swale with different dimensions, use below calculator and use Excel Goal Seek to determine new depth of flow.

Q_{biofil}	0.260	cfs - runoff treatment design flow rate
A	2.307	ft2 - wetted area
R	0.285	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	6.00	ft - enter new bottom width if applicable (2 foot is minimum)
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow

Q_{biofil} 0.521 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "y" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-8 **Enter Final Bioswale Dimensions from the calculations in Step D-7a or D-7b**

Enter Final Swale Area	2.307	ft2 - Wetted Area
Enter Final Swale R	0.285	ft - hydraulic radius
Enter Final Swale slope s	0.015	ft/ft longitudinal slope of swale
Enter Final Swale n	0.35	Manning's coefficient
Enter Final Swale bottom width b	6.00	ft - swale bottom width
Enter Final Swale $z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale $z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale flow depth y	0.330	ft - design depth flow

D-9 **Computer the flow velocity at Q_{biofil}**

$$V_{biofil} = \frac{Q_{biofil}}{A}$$

HRM Chapter 5 Equation E-12

V_{biofil}	0.11	ft/sec - flow velocity; 1 ft/sec maximum

Flow veloicty is OK since it is less than 1 ft/sec

D-10 **Compute Swale Length L (ft)**

$$L = V_{biofil} \times t$$

t	540	seconds - 9 minutes (540 seconds) for CABS, Basic, and Wet bioswale
L	60.86	ft - required length of bioswale; If swale is less than 100 feet, make swale have narrower bottom width (2 foot minimum) and repeat Steps D-7 - D-10 and recalculate to get length over 100 feet or keep swale bottom width make swale length 100 feet minimum

D-11 Does the bioswale need to be redesigned to fit within the provided right of way?

No	Continue to Step FC-1

Freeboard Check (Online Swales Only)

FC-1	Q25yr	0.61	cfs - If in Eastern Washington, use the 25 year storm event
		1.00	Safety Factor - For SBUH or SCS, use 1.0
	Q_{convey}	0.61	cfs - Q25yr x saftey factor
FC-2	n	0.03	(lowest possible Manning's from HRM)
FC-3	depth y	0.09	ft - design depth flow
	A	0.53	ft2 - wetted area
	R	0.082	ft - hydraulic radius
	S	0.015	ft/ft longitudinal slope of swale
	b	6.00	ft - swale bottom width
	$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	Q_{convey}	0.61	cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{convey} above changing the "y" value
FC-4	$D_{(total)}$	1.09	ft, total required swale depth. Does not take into account design standards for minimum ditch depth from the Design Manual (roadway sections)

Final Swale Dimensions			
Swale Length	60.86	ft	<----Note minimum swale length = 100 ft
Bottom Width	6.0	ft	
Swale Longitudinal Slope	0.015	ft/ft	
$Z_{foreslope}$	3.0		
$Z_{backslope}$	3.0		
WQ Depth	0.33	ft	
Swale Depth (includes 1 ft Freeboard)	1.09	ft	

RT.04 - Basic Biofiltration Swale and Compost Amended Biofiltration Swale
Project: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride Designed By: CDZ
Description: Checked By:

BASIC BIOSWALE AND COMPOST AMENDED BIOSWALE SPREADSHEET VERSION 2.1

Design Steps

D-1 Determine runoff treatment design flow rate Q_{wq}

Q_{wq} 0.250 Runoff treatment design flow rate from MGS Flood OR SBUH; MGSFlood reports an online and offline flow rate, please enter the applicable design flow rate

D-2 Determine the biofiltration design flow rate (Q_{biofil})

Is the bioswale in eastern WA? Yes Qwq=Qbiofil

N/A

Is bioswale online or offline? online

Q_{biofil} 0.250 runoff treatment design flow rate

D-3 Determine the longitudinal slope of the proposed biofiltration swale (ft/ft)

s 0.015 ft/ft

D-4 Select a soil and vegetation cover suitable for the biofiltration swale

soil/veg Grass-legume mix on lightly compacted topsoil with 3-inch medium compost blanket (CABS) <--Use pull down box

Manning's n= 0.35 From HRM Table 5-3

D-5 Select the design depth of flow y (see HRM Table 5-4)

y 0.33 (ft) design depth of flow; for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-6 Select a trapezoidal swale cross-sectional shape.

D-7 Use Manning's Eq and first approximations relating hydraulic radius and dimensions to get width for trapezoidal cross section

$$Q_{biofil} = \frac{1.49 A R^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad AR^{.67} = \frac{Q_{biofil}\, n}{1.49\, s^{0.5}}$$

<--manning's changed

HRM Chapter 5 Equation E-11

Use Excel Solver

D-7a

Q_{biofil}	0.250	cfs - runoff treatment design flow rate
A	2.967	ft2 - wetted area
R	0.294	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	8.00	ft - bioswale bottom width
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow = maximum depth of flow

Q_{biofil} 0.684 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "b" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-7b If the swale calculations above give a swale width less than 2 feet wide, re-run calculations with 2 foot wide swale, solve for depth y Or if redesigning swale with different dimensions, use below calculator and use Excel Goal Seek to determine new depth of flow.

Q_{biofil}	0.250	cfs - runoff treatment design flow rate
A	2.967	ft2 - wetted area
R	0.294	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	8.00	ft - enter new bottom width if applicable (2 foot is minimum)
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow

Q_{biofil} 0.684 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "y" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-8 **Enter Final Bioswale Dimensions from the calculations in Step D-7a or D-7b**

Enter Final Swale Area	2.967	ft2 - Wetted Area
Enter Final Swale R	0.294	ft - hydraulic radius
Enter Final Swale slope s	0.015	ft/ft longitudinal slope of swale
Enter Final Swale n	0.35	Manning's coefficient
Enter Final Swale bottom width b	8.00	ft - swale bottom width
Enter Final Swale $z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale $z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale flow depth y	0.330	ft - design depth flow

D-9 **Computer the flow velocity at Q_{biofil}**

$$V_{biofil} = \frac{Q_{biofil}}{A}$$

HRM Chapter 5 Equation E-12

V_{biofil}	0.08	ft/sec - flow velocity; 1 ft/sec maximum

Flow veloicty is OK since it is less than 1 ft/sec

D-10 **Compute Swale Length L (ft)**

$$L = V_{biofil} \times t$$

t	540	seconds - 9 minutes (540 seconds) for CABS, Basic, and Wet bioswale
L	45.51	ft - required length of bioswale; If swale is less than 100 feet, make swale have narrower bottom width (2 foot minimum) and repeat Steps D-7 - D-10 and recalculate to get length over 100 feet or keep swale bottom width make swale length 100 feet minimum

D-11 Does the bioswale need to be redesigned to fit within the provided right of way?

No	Continue to Step FC-1

Freeboard Check (Online Swales Only)

FC-1	Q25yr	0.58	cfs - If in Eastern Washington, use the 25 year storm event
		1.00	Safety Factor - For SBUH or SCS, use 1.0
	Q_{convey}	0.58	cfs - Q25yr x saftey factor
FC-2	n	0.03	(lowest possible Manning's from HRM)
FC-3	depth y	0.07	ft - design depth flow
	A	0.57	ft2 - wetted area
	R	0.068	ft - hydraulic radius
	S	0.015	ft/ft longitudinal slope of swale
	b	8.00	ft - swale bottom width
	$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	Q_{convey}	0.58	cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{convey} above changing the "y" value
FC-4	$D_{(total)}$	1.07	ft, total required swale depth. Does not take into account design standards for minimum ditch depth from the Design Manual (roadway sections)

Final Swale Dimensions			
Swale Length	45.51	ft	<----Note minimum swale length = 100 ft
Bottom Width	8.0	ft	
Swale Longitudinal Slope	0.015	ft/ft	
$z_{foreslope}$	3.0		
$z_{backslope}$	3.0		
WQ Depth	0.33	ft	
Swale Depth (includes 1 ft Freeboard)	1.07	ft	

RT.04 - Basic Biofiltration Swale and Compost Amended Biofiltration Swale
Project: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride Designed By: CDZ
Description: Checked By:

BASIC BIOSWALE AND COMPOST AMENDED BIOSWALE SPREADSHEET VERSION 2.1

Design Steps

D-1 Determine runoff treatment design flow rate Q_{wq}

Q_{wq} 0.530 Runoff treatment design flow rate from MGS Flood OR SBUH; MGSFlood reports an online and offline flow rate, please enter the applicable design flow rate

D-2 Determine the biofiltration design flow rate (Q_{biofil})

Is the bioswale in eastern WA? Yes Qwq=Qbiofil

N/A

Is bioswale online or offline? online

Q_{biofil} 0.530 runoff treatment design flow rate

D-3 Determine the longitudinal slope of the proposed biofiltration swale (ft/ft)

s 0.015 ft/ft

D-4 Select a soil and vegetation cover suitable for the biofiltration swale

soil/veg Grass-legume mix on lightly compacted topsoil with 3-inch medium compost blanket (CABS) <--Use pull down box

Manning's n= 0.35 From HRM Table 5-3

D-5 Select the design depth of flow y (see HRM Table 5-4)

y 0.33 (ft) design depth of flow; for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-6 Select a trapezoidal swale cross-sectional shape.

D-7 Use Manning's Eq and first approximations relating hydraulic radius and dimensions to get width for trapezoidal cross section

$$Q_{biofil} = \frac{1.49 A R^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad AR^{.67} = \frac{Q_{biofil}\, n}{1.49\, s^{0.5}}$$

<--manning's changed

HRM Chapter 5 Equation E-11

Use Excel Solver

D-7a

Q_{biofil}	0.530	cfs - runoff treatment design flow rate
A	2.343	ft2 - wetted area
R	0.286	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	6.11	ft - bioswale bottom width
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow = maximum depth of flow

Q_{biofil} 0.530 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "b" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-7b If the swale calculations above give a swale width less than 2 feet wide, re-run calculations with 2 foot wide swale, solve for depth y Or if redesigning swale with different dimensions, use below calculator and use Excel Goal Seek to determine new depth of flow.

Q_{biofil}	0.530	cfs - runoff treatment design flow rate
A	2.343	ft2 - wetted area
R	0.286	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	6.11	ft - enter new bottom width if applicable (2 foot is minimum)
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow

Q_{biofil} 0.530 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "y" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-8 **Enter Final Bioswale Dimensions from the calculations in Step D-7a or D-7b**

Enter Final Swale Area	2.343	ft2 - Wetted Area
Enter Final Swale R	0.286	ft - hydraulic radius
Enter Final Swale slope s	0.015	ft/ft longitudinal slope of swale
Enter Final Swale n	0.35	Manning's coefficient
Enter Final Swale bottom width b	6.11	ft - swale bottom width
Enter Final Swale $z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale $z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale flow depth y	0.330	ft - design depth flow

D-9 **Computer the flow velocity at Q_{biofil}**

$$V_{biofil} = \frac{Q_{biofil}}{A}$$

HRM Chapter 5 Equation E-12

V_{biofil}	0.23	ft/sec - flow velocity; 1 ft/sec maximum

Flow veloicty is OK since it is less than 1 ft/sec

D-10 **Compute Swale Length L (ft)**

$$L = V_{biofil} \times t$$

t	540	seconds - 9 minutes (540 seconds) for CABS, Basic, and Wet bioswale
L	122.15	ft - required length of bioswale; If swale is less than 100 feet, make swale have narrower bottom width (2 foot minimum) and repeat Steps D-7 - D-10 and recalculate to get length over 100 feet or keep swale bottom width make swale length 100 feet minimum

D-11 Does the bioswale need to be redesigned to fit within the provided right of way?

No	Continue to Step FC-1

Freeboard Check (Online Swales Only)

FC-1	Q25yr	1.24	cfs - If in Eastern Washington, use the 25 year storm event
		1.00	Safety Factor - For SBUH or SCS, use 1.0
	Q_{convey}	1.24	cfs - Q25yr x saftey factor
FC-2	n	0.03	(lowest possible Manning's from HRM)
FC-3	depth y	0.13	ft - design depth flow
	A	0.83	ft2 - wetted area
	R	0.121	ft - hydraulic radius
	S	0.015	ft/ft longitudinal slope of swale
	b	6.11	ft - swale bottom width
	$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	Q_{convey}	1.24	cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{convey} above changing the "y" value
FC-4	$D_{(total)}$	1.13	ft, total required swale depth. Does not take into account design standards for minimum ditch depth from the Design Manual (roadway sections)

Final Swale Dimensions		
Swale Length	122.15	ft
Bottom Width	6.1	ft
Swale Longitudinal Slope	0.015	ft/ft
$z_{foreslope}$	3.0	
$z_{backslope}$	3.0	
WQ Depth	0.33	ft
Swale Depth (includes 1 ft Freeboard)	1.13	ft

RT.04 - Basic Biofiltration Swale and Compost Amended Biofiltration Swale
Project: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride Designed By: CDZ
Description: Checked By:

BASIC BIOSWALE AND COMPOST AMENDED BIOSWALE SPREADSHEET VERSION 2.1

Design Steps

D-1 Determine runoff treatment design flow rate Q_{wq}

Q_{wq} 0.220 Runoff treatment design flow rate from MGS Flood OR SBUH; MGSFlood reports an online and offline flow rate, please enter the applicable design flow rate

D-2 Determine the biofiltration design flow rate (Q_{biofil})

Is the bioswale in eastern WA? Yes Qwq=Qbiofil

N/A

Is bioswale online or offline? online

Q_{biofil} 0.220 runoff treatment design flow rate

D-3 Determine the longitudinal slope of the proposed biofiltration swale (ft/ft)

s 0.015 ft/ft

D-4 Select a soil and vegetation cover suitable for the biofiltration swale

soil/veg Grass-legume mix on lightly compacted topsoil with 3-inch medium compost blanket (CABS) <--Use pull down box

Manning's n= 0.35 From HRM Table 5-3

D-5 Select the design depth of flow y (see HRM Table 5-4)

y 0.33 (ft) design depth of flow; for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-6 Select a trapezoidal swale cross-sectional shape.

D-7 Use Manning's Eq and first approximations relating hydraulic radius and dimensions to get width for trapezoidal cross section

$$Q_{biofil} = \frac{1.49 A R^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad AR^{.67} = \frac{Q_{biofil}\, n}{1.49\, s^{0.5}}$$

<--manning's changed

HRM Chapter 5 Equation E-11

Use Excel Solver

D-7a	Q_{biofil}	0.220	cfs - runoff treatment design flow rate
	A	2.967	ft2 - wetted area
	R	0.294	ft - hydraulic radius
	s	0.015	ft/ft longitudinal slope of swale
	n	0.35	Manning's coefficient
	b	8.00	ft - bioswale bottom width
	$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	y	0.330	ft - design depth flow = maximum depth of flow
	Q_{biofil}	0.684	cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "b" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-7b If the swale calculations above give a swale width less than 2 feet wide, re-run calculations with 2 foot wide swale, solve for depth y Or if redesigning swale with different dimensions, use below calculator and use Excel Goal Seek to determine new depth of flow.

	Q_{biofil}	0.220	cfs - runoff treatment design flow rate
	A	2.967	ft2 - wetted area
	R	0.294	ft - hydraulic radius
	s	0.015	ft/ft longitudinal slope of swale
	n	0.35	Manning's coefficient
	b	8.00	ft - enter new bottom width if applicable (2 foot is minimum)
	$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	y	0.330	ft - design depth flow
	Q_{biofil}	0.684	cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "y" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-8 **Enter Final Bioswale Dimensions from the calculations in Step D-7a or D-7b**

Enter Final Swale Area	2.967	ft2 - Wetted Area
Enter Final Swale R	0.294	ft - hydraulic radius
Enter Final Swale slope s	0.015	ft/ft longitudinal slope of swale
Enter Final Swale n	0.35	Manning's coefficient
Enter Final Swale bottom width b	8.00	ft - swale bottom width
Enter Final Swale $z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale $z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale flow depth y	0.330	ft - design depth flow

D-9 **Computer the flow velocity at Q_{biofil}**

$$V_{biofil} = \frac{Q_{biofil}}{A}$$

HRM Chapter 5 Equation E-12

V_{biofil}	0.07	ft/sec - flow velocity; 1 ft/sec maximum

Flow veloicty is OK since it is less than 1 ft/sec

D-10 **Compute Swale Length L (ft)**

$$L = V_{biofil} \times t$$

t	540	seconds - 9 minutes (540 seconds) for CABS, Basic, and Wet bioswale
L	40.04	ft - required length of bioswale; If swale is less than 100 feet, make swale have narrower bottom width (2 foot minimum) and repeat Steps D-7 - D-10 and recalculate to get length over 100 feet or keep swale bottom width make swale length 100 feet minimum

D-11 Does the bioswale need to be redesigned to fit within the provided right of way?

No	Continue to Step FC-1

Freeboard Check (Online Swales Only)

FC-1	Q25yr	0.52	cfs - If in Eastern Washington, use the 25 year storm event
		1.00	Safety Factor - For SBUH or SCS, use 1.0
	Q_{convey}	0.52	cfs - Q25yr x saftey factor
FC-2	n	0.03	(lowest possible Manning's from HRM)
FC-3	depth y	0.07	ft - design depth flow
	A	0.54	ft2 - wetted area
	R	0.064	ft - hydraulic radius
	S	0.015	ft/ft longitudinal slope of swale
	b	8.00	ft - swale bottom width
	$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	Q_{convey}	0.52	cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{convey} above changing the "y" value
FC-4	$D_{(total)}$	1.07	ft, total required swale depth. Does not take into account design standards for minimum ditch depth from the Design Manual (roadway sections)

Final Swale Dimensions			
Swale Length	40.04	ft	<----Note minimum swale length = 100 ft
Bottom Width	8.0	ft	
Swale Longitudinal Slope	0.015	ft/ft	
$z_{foreslope}$	3.0		
$z_{backslope}$	3.0		
WQ Depth	0.33	ft	
Swale Depth (includes 1 ft Freeboard)	1.07	ft	

RT.04 - Basic Biofiltration Swale and Compost Amended Biofiltration Swale
Project: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride Designed By: CDZ
Description: Checked By:

BASIC BIOSWALE AND COMPOST AMENDED BIOSWALE SPREADSHEET VERSION 2.1

Design Steps

D-1 Determine runoff treatment design flow rate Q_{wq}

Q_{wq} 0.130 Runoff treatment design flow rate from MGS Flood OR SBUH; MGSFlood reports an online and offline flow rate, please enter the applicable design flow rate

D-2 Determine the biofiltration design flow rate (Q_{biofil})

Is the bioswale in eastern WA? Yes Qwq=Qbiofil

N/A

Is bioswale online or offline? online

Q_{biofil} 0.130 runoff treatment design flow rate

D-3 Determine the longitudinal slope of the proposed biofiltration swale (ft/ft)

s 0.015 ft/ft

D-4 Select a soil and vegetation cover suitable for the biofiltration swale

soil/veg Grass-legume mix on lightly compacted topsoil with 3-inch medium compost blanket (CABS) <--Use pull down box

Manning's n= 0.35 From HRM Table 5-3

D-5 Select the design depth of flow y (see HRM Table 5-4)

y 0.33 (ft) design depth of flow; for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-6 Select a trapezoidal swale cross-sectional shape.

D-7 Use Manning's Eq and first approximations relating hydraulic radius and dimensions to get width for trapezoidal cross section

$$Q_{biofil} = \frac{1.49 A R^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad AR^{.67} = \frac{Q_{biofil}\, n}{1.49\, s^{0.5}}$$

<--manning's changed

HRM Chapter 5 Equation E-11

Use Excel Solver

D-7a

Q_{biofil}	0.130	cfs - runoff treatment design flow rate
A	3.627	ft2 - wetted area
R	0.300	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	10.00	ft - bioswale bottom width
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow = maximum depth of flow

Q_{biofil} 0.847 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "b" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-7b If the swale calculations above give a swale width less than 2 feet wide, re-run calculations with 2 foot wide swale, solve for depth y Or if redesigning swale with different dimensions, use below calculator and use Excel Goal Seek to determine new depth of flow.

Q_{biofil}	0.130	cfs - runoff treatment design flow rate
A	3.627	ft2 - wetted area
R	0.300	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	10.00	ft - enter new bottom width if applicable (2 foot is minimum)
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow

Q_{biofil} 0.847 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "y" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-8 **Enter Final Bioswale Dimensions from the calculations in Step D-7a or D-7b**

Enter Final Swale Area	3.627	ft2 - Wetted Area
Enter Final Swale R	0.300	ft - hydraulic radius
Enter Final Swale slope s	0.015	ft/ft longitudinal slope of swale
Enter Final Swale n	0.35	Manning's coefficient
Enter Final Swale bottom width b	10.00	ft - swale bottom width
Enter Final Swale $z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale $z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale flow depth y	0.330	ft - design depth flow

D-9 **Computer the flow velocity at Q_{biofil}**

$$V_{biofil} = \frac{Q_{biofil}}{A}$$

HRM Chapter 5 Equation E-12

V_{biofil}	0.04	ft/sec - flow velocity; 1 ft/sec maximum

Flow veloicty is OK since it is less than 1 ft/sec

D-10 **Compute Swale Length L (ft)**

$$L = V_{biofil} \times t$$

t	540	seconds - 9 minutes (540 seconds) for CABS, Basic, and Wet bioswale
L	19.36	ft - required length of bioswale; If swale is less than 100 feet, make swale have narrower bottom width (2 foot minimum) and repeat Steps D-7 - D-10 and recalculate to get length over 100 feet or keep swale bottom width make swale length 100 feet minimum

D-11 Does the bioswale need to be redesigned to fit within the provided right of way?

No	Continue to Step FC-1

Freeboard Check (Online Swales Only)

FC-1	Q25yr	0.30	cfs - If in Eastern Washington, use the 25 year storm event
		1.00	Safety Factor - For SBUH or SCS, use 1.0
	Q_{convey}	0.30	cfs - Q25yr x saftey factor
FC-2	n	0.03	(lowest possible Manning's from HRM)
FC-3	depth y	0.04	ft - design depth flow
	A	0.42	ft2 - wetted area
	R	0.041	ft - hydraulic radius
	S	0.015	ft/ft longitudinal slope of swale
	b	10.00	ft - swale bottom width
	$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	Q_{convey}	0.30	cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{convey} above changing the "y" value
FC-4	$D_{(total)}$	1.04	ft, total required swale depth. Does not take into account design standards for minimum ditch depth from the Design Manual (roadway sections)

Final Swale Dimensions			
Swale Length	19.36	ft	<----Note minimum swale length = 100 ft
Bottom Width	10.0	ft	
Swale Longitudinal Slope	0.015	ft/ft	
$z_{foreslope}$	3.0		
$z_{backslope}$	3.0		
WQ Depth	0.33	ft	
Swale Depth (includes 1 ft Freeboard)	1.04	ft	

RT.04 - Basic Biofiltration Swale and Compost Amended Biofiltration Swale
Project: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride Designed By: CDZ
Description: Checked By:

BASIC BIOSWALE AND COMPOST AMENDED BIOSWALE SPREADSHEET VERSION 2.1

Design Steps

D-1 Determine runoff treatment design flow rate Q_{wq}

Q_{wq} 0.090 Runoff treatment design flow rate from MGS Flood OR SBUH; MGSFlood reports an online and offline flow rate, please enter the applicable design flow rate

D-2 Determine the biofiltration design flow rate (Q_{biofil})

Is the bioswale in eastern WA? Yes Qwq=Qbiofil

N/A

Is bioswale online or offline? online

Q_{biofil} 0.090 runoff treatment design flow rate

D-3 Determine the longitudinal slope of the proposed biofiltration swale (ft/ft)

s 0.015 ft/ft

D-4 Select a soil and vegetation cover suitable for the biofiltration swale

soil/veg Grass-legume mix on lightly compacted topsoil with 3-inch medium compost blanket (CABS) <--Use pull down box

Manning's n= 0.35 From HRM Table 5-3

D-5 Select the design depth of flow y (see HRM Table 5-4)

y 0.33 (ft) design depth of flow; for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-6 Select a trapezoidal swale cross-sectional shape.

D-7 Use Manning's Eq and first approximations relating hydraulic radius and dimensions to get width for trapezoidal cross section

$$Q_{biofil} = \frac{1.49 A R^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad AR^{.67} = \frac{Q_{biofil}\, n}{1.49\, s^{0.5}}$$

<--manning's changed

HRM Chapter 5 Equation E-11

Use Excel Solver

D-7a

Q_{biofil}	0.090	cfs - runoff treatment design flow rate
A	2.307	ft2 - wetted area
R	0.285	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	6.00	ft - bioswale bottom width
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow = maximum depth of flow

Q_{biofil} 0.521 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "b" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-7b If the swale calculations above give a swale width less than 2 feet wide, re-run calculations with 2 foot wide swale, solve for depth y Or if redesigning swale with different dimensions, use below calculator and use Excel Goal Seek to determine new depth of flow.

Q_{biofil}	0.090	cfs - runoff treatment design flow rate
A	2.307	ft2 - wetted area
R	0.285	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	6.00	ft - enter new bottom width if applicable (2 foot is minimum)
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow

Q_{biofil} 0.521 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "y" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-8 **Enter Final Bioswale Dimensions from the calculations in Step D-7a or D-7b**

Enter Final Swale Area	2.307	ft2 - Wetted Area
Enter Final Swale R	0.285	ft - hydraulic radius
Enter Final Swale slope s	0.015	ft/ft longitudinal slope of swale
Enter Final Swale n	0.35	Manning's coefficient
Enter Final Swale bottom width b	6.00	ft - swale bottom width
Enter Final Swale $z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale $z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale flow depth y	0.330	ft - design depth flow

D-9 **Computer the flow velocity at Q_{biofil}**

$$V_{biofil} = \frac{Q_{biofil}}{A}$$

HRM Chapter 5 Equation E-12

V_{biofil}	0.04	ft/sec - flow velocity; 1 ft/sec maximum

Flow veloicty is OK since it is less than 1 ft/sec

D-10 **Compute Swale Length L (ft)**

$$L = V_{biofil} \times t$$

t	540	seconds - 9 minutes (540 seconds) for CABS, Basic, and Wet bioswale
L	21.07	ft - required length of bioswale; If swale is less than 100 feet, make swale have narrower bottom width (2 foot minimum) and repeat Steps D-7 - D-10 and recalculate to get length over 100 feet or keep swale bottom width make swale length 100 feet minimum

D-11 Does the bioswale need to be redesigned to fit within the provided right of way?

No	Continue to Step FC-1

Freeboard Check (Online Swales Only)

FC-1	Q25yr	0.20	cfs - If in Eastern Washington, use the 25 year storm event
		1.00	Safety Factor - For SBUH or SCS, use 1.0
	Q_{convey}	0.20	cfs - Q25yr x saftey factor
FC-2	n	0.03	(lowest possible Manning's from HRM)
FC-3	depth y	0.04	ft - design depth flow
	A	0.27	ft2 - wetted area
	R	0.043	ft - hydraulic radius
	S	0.015	ft/ft longitudinal slope of swale
	b	6.00	ft - swale bottom width
	$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	Q_{convey}	0.20	cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{convey} above changing the "y" value
FC-4	$D_{(total)}$	1.04	ft, total required swale depth. Does not take into account design standards for minimum ditch depth from the Design Manual (roadway sections)

Final Swale Dimensions			
Swale Length	21.07	ft	<----Note minimum swale length = 100 ft
Bottom Width	6.0	ft	
Swale Longitudinal Slope	0.015	ft/ft	
$z_{foreslope}$	3.0		
$z_{backslope}$	3.0		
WQ Depth	0.33	ft	
Swale Depth (includes 1 ft Freeboard)	1.04	ft	

RT.04 - Basic Biofiltration Swale and Compost Amended Biofiltration Swale
Project: I-90 / Argonne Rd & Mullan Rd Interchange - STA Park & Ride Designed By: CDZ
Description: Checked By:

BASIC BIOSWALE AND COMPOST AMENDED BIOSWALE SPREADSHEET VERSION 2.1

Design Steps

D-1 Determine runoff treatment design flow rate Q_{wq}

Q_{wq} 0.570 Runoff treatment design flow rate from MGS Flood OR SBUH; MGSFlood reports an online and offline flow rate, please enter the applicable design flow rate

D-2 Determine the biofiltration design flow rate (Q_{biofil})

Is the bioswale in eastern WA? Yes Qwq=Qbiofil

N/A

Is bioswale online or offline? online

Q_{biofil} 0.570 runoff treatment design flow rate

D-3 Determine the longitudinal slope of the proposed biofiltration swale (ft/ft)

s 0.015 ft/ft

D-4 Select a soil and vegetation cover suitable for the biofiltration swale

soil/veg Grass-legume mix on lightly compacted topsoil with 3-inch medium compost blanket (CABS) <--Use pull down box

Manning's n= 0.35 From HRM Table 5-3

D-5 Select the design depth of flow y (see HRM Table 5-4)

y 0.33 (ft) design depth of flow; for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-6 Select a trapezoidal swale cross-sectional shape.

D-7 Use Manning's Eq and first approximations relating hydraulic radius and dimensions to get width for trapezoidal cross section

$$Q_{biofil} = \frac{1.49 A R^{\frac{2}{3}} s^{\frac{1}{2}}}{n} \qquad AR^{.67} = \frac{Q_{biofil}\, n}{1.49\, s^{0.5}}$$

<--manning's changed

HRM Chapter 5 Equation E-11

Use Excel Solver

D-7a

Q_{biofil}	0.570	cfs - runoff treatment design flow rate
A	2.802	ft2 - wetted area
R	0.292	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	7.50	ft - bioswale bottom width
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow = maximum depth of flow

Q_{biofil} 0.643 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "b" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-7b If the swale calculations above give a swale width less than 2 feet wide, re-run calculations with 2 foot wide swale, solve for depth y Or if redesigning swale with different dimensions, use below calculator and use Excel Goal Seek to determine new depth of flow.

Q_{biofil}	0.570	cfs - runoff treatment design flow rate
A	2.802	ft2 - wetted area
R	0.292	ft - hydraulic radius
s	0.015	ft/ft longitudinal slope of swale
n	0.35	Manning's coefficient
b	7.50	ft - enter new bottom width if applicable (2 foot is minimum)
$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
y	0.330	ft - design depth flow

Q_{biofil} 0.643 cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{biofil} above changing the "y" value

Note: Depth of flow for basic biofiltration swale and CABS = 4" max (0.33 ft max) for WQ event

D-8 **Enter Final Bioswale Dimensions from the calculations in Step D-7a or D-7b**

Enter Final Swale Area	2.802	ft2 - Wetted Area
Enter Final Swale R	0.292	ft - hydraulic radius
Enter Final Swale slope s	0.015	ft/ft longitudinal slope of swale
Enter Final Swale n	0.35	Manning's coefficient
Enter Final Swale bottom width b	7.50	ft - swale bottom width
Enter Final Swale $z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale $z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
Enter Final Swale flow depth y	0.330	ft - design depth flow

D-9 **Computer the flow velocity at Q_{biofil}**

$$V_{biofil} = \frac{Q_{biofil}}{A}$$

HRM Chapter 5 Equation E-12

V_{biofil}	0.20	ft/sec - flow velocity; 1 ft/sec maximum

Flow veloicty is OK since it is less than 1 ft/sec

D-10 **Compute Swale Length L (ft)**

$$L = V_{biofil} \times t$$

t	540	seconds - 9 minutes (540 seconds) for CABS, Basic, and Wet bioswale
L	109.86	ft - required length of bioswale; If swale is less than 100 feet, make swale have narrower bottom width (2 foot minimum) and repeat Steps D-7 - D-10 and recalculate to get length over 100 feet or keep swale bottom width make swale length 100 feet minimum

D-11 Does the bioswale need to be redesigned to fit within the provided right of way?

No	Continue to Step FC-1

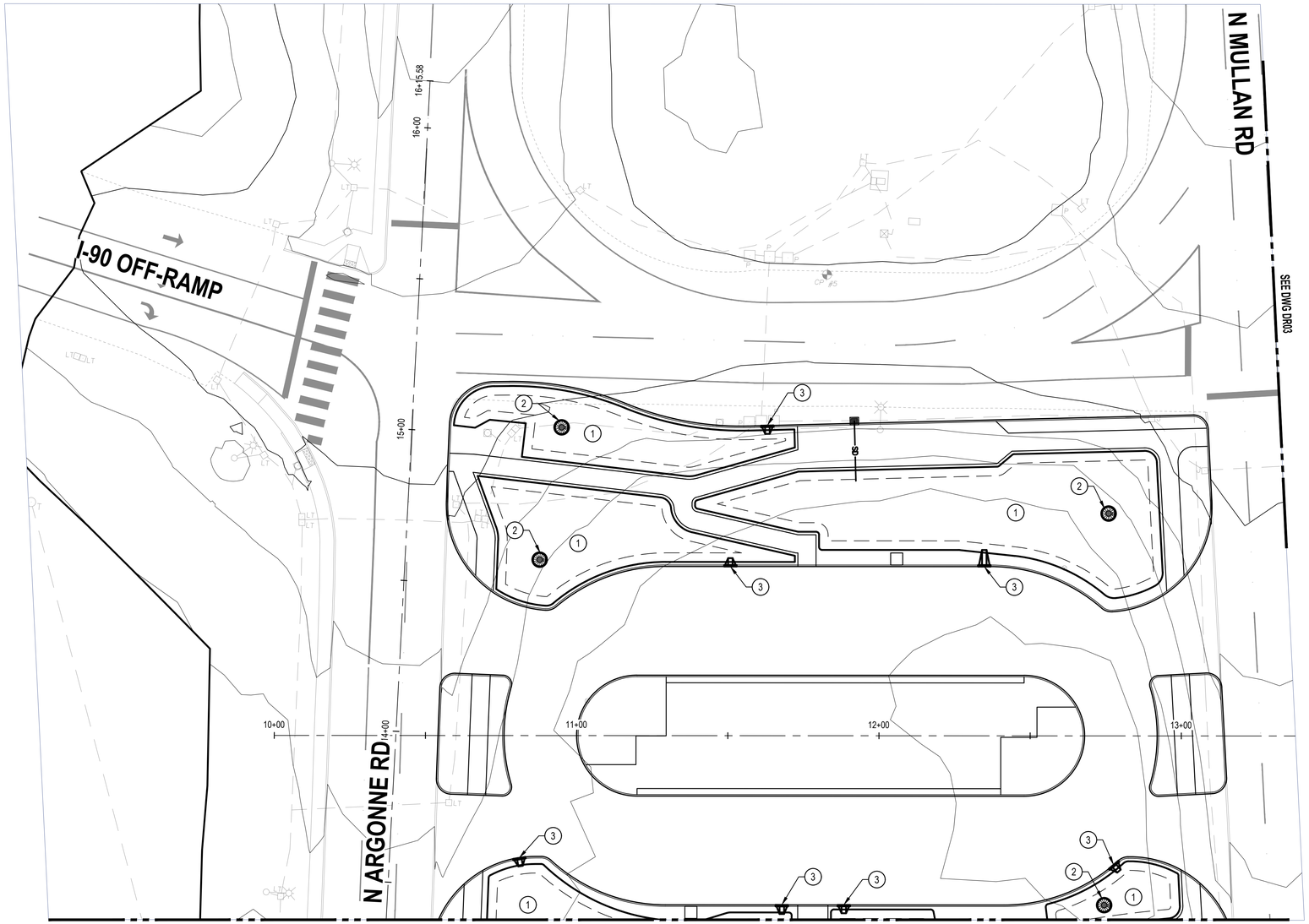
Freeboard Check (Online Swales Only)

FC-1	Q25yr	1.34	cfs - If in Eastern Washington, use the 25 year storm event
		1.00	Safety Factor - For SBUH or SCS, use 1.0
	Q_{convey}	1.34	cfs - Q25yr x saftey factor
FC-2	n	0.03	(lowest possible Manning's from HRM)
FC-3	depth y	0.12	ft - design depth flow
	A	0.94	ft2 - wetted area
	R	0.114	ft - hydraulic radius
	S	0.015	ft/ft longitudinal slope of swale
	b	7.50	ft - swale bottom width
	$z_{foreslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	$z_{backslope}$	3.00	horizontal number of bioswale slope i.e. 1V:3H, z=3 in this instance
	Q_{convey}	1.34	cfs - use goal seek under "What-If Analysis" in the "DATA" menu to set this cell equal to Q_{convey} above changing the "y" value
FC-4	$D_{(total)}$	1.12	ft, total required swale depth. Does not take into account design standards for minimum ditch depth from the Design Manual (roadway sections)

Final Swale Dimensions		
Swale Length	109.86	ft
Bottom Width	7.5	ft
Swale Longitudinal Slope	0.015	ft/ft
$z_{foreslope}$	3.0	
$z_{backslope}$	3.0	
WQ Depth	0.33	ft
Swale Depth (includes 1 ft Freeboard)	1.12	ft

Appendix A-4

Drainage Plan Sheets, Structure Notes, and Details



STORM DRAINAGE GENERAL NOTES

1. FOR ALL BIO-INFILTRATION SWALES THE TOP 12" OF SOIL SHALL CONSIST OF A THOROUGHLY BLENDED MIX OF 50% COMPOST WITH 50% NATIVE SOILS.
2. THE TOP 18" OF SOIL FOR ALL L.I.D. POND BOTTOMS SHALL CONSIST OF 40% COMPOST / 60% MINERAL AGGREGATE; COMPOST CATION EXHANGE CAPACITY (CEC) SHALL BE EQUAL TO OR GREATER THAN 5 MILLIEQUIVALENTS / 100 GRAMS OF DRY SOIL; MINERAL AGGREGATE SHALL BE WELL-GRADED SAND PER ASTM D2487-11 WITH COEFFICIENT OF UNIFORMITY CU = D60/D10 EQUAL TO OR GREATER THAN 4 AND COEFFICIENT OF CURVE CC = (D30)2/D60 X D10 GREATER THAN OR EQUAL TO 1 AND LESS THAN OR EQUAL TO 3. A BIORETENTION SOIL MEDIA DATA SHEET SHALL BE SUBMITTED TO THE ENGINEER OF RECORD AND THE CITY OF SPOKANE VALLEY FOR REVIEW AND APPROVAL PRIOR TO INSTALLATION.

   MINERAL AGGREGATE GRADATION

SEIVE SIZE	PERCENT PASSING
3/8"	100
#4	95-100
#10	75-90
#40	25-40
#100	4-10
#200	2-5

3. PROPOSED CONTOURS SHOWN ARE FINISHED GRADES.
4. CURB INLET HORIZONTAL CONTROL PROVIDED AT CENTERLINE AT FACE OF CURB.

CONSTRUCTION NOTES

1. CONSTRUCT BIO-RETENTION SWALE PER COSV STANDARDS
2. INSTALL DRYWELL TYPE A PER COSV STD PLAN S-101. FRAME AND GRATE PER COSV STD PLAN S-104. SPACING BETWEEN DRYWELL AND CURB INLET SHALL BE A MINIMUM OF 5'-9" PER STD PLAN S-130
3. INSTALL 6' WIDE CURB INLET TYPE 1 PER COSV STD PLAN S-110
4. CONSTRUCT VEGETATED FILTER STRIP

LEGEND

- XXXX — MAJOR CONTOUR
- XXXX — MINOR CONTOUR
- XXXX — EXISTING CONTOUR
- 2% — GRADE SLOPE DIRECTION
- SD — STORM DRAIN PIPE
- DRAINAGE POND BOTTOM
- DRYWELL
- CB TYPE 1

N

0 10' 20' 40'
1 inch = 20 feet

NOT FOR CONSTRUCTION - 30% SUBMITTAL

MARK A. BROWN, STATE OF WASHINGTON, 36808, REGISTERED PROFESSIONAL ENGINEER

NO.	DATE	BY	CHD.	APPR.	REVISION

DRAWN BY: TAJ | DESIGNED BY: MLT
CHECKED BY: JRP | APPROVED BY: MAB
DATE: 6/16/2025
J O B No. : 2400399
SCALE: AS NOTED

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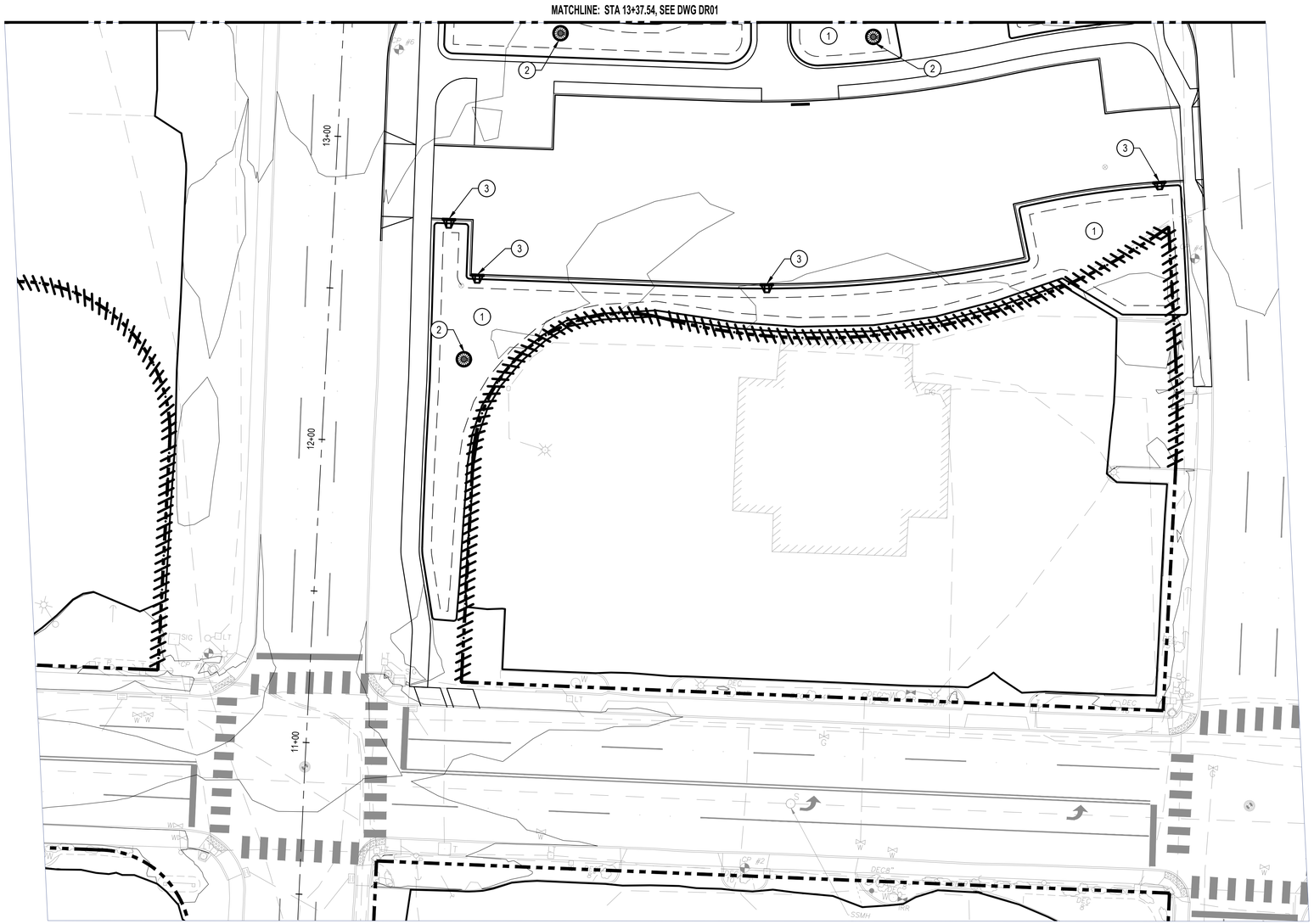
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ARGONNE STATION PARK AND RIDE PROJECT
SPOKANE VALLEY, WA

DRAINAGE PLAN

SHEET
DR01

Jun 16, 2025 - 3:16pm terence.j Z:\2400001 - 2409999\2400399 STA I-90 Valley HPTC WO7 Argonne SV\CAD\Design\ARG-DR.dwg



STORM DRAINAGE GENERAL NOTES

1. FOR ALL BIO-INFILTRATION SWALES THE TOP 12" OF SOIL SHALL CONSIST OF A THOROUGHLY BLENDED MIX OF 50% COMPOST WITH 50% NATIVE SOILS.

2. THE TOP 18" OF SOIL FOR ALL L.I.D. POND BOTTOMS SHALL CONSIST OF 40% COMPOST / 60% MINERAL AGGREGATE; COMPOST CATION EXHANGE CAPACITY (CEC) SHALL BE EQUAL TO OR GREATER THAN 5 MILLIEQUIVALENTS / 100 GRAMS OF DRY SOIL; MINERAL AGGREGATE SHALL BE WELL-GRADED SAND PER ASTM D2487-11 WITH COEFFICIENT OF UNIFORMITY CU = D60/D10 EQUAL TO OR GREATER THAN 4 AND COEFFICIENT OF CURVE CC = (D30)2/D60 X D10 GREATER THAN OR EQUAL TO 1 AND LESS THAN OR EQUAL TO 3. A BIORETENTION SOIL MEDIA DATA SHEET SHALL BE SUBMITTED TO THE ENGINEER OF RECORD AND THE CITY OF SPOKANE VALLEY FOR REVIEW AND APPROVAL PRIOR TO INSTALLATION.

   MINERAL AGGREGATE GRADATION

SEIVE SIZE	PERCENT PASSING
3/8"	100
#4	95-100
#10	75-90
#40	25-40
#100	4-10
#200	2-5

3. PROPOSED CONTOURS SHOWN ARE FINISHED GRADES.

4. CURB INLET HORIZONTAL CONTROL PROVIDED AT CENTERLINE AT FACE OF CURB.

CONSTRUCTION NOTES

(1) CONSTRUCT BIO-RETENTION SWALE PER COSV STANDARDS

(2) INSTALL DRYWELL TYPE A PER COSV STD PLAN S-101. FRAME AND GRATE PER COSV STD PLAN S-104. SPACING BETWEEN DRYWELL AND CURB INLET SHALL BE A MINIMUM OF 5'-9" PER STD PLAN S-130

(3) INSTALL 6' WIDE CURB INLET TYPE 1 PER COSV STD PLAN S-110

(4) CONSTRUCT VEGETATED FILTER STRIP

LEGEND

- XXXX — MAJOR CONTOUR
- XXXX — MINOR CONTOUR
- XXXX — EXISTING CONTOUR
- 2% — GRADE SLOPE DIRECTION
- SD — STORM DRAIN PIPE
- DRAINAGE POND BOTTOM
- DRYWELL
- CB TYPE 1

N

0 10' 20' 40'

1 inch = 20 feet

MARK A. BROWER STATE OF WASHINGTON 36938 REGISTERED PROFESSIONAL ENGINEER

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CHECKED BY JRP | APPROVED BY MAB
DATE 6/16/2025
J O B No. : 2400399

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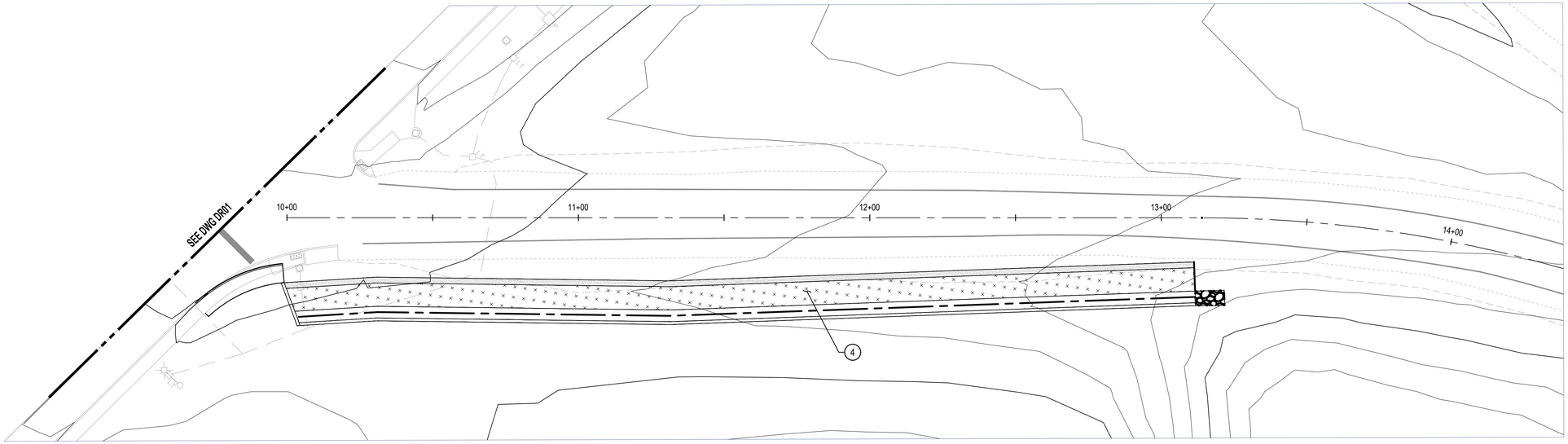
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DRAINAGE PLAN

SHEET **DR02**

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STORM DRAINAGE GENERAL NOTES

1. FOR ALL BIO-INFILTRATION SWALES THE TOP 12" OF SOIL SHALL CONSIST OF A THOROUGHLY BLENDED MIX OF 50% COMPOST WITH 50% NATIVE SOILS.

2. THE TOP 18" OF SOIL FOR ALL L.I.D. POND BOTTOMS SHALL CONSIST OF 40% COMPOST / 60% MINERAL AGGREGATE; COMPOST CATION EXHANGE CAPACITY (CEC) SHALL BE EQUAL TO OR GREATER THAN 5 MILLIEQUIVALENTS / 100 GRAMS OF DRY SOIL; MINERAL AGGREGATE SHALL BE WELL-GRADED SAND PER ASTM D2487-11 WITH COEFFICIENT OF UNIFORMITY CU = D60/D10 EQUAL TO OR GREATER THAN 4 AND COEFFICIENT OF CURVE CC = (D30)2/D60 X D10 GREATER THAN OR EQUAL TO 1 AND LESS THAN OR EQUAL TO 3. A BIORETENTION SOIL MEDIA DATA SHEET SHALL BE SUBMITTED TO THE ENGINEER OF RECORD AND THE CITY OF SPOKANE VALLEY FOR REVIEW AND APPROVAL PRIOR TO INSTALLATION.

   MINERAL AGGREGATE GRADATION

SEIVE SIZE	PERCENT PASSING
3/8"	100
#4	95-100
#10	75-90
#40	25-40
#100	4-10
#200	2-5

3. PROPOSED CONTOURS SHOWN ARE FINISHED GRADES.

4. CURB INLET HORIZONTAL CONTROL PROVIDED AT CENTERLINE AT FACE OF CURB.

CONSTRUCTION NOTES

1. CONSTRUCT BIO-RETENTION SWALE PER COSV STANDARDS
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3. INSTALL 6' WIDE CURB INLET TYPE 1 PER COSV STD PLAN S-110
4. CONSTRUCT VEGETATED FILTER STRIP

LEGEND

- XXXX — MAJOR CONTOUR
- XXXX — MINOR CONTOUR
- XXXX — EXISTING CONTOUR
- 2% — GRADE SLOPE DIRECTION
- SD — STORM DRAIN PIPE
- DRAINAGE POND BOTTOM
- DRYWELL
- CB TYPE 1

N

0 10' 20' 40'

1 inch = 20 feet

MARK A. BROWER — STATE OF WASHINGTON — 36938 — REGISTERED PROFESSIONAL ENGINEER

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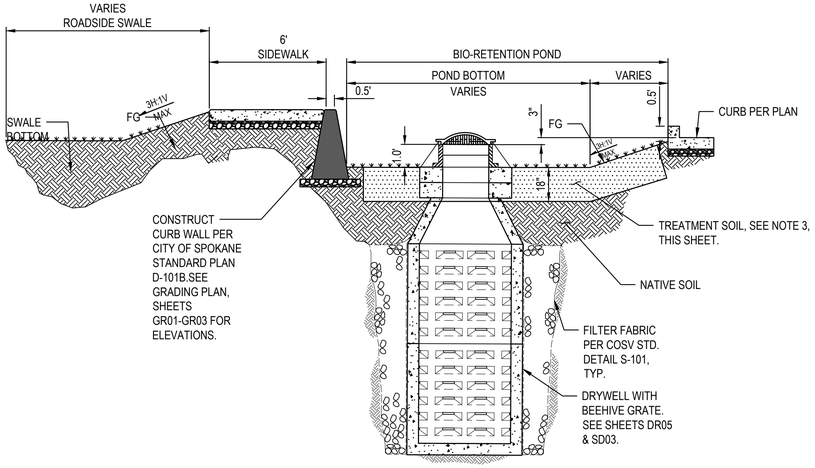
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DRAINAGE PLAN

SHEET
DR03

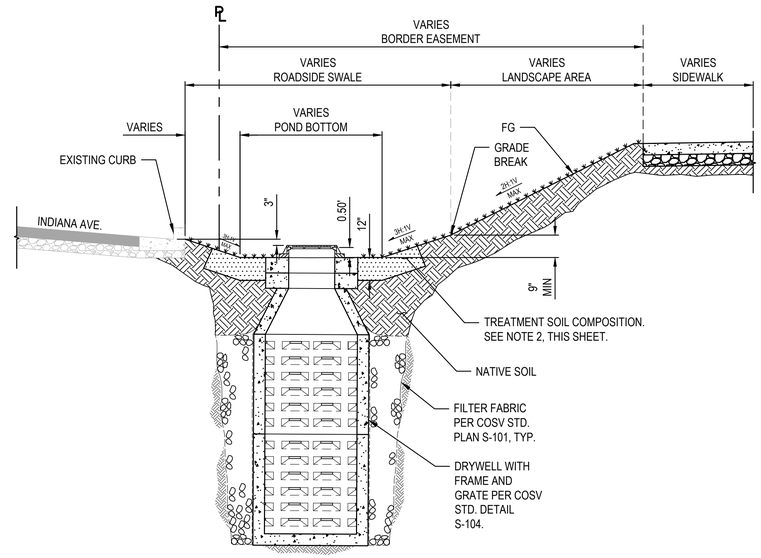
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BIO-RETENTION PONDS #1 & 2 TYPICAL SECTION

NTS

1 DR03



ROADSIDE SWALE TYPICAL SECTION

NTS

2 DR03

STORM DRAINAGE GENERAL NOTES

1. ALL SPOT ELEVATIONS ARE TAKEN AT FLOW LINE OF GUTTER UNLESS OTHERWISE NOTED.
2. FOR ALL BIO-INFILTRATION SWALES THE TOP 12" OF SOIL SHALL CONSIST OF A THOROUGHLY BLENDED MIX OF 50% COMPOST WITH 50% NATIVE SOILS.
3. THE TOP 18" OF SOIL FOR ALL L.I.D. POND BOTTOMS SHALL CONSIST OF 40% COMPOST / 60% MINERAL AGGREGATE; COMPOST CATION EXHANGE CAPACITY (CEC) SHALL BE EQUAL TO OR GREATER THAN 5 MILLIEQUIVALENTS / 100 GRAMS OF DRY SOIL; MINERAL AGGREGATE SHALL BE WELL-GRADED SAND PER ASTM D2487-11 WITH COEFFICIENT OF UNIFORMITY CU = D60/D10 EQUAL TO OR GREATER THAN 4 AND COEFFICIENT OF CURVE CC = (D30)2/D60 X D10 GREATER THAN OR EQUAL TO 1 AND LESS THAN OR EQUAL TO 3. A BIORETENTION SOIL MEDIA DATA SHEET SHALL BE SUBMITTED TO THE ENGINEER OF RECORD AND THE CITY OF SPOKANE VALLEY FOR REVIEW AND APPROVAL PRIOR TO INSTALLATION.

   MINERAL AGGREGATE GRADATION

SEIVE SIZE	PERCENT PASSING
3/8"	100
#4	95-100
#10	75-90
#40	25-40
#100	4-10
#200	2-5

4. PROPOSED CONTOURS SHOWN ARE FINISHED GRADES.

LEGEND

- XXXX — MAJOR CONTOUR
- XXXX — MINOR CONTOUR
- XXXX — EXISTING CONTOUR
- GRADE BREAK/ RIDGE LINE
- 2% — GRADE SLOPE DIRECTION
- SD — STORM DRAIN PIPE
- DRAINAGE POND BOTTOM
- DRYWELL
- CB TYPE 1
- PIPE (DAY LIGHT)
- V-DITCH

MARK A. BROWER
STATE OF WASHINGTON
36928
REGISTERED
PROFESSIONAL ENGINEER

NOT FOR CONSTRUCTION - 30% SUBMITTAL

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DRAINAGE DETAILS

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DD01

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Appendix A-5

Drainage Profile Sheets (if applicable)

Appendix A-6

Roadway Cross Sections and Profiles (if applicable)

Appendix A-7

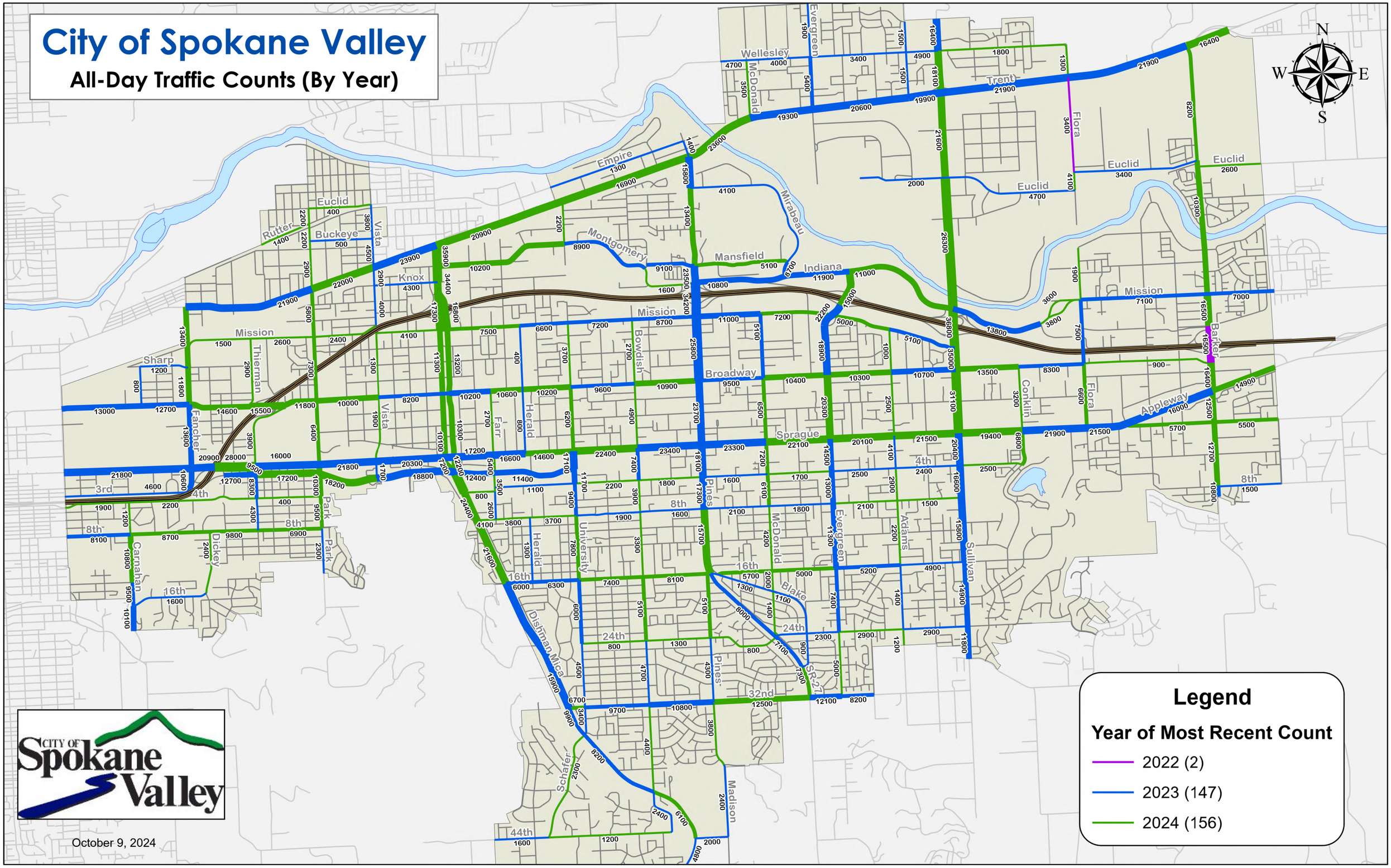
Miscellaneous, Contract Plans Sheets (if applicable)

Appendix A-8

Traffic Analysis Data (Design Year ADT)

City of Spokane Valley

All-Day Traffic Counts (By Year)



CITY OF Spokane Valley

October 9, 2024

Legend

Year of Most Recent Count

- 2022 (2)
- 2023 (147)
- 2024 (156)

Appendix A-9

Environmental Documentation

Spokane Valley Rathdrum Prairie Aquifer

0.5 0 0.5 1 Miles

N W E S

Projection: Lambert Conformal Conic
Central Meridian: -177.42 degrees
Origin: 47.25 degrees

Legend

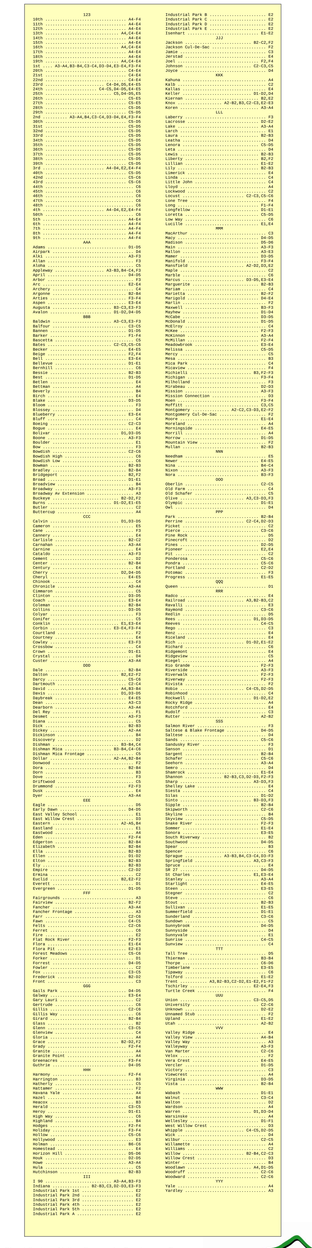
- Type A Well Head
- 1000' Well Head Buffer
- City of Spokane Valley
- Aquifer
- Urban Growth Area
- Seasonal Streams

Aquifer - River Exchange

- Gaining Reach
- Losing Reach
- Transitional Reach
- Minimum Interaction

Aquifer Susceptibility (CARA)

- Low
- Moderate
- High



Product of the City of Spokane Valley, Community Development Department

Notice: The information shown on this map is compiled from various sources and is subject to constant revision. The City makes no claims or guarantees about the accuracy or currency of this map and expressly disclaims liability for errors and omissions in its contents. To confirm accuracy contact the City of Spokane Valley, Community Development Department, Division of Planning, (509) 921-1000.

City of Spokane Valley

Effective Date: 5/10/2006
Ordinance No, 06-010

Appendix A-10

Specialty Design Reports

Appendix A-11

Deviations to the Hydraulics Manual or Highway Runoff Manual

Appendix A-12

UIC Registration Forms

Appendix A-13

Supplements and Revisions