

## Green Infrastructure Standard Specifications and Plan Templates



Central States Water Environment Association  
November 14, 2017



## Outline

- Project Goals and Objectives
- Green Infrastructure Sizing Calculator
- Standard Plan Templates / Typical Details
- Standard Specifications
- Plan Template Report



## Project Goals and Objectives

- The District has adopted its 2035 Vision that includes multiple objectives of zero basement backups, zero overflows, reduced water quantity and improved water quality consistent with the Regional GI Plan.
- The District intends to utilize GI strategies to capture and manage the first 0.5 inches of rainfall that falls on impervious cover, with a long-term goal of providing approximately 740 million gallons of storage volume through the GI strategies.



## Project Goals and Objectives

- Provide various GI specifications and plan templates for project partners moving forward on GI projects.
- Opportunity to maximize future funding opportunities, save money on design, and help ensure projects function as designed.
- Standard specifications and plan templates to help future projects avoid failing and being “overdesigned.”
- Simplify and standardize the design process for various types of GI that can assist both public and private entities in the process of developing and implementing GI projects.



## Project Goals and Objectives

- The GI Standard Specifications and Plan Templates project is focused on the following GI strategies:
  - Bioretention / Bioswale
  - Porous Pavement
  - Rain Garden
  - Stormwater Trees
  - Native Landscaping
  - Soil Amendments



## Project Goals and Objectives

- Tools developed include the following:
  - Green Infrastructure Sizing Calculator
  - Standard Plan Templates / Typical Details
  - Standard Specifications
  - GI Standard Specifications and Plan Templates Report



# GI Sizing Calculator

- Calculator Includes the following strategies:
  - Bioswale / Bioretention
  - Porous Pavement
  - Rain Garden
  - Stormwater Trees
  - Native Landscaping
  - Soil Amendments

**Green Infrastructure Sizing Calculator**  
Milwaukee Metropolitan Sewerage District

**Project Drainage Area**

2.00	Drainage Area (Acres)	300	Available Project Area Length (Feet)
3.00	Impervious Drainage Area (Acres)	50	Available Project Area Width (Feet)
R	Land Use (C=Commercial, I=Industrial, R=Residential)	4	Length to Width Ratio
		10,000	Available Project Area (ft <sup>2</sup> )

**Project Specific Questions**

Yes / No

- Is the project area for the green infrastructure strategy within the right-of-way?
- Are the topographic slopes adjacent to the green infrastructure strategy greater than 12%?
- Is the depth to groundwater less than 6 feet?
- Is the depth to groundwater less than 6 feet?
- Is the project area within 10% of horizon line of building foundations?
- Is the project area within 10% of slope from underground sanitary sewer in the structure or other utility?

**Green Infrastructure Strategies**

Bioswale / Bioretention, Porous Pavement, Stormwater Trees, Native Landscaping, Soil Amendments

Stormwater Runoff Generated from Impervious Surfaces During a 0.5-inch Rainfall Event: 13,600 gallons



# GI Sizing Calculator (Bioswale/Bioretention, Default)

**Bioswale / Bioretention Sizing Calculator (Default)**

**Typical Section Input Data (Fixed Only for Default)**

Freeboard Above Surface Paving	6	in.
Adjacent Side Slopes	3	1:1
Surface Ponding Depth	12	in.
Match Layer Depth (or Concrete Filter Bed)	3	in.
Engineered Soil Media Layer Depth	24	in.
Engineered Soil Media Infiltration Rate	2.5	in./hr.
Flow Control Layer Depth	4	in.
Storage Layer Material	A	
Storage Layer Depth	24	in.
Sand/Shell Infiltration Layer	3	in.
Native Soil Infiltration Rate	0.13	in./hr.
Underdrain Diameter	6	in.
Underdrain Offset (Optional)	6	in.
Planting Bed Length to Width Ratio	2.0	1:1

**Typical Cross Section Image**

**Results**

Drainage Area	2.00	acres
Impervious Drainage Area	1.00	acres
Drainage Area Percent Impervious	50.0	%
Required Total Storage Volume of Bioswale / Bioretention	13,600	gallons
Planting Bed Surface Length	38	feet
Planting Bed Surface Width	18	feet
Required Planting Bed Surface Area	711	ft <sup>2</sup>
Required Surface Area at Existing Ground Surface	1,300	ft <sup>2</sup>
Total Storage Unit Volume	32.8	gallons/ft <sup>2</sup>
Approximate Total Storage Volume	15,600	gallons
Unit Volume	7.5	gallons/ft <sup>2</sup>
Storage Volume	5,390	gallons
Underdrain Flow Rate	1,581	cfs
Has adequate storage volume been provided?	Yes	



# GI Sizing Calculator

## (Bioswale/Bioretention, Variable)

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**Bioswale / Bioretention Sizing Calculator (Variable)**

[Click Here to Return to Cover Page](#)

[Click Here for Quantities and Opinion of Cost](#)

[Click Here for Typical Details and Specifications](#)

[Click Here for Bioswale / Bioretention Sizing \(Default\)](#)

**Typical Section Input Data**

Freeword Above Surface Paving	8	in.
Adjacent Side Slopes	3	:1
Surface Paving Depth	12	in.
Match Layer Depth (for Concrete Fiber Mesh)	3	in.
Engineered Soil Media Layer Depth	30	in.
Engineered Soil Media Infiltration Rate	2.5	in./hr.
Pea Gravel Layer Depth	4	in.
Storage Layer Material	A	
Storage Layer Depth	20	in.
Sand/Soil Interface Layer	1	in.
Native Soil Infiltration Rate	0.13	in./hr.
Underdrain Diameter	6	in.
Underdrain Offset (Optional)	6	in.
Planting Bed Length to Width Ratio	2.0	:1

**Typical Cross Section Image**

**Extra Information / Notes**

The storage thickness of the storage layer shall be that which results in a total device storage area of 2.0 acres, but shall not exceed 45 inches. (MMSD Construction Practice Standard Table 9.6.7.2)

**Results**

Drainage Area	2.00	acres
Impervious Drainage Area	1.00	acres
Drainage Area Percent Impervious	50.0	%
Required Total Storage Volume of Bioswale / Bioretention	13,600	gallons
Planting Bed Surface Length	60.0	feet
Planting Bed Surface Width	20.0	feet
Planting Bed Surface Area	800	sq ft
Surface Area of Existing Ground Surface	1,400	sq ft
Total Storage Unit Volume	20.8	gallons/ft <sup>2</sup>
Total Storage Volume	16,550	gallons
Flow Volume	2.5	gallons/ft <sup>2</sup>
Discharge Volume	6,000	gallons
Underdrain Flow Rate	1.796	cfs
Has adequate storage volume been provided?	Yes	

# GI Sizing Calculator

## (Porous Pavement)

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**Porous Pavement Sizing Calculator (Default)**

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[Click Here for Porous Pavement Sizing \(Variable\)](#)

**Typical Section Input Data (Read-Only for Default)**

Porous Pavement Surface Type	P	
Paver or Block Joint Type	F	
Porous Pavement Surface Depth	4	in.
Bedding Layer Depth (Pea Gravel)	2	in.
Base Course Depth (Aggregate)	4	in.
Underdrain Diameter	6	in.
Storage Layer Depth (Aggregate)	18	in.
Native Soil Infiltration Rate	0.13	in./hr.
Underdrain Offset (Optional)	6	in.




**Typical Cross Section Image**


**Extra Information / Notes**

**Results**

Drainage Area	2.00	acres
Impervious Drainage Area	1.00	acres
Drainage Area Percent Impervious	50.0	%
Required Total Storage Volume of Porous Pavement	13,600	gallons
Porous Pavement Surface Length	125	feet
Porous Pavement Surface Width	20	feet
Minimum Required Porous Pavement Surface Area to Store Impervious Runoff from 0.5 Inch Event	2,498	sq ft
Total Unit Storage Volume	5.4	gallons/ft <sup>2</sup>
Total Storage Volume	13,600	gallons
MMSD Regional Green Infrastructure Plan Storage Unit Volume	3.0	gallons/ft <sup>2</sup>
MMSD Regional Green Infrastructure Plan Total Storage Volume	7,493	gallons
Underdrain Flow Rate	0.9880	cfs
Has adequate storage volume been provided?	Yes	

## GI Sizing Calculator (Rain Garden)



### Rain Garden Sizing Calculator (Default)

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[Click Here for Typical Details and Specifications](#)


[Click Here for Rain Garden Sizing \(Variable\)](#)

#### Typical Section Input Data (Read-Only for Default)

Adjacent Surface Slope	2	%
Side Slopes	1	:1
Ponding Depth	4	in.
Mulch Layer Depth	2	in.
Soil Media Layer Depth	6	in.
Native Soil Infiltration Rate	0.13	in./hr.

#### Extra Information / Notes




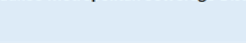

#### Typical Cross Section Image



#### Results

Drainage Area	4,356	ft <sup>2</sup>
Impervious Area	2,178	ft <sup>2</sup>
Drainage Area Percent Impervious	50.0	%
Required Total Storage Volume of Rain Garden	679	gallons
Rain Garden Surface Length	38.6	feet
Rain Garden Surface Width	9.3	feet
Rain Garden Length to Width Ratio	2.0	:1
Required Rain Garden Surface Area	373	ft <sup>2</sup>
Required Surface Area at Existing Ground Surface	392	ft <sup>2</sup>
Total Storage Unit Volume	3.9	gallons/ft <sup>2</sup>
Approximate Total Storage Volume	679	gallons
MMSD Regional Green Infrastructure Plan Storage Unit Volume	4.4	gallons/ft <sup>2</sup>
MMSD Regional Green Infrastructure Plan Total Storage Volume	760	gallons
Has adequate storage volume been provided?	Yes	

## GI Sizing Calculator (Stormwater Tree)

### Stormwater Tree

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[Click Here for Typical Details and Specifications](#)

#### Input Data


Number of Stormwater Trees to be Installed	600
--------------------------------------------	-----

#### Results


Drainage Area	2.00	acres
Impervious Drainage Area	1.00	acres
Drainage Area Percent Impervious	50.0	%
Required Total Storage Volume	13,600	gallons
MMSD Regional Green Infrastructure Plan Storage Unit Volume	25.0	gallons/tree
MMSD Regional Green Infrastructure Plan Total Storage Volume	15,000	gallons
Has adequate storage volume been provided?	Yes	

# GI Sizing Calculator

## (Native Landscaping)




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**FRESHCOAST**  
MILWAUKEE, WISCONSIN

**Green Infrastructure Sizing Calculator**  
Milwaukee Metropolitan Sewerage District



**STRAND**  
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**Native Landscaping**

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**Input Data**

Area of Native Landscaping to be Installed  ft<sup>2</sup>

**Results**

Drainage Area	2.00	acres
Impervious Drainage Area	1.00	acres
Drainage Area Percent Impervious	50.0	%
Required Total Storage Volume	13,600	gallons
MMSD Regional Green Infrastructure Plan Storage Unit Volume	0.4	gallons/ft <sup>2</sup>
MMSD Regional Green Infrastructure Plan Total Storage Volume	2,000	gallons
Has adequate storage volume been provided?	No	



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# GI Sizing Calculator

## (Soil Amendments)




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MILWAUKEE, WISCONSIN

**Green Infrastructure Sizing Calculator**  
Milwaukee Metropolitan Sewerage District



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**Soil Amendments**

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**Input Data**

Area of Soil Amendments to be Installed  ft<sup>2</sup>

**Results**

Drainage Area	2.00	acres
Impervious Drainage Area	1.00	acres
Drainage Area Percent Impervious	50.0	%
Required Total Storage Volume	13,600	gallons
MMSD Regional Green Infrastructure Plan Storage Unit Volume	0.2	gallons/ft <sup>2</sup>
MMSD Regional Green Infrastructure Plan Total Storage Volume	200	gallons
Has adequate storage volume been provided?	No	



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# GI Sizing Calculator

## (Quantities and Opinion of Probable Cost)

**Green Infrastructure Sizing Calculator**  
Milwaukee Metropolitan Sewerage District

Bioswale / Bioretention Sizing Calculator (Default)

Quantities List and Preliminary Opinion of Probable Construction Cost

Year of Original Opinion of Probable Construction Cost	2016
Anticipated Year of Construction	2021
Annual Inflation Adjustment	3.0%

*Note: Please provide specific quantities in blue boxes based on specific design configuration. The other quantities are calculated based on results of the Green Infrastructure Sizing Calculator.*

Item #	Item Description	Quantity	Unit	Unit Cost	Total Cost
1	Excavation	155	CY	\$ 30.00	\$ 4,650
2	Mulch	7	CY	\$ 60.00	\$ 390
3	Engineered Soil Media	53	CY	\$ 80.00	\$ 4,210
4	No. 8 Aggregate (Pea Gravel Layer)	12	TON	\$ 50.00	\$ 610
5	No. 2 Aggregate (Storage Layer)	24	TON	\$ 50.00	\$ 1,200
6	Sand (Sand/Soil Interface Layer)	9	TON	\$ 50.00	\$ 450
7	Plantings	711	SF	\$ 5.00	\$ 3,550
8	6-Inch Perforated Underdrain	38	LF	\$ 15.00	\$ 570
9	Underdrain in Cleasout	1	EA	\$ 200.00	\$ 200
10	Overflow Structure	1	EA	\$ 2,000.00	\$ 2,000
11	Observation Well	1	EA	\$ 1,000.00	\$ 1,000
12	Splash Pad / Energy Dissipation	2	EA	\$ 500.00	\$ 1,000
13	Erosion Control	1	LS	\$ 1,000.00	\$ 1,000
Subtotal					\$ 24,170
Contingencies (20%)					\$ 4,834
Total Opinion of Probable Construction Cost					\$ 28,004
Total Opinion of Probable Construction Cost (Adjusted for Inflation)					\$ 33,624
Opinion of Probable Construction Cost per Square Foot of Green Infrastructure Strategy					\$ 41
Anticipated Annual Operation and Maintenance Cost for Green Infrastructure Strategy					\$ 1,681

# GI Sizing Calculator

## (TMDL)

**Green Infrastructure Sizing Calculator**  
Milwaukee Metropolitan Sewerage District

Bioswale / Bioretention Sizing Calculator (Default)

Typical Section Input Data (Used Only for Default)

Freeboard Area Surface Ponding	4	in.
Address Side Slopes	1	1
Surface Ponding Depth	12	in.
Mulch Layer Depth (at Concrete/Soil Media)	3	in.
Engineered Soil Media Layer Depth	24	in.
Engineered Soil Media Infiltration Rate	0.3	in./hr.
Pea Gravel Layer Depth	4	in.
Storage Layer Material	A	
Storage Layer Depth	24	in.
Sand/Soil Interface Layer	3	in.
Surface Soil Infiltration Rate	0.23	in./hr.
Underdrain Diameter	4	in.
Underdrain Spacing (Default)	4	in.
Planting Bed Length to Width Ratio	2.0	0

Typical Cross Section Image

Extra Information / Notes

Results

Drainage Area	2.00	acres
Impervious Drainage Area	1.00	acres
Drainage Area Percent Impervious	50.0	%
Required Total Storage Volume (Minimum Storage Volume)	10,000	gallons
Planting Bed Surface Length	38	feet
Planting Bed Surface Width	19	feet
Required Planting Bed Surface Area	711	sf
Required Surface Area of Existing Ground Surface	3,368	sf
Total Storage Unit Volume	19.4	gallons/sf
Approximate Total Storage Volume	13,040	gallons
Volume	0.3	gallons/sf
Volume	5,330	gallons
Underdrain Flow Rate	1.26	in.

Has adequate storage volume been provided? Yes

Extra Results

Minimum Annual Storage Volume	0.00	acres-foot
Soil Porosity	0.47	
Soil Porosity	0.40	

Water Quality: TMDL



# WinSLAMM Modeling

- GI Strategies Evaluated



# GI Sizing Calculator

**Green Infrastructure Sizing Calculator**  
Milwaukee Metropolitan Sewerage District

*Source: Total Maximum Daily Loads for Total Phosphorus, Total Suspended Solids, and Total Nitrogen, Milwaukee River Basin, Wisconsin - Draft Report, July 21, 2014*  
*Appendix A - TMDL A.20 (MPO) - Required Percent Reduction of TSS TP and TN by Municipality - Draft, 11/16/2016 (Page 20 of 20)*  
*Appendix A - TMDL A.20 (MPO) - Required Percent Reduction of TSS TP and TN by Municipality - Draft, 11/16/2016 (Page 21 of 20)*  
*Appendix A - TMDL A.20 (MPO) - Required Percent Reduction of TSS TP and TN by Municipality - Draft, 11/16/2016 (Page 22 of 20)*

Municipality	Watershed	Area	TP Load	TP % Red	TP % Red	TSS Load	TSS % Red	TSS % Red
Brookfield, Village	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Brookfield, City	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Brookfield, Town	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Brown Deer, Village	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Dunbar, Village	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
East Troy, City	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Elin Grove, Village	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Fox Point, Village	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Greenfield, Village	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Milwaukee, City	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
North Shore, City	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Shoreland, City	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
West Allis, City	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
Wauwatosa, City	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%
	Milwaukee	200	2,200	50%	50%	2,200	50%	50%

	Average TP % Reduction	Average TSS % Reduction
Max	88%	88%
Min	14%	48%
Avg	60%	66%



*Note: Several municipalities within the MMSD's service area are not included in the Draft TMDL, including East Troy, Franklin, Oak Creek, Waukesha, and Menomonee Falls.*



## GI Calculator TMDL Results

Average WinSLAMM Modeling Results			
	Estimated Runoff Reduction (%)	Estimated TSS Reduction (%)	Estimated TP Reduction (%)
Bioswale/Bioretentation	20%	65%	20%
Porous Pavement	30%	70%	55%
Rain Garden	60%	60%	60%
Draft TMDL Average	-	66%	60%

Water Quality / TMDL Results		
Estimated Runoff Reduction	20.0%	
Estimated TSS Reduction	65.0%	
Estimated TP Reduction	20.0%	
Typical Year Runoff Volume	707,000	gallons
Typical Year Runoff Volume Reduction	141,400	gallons
0.5-Inch Rainfall Event Runoff Volume from Imp. Areas	13,600	gallons
0.5-Inch Rainfall Event Runoff Volume Reduction	2,720	gallons
Typical Year TSS Load	802.9	pounds
Typical Year TSS Load Reduction	521.9	pounds
0.5-Inch Rainfall Event TSS Load	16.5	pounds
0.5-Inch Rainfall Event TSS Load Reduction	10.7	pounds
Typical Year TP Load	2.790	pounds
Typical Year TP Load Reduction	0.558	pounds
0.5-Inch Rainfall Event TP Load	0.056	pounds
0.5-Inch Rainfall Event TP Load Reduction	0.011	pounds

## GI Standard Plan Templates



- Standard Plan Templates / Typical Details Developed
  - Bioretention/Bioswale
  - Porous Pavement
  - Rain Garden
  - Stormwater Trees
  - Native Landscaping
  - Soil Amendments

Contract Documents  
Milwaukee Metropolitan  
Sewerage District

**WATERCOURSE**  
Green Infrastructure  
Specifications and Plan Templates

Contract M03064P21  
Plans

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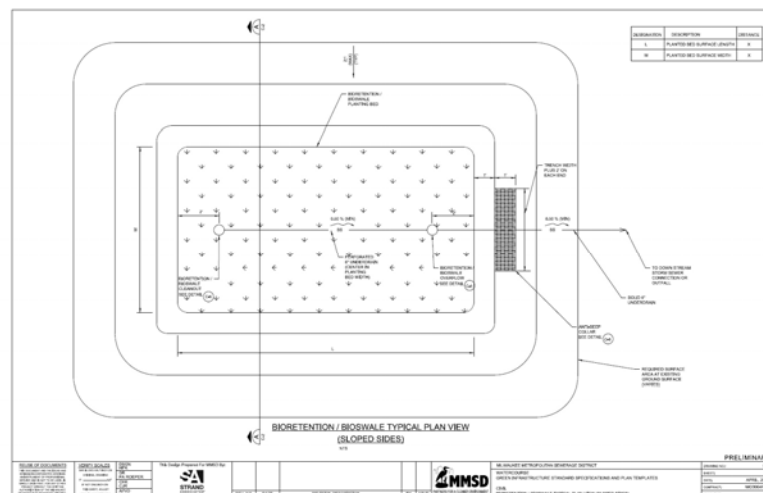
## Plan Templates – Bioretention/Bioswale

- Plan and Section Views – Open Space with Side Slopes (grass)
- Plan and Section Views – Concrete Perimeter (curb)
- Details
  - Overflow
  - Cleanout
  - Observation Well
  - Anti-Seep Collar
  - Plant Spacing
- Cross Section – Trench Drain and Splash Pads
- Plan and Section Views – Pretreatment Basin Option
- Plan and Section Views – Filter Strip Option



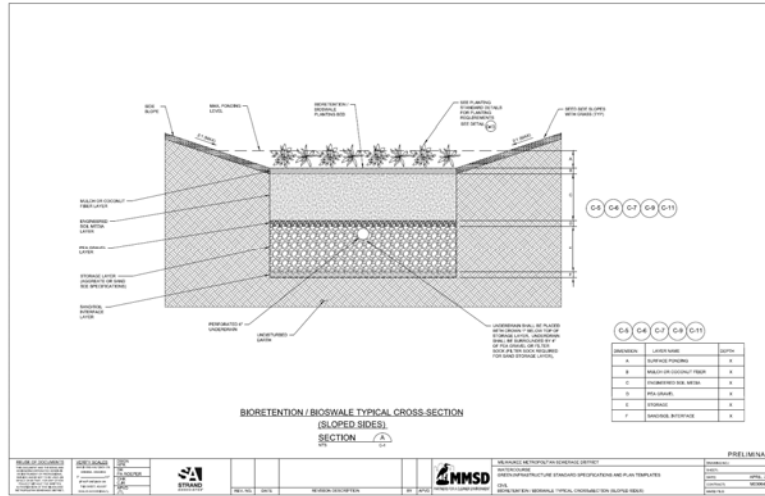
## Plan Templates – Bioretention/Bioswale

Typical Plan View (Sloped Sides)



# Plan Templates – Bioretention/Bioswale

Typical Cross Section (Sloped Sides)

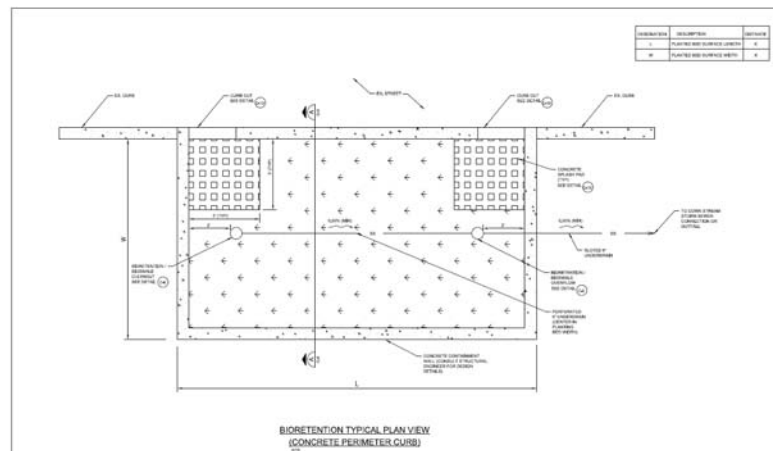


PROJECT NO.	DATE	SCALE	DESIGNER	CHECKER	APPROVER	DATE	DESCRIPTION



# Plan Templates – Bioretention/Bioswale

Typical Plan View (Concrete Perimeter Curb)

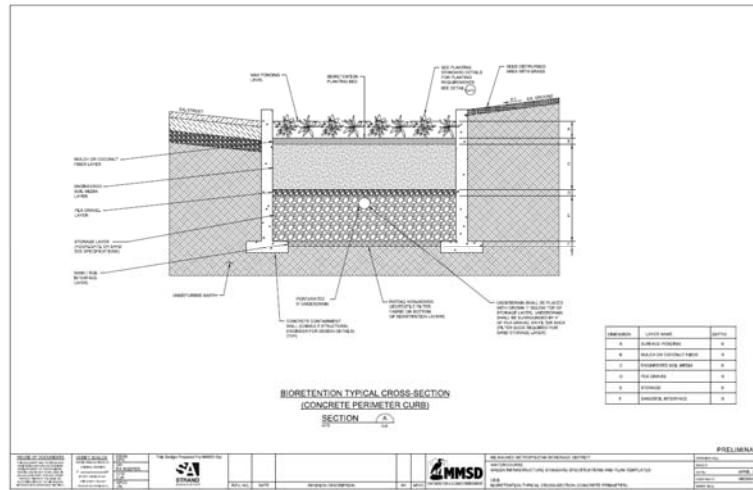


PROJECT NO.	DATE	SCALE	DESIGNER	CHECKER	APPROVER	DATE	DESCRIPTION



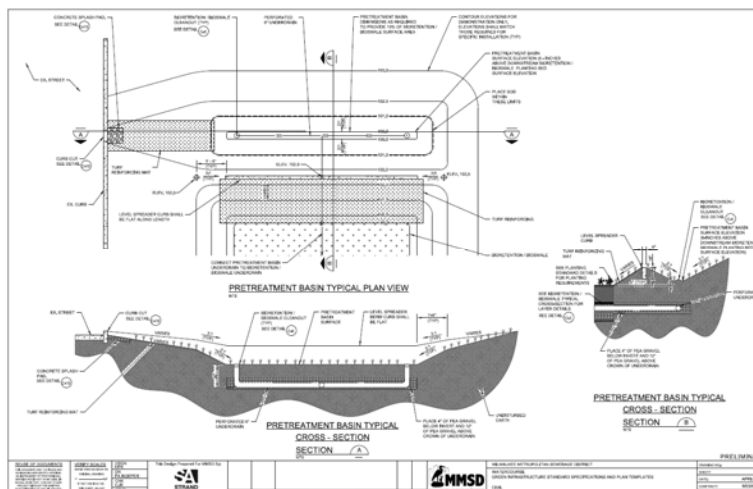
# Plan Templates – Bioretention/Bioswale

## Typical Cross Section (Concrete Perimeter Curb)

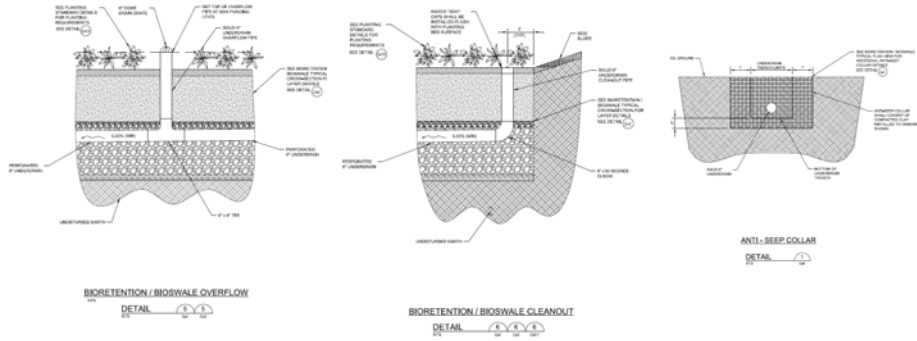


# Plan Templates – Bioretention/Bioswale

## Pre-Treatment Option



## Plan Templates – Bioretention/Bioswale



Overflow Structure

Cleanout Detail

Anti-Seep Collar

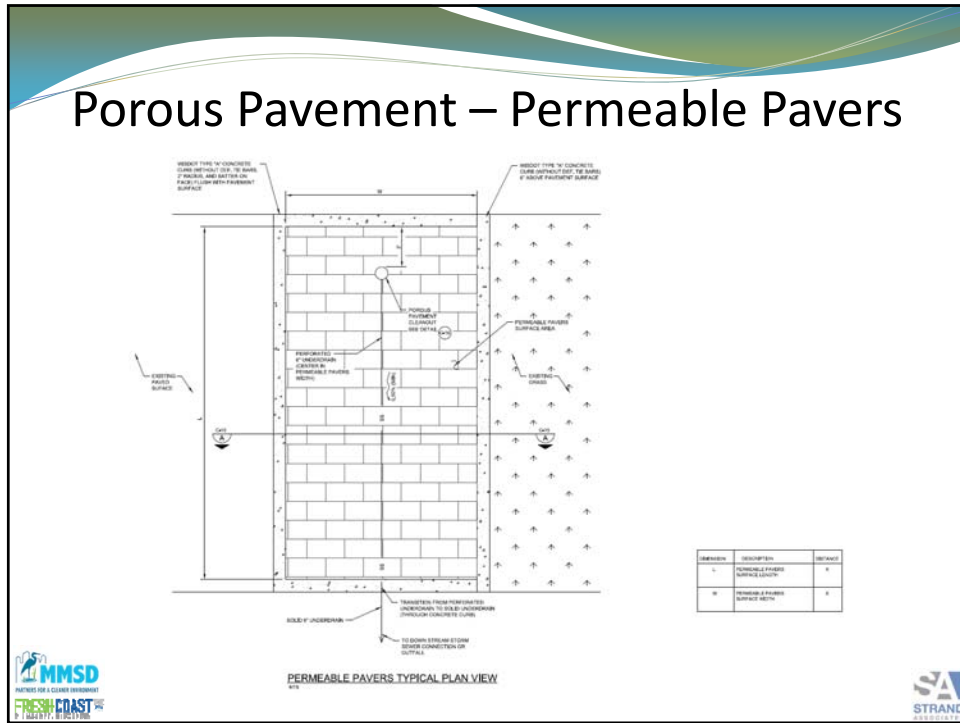


## Plan Templates – Porous Pavement

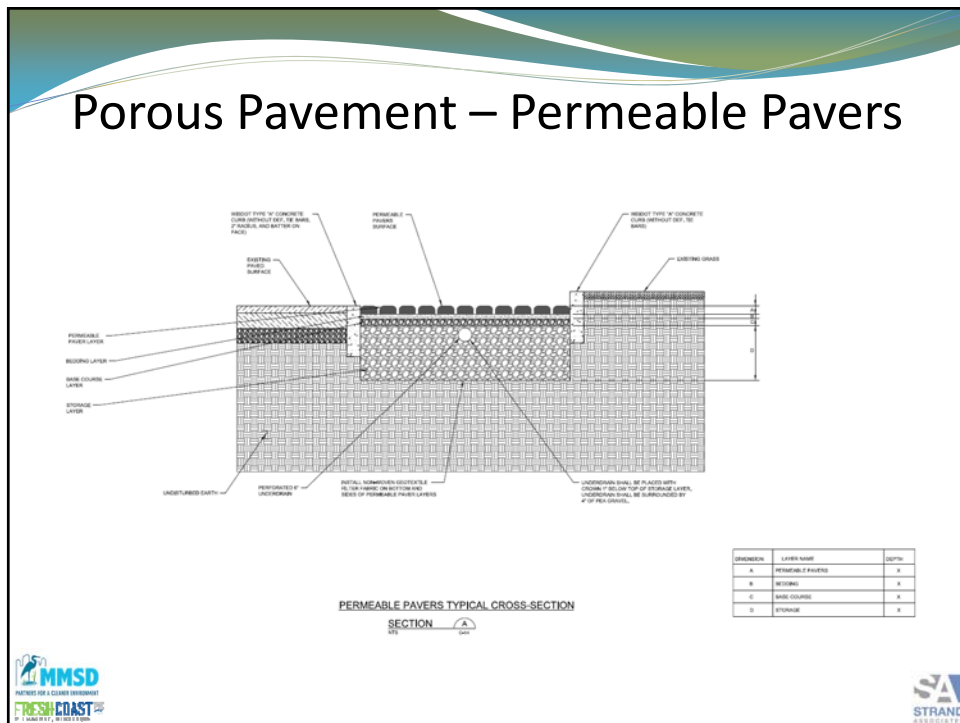
- Plan and Section Views – Permeable Pavers
- Plan and Section Views – Pervious Concrete/Porous Asphalt
- Details
  - Cleanout
  - Observation Well



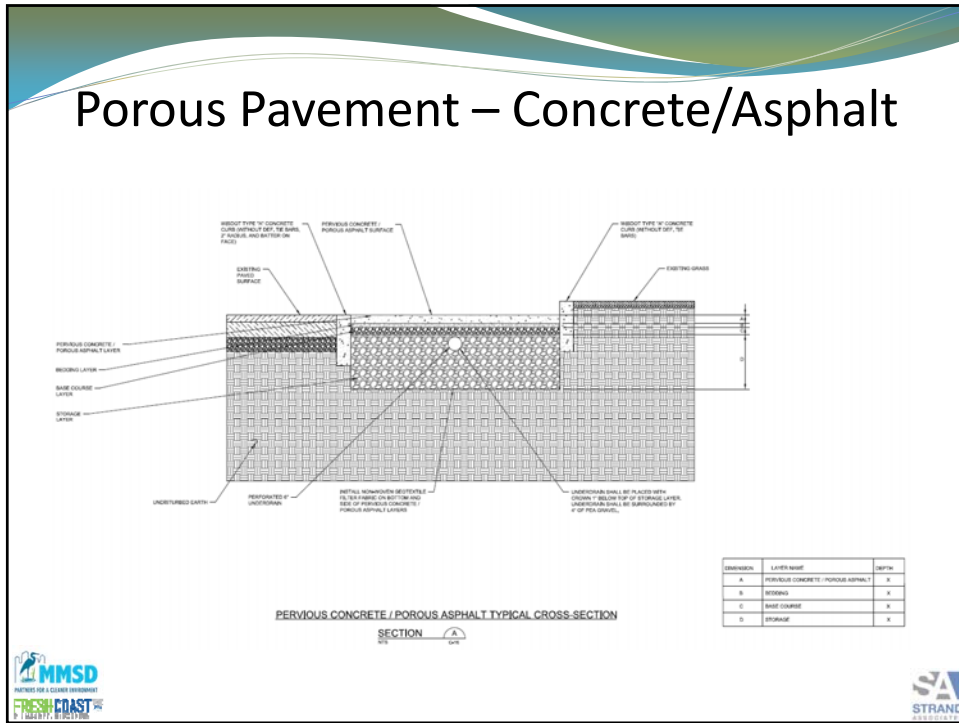
# Porous Pavement – Permeable Pavers



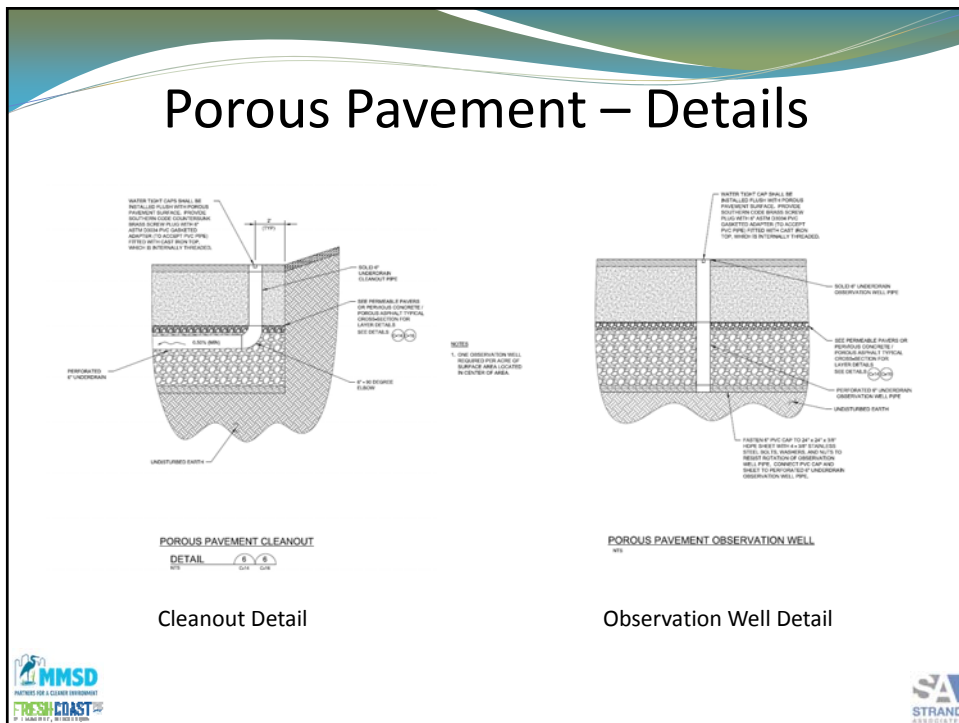
# Porous Pavement – Permeable Pavers



# Porous Pavement – Concrete/Asphalt



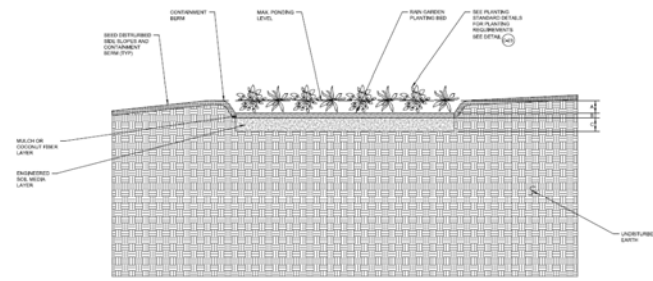
# Porous Pavement – Details







# Rain Garden – Cross Section

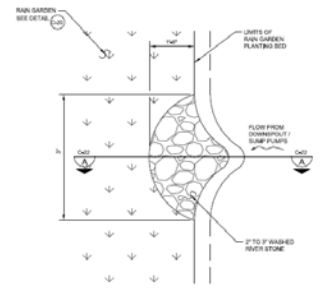


DIMENSION	LAYER NAME	DEPTH
A	SURFACE PONDING	X
B	MEDIA ON GEOCOCULT FIBERS	X
C	ENGINEERED SOIL MEDIA	X

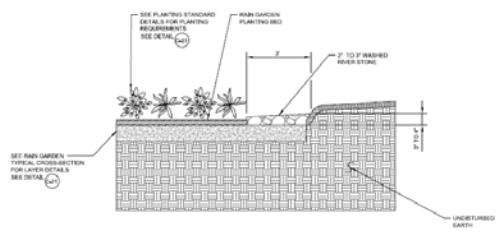
RAIN GARDEN TYPICAL CROSS-SECTION  
SECTION A-A  
DETAIL 21



# Rain Garden – Details



PLAN VIEW

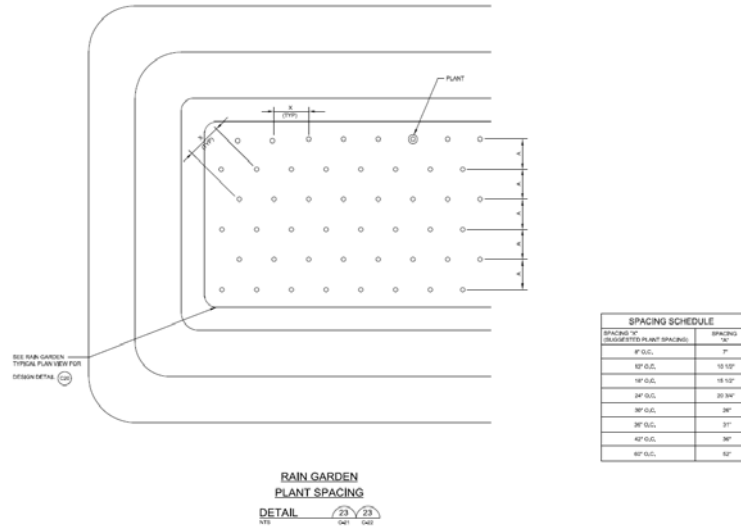


SECTION A-A

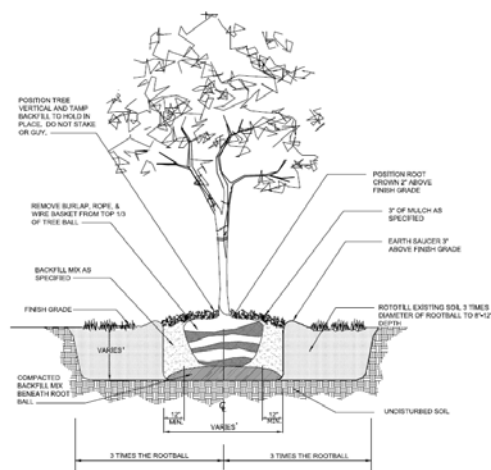
RAIN GARDEN ENERGY DISSIPATION STONE  
DETAIL 22



# Rain Garden – Plant Spacing



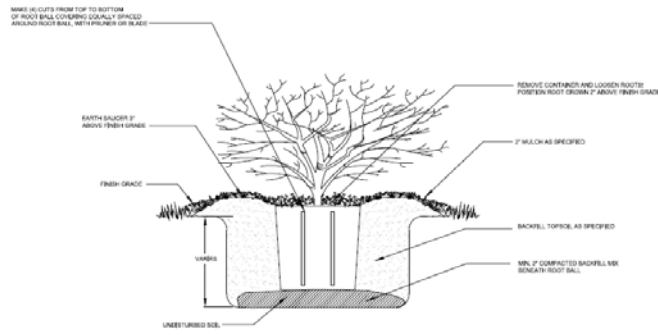
# Plan Templates – Stormwater Trees



STORMWATER TREE DETAIL



## Plan Templates – Native Landscaping



NATIVE LANDSCAPING DETAIL  
N18





## GI Standard Specifications

- Standard Specification Section
  - Bioretention/Bioswale
  - Porous Pavement
  - Rain Garden
  - Stormwater Trees
  - Native Landscaping
  - Soil Amendments



# Specification Format

- Follows MMSD format (three part)
  - Part A – Scope (Related work, submittals, qualifications, etc.)
  - Part B – Materials (Media, surface layer, storage layer, piping, etc.)
  - Part C – Workmanship (Site stabilization, suitable weather, compaction avoidance, etc.)
- Specifications are based on WDNR Technical Standards where applicable

# Specification – Bioretention/Bioswale

**02037 BIORETENTION - BIOSWALL GREEN INFRASTRUCTURE STRATEGY**

**INTS:** This specification is intended to be used as part of the Milwaukee Metropolitan Sewerage District's Green Solutions Program for implementation of green infrastructure strategies into Contract Documents by local municipalities or other entities. The specification is also intended to be used in conjunction with the Green Infrastructure Sizing Calculator and the Green Infrastructure Typical Details developed for the Green Solutions Program. The specification is considered to be a technical guidance document to assist users with the design of green infrastructure strategies. It is the responsibility of the local municipality or design engineer to make revisions to the specification as needed for specific design projects. It is recommended the documents are reviewed by a licensed professional engineer before releasing for construction. Note that the specification was last updated by the District in 2016.

**A. SCOPE**

This Section covers the work necessary to furnish and install bioretention/ bioswale green infrastructure strategies, including the engineered soil media layer, surface mulch layer or coconut fiber mat, stormwater storage layer, underdrain piping, cleanouts, observation wells, anti-sweep collars, and overflow structures.

**1. GENERAL**

**INTS:** Update language of this Section as necessary based on applicable references to **Items and specifications.**

See **CONDITIONS OF THE CONTRACT**, and Division 1, **GENERAL REQUIREMENTS**, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

**2. RELATED WORK**

**INTS:** The list below may not be fully inclusive depending upon the specifics of each individual project. Update language of this Section as necessary based on applicable references to other technical specification sections.

The applicable requirements, materials and workmanship specified in the following Sections are included by reference in this Section. The list below is from the Wisconsin Department of Transportation (WisDOT) Standards and Specifications for Highway and Structure Construction, latest edition.

Section 201 Clearing and Grubbing  
 Section 205 Roadway and Drainage Excavation  
 Section 501 Concrete  
 Section 601 Concrete Curb and Gutter  
 Section 602 Concrete Sidewalks  
 Section 611 Catch Basins, Manholes, and Inlets  
 Section 612 Underdrains

02037  
1

Section 027 Mulching  
 Section 028 Erosion Control  
 Section 030 Seeding  
 Section 031 Sodding  
 Section 043 Geotextile Fabrics

The following specification is developed for the Milwaukee Metropolitan Sewerage District's Green Solutions Program may also include related work.

Section 0240 Exterior Plant (Native Landscaping and Stormwater Trees)

**3. SUBMITTALS**

**a. SUBMITTALS REQUIRED PRIOR TO BID/OPENING**

Field approval of materials is not required. Suppliers and products have been identified as a means of establishing quality, but not for purposes of limiting competition.



**b. SUBMITTALS DURING CONSTRUCTION**

**INTS:** Update language of this Section as necessary based on applicable references to **Items and specifications.**

Submittals during construction shall be made in accordance with Section 01300 in Division 1, **GENERAL REQUIREMENTS**. In addition, the following specific information shall be provided:

1. **CONTRACTOR'S Qualifications:** CONTRACTOR shall submit information showing conformance with qualification requirements listed in specifications. Submit **CONTRACTOR Qualifications to OWNER** for review prior Notice to Proceed.
2. **Engineered Soil Media Mixture Analysis:** CONTRACTOR shall submit soil analysis by a qualified soil-testing laboratory showing conformance with engineered soil media mixture specifications. Submit soil analysis to **OWNER** for review and approval prior to installation.
3. **Engineered Soil Media Infiltration Test:** CONTRACTOR shall conduct and submit results of an on-site infiltration test of the engineered soil media to ensure conformance with saturated hydraulic conductivity criteria. Using 2 cubic yards of the prepared engineered soil media, CONTRACTOR shall place the material on site at the proper location and depth, allow for proper settlement of the engineered soil media, and conduct an infiltration test using a double-ring infiltrometer in accordance with ASTM D3335. Submit

02037  
2

# GI Standard Specifications and Plan Templates Report

- Concise report to supplement GI calculator, specifications and plan templates.
- Report Contents
  - Introduction (Purpose, GI tool, summary of strategies)
  - GI Strategies (Individual Sections)
    - Bioretention/Bioswales
    - Rain Gardens
    - Porous Pavement
    - Stormwater Trees
    - Native Landscaping
    - Soil Amendments
  - TMDL Considerations
  - Appendix A – Plan Templates/Example Typical Details
  - Appendix B – Specifications
  - Appendix C – Inspection and Maintenance Checklists
  - Appendix D – Trees and Plant Lists



# GI Standard Specifications and Plan Templates Report

## 2.) BIORETENTION/BIOSWALES

### 2.1 Description

Bioretention/bioswales are designed to promote stormwater storage, water quantity reduction through infiltration and evapotranspiration, peak flow rate reduction, and water quality improvement. Although comparable in nature to rain gardens, bioretention/bioswales are intended to capture stormwater runoff from larger drainage areas and include deeper layers of materials. Bioretention/bioswales consist of designed layers of surface water ponding, hardwood mulch, engineered soil media, one gravel, aggregate or sand storage, and an underdrain constructed at nearly flat slopes which collectively provide storage and water quality improvement. Bioretention/bioswales also provide an added benefit of reducing total suspended solids (TSS) and removing other nutrients conveyed by stormwater runoff. This strategy is typically planted with native plants which serve to stabilize the surface to prevent erosion, promote absorption and evapotranspiration, and prevent engineered soil compaction through root growth.



Figure 2.1.1 Bioretention/Bioswale Example

### 2.2 Site Suitability Considerations

Table 2-2-1 summarizes site suitability considerations that should be evaluated or considered when planning and selecting a suitable location for a bioretention/bioswale system.

Table 2-2-1 Bioretention/Bioswale Site Suitability Considerations

SITE CONSIDERATION	VALUE / DESCRIPTION
Maximum Drainage Area	Less than 2 Acres
Maximum Impervious Drainage Area	Less than 2 Acres
Soil Hydrologic Group and Infiltration Rate	A (Underdrain Required if Infiltration Less than 3.6 in/hr) & C, D (Underdrain Required)
Prohibited Adjacent Land Use	Construction, Unstable Landscaping, Agricultural
Construct within Right-of-Way	Yes
Construct Above Buried Utilities	No
Maximum Adjacent Site Slope	0.5 to 20 Percent
Maximum Longitudinal Slope	Less than 1 Percent
Distance From Wastewater Treatment	More than 50 Feet
Distance from Building Foundations	More than 10 Feet

Designers should review the Wisconsin Department of Natural Resources (DNR) Conservation Practice Standards (CPS) section titled "Site Evaluation for Stormwater Infiltration (Section 1002)" for additional details related to green infrastructure strategy siting considerations.



# GI Standard Specifications and Plan Templates Report

## 2.3 Design Considerations

Table 2.3-1 summarizes design considerations that should be evaluated or considered when designing a bioretention/bioswale system. Refer to Appendix D for plan lists that can be considered for bioretention/bioswale green infrastructure strategies.

Table 2.3-1 Bioretention/Bioswales Design Considerations

DESIGN CONSIDERATION	VALUE / DESCRIPTION
Surface Area	Size to Provide Storage for the 0.5-inch Rainfall Event Using Green Infrastructure Sizing Tool
Length to Width Ratio	2:1 (Suggested)
Ponding Area Side Slopes	Maximum of 2:1
Ponding Area Depth	Maximum of 12 Inches
Mulch Layer Depth	2 to 3 Inches
Engineered Soil Media Layer Depth	Minimum of 24 Inches
Pea Gravel Layer Depth	Maximum of 4 Inches (Required if Aggregate Storage Layer is Used)
Storage Layer Depth	Maximum of 48 Inches, Either Washed Aggregate or Sand
Sand/Soil Interface Depth	3 Inches, Required When Native Soil Infiltration Rate is Less than 3.6 in/hr
Ponding Drawdown Time	Maximum of 24 Hours
Total System Drawdown Time	Maximum of 72 Hours
Underdrain	Minimum 6-inch-Diameter Perforated Pipe (Optional Control Orifice Can Be Added to Increase Detention Time, Sized to Meet Maximum Drawdown Time)
Overflow Structure	Required to Limit Maximum Ponding Depth
Pre-treatment	Sediment Forebay, Vegetated Channels, or Filter Strips

Designers should review the WDMR CFS section titled "Bioretention for Infiltration (Section 1004)" for additional design considerations for bioretention/bioswale green infrastructure strategies.

## 2.4 Costs

**2.4.a. Construction Costs**  
Construction costs are variable depending on the specific characteristics of the project including, but not limited to, location, existing surface features, adjacent surface improvements, the depths of the bioretention/bioswale layers, and surface area. Designers are encouraged to refer to the Green Infrastructure Sizing Calculator for a listing of typical items, quantities, and unit costs for bioretention/bioswale green infrastructure strategies to develop a planning level estimate of probable construction cost. For bioretention/bioswale green infrastructure strategies utilizing the default design from the Green Infrastructure Sizing Calculator, the typical cost per square foot is between \$35/m<sup>2</sup> and \$55/m<sup>2</sup>.

**2.4.b. Operation and Maintenance Costs**  
Operation and maintenance (O&M) costs include the costs for weeding of the planting surface, watering, and general upkeep. Typical O&M activities are included in Appendix C. Replacement of major components, including engineered soil media and plantings, is not anticipated for

annual operation and maintenance of bioretention/bioswales. Based on a review of various sources of O&M cost data of green infrastructure strategies, the annual O&M cost for bioretention/bioswales is approximately 5 percent of the initial construction cost. Local municipalities should review the suggested value and compare it with their own experience and data as projects continue to get implemented.

## 3.4.a. Life Cycle Costs

Each green infrastructure strategy has an anticipated useful life, and this must be considered when performing a life cycle cost analysis. The useful lives of green infrastructure strategies are not as well established as traditional storm water features (i.e., piping). Consequently, a review of published values may yield differing results. Based on a review of various sources of life cycle cost data of green infrastructure strategies, the useful life expectancy for bioretention/bioswale green infrastructure strategies is approximately 20 years. After this time frame, major components may require complete replacement depending upon the magnitude of sediment buildup over a long-term duration, including the potential replacement of engineered soil media, aggregate storage layers, and plantings. Infiltration tests and geotechnical assessments of the engineered soil profile can help determine the potential magnitude of replacement at the end of the anticipated useful life. Local municipalities should review the suggested value and compare it with their own experience and data as projects continue to be implemented.

## 2.5 Plan Templates/Example Typical Details

Refer to Appendix A for plan templates/example typical details for bioretention/bioswale systems.

## 2.6 Specifications

Refer to Appendix B for specifications for bioretention/bioswale systems.

## 2.7 Inspection and Maintenance

Refer to Appendix C for an inspection and maintenance checklist for bioretention/bioswale systems.



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# Presentation Summary

- GI Sizing Calculator – Planning Level tool to Evaluate Preliminary Costs and Sizing Requirements for GI
- GI Standard Plan Templates - Provides General Cross Section for GI Strategies
- GI Standard Specifications – Provides Material Specifications and Installation Requirements for GI
- GI Template Report – Provides Additional Information to Supplement GI Calculator



## Where the tool can be found

- <https://www.freshcoast740.com/resources>
- MMSD has developed a SOP for the non-engineer (available on freshcoast website)
- Download the zip file to have access to the GI Plans, Specs, and sizing tool



## Thank You!

## Questions?



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