



# Understanding DWSD's Drainage Program

Technical Seminar for Engineers,  
Landscape Architects, and Developers  
October 28, 2022

# Technical Seminar Agenda

- Introduction
- Drainage Charge Background and Program Fundamentals
- Questions?
- Green Stormwater Infrastructure (GSI) Credits
- Direct Discharge Credits
- Credit Application Process
- Green Stormwater Infrastructure (GSI) Credits Technical Considerations
- Questions?

# DWSD's Technical Seminar Goals

- Provide accurate technical and program information to technical service providers working in Detroit
- Clarify credit-eligible green stormwater infrastructure technical issues related to methodology, design, and maintenance
- Create a network of knowledgeable technical service providers to better support Detroit property owners seeking stormwater management support for any reason



# **DRAINAGE CHARGE BACKGROUND AND PROGRAM FUNDAMENTALS**

# Drainage Charge Myths and Facts



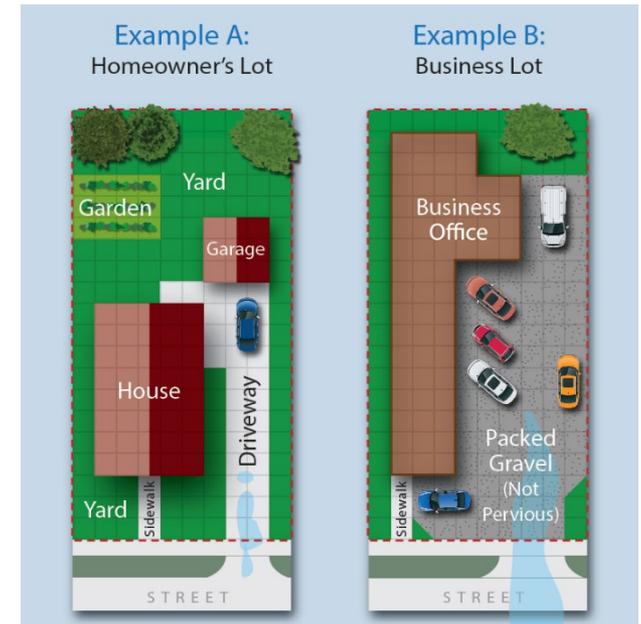
Myths	Facts
Charge is new.	Charged since 1975. Comply with MI law. Embedded in sewerage charges.
Rain water is clean.	Runoff mixed with dirt, oil. Blended with sanitary waste. Must be treated.
Charge is a money grab.	Recovers wet weather costs.
Doesn't rain every month.	Based on annualized wet weather events. Simpler billing.
Rate is unfair.	Based on parcel impact to sewer system. Uses Impervious acreage.
All Detroiters don't pay.	All customers charged except parcels <.02 imp. Acres.

# How is the Drainage Charge Calculated?



**Charge** = amount of impervious surface multiplied by impervious surface rate

**Impervious surface** consists of hard surfaces that cause stormwater to run off



**Parcels with less than 0.02 impervious acres (871 square feet) are not assessed for drainage charges**

# How to Verify Property Data

## Resources for Nonresidential Property Owners

### How Do You Verify Property Data?

DWSD customers should validate your property data using the DWSD Parcel Viewer, which allows you to search for parcel information by address. DWSD uses data from the City of Detroit Assessor's Office and flyover images to determine the amount of impervious surface on each parcel. The hard, impervious surface area recorded for your property will be used to calculate drainage charges. Open the parcel viewer and type your street address with your zip code. If you disagree with the data, please complete the adjustment application.

### Make Sure We Are Accurate

If your hard surface is incorrect, fill out the

Drainage Charge Adjustment Application

or call a DWSD Customer Care representative at 313-267-8000.

\* Projected rates are subject to Board of Water Commissioners approval. Charge includes the 25% green credit, and only applies to households subject to the fee. Residential properties with less than 0.02 impervious acres will not be billed.

# Examples of Impervious Surface Areas

## Impervious Surface



TABLE 2 - Impervious Surface Areas

Land Cover Type	Impervious	Pervious	Storm Water Practice*
Buildings and roofs	✓		
Concrete (parking, driveways, sidewalks, etc.)	✓		
Asphalt (parking, driveways, sidewalks, etc.)	✓		
Brick surface (parking, driveways, sidewalks, etc.)	✓		
Any gravel or dirt surface that is used for vehicular traffic (driving or parking)	✓		
Uncompacted dirt/gravel (no vehicular traffic)		✓	
Decks, pavement below	✓		
Decks, vegetation or earth below		✓	
Stockpiled dirt/gravel/sand/ other materials		✓	
Railroads with gravel ballast		✓	
Gravel or decorative stone used for landscaping (not compacted, open- graded)		✓	
Gravel walkway (No vehicular traffic)		✓	
Impervious area covered with a minimum of 2'-0" dirt surrounded by pervious area		✓	
Lawn, vegetated areas		✓	
Permeable pavement*	✓		✓
Ponds (natural, ornamental)		✓	
Buildings with green roofs*	✓		✓
Swimming pools		✓	

\*Surface areas eligible for a green credit. Both permeable pavement and buildings with green roofs are considered impervious.

## Pervious Surface



# Impervious Surfaces

## Impervious Surface



# Pervious Surfaces

## Pervious Surfaces



# Impervious or Pervious?

- The following surfaces are **PERVIOUS**, but may show as impervious in aerial photography:
  - Mulch (gardens, playgrounds, etc).
  - Landscaping gravel
- Compacted gravel or dirt is **IMPERVIOUS**. A gravel or dirt surface that is driven on will be treated as impervious.

# Obtaining Impervious Acre Data By Parcel

DWSD Parcel Viewer - <http://www.detroitmi.gov/DWSDparcelviewer>

- Uses City Assessor's Office data
- Online Access Available 24/7
- Searchable by Property Address
- Total and Impervious Parcel Data Provided

## How to Identify Hard Surfaces on Your Property

Go to see the satellite imagery DWSD used to identify hard surfaces on your property.

- **STEP 1**

Go to

**DWSD Parcel Viewer**

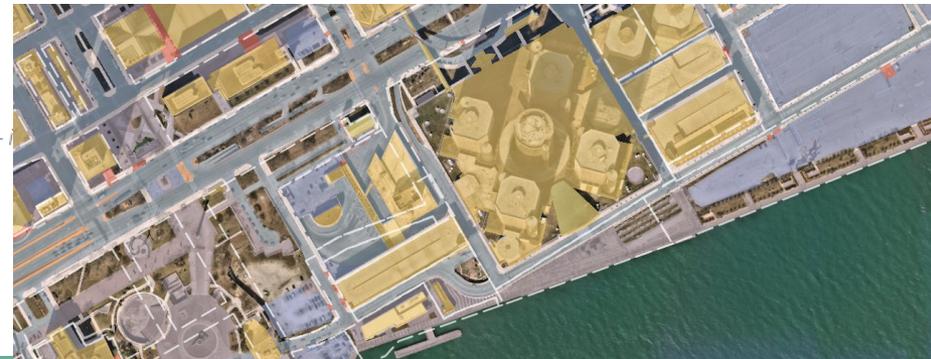
- **STEP 2**

Enter your address.

- **STEP 3**

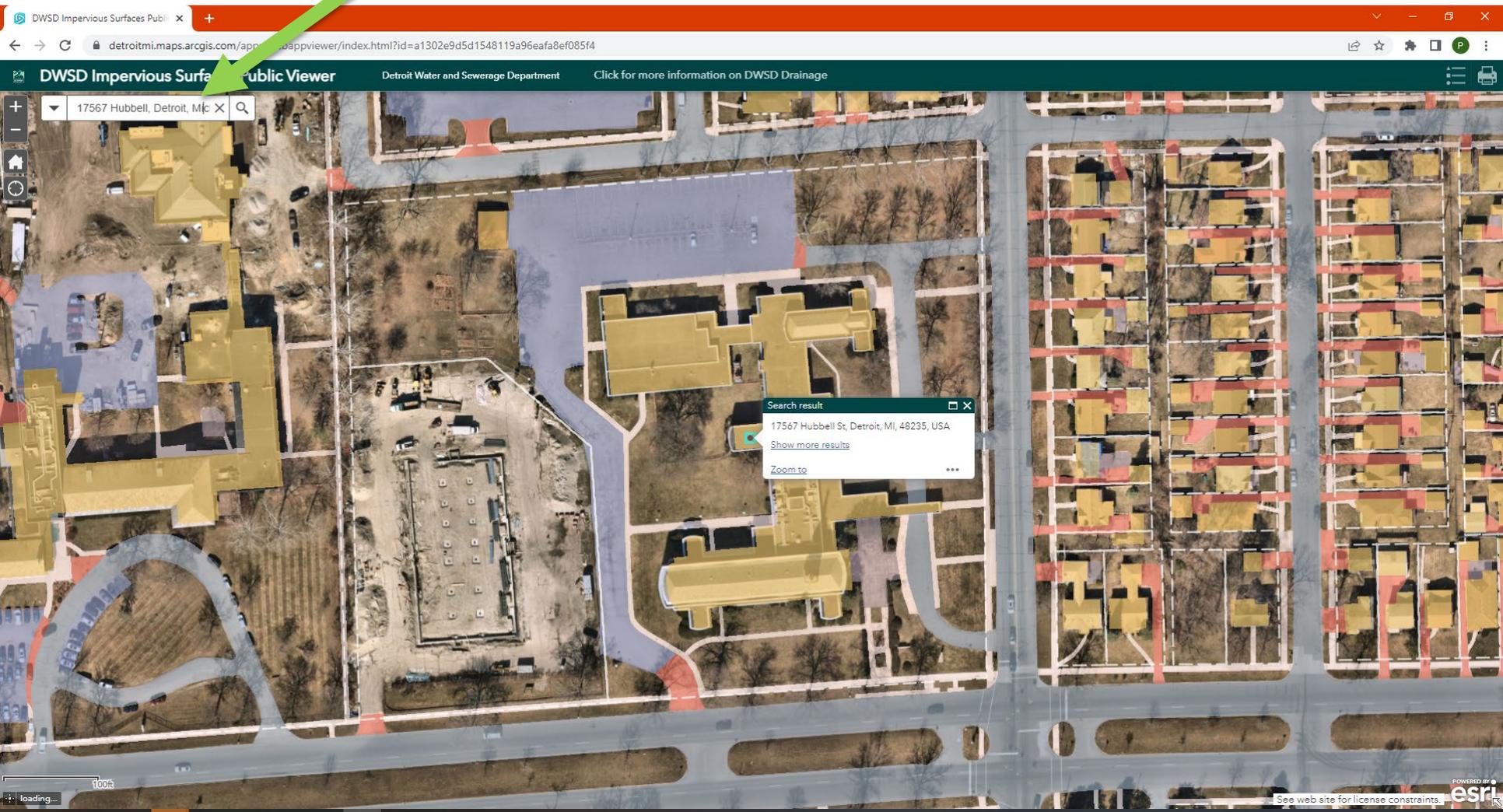
View your parcel information.

*Display may appear differently depending on your browser. Use + and -  
the map to click on your parcel.*



# Address Search

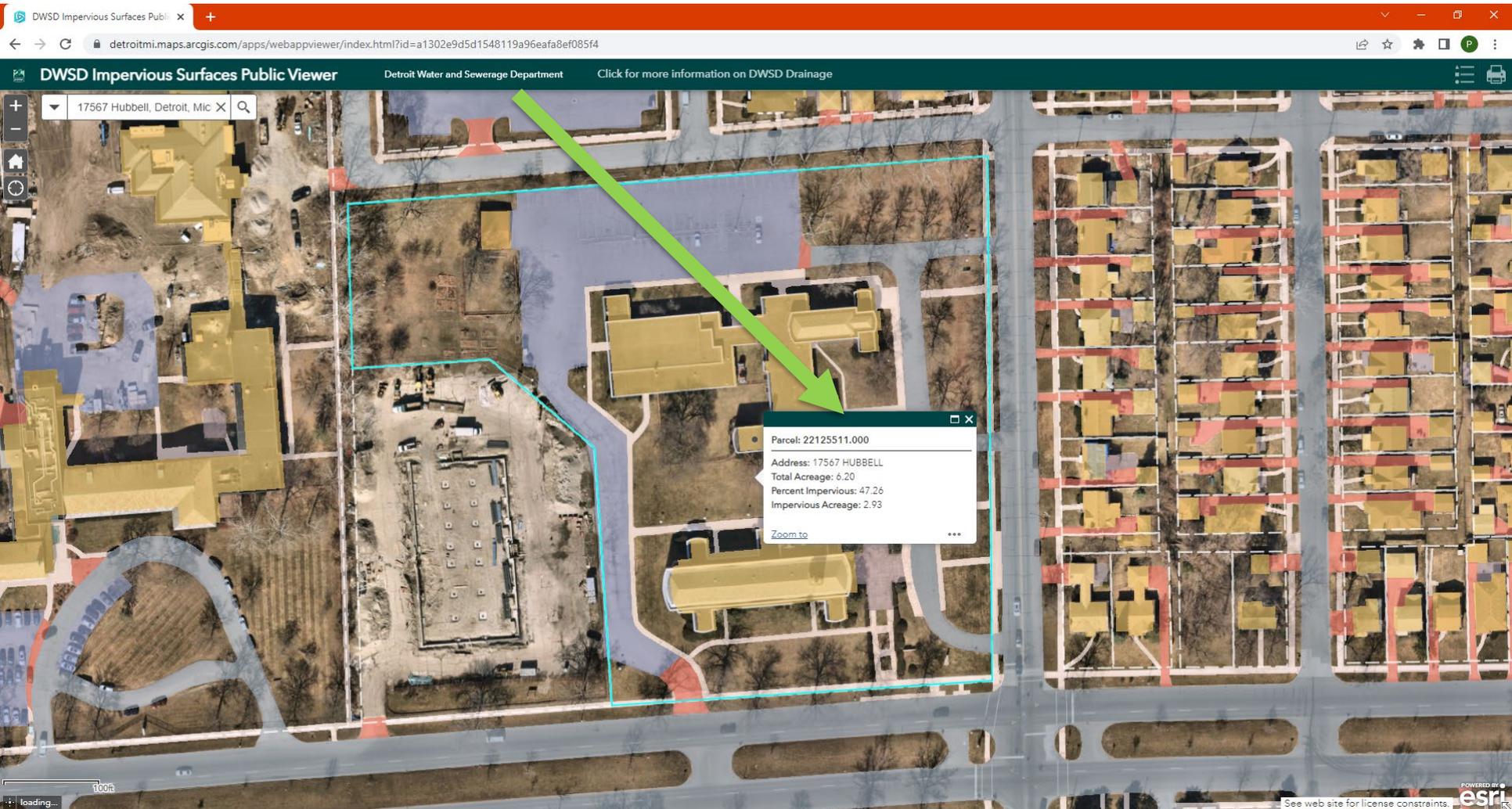
- User enters property address in search field



# Property Specific Data



- User clicks on parcel for data



# Impervious Area Changes

- If site has changed or some area needs to be reclassified:
  - ✓ Complete Drainage Charge Adjustment Application
  - ✓ Include Site Photos
- Adjustments of less than 435 square feet will not be made
  - ✓ Calculations already provides an allowance
  - ✓ Impervious area measures are truncated to 0.01 of an acre in the data management system

# Impervious Area Adjustment



DWSD Drainage Program  
6425 Huber Street  
Detroit, MI 48211  
313-267-8000 (option 6)  
[drainage@detroitmi.gov](mailto:drainage@detroitmi.gov)

## Drainage Charge Adjustment Application (Please fill out one form per parcel)

Use this application to report updates to parcel information and/or changes to the amount of impervious area for any adjustments to the drainage charge.

*Note: The effective date of any adjustments resulting from review of the application will be a maximum of 28 days prior to the date the application was received by the Department depending upon the billing cycle.*

Email completed application and supporting documentation to:  
[drainage@detroitmi.gov](mailto:drainage@detroitmi.gov) or fax to: 313-842-6495

Alternatively, application can be mailed to:  
**DWSD Drainage Program**  
6425 Huber Street  
Detroit, MI 48211

1. **Property Owner:** \_\_\_\_\_  
(Must match owner name in the City Assessor's parcel database/records.  
If owner name is different, provide legal documentation.)
  
2. **Mailing Address:** \_\_\_\_\_  
Street Address City Zip
  
3. **Phone:** \_\_\_\_\_ 4. **Email:** \_\_\_\_\_
  
5. **Authorized Representative, if any (name, address, email, contact number):**  
\_\_\_\_\_
  
6. **Service Address:** \_\_\_\_\_  
Street Address City Zip
  
7. **Parcel ID:** \_\_\_\_\_
  
8. **DWSD Account No.:** \_\_\_\_\_
  
9. **Property Classification:**  
 Residential  
 Commercial  
 Industrial  
 Faith Based  
 Tax Exempt

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# Example Adjustment Application Form – pg. 1



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Alternatively, application can be mailed to:  
DWSD Drainage Program  
6425 Huber Street  
Detroit, MI 48211

- Property Owner:** John Smith  
(Must match owner name in the City Assessor's parcel database. If owner name is different, provide legal documentation.)
- Mailing Address:** 1234 Sample Street, Detroit 49999  
Street Address City Zip
- Phone:** (123) 456-7890 **4. Email:** johnsmith@email.com
- Authorized Representative, if any (name, address, email, contact number):**  
John Smith
- Service Address:** 1234 Sample Street, Detroit 49999  
Street Address City Zip
- Parcel ID:** 123-456789
- DWSD Account No.:** 987-6543.210
- Property Classification:**
  - Residential
  - Commercial
  - Industrial
  - Faith Based
  - Tax Exempt

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Page 1

Use this application to report updates to parcel information and/or changes to the amount of impervious area for any adjustments to the drainage charge.

*Note: The effective date of any adjustments resulting from review of the application will be a maximum of 28 days prior to the date the application was received by the Department depending upon the billing cycle.*

Email completed application and supporting documentation to:  
[drainage@detroitmi.gov](mailto:drainage@detroitmi.gov) or fax to: 313-842-6495

# Example Adjustment Application Form – pg. 2



## 10. Reason for Adjustment Request:

Please provide a brief description of the adjustment(s) you are requesting in the space below.

Part of my property is misidentified as impervious. The property is all vegetated and should be changed to pervious. Provided photo and map of the property.

Check one or more of the following and attach supporting documentation as applicable.

- Parcel Information Update (Check all that apply):
  - Incorrect Service Address: Attach current owner and service address for parcel (if known)
  - Property Sale or Split/Combination: Attach copy of legal document (Required)
  - Water Account Not Associated with Correct Parcel – Attach copy of water bill (Required)
  - Other: \_\_\_\_\_
- Impervious Area Adjustment
  - Original Total Impervious Area (sq. ft. or acres): 6098.4
  - New Total Impervious Area (sq. ft. or acres): 350 sft
  - Site Color Photographs (Required)
  - Type of Area You are Disputing (for example, swimming pool, encroaching road, parcel boundary): \_\_\_\_\_

- Removed Impervious Area
    - Impervious Area Removed (sq. ft. or acres): \_\_\_\_\_
    - Site color photographs (Required)
- Methods Used to Remove Impervious Area
- Removal of paved surface
  - Tillage of soil
  - Soil amendments (e.g., mulch) added
  - Landscaping/plants added

**Note:** Property owners may not appeal the inclusion of gravel surfaces with evidence of vehicular traffic as an impervious surface on their drainage charge. Impervious area adjustments of less than 435 square feet cannot be adjusted.

## Owner Certification and Right-Of-Entry

I certify that the above information is true to the best of my knowledge. I further understand that the DWSD drainage charge will be based on the information provided by me and other available information, and the adjustment may result in an increase of the DWSD drainage charge. DWSD may revoke the adjustment if it later determines that the information provided is inaccurate.

In addition to the above certification, by signing below, I agree to allow DWSD or its designee on-site, if necessary, to review and verify the information above and in the case of restored soils, to visit the site periodically to confirm that restored soils remain intact and pervious.

\_\_\_\_\_  
Signature of Owner/Authorized Representative

\_\_\_\_\_  
Print Name

\_\_\_\_\_  
Date

DWSD may publish in any media of communication (print, news, television, radio, Internet, etc.) some or all of the information submitted in this application, including, but not limited to the amount of GSI credits awarded.

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Page 2

- Impervious Area Adjustment
  - Original Total Impervious Area (sq. ft. or acres): 6098.4
  - New Total Impervious Area (sq. ft. or acres): 350 sft
  - Site Color Photographs (Required)
  - Type of Area You are Disputing (for example, swimming pool, encroaching road, parcel boundary): \_\_\_\_\_

# Example Adjustment Application Form – photos



X = Where photo was taken

↗ = Direction facing



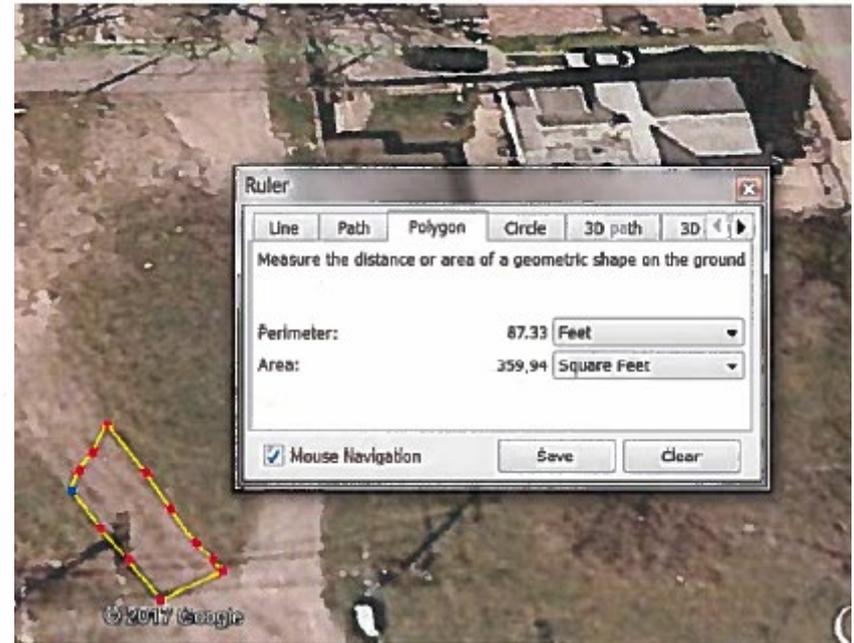
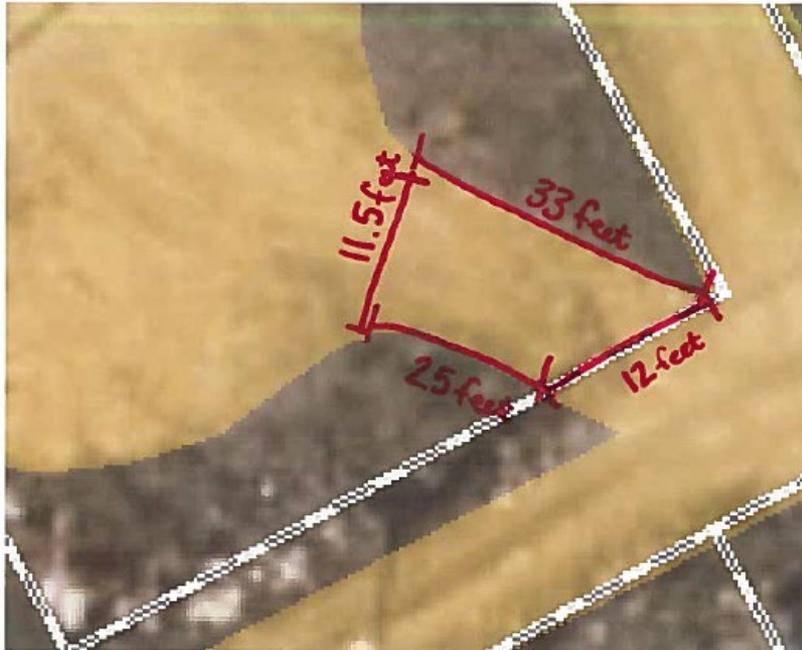
 = Area Requesting a change/adjustment to Previous.

# Example Adjustment Application Form - photos



# Example Adjustment Application Form - drawings

Dimensions of Remaining Impervious Area



# Requesting a Site Assessment



- ❑ Customer has an issue with their drainage charge
- ❑ Complete site assessment form
- ❑ DWSD representative will conduct initial interview and follow up



## Non-Residential Customer Site Assessment Program

Green Storm Water Infrastructure  
Detroit Water and Sewerage Department  
735 Randolph Street, Room 806  
Detroit, MI 48226  
313.267.8000 | [drainage@detroitmi.gov](mailto:drainage@detroitmi.gov)

### Property Information

Information about the property being referenced

Property Owner \*

Property Address(s) \*

DWSD Account Number(s)

Parcel ID(s)

### Contact Information

Contact person's name, mailing address, phone and email

Name \*



# QUESTIONS?



# **GREEN STORMWATER INFRASTRUCTURE (GSI) CREDITS**

# Purpose of GSI Credits

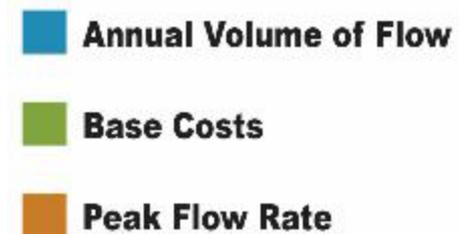
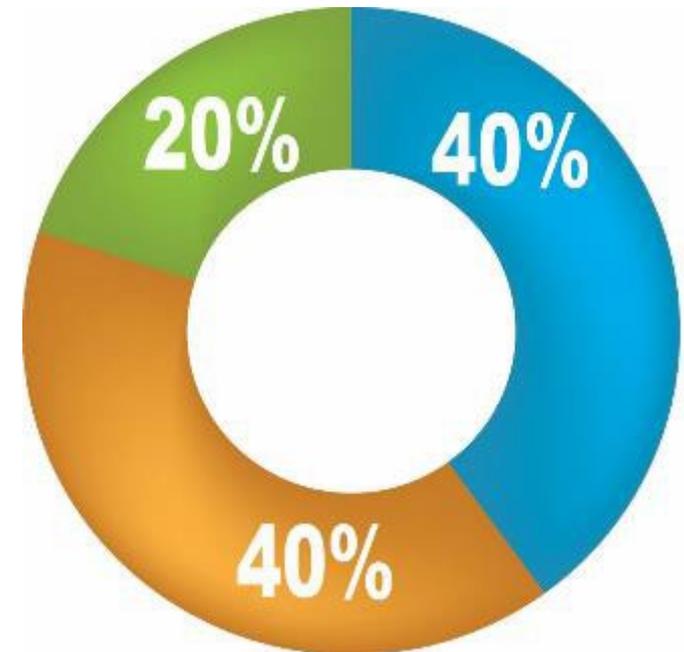
*Provide incentives for property owners to control stormwater flows on site AND opportunities for property owners to reduce their bills*

# GSI Credit Benefits

- Detroit Stormwater Management Benefits
  - Reduce the amount of stormwater needing treatment at the Wastewater Treatment Plant and at Combined Sewer Overflow (CSO) facilities
  - Defer additional CSO investment
  - Reduce overloading of sewer system
  - Helps the environment
- Property Owner Benefit
  - Reduced drainage charge
  - Increases property value
  - Contributes to a reduction in overall cost for DWSD – helps control future rate increases

# GSI Credit Components

- Annual Volume of Flow
  - Reduced volume results in less treatment of stormwater at the WWTP, and operation costs.
- Peak Flow Rate
  - Control of peak flows reduces the frequency at which CSO facilities operate and defers the need for additional facilities.
- Base Costs
  - DWSD must provide a sewer system, CSO and treatment capabilities for residual or potential discharges to the sewer system.



# GSI Credit Component Summary

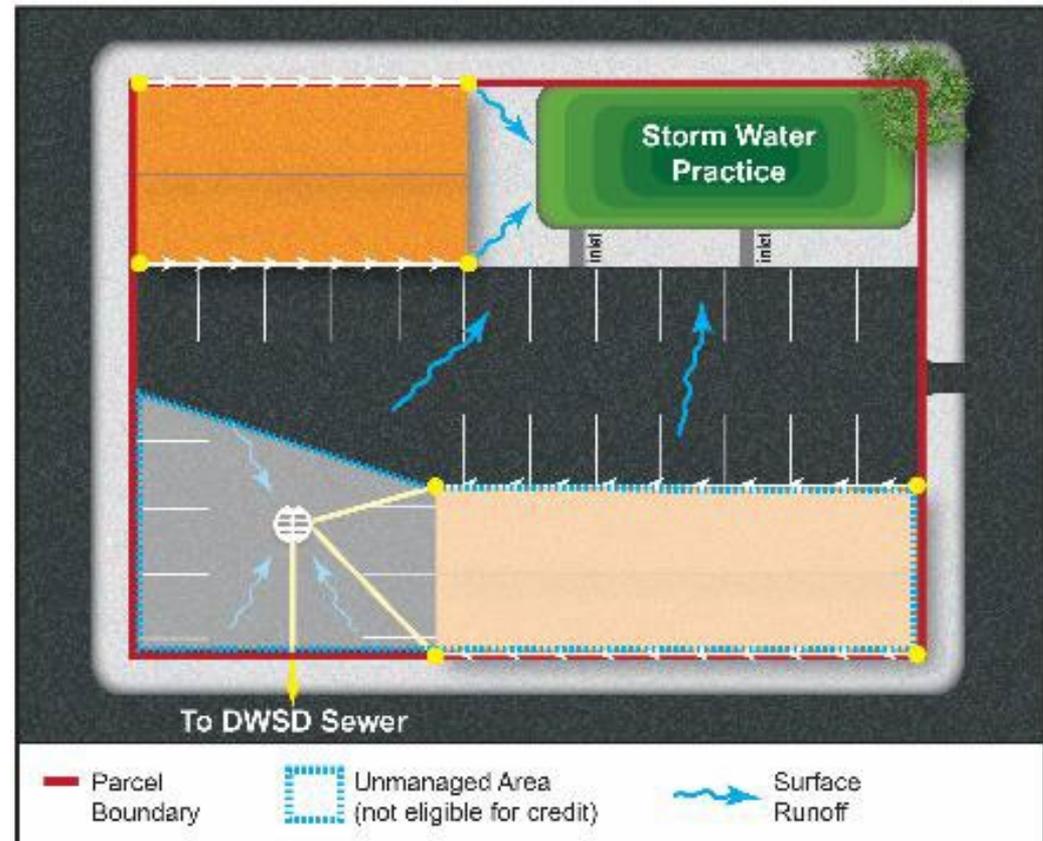


	<b>Volume Credit (up to 40%)</b>
Purpose	Reduce amount of stormwater flow treated at WWTP
How	Infiltrate, evaporate, reuse
Based On	Average annual runoff removed (controlled)
How is it calculated?	$\frac{\text{Annual volume removed}}{\text{Annual volume generated}}$

	<b>Peak Flow Credit (up to 40%)</b>
Purpose	Reduce combined sewer overflows and operation of CSO facilities
How	Store temporarily, control flow rate to the sewer system
Based On	Detention provided
How is it calculated?	$\frac{\text{Detention provided}}{100 \text{ year, 24 hr detention required}}$

# GSI Credit Flexibility

- Partial Site
- Partial Control
- Volume management, peak flow management or both
- Multiple practices
- Credit is sliding scale



# Potential for Shared GSI Practices

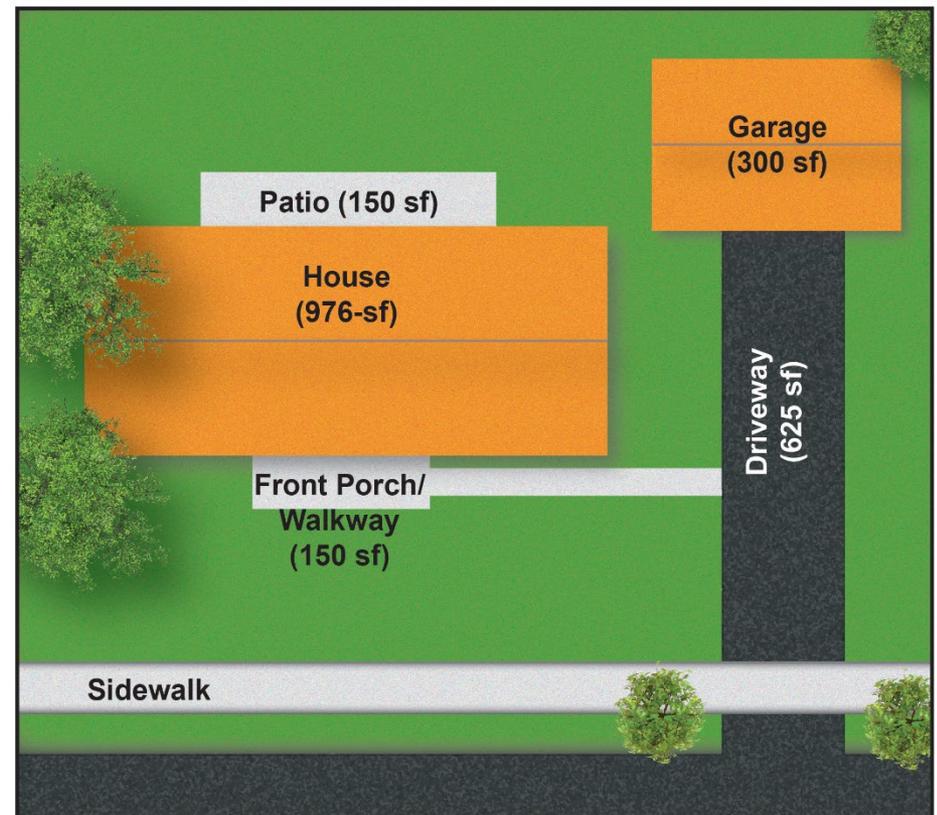
- Multiple parcels/property owners
- Single “shared” green infrastructure practice
- Legal agreement between property owners
- DWSD not responsible for any private transactions associated with financing and/or maintenance



# Residential Credit Program

## Typical Single Family Residential Property

Residential property owners will receive an automatic credit that accounts for disconnected impervious surfaces and disconnected downspouts



# Credits for Commonly Used Stormwater Management Practices



Practice Type	Volume Credit	Peak Flow Credit	Potential Credit for Area Managed (%)
Downspout disconnection	✓		0-40
Disconnected impervious area	✓		0-40
Bioretention	✓	✓	0-80
Detention basins		✓	0-40
Subsurface detention storage		✓	0-40
Permeable pavements	✓	✓	0-80
Green roof	✓		0-40
Water harvesting*	✓	✓	0-80
*For water harvesting, peak flow volume evaluated on a case-by-case basis			



# DIRECT DISCHARGE CREDITS

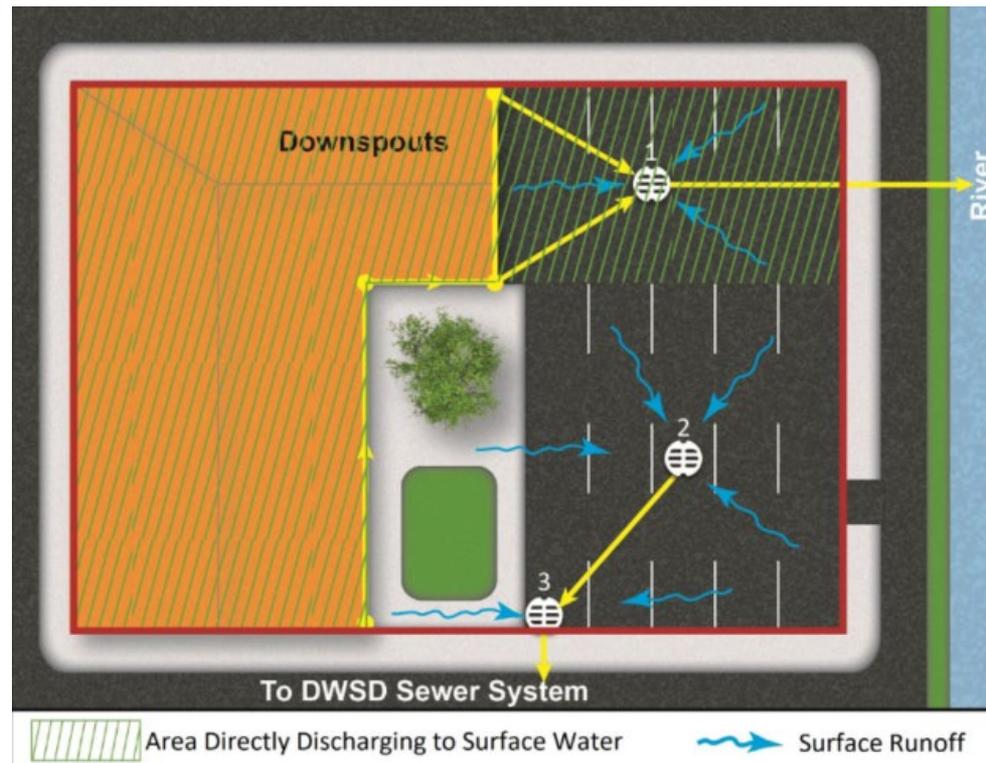
# Direct Discharge Credits

- Stormwater runoff directly discharging to surface waters (the Detroit or Rouge Rivers) with or without using DWSD infrastructure.
  - Potential Credit Value: 0-100%
  - Use the DWSD outfall to discharge --> maximum credit 80%.
  - The parcel/area must be able to manage the 100-year, 24-hour storm event.



# Direct Discharge

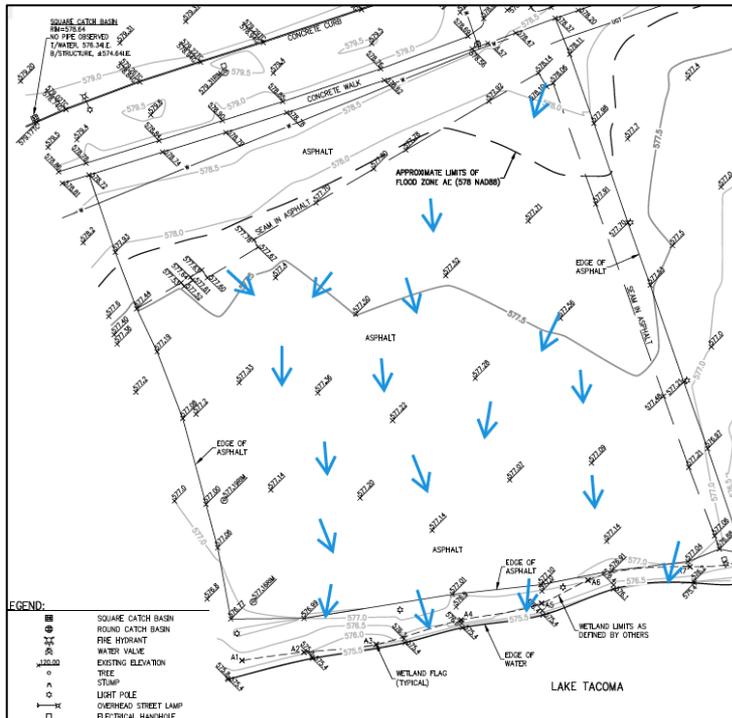
- The amount of drainage credit is determined based on how much of the total site impervious area is discharging to surface water.



# Different Types of Direct Discharge

## 1. External/ Visible Stormwater Conveyance System

- Includes sheet flow, external downspouts, and overland channels to the river.



## 2. Internal/ Underground Stormwater Conveyance System

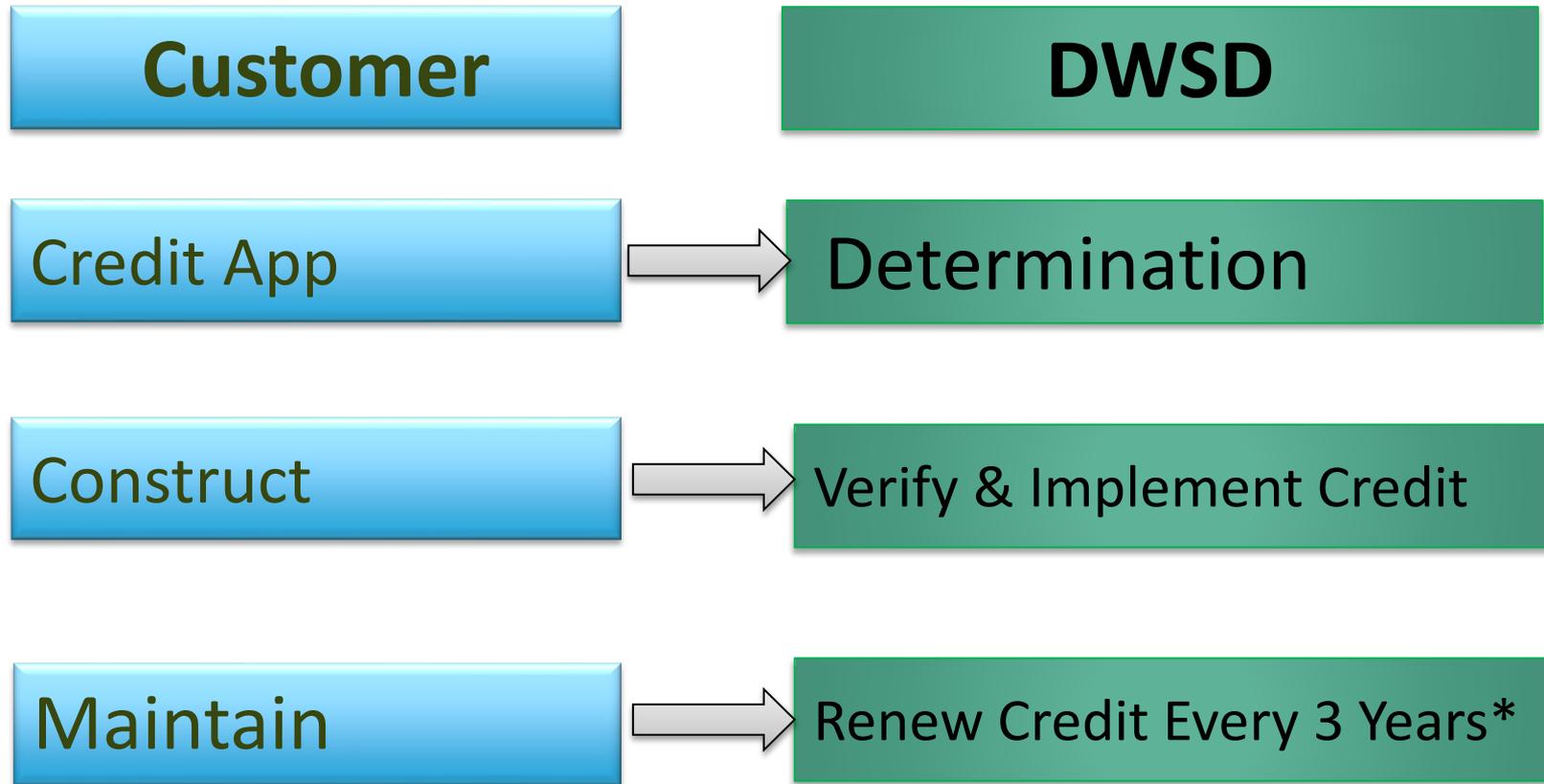
- Includes pipe systems and internal downspouts with outlets to the river.





# CREDIT APPLICATION PROCESS

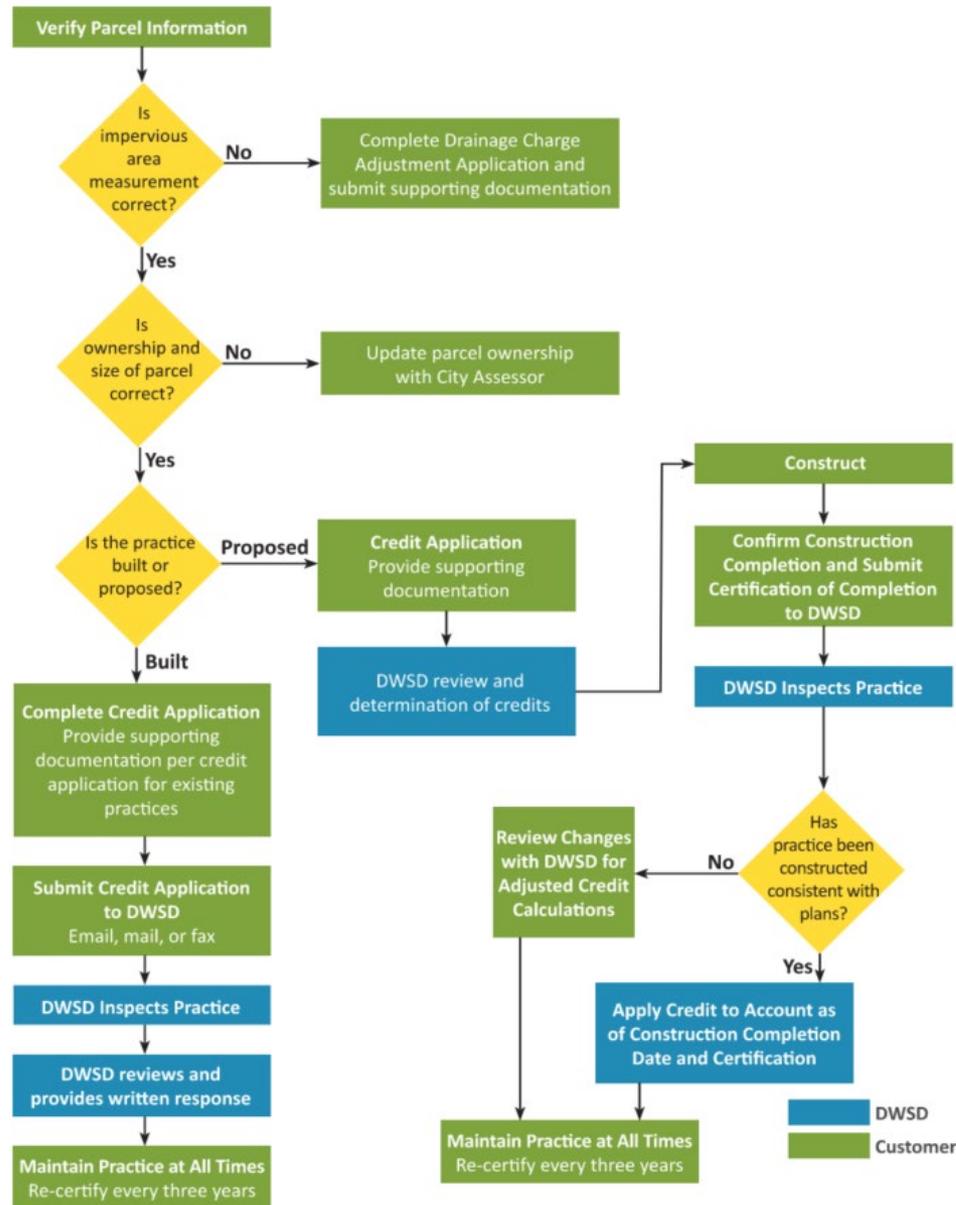
# Overview of Credit Application Process



Note: For GSI and direct discharge credit eligibility, design documents must be stamped by a PE or Landscape Architect

\*Renewal of credit is dependent on maintaining the practice.

# Application Process





# Credit Application - GSI Checklist



Item	Checklist
Scaled Site Plan showing all parcels and surface features	<input type="checkbox"/>
Complete engineered drawings stamped by a registered Professional Engineer or Landscape Architect.	<input type="checkbox"/>
Existing roof drainage system defined (with drainage areas)	<input type="checkbox"/>
Proposed roof drainage system defined (with drainage areas)	<input type="checkbox"/>
Drainage areas to each practice defined	<input type="checkbox"/>
Existing site drainage and sewer system defined (with drainage areas)	<input type="checkbox"/>
Maintenance Plan	<input type="checkbox"/>
Photographs clearly showing existing practices	<input type="checkbox"/>
Environmental history of site	<input type="checkbox"/>
Identification of proposed connections to DWSD Sewers, if applicable	<input type="checkbox"/>
ALTA Survey, if applicable	<input type="checkbox"/>
Complete listing of permits applied for/expected	<input type="checkbox"/>
Geotechnical investigation results, if applicable	<input type="checkbox"/>

# Credit Application – Direct Discharge Checklist



Supporting Documentation for Direct Discharge	External/Visible Stormwater Conveyance System	Internal/Underground Stormwater Conveyance System
Map of the property that clearly identifies all impervious surfaces discharging with the conveyance system and all connections marked	✓	✓
Site photographs (photos of all visible connections and conveyance structures)	✓	✓
Dye Test Report or Engineered drawings of the conveyance system stamped by a registered Professional Surveyor, Professional Engineer or Landscape Architect		✓
Topographic Survey, if applicable	✓	✓
MDEQ/EGLE Permit, if available	✓	✓

# Completing Application - Post Construction

- Submit the following to DWSD
  - As-built drawings
  - Photos of completed practice
  - Certificate of Completion
- Certificate of Completion
  - A document stating when the project was completed.
  - Should be signed and stamped by project engineer.



# Effective Date of Credits

- Approved effective date of credits is based on either:
  - Date of the signed/stamped certification of completion
  - Date of the credit application
- The later date is used.
- Credits will be applied to the next billing cycle after review/approval.

# DRAINAGE CREDITS FOR COMMON STORMWATER PRACTICES

# Disconnected Downspouts

## Potential (Volume) Credit

Value: 0-40%

- Redirect roof runoff to pervious area (lawn or well vegetated area)

### Should not:

- Create flooding OR
- discharge to right of way (ROW) OR
- discharge to neighboring property



Credit Tip: A downspout can go to lawn or a bioretention practice. Bioretention typically results in a greater credit for the same footprint.

# Disconnected Impervious Area

Potential Credit Value: 0-40%

- Runoff from roofs, parking lots, sidewalks, driveways directed to pervious areas (lawn or landscaped area)

## Should not:

- create flooding OR
- discharge to right of way (i.e. street) OR
- discharge to neighboring property



 Credit Tip: Larger ratios of pervious area to impervious area will result in higher credit percentages

# Bioretention

## Potential Credit Value: 0-80%



- Depressed area with layer of engineered soil, mulch, and/or vegetation to capture and infiltrate runoff
- May include underdrain
- Surface storage must drain below the ground within 24 hours
- Subsurface storage must drain from the practice within 72 hours



Credit Tip: Larger ratios of bioretention area to managed impervious area will result in higher credit percentages.



# Detention Basins

**Potential Credit Value: 0-40%**

Dry or wet ponds designed to temporarily store and slowly release runoff to the combined sewer system with a controlled outlet. The controlled outlet cannot exceed a flow rate of 0.15 cfs/acre.



Credit Tip: Increase basin size; use stored water for irrigation to obtain a volume credit (up to additional 40%).



# Subsurface Storage

**Potential Credit Value: 0-40%**

Serves same function as a detention basin but is located below ground in vaults, large-diameter or low profile storage pipes.



**Credit Tip: Increase storage size; use stored water for irrigation to obtain a volume credit (up to additional 40%).**

# Permeable Pavement

## Potential Credit Value: 0-80%

- Permeable pavement layer with an aggregate stone layer to infiltrate runoff
- May include underdrain
- Max standard (non-permeable) pavement to permeable pavement ratio is 2:1



Credit Tip: The more stone storage provided below pavement surface, the larger the credit.



# Green Roof

Potential Credit Value: 0-40%

- Roof top with vegetation to absorb and filter rainfall
- May be connected to other stormwater practices
- Must ensure roof can structurally support the vegetated system



Credit Tip: Increase the depth of the soil media to receive a larger credit.

# Water Harvesting/Reuse

**Potential Credit Value: 0-80%**

- Cisterns used to store runoff from impervious areas
- Water can be used for watering vegetation or greywater systems
- May be either above or below ground
- Any water reuse system must be routine and metered



Credit Tip: To increase the credit for a reuse system, implement multiple ways to reuse the water.



# **DRAINAGE CREDIT CALCULATION METHODOLOGIES**

# Credit Calculation Approaches

	Volume Credit	Peak Flow Credit
Purpose:	Reduce amount of stormwater flow at WWTP	Reduce local flooding and CSOs
How:	Slow it down, spread it out and soak it in	Provide detention with a controlled release rate
Based On:	Average annual runoff	Discrete design storm
Calculation:	$\frac{\text{Annual volume removed}}{\text{Annual volume generated}}$	$\frac{\text{Detention provided}}{\text{Detention required, 100 yr} - 24 \text{ hr}}$
Methodologies:		
Simplified Various	✓	✓
SWMM	✓	✓
EPA SW Calc	✓	
CN	✓	✓
Rational	✓	✓

# DWSD Simplified Methods

	<b>Credit Type</b>	<b>Based on:</b>	<b>Applicable to:</b>
<b>Disconnected Impervious Method</b>	Volume	Relative size of impervious area and pervious area onto which it discharges	Disconnected impervious surfaces
<b>Equivalent Rainfall Depth Method</b>	Volume	Equivalent rainfall depth contained in the retention zone of a practice	Bioretention and permeable pavements
<b>Modified Rational Method</b>	Peak Flow	Drainage area and release rate	Detention basins
<b>Water Balance for Water Reuse Systems</b>	Volume	Storage volume and the demand of water reuse	Water harvesting systems

# Disconnected Impervious Method

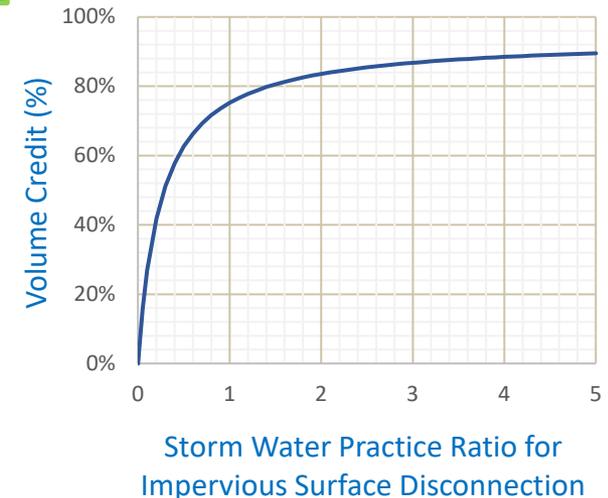
## *Basis for the Equation*

- 53.5 years of rainfall records
- Simulated with EPA SWMM
- Catchments in series

$$\text{Volume Credit (\%)} = 0.94 * \frac{\text{Practice Ratio}}{0.25 + \text{Practice Ratio}}$$



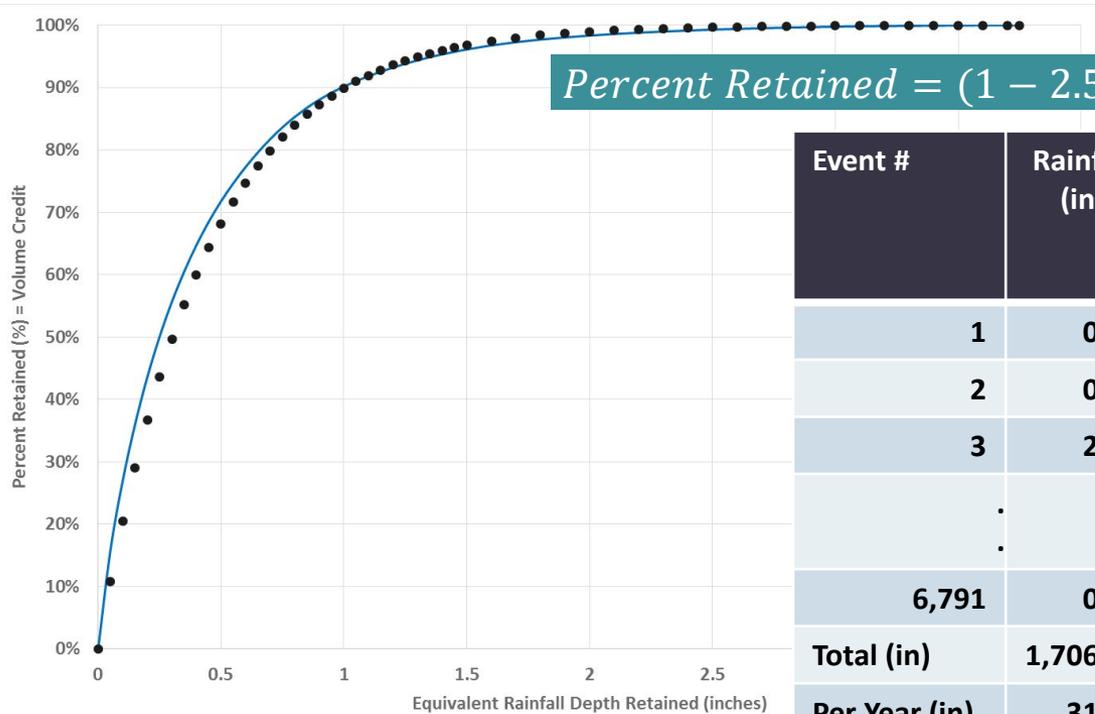
- Model Parameters
  - Horton infiltration constant  $f_c = 0.1$  in/hr
  - Pervious depression storage = 0.8 inches (20% useable void in 4-inch topsoil)
  - Slope = 1%
- Resultant volume reduction quantified as pervious area increases
- $\text{Practice Ratio} = \frac{\text{Storm Water Practice Area}}{\text{Drainage Area}}$



# Equivalent Rainfall Depth Method

## *Basis for the Equation*

- 53.5 years of rainfall records
- Regression equation to fit data



$$\text{Percent Retained} = (1 - 2.5^{-2.5 * \text{Equivalent Rainfall Retained (in)}}) * 100$$

Event #	Rainfall (in)	Rainfall Retained per Event (in)				
		0.00	0.10	0.20	...	4.00
		Excess Rainfall (in)				
1	0.06	0.00	0.00	0.00	...	0.00
2	0.21	0.21	0.11	0.01	...	0.00
3	2.11	2.11	2.01	1.91	...	0.00
:	:	:	:	:	:	:
6,791	0.62	0.62	0.52	0.42	...	0.00
<b>Total (in)</b>	<b>1,706.10</b>	<b>1,706.10</b>	<b>1,246.56</b>	<b>963.04</b>	...	<b>0.00</b>
<b>Per Year (in)</b>	<b>31.90</b>	<b>31.90</b>	<b>23.31</b>	<b>18.01</b>	...	<b>0.00</b>
<b>% Retained</b>		<b>0%</b>	<b>26.9%</b>	<b>43.6%</b>	...	<b>100%</b>

# Modified Rational Method

## *Basis for the Equation for Detention Calculations*

- Detention Volume Required ( $V_n$ ) = Runoff Volume – Volume Released
- Where:
  - Runoff Volume = Storm Duration (D) \* Peak Flow ( $Q_p$ )
  - Peak Flow ( $Q_p$ ) = C \* I \* A
  - Volume Released ( $V_R$ ) = Storm Duration (D) \* Release Rate ( $Q_R$ ) \* Area (A)
- Modified Rational rewritten as
  - $V_n = (D * C * I * A) - (D * Q_R * A)$
- Unit Conversion
  - $V_n(ft^3) = \left( D(min) * \frac{hr}{60 min} * C * I \left( \frac{in}{hr} \right) * \frac{ft}{12 inch} * A(ac) * \frac{43560 ft^2}{1 acre} \right) - \left( D(min) * \frac{60 sec}{min} * \frac{Q_R(ft^3)}{sec} * A(ac) * \frac{43560 ft^2}{1 acre} \right)$
- Simplify
  - $V_n = (60.5 * D * C * A * I) - (60 * D * Q_R * A)$

# Modified Rational Method

## *Basis for the Equation - Rainfall Intensity*

- NOAA Atlas 14
- Detroit Metro Airport
- IDF Curve
  - $$I = \frac{38.0708t^{0.2081}}{(12.1177+D)^{0.8395}}$$
  - I, rainfall intensity, inches per hour
  - D, storm duration, minutes
  - t, recurrence interval, years

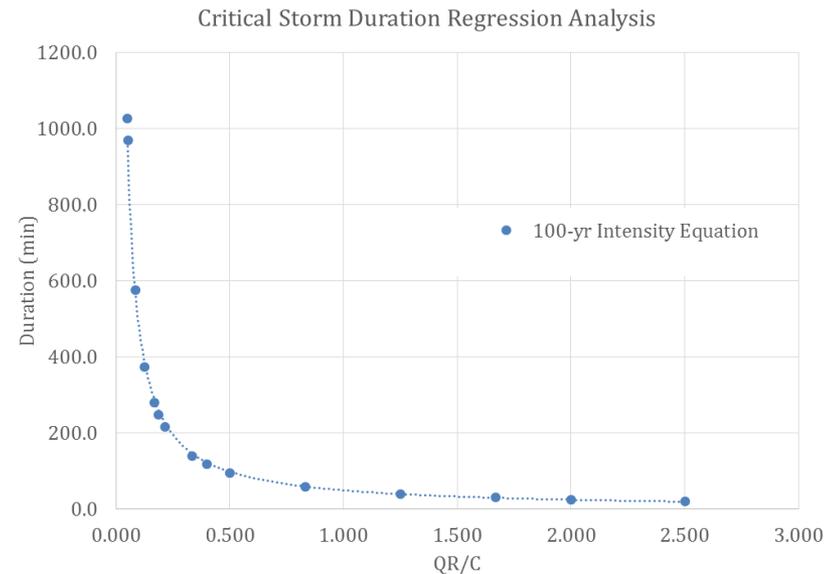
# Modified Rational Method

## *Basis for the Equation – Storm Duration*

- Critical storm duration regression analysis

- $D_{100} = 49.988 \left( \frac{Q_R}{C} \right)^{-0.984}, R^2 = 0.9989$

- $D_2 = 21.352 \left( \frac{Q_R}{C} \right)^{-0.998}$



# Modified Rational Method

## *Basis for the Equation – Summary*

- Given
  - Area (A), Rational Coefficient (C), Release Rate ( $Q_R$ )
- Calculate
  - $D_{100} = 49.988 \left(\frac{Q_R}{C}\right)^{-0.984}$ ,  $D_2 = 21.352 \left(\frac{Q_R}{C}\right)^{-0.998}$
  - $I = \frac{38.0708t^{0.2081}}{(12.1177+D)^{0.8395}}$
  - $V_n = (60.5 * D * C * A * I) - (60 * D * Q_R * A)$
- Hence, we can direct solve the Modified Rational Method for the required storage
- *Peak Flow Credit* =  $\frac{V_{provided}}{V_{100\ year}}$

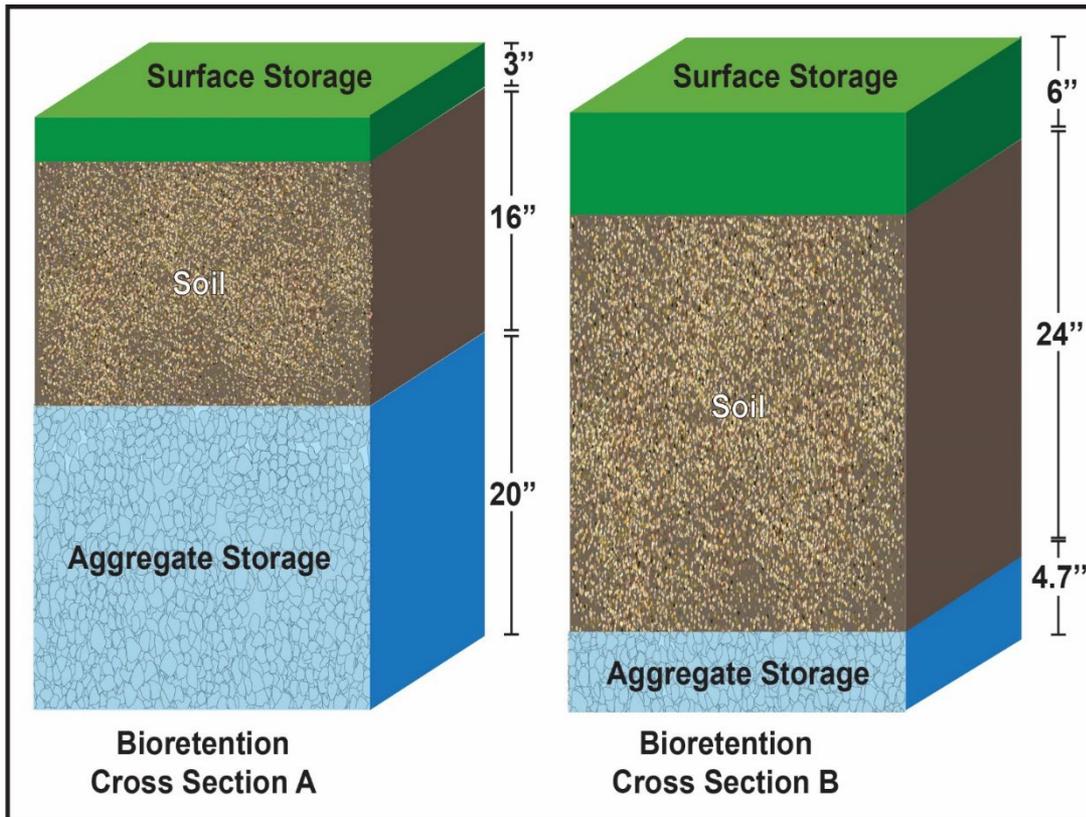
Equivalent Water Depth  
Retention vs Detention  
Underdrain Outlets  
Infiltration Tests  
Practice Area Definition

# DESIGN DETAILS

# Equivalent Water Depth

*Equivalent Water Depth (in)*

$$= \text{surface storage (in)} + (\text{soil depth (in)} \times \text{usable void ratio}) + (\text{aggregate depth (in)} \times \text{usable void ratio})$$

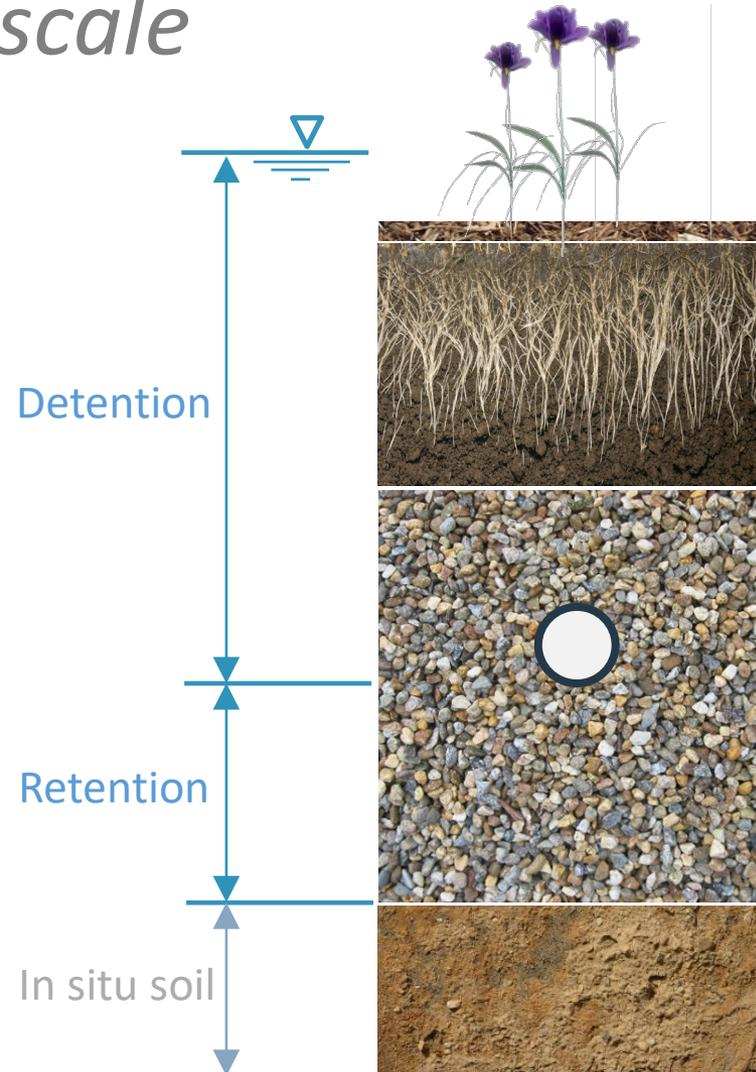


Note: If independent testing is not conducted, void ratios are assumed to be 0.2 for soils and 0.4 for aggregate.

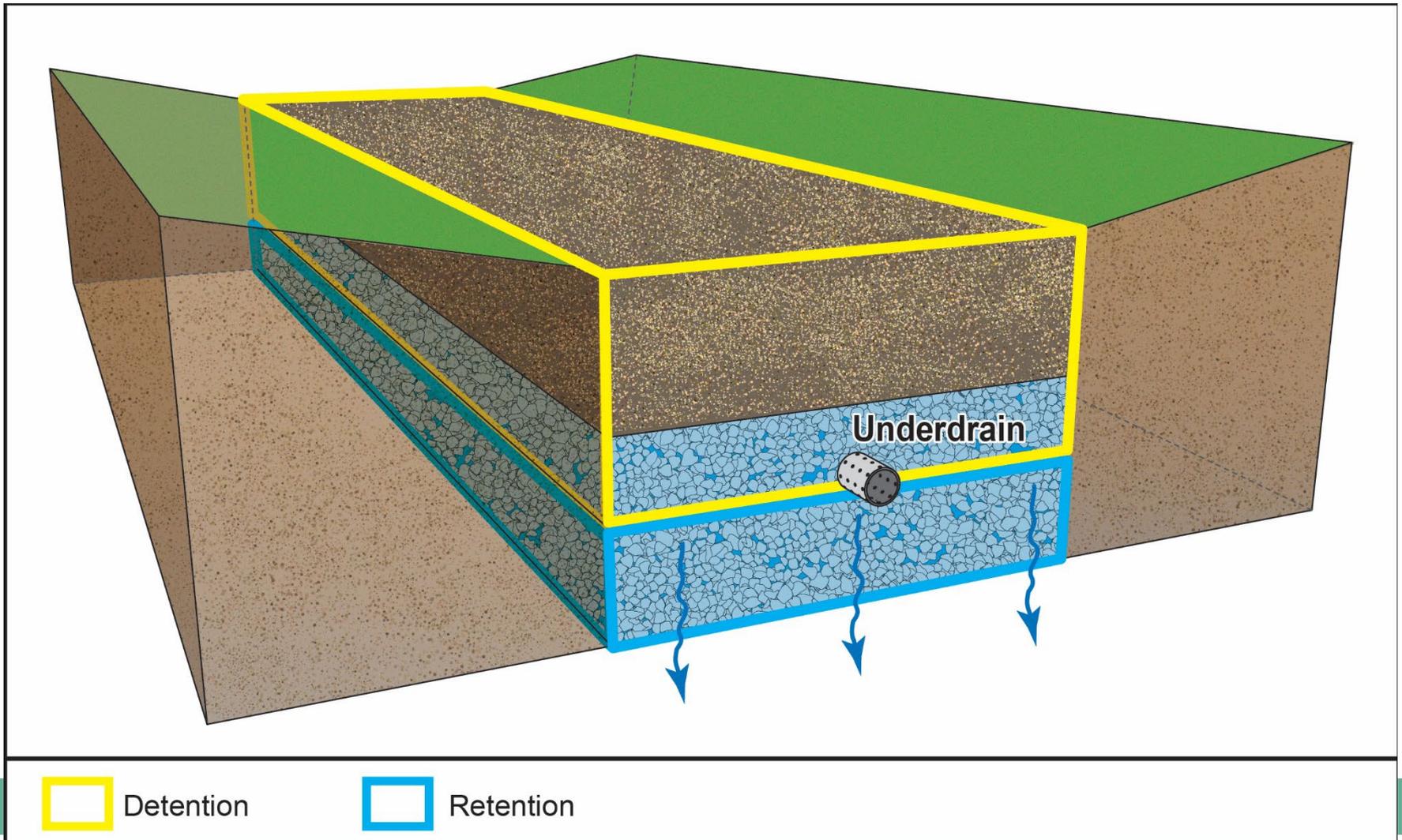
# Retention and Detention

*at the practice scale*

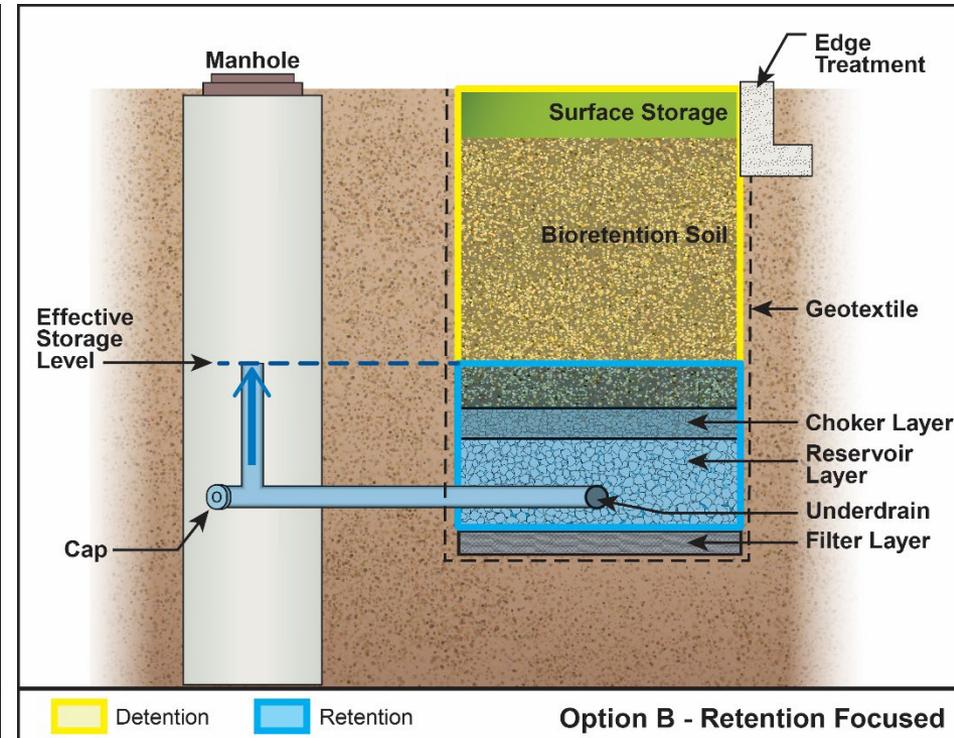
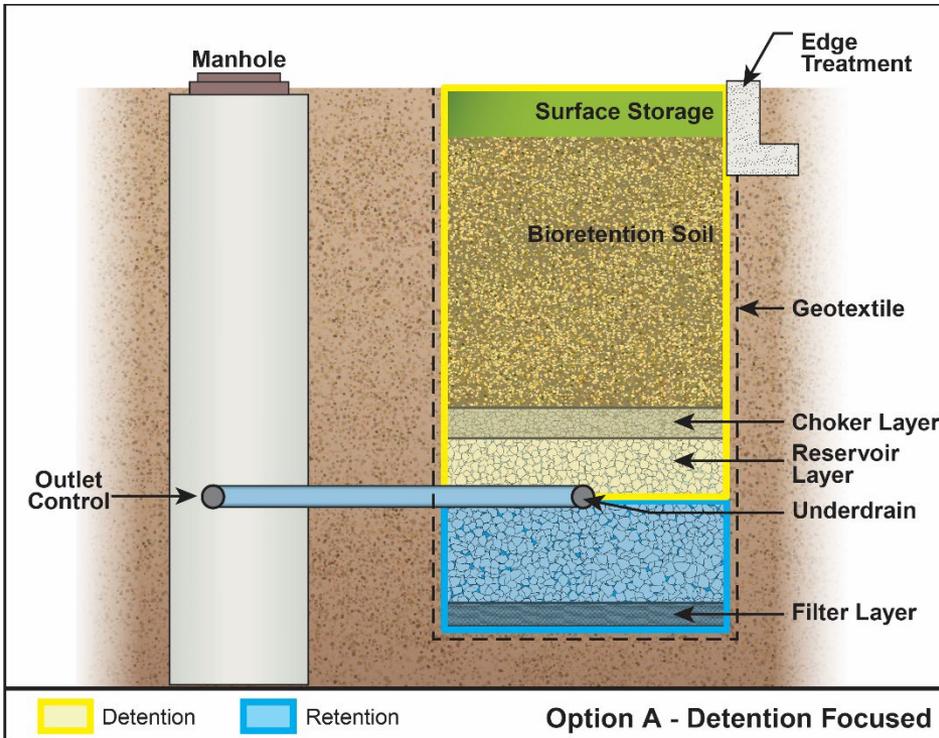
- Retention - *permanently removed*
  - Evapotranspiration
  - Water Reuse
  - Infiltration
- Detention - *temporarily detained then released*
  - *If released at a controlled rate*



# Retention and Detention Zones



# Underdrain Outlet Elevation



# Infiltration Tests

If an infiltration test is done for the practice, it should meet the following criteria:

- A minimum of two tests performed
- Conducted at a depth consistent with depth of practice
- Safety factor of “2” applied

Acceptable Infiltration testing protocols can be found in:

- Chapter 6 of [Detroit’s Stormwater Management Design Manual](#),
- Soil Infiltration Testing Protocol located in Appendix E of the [Southeast Michigan Council of Governments Information Center Low Impact Development Manual for Michigan](#).

*Note: If an infiltration test is not conducted, a value of 0.1 inches per hour will be used for infiltrating practices.*

# Commonly Used Stormwater Practice Area Definitions



<b>Downspout Disconnection</b>	<b>Bioretention</b>	<b>Permeable Pavement</b>	<b>Other Disconnected Impervious Surfaces</b>
<p>Length from the end of the downspout to the edge of the property measured along the path that water will flow, multiplied by an assumed width equal to 5 feet.</p>	<p>Surface area of the bioretention not including the side slopes.</p>	<p>The surface area of the aggregate reservoir layer if the equivalent water depth for retention is provided in the aggregate reservoir.</p>	<p>The surface area over which infiltration will naturally occur. This is based on the width of the sheet flow when it leaves the impervious surface multiplied by the length of the flow path in the pervious area.</p>

1. Evaluating a site for GSI opportunities
2. Credit Application – calculations and submittal

## **CREDIT EXAMPLES**

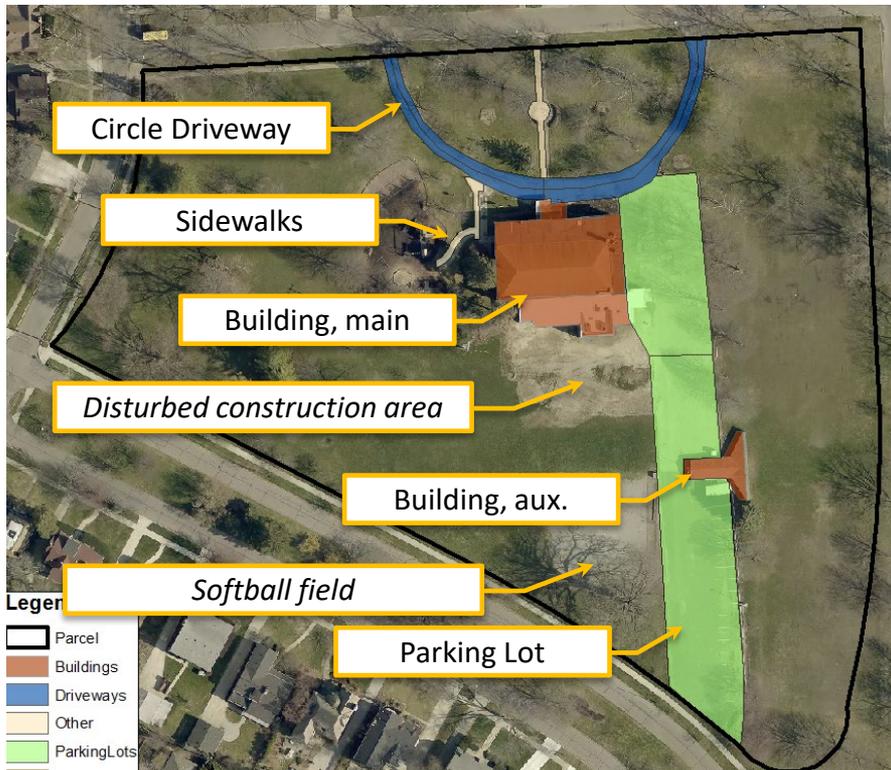


# EXAMPLE 1

## EVALUATING A SITE FOR GSI OPPORTUNITIES

# Background

- Commercial site
- Site improvements are being planned



Surface	Area (sf)	Area (ac)
<u>Impervious</u>		
Sidewalks	1,260	0.02
Circle Driveway	5,675	0.12
Parking Lot	25,570	0.62
Building, main	9,360	0.21
Building, aux.	1,260	0.02
<i>subtotal</i>	<i>43,125</i>	<i>0.99</i>
<u>Pervious</u>	270,507	6.21
Total	313,632	7.20

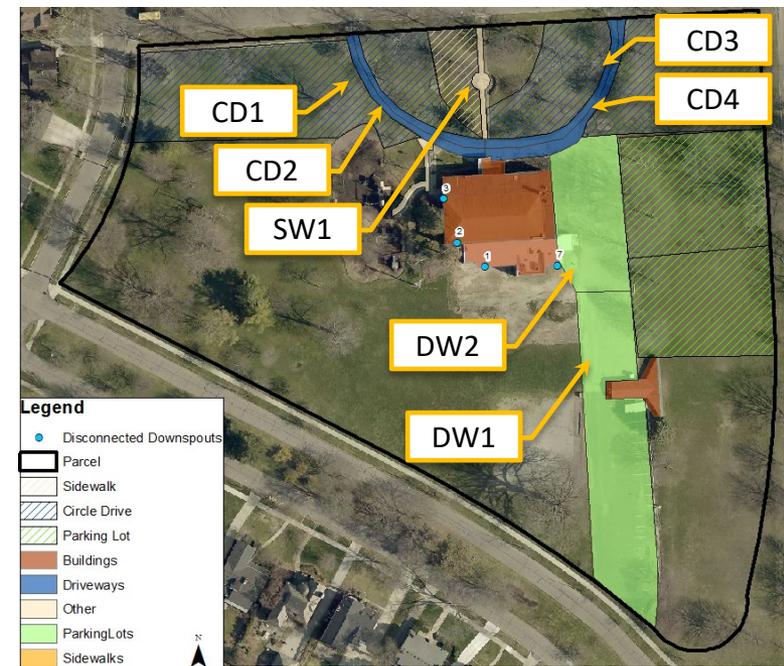
# Workflow

1. What credits is the site currently eligible for?
  - a) Disconnected impervious area
  - b) Disconnected downspouts
2. Basic improvement ideas
  - a) Construct permeable pavement
3. Next step ideas
  - a) Route roof to permeable pavement
  - b) Route roof to bioretention
4. Summarize planned improvements
5. Fill out Drainage Credit Application

# 1. Credits Currently Eligible For

## a) Disconnected Impervious Area

- $Practice\ Ratio = \frac{Practice\ Area}{Managed\ Impervious\ Area}$
- $Volume\ Credit(\%) = 0.94 * \frac{Practice\ Ratio}{0.25 + Practice\ Ratio} * 100$
- $Practice\ Credit(\%) = Volume\ Credit * 0.40$
- $Site\ Credit(\%) = \frac{Managed\ Impervious\ Area}{Total\ Site\ Impervious\ Area} * Practice\ Credit$
- *Total site impervious area is 43,125 sf*

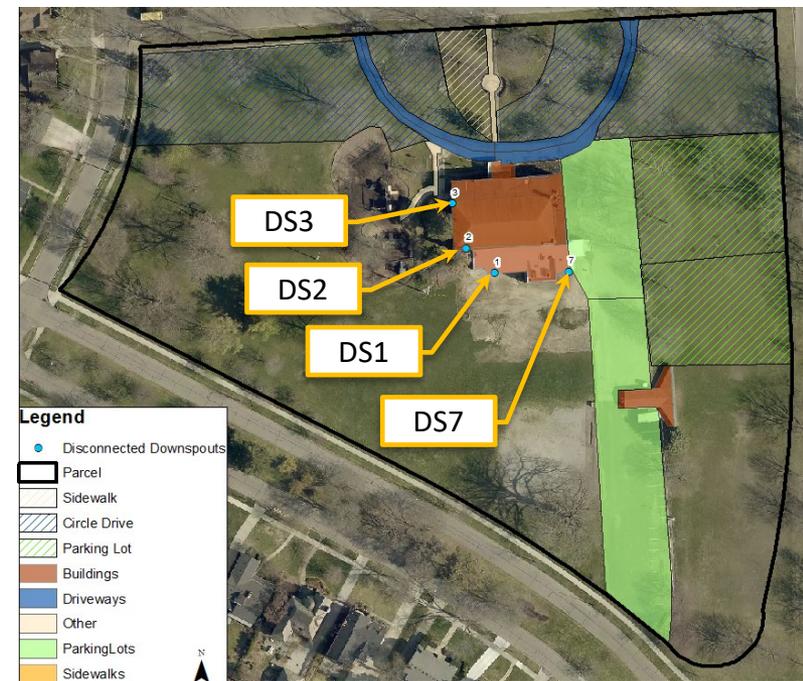


Description	Managed Impervious Area (sf)	Stormwater Practice Area (sf)	Practice Ratio	Volume Credit (%)	Practice Credit (%)	Site Credit (%)
Circle Drive 1 (CD1)	870	19,165	22.0	92.94%	37.18%	0.75%
Circle Drive 2 (CD2)	870	4,790	5.5	89.91%	35.97%	0.73%
Circle Drive 3 (CD3)	1,305	7,405	5.67	90.03%	36.01%	1.09%
Circle Drive 4 (CD4)	1,305	15,680	12.0	92.08%	36.83%	1.12%
Sidewalk 1 (SW1)	435	3050	7.0	90.76%	36.30%	0.37%
Driveway 1 (DW1)	3,050	13,025	4.27	88.80%	35.52%	2.51%
Driveway 2 (DW2)	6,885	15,290	2.22	84.49%	33.80%	5.39%
<b>Totals</b>	<b>10,800</b>	<b>78,425</b>			<b>Total Credit</b>	<b>11.96%</b>
					<b>Total Credit (Rounded)</b>	<b>12.0%</b>

# 1. Credits Currently Eligible For

## b) Disconnected Downspouts

- $Practice\ Ratio = \frac{Practice\ Area}{Managed\ Impervious\ Area}$
- $Volume\ Credit(\%) = 0.94 * \frac{Practice\ Ratio}{0.25 + Practice\ Ratio} * 100$
- $Practice\ Credit(\%) = Volume\ Credit * 0.40$
- $Site\ Credit(\%) = \frac{Managed\ Impervious\ Area}{Total\ Site\ Impervious\ Area} * Practice\ Credit$
- *Total site impervious area is 43,125 sf*



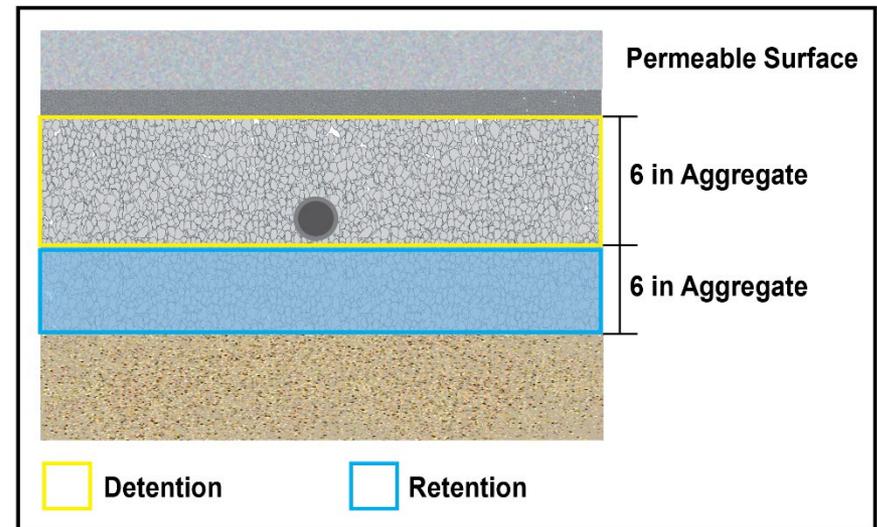
Description	Managed Impervious Area (sf)	Stormwater Practice Area (sf)	Practice Ratio	Volume Credit	Practice Credit	Site Credit
Downspout 1 (DS1)	500*	26.6 ft. x 5 ft. = 133.2 sf	0.27	48.49%	19.40%	0.22%
Downspout 2 (DS2)	250	50.1 ft. x 5 ft. = 250.3 sf	0.50	62.69%	25.08%	0.29%
Downspout 3 (DS3)	500*	27.3 ft. x 5 ft. = 136.7 sf	0.27	49.11%	19.64%	0.23%
Downspout 7 (DS7)	500*	25.7 ft. x 5 ft. = 128.5 sf	0.26	47.65%	19.06%	0.22%
<b>Totals</b>	<b>1,750</b>	<b>648.7</b>			<b>Total:</b>	<b>0.96%</b>
				<b>Total Credit (Rounded)</b>		<b>1.0%</b>

\*Design Criteria: Managed Impervious Area can not exceed 500 sf for a disconnected downspout.

## 2. Basic Improvements

### a) Permeable Pavement – Introduction

- Reconstruct the circle drive (5,675 sf) with porous pavement
- Cross Section
  - Pavement material ignored for equivalent water depth
  - 6-in of aggregate base with 40% effective porosity ABOVE underdrain
  - 6-in of aggregate base with 40% effective porosity BELOW underdrain
- Assumed suitable soils for infiltration
  - 0.1 in/hr infiltration rate
- Calculate Credit in two parts
  - Volume Credit
  - Peak Flow Credit



## 2. Basic Improvements

### a) Permeable Pavement – Volume Credit



- Reconstruct the circle drive (5,675 sf) with porous pavement
- Assumed pavement cross-section
  - Pavement material ignored for equivalent water depth
  - 6-in of aggregate base with 40% effective porosity BELOW underdrain
- Assumed suitable soils for infiltration
- Assume no additional run-on from other impervious surfaces
  - Equivalent rainfall depth equals the equivalent water depth

Step	Topic	Equation		Result
1	Equivalent Water Depth	$= \text{Layer Thickness} * \text{Effective Porosity}$	$= 6 \text{ in} * 0.40$	2.4 in
2	Retention Volume	$= \text{Practice Area} * \text{Equiv Water Depth}$	$= 5,675 \text{ sf} * 2.4 \text{ in} * \frac{\text{ft}}{12 \text{ in}}$	1,135 cf
3	Equivalent Rainfall Depth	$= \frac{\text{Retention Volume}}{\text{Managed Imperv Area}}$	$= \frac{1,135 \text{ cf}}{5,675 \text{ sf}} * \frac{12 \text{ in}}{\text{ft}}$	2.4 in
4	Volume Credit (%)	$= (1 - 2.5^{(-2.5 * \text{Equiv Rainfall Depth (in)})}) * 100$	$= (1 - 2.5^{(-2.5 * 2.4)}) * 100$	99.59%
5	Practice Credit (%)	$= \text{Volume Credit} * 0.40$	$= 99.59\% * 0.40$	39.83%
6	Site Credit (%)	$= \frac{\text{Managed Impervious Area}}{\text{Total Site Impervious Area}} * \text{Practice Credit}$	$= \frac{5,675}{43,125} * 39.8\%$	5.25%

## 2. Basic Improvements

### a) Permeable Pavement – Peak Flow

- Reconstruct the circle drive (5,675 sf) with porous pavement
- Assumed pavement cross-section
  - Pavement material ignored for equivalent water depth
  - 6-in of aggregate base (with 40% effective porosity) ABOVE underdrain
- Assumed suitable soils for infiltration



Step	Topic	Equation		Result
1	Equivalent Water Depth (EWD)	$= \text{Layer Thickness} * \text{Effective Porosity}$	$= 6 \text{ in} * 0.40$	2.4 in
2	2 year, 24 hour Storm Event Volume	$= 4,220 \frac{cf}{\text{imperv. acres}} * \text{Managed Imperv. Acres}$	$= 4,220 \frac{cf}{\text{imperv ac}} * 0.13 \text{ ac}$	549 cf
3	100 Year, 24 hour Storm Event Volume	$= 11,750 \frac{cf}{\text{imperv. acres}} * \text{Managed Imperv. Acres}$	$= 11,750 \frac{cf}{\text{imperv. ac}} * 0.13 \text{ ac}$	1,528 cf
4	Volume Provided	$= \text{EWD (ft)} * \text{Practice Area (ft}^2\text{)}$	$= (2.4 \text{ in}/12) * 5,675 \text{ sf}$	1,135 cf
5	Peak Flow Credit (%)	$= \frac{V_{\text{provided}}}{V_{100}} * 100$	$= \frac{1,135 \text{ cf}}{1,527.5 \text{ cf}} * 100$	74.30%
6	Practice Credit (%)	$= \text{Peak Flow Credit} * 0.4$	$= 74.30\% * 0.40$	29.72%
7	Site Credit (%)	$= \frac{\text{Managed Impervious Area}}{\text{Total Site Impervious Area}} * \text{Practice Credit}$	$= \frac{5,675}{43,125} * 29.7\%$	3.91%

## 2. Basic Improvements

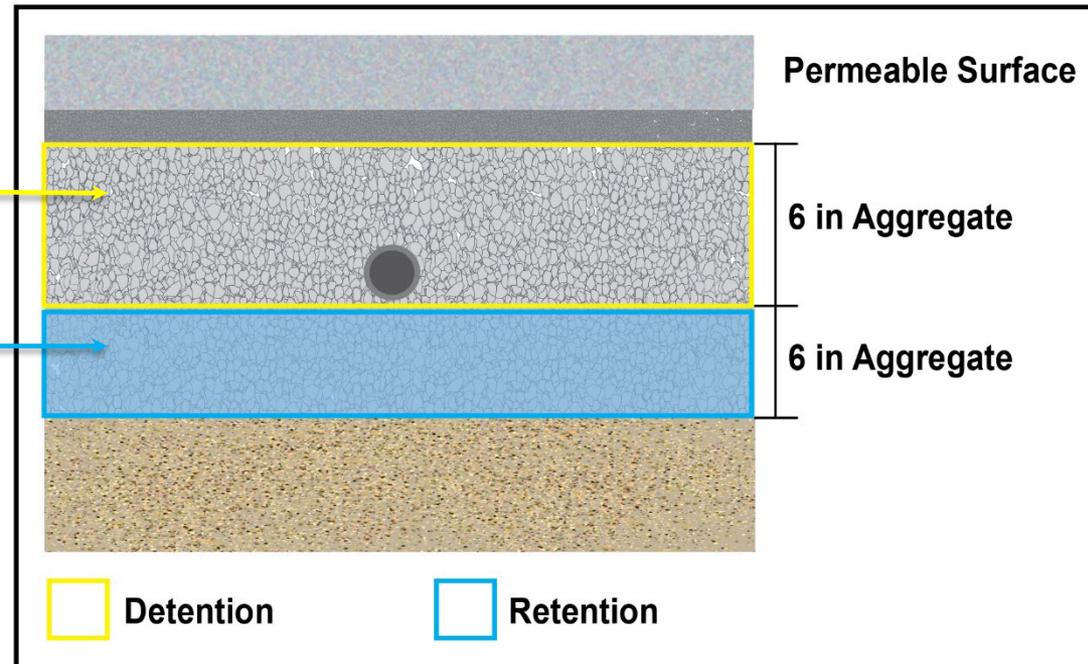
### a) Permeable Pavement – Conclusion

- Reconstruct the circle drive (5,675 sf) with porous pavement



$$Site\ Credit_{Peak\ Flow}\ (%) = 3.91\%$$

$$Site\ Credit_{Volume}\ (%) = 5.25\%$$



Site Credit	
Total Site Credit	= 9.16%
<b>Total Site Credit (Rounded)</b>	<b>=10.0%</b>

### 3. Next Step Ideas–

#### a) Route Roof to Permeable Pavement

How can that credit be increased?

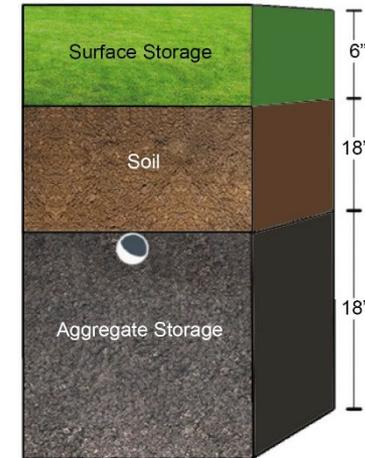
- Connect Downspouts
  - New Managed Impervious Area = 10,025 sf
- Increase Cross Section
  - New Cross Section: 10” of Agg. above underdrain



Concept	Managed Impervious Area	SW Practice Area	Equiv. Water Depth	Volume Practice Credit	Peak Flow Practice Credit	Total Site Credit
Permeable Pavement in Circle Drive	5,675 sf	5,675 sf	2.4 in (ret) 2.4 in (det.)	39.83%	29.72%	<b>10.0%</b> (9.1%)
Permeable Pavement (with Downspouts)	10,025 sf	5,675 sf	2.4 in (ret) 4.0 in (det.)	38.30%	27.98%	<b>16.0%</b> (15.4%)

### 3. Next Step Ideas– b) Route Roof to Bioretention

- Redirect Downspouts into Bioretention
- Varied Practice Size
- Cross Section:
  - 6” of Surface Storage
  - 18” of Engineered Soil (20% effective porosity)
  - 18” of Aggregate (40% effective porosity)



Concept	Managed Impervious Area	Equivalent Water Depth	SW Practice Area	Site Credit (Rounded Up)
Bioretention (With Downspouts 1,2,7)	3,925 sf	7.2 in (ret.) 9.6 in (det.)	700 sf	<b>6.0%</b> (5.3%)
			850 sf	<b>6.0%</b> (5.8%)
			1,000 sf	<b>7.0%</b> (6.3%)
			1,250 sf	<b>7.0%</b> (7.0%)
			1,500 sf	<b>8.0%</b> (7.3%)

# 4. Summarize Planned Improvements

- Combining GSI

Concept	Managed Impervious Area	SW Practice Area	Overall Site Credit
<b>Parking Lot</b>			
Disconnected Impervious	9,935 sf	28,315 sf	7.9%
<b>Building</b>			
Disconnect Downspouts to Permeable Pavement	*Included in Permeable Pavement on circle drive below		
Downspouts to Bioretention	3,925 sf	850 sf	5.8%
<b>Circle Drive</b>			
Permeable Pavement (Circle Drive)	10,025 sf	5,675 sf	15.4%
<b>TOTAL</b>			
	23,885 sf	34,840 sf	29.1%
<b>TOTAL CREDIT (Rounded):</b>			<b>30.0%</b>



# 5. Fill out credit application

- Once all the Engineered Drawings are complete, submit ***Drainage Credit Application***
- Item 15 on application is practice specific and will need to be filled out for each practice
- For the disconnected impervious credit, an additional attachment needs to be filled out

## #15 for Permeable Pavement

Total Managed Area (acres or sq. ft.)	10,025 sf
Managed Impervious Area (acres or sq. ft.)	10,025 sf
Stormwater Practice Type	Permeable Pavement
Stormwater Practice Area (acres or sq. ft.)	5,675 sf
Retention Zone Equivalent Water Depth (inches)	2.4 in
Retention Zone Volume (Generally this is a calculated value based on the practice area and the equivalent water depth).	1,135 cf
Detention Zone Equivalent Water Depth (inches)	4.0 in
Detention Zone Volume (Generally this is a calculated value based on the practice area and the equivalent water depth).	1,890 cf
Detention Volume (for detention ponds or similar)	N/A

## #15 for Bioretention

Total Managed Area (acres or sq. ft.)	3,925 sf
Managed Impervious Area (acres or sq. ft.)	3,925 sf
Stormwater Practice Type	Bioretention
Stormwater Practice Area (acres or sq. ft.)	850 sf
Retention Zone Equivalent Water Depth (inches)	7.2 in
Retention Zone Volume (Generally this is a calculated value based on the practice area and the equivalent water depth).	510 cf
Detention Zone Equivalent Water Depth (inches)	9.6 in
Detention Zone Volume (Generally this is a calculated value based on the practice area and the equivalent water depth).	680 cf
Detention Volume (for detention ponds or similar)	N/A

# 5. Fill out credit application

**11. Complete this section for disconnected impervious and downspout disconnection:**

- Prepare a map of the property (can use a google earth image, sketch, parcel viewer image, etc.) that identifies the impervious area that generates stormwater runoff, the pervious area accepting the storm water runoff and how the stormwater runoff is transferred.
- Provide site photographs for each disconnected impervious area or downspout disconnection that is discharging to a pervious area.
- Number each of the roofs/impervious areas on the map of the property that discharge to pervious area and fill out the table below.

*Chapter 4 of the Drainage Program Guide outlines the criteria required for disconnected impervious and downspout disconnection to be credit eligible.*

*Note: For Downspout Disconnection, the "total receiving pervious area" typically considered can be measured from the end of the downspout to the edge of the property measured along the path that water will flow multiplied by an assumed width equal to 5 feet.*

*Note: For Disconnected Impervious, the "total receiving pervious area" typically considered is based on the width of the sheet flow when it leaves the impervious surface multiplied by the length of the flow path in the pervious area.*

Impervious Area Number	Type of Impervious Area (e.g., roof, sidewalk, pavement)	Total Impervious Area ( <u>acres</u> or ft <sup>2</sup> )	Type of Pervious Area (e.g., lawn, garden, landscape gravel)	Total Receiving Pervious Area ( <u>acres</u> or ft <sup>2</sup> )	Practice Ratio = $\frac{\text{Total Receiving Pervious Area}}{\text{Total Impervious Area}}$	Individual Site Credit (%) <sup>*</sup>
Area 1						
Area 2						
Area 3						
Area 4						

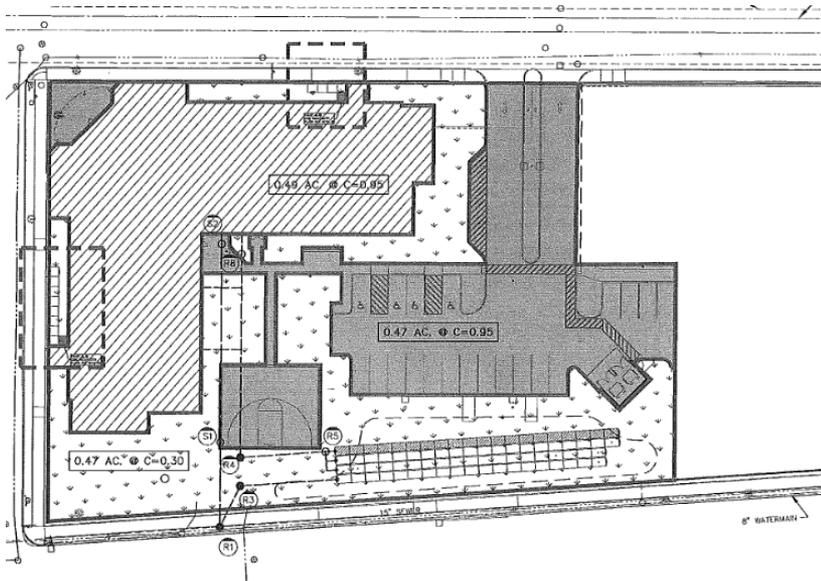
<sup>\*</sup>To assist with site credit calculation, the information from the table can be filled into the Credit Calculator tool on our website: <https://detroitmi.gov/document/drainage-charge-credit-calculator>

# **EXAMPLE 2**

## **CALCULATING CREDITS FROM A CREDIT APPLICATION**

# Background

- Commercial site
- Plan to Add Rain Garden with Subsurface Storage



Submitted the following:

- Completed Application
- PE Stamped Drawings

# Workflow

1. Check application for all requested information
2. Verify the customer's calculated volume credit
3. Verify the customer's calculated peak flow credit
4. Summarize results

# 1. Check application for all requested information

- Total Site Area: 1.42 ac
- Total Impervious Area: 0.96 ac
- Managed Impervious Area: 0.92 ac

9. Complete table of overall site data. This table should be completed for all parcels in which a credit is sought. Attach a separate sheet, if needed.

Overall site data (Note: use consistent units as appropriate based on parcel size. Acres should be shown to the 0.01 acre)

Parcel Number	Total Site Area (Acres or ft <sup>2</sup> )	Total Impervious Area (Acres or ft <sup>2</sup> )	Managed Impervious Area (Acres or ft <sup>2</sup> )
XXXXXXXX	1.42 ac	0.96 ac	0.92 ac

10. List proposed stormwater management practice(s) and the calculated amount of credit(s). Attach a separate sheet, if needed.

Managed Impervious Area for each Practice (Acres or ft <sup>2</sup> )	Stormwater Management Practice (Acres or ft <sup>2</sup> )	Site Credit for Each Practice (%)
0.92 ac	0.051 ac	47%

**Total Site Credit: 47 %**

*For practices that are across multiple parcels, the total site credit will need to be calculated for each parcel.*

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# 1. Check application for all requested information

12. Provide performance data for the engineered practices. Each practice will require the following information. The information can be presented in a table, spreadsheet or in the credit calculator tool.

Information Required for Each Practice	Practice Includes Retention	Practice Includes Detention
Total Managed Area (acres or ft <sup>2</sup> )	✓	✓
Managed Impervious Area (acres or ft <sup>2</sup> )	✓	✓
Stormwater Practice Name	✓	✓
Stormwater Practice Area (acres or ft <sup>2</sup> )	✓	✓
Retention Zone Equivalent Water Depth (inches)	✓	
Retention Zone Volume (generally this is a calculated value based on the practice area and the equivalent water depth).	✓	
Infiltration Rate Supported with On-Site Testing	✓	
Detention Zone Equivalent Water Depth (inches)		✓
Detention Zone Volume (generally this is a calculated value based on the practice area and the equivalent water depth)		✓

13. Provide supporting documentation required for engineered practices. Use the following check list to indicate the information that is included with the application.

Item	Checklist
Scaled Site Plan showing all parcels and surface features	<input type="checkbox"/>
Complete engineered drawings stamped by a registered Professional Engineer or Landscape Architect.	<input type="checkbox"/>
Existing roof drainage system defined (with drainage areas)	<input type="checkbox"/>
Proposed roof drainage system defined (with drainage areas)	<input type="checkbox"/>
Drainage areas to each practice defined	<input type="checkbox"/>
Existing site drainage and sewer system defined (with drainage areas)	<input type="checkbox"/>
Maintenance Plan	<input type="checkbox"/>
Photographs clearly showing existing practices	<input type="checkbox"/>
Environmental history of site	<input type="checkbox"/>
Identification of proposed connections to DWSD Sewers, if applicable	<input type="checkbox"/>
ALTA Survey, if applicable	<input type="checkbox"/>
Complete listing of permits applied for/expected	<input type="checkbox"/>
Geotechnical investigation results, if applicable	<input type="checkbox"/>

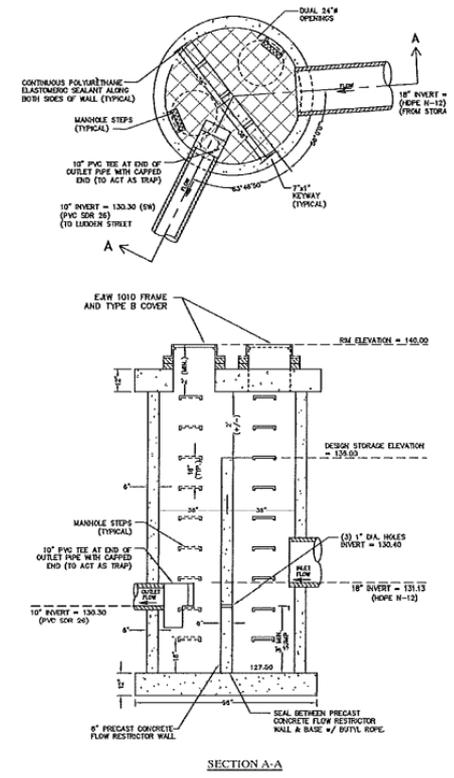
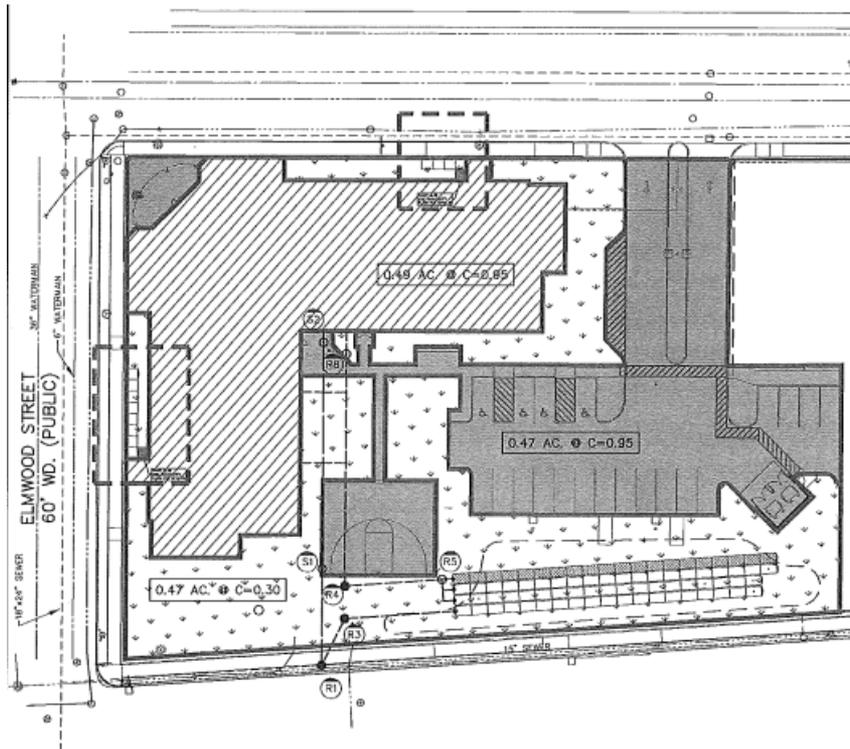
14. Provide performance data for green roof and include the following information:

- Dimensional drawing of the portion of the roof that is green.
- Dimensional drawing of the green roof cross section.
- Calculations estimating performance (EPA national stormwater calculator is preferred), see Chapter 4 of the Drainage Program Guide.

Total Managed Area	0.92 acres
Managed Impervious Area	0.92 acres
Stormwater Practice Type	Bioretention with Subsurface Storage
Stormwater Practice Area	0.51 acres
Retention Zone Equivalent Water Depth	4 inches
Retention Volume	727 cf
Detention Zone Equivalent Water Depth	18 inches
Detention Zone Volume	8,708 cf

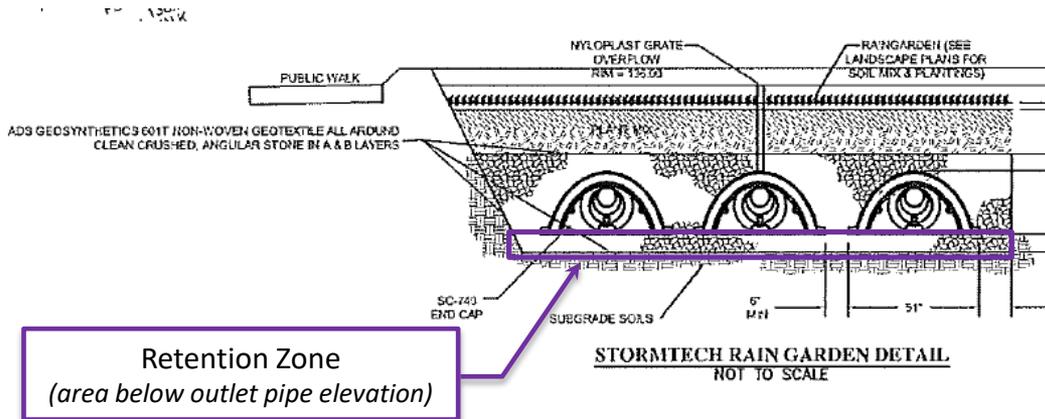
# 1. Check application for all requested information

- Attachments



R.3 OUTLET CONTROL STRUC

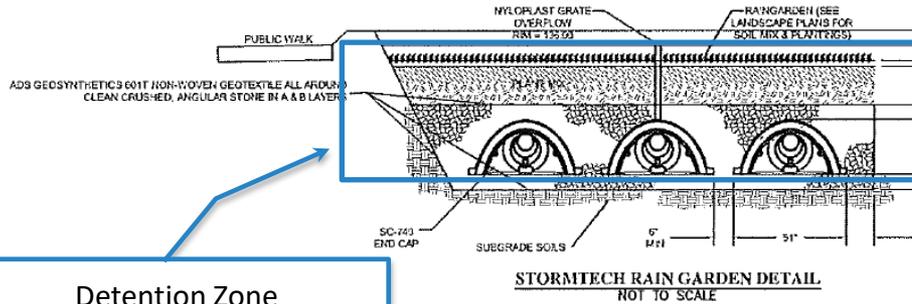
## 2. Calculate volume credit for rain garden



- Provided Intended Cross Section
  - Assume 0.1 in/hr and a max EWD of 7.2 in
  - Assumed 0.4 void ratio.
- Stormwater Practice Area: 2,205 sf

Step	Topic	Equation		Result
1	Equivalent Water Depth	$= \text{Layer Thickness} * \text{Effective Porosity}$	$= 10 \text{ in} * 0.40$	4 in
2	Retention Volume	$= \text{Practice Area} * \text{Equiv Water Depth}$	$= 2,205 \text{ sf} * 4 \text{ in} * \frac{\text{ft}}{12 \text{ in}}$	728 cf
3	Equivalent Rainfall Depth	$= \frac{\text{Retention Volume}}{\text{Managed Imperv Area}}$	$= \frac{728 \text{ cf}}{40,075 \text{ sf}} * \frac{12 \text{ in}}{\text{ft}}$	0.22 in
4	Volume Credit (%)	$= (1 - 2.5^{(-2.5 * \text{Equiv Rainfall Depth (in)})}) * 100$	$= (1 - 2.5^{(-2.5 * 0.22)}) * 100$	39.73%
5	Practice Credit (%)	$= \text{Volume Credit} * 0.40$	$= 39.73\% * 0.40$	15.89%
6	Site Credit (%)	$= \frac{\text{Managed Impervious Area}}{\text{Total Site Impervious Area}} * \text{Practice Credit}$	$= \frac{40,075}{41,818} * 15.89\%$	15.23%

# 3. Calculate peak flow credits for rain garden



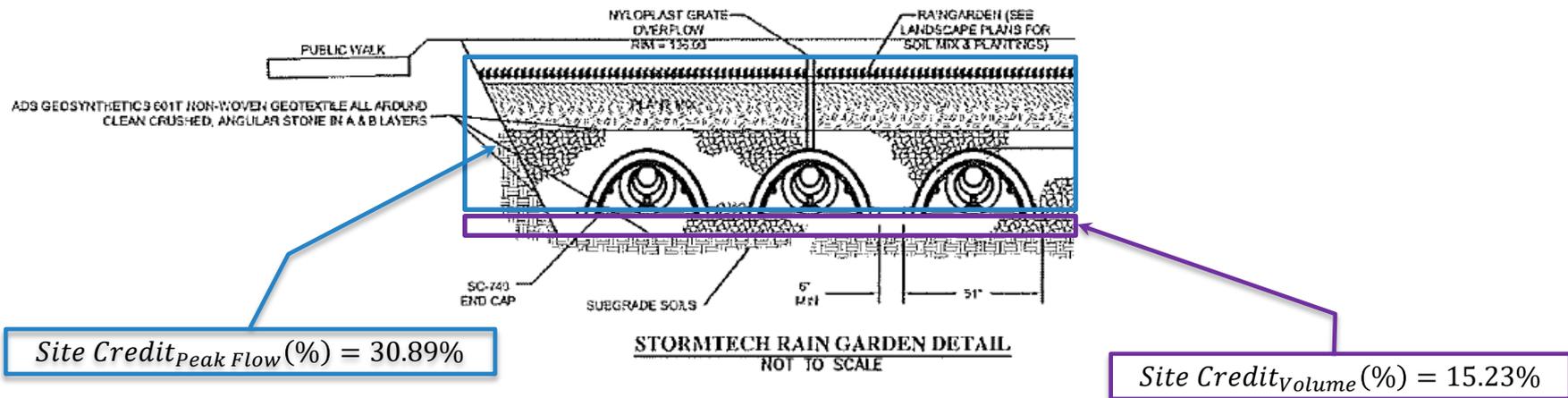
Detention Zone  
(area above outlet pipe elevation)

- Managed Impervious Area: 0.92 acres (40,075 sf)
- Provided Intended Cross Section
  - 8 in of surface storage
  - 14 in of soil
  - 18 in of aggregate

Step	Topic	Equation		Result
1	Equivalent Water Depth (EWD)	$= \text{Layer Thickness} * \text{Effective Porosity}$	$= 8 \text{ in} + (14 \text{ in} * 0.2) + (18 \text{ in} * 0.4)$	18 in
2	2 year, 24 hour Storm Event Volume	$= 4,220 \frac{cf}{\text{imperv. acres}} * \text{Managed Imperv. Acres}$	$= 4,220 \frac{cf}{\text{imperv. ac}} * 0.92 \text{ ac}$	3,882 cf
3	100 Year, 24 hour Storm Event Volume	$= 11,750 \frac{cf}{\text{imperv. acres}} * \text{Managed Imperv. Acres}$	$= 11,750 \frac{cf}{\text{imperv. ac}} * 0.92 \text{ ac}$	10,810 cf
4	Volume Provided	$= \text{EWD (ft)} * \text{Practice Area (ft}^2) + \text{Pipe Storage Volume}$	$= (18 \text{ in}/12) * 2,205 \text{ sf} + 5,401 \text{ cf}$	8,708.5 cf
5	Peak Flow Credit (%)	$= \frac{V_{\text{provided}}}{V_{100}} * 100$	$= \frac{8,708.5 \text{ cf}}{10,810 \text{ cf}} * 100$	= 80.55%
6	Practice Credit (%)	$= \text{Peak Flow Credit} * 0.4$	$= 80.55\% * 0.40$	= 32.23%
7	Site Credit (%)	$= \frac{\text{Managed Impervious Area}}{\text{Total Site Impervious Area}} * \text{Practice Credit}$	$= \frac{40,075}{41,818} * 32.23\%$	= 30.89%

# 4. Summarize results

- Rain Garden with Subsurface Storage



Site Credit	
Total Site Credit	=46.12%
<b>Total Site Credit (Rounded)</b>	<b>=47.0%</b>

# Drainage Credit Calculator

- Allows user to define various tributary areas and standard practices
- Calculates credits using DWSD simplified methods
- Built in excel format
- Available for use: [DWSD Credit Calculator](#)

**Advanced Credit Calculator**

The advanced version of the credit calculator allows the user to specify the stormwater management practices' cross section details and calculate a more accurate credit. For help calculating the EWD, see "EWD Calculator" Tab.

**Site Information and Impervious Area Adjustments**

Property Address:

Parcel Number:  Total Acreage:  Site Impervious Acreage:  Impervious Acreage Removed:  Remaining Impervious Acreage:

Have you conducted an infiltration test on your property?  Infiltration Rate:  inches/hour

Parcel Number	Total Acreage	Site Impervious Acreage	Impervious Acreage Removed	Remaining Impervious Acreage
1				0.00
2				0.00
3				0.00
Total	0.00	0.00	0.00	0.00

Converter:  Square Feet  Acres

**Data Input Options**

EWD: Equivalent Water Depths (EWDs) calculate a volume using the Stormwater Practice Area and EWDs. This option assumes vertical side slopes.

User Inputted Volumes: The user may manually input volumes retained and detained into the calculator. When this option is used, the supporting calculations, assumptions, and justifications must be with the credit application. This option allows for detention storage in the side slopes.

Note: For infiltration, no volume credit will be given for side slopes as typically side slopes are compacted during construction activities.

**GSI Selection, Cross Section, and Size**

Practice Number	Description	Practice Information		Physical Characteristics of Practice				Volumetric Credit Calculator					Peak Flow Credit Calculator					Total Site Credit (%)			
		Managed Impervious Area (Acres)	GSI Practice Type	Stormwater Practice Area (Acres)	EWD-Retention Zone (in)	EWD-Detention Zone (in)	Retention Volume (cf)	Detention Volume (cf)	Does Practice Qualify for a Volumetric Credit	Practice Ratio	Volume Credit (%)	Practice Volume Credit (%)	Site Volume Credit (%)	Does Practice Qualify for a Peak Flow Credit	2 Year Storage Volume Required (cf)	100 Year Storage Volume Required (cf)	Volume Provided (cf)		Peak Flow Credit (%)	Practice Peak Flow Credit (%)	Site Peak Flow Credit (%)
1				EWDs					NO	N/A	N/A	N/A	N/A	NO	N/A	N/A	N/A	N/A	N/A	N/A	0.00%
2				Storage Volume					NO	N/A	N/A	N/A	N/A	NO	N/A	N/A	N/A	N/A	N/A	N/A	0.00%
3				EWDs					NO	N/A	N/A	N/A	N/A	NO	N/A	N/A	N/A	N/A	N/A	N/A	0.00%
4				Storage Volume					NO	N/A	N/A	N/A	N/A	NO	N/A	N/A	N/A	N/A	N/A	N/A	0.00%
5				EWDs					NO	N/A	N/A	N/A	N/A	NO	N/A	N/A	N/A	N/A	N/A	N/A	0.00%



# MAINTENANCE

# GSI Maintenance Requirements



- GSI must be maintained to function as designed
- Maintenance plan to be submitted with credit application
- Inspection by DWSD or DWSD authorized inspector every 3 years
- Annual report for rainwater harvesting GSI practices to report water storage/usage

# Bioretention Maintenance Recommendations

- Inspect for sediment build-up and erosion
- Repair soil erosion and add additional soil stabilization measures;



# Bioretention Maintenance Recommendations

- Remove weeds regularly
- Periodic watering
- Removal of accumulated trash and dirt
- Adding mulch when needed



# Permeable Pavement Maintenance Recommendations

- Vacuum with standard street sweeping equipment
- Avoid use of sand and other fine aggregate during winter conditions



# Permeable Pavement Maintenance Recommendations

- Fully stabilize any adjacent area that have vegetation
- Inspect during rainstorms to ensure water is infiltrating



# Detention Maintenance Recommendations

- Monitor sediment accumulation levels
- Inspect basin for clogging and excessive debris
- Inspect stormwater inlets and outlets



# Detention Maintenance Recommendations

- Inspect side slopes for tunneling or burrowing of wildlife
- Maintain vegetation along side slopes



# Subsurface Storage Maintenance Recommendations

- Inspect catch basins, inlets, and pretreatment devices
- Evaluate drain-down time of the system



# Subsurface Storage Maintenance Recommendations

- Maintain vaults, chambers, and pipes free of sediment



# Water Harvesting Maintenance Recommendations

- Downspouts are properly positioned, intact, and free of debris
- Filters and screens are intact and free of debris and sediment
- Tanks and covers are intact and not leaking



# Water Harvesting Maintenance Recommendations

- Overflow outlets are clear and directed away from building and foundations
- Spigots and hoses are functioning optimally
- Pumps, if installed, are working properly
- Maintain inventory of water storage/usage



# Green Roof Maintenance Recommendations

- Inspect during the growing season to assess vegetative cover, drainage issues, rooftop structure
- Inspect drainage system for leaks
- Add/replace plants/media to repair base areas
- Remove woody plants





# QUESTIONS?



## Website:

[www.detroitmi.gov/drainage](http://www.detroitmi.gov/drainage)

## Email (recommended):

[drainage@detroitmi.gov](mailto:drainage@detroitmi.gov)

## Phone Number:

313-267-8000, option 6



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