



# **GREEN INFRASTRUCTURE GRANTS PROGRAM Operation & Maintenance Workshop**



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# Agenda

- Introduction
- O & M General Overview
- SCM - Design
- SCM - Construction
- SCM - Maintenance



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# Introduction

- The Northeast Ohio Regional Sewer District supports the strategic implementation and long-term maintenance of green infrastructure that protects, preserves, enhances, and restores natural hydrologic function.
- The Green Infrastructure Grant (GIG) for the Combined Sewer Area Program (Program) focus is the funding of green infrastructure projects to remove stormwater runoff from the combined sewer collection system within the District's combined sewer service area.



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# Introduction

- The District is now requiring, through our GIG Agreement, that all grantees attend an Operation & Maintenance (O&M) Workshop to ensure green infrastructure practices will continue to function properly and yield expected water quality and environmental benefits, while ensuring good stewardship of rate payer dollars.



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# Green Infrastructure Grant Program

Funding Round	Award Recommendations	Runoff Reduction gallons/year
<b>2014 GREEN INFRASTRUCTURE GRANTS PROGRAM</b>		
<b>TOTAL</b>	<b>\$1,746,274</b>	<b>7,138,890</b>
<b>2016 GREEN INFRASTRUCTURE GRANTS PROGRAM</b>		
<b>TOTAL</b>	<b>\$1,974,747</b>	<b>9,658,777</b>
<b>2018 GREEN INFRASTRUCTURE GRANTS PROGRAM</b>		
<b>TOTAL</b>	<b>\$799,130</b>	<b>1,730,688</b>
<b>2019 GREEN INFRASTRUCTURE GRANTS PROGRAM</b>		
<b>TOTAL</b>	<b>\$1,908,361</b>	<b>4,906,083</b>
<b>2020 GREEN INFRASTRUCTURE GRANTS PROGRAM</b>		
<b>TOTAL</b>	<b>\$1,935,944</b>	<b>2,913,808</b>
<b>GRAND TOTAL</b>	<b>\$8,364,456</b>	<b>26,348,246</b>



# Stormwater Control Measures

- Bioretention Practices
- Cistern
- Green Wall
- Permeable Pavement
- Underground Infiltration/  
Detention Systems



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Operation & Maintenance

# GENERAL OVERVIEW



# General Overview



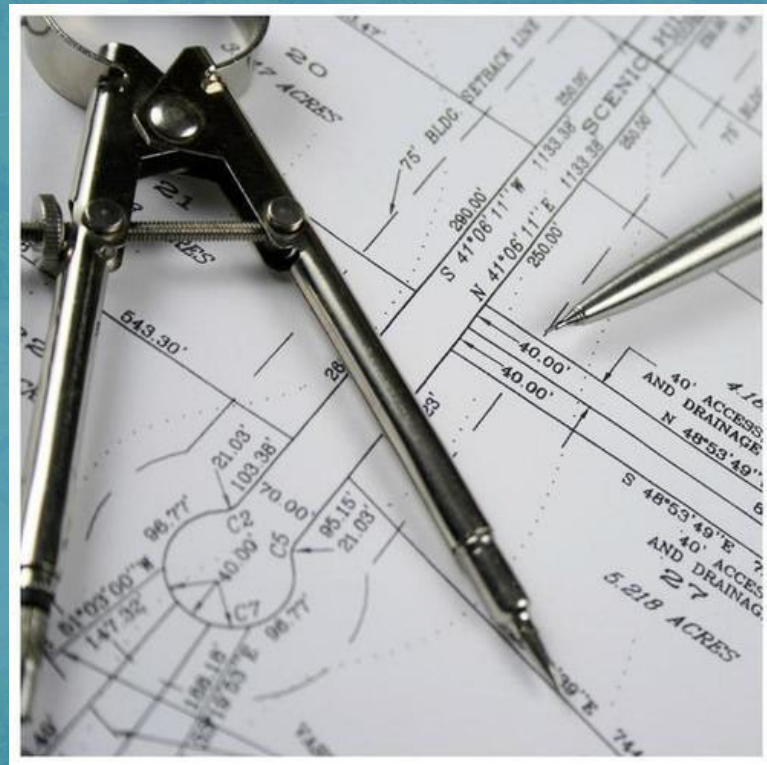
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# General Overview - Design



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# General Overview - Construction



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# General Overview – Day 1



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# General Overview – Day 1



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# General Overview – the first few months



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# General Overview – the awkward years



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# General Overview – Maturity



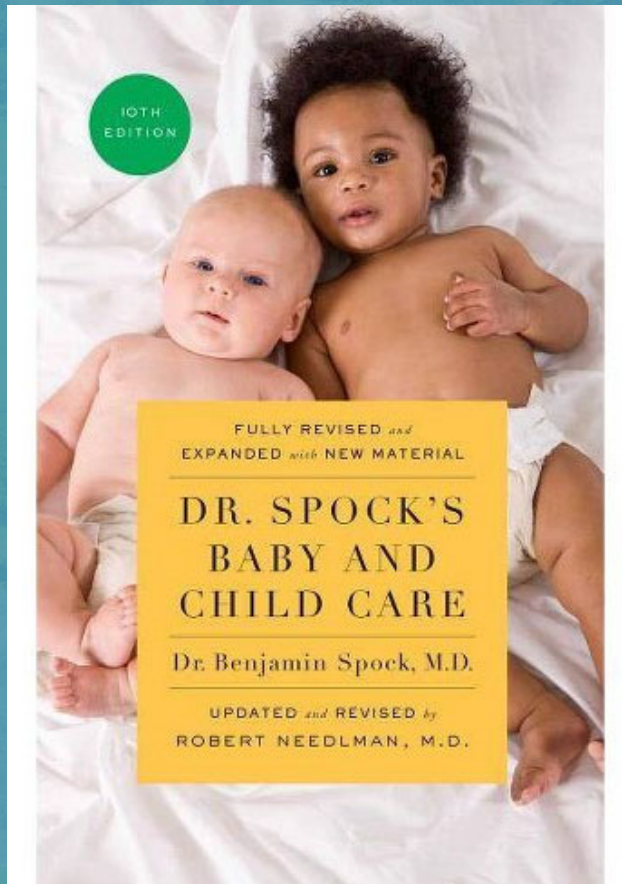
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# General Overview - Construction





# General Overview - Design Considerations



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# General Overview - Design

- Begin with the end in mind
- Setup project for success
  - Construction
  - Long-term maintenance



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# General Overview - Design

- Refer to an accepted standard



## Rainwater and Land Development

Ohio's Standards for Stormwater Management  
Land Development and Urban Stream Protection

**\*Third Edition 2006**

*\*Updated to include all new materials,  
changes and corrections as of 11-6-14.*

Ohio Department of Natural Resources  
Division of Soil and Water Conservation

2045 Morse Road, Building B-3  
Columbus, Ohio 43229-6605  
(614) 265-6610



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# General Overview - Design

- Ensure accessibility by needed equipment



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# General Overview - Design

- Schedule

## **Construction Issues**

1. **Timing of Construction** - Construction of bioretention practices shall take place after land grading is complete and the contributing drainage area has been stabilized. Construction may take place if the entire contributing area can be effectively diverted until construction is complete and fully-vegetated cover protects all soil areas. Construction shall not occur during periods of precipitation since clogging of soils, bedding, filter or planting media may occur.



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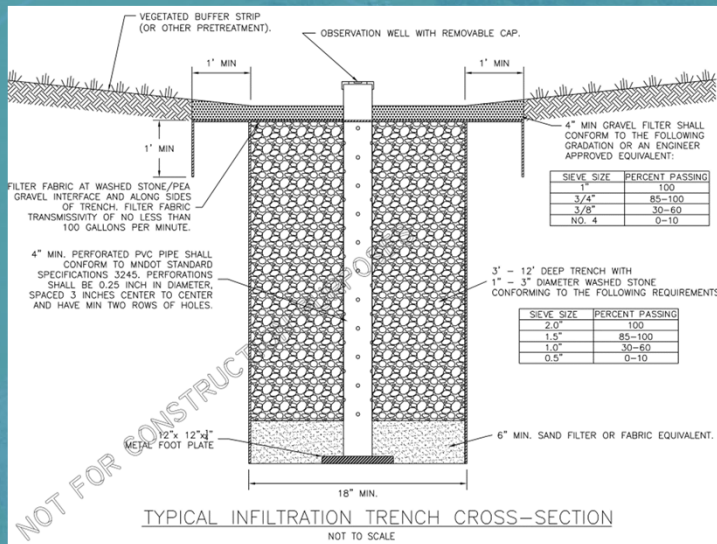


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# General Overview - Design

- Consider ways to simplify inspections (e.g., observation wells)



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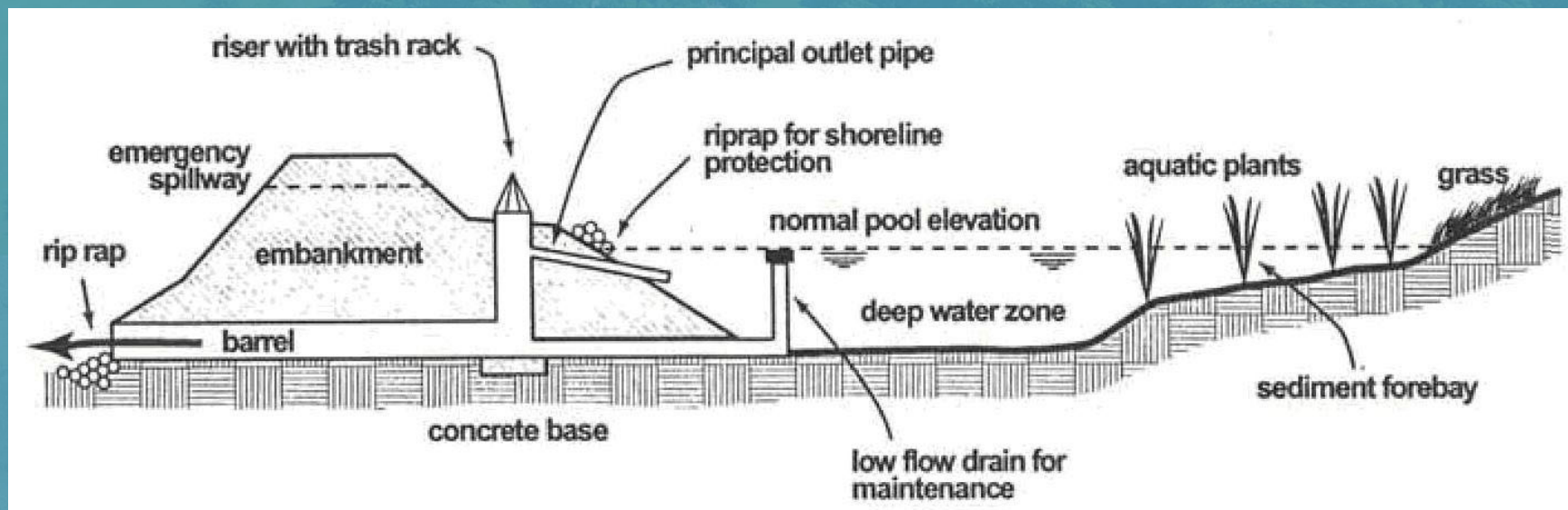


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# General Overview - Design

- Flood Routing
  - What happens if the practice clogs/fails?



# General Overview - Design



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# General Overview - Design

## • Material Specifications

4. *Planting Soil* – The planting soil filters the treatment volume, detains runoff in the available void space and provides a media for plant growth and a biological community. Much of the pollutant removal occurs in this zone due to filtering, microbial activity, ion exchange, adsorption and plant uptake. The planting soil (an engineered soil media) shall be at least two feet deep and up to four feet in depth (settled) depending upon the planned vegetation. Greater depth is necessary to accommodate the root ball of trees planted in bioretention facilities. Soils and soil mixes must be certified by a qualified laboratory (1 test per 100 yd<sup>3</sup> of soil) and have the following attributes:

- Texture class: loamy sand. Having no less than 80% sand and no greater than 10% clay considering only the mineral fraction of the soil.
- pH range: 5.2 - 8.0
- Soluble Salts: 500 ppm maximum.
- Decomposed organic matter: 3-5% by weight [Note: this translates to 8-20% organic matter by volume. See note on “Creating a Suitable Soil Media” below.]
- Phosphorus: phosphorus of the planting media should fall between 15 and 60 mg/kg (ppm) as determined by the Mehlich III test. For sites in watersheds with a phosphorus TMDL or sites with high phosphorus loads, the phosphorus content of the planting media should fall between 10 and 30 mg/kg as determined by the Mehlich III test.
- Sand added shall be clean and meet AASHTO M-6 or ASTM C-33 with a grain size of 0.02-0.04” inches.



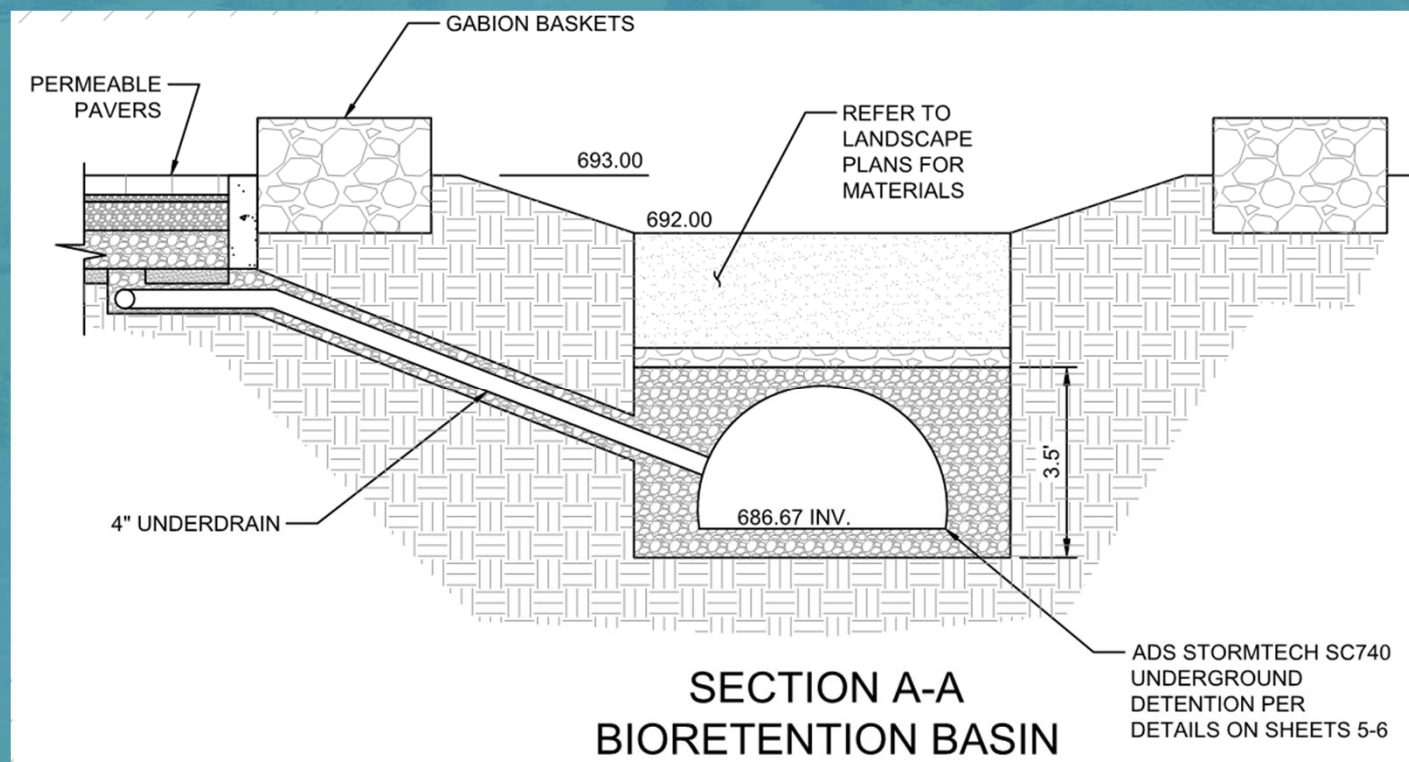
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# General Overview - Design

- Applicable Notes & Details





# General Overview - Construction Considerations



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Milestone Inspections



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# General Overview - Construction

- Do not ruin your SCM!!!



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# General Overview - Construction

- Follow the construction schedule



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# General Overview - Construction

- Scarify underlying subsoil of infiltrating practices





# General Overview - Construction

- Keep sediment out!!



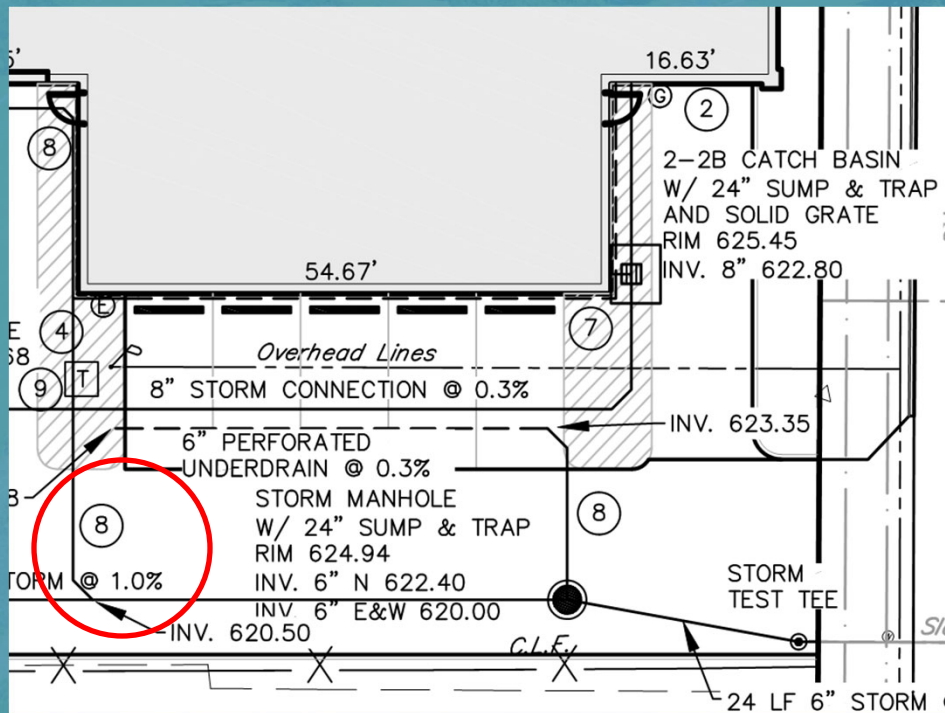
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# General Overview - Construction

- Refer to applicable notes



## UTILITY NOTES:

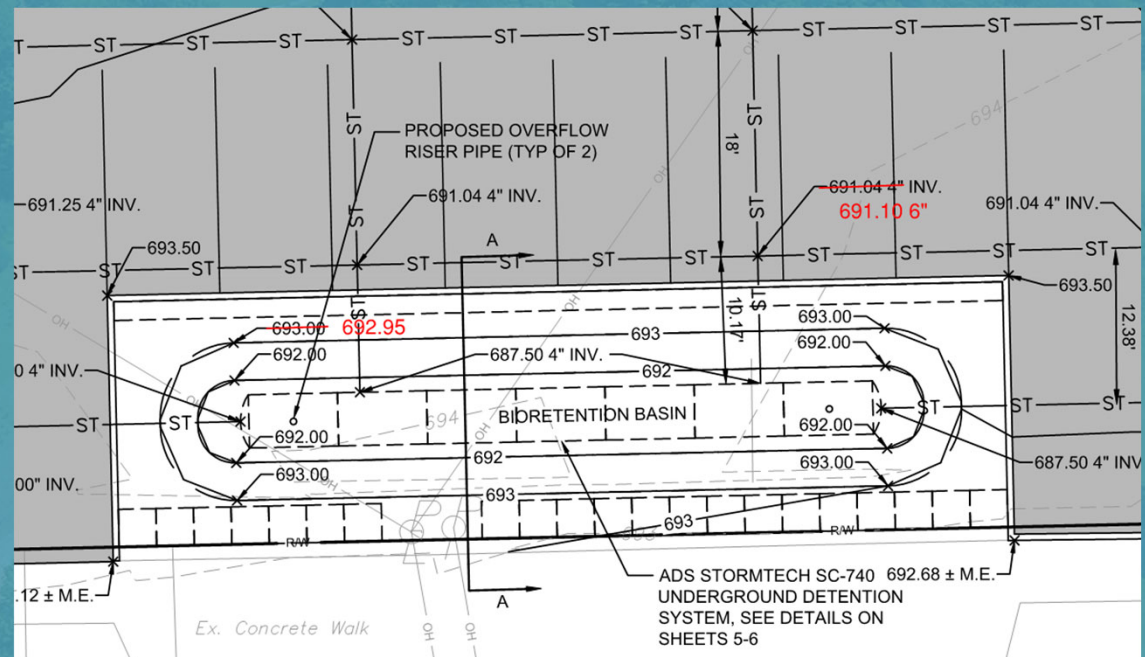
- 1 PRIOR TO CONSTRUCTION THE CONTRACTOR SHALL LOCATE EXISTING SLANTS #21 AND #28 FOR RE-USE. CONTRACTOR SHALL EXPOSE SLANT AND IT SHALL BE INSPECTED BY WATER POLLUTION CONTROL FOR REUSE. IF CONNECTION IS VIABLE CONTRACTOR SHALL NOTIFY ENGINEER OF LOCATION AND ELEVATION. IF WATER POLLUTION CONTROL DETERMINES THE SLANT IS NO LONGER VIABLE THE CONTRACTOR SHALL INSTALL A NEW 6" VCP SLANT PER WPC STANDARDS. CONTRACTOR TO COORDINATE WITH WATER POLLUTION CONTROL. SEWER WITHIN THE R/W, FROM TEST TEE TO THE MAIN SHALL BE 6" VCP @ A MINIMUM SLOPE OF 1.0%.
- 2 PROPOSED GAS METER. LOCATION AND SIZE AND CONNECTION TO BE COORDINATED WITH UTILITY COMPANIES PRIOR TO CONSTRUCTION.
- 3 RELOCATED WATER SPIGOT. CONTRACTOR TO COORDINATE FINAL LOCATION WITH OWNER PRIOR TO CONSTRUCTION. IF EXISTING SHUT OFF VALVE IS WITHIN CONSTRUCTION LIMITS, CONTRACTOR SHALL ALSO RELOCATE VALVE WITH WATER SPIGOT.
- 4 PROPOSED ELECTRIC METER AND TRANSFORMER. CONTRACTOR SHALL COORDINATE WITH MEP PLANS AND UTILITY COMPANIES PRIOR TO CONSTRUCTION.
- 5 PROPOSED 4" FIRE LINE AND 2" DOMESTIC LINE. METER AND BACKFLOW SHALL BE LOCATED INSIDE BUILDING.
- 6 CURB UNDERDRAIN. SEE DETAIL SHEET C6.01.
- 7 6" PERFORATED UNDERDRAIN AT 0.3% SLOPE WHERE PAVERS MEET BUILDING. SEE DETAIL SHEET C6.02.
- 8 SOLID PIPE FOR CONNECTION BETWEEN PERFORATED PIPE AND COLLECTOR PIPE.



# General Overview - Construction

- Complete as-built drawings

<h2>AS-BUILT DRAWINGS</h2> <p>This drawing has been modified to conform to As-Built construction condition, as provided by the Construction Contractor:</p> <p>(NAME OF COMPANY HERE)</p> <hr/> <p>COMPANY</p> <p>(TO BE HAND SIGNED ONLY)</p> <hr/> <p>COMPANY REPRESENTATIVE</p> <p>(date the as-builts will actually be signed)</p> <hr/> <p>DATE</p>
--



# General Overview - Construction

- Update O&M plan as applicable when design changes are made during construction



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# General Overview - Construction

- Construct infiltrating practices during dry weather only



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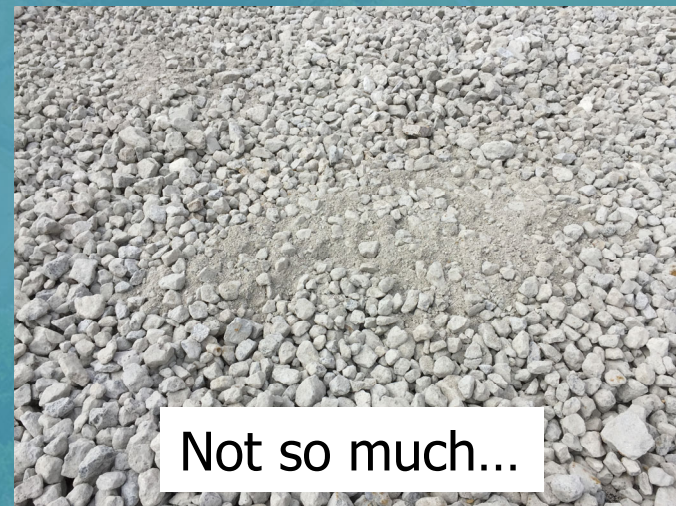
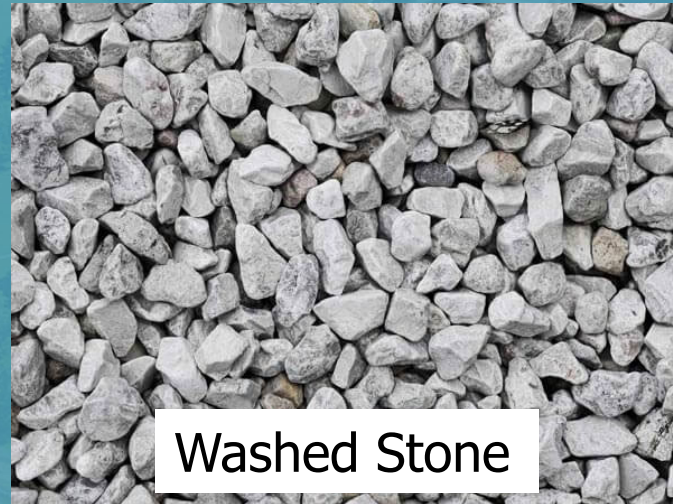


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# General Overview - Construction

- Ensure non-contaminated construction materials are used





# General Overview – Maintenance Considerations



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# General Overview – Maintenance

What do the following  
have in common?



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# General Overview – Maintenance



A man-made  
feature that  
requires no  
maintenance

A perfect system of government



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# General Overview – Maintenance

**THEY DON'T EXIST!!!**



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# General Overview – Maintenance

- First year need\$ vs long-term need\$



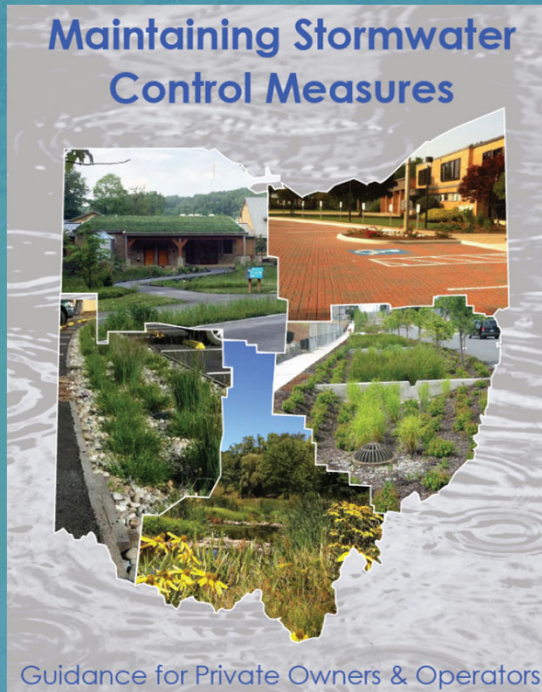
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# General Overview – Maintenance



MAINTAINING STORMWATER CONTROL MEASURES Guidance for Private Owners & Operators	
STORMWATER CONTROL MEASURES	
Stormwater Control Measures	
Over the next few pages we will discuss common SCMs approved for use in Ohio. A good understanding of SCM design and operation will enable property owners and operators of SCMs to plan and implement required maintenance activities on schedule.	
<i>If your SCM is not listed in this manual, please contact your local stormwater manager.</i>	
•	Bioretention Area (page 7)
•	Dry Pond or Dry Extended Detention Basin (page 9)
•	Wet Pond or Wet Extended Detention Basin (page 11)
•	Vegetated Infiltration Swale (page 13)
•	Permeable Pavement (page 15)
•	Green Roof (page 18)
•	Non-Structural SCMs: Riparian & Wetland Setbacks and Conservation Areas (page 19)
•	Rain Barrels & Cisterns (page 21)
•	Rain Gardens (page 23)
•	Sand Filter System (page 25)
•	Underground Detention (page 27)
•	Oil-Water Separator (page 29)

MAINTAINING STORMWATER CONTROL MEASURES Guidance for Private Owners & Operators	
TABLE OF CONTENTS	
2	History of Stormwater Management Solutions in Ohio
4	Key Points to Remember When Using This Guidance Manual
6	Stormwater Control Measures
30	Routine and Non-Routine Maintenance
42	Inspection & Maintenance Agreements and Easements
43	Tips to Lessen Maintenance Costs
APPENDIX 1	Glossary of Commonly Used Terms
APPENDIX 2	Inspection & Maintenance Check Lists
APPENDIX 3	Operation & Maintenance Resources
APPENDIX 4	Inspection & Maintenance Agreement Template
APPENDIX 5	Bioretention Area & Rain Garden Planting Lists
APPENDIX 6	List of Common Invasive Plants

[http://neohiostormwater.com/uploads/3/5/0/4/35043674/compressed\\_scm\\_om\\_manual\\_final\\_8-21-15.pdf](http://neohiostormwater.com/uploads/3/5/0/4/35043674/compressed_scm_om_manual_final_8-21-15.pdf)



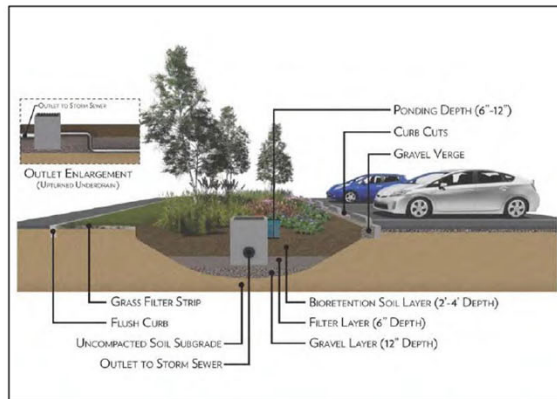
# General Overview – Maintenance

## MAINTAINING STORMWATER CONTROL MEASURES Guidance for Private Owners & Operators

### STORMWATER CONTROL MEASURES

#### Bioretention Area

Bioretention areas are depressed areas that allow shallow ponding of stormwater runoff that utilize specified soil media, mulch and vegetation to capture and treat stormwater runoff from impervious surfaces such as parking lots and rooftops. The soil media, mulch and vegetation filter pollutants to improve water quality within urban environments. The specified soil media, composed of sand, is placed over layers of sand, pea gravel and gravel within the depression which enables ponded stormwater runoff to be treated and filtered and before either soaking into the underlying soils or leaving through an underdrain pipe. Underdrains may be installed to drain the bioretention area to local sewers or appropriate outlet. Bioretention areas are planted with specific types of plant material that can withstand both wet and dry weather conditions. Recommended plant material information for Bioretention Areas can be found in Appendix 5.



Typical bioretention area cross-section view. Credit: Chagrin River Watershed Partners, Inc.

## MAINTAINING STORMWATER CONTROL MEASURES Guidance for Private Owners & Operators

### STORMWATER CONTROL MEASURES



Planted bioretention area with sidewalk curb cut in foreground. Stormwater runoff is conveyed through gravel to shallow depression of bioretention area. Credit: Northeast Ohio Regional Sewer District



Weeds and untrimmed plantings prevent stormwater runoff from entering the bioretention area from the curb cut. Credit: Northeast Ohio Regional Sewer District



Stormwater flow will be blocked by the dead vegetation on the outlet catch basin grate. Credit: Chagrin River Watershed Partners



Erosion of side slopes and subsequent sediment accumulation within bioretention area and contribute to clogging issues. Credit: Summit Soil & Water Conservation District

#### MAINTENANCE REQUIRED WHEN:

- Standing water is visible 48 hours after a rain event.
- Erosion is visible within the bioretention area, or on the slopes and inlets leading into the bioretention area.
- Vegetation, sediment or debris is blocking inlets or outlets.
- Vegetation is wilting, discolored, or dying.
- Foul odors present.
- Sediment has accumulated over the mulch or soil media.

# General Overview – Maintenance

## MAINTAINING STORMWATER CONTROL MEASURES Guidance for Private Owners & Operators

### ROUTINE AND NON-ROUTINE MAINTENANCE

#### Recommendations for Routine and Non-Routine Maintenance

The following section lists general recommendations for routine and non-routine maintenance items. Some routine maintenance items are completed on a seasonal basis, others require greater frequency. Non-routine maintenance items often require professional expertise and assistance before appropriate corrective measures can be determined. Resources for professional assistance are listed in Appendix 3.

#### Bioretention Area

##### Routine Maintenance:

- **Sediment and Debris:** Remove gross accumulated sediment and debris from the mulch or grass surface area of the bioretention area.
- **Outlet Structure:** Keep outlets of bioretention area free from blockage by sediment, debris, trash, mulch or plant material.
- **Erosion and Scour:** Repair soil erosion or scouring within the bioretention area, side slopes or inlets leading into the bioretention area.
- **Mulch:** Maintain a 2 to 3 inch depth of hardwood bark mulch layer within the planted area of the bioretention area. If an excessive depth of mulch exists, remove mulch until the mulch layer is 2 to 3 inches in depth.
- **Curb Cuts:** Keep curb cuts to bioretention area free from blockage by sediment, debris and trash.
- **Weeds:** Remove weeds and invasive plants from bioretention area.
- **Vegetation Management:** Inspect plant health seasonally to ensure vigorous growth. Prune plants, particularly shrubs and trees, during the dormant season (fall to early spring).
- **Snow Removal:** Do not pile or store snow within the bioretention area as this will compact the specialized soils and add sediments that may lead to clogging.

##### Non-Routine Maintenance:

- **Plant Replacement:** Replace diseased or dying plants.
- **Water Ponding Period:** When ponding continues beyond a 48 hour period or the designed ponding duration, there may be construction, or design issues that need to

#### Bioretention Area Inspection and Maintenance Checklist

Facility:		
Location/Address:		
Date:	Time:	Weather Conditions:
Inspector:		Title:
Rain in Last 48 Hours <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, list amount and timing:		
Pretreatment: <input type="checkbox"/> vegetated filter strip <input type="checkbox"/> swale <input type="checkbox"/> turf grass <input type="checkbox"/> forebay <input type="checkbox"/> other, specify: <input type="checkbox"/> none		
Site Plan or As-Built Plan Available: <input type="checkbox"/> Yes <input type="checkbox"/> No		

Inspection Item	Comment	Action Needed
<b>1. PRETREATMENT</b>		
Sediment has accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Trash and debris have accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>2. DEWATERING</b>		
Standing water is present after 24 hours. If yes, describe sheen, color, or smell.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>3. INLETS</b>		
Inlets are in poor structural condition.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sediment has accumulated and/or is blocking the inlets.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Erosion is occurring around the inlets.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>3. VEGETATION</b>		
Vegetation is wilting, discolored, or dying due to disease or stress.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Vegetation needs to be controlled through mowing or manual removal.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>4. BIORETENTION MAIN INFILTRATION AREA</b>		
Trash and debris have accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sediment has accumulated at the surface.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Topmost layer is caked or crusted over with sediment.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Erosion is evident.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Mulch is compacted.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sinkholes or animal borrows are present.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>5. SIDE SLOPES AND EMBANKMENT</b>		
Erosion is evident.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sinkholes or instability is evident.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>6. OUTLETS AND OVERFLOW STRUCTURE (i.e., catch basin)</b>		
Outlets or overflow structures in poor structural condition.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sediment, trash or debris is blocking the outlets or overflow structure.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Erosion is occurring around the outlets or overflow structure.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Height from surface of practice to top of overflow structure is insufficient to allow for ponding during rain events.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No



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THE CLEVELAND MUSEUM OF NATURAL HISTORY  
WELCOME

Operation & Maintenance

# BIORETENTION



# Bioretention

- Small-scale, vegetated depressions
- Small contributing areas (e.g. roads and roof tops)
- Stormwater runoff percolates through soil and plant roots
- Physical, chemical and biological processes
- Clean water infiltrates or is discharged



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# Bioretention - Design



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# Bioretention - Design

- General
  - Use accepted standards
  - Ensure accessibility
  - Prepare logical schedule
  - Keep inspection & maintenance in mind
  - Include applicable notes & details
  - Provide for flood routing
  - Provide material specifications





# Bioretention - Design

- Design assumptions made:
  - Appropriate drainage area vs. filter bed area (5% of watershed's IA)
  - Adequate outlet
  - Groundwater considerations
  - Setbacks met



# Bioretention - Design

- Assumptions:
  - Appropriate drainage area vs. filter bed area (5% of watershed's IA)



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# Bioretention - Design

- Pre-treatment options:



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# Bioretention - Design

- Curb cuts: Sumps (easy) vs. Slopes (hard)





# Bioretention - Design

- Curb cuts: Use the right size stone



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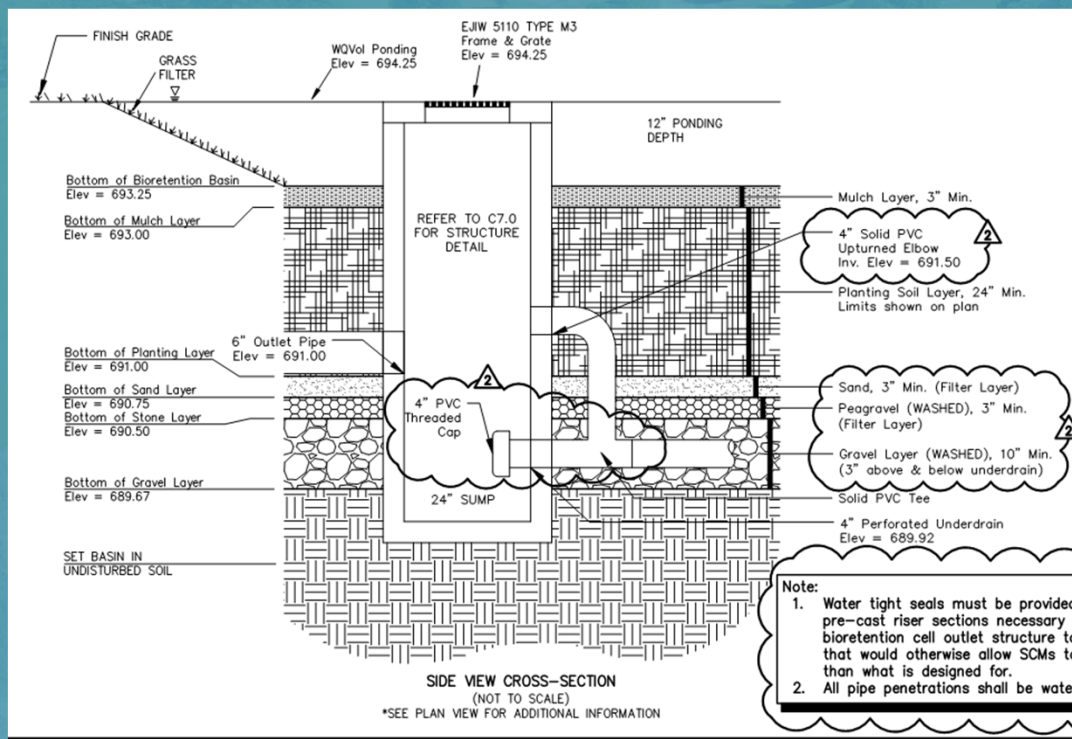


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# Bioretention - Design

- Upturned elbows:





# Bioretention - Design

- Infiltration testing:



Double-ring  
infiltrometer



Infiltration test pit



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# Bioretention - Design

- Plant Selection:
  - Aesthetics
  - Line of site
  - Moisture variability
  - Salt tolerance
  - Sunlight needs



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# Bioretention - Construction



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# Bioretention - Construction

- General
  - Adhere to construction schedule
  - Keep sediment away!
  - Refer to applicable notes/details
  - Construct during good weather
  - Scarify subsoil (infiltrating practices)
  - Use non-contaminated materials
  - Plan revisions = O&M Plan revisions
  - As-built drawings
  - Milestone inspections





# Bioretention - Construction

- Avoid compaction



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# Bioretention - Construction

- Account for settling of layers (additional 5% volume)





# Bioretention - Construction

- Keep sediment out!!!



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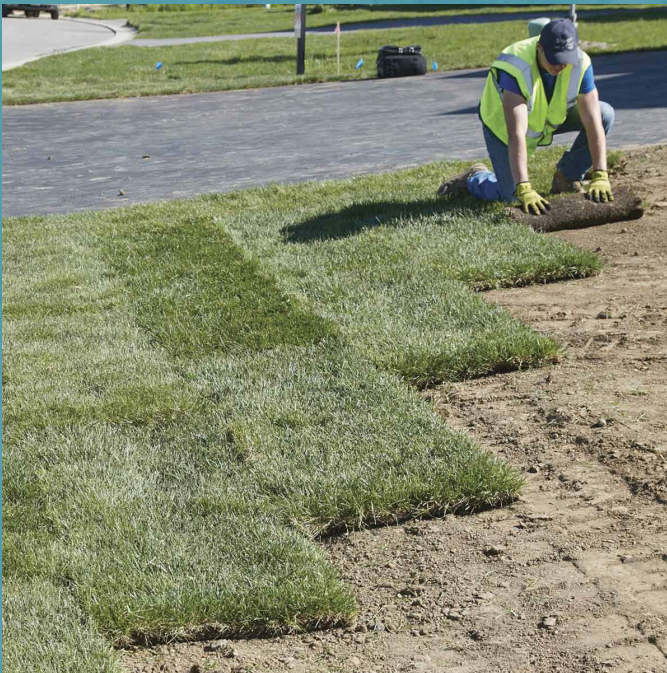


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# Bioretention - Construction

- Pre-treatment grass filter strips...sod in place of seed & mulch



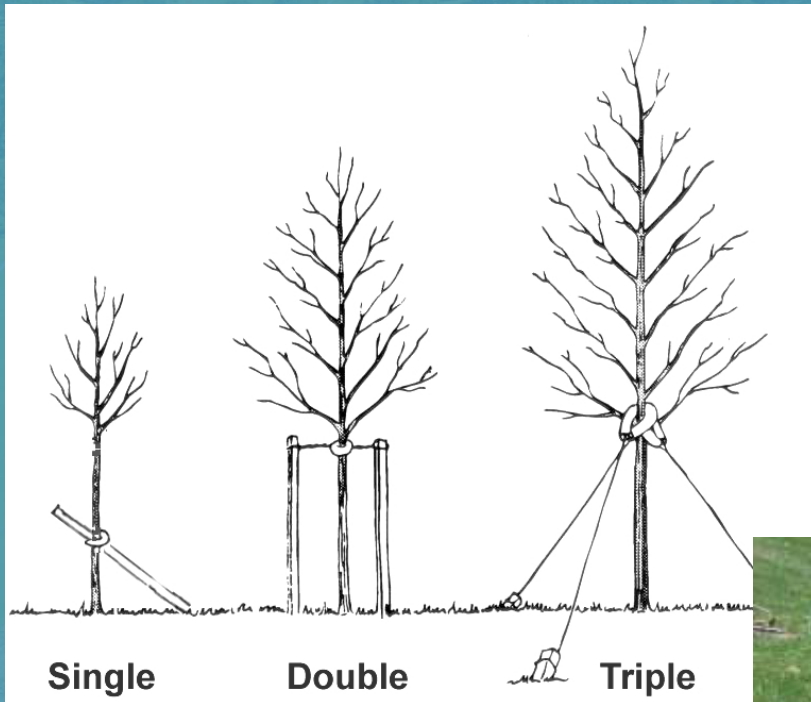
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# Bioretention - Construction



- Properly stake taller plants



# Bioretention - Maintenance



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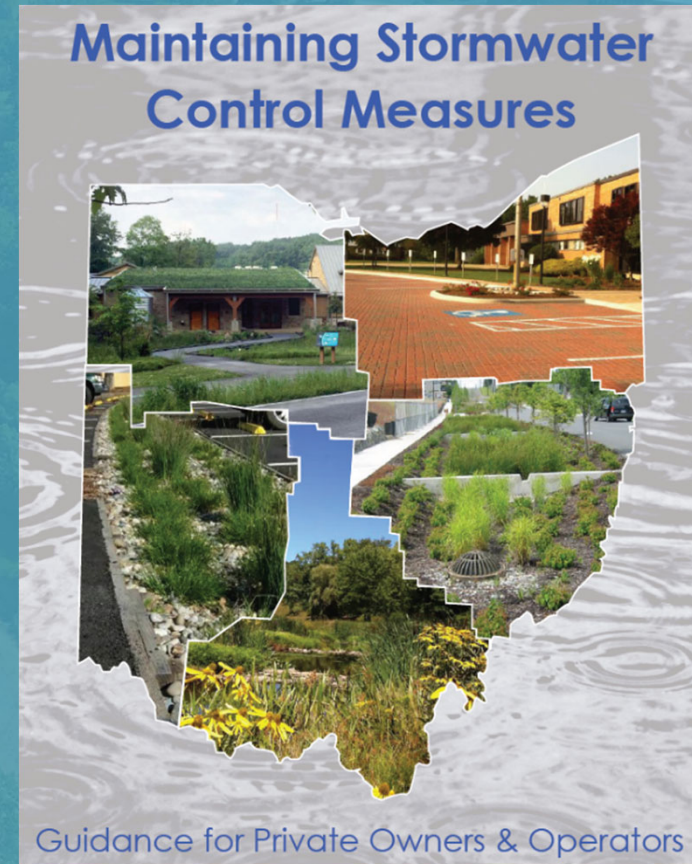


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# Bioretention - Maintenance

- General
  - All SCMs will require maintenance
  - First year need\$ vs. long-term need\$



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# Bioretention - Maintenance

Bioretention Area Inspection and Maintenance Checklist

Facility:			
Location/Address:			
Date:	Time:	Weather Conditions:	Title: Date of Last Inspection:
Inspector:			
Rain in Last 48 Hours <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, list amount and timing:			
Pretreatment: <input type="checkbox"/> vegetated filter strip <input type="checkbox"/> swale <input type="checkbox"/> turf grass <input type="checkbox"/> forebay <input type="checkbox"/> other, specify: <input type="checkbox"/> none			
Site Plan or As-Built Plan Available: <input type="checkbox"/> Yes <input type="checkbox"/> No			

Inspection Item	Comment	Action Needed
<b>1. PRETREATMENT</b>		
Sediment has accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Trash and debris have accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>2. DEWATERING</b>		
Standing water is present after 24 hours. If yes, describe sheen, color, or smell.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>3. INLETS</b>		
Inlets are in poor structural condition.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sediment has accumulated and/or is blocking the inlets.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Erosion is occurring around the inlets.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>3. VEGETATION</b>		
Vegetation is wilting, discolored, or dying due to disease or stress.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Vegetation needs to be controlled through mowing or manual removal.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>4. BIORETENTION MAIN INFILTRATION AREA</b>		
Trash and debris have accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sediment has accumulated at the surface.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Topmost layer is caked or crusted over with sediment.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Erosion is evident.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Mulch is compacted.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sinkholes or animal borrows are present.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>5. SIDE SLOPES AND EMBANKMENT</b>		
Erosion is evident.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sinkholes or instability is evident.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>6. OUTLETS AND OVERFLOW STRUCTURE (i.e., catch basin)</b>		
Outlets or overflow structures in poor structural condition.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sediment, trash or debris is blocking the outlets or overflow structure.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Erosion is occurring around the outlets or overflow structure.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Height from surface of practice to top of overflow structure is insufficient to allow for ponding during rain events.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No

Additional Notes:

Wet weather inspection needed ☐ Yes ☐ No

Site Sketch:



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# Bioretention - Maintenance

- Pre-treatment
  - Remove accumulated sediments
- De-watering
  - Ensure it drains



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# Bioretention - Maintenance

- Inlets
  - Are they stabilized?
- Vegetative health
  - Watering & weeding
  - Trimming/pruning
  - Thinning
  - Winterizing



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# Bioretention - Maintenance

- Infiltration bed



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# Bioretention - Maintenance

- Outlet & Overflow





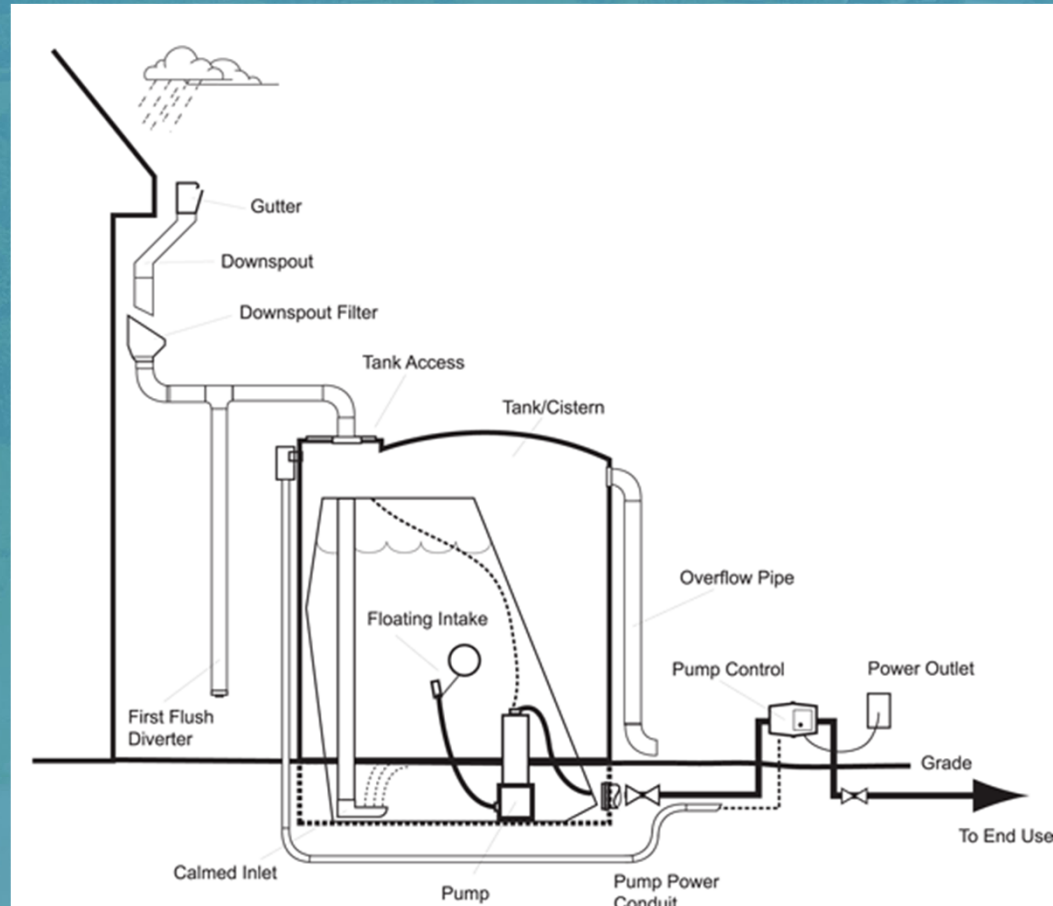


Operation & Maintenance

# CISTERN (RAINWATER HARVESTING)



# Cistern



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# Cistern

- Water distribution
  - Can be used for on-site irrigation or domestic use
  - Controlled through automation or passively
  - Must have an overflow for large storms



# Cistern - Design



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# Cistern - Design

- General
  - Accepted standards
  - Accessibility
  - Schedule
  - Simplify inspections
  - Applicable notes & details
  - Flood routing
  - Material specifications



# Cistern - Design

- Design assumptions made:
  - Catchment area – dictates type of pre-treatment needed
  - Drainage area – sized according to drainage area and volume needed
  - Proper base is provided
  - Outlet (overflow) is appropriate
  - Setbacks are adhered to (property line and building)





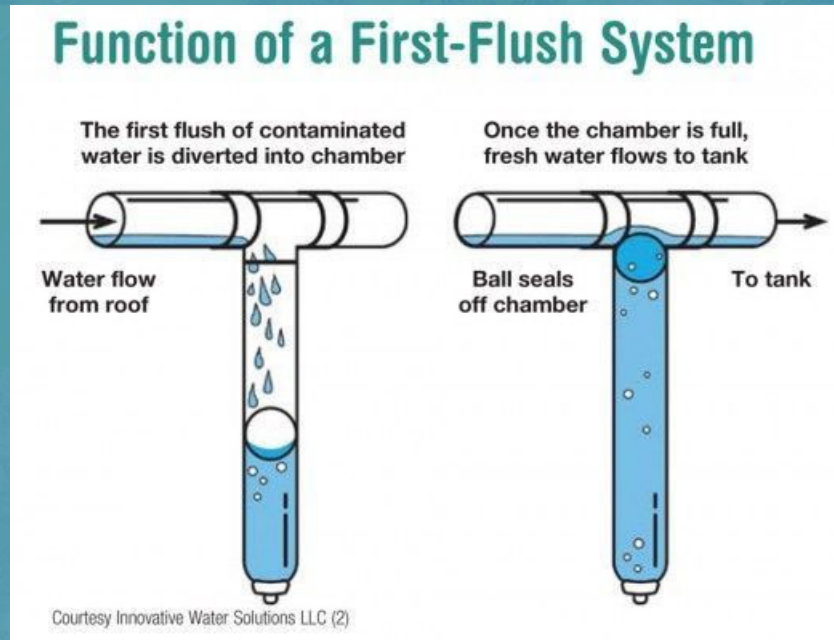
# Cistern - Design

- Design assumptions cont'd:
  - Quality – life expectancy and durability (local seasonal conditions were considered)
  - Adhere to applicable plumbing codes
  - Sunlight exposure minimized (above ground)
  - System is flushable
  - Tank is accessible



# Cistern - Design

- Pre-treatment





# Cistern - Design

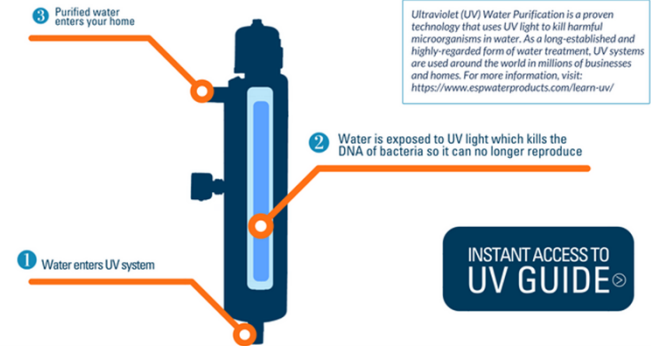
- General treatment of water

Filter



## HOW DOES UV WORK?

The ULTRAVIOLET WATER PURIFICATION PROCESS



Ultraviolet Light



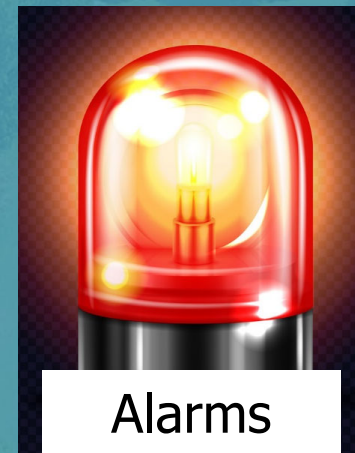
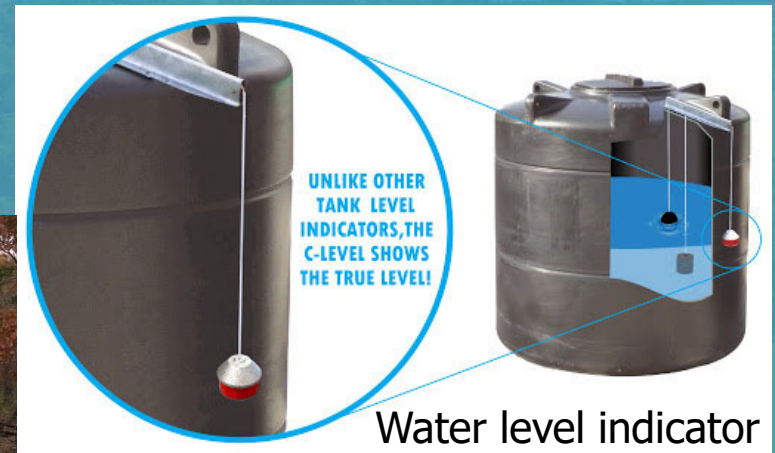
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# Cistern - Design

- Design features





# Cistern - Construction



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# Cistern - Construction

- General
  - Adhere to construction schedule
  - Keep sediment away!
  - Refer to applicable notes/details
  - Plan revisions = O&M Plan revisions
  - As-built drawings
  - Milestone inspections





# Cistern - Construction

- Testing water tightness, mechanical components and alarms



# Cistern - Maintenance



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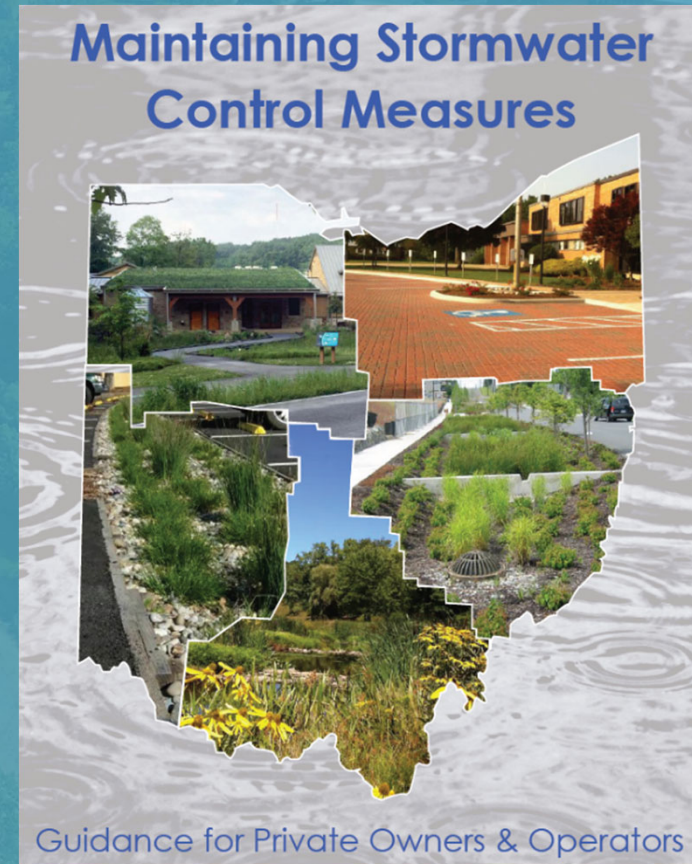


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# Cistern - Maintenance

- General
  - All SCMs will require maintenance
  - First year need\$ vs. long-term need\$



# Cistern - Maintenance

Rain Barrel/Cistern Inspection and Maintenance Checklist

Facility:			
Location/Address:			
Date:	Time:	Weather Conditions:	Date of Last Inspection:
Inspector:			
Rain in Last 48 Hours: <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, list amount and timing:			
Pretreatment: <input type="checkbox"/> downspout screen <input type="checkbox"/> gutter guards <input type="checkbox"/> rain barrel filter/screen <input type="checkbox"/> other, specify:			
Site Plan or As-Built Plan Available: <input type="checkbox"/> Yes <input type="checkbox"/> No			

Inspection Item	Comment	Action Needed
<b>1. PRETREATMENT</b>		
Sediment and debris have accumulated in gutter.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
The screen or trap is clogged or not attached.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>2. FOUNDATION</b>		
Barrel foundation is unstable.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>3. INLETS/DOWNSPOUTS</b>		
Gutters and downspouts joints are disconnected and/or leaks are present.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Downspouts are disconnected to barrel and/or leaks are present.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Diverter is disconnected and/or leaks are present.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>3. SPIGOT</b>		
Visible leaks are present and connections are not tight.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Valves and knobs do not turn.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>4. RAIN BARREL/CISTERN</b>		
Sediment accumulated at bottom of barrel.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Odor of mildew present or algae is visible inside the barrel.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Cracks or leaks are visible in barrel.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Mosquito larva is visible in barrel.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>5. OVERFLOW STRUCTURE</b>		
Overflow is directed away from the structure or disconnected from the downspout.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Other:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Special Notes: An untrained individual should never enter a cistern. Never drink water from a rain barrel or a cistern. Always follow the manufacturer's manual and recommended maintenance schedule.		
Additional Notes:		
Wet weather inspection needed <input type="checkbox"/> Yes <input type="checkbox"/> No		

Site Sketch:



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# Cistern - Maintenance

- Tank stability
- Check for leaks (pipes, hoses, valves)



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# Cistern - Maintenance

- Test mechanicals
- Water sampling



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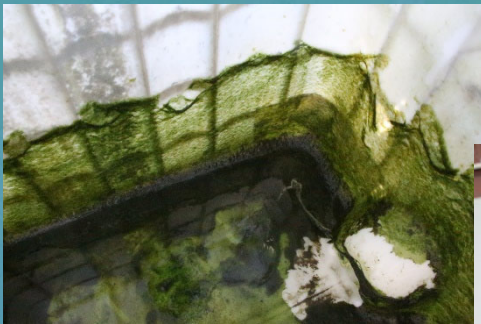


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# Cistern - Maintenance

- Flush & sanitize entire system (confined space entry)



- Winterization





A photograph of a building facade covered in a dense green wall of various plants, including ferns and small shrubs. The plants are arranged in a grid-like pattern, creating a lush, textured surface. Several windows are visible, some with dark frames. In the foreground, there is a wooden planter box with a diagonal slat design, filled with greenery. The planter box is on wheels and sits on a concrete sidewalk. A street lamp is visible on the right side of the building. The sky is overcast.

Operation & Maintenance

# GREEN WALL



# Green Wall - Design

- Vertical structures that have different types of plants or other greenery attached to them.
- Growth medium consisting of soil, stone, or water
- Built-in irrigation systems.



# Green Wall - Design



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# Green Wall - Design

- General
  - Use accepted standards
  - Ensure accessibility
  - Prepare logical schedule
  - Keep inspection & maintenance in mind
  - Include applicable notes & details
  - Provide for flood routing
  - Provide material specifications
  - Refer to Cistern slides – ensure proper conveyance for irrigation



# Green Wall - Construction



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# Green Wall - Construction

- General
  - Adhere to construction schedule
  - Refer to applicable notes/details
  - Construct during good weather
  - Use non-contaminated materials
  - Plan revisions = O&M Plan revisions
  - As-built drawings
  - Milestone inspections
  - Refer to Cistern slides – ensure proper conveyance for irrigation



# Green Wall - Maintenance



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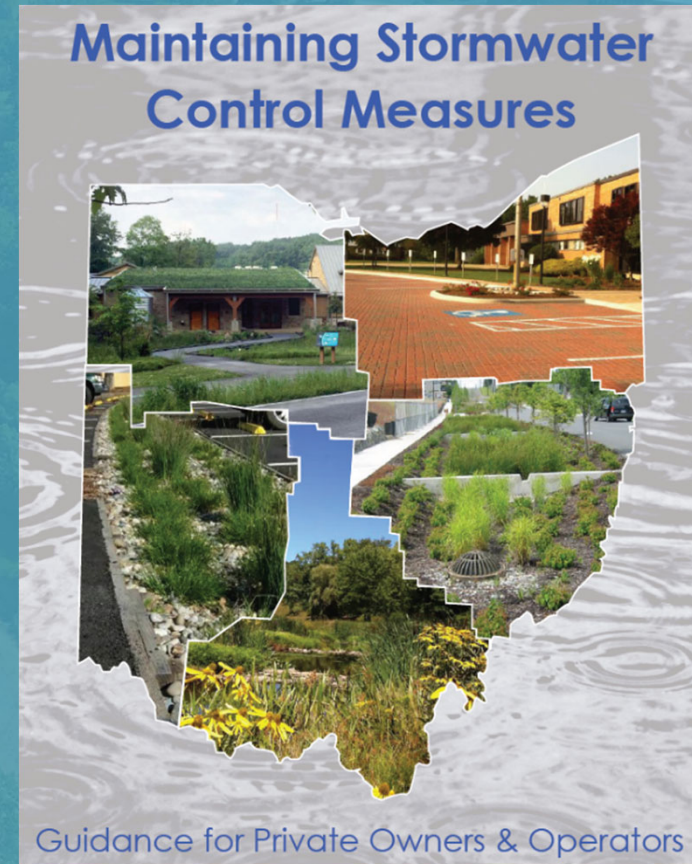


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# Green Wall - Maintenance

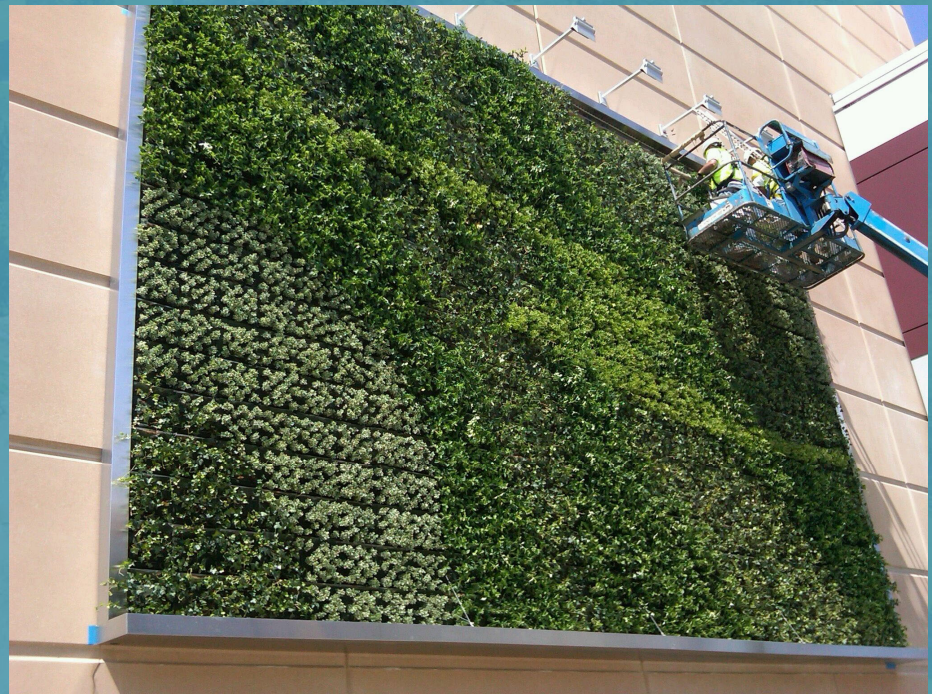
- General
  - All SCMs will require maintenance
  - First year need\$ vs. long-term need\$





# Green Wall - Maintenance

- Refer to Cistern Maintenance
- Accessibility with specialized equipment



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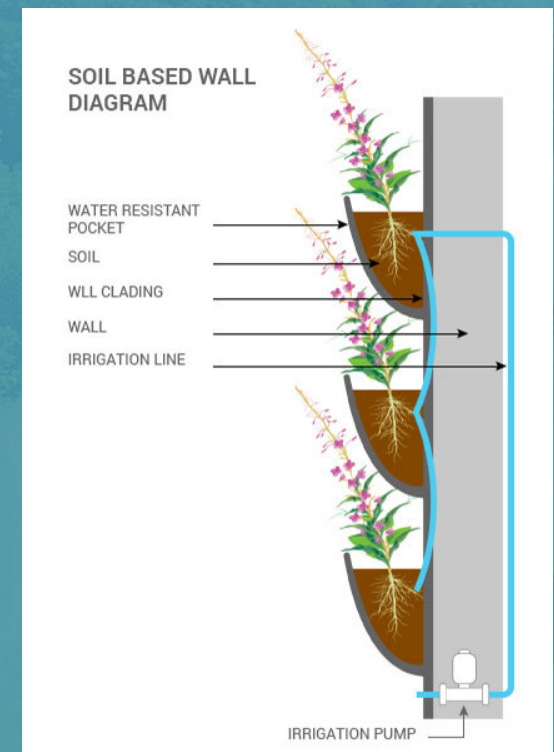
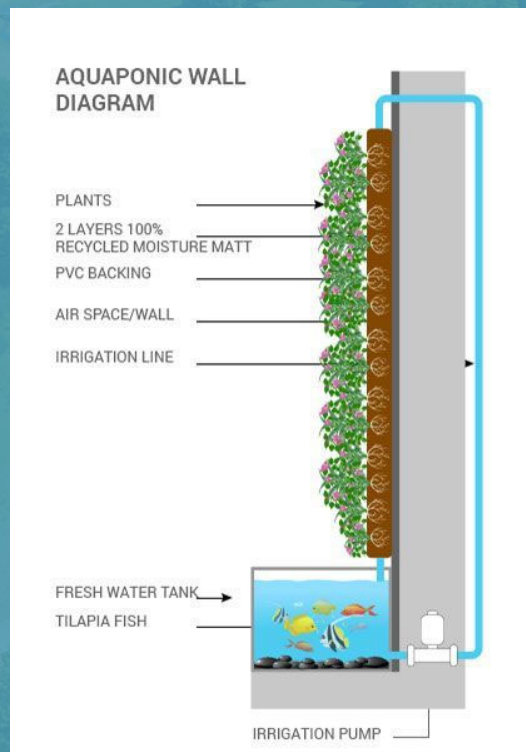


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# Green Wall - Maintenance

- Long-term structural stability



# Green Wall - Maintenance

- Plant health
- Winterization (irrigation system & plants)



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A wide, paved walkway made of interlocking bricks leads towards a brick building with a double door. The bricks are arranged in a pattern of light and dark brown. The building has a dark brown brick facade and a double door with a small arched window above it. To the left, there is a wooden ramp and a blue storage container. The sky is overcast.

Operation & Maintenance

# PERMEABLE PAVEMENT

# Permeable Pavement

- Provide structural support for vehicle, bicycle, and pedestrian traffic
- Allows water to permeate through the pavement surface, aggregate base, and to infiltrate into the subgrade soils
- Receive runoff from adjacent rooftops and/or traditional paved areas





# Permeable Pavement - Design



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# Permeable Pavement - Design

- General
  - Use accepted standards
  - Ensure accessibility
  - Prepare logical schedule
  - Keep inspection & maintenance in mind
  - Include applicable notes & details
  - Provide for flood routing
  - Provide material specifications



# Permeable Pavement - Design

- Design assumptions made:
  - Traffic loading patterns
  - Contributing drainage area's land use impacts (i.e., sediments)
  - Foundation offsets
  - Groundwater issues addressed
  - Flat subgrade provided

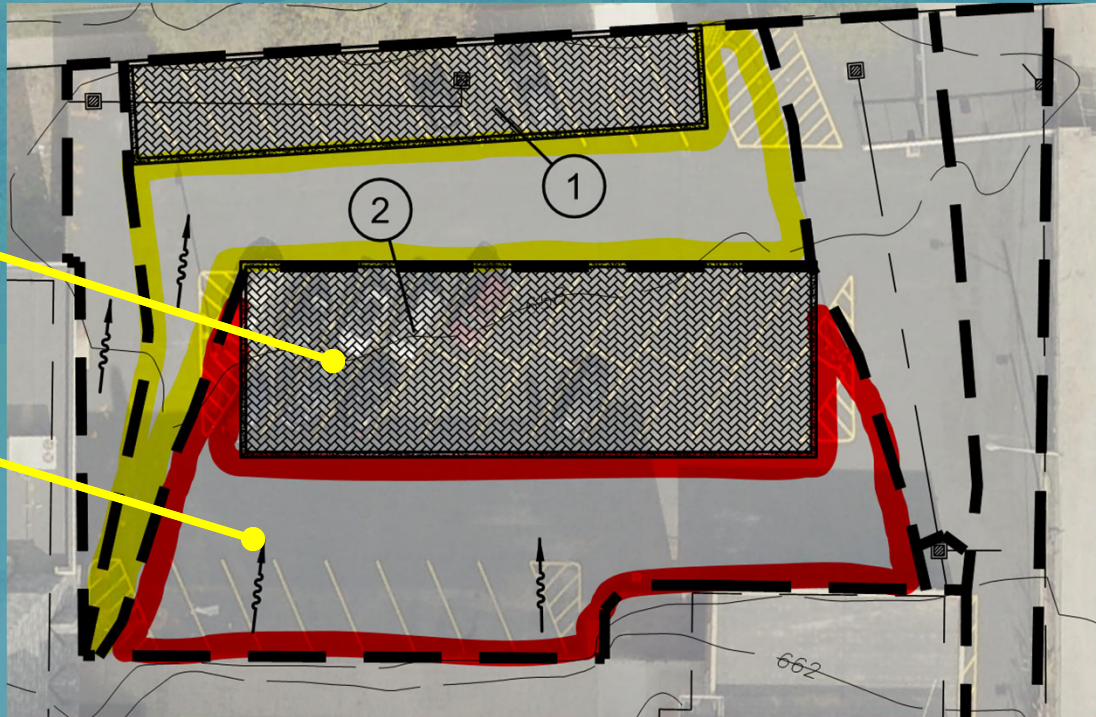
# Permeable Pavement - Design

- Drainage area ratios (max. 2:1, traditional pavement-to-permeable pavement)

Paver field = 5,000 sq.ft

Pavement drainage area  
= 7,500 sq.ft

Ratio of 1.5:1



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# Permeable Pavement - Design

- Underdrains & elbows



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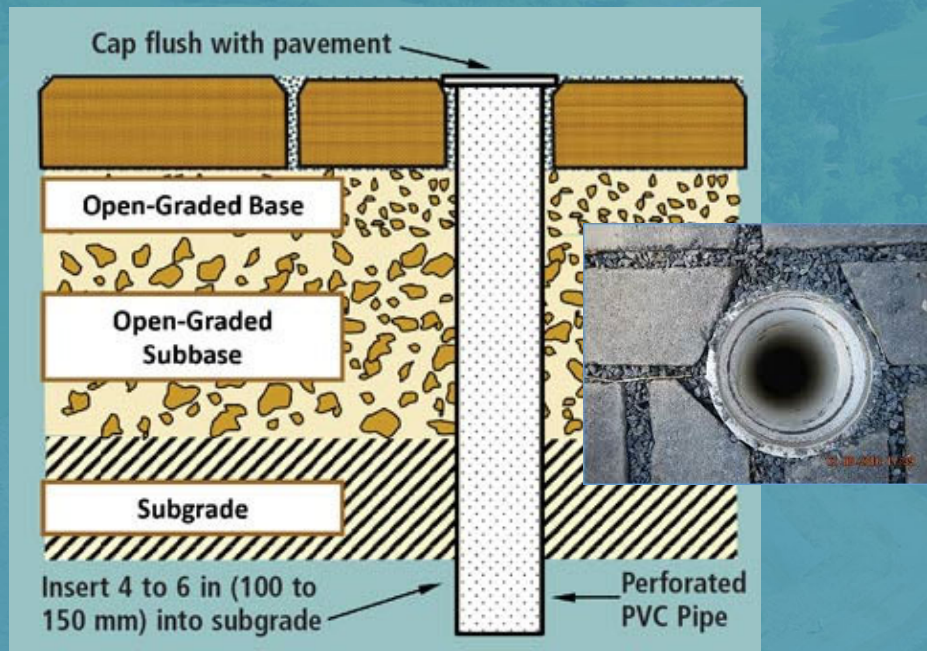


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# Permeable Pavement - Design

- Observation wells
- Edge restraints (curbing)





# Permeable Pavement - Design

- Infiltration testing\*:



\*based on finished compaction



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# Permeable Pavement - Design

- Erosion & sediment control plan



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# Permeable Pavement - Construction



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# Permeable Pavement - Construction

- General
  - Adhere to construction schedule
  - Keep sediment away!
  - Refer to applicable notes/details
  - Construct during good weather
  - Scarify subsoil (infiltrating practices)
  - Use non-contaminated materials
  - Plan revisions = O&M Plan revisions
  - As-built drawings
  - Milestone inspections





# Permeable Pavement - Construction

- Do not work on the subgrade when it is raining
- Remove unintended sediments before backfilling



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# Permeable Pavement - Maintenance



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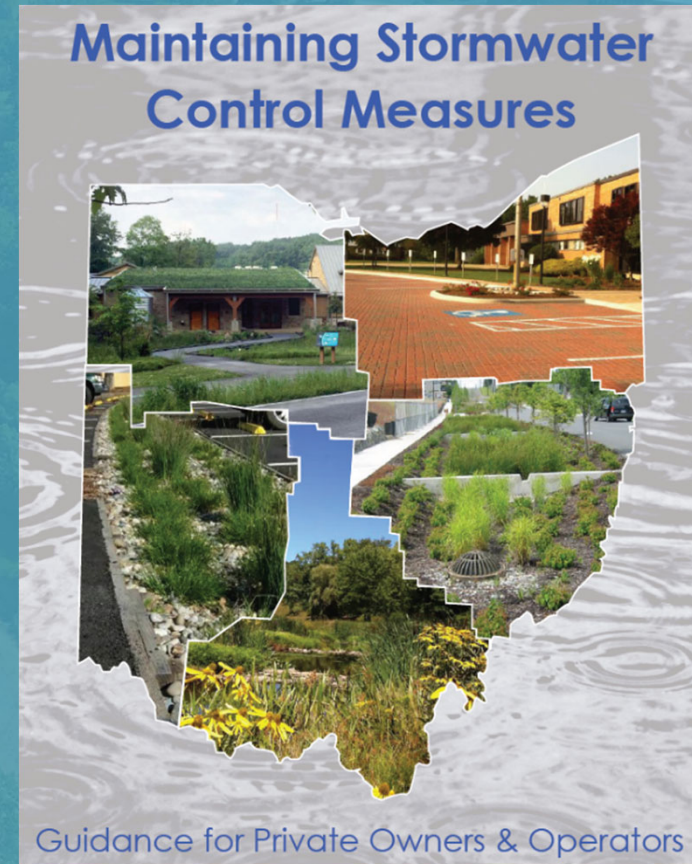


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# Permeable Pavement - Maintenance

- General
  - All SCMs will require maintenance
  - First year need\$ vs. long-term need\$



# Permeable Pavement - Maintenance

Permeable Pavement Inspection and Maintenance Checklist

Facility:			
Location/Address:			
Date:	Time:	Weather Conditions:	Date of Last Inspection:
Inspector:		Title:	
Rain in Last 48 Hours <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, list amount and timing:			
Pavement Type: <input type="checkbox"/> permeable interlocking concrete pavement (PICP) <input type="checkbox"/> asphalt <input type="checkbox"/> concrete <input type="checkbox"/> other, specify:			
Pretreatment: <input type="checkbox"/> vegetated filter strip <input type="checkbox"/> swale <input type="checkbox"/> turf/grass <input type="checkbox"/> forebay <input type="checkbox"/> other, specify: <input type="checkbox"/> none			
Site Plan or As-Built Plan Available: <input type="checkbox"/> Yes <input type="checkbox"/> No			

\*Permeable interlocking concrete pavement (PICP)

Inspection Item		Comment	Action Needed
<b>1. PRETREATMENT</b>			
Sediment has accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
Trash and debris have accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>2. PAVEMENT TRANSITION AREA</b>			
Non-permeable transition area at pavement edges is unstable/deteriorating.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>3. DEWATERING</b>			
Standing water is visible on the surface after a rain event.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>4. PAVEMENT SURFACE AND JOINTS</b>			
Sediment has accumulated on pavement surface.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
Trash and debris have accumulated on pavement surface or around curbing.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
Pavement has deteriorated, cracked, settled, or raveled.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
Sediment has accumulated in the joints of PICP.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
Vegetation is growing in the joints of PICP.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
Gravel is insufficient in the joints of PICP.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A		<input type="checkbox"/> Yes <input type="checkbox"/> No
Additional Notes			

Wet weather inspection needed ☐ Yes ☐ No

Site Sketch



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# Permeable Pavement - Maintenance

- Remove landscaping debris regularly
- Stockpile snow piles downslope



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# Permeable Pavement - Maintenance

- Do not apply any sealants



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# Permeable Pavement - Maintenance

- Vacuum/sweep 2x-4x per year

Regenerative air sweeper



Debris disposal



DIY –  
old  
school

A photograph of a construction site for an underground infiltration/detention system. In the foreground, a large concrete pipe is partially visible. In the middle ground, three large, orange, corrugated pipe sections are laid out in a row, with a worker standing between them. The background shows a building and some construction equipment.

Operation & Maintenance

# UNDERGROUND INFILTRATION/ DETENTION SYSTEMS





# Underground Systems

- Saves valuable space - area above remains available for traditional uses (parking, roads, active recreation, etc.)
- Allows water to infiltrate into the subgrade soils
- Receive runoff from adjacent rooftops and/or traditional paved areas



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# Underground Systems - Design



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# Underground Systems - Design

- General
  - Use accepted standards
  - Ensure accessibility
  - Prepare logical schedule
  - Keep inspection & maintenance in mind
  - Include applicable notes & details
  - Provide for flood routing
  - Provide material specifications



# Underground Systems - Design

- Design assumptions made:
  - Traffic loading patterns
  - Foundation offsets
  - Groundwater issues addressed
  - Flat subgrade provided



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# Underground Systems - Design

- Pre-treatment options (80% TSS removal)



**AQUA-FILTER™**

**Installation Benefits**

- Installs easily without the use of a crane, resulting in measurable project cost savings
- H2O loading capabilities:
  - Inlet/outlet stub-out connections
  - Lightweight and durable construction
  - Lifting supports & cables provided

**Inspection & Maintenance**

- AquaShield™ offers an extensive maintenance program that will keep the system at peak performance
- Download manuals from the on-line system catalog

**Aqua-Filter™ System**      **Filter Media**      **Sediment Storage**



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# Underground Systems - Design

- Observation & accessibility ports



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# Underground Systems - Construction



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# Underground Systems - Construction

- General
  - Adhere to construction schedule
  - Keep sediment away!
  - Refer to applicable notes/details
  - Construct during good weather
  - Scarify subsoil (infiltrating practices)
  - Use non-contaminated materials
  - Plan revisions = O&M Plan revisions
  - As-built drawings
  - Milestone inspections





# Underground Systems - Construction

- Do not work on the subgrade when it is raining
- Remove unintended sediments before backfilling



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# Underground Systems - Maintenance



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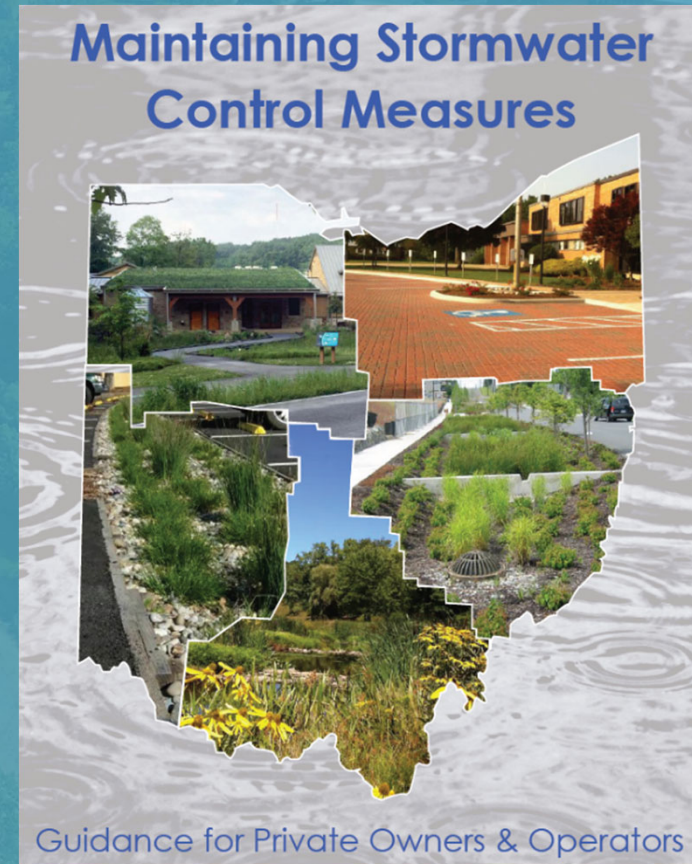


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# Underground Systems - Maintenance

- General
  - All SCMs will require maintenance
  - First year need\$ vs. long-term need\$



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# Underground Systems - Maintenance

## Underground Detention System Inspection and Maintenance Checklist

Facility:			
Location/Address:			
Date:	Time:	Weather Conditions:	Date of Last Inspection:
Inspector:		Title:	
Rain in Last 48 Hours: <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, list amount and timing:			
Pretreatment: <input type="checkbox"/> vegetated filter strip <input type="checkbox"/> swale <input type="checkbox"/> turf grass <input type="checkbox"/> forebay <input type="checkbox"/> other, specify: <input type="checkbox"/> none			
Site Plan or As-Built Plan Available: <input type="checkbox"/> Yes <input type="checkbox"/> No			

\*Do not enter underground detention chambers to inspect system unless Occupational Safety & Health Administration (OSHA) regulations for confined space entry are followed.  
 \*Follow inspection and maintenance instructions and schedules provided by system manufacturer and installer.  
 \*Properly dispose of all wastes.

Inspection Item	Comment	Action Needed
<b>1. PRETREATMENT</b>		
Sediment has accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Trash and debris have accumulated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>2. INLETS</b>		
Inlets are in poor structural condition.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sediment, trash, or debris have accumulated and/or is blocking the inlets.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>3. CHAMBERS</b>		
Sediment accumulation threshold has been reached.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Trash and debris have accumulated in chambers.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>4. OTHER SYSTEM COMPONENTS</b>		
Structural deterioration is evident.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>5. OUTLETS</b>		
Outlets in poor structural condition.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Sediment, trash or debris are blocking outlets.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Erosion is occurring around outlets.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
<b>6. OTHER</b>		
Evidence of ponding water on area draining to system.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Evidence that water is not being conveyed through the system.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="checkbox"/> Yes <input type="checkbox"/> No
Additional Notes		
Wet weather inspection needed <input type="checkbox"/> Yes <input type="checkbox"/> No		

Site Sketch:



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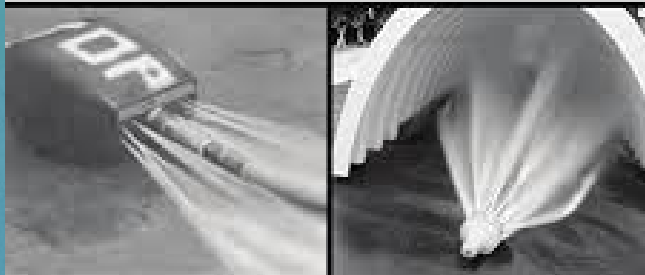


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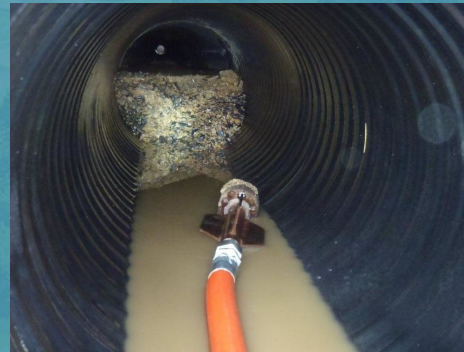


# Underground Systems - Maintenance

- Specialized equipment to remove accumulated sediments



Culvert cleaning nozzle



Debris disposal



Vac truck

# Conclusion

- Maintenance Considerations
  - Design Phase
  - Construction Phase
  - Long-Term



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# Conclusion

- Additional Resources
  - Cistern Video:
    - <https://youtube/ORzczMLq5to>
  - Underground Infiltration/  
Detention Video:
    - <https://www.youtube.com/watch?v=Upn5aPEESGA>



# Thank You

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<https://www.neorsd.org/stormwater-2/>



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