Advancing Green Infrastructure in Coastal Georgia through Photo-Based O&M Tools

Robert A. Brown, Ph.D., P. E.
Goodwyn Mills Cawood

Jessica T. R. Brown, P. E.
University of Georgia

Kelly Hill
Georgia DNR, Coastal Resources Division

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Marine Extension and Georgia Sea Grant
UNIVERSITY OF GEORGIA
Sea Grant

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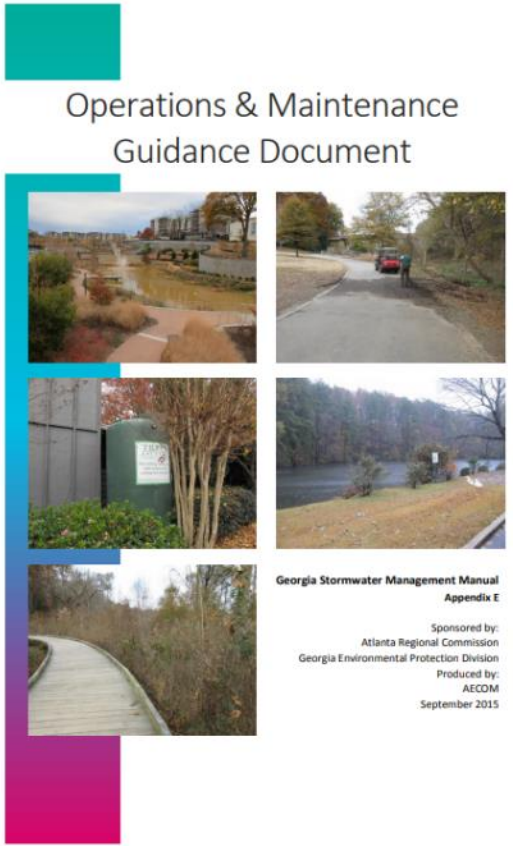
The Need:

Permit Requirement;
Available Resources; &
Ongoing Efforts

GEORGIA NPDES MS4 PERMIT:
GI/LID INSPECTION & MAINTENANCE BMP

MS4 Permit Type	Current Permit	Upcoming Permit	Notes
Phase I Large	3.3.11	t.b.d.	
Phase I Medium	3.3.11	3.3.11	Added more details on Maintenance
Phase II	4.2.5; BMP #7	4.2.5; BMPs #7 & #8	Inspection & Maintenance separated

GEORGIA STORMWATER MANAGEMENT MANUAL, APPENDIX E – "O&M GUIDANCE DOCUMENT"



If the permeable bricks/blocks are not draining properly, check for clogging between the bricks or blocks or at the upper layer of the aggregate, directly below the bricks/blocks. If clogging occurs, then the stones between the blocks/bricks should be replaced. In addition, the top layer of soil under the bricks/blocks may also need to be cleaned and replaced. Some areas of the blocks/bricks may need additional maintenance due to potential sources of clogging which include unstable soil upstream of the practice, leaves from trees, low points in blocks/bricks, trash, and debris from vehicle traffic. Another reason for the bricks/blocks not draining properly is settling. If major settling occurs, then the bricks/blocks should be removed, cleaned, and replaced.

Permeable bricks/blocks may also include an underdrain. If the practice includes an underdrain, additional maintenance will be required. Periodic testing will need to be done on the system to make sure that the underdrain is not clogged. This is done by pouring water into cleanout and observing how the water exits the practice. The observation well should be checked to make sure water is draining out of the practice.

The table below shows a schedule for when different maintenance activities should be performed on the permeable bricks/blocks.

Permeable Bricks/Blocks Typical Routine Maintenance Activities and Schedule

Activity	Schedule
• Keep the permeable bricks/blocks free of trash, debris, and sediment. • Make sure that there is no standing water in the bricks/blocks between storms. • Remove weeds and grass growing between the bricks/blocks (unless concrete grid pavers are being used). • Mow grass within the bricks/blocks (only for concrete grid with grass) • Mow / trim grass or vegetation near the bricks/blocks and remove clippings from area. • Visually inspect the bricks/blocks after large storms to ensure the overflow drainage system is working. • Inspect the bricks/blocks for damage and repair. • Vacuum sweep permeable brick/block surface to keep free of sediment. • After cleaning, additional aggregate may need to be added between the pavers. Replace aggregate between pavers as necessary.	Monthly during warm weather
• Keep the contributing drainage area and surface of the bricks/blocks clear of debris, trash, and sediment. • Ensure that the areas surrounding the practice are stabilized and mowed, remove grass clippings.	As needed, based on inspection

Bioretention Area

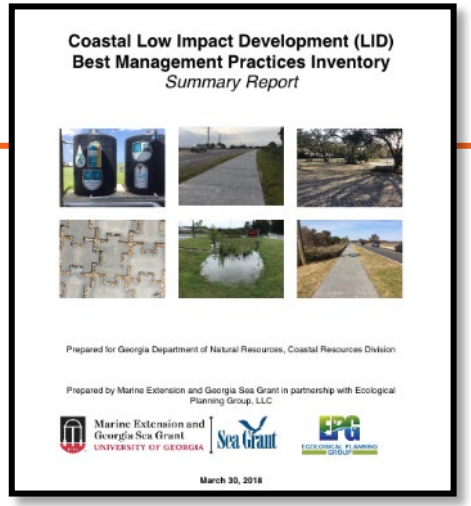
Maintenance Item	Condition				Comment
	Good	Marginal	Poor	N/A*	
General Inspection					
Access to the site is adequately maintained for inspection and maintenance.					
Area is clean (trash, debris, grass clippings, etc. removed).					
Inlet Structure					
Drainage ways (overland flow or pipes) to the practice are free of trash, debris, large branches, etc.					
Area around the inlet structure is mowed and grass clippings are removed.					
No evidence of gullies, rills, or excessive erosion around the inlet structure.					
Water is going through structure (i.e. no evidence of water going around the structure).					
Diversion structure (high flow bypass structure or other) is free of trash, debris, or sediment. Comment on overall condition of diversion structure and list type.					
Pretreatment (choose one)					
Forebay – area is free of trash, debris, and sediment.					
Weir – area is free of trash, debris, and sediment is less than 25% of the total depth of the weir.					
Filter Strip or Grass Channels – area is free of trash debris and sediment. Area has been mowed and grass clippings are removed. No evidence of erosion.					
Rock Lined Plunge Pools – area is free of trash debris and sediment. Rock thickness in pool is adequate.					
Main Treatment					
Main treatment area is free of trash, debris, and sediment.					
Erosion protection is present on site (i.e. turf reinforcement mats). Comment on types of erosion protection and evaluate condition.					

Bioretention Area

Maintenance Item	Condition				Comment
	Good	Marginal	Poor	N/A*	
No evidence of long-term ponding or standing water in the ponding area of the practice (examples include: stains, odors, mosquito larvae, etc).					
Structure seems to be working properly. No settling around the structure. Comment on overall condition of structure.					
Vegetation within and around practice is maintained per landscaping plan. Grass clippings are removed.					
Mulching depth of 3-4 inches is maintained. Comment on mulch depth.					
Native plants were used in the practice according to the planting plan.					
No evidence of use of fertilizer on plants (fertilizer crusting on the surface of the soil, tips of leaves turning brown or yellow, blackened roots, etc.).					
Plants seem to be healthy and in good condition. Comment on condition of plants.					
Emergency Overflow					
Emergency overflow is free of trash, debris, and sediment.					
No evidence of erosion, scour, or flooding around the structure.					
Outlet Structure					
Outlet structure is free of trash, debris, and sediment.					
No evidence of erosion, scour, or flooding around the structure.					
Results					
Overall condition of Bioretention Area:					
Additional Comments					

Notes: *If a specific maintenance item was not checked, please check N/A and explain why in the appropriate comment box.

COASTAL LID INVENTORY PROJECT



- **2016-17 Inventory**
  - **220 GI/LID practices; 89.3M gallons** of stormwater/yr
  - 62% Permeable Pavement (n=137), 20% Bioretention (n=43)
  - Perceived Effectiveness -
    3 out of 4 sites <25% surface area clogging

- **2021-22 Inventory**
  - **66+ practices,** on-going assessments (NCE 9/2022)
  - **Reevaluated 146 locations** Dec 2021
  - Pilot construction and maintenance cost study

https://gacoast.uga.edu/stormwater-management/,
select LID Inventory dropdown

FOCUS GROUP HIGHLIGHTS ON THE CSS & COASTAL NPS MANAGEMENT

Inventory: 15% located on municipally-owned properties

<u>Training recommendations</u>

- Design/siting
- Construction
- **Post Construction Inspection and Maintenance**

"target inspectors completing regular inspections and public works employees and contractors conducting maintenance."

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The Solution: Section 319(h) Grant Project

This project was financed through a grant from the U.S. Environmental Protection Agency under the Provisions of Section 319(h) of the Federal Water Pollution Control Act and managed via the Georgia Nonpoint Source Program.

PROJECT OVERVIEW:
GA EPD 319(h) GRANT

- Key Deliverables:
  - –Photo-based O&M/Inspection Guides (factsheets and checklists) for:
    (1) permeable pavement, (2) bioretention, and (3) bioswales
  - –Video clips & photo-documentation (before/during/after) of maintenance activities for permeable pavement & bioretention

- Project Team:
  - –Grantee: UGA Marine Extension & Georgia Sea Grant
    - Jessica Brown, Stormwater Specialist for UGA – Grant PI / Technical
    - Communications & Design Team for factsheet/digital tools preparation
  - –Subcontractor: **GMC**, GI/LID technical resource for tool development
  - –IMPFG (Insp. & Maint. Prof. Focus Group) & Technical Review Team

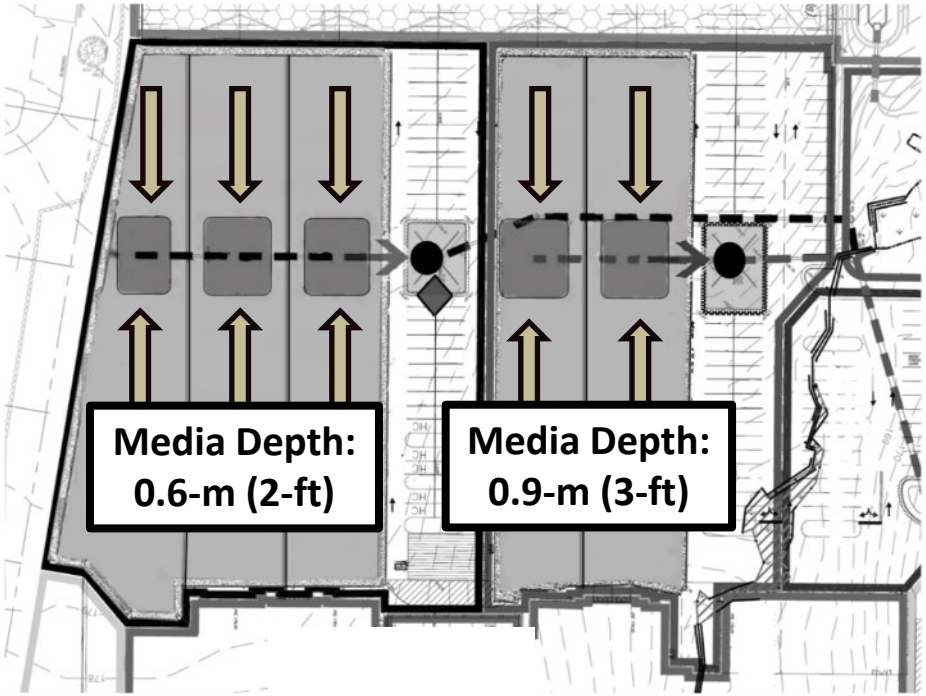
FOCUS GROUPS & REVIEW COMMITTEE

- Inspection & Maintenance Professionals Focus Group (IMPFG):
  - –50+ individuals representing municipal stormwater, engineering and public works & private industry
  - –Feedback on needs and tools that would be most effective

- Technical Review Committee
  - –One state agency representative & one local municipality
  - –Review of Tools

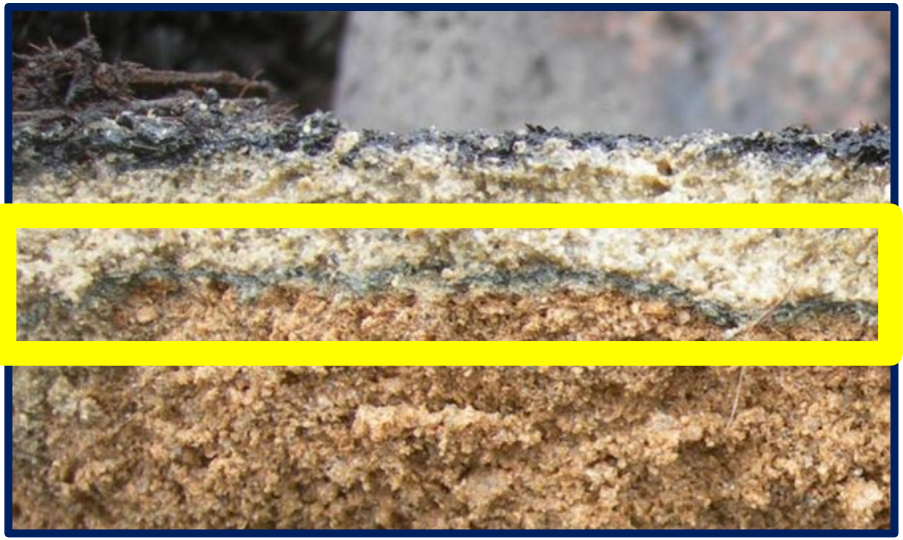
Background:
Importance of O&M for Green Infrastructure

OVERSIGHT AND INSPECTIONS ARE CRITICAL (*Ph.D. RESEARCH AT N.C. STATE UNIVERSITY*)



SEDIMENTATION REDUCED INFILTRATION RATE (CONSTRUCTION SEQUENCING ISSUE)

- Investigation showed that granite fines from crusher run base migrated through fabric



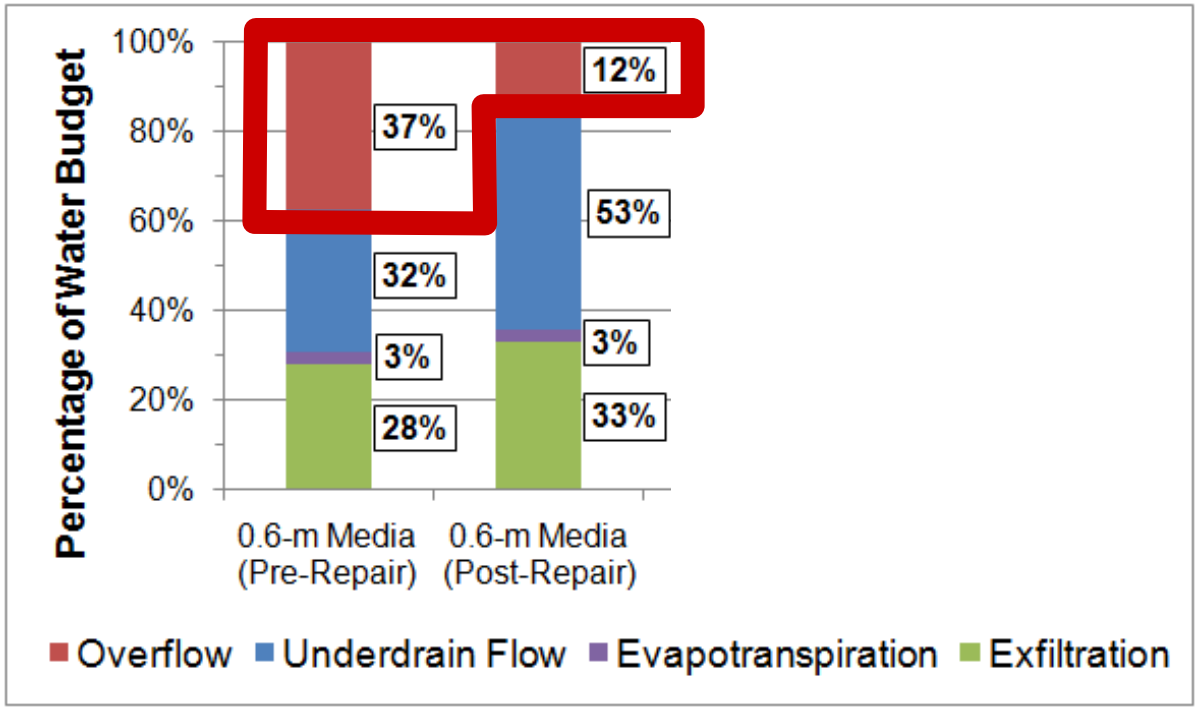
MONITOR … MAINTAIN … MONITOR

- Removed fines layer within the top 2-4 inches
  - –Infiltration rate increased by a factor of 10
  - –No media was replaced because system was already undersized
  - –Surface ponding volume doubled

Monitoring Period	Pre-Repair	Post-Repair
Dates	3/31/08–3/11/09	3/12/09–3/24/10
Number of Events	**64**	**76**
Events > 1 inch	**11**	**14**
Events with Overflow *(% surface storage vs. required)*:		
0.6-m Media Depth	**38** *(28% storage)*	**18** *(53% storage)*
0.9-m Media Depth	**35** *(35% storage)*	**18** *(66% storage)*

ANNUAL WATER BALANCE "BEFORE" & "AFTER"

- Restored/"faster" infiltration rates resulted in better hydrologic & WQ performance
- Inspection program important to:
  1. Systems are functioning as intended
  2. Verify construction matches design plans



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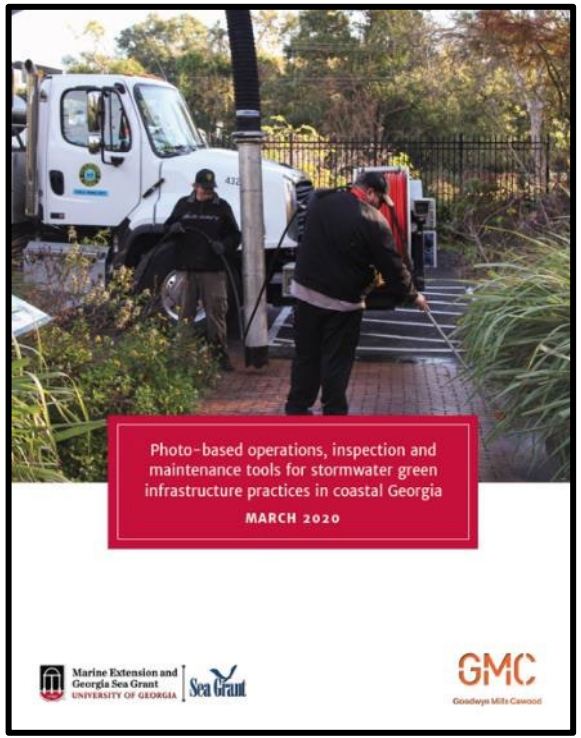
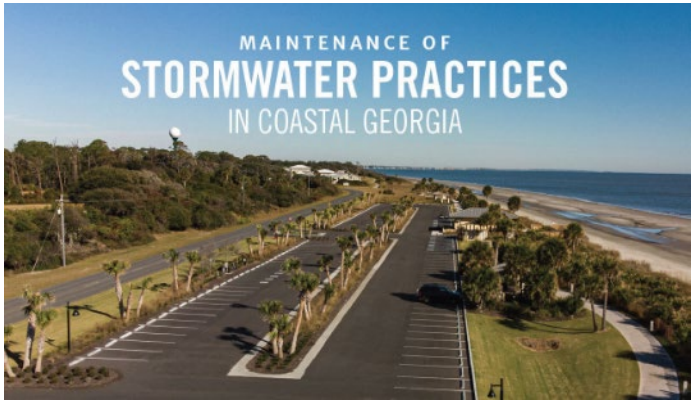
Inspection and Maintenance Guidance & Developed Tools

21% of survey respondents in 2019 study cited "**private landscapers and public works staff**" as "**audience in most need for stormwater training.**"





PERMEABLE PAVEMENT
(PERVIOUS CONCRETE OR POROUS ASPHALT) FACT SHEET

Permeable pavement systems have structural units that incl
void, or open, spaces, allowing stormwater to infiltrate and
treated and stored in an underlying gravel base. The stormw
is then filtered through native soils or is discharged through
underdrain. Permeable pavement systems include, permeabl
pavers (bricks or blocks), along with pervious concrete and p
asphalt. Pervious concrete and porous asphalt are similar in
their mixtures consist primarily of larger aggregate, which c
void spaces within the material. The pervious concrete or po
asphalt is applied over an open-graded gravel base course t
used for structural strength, stability and storage of stormw
It is important that the subgrade not be overly compacted d
placement.

These systems are designed to reduce peak flows and volumes o
stormwater runoff. They are advantageous for groundwater rech
particularly in areas where land values are high, as vehicles can
and park on this stormwater practice. Placement of these systen
where in-situ subsoils have an infiltration rate greater than 0.5
hr. is recommended. When underlying soils have low permeabilit
permeable pavement systems can utilize an underdrain to return
filtered runoff to the conveyance system. Permeable pavement
designed to reduce runoff and improve water quality for average
events (1.2 inches), but they can be designed to handle larger st
events with heavier rain. The ratio of impervious area to porous
surface area should be no greater than 3:1. The ratio of impervio
to pervious concrete surface area should be no greater than 1:1.

POROUS ASPHALT POLLUTANT REMOVAL[1]

80% of suspended solids
50% of phosphorus
50% of nitrogen
60% of metals

PERVIOUS CONCRETE POLLUTANT REMOVAL[1]

80% of suspended solids
50% of phosphorus
65% of nitrogen
60% of metals

As with any type of infrastructure, pervious concrete, porous asphalt and other green infrastructure practices require maintenance to ensure continued functionality. It is important to avoid compaction and clogging of these pavement systems, beginning with construction. Undesirable vegetation, sediment accumulation and debris are common culprits of clogged permeable pavement systems. General inspection and assessment of three critical features can keep the practice operational. Street sweeping can be effective for source control and routine maintenance of the top layer. Surface cleaning is required to remove debris and undesired vegetation that clog the top layer of the permeable pavement system. Locations that are highly trafficked or near overhanging vegetation may need more frequent surface cleaning to maintain higher infiltration rates.

Three Critical Features to Inspect

1 **Drainage Area**
The condition of the drainage area or surrounding landscape that will contribute runoff to the practice is essential to its overall function. Unstable areas that are sources of sediment or drainage ways that have pollutants such as trash, debris, sediment, and grass clippings can hinder the performance of the permeable pavement by clogging the pavement surface or contributing additional nutrient and pollutant loads.

2 **Inlet and Outlet Structures**
If inlet or outlet structures are impeded, this could mean a number of things. Structural damage might be present, there might be evidence of erosion, or runoff may not be flowing over the pavement surface and maintenance is required to restore function.

3 **Pavement Surface**
Physical clues such as accumulation of fine sediment, stains, standing water, as well as cracking or settling of pervious concrete or porous asphalt are evidence of surface clogging, structural damage and subsequent maintenance needs. Pervious concrete raveling (i.e. aggregate becoming loose) and no visible pore space can reduce functionality or become a hazard to the public. This should be inspected regularly and replaced if needed.

Maintenance costs vary based on many factors. The maintenance cost as a percentage of capital cost is estimated at 3-5%; however, more robust local datasets are needed.[2]

1 Georgia Stormwater Management Manual. Atlanta, 2016. 2016 Edition. https://atlantaregional.org/natural-resources/water/georgia-stormwater-management-manual/

2 Clary, J. and Piza, H. (2017). "Cost of Maintaining Green Infrastructure." ASCE. Reston, VA

For more a more detailed inspection checklist reference:

gacoast.uga.edu/stormwater-management

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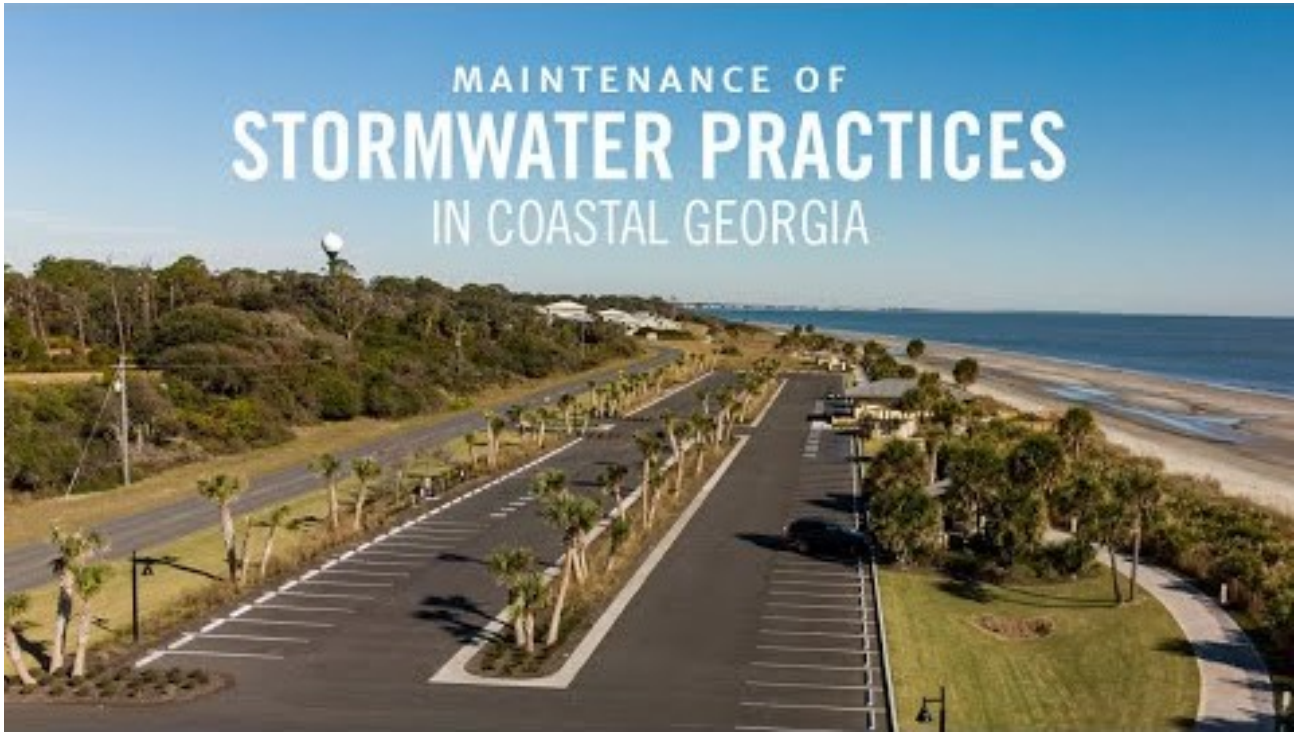
GREEN INFRASTRUCTURE & MAINTENANCE / COASTAL GEORGIA (VIDEO)



Weblink:
https://www.youtube.com/watch?v=GK1Hcx9rwAk

Site ID/Name: _____ Location: _____ Inspector: _____ Date: _____

BIORETENTION

Applies to Bioinfiltration, Bioswales (Dry Enhanced Swales) and Rain Gardens.

GOOD EXAMPLES

GENERAL INSPECTION QUESTIONS

Note: 'Yes' indicates a maintenance need and action

General:

1. Is access to the site inadequately maintained for inspection and maintenance? YES / NO
2. Are grass clippings present in the drainage area or within the system [inlet structure, pretreatment (filter strip and grass channel), main treatment, or outlet/overflow structure]? *(Note: grass clippings should be removed)* YES / NO

Drainage Area: *(pertains to the surrounding landscape that will contribute runoff to the practice)*

3. Is there any exposed or unstable soil that could cause sediment accumulation within the practice? YES / NO
4. Do the drainage ways (overland flow or pipes) to the practice have trash, debris, grass clippings, large branches, etc. present? YES / NO

Inlet Structure / Pretreatment: (Choose One)

A. *Forebay* B. *Weir* C. *Filter Strip / Grass Channels* D. *Rock-Lined Plunge Pools*

5. Does this area have trash, debris, or sediment present? YES / NO
6. Condition of A-D listed above:
   - A/C: Is there any undesirable vegetation or unhealthy grass *(bare or dying)*? YES / NO
   - B: Is the sediment more than 25% of the total depth of the weir? YES / NO
   - D: Is the rock thickness in the pool inadequate? YES / NO
7. Is there evidence of runoff short-circuiting (going around) the inlet structure? YES / NO
8. Is there evidence of gullies, rills, or erosion around the inlet or pre-treatment structure? YES / NO
9. Does the area around the inlet structure (including filter strip and grass channels) need to be mowed? YES / NO
10. If a diversion structure (high flow bypass structure or underdrain) is present, is there presence of trash, debris, on sediment? YES / NO

Main Treatment:

11. Is there evidence of long-term ponding or standing water in the practice (more than 48 hours after a rain event)? (e.g., stains, odors, mosquito larvae, etc.) YES / NO
12. Is there any evidence of fertilizer use on plants? (e.g., fertilizer crusting on surface of soil, tips of leaves turning brown or yellow, blackened roots, etc.) YES / NO
13. For practices with internal check dams to allow for surface ponding on a slope, is there erosion present around the side of the check dams? YES / NO
14. Is the mulch depth inadequate or too deep? Note: target depth is 2 to 4 inches YES / NO

Underdrain: (if installed)

15. If cleanouts are included, are caps missing? YES / NO
16. Are cleanout caps in poor condition? (e.g., inadequately sealed or set below maximum ponding depth) YES / NO
17. Are there any signs of the underdrain being clogged or a blockage? YES / NO

Emergency Overflow / Outlet Structure:

18. Do these structures have trash, debris, sediment or structural damage present? YES / NO
19. Is there evidence of erosion, scour, or flooding around the structure? YES / NO

COMMENTS: _____

QUALITATIVE INSPECTION QUESTIONS (GOOD/MARGINAL/POOR)

Note: 'Poor' indicates a maintenance need and action

20. Rate the presence of sediment accumulation in the bioretention surface area.	**GOOD** (<25% of area)	**MARGINAL** (25-50%)	**POOR** (>50%)
21. Rate the presence of debris (e.g., leaves, trash, grass clippings) in the bioretention surface area.	**GOOD** (<25% of area)	**MARGINAL** (25-50%)	**POOR** (>50%)
22. Rate the presence of undesirable vegetation.	**GOOD** (<25% of area)	**MARGINAL** (25-50%)	**POOR** (>50%)
23. Rate the condition of plant health per landscaping plan and site objectives.*	**GOOD** (<25% dying/stressed)	**MARGINAL** (25%-50% dying/stressed)	**POOR** (>50% dying/stressed)
24. Rate the condition of plant density per landscaping plan and site objectives.*	**GOOD** (>50% vegetation coverage)	**MARGINAL** (25%-50% vegetation)	**POOR** (overgrown or <25% vegetation)

** General percentages provided if landscaping plan and site objectives are not available*

EXAMPLES OF POTENTIAL ISSUES:

5 **INLET SEDIMENT**

5 **INLET STRUCTURE DEBRIS & SEDIMENT**

8 **INLET EROSION** (GRASS CHANNEL)

8 **INLET EROSION** (ROCK PLUNGE POOL)

8 **PRETREATMENT EROSION** (FILTER STRIPS), 14 **MULCH** (NONE), & 24 **PLANT DENSITY** (POOR)

8 **PRETREATMENT EROSION** (SLIDE SLOPES) & 22 **UNDESIRABLE VEGETATION** (POOR)

11 **EXCESSIVE PONDING** (CATTAILS & STAINING)

14 **MULCH** (NONE), 18 **OUTLET DEBRIS**, & 22 **UNDESIRABLE VEGETATION** (MARGINAL)

14 **MULCH** (NONE) & 22 **UNDESIRABLE VEGETATION** (POOR)

14 **MULCH** (NONE) & 24 **PLANT DENSITY** (POOR)

14 **MULCH** (<2"), 22 **UNDESIRABLE VEGETATION** (MARGINAL) & 24 **PLANT DENSITY** (MARGINAL)

18 **OUTLET DEBRIS**

19 **OUTLET STRUCTURE EROSION**

23 **PLANT HEALTH** (POOR - EXPOSED ROOTS AND UNSTABLE)

23 **PLANT HEALTH** (GOOD) & 24 **PLANT DENSITY** (POOR - OVERGROWN)

Site ID/Name: _____ Location: _____ Inspector: _____ Date: _____

PERMEABLE PAVEMENT

Permeable Interlocking Concrete Pavement (PICP)





GOOD EXAMPLES

GENERAL INSPECTION QUESTIONS

Note: 'Yes' indicates a maintenance need and action

General:

1. Is access to the site inadequately maintained for inspection and maintenance? YES / NO
2. Is there evidence of runoff short-circuiting (going around) the practice? YES / NO
3. Is there evidence of gullies, rills, or erosion around the practice? YES / NO

Drainage Area: *(pertains to the surrounding landscape that will contribute runoff to the practice)*

4. Does the vegetation around the practice need to be pruned/mowed? Is vegetation unhealthy? (e.g., signs of bare/dead grass) YES / NO
   Note: grass clippings should be removed.
5. Is there any exposed or unstable soil around the practice that could cause sediment accumulation within the practice? YES / NO

Permeable Pavement Surface:

6. Is there evidence of long-term ponding or standing water in the practice? YES / NO
7. Are there signs of the bricks/pavers settling? YES / NO
8. Do the bricks/pavers show signs of cracks, splitting or structural damage? YES / NO
9. Is there aggregate missing between the bricks/pavers? YES / NO

Inlets/Outlets:

10. Do drainage ways (overland flow or pipes) to the practice have trash, debris, large branches, etc. present? YES / NO
11. If cleanouts are included, are caps missing? YES / NO
12. If an underdrain system is included, are there signs of it clogging or a blockage? YES / NO
13. Does the emergency overflow have trash, debris, sediment or structural damage present? YES / NO

Special Scenario (Concrete Grid Pavers with Vegetation):

A. Is the grass in the concrete grid unhealthy? (e.g., dead grass or bare spots) YES / NO
B. Is the grass in the concrete grid unmowed or are grass clippings present? YES / NO

QUALITATIVE INSPECTION QUESTIONS (GOOD/MARGINAL/POOR)

Note: 'Poor' indicates a maintenance need and action

14. Rate the presence of undesirable vegetation. GOOD (<25% OF AREA) MARGINAL (25-50%) POOR (>50%)
15. Rate the presence of sediment accumulation in pore spaces/aggregate between pavers. GOOD (<25% OF AREA) MARGINAL (25-50%) POOR (>50%)
16. Rate the presence of debris (e.g., leaves, trash, grass clippings) on the permeable pavement surface. GOOD (<25% OF AREA) MARGINAL (25-50%) POOR (>50%)

COMMENTS: _____

EXAMPLES OF POTENTIAL ISSUES:

5 UNSTABLE DRAINAGE AREA

5 UNSTABLE DRAINAGE AREA

7 SETTLING & 15 SEDIMENT

7 SETTLING

8 STRUCTURAL

8 STRUCTURAL &
15 SEDIMENT (POOR)

9 AGGREGATE

9 AGGREGATE

14 VEGETATION (POOR)

14 VEGETATION (POOR)

14 VEGETATION (MARGINAL)

15 SEDIMENT (POOR)

15 SEDIMENT (POOR)

16 DEBRIS (POOR)

16 DEBRIS (POOR)

Site ID/Name: _____ Location: _____ Inspector: _____ Date: _____

PERMEABLE PAVEMENT

Pervious Concrete (PC)
(applicable to Porous Asphalt)

GOOD EXAMPLES

GENERAL INSPECTION QUESTIONS

Note: 'Yes' indicates a maintenance need and action

General:

1. Is access to the site inadequately maintained for inspection and maintenance? **YES / NO**
2. Is there evidence of runoff short-circuiting (going around) the practice? **YES / NO**
3. Is there evidence of gullies, rills, or erosion around the practice? **YES / NO**

Drainage Area: *(pertains to the surrounding landscape that will contribute runoff to the practice)*

4. Does the vegetation around the practice need to be pruned/mowed? Is vegetation unhealthy? (e.g., signs of bare/dead grass) **YES / NO**
   Note: grass clippings should be removed.
5. Is there any exposed or unstable soil around the practice that could cause sediment accumulation within the practice? **YES / NO**

Permeable Pavement Surface:

6. Is there evidence of long-term ponding or standing water in the practice? **YES / NO**
7. Are there signs of the pervious concrete settling or cracking? **YES / NO**

Inlets/Outlets:

8. Do drainage ways (overland flow or pipes) to the practice have trash, debris, large branches, etc. present? **YES / NO**
9. If cleanouts are included, are caps missing? **YES / NO**
10. If an underdrain system is included, are there signs of it clogging or a blockage? **YES / NO**
11. Does the emergency overflow have trash, debris, sediment or structural damage present? **YES / NO**

QUALITATIVE INSPECTION QUESTIONS (GOOD/MARGINAL/POOR)

Note: 'Poor' indicates a maintenance need and action

12. Rate the presence of undesirable vegetation.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
13. Rate the presence of sediment accumulation in pore spaces.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
14. Rate the presence of debris (e.g., leaves, trash, grass clippings) on the permeable pavement surface.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
15. Rate the presence of concrete raveling. (e.g., aggregate becoming loose)	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
16. Is there visible smearing of pervious concrete? (e.g., no visible pore space)	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)

COMMENTS: _____

EXAMPLES OF POTENTIAL ISSUES:

5 UNSTABLE DRAINAGE AREA & 13 SEDIMENT (POOR)

5 UNSTABLE DRAINAGE AREA & 14 DEBRIS (MARGINAL)

6 STANDING WATER, 12 VEGETATION (POOR) & 13 SEDIMENT (POOR)

6 PONDING / STANDING WATER

7 CRACKING-STRUCTURAL

7 CRACKING & 15 RAVELING (POOR)

7 CRACKING-STRUCTURAL

13 SEDIMENT (POOR)

13 SEDIMENT (POOR)

14 DEBRIS (MARGINAL)

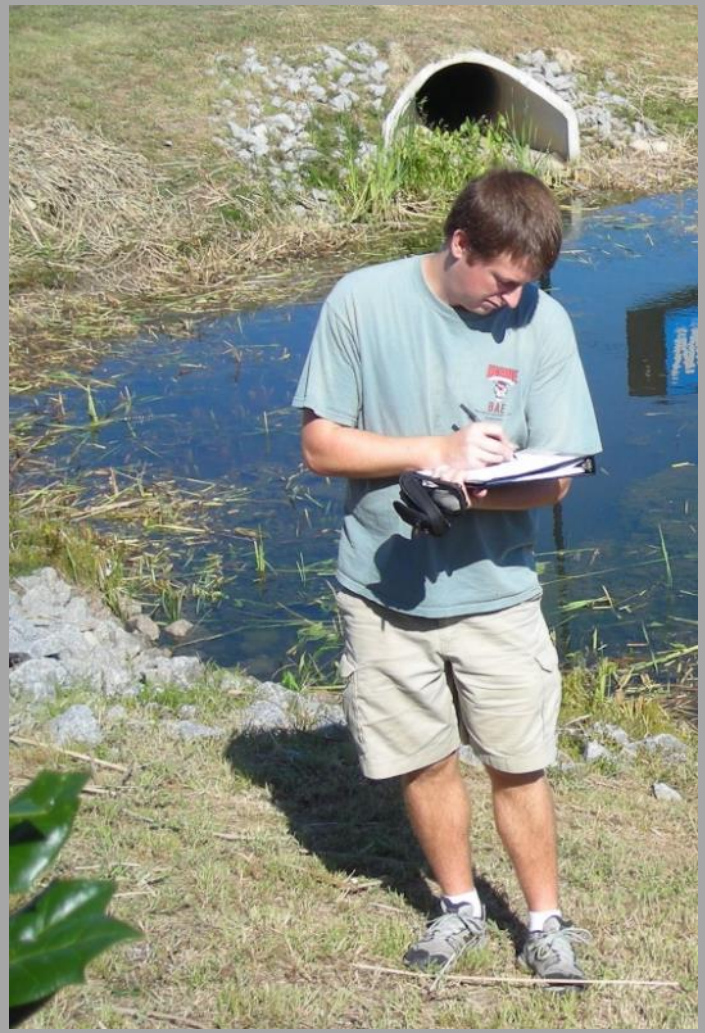
15 RAVELING (POOR)

15 RAVELING (MARGINAL)

16 SMEARING (POOR)

16 SMEARING (POOR)

16 SMEARING (POOR)
(COVERED WITH ASPHALT SEALER)



Inspection Activities & The Checklist

THE BASICS AND WHAT IS “GOOD”

Site Information

Site ID/Name: _____ Location: _____ Inspector: _____ Date: _____

BIORETENTION

Applies to Bioinfiltration, Bioswales (Dry Enhanced Swales) and Rain Gardens.

GOOD EXAMPLES

GENERAL INSPECTION QUESTIONS

Site ID/Name: _____ Location: _____ Inspector: _____ Date: _____

PERMEABLE PAVEMENT

Permeable Interlocking Concrete Pavement (PICP)

GOOD EXAMPLES

GENERAL INSPECTION QUESTIONS

Inlets, Outlets, and Structures

Site ID/Name: _____ Location: _____ Inspector: _____ Date: _____

PERMEABLE PAVEMENT

Pervious Concrete (PC)
(applicable to Porous Asphalt)

GOOD EXAMPLES

INSPECTION ACTIVITIES

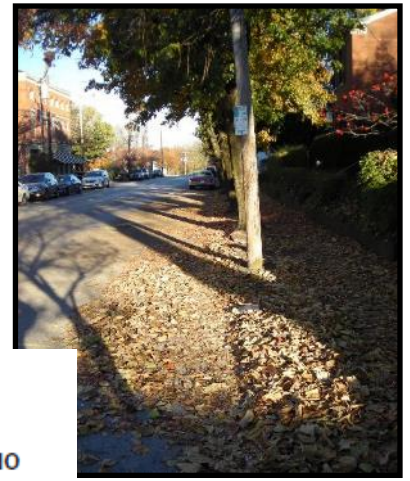
Checklists broken down by element

- –General
- –Drainage area
- –Inlets/Pre-treatment
- –Main Treatment/Surface
- –Outlets/Underdrain
- – Qualitative Features: Sediment, Debris, Vegetation, Structural

If you answer yes, maintenance is needed.

Action is to follow.

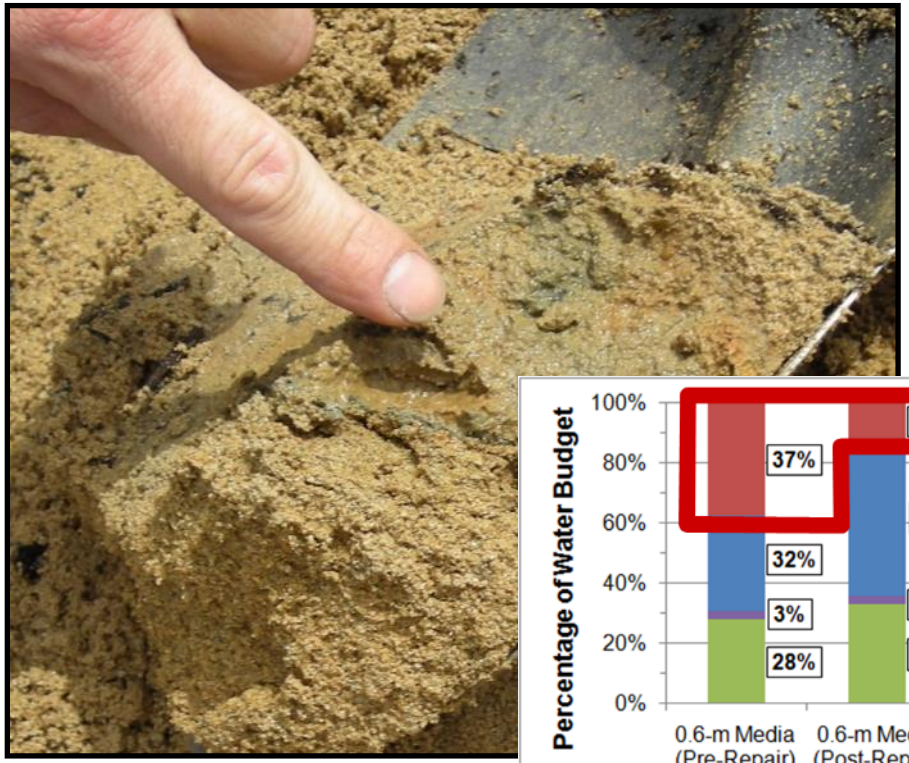
DRAINAGE AREA

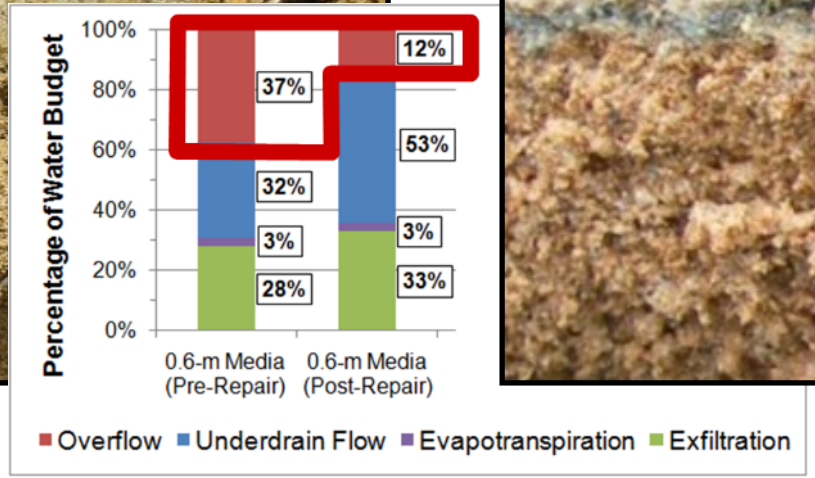


Drainage Area: *(pertains to the surrounding landscape that will contribute runoff to the practice)*

4. Does the vegetation around the practice need to be pruned/mowed? Is vegetation unhealthy? (e.g., signs of bare/dead grass) **YES / NO**
   Note: grass clippings should be removed.
5. Is there any exposed or unstable soil around the practice that could cause sediment accumulation within the practice? **YES / NO**

SEDIMENT FROM DRAINAGE AREA IMPACT: RECALL “SURFACE CLOGGING LAYER”



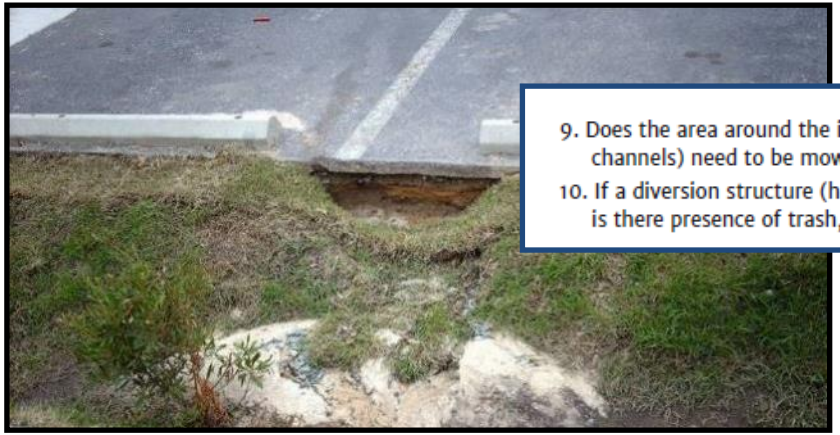


INLET STRUCTURES / PRE-TREATMENT (BIORETENTION) *QUESTIONS 5-10

Inlet Structure / Pretreatment: (Choose One)

A. *Forebay* B. *Weir* C. *Filter Strip / Grass Channels* D. *Rock-Lined Plunge Pools*

5. Does this area have trash, debris, or sediment present? YES / NO
6. Condition of A-D listed above:
   - A/C: Is there any undesirable vegetation or unhealthy grass *(bare or dying)*? YES / NO
   - B: Is the sediment more than 25% of the total depth of the weir? YES / NO
   - D: Is the rock thickness in the pool inadequate? YES / NO
7. Is there evidence of runoff short-circuiting (going around) the inlet structure? YES / NO
8. Is there evidence of gullies, rills, or erosion around the inlet or pre-treatment structure? YES / NO



9. Does the area around the inlet structure (including filter strip and grass channels) need to be mowed? YES / NO
10. If a diversion structure (high flow bypass structure or underdrain) is present, is there presence of trash, debris, on sediment? YES / NO

MAIN TREATMENT (BIORETENTION)

*QUESTIONS 11-14

Main Treatment:

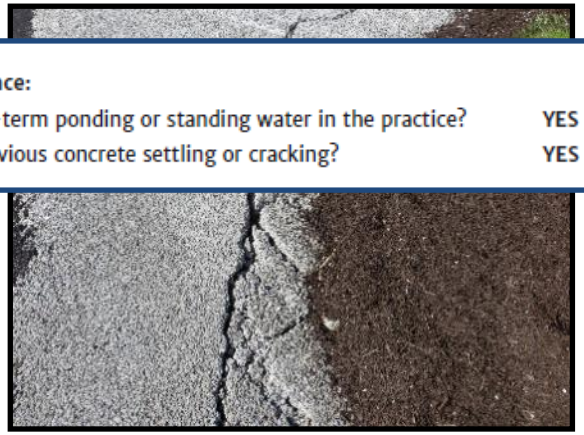
11. Is there evidence of long-term ponding or standing water in the practice (more than 48 hours after a rain event)? (e.g., stains, odors, mosquito larvae, etc.) YES / NO

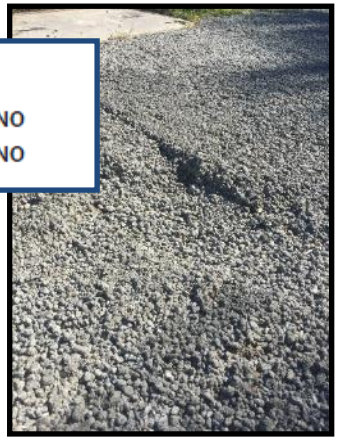
12. Is there any evidence of fertilizer use on plants? (e.g., fertilizer crusting on surface of soil, tips of leaves turning brown or yellow, blackened roots, etc.) YES / NO

13. For practices with internal check dams to allow for surface ponding on a slope, is there erosion present around the side of the check dams? YES / NO

14. Is the mulch depth inadequate or too deep? Note: target depth is 2 to 4 inches YES / NO

PAVEMENT SURFACE





Permeable Pavement Surface:

6. Is there evidence of long-term ponding or standing water in the practice? **YES / NO**
7. Are there signs of the pervious concrete settling or cracking? **YES / NO**

Permeable Pavement Surface:

6. Is there evidence of long-term ponding or standing water in the practice? **YES / NO**
7. Are there signs of the bricks/pavers settling? **YES / NO**
8. Do the bricks/pavers show signs of cracks, splitting or structural damage? **YES / NO**
9. Is there aggregate missing between the bricks/pavers? **YES / NO**

INLETS/OUTLETS, UNDERDRAINS AND EMERGENCY OVERFLOWS

Underdrain: (if installed)

15. If cleanouts are included, are caps missing? YES / NO
16. Are cleanout caps in poor condition? (e.g., inadequately sealed or set below maximum ponding depth) YES / NO
17. Are there any signs of the underdrain being clogged or a blockage? YES / NO

Emergency Overflow / Outlet Structure:

18. Do these structures have trash, debris, sediment or structural damage present? YES / NO
19. Is there evidence of erosion, scour, or flooding around the structure? YES / NO

Inlets/Outlets:

8. Do drainage ways (overland flow or pipes) to the practice have trash, debris, large branches, etc. present? YES / NO
9. If cleanouts are included, are caps missing? YES / NO
10. If an underdrain system is included, are there signs of it clogging or a blockage? YES / NO
11. Does the emergency overflow have trash, debris, sediment or structural damage present? YES / NO

QUALITATIVE FEATURES – BIORETENTION

QUALITATIVE INSPECTION QUESTIONS (GOOD/MARGINAL/POOR) *Note: 'Poor' indicates a maintenance need and action*

20. Rate the presence of sediment accumulation in the bioretention surface area.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
21. Rate the presence of debris (e.g., leaves, trash, grass clippings) in the bioretention surface area.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
22. Rate the presence of undesirable vegetation.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
23. Rate the condition of plant health per landscaping plan and site objectives.*	GOOD (<25% dying/stressed)	MARGINAL (25%-50% dying/stressed)	POOR (>50% dying/stressed)
24. Rate the condition of plant density per landscaping plan and site objectives.*	GOOD (>50% vegetation coverage)	MARGINAL (25%-50% vegetation)	POOR (overgrown or <25% vegetation)

** General percentages provided if landscaping plan and site objectives are not available*

VEGETATION TYPE AND HEALTH OFFERS CLUES ON EXTENT OF SURFACE PONDING

GMC

Mechanics of Sediment Clogging in Permeable Pavement

QUALITATIVE FEATURES – PERMEABLE PAVEMENT

QUALITATIVE INSPECTION QUESTIONS (GOOD/MARGINAL/POOR)

Note: 'Poor' indicates a maintenance need and action

12. Rate the presence of undesirable vegetation.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
13. Rate the presence of sediment accumulation in pore spaces.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
14. Rate the presence of debris (e.g., leaves, trash, grass clippings) on the permeable pavement surface.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
15. Rate the presence of concrete raveling. (e.g., aggregate becoming loose)	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
16. Is there visible smearing of pervious concrete? (e.g., no visible pore space)	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)

COMMENTS: _____

QUALITATIVE INSPECTION QUESTIONS (GOOD/MARGINAL/POOR)

Note: 'Poor' indicates a maintenance need and action

14. Rate the presence of undesirable vegetation.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
15. Rate the presence of sediment accumulation in pore spaces/aggregate between pavers.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)
16. Rate the presence of debris (e.g., leaves, trash, grass clippings) on the permeable pavement surface.	GOOD (<25% of area)	MARGINAL (25-50%)	POOR (>50%)

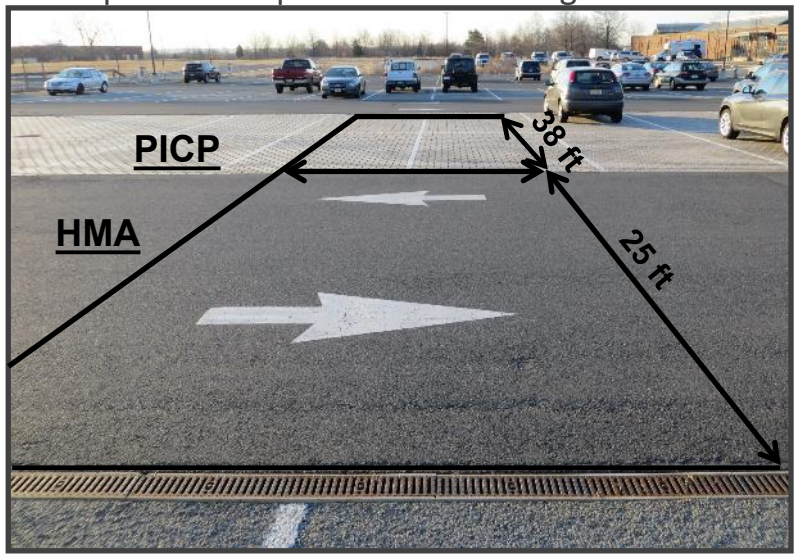
COMMENTS: _____

SEDIMENT ACCUMULATES (AND CLOGGING PROGRESSES) FROM UPGRADIENT EDGE.

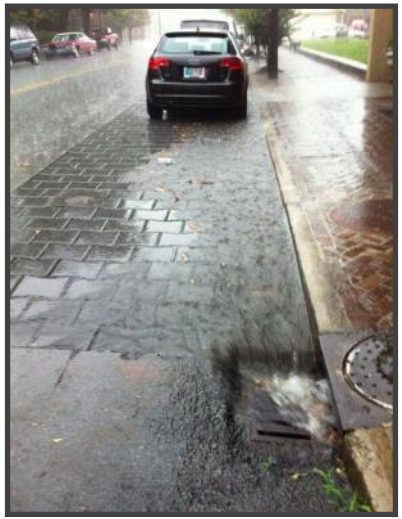
- Sediment is not “snow” that spreads evenly over the surface.

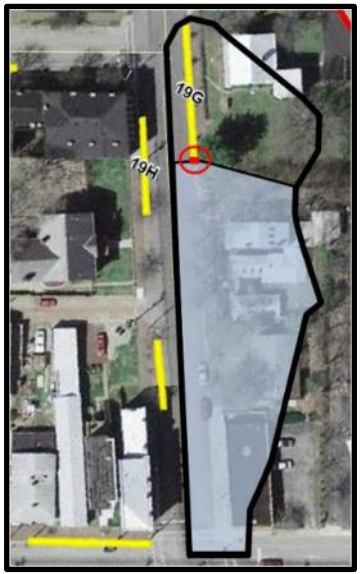
THE RATIO OF DRAINAGE AREA TO UPGRADIENT FLOW WIDTH DRIVES SEDIMENT LOAD (& MAINTENANCE FREQUENCY)

- **Edison, NJ – EPA parking lot:**
  - –7.6 m^2/m (25 ft^2/ft)
  - – Clogging has progressed 15 to 45 cm (0.5-1.5 ft) after 3 years (no maintenance)
  - – Total permeable pavement flow length is 38 ft



- **Louisville, KY (CSO 130) 19G:**
  - –3,852 m^2/m (12,640 ft^2/ft)
  - – Assumes a 0.23-m (9-in) flow width (median 5-min flow width)





MAINTENANCE FREQUENCY

- Once per 2-3 decades

- Once per 2-3 months

REMOVING PAVERS AT SELECTED LOCATIONS PROVIDES INFORMATION ON HOW THE SURFACE CLOGS.

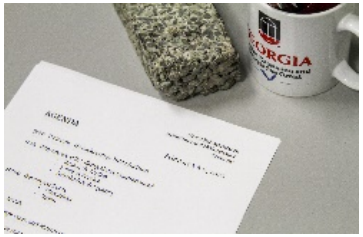
MOST OF THE FINES ARE TRAPPED IN THE TOP 20 MM (3/4”).

GMC

Impact & Next Steps

Impact

- Workshops held in Feb. 2020 (free, 21 participants)
- **“98% of training participants agree or strongly agree** that within 12 months they plan to put into practice something they learned from the training”
- Engaged 60+ stormwater managers/maintenance professionals in the lower coastal plain, 22+ statewide



“The information was good, and the presenters made it digestible, and they provided many resources to make maintenance simple.”
- Training Participant

Impact

Training content presented at five regional conferences, 2 national, 1 international

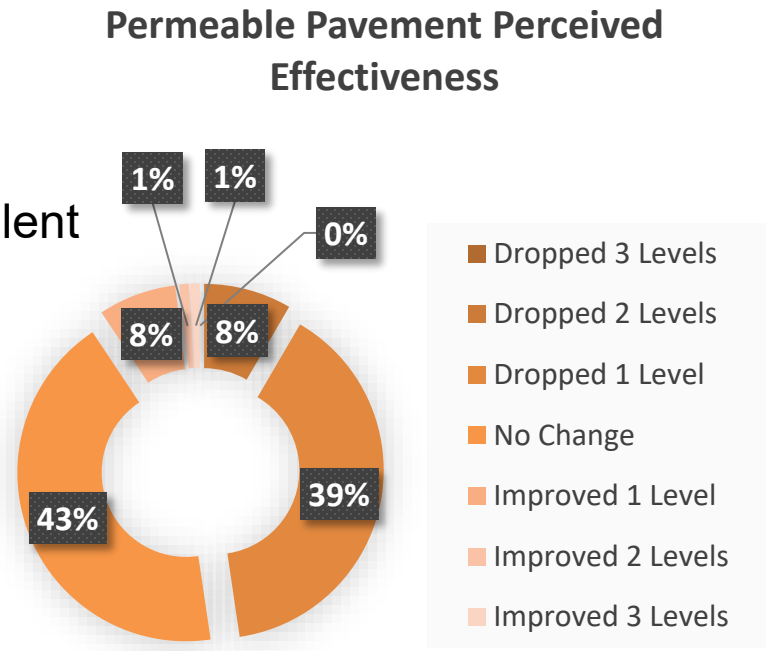
44% of permitted municipalities (coastal region) have included the tools as recommended resources for inspection, operations and maintenance in their GI/LID plan updates as part of their MS4 permit

95% of the GI/LID practices in Coastal Georgia are being assessed by permitted municipalities utilizing the tools within one year

LID INVENTORY – INITIAL COMPARISONS

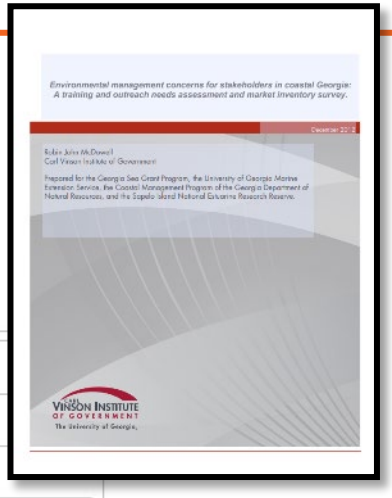
2021-22 Inventory

- **66+ new practices,** on-going assessments
- **Reevaluated 146 locations** (Mar 2022)
  (PP=107, Bio/RG/BS=39)
  - visual assessments: poor, fair, good, excellent
- About half were static (no change) visual assessment (PP = 43%, Bio = 56%)
- 39% of permeable pavement dropped 1 level



NEXT STEPS / FUTURE WORK

- Complete 2021-22 LID Inventory (Summer 2022)
- Permeable pavement infiltration study (add-on) to quantify visual assessments (Summer 2022)
- Expand the content and develop online course – starts in Fall 2022
- Follow-up evaluation with training workshop participants



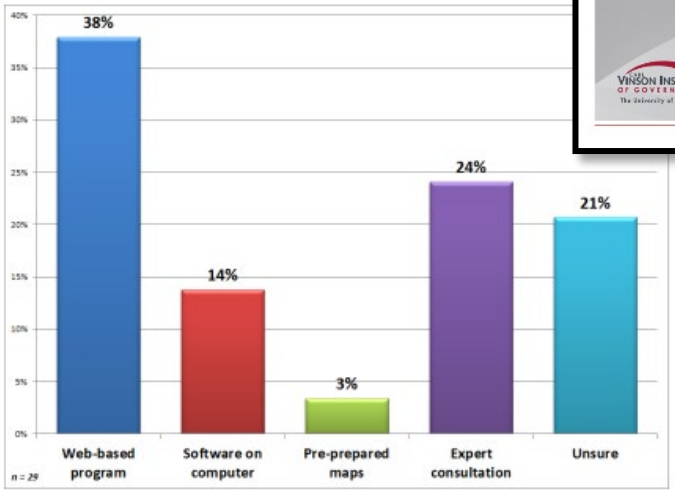


Figure 42: Local government preferences for receiving information on planning/zoning

2012 Concerns Report - https://coastalgadnr.org/sites/default/files/crd/CZM/TechAssist/CoastalGANeedsAsses_FinalReport_Dec2012.pdf


Thank you!
rob.brown@gmcnetwork.com