PLANNING A STORMWATER MANAGEMENT STRATEGY IN YOUR COMMUNITY

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AGENDA

- HOW DO YOU IMPLEMENT A STORMWATER STRATEGY IN YOUR COMMUNITY
  - OVERVIEW OF APPROACHES
  - DRIVERS
    - MS4 PERMITS
    - CRS
  - PUBLIC VERSUS PRIVATE INVESTMENT
  - TECHNICAL SUPPORT
    - DESIGN GUIDELINES
    - TRAINING
  - INCENTIVES
    - FEES AND CREDITS
  - MANAGEMENT
    - REVIEW
    - MAINTENANCE

GREEN INFRASTRUCTURE TOOL BOX

- TREE PROGRAM
- STREAMWAYS, GREENWAYS, BLUEWAYS
- LOW IMPACT DEVELOPMENT

http://www.washingtonnature.org/cities/

STREAMWAYS, GREENWAYS, AND BLUEWAYS

Park Systems

Wildlife Habitats and Corridors

Hub and Corridor Design

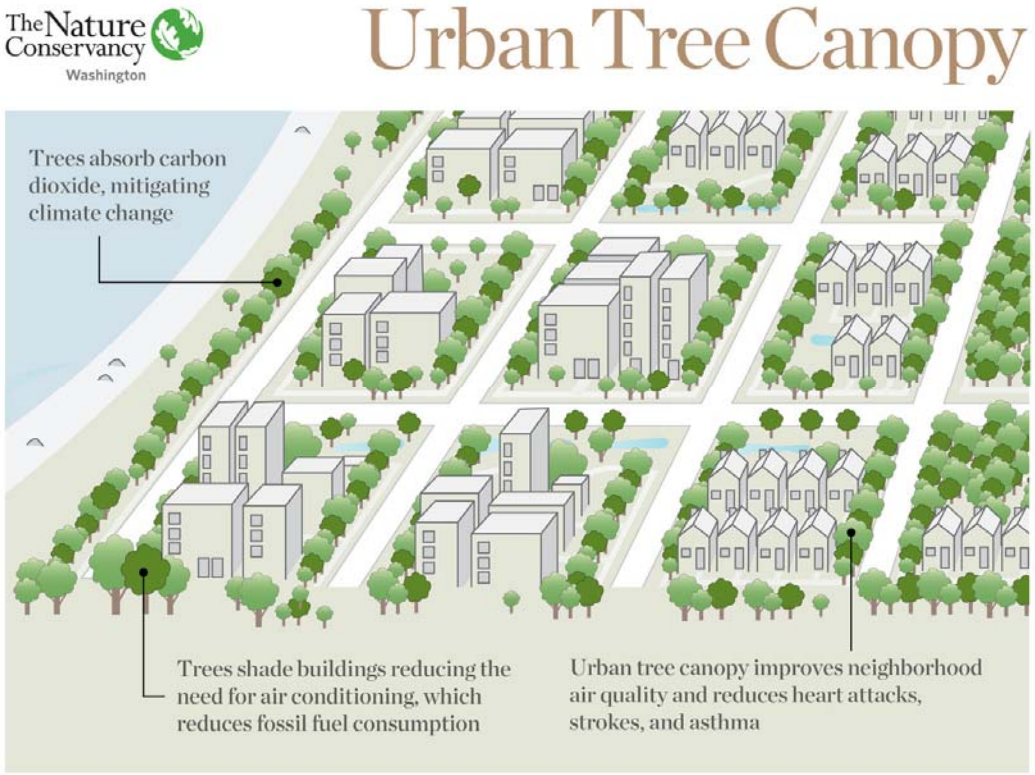
http://stormwater.wef.org/2014/04/water-wellness/

STREAMWAYS AND STREAM RESTORATION

- After (May 2015)

TREE PROGRAM

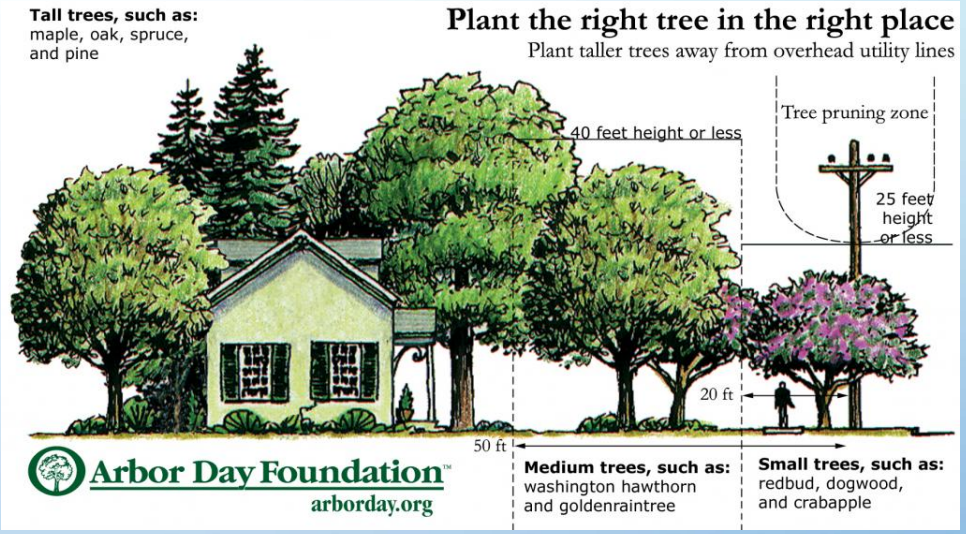
- Help Manange Small Storms
- Cooling – Reduce Heat Island Impacts
- Manage Air Pollution
- Improve walkability and Neighborhood Activity
- Provide Habitat
- Improve Tax Base



TREE PROGRAM

- STREET TREES- SHADEWAYS
- RESIDENTIAL TREES
- PARKWAYS

- NOT JUST TREE ORDINANCE…
  - GREEN STREETS
  - TREE PLANTING PROGRAM
  - PLAZA AND PARKING LOT SHADE PROGRAMS
  - TREE GIVEAWAYS



USING TREES TO MEET STORMWATER CREDIT

Portland, OR — 2004 Stormwater Management Manual

- Subtract Impervious Cover under trees within 25 feet of impervious cover that meets certain criteria
- Existing Tree = 50% of Existing Canopy, New Trees = 100 to 200 ft^2 of impervious cover

Indianapolis, IN — 2007 Stormwater Green Infrastructure Supplemental Document

- Credits for new or exiting tree canopy within 20 feet of impervious surfaces.
- 1 tree= 100 ft^2 of Impervious Cover

Pine Lake, GA — 2003 Ordinance

- Trees count towards site runoff requirements
- Trees = 10 to 20 gallons/in DBH

Minnesota — Volume, TSS, Phosphorus Credit

- Based on interception, evaporation, and infiltration
- Example : Mature Red Maple with infiltration area= 340 cf

Philadelphia, PA — 2011 Stormwater Manual

- Reduction in impervious area

Washington, DC — 2013 Guidebook

- Trees receive retention value
- Preserved Trees = 20$ft^{3;}$ New Trees = 10 ft^3

STORMWATER CONTROLS

- STORMWATER CONTROL MEASURES
- BEST MANAGEMENT PRACTICES
- SUSTAINABLE URBAN DRAINAGE SYSTEMS
- LOW IMPACT DEVELOPMENT

Bioretention

Rainwater Capture

Bioswales

Vegetated Filter

Permeable Pavement

Green Roof

Sand Filter

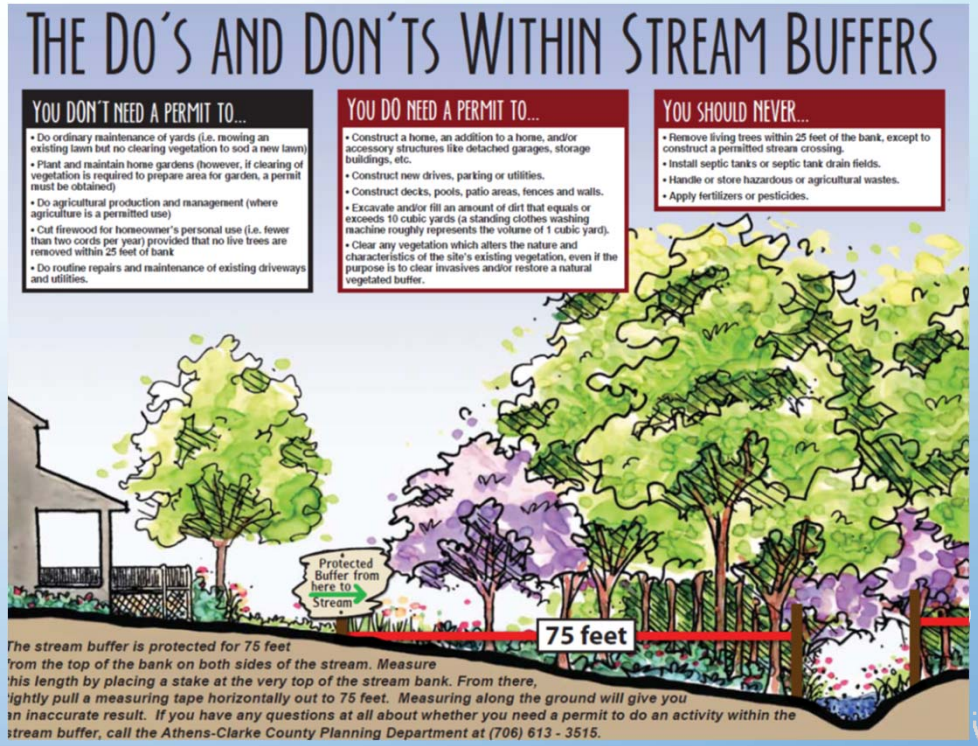
Extended Detention Basin

Constructed Wetland

OTHER MANAGEMENT STRATEGIES

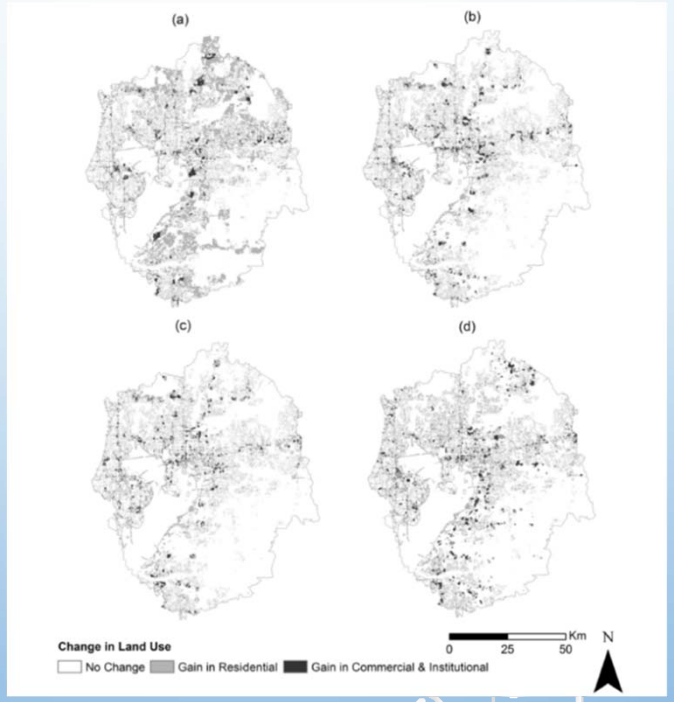
- LOCAL FLOODPLAINS
- FLOODPLAIN PROTECTION ORDINANCES
- STREAM BUFFER REQUIREMENTS

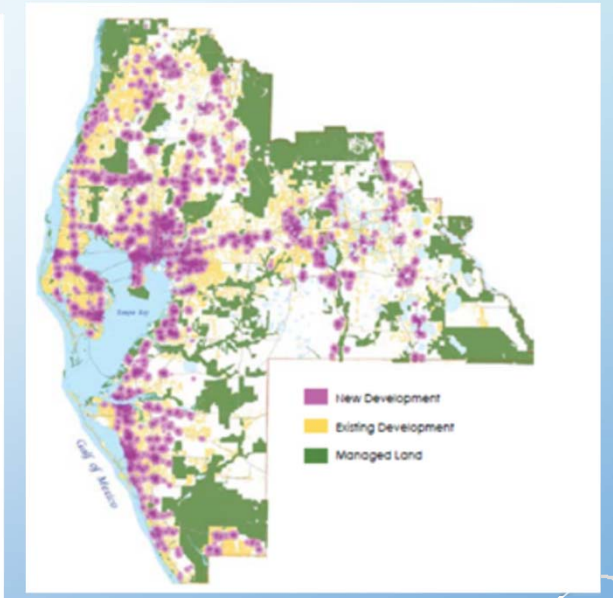
https://www.fema.gov/media-library/assets/images/51686



https://www.athensclarkecounty.com/DocumentCenter/View/2211

MASTER PLANNING AS A DRIVING FORCE





PLANNING IN CONTEXT

Flood Damage Reduction

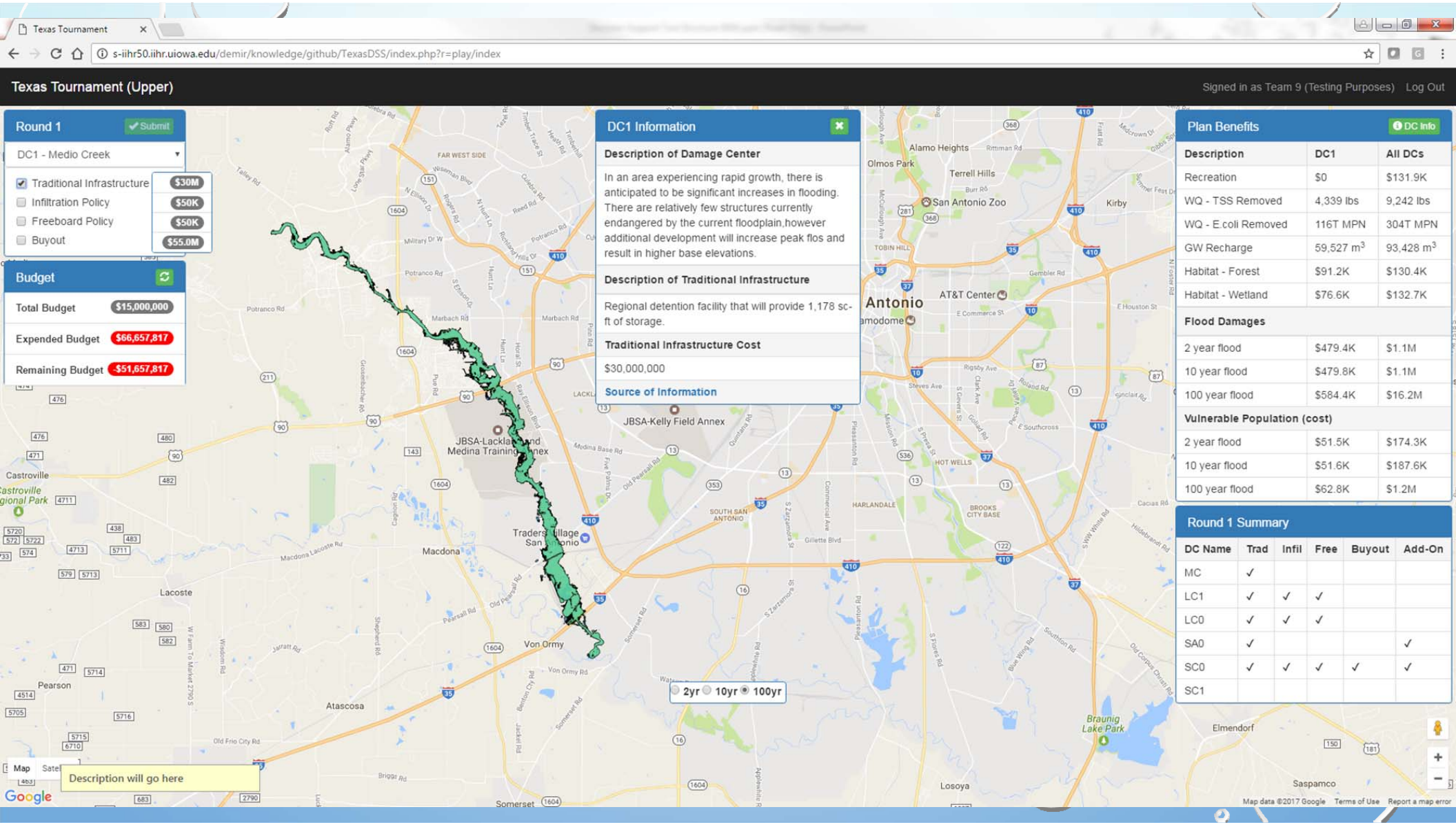
Vulnerable Populations Impacted

Water Quality: Pollutant Reduction (TSS and *E. coli*)

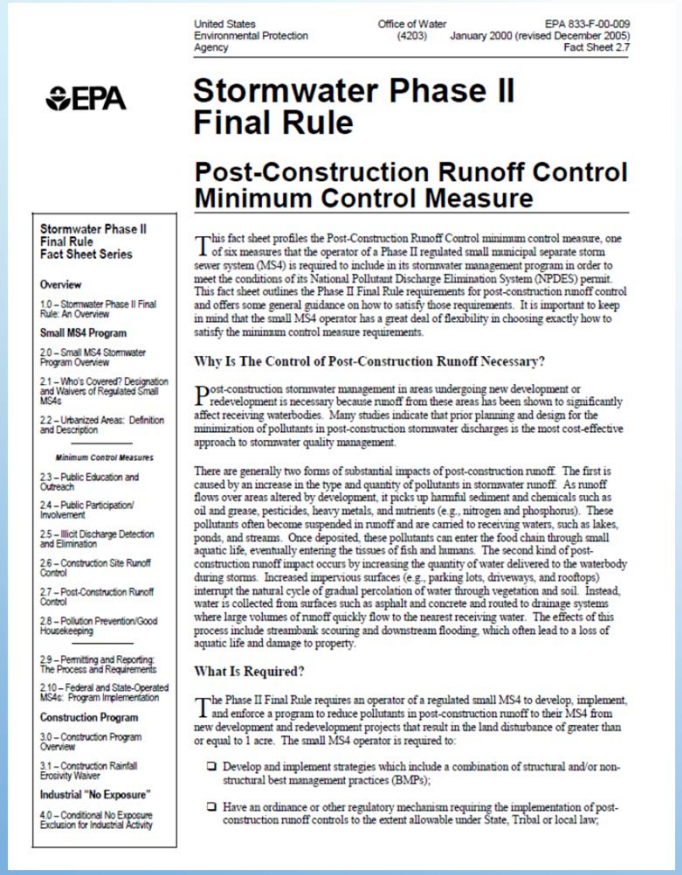
Riparian Corridors Protected: Riparian Corridors and Wetlands

Water Resources: Groundwater Recharge

Recreation: Improvements in Property Values


Texas Tournament
s-iihr50.iihr.uiowa.edu/demir/knowledge/github/TexasDSS/index.php?r=play/index
Texas Tournament (Upper)
Signed in as Team 9 (Testing Purposes) Log Out
Round 1
Submit
DC1 - Medio Creek
Traditional Infrastructure $30M
Infiltration Policy $50K
Freeboard Policy $50K
Buyout $55.0M
Budget
Total Budget $15,000,000
Expended Budget $66,657,817
Remaining Budget $51,657,817
DC1 Information
Description of Damage Center
In an area experiencing rapid growth, there is anticipated to be significant increases in flooding. There are relatively few structures currently endangered by the current floodplain,however additional development will increase peak flos and result in higher base elevations.
Description of Traditional Infrastructure
Regional detention facility that will provide 1,178 sc-ft of storage.
Traditional Infrastructure Cost
$30,000,000
Source of Information
Plan Benefits
DC Info
Description | DC1 | All DCs
Recreation | $0 | $131.9K
WQ - TSS Removed | 4,339 lbs | 9,242 lbs
WQ - E.coli Removed | 116T MPN | 304T MPN
GW Recharge | 59,527 m3 | 93,428 m3
Habitat - Forest | $91.2K | $130.4K
Habitat - Wetland | $76.6K | $132.7K
Flood Damages
2 year flood | $479.4K | $1.1M
10 year flood | $479.8K | $1.1M
100 year flood | $584.4K | $16.2M
Vulnerable Population (cost)
2 year flood | $51.5K | $174.3K
10 year flood | $51.6K | $187.6K
100 year flood | $62.8K | $1.2M
Round 1 Summary
DC Name | Trad | Infil | Free | Buyout | Add-On
MC | ✓
LC1 | ✓ | ✓ | ✓
LC0 | ✓ | ✓ | ✓
SA0 | ✓ | ✓
SC0 | ✓ | ✓ | ✓ | ✓ | ✓
SC1
2yr 10yr 100yr
Description will go here
Map
Google
Map data ©2017 Google Terms of Use Report a map error

MS4 PERMIT REQUIREMENTS



United States Environmental Protection Agency | Office of Water (4203) | EPA 833-F-00-009 January 2000 (revised December 2005) Fact Sheet 2.7

EPA

Stormwater Phase II Final Rule

Post-Construction Runoff Control Minimum Control Measure

Stormwater Phase II Final Rule Fact Sheet Series

Overview

1.0 – Stormwater Phase II Final Rule: An Overview

Small MS4 Program

2.0 – Small MS4 Stormwater Program Overview

2.1 – Who's Covered? Designation and Waivers of Regulated Small MS4s

2.2 – Urbanized Areas: Definition and Description

Minimum Control Measures

2.3 – Public Education and Outreach

2.4 – Public Participation/ Involvement

2.5 – Illicit Discharge Detection and Elimination

2.6 – Construction Site Runoff Control

2.7 – Post-Construction Runoff Control

2.8 – Pollution Prevention/Good Housekeeping

2.9 – Permitting and Reporting: The Process and Requirements

2.10 – Federal and State-Operated MS4s: Program Implementation

Construction Program

3.0 – Construction Program Overview

3.1 – Construction Rainfall Erosivity Waiver

Industrial "No Exposure"

4.0 – Conditional No Exposure Exclusion for Industrial Activity

This fact sheet profiles the Post-Construction Runoff Control minimum control measure, one of six measures that the operator of a Phase II regulated small municipal separate storm sewer system (MS4) is required to include in its stormwater management program in order to meet the conditions of its National Pollutant Discharge Elimination System (NPDES) permit. This fact sheet outlines the Phase II Final Rule requirements for post-construction runoff control and offers some general guidance on how to satisfy those requirements. It is important to keep in mind that the small MS4 operator has a great deal of flexibility in choosing exactly how to satisfy the minimum control measure requirements.

Why Is The Control of Post-Construction Runoff Necessary?

Post-construction stormwater management in areas undergoing new development or redevelopment is necessary because runoff from these areas has been shown to significantly affect receiving waterbodies. Many studies indicate that prior planning and design for the minimization of pollutants in post-construction stormwater discharges is the most cost-effective approach to stormwater quality management.

There are generally two forms of substantial impacts of post-construction runoff. The first is caused by an increase in the type and quantity of pollutants in stormwater runoff. As runoff flows over areas altered by development, it picks up harmful sediment and chemicals such as oil and grease, pesticides, heavy metals, and nutrients (e.g., nitrogen and phosphorus). These pollutants often become suspended in runoff and are carried to receiving waters, such as lakes, ponds, and streams. Once deposited, these pollutants can enter the food chain through small aquatic life, eventually entering the tissues of fish and humans. The second kind of post-construction runoff impact occurs by increasing the quantity of water delivered to the waterbody during storms. Increased impervious surfaces (e.g., parking lots, driveways, and rooftops) interrupt the natural cycle of gradual percolation of water through vegetation and soil. Instead, water is collected from surfaces such as asphalt and concrete and routed to drainage systems where large volumes of runoff quickly flow to the nearest receiving water. The effects of this process include streambank scouring and downstream flooding, which often lead to a loss of aquatic life and damage to property.

What Is Required?

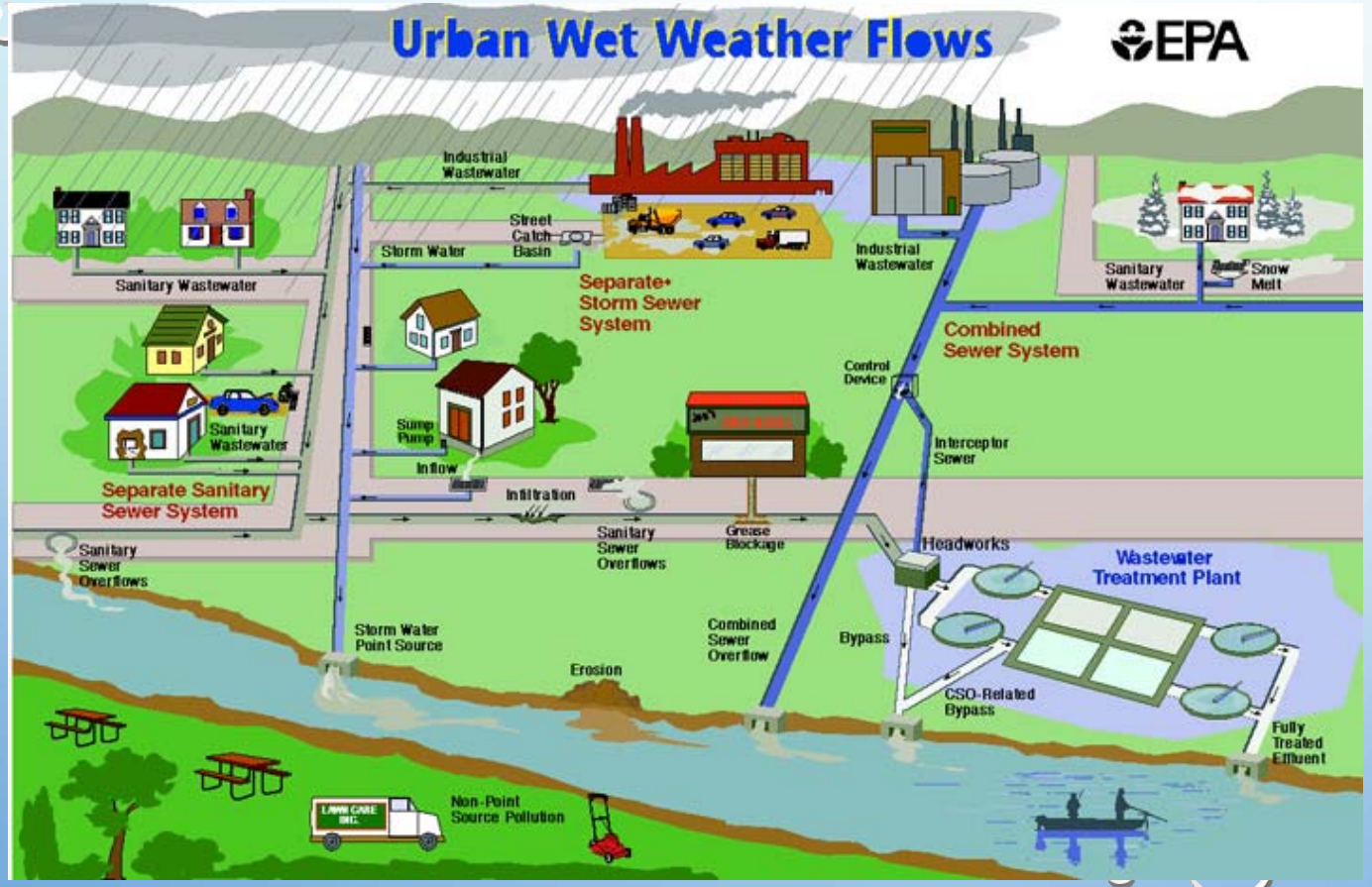
The Phase II Final Rule requires an operator of a regulated small MS4 to develop, implement, and enforce a program to reduce pollutants in post-construction runoff to their MS4 from new development and redevelopment projects that result in the land disturbance of greater than or equal to 1 acre. The small MS4 operator is required to:

- ❑ Develop and implement strategies which include a combination of structural and/or non-structural best management practices (BMPs);
- ❑ Have an ordinance or other regulatory mechanism requiring the implementation of post-construction runoff controls to the extent allowable under State, Tribal or local law;

https://www3.epa.gov/npdes/pubs/fact2-7.pdf

- "THE PHASE II FINAL RULE REQUIRES AN OPERATOR OF A REGULATED SMALL MS4 TO DEVELOP, IMPLEMENT, AND ENFORCE A PROGRAM TO REDUCE POLLUTANTS IN POST-CONSTRUCTION RUNOFF TO THEIR MS4 FROM NEW DEVELOPMENT AND REDEVELOPMENT PROJECTS THAT RESULT IN THE LAND DISTURBANCE OF GREATER THAN OR EQUAL TO 1 ACRE."

MS4 PERMITS AS A DRIVER



http://www.epa.ohio.gov/portals/35/cso/wet_weather_flow_graphic.jpg

Watershed Impairment

TMDL

Implementation Plan

MS4 Permit

MS4 PERMIT REQUIREMENTS

- SET A GOAL
  - MUST BE MEASURABLE
  - EXAMPLE: "REDUCE BY X % OF IMPERVIOUS COVER AREA DIRECTLY CONNECTED TO THE STORM SEWER SYSTEM"
- DEVELOP A STRATEGY –
  - BMPS IDENTIFIED IN PLANNING PROCEDURES
    - PROMOTE BMPS IN MASTERPLANS, COMPREHENSIVE PLANS, AND ZONING ORDINANCES
- IMPLEMENT WITH ORDINANCE
  - AVOID "TO EXTENT PRACTICABLE" LANGUAGE
- ENSURE MAINTENANCE

COMMUNITY RATING SYSTEM (CRS)

- PROGRAM WITHIN THE NATIONAL FLOOD INSURANCE PROGRAM (NFIP) WHICH ENCOURAGES COMMUNITY ACTION TO MANAGE FLOODPLAINS ABOVE AND BEYOND THE MINIMUM NFIP

CRS CLASSES AND DISCOUNTS

Rate Class	Discount SFHA*	Non-SFHA**	Credit Points Required
1	45%	10%	4,500 +
2	40%	10%	4,000 - 4,499
3	35%	10%	3,500 - 3,999
4	30%	10%	3,000 - 3,499
5	25%	10%	2,500 - 2,999
6	20%	10%	2,000 - 2,499
7	15%	5%	1,500 - 1,999
8	10%	5%	1,000 - 1,499
9	5%	5%	500 - 999
10	0%	0%	0 - 499

- 62 CRS COMMUNITIES IN TEXAS
- HIGHEST CLASS
  - CITY OF GRAND PRAIRIE (5)
  - CITY OF HOUSTON (5)
  - CITY OF PASADENA (5)
  - CITY OF PLANO (5)

CRS CREDIT FOR ONSITE STORMWATER MANAGEMENT

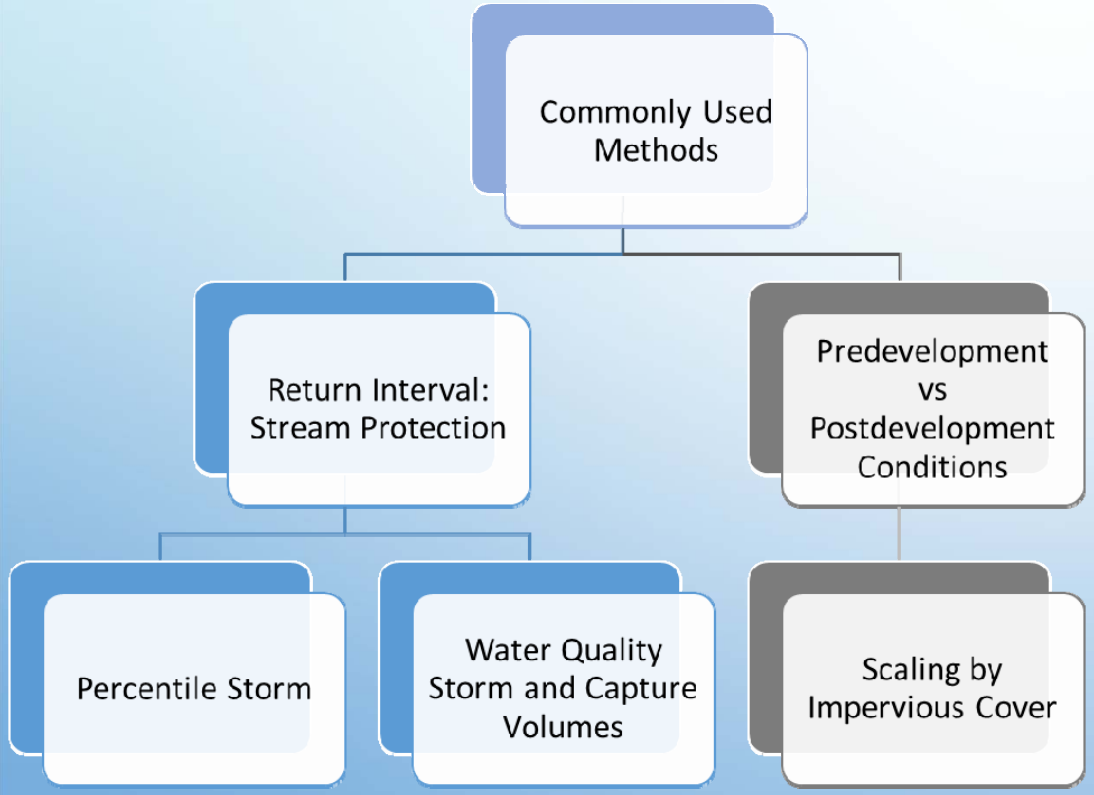
- PROTECTING NATURAL FLOODPLAIN FUNCTION
  - SECTION 450 – LOW IMPACT DEVELOPMENT (LID)
    - STORMWATER MANAGEMENT REGULATIONS (SMR)
      - REGULATING DEVELOPMENT ON A CASE BY BASE BASIS TO ENSURE THAT THE PEAK FLOW OF STORMWATER RUNOFF FROM EACH SITE WILL NOT EXCEED THE PRE-DEVELOPMENT RUNOFF
        - UP TO 25 POINTS- LID ORDINANCE
    - WATER QUALITY REGULATIONS
      - REGULATIONS THAT IMPROVE STORMWATER RUNOFF THROUGH THE USE OF BEST MANAGEMENT PRACTICES (20 POINTS)
    - PARTIAL CREDIT AVAILABLE FOR LID ORDINANCES

"Credit for LID is also provided if the community's stormwater management ordinance requires the use of "soft" techniques to reduce runoff to the maximum extent possible before using detention. This can be thought of as a requirement to mimic natural hydrologic runoff and minimize the impact of land development on water resources to the maximum extent possible. The developers are required to control the runoff, but detention ponds are discouraged in favor of on-site infiltration."

IMPLEMENTING LID IN AN ORDINANCE

- EXAMPLE:
  - "SMALL SCALE STORMWATER MANAGEMENT PRACTICES, NON-STRUCTURAL TECHNIQUES, AND BETTER SITE PLANNING TO MIMIC NATURAL HYDROLOGIC RUNOFF CHARACTERISTICS AND MINIMIZE THE IMPACT OF LAND DEVELOPMENT ON WATER RESOURCES MUST BE IMPLEMENTED. ONLY WHEN IT IS ABSOLUTELY NECESSARY IS THE USE OF A STRUCTURAL BMP WARRANTED." - BERKELEY COUNTY, WEST VIRGINIA

SETTING GOALS



- SCIENCE BASED CRITERIA
  - STREAM PROTECTION STANDARD
  - WATER QUALITY VOLUME
    - TMDL
    - WATERSHED PROTECTION PLANS
    - PERMITS
- BALANCE PRIVATE BENEFIT AND PUBLIC COST
  - STORMWATER UTILITY COSTS

One –Bay

Master Planning

Urban Center	Standard(s)
Fort Worth, TX	• rainfall of 1.5 inches (85th percentile storm) • Post-development channel velocities cannot be increased by more than 5% above predevelopment velocities • Twenty-four hours of extended detention shall be provided for on-site, post-developed runoff generated by the **1-year, 24-hour rainfall** event to protect downstream channels.
Austin, TX	• The minimum volume is the first one-half (0.5) inch of runoff plus an additional one-tenth (0.1) inch for each ten (10) percent increase of impervious cover over twenty (20) percent within the drainage area to the control.
Harris County, TX	• First 1" of runoff
Philadelphia, PA	• 1" runoff from Impervious Cover for Separate Sewer Areas must be infiltrated • 20% of Water Quality Volume must be routed through a BMP • Channel Protection- detain and release **1 year 24 hour storm**
Kansas City, KS	• 90 percent volume of all 24-hour storms on an annual basis- 90th Percentile Storm
Atlanta, GA	• 1.2" of Runoff and 80% of Solids • 30% Reduction of 100 year Storm • 1" must be evaporated/infiltrated/reused
Chicago, Illinois	• Depth and Flow Rate standards dependent on Impervious Cover Area
San Diego, CA	• discharge rates and durations are mitigated with the flow range of 10 % of the 2-year flow to the 10-year flow • 85th percentile water quality design
Los Angeles, CA	• "Post-development peak storm water runoff discharge rates shall not exceed the estimated pre-development rate" (>0.1") • 85th percentile 24-hour runoff event- V • flow of runoff = 2* the 85th percentile hourly rainfall intensity-Q
Denver, CO	• Standards set by the Water Quality Capture Volume

INVESTMENT IN STORMWATER MANAGEMENT

Pardon Our Dust!

The San Antonio River Authority (SARA) recently received a grant from the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency that will fund stormwater retrofits at SARA's main office at 100 E. Guenther and at SARA's Environmental Center at 600 E. Euclid. Construction of the Low Impact Development (LID) stormwater retrofits will begin this summer and include cisterns, rain gardens and permeable pavement parking stalls.

Rendering of a rain water collection cistern at SARA's Guenther office location.

WATERSHED WISE

Our love of the river runs deep,

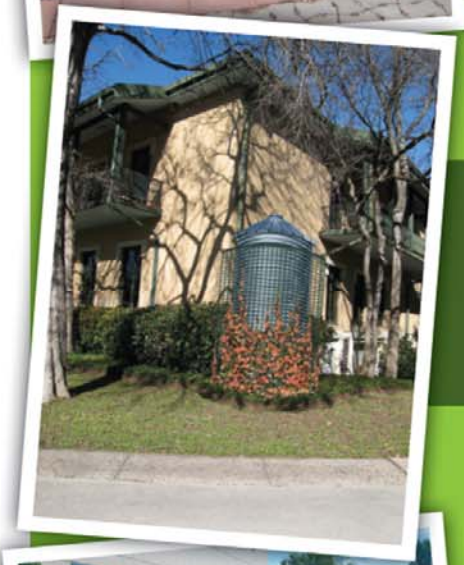
and we are managing our stormwater onsite to protect it.

Untreated rainwater that flows into storm drains and is directed to our creeks and rivers is known as stormwater runoff. In the San Antonio River Watershed, stormwater runoff is the most significant contributor to water quality degradation. To help prevent stormwater pollution from entering the river, SARA is installing Low Impact Development (LID) Best Management Practices (BMPs) designed to capture first-flush stormwater pollutants. LID BMPs capture and treat pollutants before they reach our river.

To learn more about these practices and how you can be Watershed Wise, visit our website at www.sara-tx.org.

SAN ANTONIO RIVER AUTHORITY
Leaders in Watershed Solutions

We are adding permeable pavement to reduce stormwater runoff



We are adding cisterns to capture and reuse stormwater runoff

We are adding rain gardens to treat stormwater runoff

DOCUMENTING THE CONSTRUCTION PROCESS

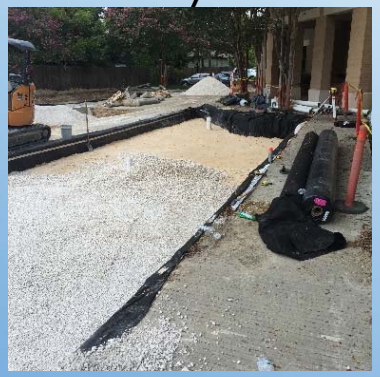
Initial Condition

Excavation

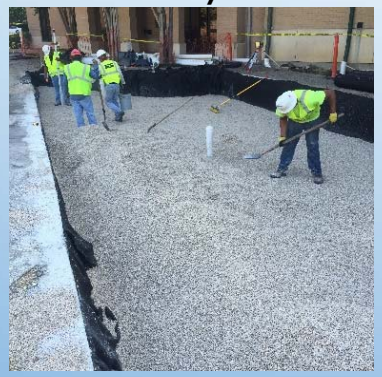
Liner

Gravel Layer

Choke Layer



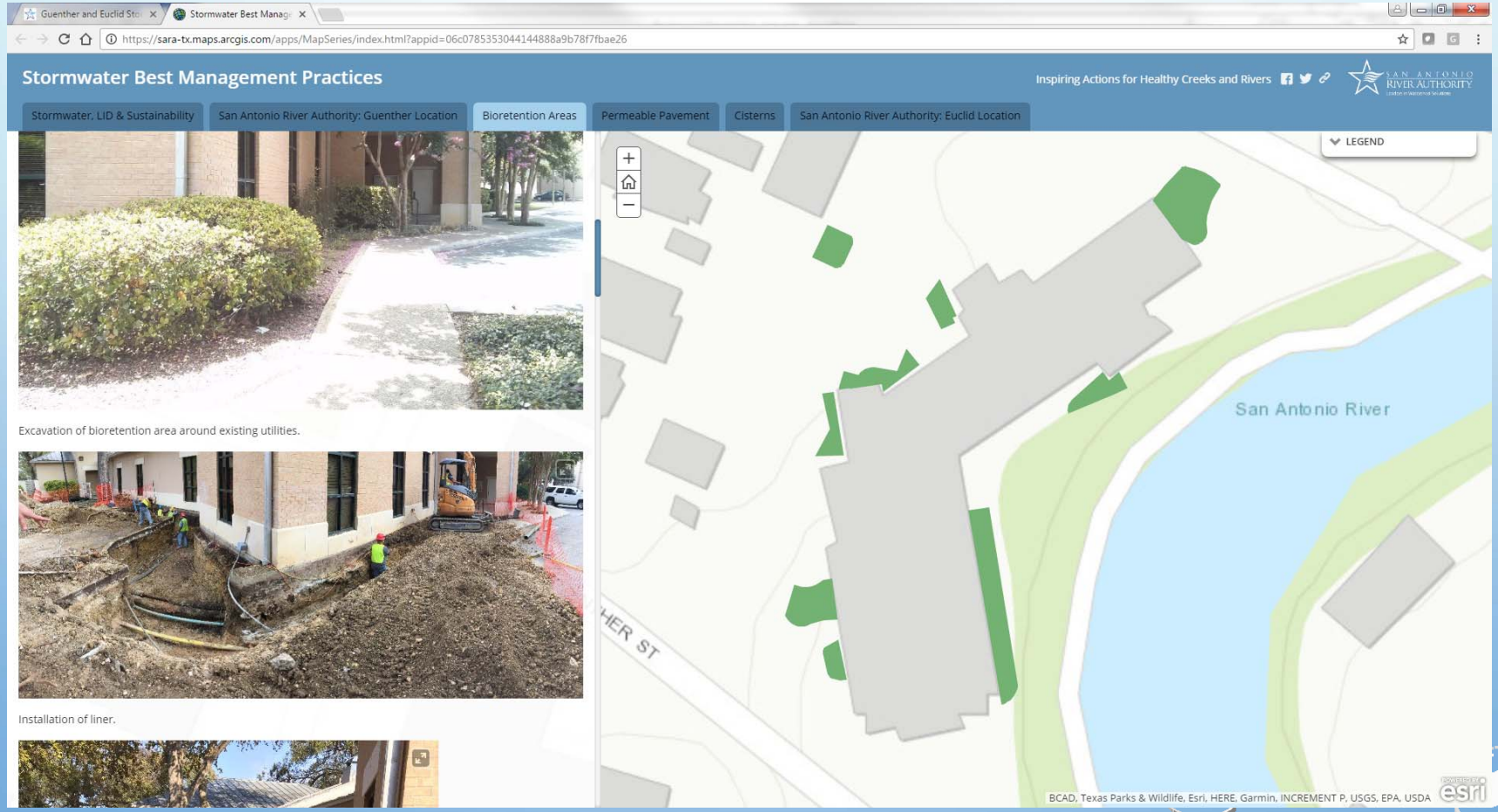
Gravel Layer



Bedding Layer

Pavers

USING THE SITE TO EDUCATE



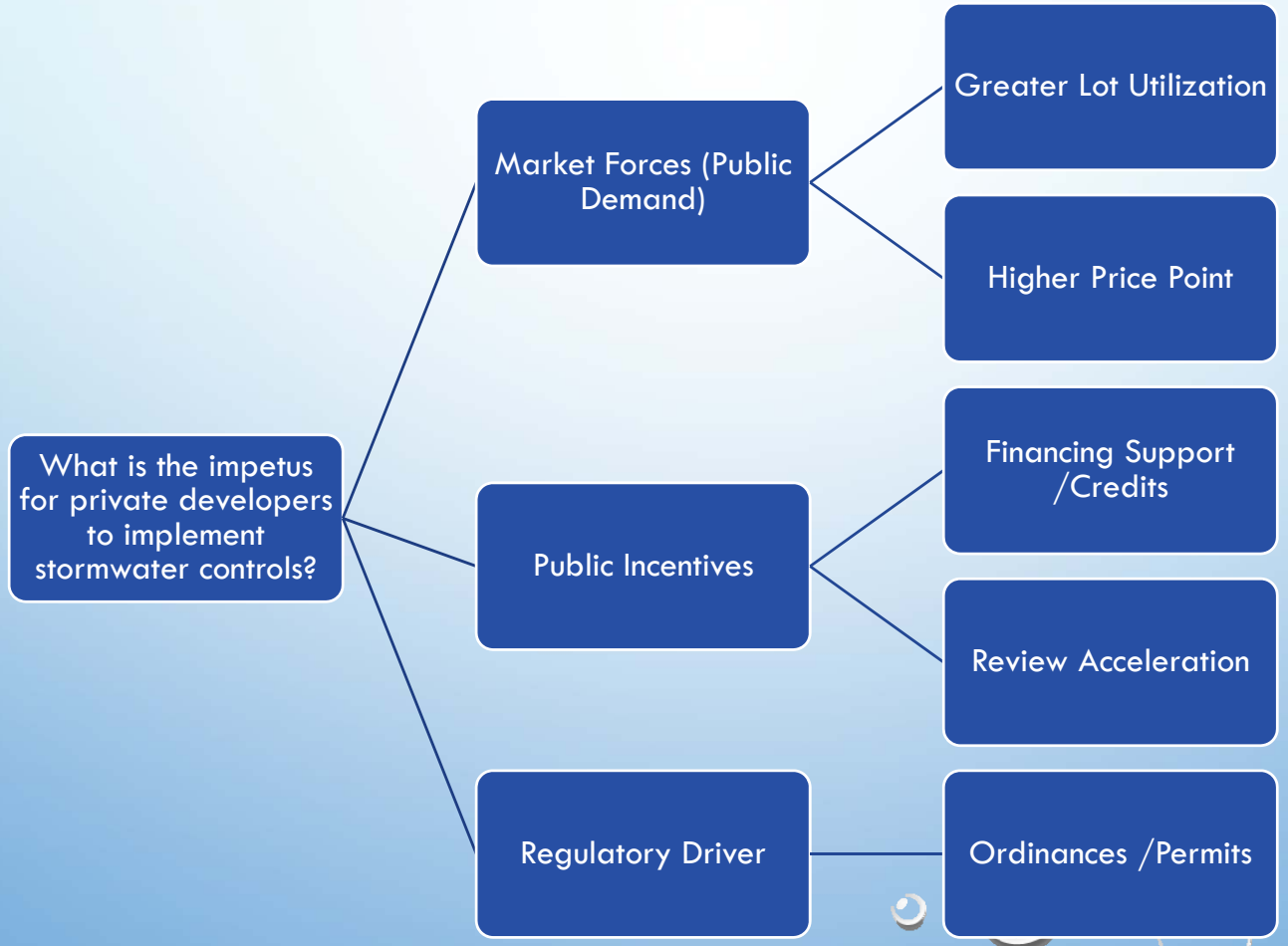
USE THE SITE FOR TRAINING

- HARD HAT TOURS DURING CONSTRUCTION
- OPEN HOUSE
- CONTRACTORS WORKSHOP

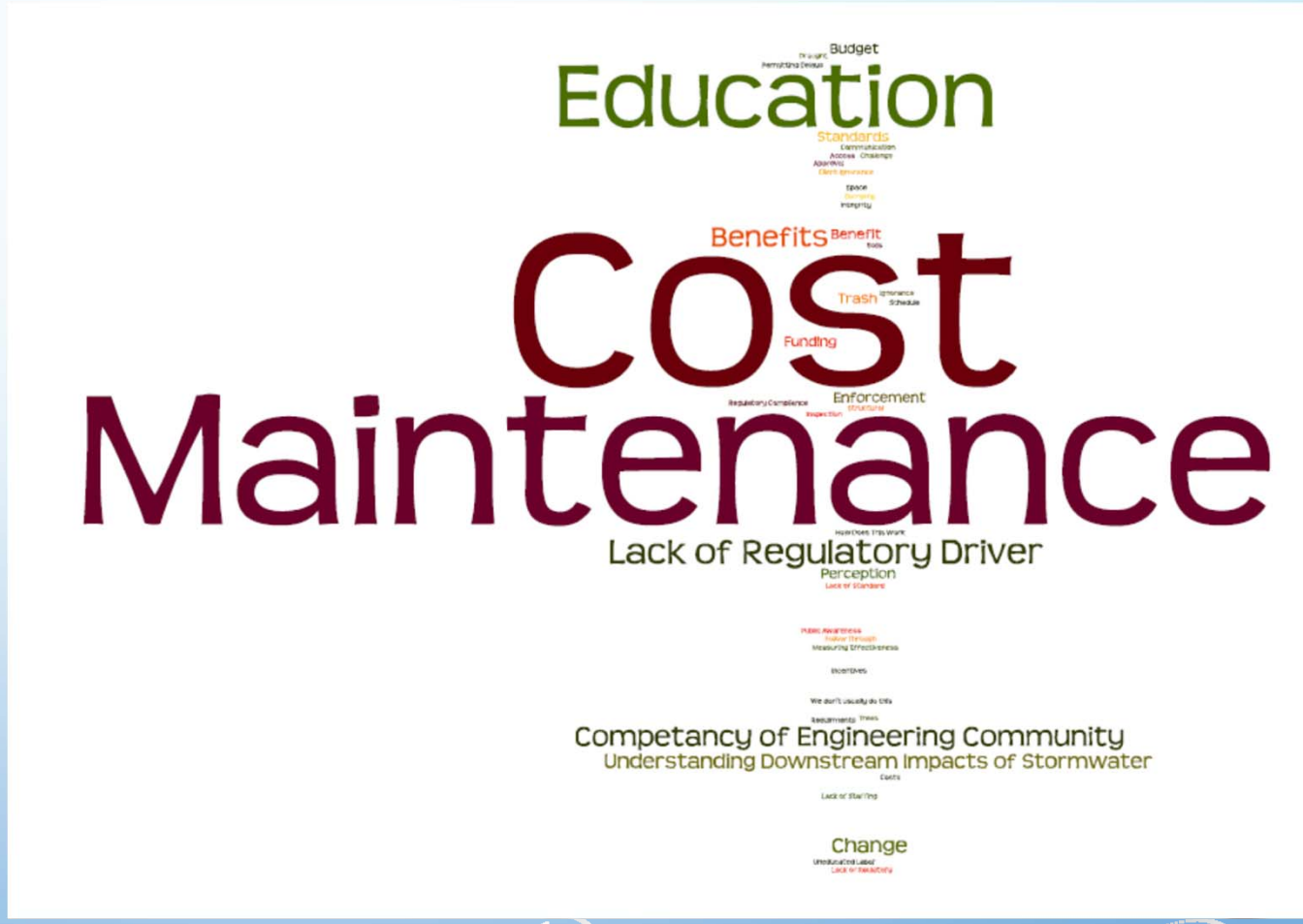
MONITORING PERFORMANCE

QUICK LESSONS LEARNED

WHAT IS THE DRIVER FOR PRIVATE INVESTMENT?



WHAT ARE THE CONCERNS OF THE DESIGN COMMUNITY WHEN ADVOCATING FOR LID WITH THEIR CLIENTS?

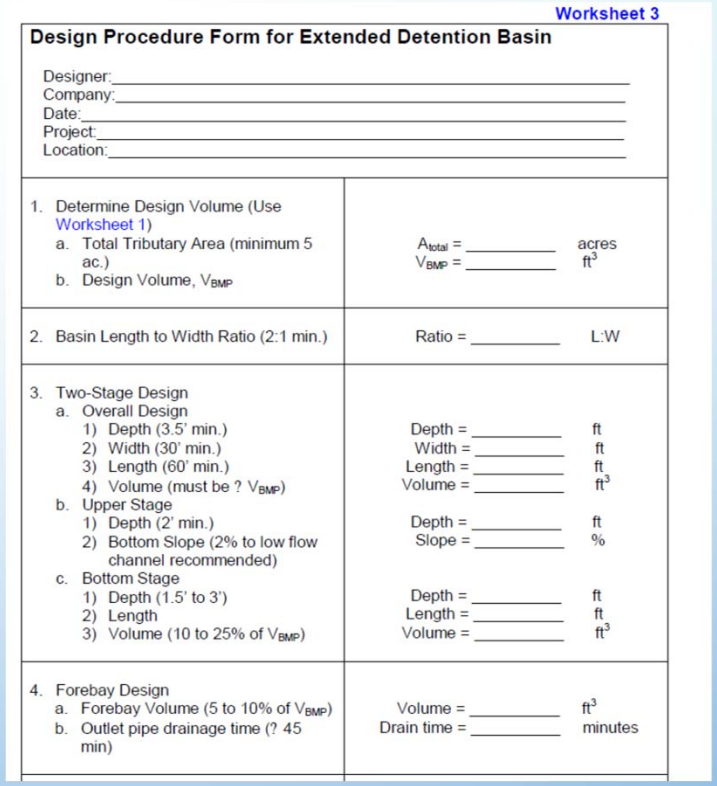


50 % OF GOVERNMENT STAFF REPORTED TO HAVE CONCERNS REGARDING ON-SITE STORMWATER MANAGEMENT…

- 34% - COST
- 34% - STAFFING
- 16% - *INSTITUTIONAL WILLINGNESS TO EMBRACE CHANGE*

DESIGN GUIDELINES

- CLEAR DESIGN OBJECTIVES
- DESIGN GUIDANCE
  - STANDARD DETAILS AND SPECIFICATIONS
- PERIODIC TRAINING



Worksheet 3

Design Procedure Form for Extended Detention Basin

Designer: _____
Company: _____
Date: _____
Project: _____
Location: _____

1. Determine Design Volume (Use Worksheet 1) a. Total Tributary Area (minimum 5 ac.) b. Design Volume, V_{BMP}	A_{total} = _____ acres V_{BMP} = _____ ft^3
2. Basin Length to Width Ratio (2:1 min.)	Ratio = _____ L:W
3. Two-Stage Design a. Overall Design 1) Depth (3.5' min.) 2) Width (30' min.) 3) Length (60' min.) 4) Volume (must be ? V_{BMP}) b. Upper Stage 1) Depth (2' min.) 2) Bottom Slope (2% to low flow channel recommended) c. Bottom Stage 1) Depth (1.5' to 3') 2) Length 3) Volume (10 to 25% of V_{BMP})	 Depth = _____ ft Width = _____ ft Length = _____ ft Volume = _____ ft^3 Depth = _____ ft Slope = _____ % Depth = _____ ft Length = _____ ft Volume = _____ ft^3
4. Forebay Design a. Forebay Volume (5 to 10% of V_{BMP}) b. Outlet pipe drainage time (? 45 min)	Volume = _____ ft^3 Drain time = _____ minutes

http://rcflood.org/downloads/Operations%20and%20Maintenance/BMPHandbook%20_draft7a_.pdf

DESIGN MANUALS

http://www.lgc.org/wordpress/wp-content/uploads/2015/06/Riverbank_LID_Manual_Final_Jan13_highres.pdf

Other Names: Infiltration Trench, Dry Well, Drainage Well, Seepage Pit

Technical Information

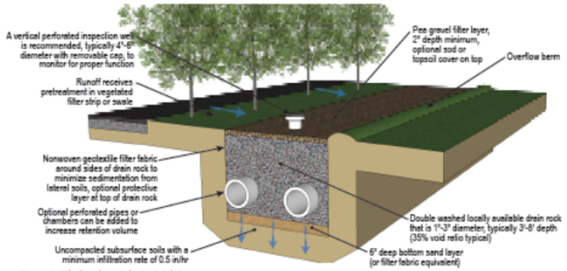


Figure: Infiltration trench typical detail

Design & Sizing Criteria

- Infiltration facilities are volume-based systems sized to capture the WQV within the void space of the storage layer and should infiltrate all stored runoff into the subsoils within a maximum 72 hour drawdown time.
- Requires a minimum subgrade soil infiltration rate of 0.5 in/hr minimum. If soil infiltration rates exceed 2.5 in/hr, runoff should be fully treated (with one or more upstream BMPs) prior to infiltration to protect groundwater quality.
- Requires a 10 foot minimum separation from the bottom of the facility to the seasonally high groundwater elevation.
- Should be placed a minimum of 10 feet from building foundations and 100 feet from drinking water wells.
- Should be installed with a flat bottom to promote uniform infiltration.
- To help prevent clogging and ease maintenance, it is important to provide upstream pretreatment (using filter strips, swales, forebays, or manhole sumps) to remove coarse sediment, particles, and oils.
- If possible, system should be designed to avoid classification as a Class V injection well, which requires submission of an inventory form to the EPA. A Class V injection well is deeper than it is wide.
- If infiltration is not possible, can be installed with an orifice to provide flow and volume control functions without any water quality treatment.

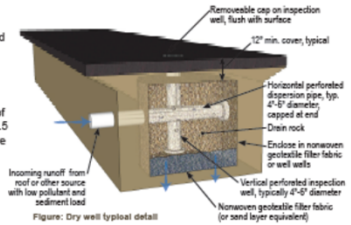


Figure: Dry well typical detail

Proprietary Systems

There are many retention systems designed to maximize subsurface capture volume and that include components for pretreatment and flow control.

Cudo Cubes are an example of a typical modular block system.

Triton stormwater chambers are a typical semi-circular linked chamber system.

Note: Proprietary systems are included for representative purposes only and are not an endorsement of any specific product.

Siting and Suitability

Bioswales are highly versatile stormwater BMPs that effectively reduce pollutants. With a narrow width, bioswales can be integrated into site plans with various configurations and components. Ideal sites for bioswales include the right-of-way of linear transportation corridors and along borders or medians of parking lots. In heavily trafficked areas, curb cuts can be used to delineate boundaries. Bioswales can be combined with other basic and stormwater runoff BMPs to form a treatment train, reducing the required size of a single BMP unit.

Drainage Area: Less than 2 acres and fully stabilized.

Aquifer Protection Zones and Karst: Use impermeable liner to protect subsurface resources and prevent sinkholes.

Head Requirements: Bioswale typically requires a minimum of 2.5 to 3.5 ft of elevation difference between the inlet and outlet to the receiving storm drain network.

Slopes: Slopes draining to bioswale should be 15% or less, side slopes should be 3:1 (H:V) or flatter, and check dams should be used to provide longitudinal bed slopes of 2% (average slope should not exceed 5% from inlet to outlet).

Setbacks: Provide 10-ft setback from structures/foundations, 100-ft setback from septic fields and water supply wells, and 50-ft setback from steep slopes.

Water Table & Bedrock: At least 3 ft separation must be provided between bottom of cut (subgrade) and seasonal high water table, bedrock, or other restrictive features.

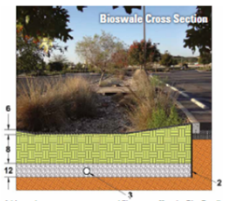
Soil Type: Bioswale can be used in any soils. If subsoil infiltration is less than 0.5 in/hr, an underdrain should be installed. A liner may be needed if subsoils contain expansive clays or calcareous minerals.

Areas of Concern: Infiltration is not allowed at sites with known soil contamination or *hot spots*, such as gas stations. An appropriate impermeable liner must be used in areas of concern.

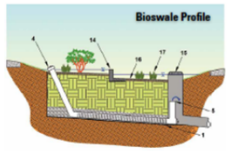
Design Considerations & Specifications

(see Appendix B for details)

		Design Component	General Specification
BMP Function	1	Impermeable liner	If non-infiltrating (per geotechnical investigation), use clay liner, geomembrane liner, or concrete.
	2	Lateral hydraulic restriction barriers	May use concrete or geomembrane to restrict lateral seepage to adjacent subgrades, foundations, or utilities.
	3	Underdrain/ Infiltration	Underdrain required if subsoil infiltration < 0.5 in/hr. Schedule 40 PVC pipe with perforations (slots or holes) every 6 inches. 4-inch diameter lateral pipes spaced no more than 10 ft on center should join a 6-inch collector pipe. If design is fully-infiltrating, ensure that subgrade compaction is minimized.
	4	Cleanouts/ Observation Wells	Provide cleanout ports/observation wells for each underdrain pipe at spacing consistent with local regulations.
	5	Internal Water Storage (IWS)	If using underdrain, the underdrain outlet can be elevated to create a sump for additional moisture retention to promote plant survival and treatment. Top of IWZ should be greater than 18 inches below surface.
	6	Temporary Ponding Depth	Use check dams to provide 6–18 inches (8–12 inches near schools or in residential areas); average ponding depth of 9 inches is recommended.
	7	Drawdown Time	Surface drawdown: 12–24 hrs Subsurface dewatering: 48 hrs.
Soil Media	8	Soil Media Depth	2–4 feet (deeper for better pollutant removal, hydrologic benefits, and deeper rooting depths).
	9	Soil Media Composition	85–88% sand, 8–12% fines, 2–5% plant-derived organic matter (animal wastes or byproducts should never be applied).
	10	Media Permeability	1–6 in/hr infiltration rate (1–2 in/hr recommended).
	11	Chemical Analysis	Total phosphorus < 15 ppm, pH 6–8, CEC > 5 meq/100 g soil.
	12	Drainage Layer	Separate media from underdrain with 2 to 4 inches of washed concrete sand (ASTM C-33), followed by 2 inches of choking stone (ASTM No. 8) over a 1.5-ft envelope of ASTM No. 57 stone.
Routing	13	Inlet/Pretreatment	Provide stabilized inlets and energy dissipation. Install rock armored forebay for concentrated flows, gravel fringe and vegetated filter strip for sheet flows.
	14	Slope and Grade Control	If necessary, use check dams to maintain maximum 2% bed slope. Check dams should extend sufficiently deep to prevent piping (undercutting) below the check dam.
	15	Outlet Configuration	Online: All runoff is routed through system—install an elevated overflow structure or weir at the elevation of maximum ponding. Offline: Only treated volume is diverted to system—install a diversion structure or allow bypass of high flows.
Landscape	16	Mulch	Dimensional chipped hardwood or triple shredded, well-aged hardwood mulch 3-inches-deep.
	17	Vegetation	Native, deep rooting, drought tolerant plants.
	18	Multi-Use Benefits	Provide educational signage, artwork, or wildlife amenities.



A bioswale captures, conveys, and filters runoff at the Rim Retail Center. Lateral hydraulic restriction barriers protect the adjacent pavement subgrade while allowing vertical infiltration.



This schematic represents an online, infiltrating bioswale where all flow is routed through the system—check dams control the longitudinal slope and ensure capture of the design storm volume. Internal water storage is provided to enhance water retention and plant survival by upturning the underdrain.

Maintenance Considerations *(see Appendix F for detailed checklist)*

Task	Frequency	Indicator Maintenance is Needed	Maintenance Notes
Catchment inspection	Weekly or biweekly with routine property maintenance	Excessive sediment, trash, and/or debris accumulation on the surface of bioswale	Permanently stabilize any exposed soil and remove any accumulated sediment. Adjacent pervious areas may need to be regraded.
Inlet inspection		Internal erosion or excessive sediment, trash, and/or debris accumulation	Check for sediment accumulation to ensure that flow into the bioswale is as designed. Remove any accumulated sediment.
Litter/leaf removal and misc. upkeep		Accumulation of litter and debris within bioswale area, mulch around outlet, internal erosion	Litter, leaves, and debris should be removed to reduce the risk of outlet clogging, reduce nutrient inputs to the bioretention area, and to improve facility aesthetics. Erosion should be repaired and stabilized.
Pruning	1–2 times/year	Overgrown vegetation that interferes with access, lines of sight, or safety	Nutrients in runoff often cause bioretention vegetation to flourish.
Mowing	2–12 times/year	Overgrown vegetation that interferes with access, lines of sight, or safety	Frequency depends on location and desired aesthetic appeal and type of vegetation.
Outlet inspection	1 time/year	Erosion at outlet	Remove any accumulated mulch or sediment.
Mulch removal and replacement	1 time/2–3 years	Less than 3 inches of mulch remaining	Remove decomposed fraction and top off with fresh mulch to a total depth of 3 inches
Remove and replace dead plants	1 time/year	Dead plants	Plant die-off tends to be highest during the first year (commonly 10% or greater). Survival rates increase with time.
Temporary Watering	1 time/2–3 days for first 1–2 months	Until establishment and during severely-droughty weather	Watering after the initial year might be required.
Fertilization	1 time initially	Upon planting	One-time spot fertilization for first year vegetation.

BEXAR REGIONAL WATERSHED MANAGEMENT

Bioswale

Description

Bioswales are shallow, open channels that are designed to reduce runoff volume through infiltration. Additionally, bioswales remove pollutants such as trash and debris by filtering water through vegetation within the channel. Swales can serve as conveyance for stormwater and can be used in place of traditional curbs and gutters; however, when compared to traditional conveyance systems the primary objective of a bioswale is infiltration and water quality enhancement rather than conveyance. In addition to reducing the mass of pollutants in runoff, properly maintained bioswales can enhance the aesthetics of a site.

Treatment Efficiency

Runoff Volume	High (unlined)/ Low (lined)	Bacteria	High
Sediment	High	Nutrients	Medium
Trash/debris	High	Heavy Metals	High
Organics	High	Oil & Grease	High

TETRA TECH

SAN ANTONIO RIVER AUTHORITY

Design Professionals

- Site Design
- BMP Design

Government

- Implementing Ordinance
- Reviewing Design
- Staffing/ Resources

Construction and Maintenance

- Certification
- Material Development

CHECKING IN WITH THE COMMUNITY AFTER TRAINING

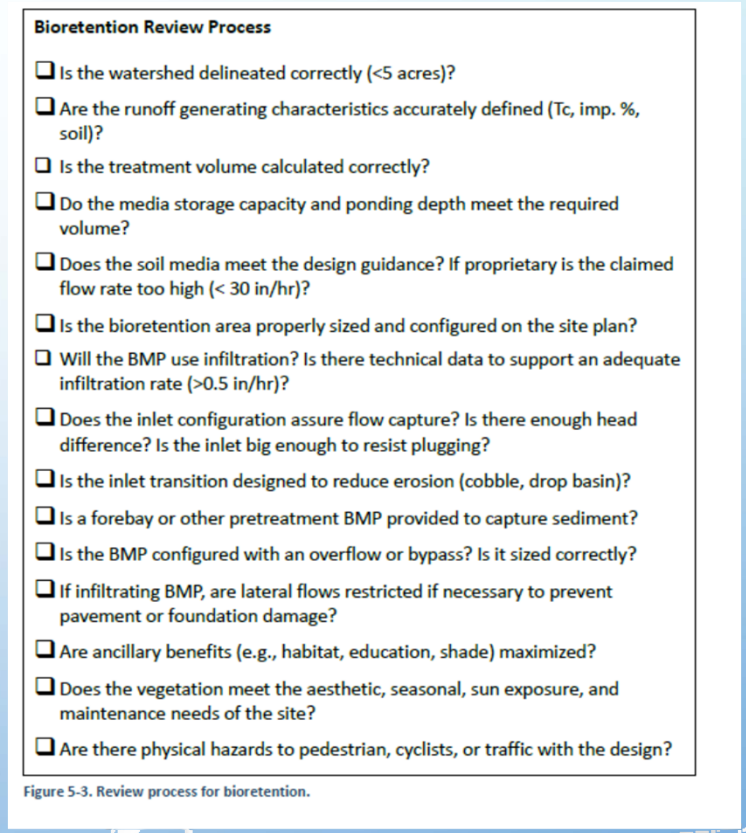
50% of government staff reported having Fewer Concerns about LID after technical and management training.

INCENTIVES

- DEVELOPMENT REQUIREMENT WAIVERS
  - SET BACKS
  - LANDSCAPE REQUIREMENTS
- IMPERVIOUS COVER CREDITS
- FEE WAIVERS
- CREDIT TO MS4 UTILITY ANNUAL FEES
- BELOW-MARKET-RATE LOAN PROGRAMS
- GRANT PROGRAMS

REVIEW- MAINTAINING STANDARDS

- WHO WILL BE CONDUCTING REVIEW?
  - WHAT QUALIFICATION OR TRAINING DO THEY NEED?
- WHAT IS THE REVIEW PROCESS AND WHERE DOES IT FIT IN WITH YOUR CURRENT REVIEW PROCESS?
- HOW DO YOU SIMPLIFY REVIEW?
  - COMPONENTIZED DESIGN WITH STANDARD DETAILS
  - DESIGN WORKSHEETS



Bioretention Review Process

- ❑ Is the watershed delineated correctly (<5 acres)?
- ❑ Are the runoff generating characteristics accurately defined (Tc, imp. %, soil)?
- ❑ Is the treatment volume calculated correctly?
- ❑ Do the media storage capacity and ponding depth meet the required volume?
- ❑ Does the soil media meet the design guidance? If proprietary is the claimed flow rate too high (< 30 in/hr)?
- ❑ Is the bioretention area properly sized and configured on the site plan?
- ❑ Will the BMP use infiltration? Is there technical data to support an adequate infiltration rate (>0.5 in/hr)?
- ❑ Does the inlet configuration assure flow capture? Is there enough head difference? Is the inlet big enough to resist plugging?
- ❑ Is the inlet transition designed to reduce erosion (cobble, drop basin)?
- ❑ Is a forebay or other pretreatment BMP provided to capture sediment?
- ❑ Is the BMP configured with an overflow or bypass? Is it sized correctly?
- ❑ If infiltrating BMP, are lateral flows restricted if necessary to prevent pavement or foundation damage?
- ❑ Are ancillary benefits (e.g., habitat, education, shade) maximized?
- ❑ Does the vegetation meet the aesthetic, seasonal, sun exposure, and maintenance needs of the site?
- ❑ Are there physical hazards to pedestrian, cyclists, or traffic with the design?

Figure 5-3. Review process for bioretention.

TRAINING YOUR REVIEWERS

- NEEDS TO COVER
  - GENERAL CONCEPTS OVERVIEW
    - WHAT AND WHY
  - SITE DESIGN
    - CHANGE IN THOUGHT PROCESS
  - BMP DESIGN
  - CONSTRUCTION TOURS
  - SITE TOURS

DEALING WITH VARIANCES

- DOES YOUR CONTROLLING ORDINANCE ALLOW FOR VARIANCES?
- DOES THE NEW ORDINANCE CONFLICT WITH EXISTING ORDINANCE?
- SET PROCEDURES FOR EVALUATING AND DECISION PROCESS FOR VARIANCES AND APPEALS
- MINIMIZE VARIANCES WITH GOOD LANGUAGE REQUIRING FUNCTION AND MINIMIZING PRESCRIPTION

http://swamplot.com/tag/variances/page/4/

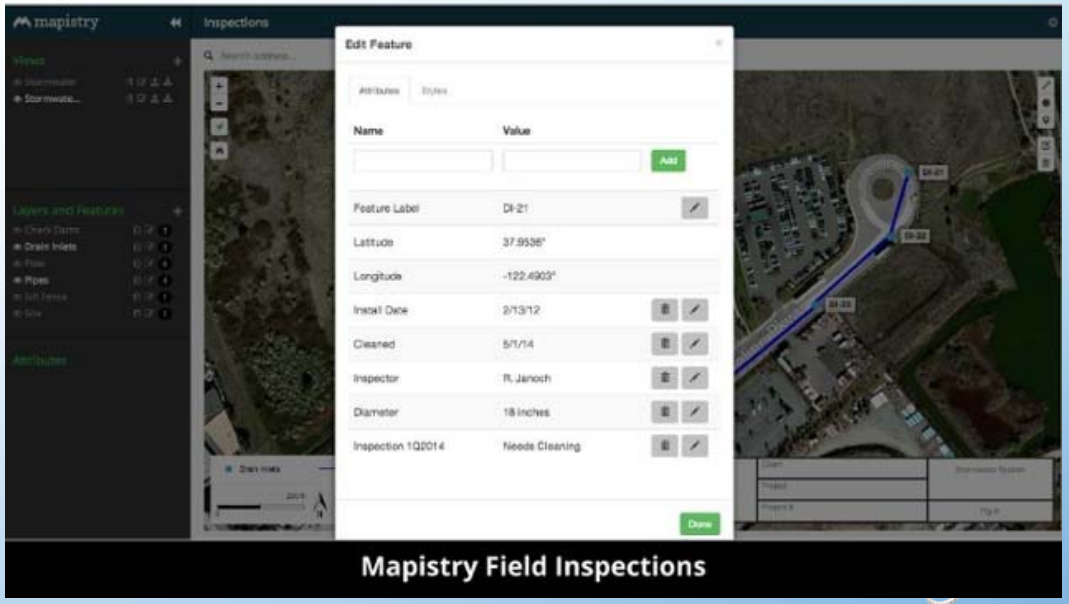
PLAN REVIEW- LEARN FROM OTHER COMMUNITIES

- NORTH CAROLINA STATE
  - REVIEWER CERTIFICATION AND TRAINING
- DENVER
  - DESIGN WORKSHEETS
- PHILADELPHIA
  - STANDARD BMP COMPONENTS, WORKSHEETS, CHECKLISTS
- COLUMBUS, OHIO
  - ONLINE LIBRARY OF STANDARD SPECIFICATIONS
- PORTLAND, OR
  - DECISION MATRIX TO GUIDE DESIGN, WORKSHEETS
- NASHVILLE, TN
  - AS-BUILT SUBMITTAL

MANAGEMENT STRATEGIES

INSPECTION

- IN HOUSE INSPECTION PROGRAM
- REQUIRE- ANNUAL CERTIFICATION BY LICENCED PE/LA
- CROWD SOURCED ALERTING



Mapistry Field Inspections

https://www.mapistry.com/stormwater-bmp-inspection-forms

MAINTENANCE STRATEGIES

- PRIVATE BMPS –
  - REQUIRE A CONTRACT WITH CERTIFIED MAINTENANCE COMPANY
  - REQUIRE ANNUAL INSPECTION
- PUBLIC BMPS –
  - INCORPORATE BMPS INTO PARKS MAINTENANCE (WORKS BEST WHEN BMPS ARE LINKED WITH GREENWAYS AND PARKS)
  - INCORPORATE MAINTENANCE INTO PUBLIC WORKS MAINTENANCE

Source: NCSU-BAE

Figure 4-6. Bioretention area clogged with sediment.

MAINTENANCE TRAINING- FIELD CREWS

- NEED QUALIFIED PERSONNEL TO INSPECT AND MAINTAIN STORMWATER BMPS
  - MS4 PERMIT COMPLIANCE REQUIREMENT
- TRAINING PROGRAM
  - REGISTRATION/CERTIFICATION
    - CHESAPEAKE BAY
    - NORTH CAROLINA
    - SAN ANTONIO RIVER AUTHORITY

MAINTENANCE- BUSINESS/LANDOWNER OUTREACH

- CHALLENGE: WHEN PROPERTY CHANGES HANDS, THE NEW OWNERS MAY NOT BE AWARE THAT THEY OWN STORMWATER INFRASTRUCTURE
- POTENTIAL SOLUTIONS:
  - DEED RECORD
  - REALTOR EDUCATION
  - MAINTENANCE AGREEMENT RENEWAL TIED WITH INCENTIVES
  - ANNUAL CERTIFICATION BY PE

MAINTENANCE- COTTAGE INDUSTRY

- DEMAND CREATES SERVICE SECTOR FOR MAINTENANCE AND RETROFIT CONTRACTORS
- MATERIALS VENDORS

MAINTENANCE- INNOVATIVE APPROACHES

- CROWD SOURCING – MAINTENANCE CONCERNS
  - ONLINE MAPPING / 311 CALL SYSTEM
- HOA PROGRAM
  - LAKE COUNTY, VIRGINIA HOW TO IDENTIFY AND MANAGE COMMUNITY BMPS
- INSPECTION WORKSHEETS AND AUTOMATED SUBMITTAL WITH PHOTOS
  - ST. LOUIS, MO
  - ENCINITAS, CA
- LIST OF REGISTERED STORMWATER MAINTENANCE CONTRACTORS
  - WASHINGTON, DC

LID MAINTENANCE – REOURCES

- CENTER FOR WATERSHED PROTECTION- YOU TUBE HOW TO VIDEO
  - HTTPS://WWW.YOUTUBE.COM/WATCH?V=COFBDMB-Q0U
- WASHINGTON
  - HTTP://WWW.ECY.WA.GOV/PROGRAMS/WQ/STORMWATER/MUNICIPAL/LID/TRAINING/LIDO&MGUIDANCEDOCUMENT.PDF
- CHESAPEAKE BAY
  - HTTP://CHESAPEAKESTORMWATER.NET/TRAINING-LIBRARY/STORMWATER-BMP-MAINTENANCE/
- SAN ANTONIO RIVER AUTHORITY
  - REGISTRATION PROGRAM