integrated Stormwater Management iSWM

REORGANIZE/RE-EVALUATE
SITE DEVELOPMENT CONTROLS
NCTCOG WORKSHOP

FEBRUARY 5, 2020

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INTRODUCTIONS

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URBAN ECOPLAN

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WORKSHOP #2 OUTLINE

- Workshop #1 Recap
- Addressing Feedback
  - Potential technical information updates
  - Reorganization
  - Design/Construction
- Next Steps

WORKSHOP #1 RECAP

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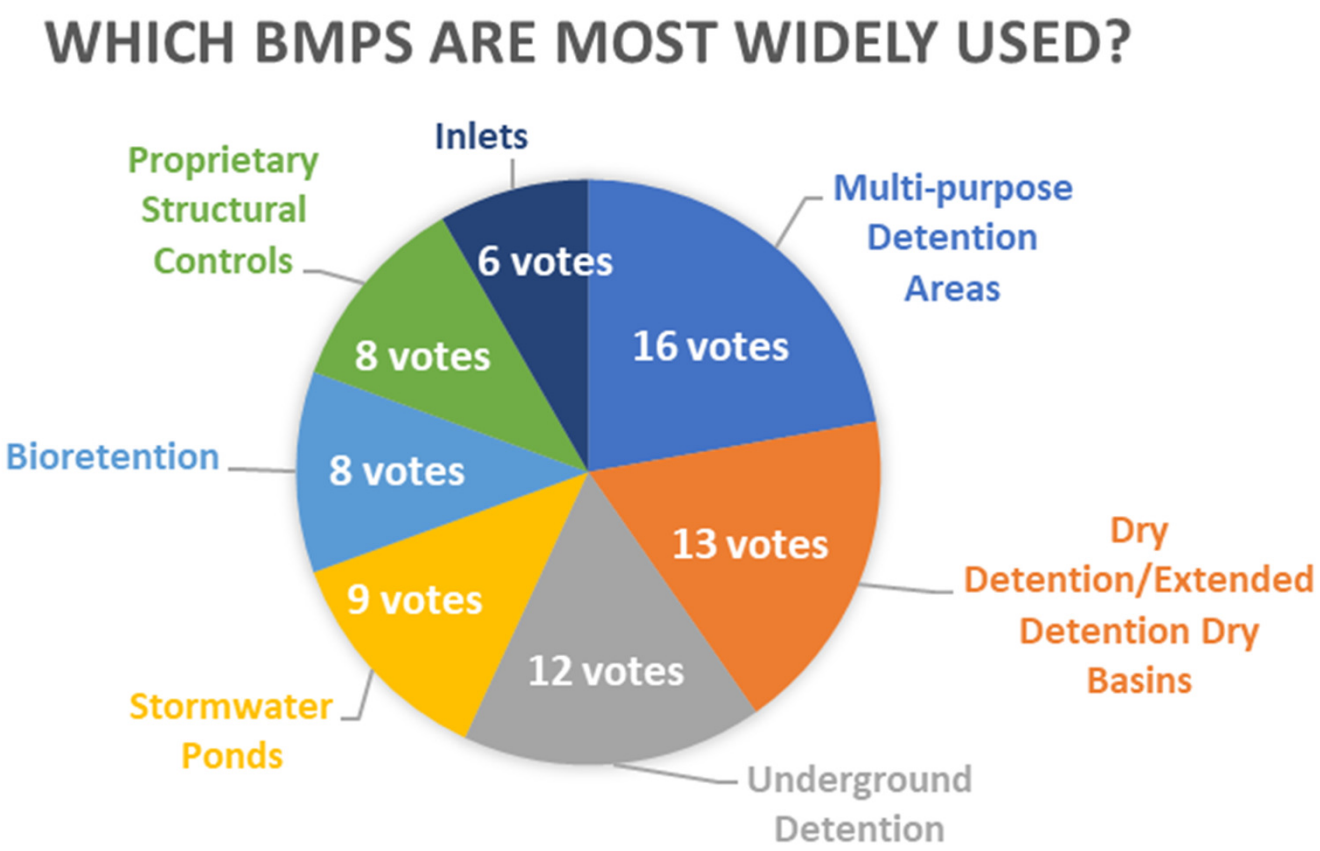
WORKSHOP 1 RECAP



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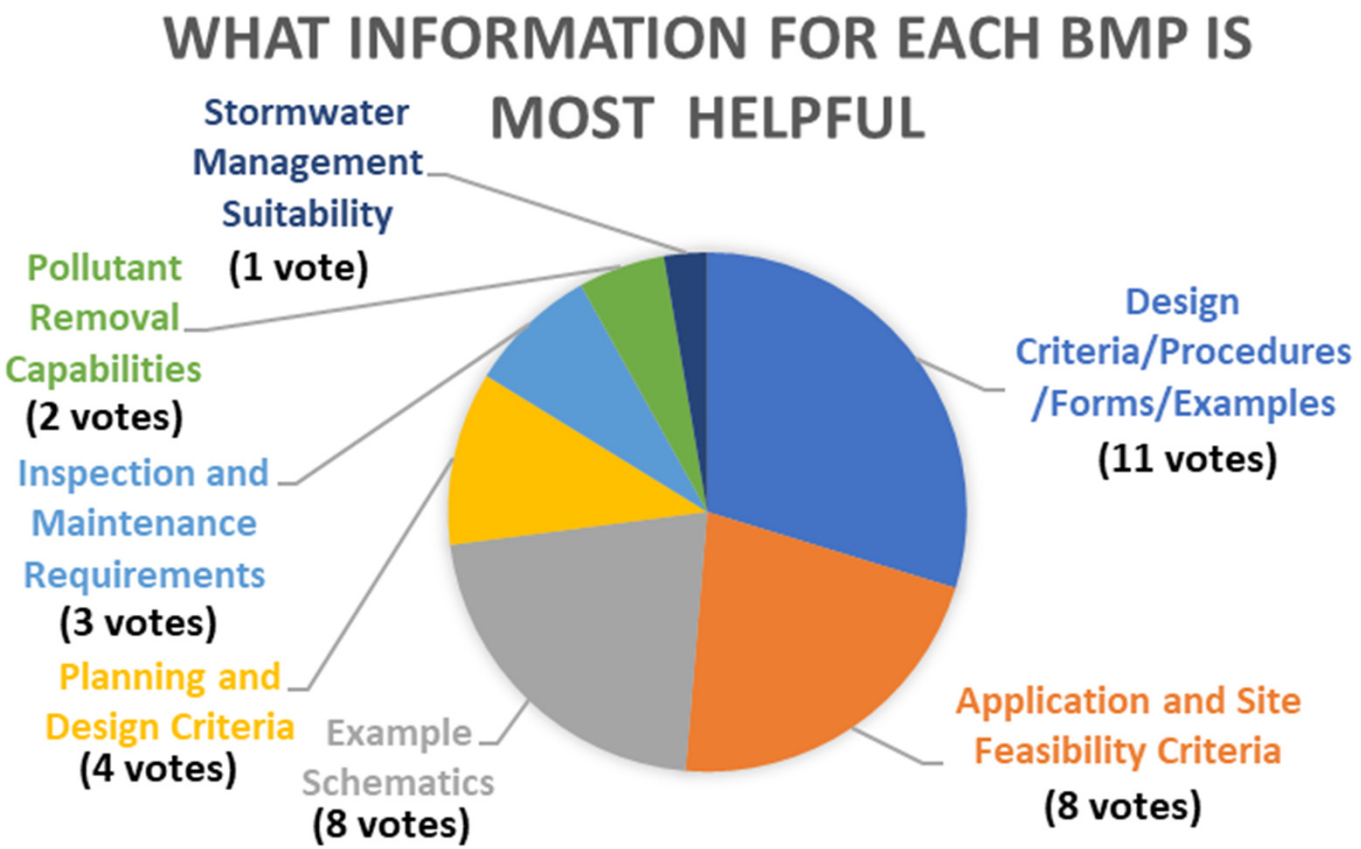

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WORKSHOP 1 RECAP

Is there information you feel is missing for some or all of the BMPs that needs to be added

Post construction testing
Construction sequence and other sensitivities of installation methods during construction.
Sample bid specs
Workman ship and qualifications
Ditto ditto on mosquito
Public information signs, e.g. no mow
Warranty requirements
Wetlands - expand the vegetation list
Ditto on the mosquito issue
Basic labeling for development plans
Identify those BMPs that could be conducive to mosquito breeding and how to design to avoid this.
Media criteria
Bare minimum requirements.
Soil types for all BMPs
Pollutant removal capabilities

WORKSHOP 1 RECAP

From a formatting or organization perspective, what is the most helpful aspect of the technical manual?

Add page # for each type... ie section 2.0 page 1-xx in addition to Sd-28 to Sd-43
Maintenance management pages for each BMP
I like the first page with info at a glance.
Table of contents linking to item
Structure by function

What is your alma mater?

POTENTIAL TECHNICAL INFORMATION UPDATES

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PRIMARY POLLUTANT REMOVAL CAPABILITIES (ISWM)

- Priority pollutants featured
- Potential removal percentages from National Pollutant Removal Database and International Stormwater BMP Database
- Missing bacteria removal rate for several BMPs
- Minimum conservative values based on BMPs designed to specifications of design manual
- Primary and secondary designations related to treatment train guidance

Table 1.2 Design Pollutant Removal Efficiencies for Stormwater Controls (Percentage)

Structural Control	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Fecal Coliform	Metals
Bioretention Areas	80	60	50	---	80
Grass Channel	50	25	20	---	30
Enhanced Dry Swale	80	50	50	---	40
Enhanced Wet Swale	80	25	40	---	20
Alum Treatment	80	80	60	90	75
Filter Strip	50	20	20	---	40
Dry Detention	65	50	30	70	---
Organic Filter	80	60	40	50	75

iSWM™ Technical Manual

Table 1.3 Structural Control Screening Matrix

Category	On-Site Storm Water Controls	STORM WATER TREATMENT SUITABILITY				WATER QUALITY PERFORMANCE			
		Water Quality Protection	Streambank Protection	On-Site Flood Control	Downstream Flood Control	TSS/ Sediment Removal Rate	Nutrient Removal Rate (TP/TN)	Bacteria Removal Rate	Hotspot Application
Bioretention Areas	Bioretention Areas	P	S	S	-	80%	60%/50%	-	✓
Channels	Enhanced Swales	P	S	S	S	80%	25%/40%	-	✓
	Channels, Grass	S	S	P	S	50%	25%/20%	-	
	Channels, Open	-	-	P	S	-	-	-	
Chemical Treatment	Alum Treatment System	P	-	-	-	90%	80%/60%	90%	✓

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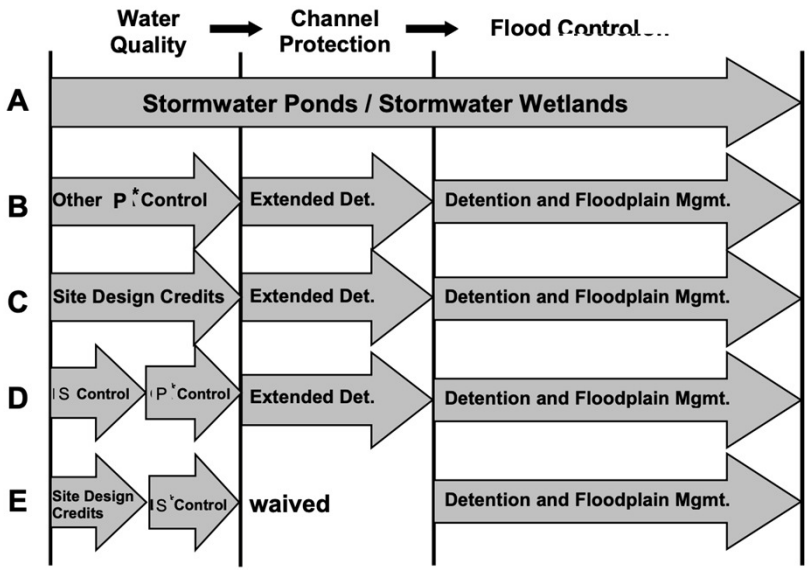
PRIMARY POLLUTANT REMOVAL CAPABILITIES (ISWM)



*P - Primary Control and S - Secondary Control Limited Application.

Figure 1.7 Examples of Structural Controls Used in Series

For treatment trains with two BMPs the following equation is used.

$$E = A + B - \{(A * B)/100\}$$

where:

E = total efficiency
A = efficiency of first or upstream BMP
B = efficiency of second BMP

For treatment trains with three BMPs the following equation is used.

$$E = 0.95 * [A_B + C - \{(A_B * C)/100\}]$$

where:

E = total efficiency
A_B = A+B-{(A*B)/100}
A = efficiency of first or upstream BMP
B = efficiency of second BMP
C = efficiency of third or downstream BMP

PRIMARY POLLUTANT REMOVAL CAPABILITIES (SARA)

- SARA manual combines hydrologic controls and removal processes
- Removal potential provided

Table 3-2. Hydrologic and water quality unit processes for BMPs

Structural BMPs	Hydrologic controls			Removal processes					
	Storage/detention or flow attenuation	Infiltration	Evapotranspiration	Settling	Filtration	Sorption	Bioaccumulation	Biotransformation/ phytoremediation	Other (e.g., photolysis; volatilization)
Infiltration BMPs									
Bioretention	●	(●)	◖	◖	●	◖	●	●	(◖)
Bioswale	(●)	(●)	◖	◖	◖	◖	◖	◖	(◖)
Permeable pavement	●	(●)	○	●	◖	(◖)	○	◖	○
Filtration BMPs									
Planter boxes	●	(●)	◖	◖	●	◖	(●)	(●)	(◖)
Green roofs	(●)	○	●	◖	○	○	(◖)	(◖)	○
Sand filter	◖	(◖)	○	○	●	(◖)	○	○	(◖)
Volume-Storage and Reuse BMPs									
Cisterns/rain barrels	●	○	○	*Treatment typically provided by downstream BMP*					
Stormwater wetlands	(●)	○	◖	●	●	◖	●	●	(◖)
Extended Detention Basin	●	(◖)	◖	●	◖	◖	(◖)	◖	◖
Conveyance and Pretreatment BMPs									
Vegetated filter strip	○	●	●	◖	◖	◖	○	○	○
Vegetated swale	(◖)	(◖)	◖	●	●	○	○	○	○

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PRIMARY POLLUTANT REMOVAL CAPABILITIES (SARA)

- SARA BMP selection matrix includes priority pollutant removal capacity
- References detailed pollutant removal efficiencies when built to meet specifications provided in appendix

Attribute		Bioretention		Bioswale		Permeable Pavement	
		Infiltrating	**Lined**	**Infiltrating**	**Lined**	**Infiltrating**	**Lined**
Edwards Aquifer Zone Allowed (see Section 2.2)		Artesian	All	Artesian	Artesian	Artesian, Contributing	All
Typical contributing drainage area (acres)		< 5		< 2		0[a]	
Min. elevation difference between inlet and outlet (ft)		3.5 (2.5 if using IWS)		3.5 (2.5 if using IWS)		1 to 2 (depends on design)	
Separation of subgrade from bedrock and seasonal high water table (ft)		≥ 3		≥ 3		≥ 3	
Practice slope		< 2%		< 2%		< 2%	
Underdrain required?		If soil infiltration < 0.5 in/hr	Yes	If soil infiltration < 0.5 in/hr	Yes	If soil infiltration < 0.5 in/hr	Yes
Pollutant Removal[e]	Sediments	High		High		High	
	Nutrients	Medium		Medium		Low	
	Trash	High		High		High	
	Metals	High		High		High	
	Bacteria	High		High		Medium	
	Oil and grease	High		High		Medium	
	Organics	High		High		Low	
Runoff volume reduction		High	Low	High	Low	High	Low

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PRIMARY POLLUTANT REMOVAL CAPABILITIES (SARA)

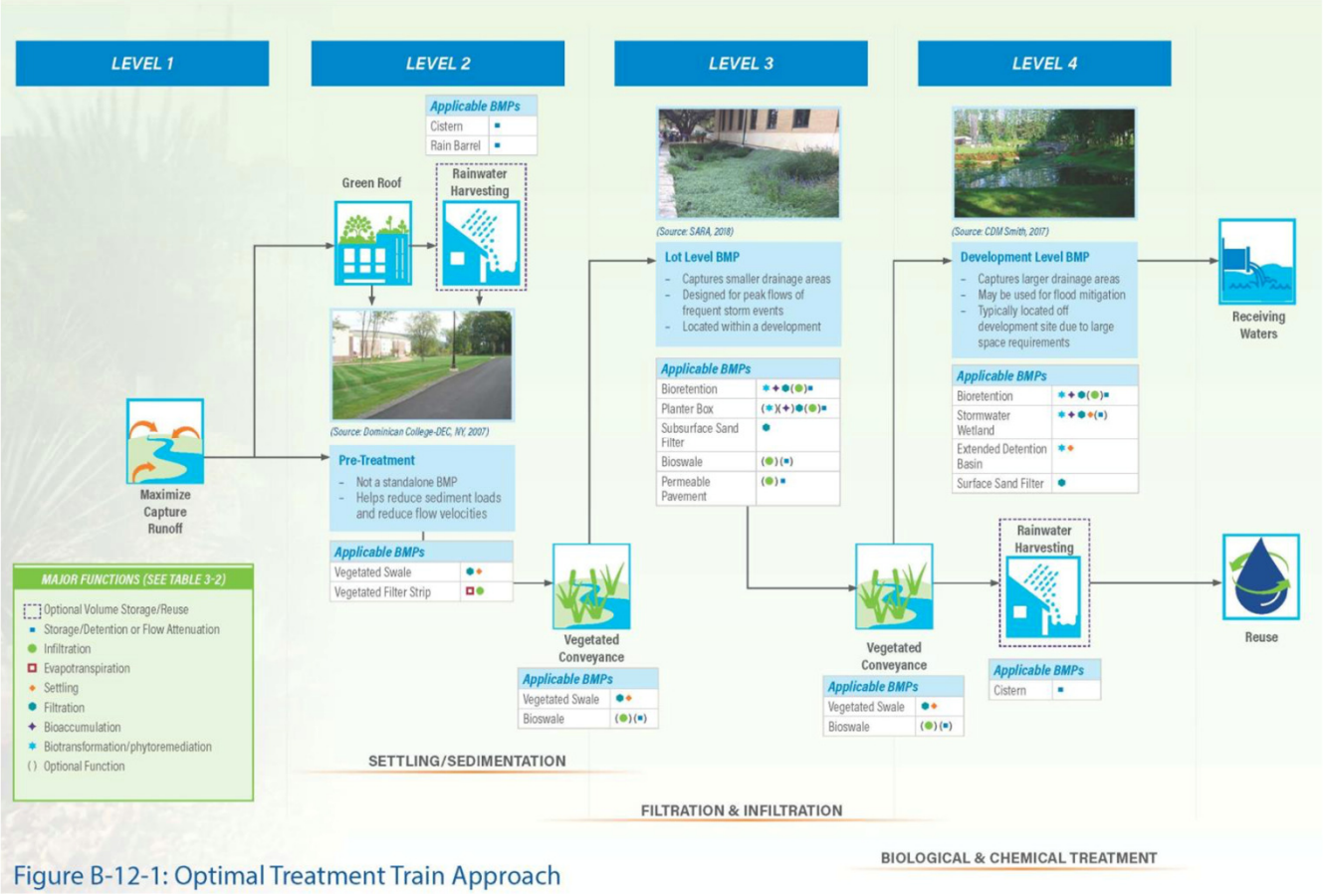

Figure B-12-1: Optimal Treatment Train Approach

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OPEN DISCUSSION: PRIMARY POLLUTANT REMOVAL CAPABILITIES

iSWM provides conservative pollutant removal efficiencies along with guidance for treatment train calculations. This allows the use of both primary and secondary BMPS to meet water quality treatment goals.

Should this planning and design approach be modified? (i.e. remove percentage removal efficiencies, include more information about pollutant removal processes for each BMP)

AT A GLANCE (ISWM)

- Design Criteria
- Advantages / Benefits
- Disadvantages / Limitations
- Maintenance Requirements
- Pollutant Removal
- Suitability
- Implementaton Considerations

2.0 Bioretention

Structural Stormwater Control

Description: Shallow stormwater basin or landscaped area that utilizes engineered soils and vegetation to capture and treat runoff.

KEY CONSIDERATIONS

DESIGN CRITERIA:

- Maximum contributing drainage area of 5 acres (< 2 acres recommended)
- Often located in "landscaping islands"
- Treatment area consists of grass filter, sand bed, ponding area, organic/mulch layer, planting soil, and vegetation
- Typically requires 5 feet of head

ADVANTAGES / BENEFITS:

- Applicable to small drainage areas
- Good for highly impervious areas, flexible siting
- Good retrofit capability
- Relatively low maintenance requirements
- Can be planned as an aesthetic feature

DISADVANTAGES / LIMITATIONS:

- Requires extensive landscaping if in public area
- Not recommended for areas with steep slopes

MAINTENANCE REQUIREMENTS:

- Inspect and repair/replace treatment area components

POLLUTANT REMOVAL

80%	**Total Suspended Solids**
60/50%	**Nutrients** - Total Phosphorus / Total Nitrogen removal
M	**Metals** - Cadmium, Copper, Lead, and Zinc removal
No Data	**Pathogens** - Coliform, Streptococci, E. Coli removal

STORMWATER MANAGEMENT SUITABILITY

- [P] **Water Quality Protection**
- [S] **Streambank Protection**
- [S] **On-Site Flood Control**
- [ ] **Downstream Flood Control**

Accepts Hotspot Runoff: Yes (requires impermeable liner)
S - in certain situations

IMPLEMENTATION CONSIDERATIONS

- [M] **Land Requirement**
- [M] **Capital Cost**
- [L] **Maintenance Burden**

Residential Subdivision Use: Yes
High Density/Ultra-Urban: Yes
Drainage Area: 5 acres max. (< 2 acres recommended)
Soils: Planting soils must meet specified criteria; No restrictions on surrounding soils
Other Considerations: Use of native plants is recommended

L=Low **M**=Moderate **H**=High

4.0 Grass Channel

Structural Stormwater Control

Description: Vegetated open channels designed to filter stormwater runoff and meet velocity targets for the water quality design storm and the "Streambank Protection" storm event.

KEY CONSIDERATIONS

DESIGN CRITERIA:

- Should not be used on slopes greater than 4%; slopes between 1% and 2% recommended
- Ineffective unless carefully designed to achieve low flow rates in the channel (<1.0 ft/s)

ADVANTAGES / BENEFITS:

- Can be used as part of the runoff conveyance system to provide pretreatment
- Grass channels can act to partially infiltrate runoff from small storm events if underlying soils are pervious
- Less expensive to construct than curb and gutter systems

DISADVANTAGES / LIMITATIONS:

- May require more maintenance than curb and gutter system
- Cannot alone achieve the 80% TSS removal target
- Potential for bottom erosion and re-suspension
- Standing water may not be acceptable in some areas

POLLUTANT REMOVAL

50%	**Total Suspended Solids**
25/20%	**Nutrients** - Total Phosphorus / Total Nitrogen removal
30%	**Metals** - Cadmium, Copper, Lead, and Zinc removal
No data	**Pathogens** - Coliform, Streptococci, E.Coli removal

STORMWATER MANAGEMENT SUITABILITY

- [S] **Water Quality Protection**
- [S] **Streambank Protection**
- [P] **On-Site Flood Control**
- [S] **Downstream Flood Control**

IMPLEMENTATION CONSIDERATIONS

- [H] **Land Requirement**
- [L] **Capital Cost**
- [M] **Maintenance Burden**

Residential Subdivision Use: Yes
High Density/Ultra-Urban: *No*
Drainage Area: *5 acres max.*
Soils: *No restrictions*
Other Considerations:

- Curb and gutter replacement

L=Low **M**=Moderate **H**=High

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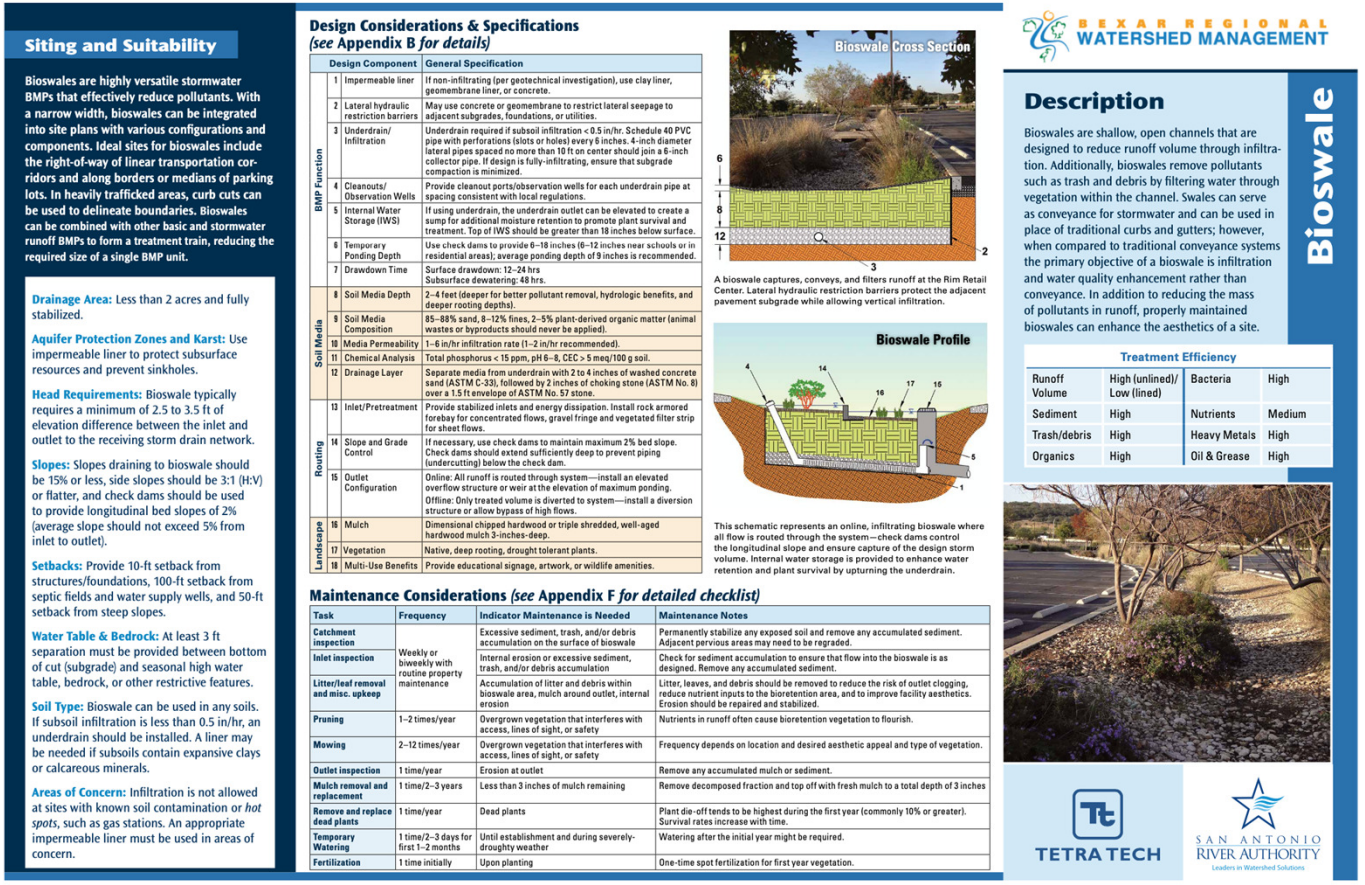
AT A GLANCE (SAN ANTONIO RIVER AUTHORITY)

- Siting and Suitability
- Design Considerations & Specifications
- **Expanded Maintenance Considerations**
- Treatment Efficiency
- Pollutant Removal
- **Cross Section**
- **Profile**



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 IWS should be greater than 18 inches below surface.
	6	Temporary Ponding Depth	Use check dams to provide 6–18 inches (6–12 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

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AT A GLANCE (SAN DIEGO COUNTY AND PHILADELPHIA)

E.15 INF-2 Bioretention

MS4 Permit Category
Retention

Manual Category
Infiltration

Applicable Performance Standard
Pollutant Control
Flow Control

Primary Benefits
Volume Reduction
Treatment
Peak Flow Attenuation

Photo Credit: Ventura County Technical Guidance Document

Description

Bioretention (bioretention without underdrain) facilities are vegetated surface water systems that filter water through vegetation and soil, or engineered media prior to infiltrating into native soils. These facilities are designed to infiltrate the full DCV. Bioretention facilities are commonly incorporated into the site within parking lot landscaping, along roadsides, and in open spaces. They can be constructed inground or partially aboveground, such as planter boxes with open bottoms (no impermeable liner at the bottom) to allow infiltration. Treatment is achieved through filtration, sedimentation, sorption, infiltration, biochemical processes and plant uptake.

Typical bioretention without underdrain components include:

- Inflow distribution mechanisms (e.g, perimeter flow spreader or filter strips)
- Energy dissipation mechanism for concentrated inflows (e.g., splash blocks or riprap)
- Shallow surface ponding for captured flows
- Side slope and basin bottom vegetation selected based on expected climate and ponding depth
- Non-floating mulch layer
- Media layer (planting mix or engineered media) capable of supporting vegetation growth
- Filter course layer consisting of aggregate to prevent the migration of fines into uncompacted native soils or the optional aggregate storage layer

DEVELOPMENT ATTRIBUTES

Construction Costs	LOW
Operations & Maintenance Costs	MODERATE
Likeliness of Failure	LOW
Ground-Level Encroachment	HIGH
Building Footprint Encroachment	MODERATE
Triple Bottom Line Benefits	HIGH

Bioinfiltration/ Bioretention

Description

Bioinfiltration and bioretention SMPs, or rain gardens, are vegetated depressions or basins that use surface storage, vegetation, planting soil, outlet controls, and other components to treat, detain, and retain stormwater runoff. These SMPs provide high-performance and cost-effective stormwater management, green space, and triple bottom line benefits. Both SMPs reduce stormwater volume and pollution by filtering runoff through a vegetated soil medium that promotes evapotranspiration. Bioinfiltration SMPs remove stormwater via infiltration into surrounding soils while bioretention SMPs attenuate runoff with flow-regulating underdrains. These SMPs can be found in a variety of configurations from relatively large and open vegetated basins to small-scale SMPs contained within flow-through planter boxes.

Key Advantages

- Flexible layout and easy to incorporate in landscaped areas
- Very effective at removing pollutants and reducing runoff volumes
- Generally one of the more cost-effective stormwater management options
- Relatively low maintenance activities costs
- Can contribute to better air quality and help reduce urban heat island impacts
- Can improve property values and site aesthetics through attractive landscaping
- Eligible for inclusion in an Expedited PCSMP Review project

Key Limitations

- May need to be combined with other SMPs to meet the Flood Control requirement
- May have limited opportunities for implementation due to the amount of open space available at the site

COMPLIANCE ATTRIBUTES

Water Quality Effluent Pollutant Load: **Bioinfiltration**	Water Quality Effluent Pollutant Load: **Bioretention**	Water Quality Infiltration & Volume Reduction: **Bioinfiltration**	Water Quality Infiltration & Volume Reduction: **Bioretention**	Water Quality Evapotranspiration	Water Quality Rate Control	Channel Protection/ Flood Control/ PHS Rate Control
LOW	MODERATE	HIGH	MODERATE	MODERATE	Yes	MODERATE

A description of each evaluated attribute can be found in the SMP Hierarchy Ranking Criteria in Section 3.2.4.

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The technical manual's current summary pages:

Currently provide enough detail (no change needed)

Need more details (i.e. maintenance considerations, cross section, profile, etc.)

VEGETATION TYPES (SAN ANTONIO RIVER AUTHORITY)

Appendix E. Plant List

Common name	*Scientific name*	Native to SARB[1]	Size		Evergreen (E) Deciduous (D) or Semi	Lifespan / Duration (Annual [A], Perennial [P], Biennial [B])	Light			Soil Moisture				Comments
			Height	Spread			Sun	Part sun/shade	Shade	Dry	Moist	Wet	Shallow water	
Rock rose	*Pavonia lasiopetala*	✓	4'	4'	D	P	✓	✓						Showy flowers, Attracts pollinators
Texas lantana	*Lantana urticoides (L. horrida)*	✓	2'-6'	2'-6'	E	P	✓	✓						Showy flowers, Attracts pollinators , stems become thorny with age
Texas sage	*Leucophyllum frutescens*	✓	2'-8'	2'-8'	E	P	✓	✓						Showy flowers, pollinators
Texas star hibiscus	*Hibiscus coccineus*		3'-6'	3'-6'	D	P	✓							Showy flowers
Turk's cap	*Malvaviscus arboreus var. drummondii*	✓	3'-5'	3'-5'	E	P		✓	✓					Showy flowers & fruits, Attracts pollinators
GRASSES & GRASS-LIKE FORBS														
Big bluestem	*Andropogon gerardii*	✓	4'-8'	1'-3'	E*	P	✓	✓						Bunchgrass, droops with high soil moisture
Buffalograss	*Bouteloua dactyloides*	✓	6"-12"	spreads	S	P	✓							Spreads by rhizomes
Bushy bluestem	*Andropogon glomeratus*	✓	2'-5'	spreads	E*	P	✓							Showy seedheads
Canada wildrye	*Elymus canadensis*	✓	2'-4'	spreads	E*	P	✓	✓						Showy seedheads , establishes quickly
Cane bluestem	*Bothriochloa barbinodis*	✓	1'-3'	spreads	E*	P	✓							
Eastern gamagrass	*Tripsacum dactyloides*	✓	3'-6'	3'-4'	E	P		✓						Soil stabilizer

VEGETATION TYPES (SAN DIEGO COUNTY)

F.3 Plant List for Bioretention Facilities

Plant Name		Irrigation Requirements		Preferred Location in Basin		Applicable Bioretention Sections (Un-Lined Facilities)				Applicability to Flow-Through Planter? (Lined Facility)	
Latin Name	Common Name	Temporary Irrigation during Plant Establishment Period	Permanent Irrigation (Drip / Spray)[1]	Basin Bottom	Basin Side Slopes	Section A Treatment-Only Bioretention in Hydrologic Soil Group A or B Soils	Section B Treatment-Only Bioretention in Hydrologic Soil Group C or D soils	Section C Treatment Plus Flow Control Bioretention in Hydrologic Soil Group A or B Soils	Section D Treatment Plus Flow Control Bioretention in Hydrologic Soil Group C or D Soils	**NO** Applicable to Un-lined Facilities Only (Bioretention Only)	**YES** Can Use in Lined or Un-Lined Facility (Flow-Through Planter OR Bioretention)
TREES[2]											
Alnus rhombifolia	White Alder	X		X	X	X	X	X	X	X	
Platanus racemosa	California Sycamore	X		X	X	X	X	X	X	X	
Salix lasiolepsis	Arroyo Willow	X			X	X	X	X	X	X	
Salix lucida	Lance-Leaf Willow	X			X	X	X	X	X	X	
Sambucus mexicana	Blue Elderberry	X			X	X	X	X	X	X	
SHRUBS / GROUNDCOVER											
Achillea millefolium	Yarrow	X			X	X	X				X
Agrostis palens	Thingrass	X			X	X	X	X	X		X
Anemopsis californica	Yerba Manza	X			X	X	X	X	X		X
Baccharis douglasii	Marsh Baccahris	X	X	X		X	X	X	X		X
Carex praegracillis	California Field Sedge	X	X	X		X	X	X	X		X
Carex spissa	San Diego Sedge	X	X	X		X	X	X	X		X
Carex subfusca	Rusty Sedge	X	X	X	X	X	X	X	X		X
Distichlis spicata	Salt Grass	X	X	X		X	X	X	X		X

OPEN DISCUSSION: VEGETATION TYPES

Would it be useful to add a North Texas vegetation table similar to examples provided?

Common name	*Scientific name*	Native to SARB[1]	Size		Evergreen (E) Deciduous (D) or Semi	Lifespan / Duration (Annual [A], Perennial [P], Biennial [B])	Light			Soil Moisture				Comments
			Height	Spread			Sun	Part sun/shade	Shade	Dry	Moist	Wet	Shallow water	
Rock rose	*Pavonia lasiopetala*	✓	4'	4'	D	P	✓	✓						Showy flowers, Attracts pollinators
Texas lantana	*Lantana urticoides (L. horrida)*	✓	2'-6'	2'-6'	E	P	✓	✓						Showy flowers, Attracts pollinators , stems become thorny with age
Texas sage	*Leucophyllum frutescens*	✓	2'-8'	2'-8'	E	P	✓	✓						Showy flowers, pollinators
Texas star hibiscus	*Hibiscus coccineus*		3'-6'	3'-6'	D	P	✓							Showy flowers
Turk's cap	*Malvaviscus arboreus var. drummondii*	✓	3'-5'	3'-5'	E	P		✓	✓					Showy flowers & fruits, Attracts pollinators
GRASSES & GRASS-LIKE FORBS														
Big bluestem	*Andropogon gerardii*	✓	4'-8'	1'-3'	E*	P	✓	✓						Bunchgrass, droops with high soil moisture
Buffalograss	*Bouteloua dactyloides*	✓	6"-12"	spreads	S	P	✓							Spreads by rhizomes
Bushy bluestem	*Andropogon glomeratus*	✓	2'-5'	spreads	E*	P	✓							Showy seedheads
Canada wildrye	*Elymus canadensis*	✓	2'-4'	spreads	E*	P	✓	✓						Showy seedheads , establishes quickly
Cane bluestem	*Bothriochloa barbinodis*	✓	1'-3'	spreads	E*	P	✓							
Eastern gamagrass	*Tripsacum dactyloides*	✓	3'-6'	3'-4'	E	P		✓						Soil stabilizer

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Should the secondary control identifier for Extended Dry and Dry Detention be removed from Technical Manual?

Yes

No

Unsure

EXTENDED DRY AND DRY DETENTION SECONDARY CONTROL

Table 3.6 Suitability of Stormwater Controls to Meet *integrated* Focus Areas

Category	*integrated* Stormwater Controls	TSS/ Sediment Removal Rate	Water Quality Protection	Streambank Protection	On-Site Flood Control	Downstream Flood Control
Channels	Enhanced Swales	80%	P	S	S	S
	Channels, Grass	50%	S	S	P	S
	Channels, Open	-	-	-	P	S
Chemical Treatment	Alum Treatment System	90%	P	-	-	-
Conveyance System Components	Culverts	-	-	-	P	P
	Energy Dissipation	-	-	P	S	S
	Inlets/Street Gutters	-	-	-	P	-
	Pipe Systems	-	-	P	P	P
Detention	Detention, Dry	65%	S	P	P	P
	Detention, Extended Dry	65%	S	P	P	P
	Detention, Multi-purpose Areas	-	-	P	P	P
	Detention, Underground	-	-	P	P	P

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REORGANIZATION

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TABLE 1.3

Table 1.3 Structural Control Screening Matrix

Category	On-Site Storm Water Controls	STORM WATER TREATMENT SUITABILITY				WATER QUALITY PERFORMANCE				SITE APPLICABILITY					IMPLEMENTATION CONSIDERATIONS			
		Water Quality Protection	Streambank Protection	On-Site Flood Control	Downstream Flood Control	TSS/ Sediment Removal Rate	Nutrient Removal Rate (TP/TN)	Bacteria Removal Rate	Retrofit Application	Drainage Area (acres)	Space Req'd (% of tributary imp. Area)	Site Slope	Minimum Head Required	Depth to Water Table	Residential Subdivision Use	High Density/Ultra Urban	Capital Cost	Maintenance Burden
Bioretention Areas	Bioretention Areas	P	S	S	-	80%	60%/50%	-	✓	5 max***	5-7%	6% max	5 ft	2 feet	✓	✓	Moderate	Low
Channels	Enhanced Swales	P	S	S	S	80%	25%/40%	-	✓	5 max	10-20%	4% max		below WT	✓		High	Low
	Channels, Grass	S	S	P	S	50%	25%/20%	-							✓		Low	Moderate
	Channels, Open	-	-	P	S	-	-	-									Low	Low
Chemical Treatment	Alum Treatment System	P	-	-	-	90%	80%/60%	90%	✓	25 min	None				✓	✓	High	High
Conveyance Components	Culverts	-	-	P	P	-	-	-							✓	✓	Low	Low
	Energy Dissipation	-	P	S	S	-	-	-							✓	✓	Low	Low
	Inlets/Street Gutters	-	-	P	-	-	-	-							✓	✓	Low	Low
	Pipe Systems	-	P	P	P	-	-	-							✓	✓	Low	Low
Detention	Detention, Dry	S	P	P	P	65%	50%											
	Detention, Extended Dry	S	P	P	P	65%	50%											
	Detention, Multi-purpose Areas	-	P	P	P	-												
	Detention, Underground	-	P	P	P	-												
Filtration	Filter Strips	S	-	-	-	50%	20%											
	Organic Filters	P	-	-	-	80%	60%											
	Planter Boxes	P	-	-	-	80%	60%											
	Sand Filters, Surface/ Perimeter	P	S	-	-	80%	50%											
	Sand Filters, Underground	P	-	-	-	80%	50%											
Hydrodynamic Devices	Gravity (Oil-Grit) Separator	S	-	-	-	40%	5%											
Infiltration	Downspout Drywell	P	-	-	-	80%	60%											
	Infiltration Trenches	P	S	-	-	80%	60%											
	Soakage Trenches	P	S	-	-	80%	60%											
Ponds	Wet Pond	P	P	P	P	80%	50%											
	Wet ED Pond	P	P	P	P	80%	50%											
	Micropool ED Pond	P	P	P	P	80%	50%											
	Multiple ponds	P	P	P	P	80%	50%											
Porous Surfaces	Green Roof	P	S	-	-	85%	95%											
	Modular Porous Paver Systems	S	S	-	-	**	80%											
	Porous Concrete	S	S	-	-	**	50%											
Proprietary Systems	Proprietary Systems ****	S	S	S	S	*	*											
Re-Use	Rain Harvesting	P	-	-	-	-												
Wetlands	Wetlands, Storm Water	P	P	P	P	80%	40%/30%	70%										
	Wetlands, Submerged Gravel	P	P	S	-	80%	50%/20%	70%	✓	5 min		3% max	2 to 3 ft	below WT	✓	✓	Moderate	High

Table 1.3 Structural Control Screening Matrix

✓ - Meets suitability criteria

P - Primary Control, meets suitability criteria

S - Secondary Control, can be incorporated into the structural control in certain situations

* Provides less than 80% TSS

Category	On-Site Storm Water Controls	STORM WATER TREATMENT SUITABILITY			
		Water Quality Protection	Streambank Protection	On-Site Flood Control	Downstream Flood Control
Bioretention Areas	Bioretention Areas	P	S	S	-
Channels	Enhanced Swales	P	S	S	S
	Channels, Grass	S	S	P	S
	Channels, Open	-	-	P	S
Chemical Treatment	Alum Treatment System	P	-	-	-
Conveyance Components	Culverts	-	-	P	P
	Energy Dissipation	-	P	S	S
	Inlets/Street Gutters	-	-	P	-
	Pipe Systems	-	P	P	P

INTEGRATED DESIGN FOCUS AREAS

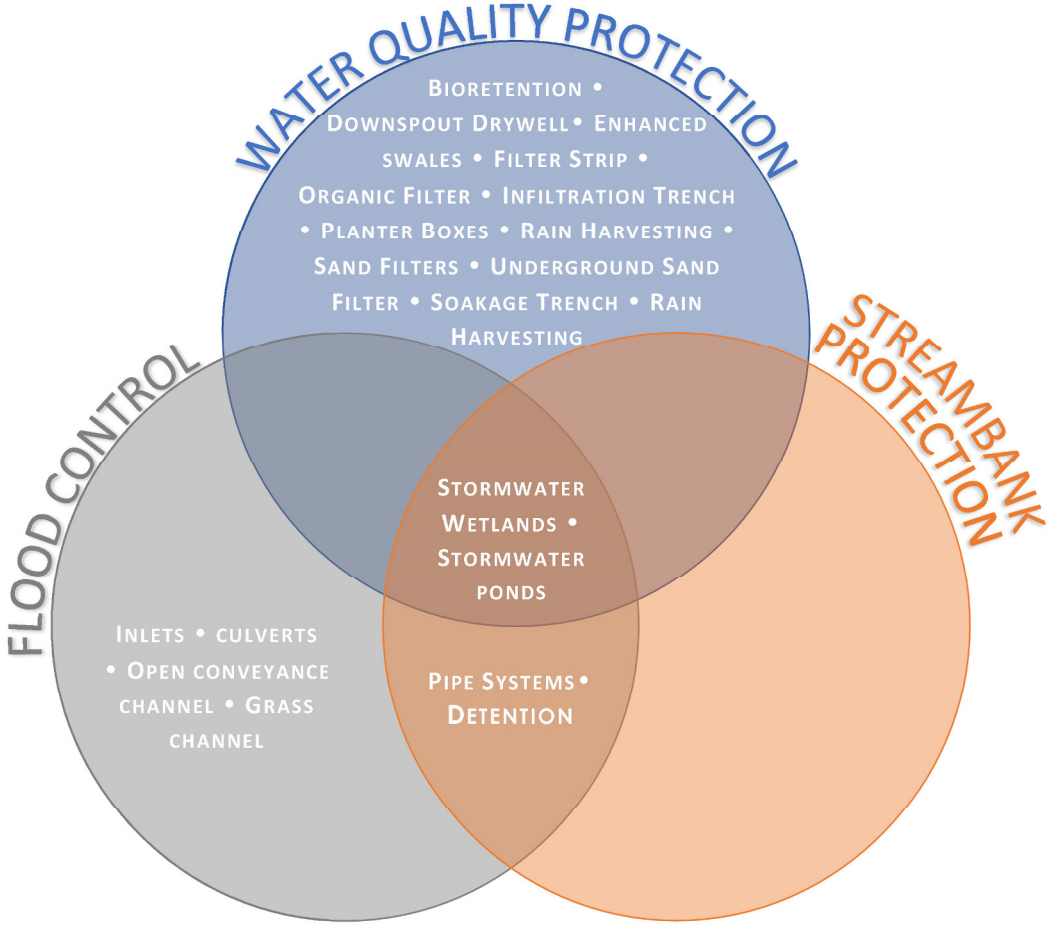

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TABLE 1.1 CATEGORIES

- **FILTRATION**
  - Filter strip
  - Organic Filter
  - Planter Boxes
  - Sand Filters
- **HYDRODYNAMIC DEVICES**
  - Gravity (Oil-Grit) Separator
- **INFILTRATION**
  - Downspout dry wells
  - Infiltration Trench
  - Soakage Trenches
- **STORMWATER PONDS**
  - Wet and Dry Detention
- **POROUS SURFACES**
  - Green roofs
  - Modular porous paver systems
  - Porous Concrete
- **PROPRIETARY SYSTEMS**
  - Commercial stormwater controls
- **RE-USE**
  - Rain harvesting (tanks/barrels)
- **STORMWATER WETLANDS**

Table 1.1 Structural Controls

Structural Control	Description
Filtration • Filter Strip • Organic Filter • Planter Boxes • Surface Sand Filter/ Perimeter Sand Filter • Underground Sand Filter	• *Filter strips* provide "biofiltering" of stormwater runoff as it flows across the grass surface. However, filter strips alone cannot meet the 70% TSS removal performance goal. Consequently, filter strips should only be used as pretreatment measure or as part of a treatment train approach. • *Organic filters* are surface sand filters where organic materials such as a leaf compost or peat/sand mixture are used as the filter media. These media may be able to provide enhanced removal of some contaminants, such as heavy metals. Given their potentially high maintenance requirements, they should only be used in environments that warrant their use. • *Planter boxes* are used on impervious surfaces in highly urbanized areas to collect and detain / infiltrate rainfall and runoff. The boxes may be prefabricated or constructed in place and contain growing medium, plants, and a reservoir. • *Sand filters* are multi-chamber structures designed to treat stormwater runoff through filtration, using a sand bed as its primary filter media. Filtered runoff may be returned to the conveyance system, or allowed to partially exfiltrate into the soil. • *Underground sand filters* are sand filter systems located in an underground vault. These systems should only be considered for extremely high density or space-limited sites.
Hydrodynamic Devices • Gravity (Oil-Grit) Separator	*Hydrodynamic controls* use the movement of stormwater runoff through a specially designed structure to remove target pollutants. They are typically used on smaller impervious commercial sites and urban hotspots. These controls typically do not meet the Primary TSS removal performance goal and therefore should only be used as a pretreatment measure and as part of a treatment train approach.
Infiltration • Downspout Dry Wells • Infiltration Trench • Soakage Trenches	• *Downspout dry wells* are essentially perforated manholes, but they can be manufactured in various sizes. Located underground, they allow stormwater infiltration even in highly urbanized areas. They should be used in conjunction with some type of pretreatment devices where there are minimal risks of groundwater contamination. • An *infiltration trench* is an excavated trench filled with stone aggregate used to capture and allow infiltration of stormwater runoff into the surrounding soils from the bottom and sides of the trench. • *Soakage trenches* are a variation of infiltration trenches. Soakage trenches drain through a perforated pipe buried in gravel. They are used in highly impervious areas where conditions do not allow surface infiltration and where pollutant concentrations in runoff are minimal (i.e. non-industrial rooftops). They may be used in conjunction with other stormwater devices, such as draining downspouts or planter boxes.

EXAMPLES

- **INFILTRATION**
  - Bioretention
  - Bioswales
  - Permeable Pavement
- **FILTRATION**
  - Planter Boxes
  - Green Roofs
  - Sand Filters
- **VOLUME-STORAGE AND REUSE**
  - Stormwater wetlands
  - Stormwater cisterns
  - Extended detention basins
- **CONVEYANCE AND PRETREATMENT BMPS**
  - Vegetated swales
  - Vegetated filter strips

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EXAMPLES

- **Harvest & Use**
  - Cistern
- **Infiltration**
  - Infiltration basin
  - Bioretention
  - Permeable Pavement
- **Unlined Biofiltration**
  - Biofiltration with partial infiltration
- **Lined Biofiltration**
  - Biofiltration
  - Nutrient sensitive media design
  - Proprietary biofiltration
- **Flow Thru Treatment**
  - Vegetated swales
  - Media filters
  - Sand filters
  - Dry extended detention basin
  - Proprietary flow thru treatment control

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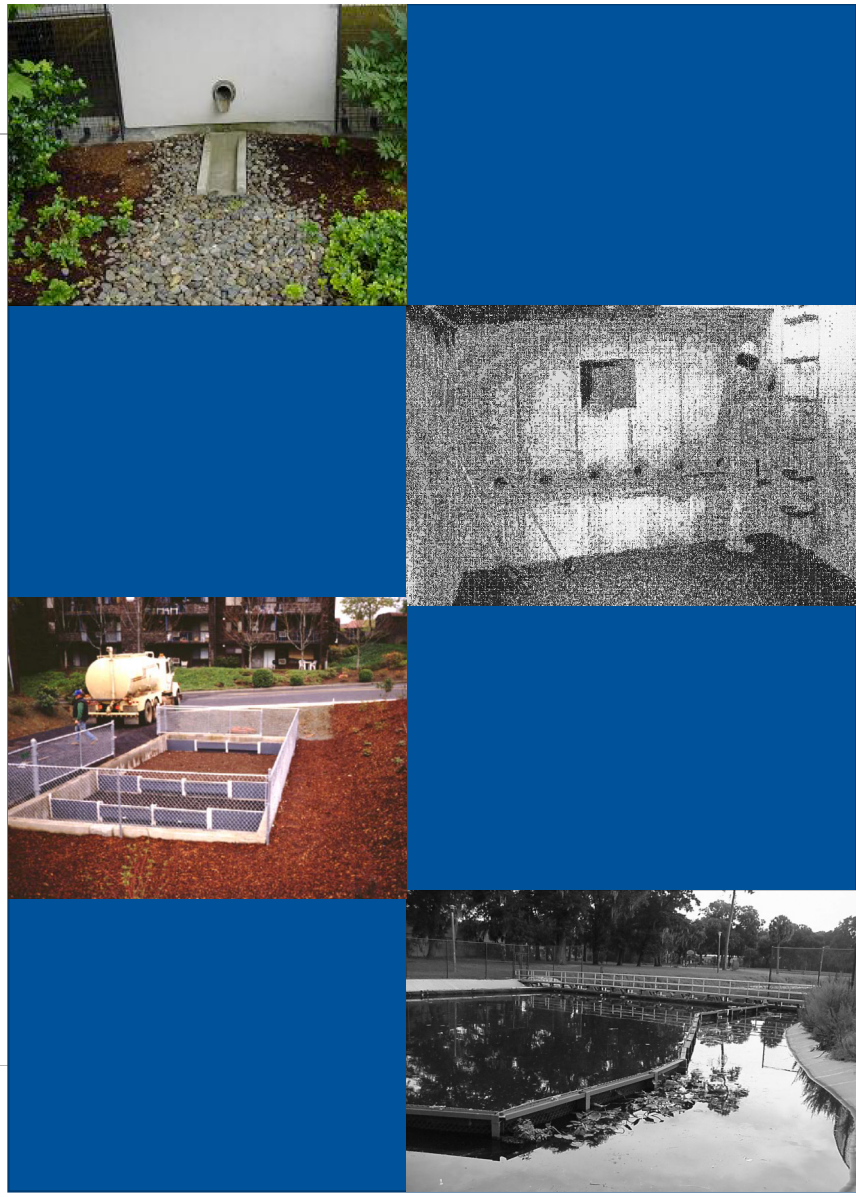
GROUPING BMPS

- **COMBINE BMPS**
  - Enhanced swale and bioretention
  - Soakage Trench and Infiltration Trench
- **REMOVE BMPS**
  - Organic Filter
  - Underground Sand Filter
  - Alum treatment system
- **DISCUSSION**
  - Grass Channel vs. Open Conveyance Channel



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Do you agree with combining the BMPs mentioned?

Only combine enhanced swale and bioretention

Only combine soakage trench and infiltration trench

Combine both sets of BMPs

Combine neither set of BMPs

The following BMPs should be removed. Select all that apply.

Organic Filter

Underground Sand Filter

Alum treatment system

All BMPs should remain in the manual

Are there additional BMPs you think should be grouped or removed? If so, please name.

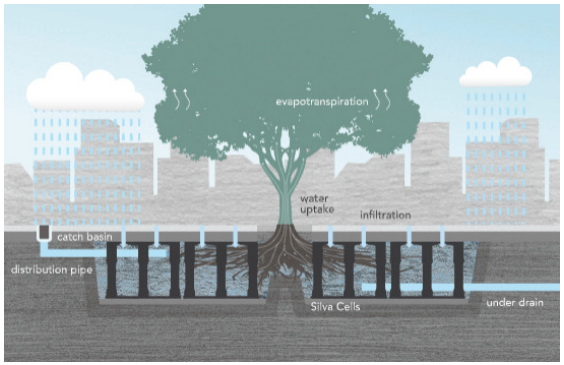
RECOMMENDED REORGANIZATION & GROUPING

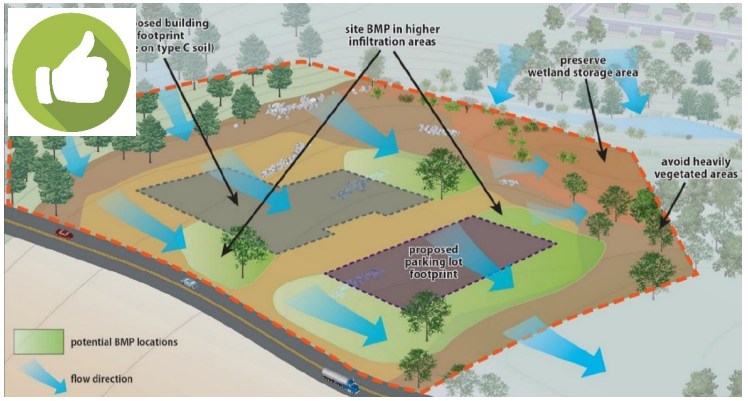
- **Infiltration**
  - Bioretention
  - Downspout Drywell
  - Infiltration/ Soakage Trench
- **Filtration**
  - Filter Strip
  - Planter Box
  - Sand Filter
- **Porous Surfaces**
  - Green roof
  - Modular Porous Pavement System
  - Porous Concrete
- **Volume-storage**
  - Dry detention / Extended detention dry basin
  - Multi-purpose detention areas
  - Underground detention
  - Rain harvesting (Tank/barrel)
- **Conveyance**
  - Grass channel
  - Open Conveyance channel
  - Culvert
  - Inlet
  - Pipe system
- **Proprietary Systems**
  - Proprietary structural control
- **Hydrodynamic Devices**
  - Gravity (oil grit) separator
- **Chemical Treatment**
  - Alum treatment system
- **Water Quality Ponds**
  - Stormwater wetland
  - Stormwater pond

Is the draft organization of the categories helpful? What suggestions would you make to improve it?

POTENTIAL NEW BMPS

- Open Green Space
  - Not recommended as a BMP – Filtration varies
  - Recommended for planning – Limit impervious area
- Silva Cells (proprietary)
- Inlet Basket
- Trash Rack





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The following BMPs should be added. Select all that apply.

Open green space

Silva cells

Inlet basket

Trash rack

None of the above

DESIGN / CONSTRUCTION

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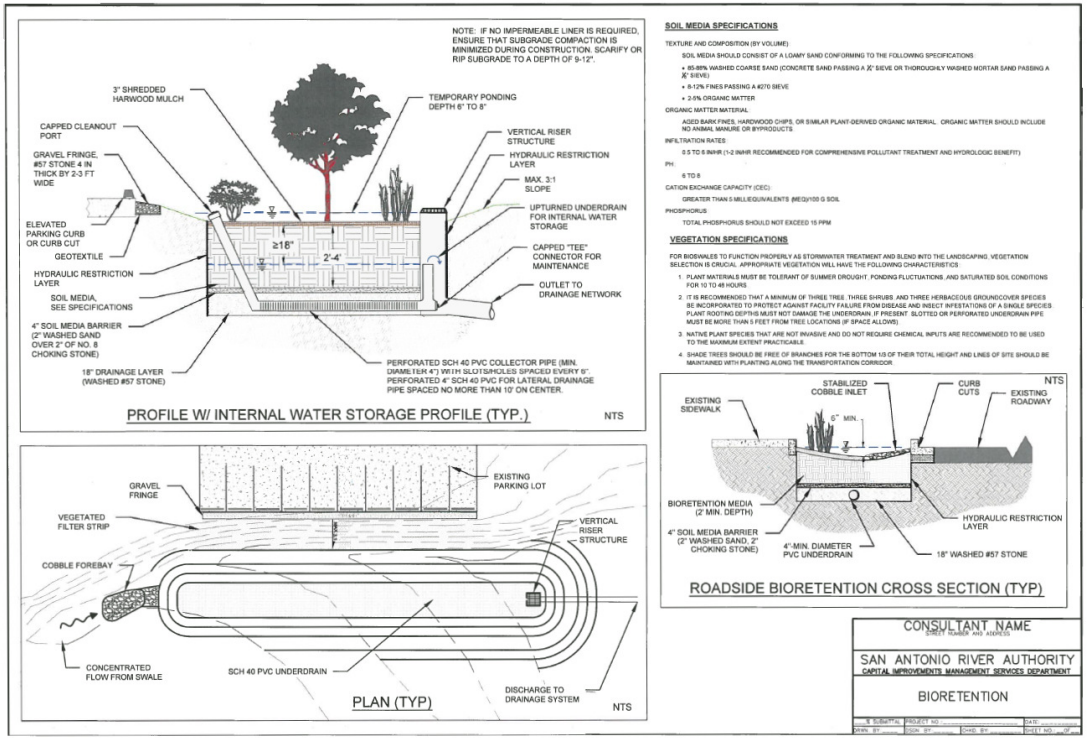
DESIGN / CONSTRUCTION

- Sample design documents
  - Bid specifications
  - Standard details
  - Checklists
- Guidance for public signage (e.g. no mow, etc.)
- Guidance on workmanship and qualifications

BMP DESIGN TEMPLATES

- **SARA** – Appendix C – Details and specifications for 9 BMPs
- **San Diego** – Appendix F – General Standards for Bioretention/Biofiltration BMPs
- **Georgia** – Appendix B – Review Checklists for Preliminary and Final Site Plans



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What would be most important to add to the technical manual? Select all that apply.

Standard Details

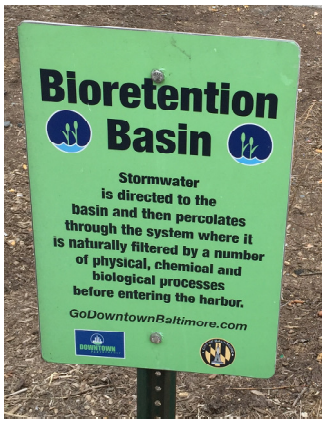
Specifications

Design check lists

None of the above

PUBLIC SIGNAGE

- Information for maintenance personnel
  - Permeable Pavement
  - Bioswale (i.e. No Mow)
- Prohibit public activities
  - Permeable Pavement
  - Rainwater Harvesting
  - Bioswale
- Public Education
  - Sand filters, stormwater wetlands, bioretention, bioswale, planter boxes, green roofs, vegetated filter strips, etc.



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Should requirements or suggestions of public signage be included in the technical manual?

Yes, this is a priority for me

Yes, but there are other revisions to the technical manual that take priority

Unsure

No, this is not a priority for me

No, this varies based on site and should be left up to the design engineer

WORKMANSHIP AND QUALIFICATIONS

- Pre-qualification examples/recognition
  - **Washington DC** – Local green infrastructure training for maintenance workers, inspectors, and contractors
  - **National Green Infrastructure Certification Program (NGICP)** – provides the base-level skill set needed to properly construct, inspect and maintain green stormwater infrastructure
  - **ICPI** – Interlocking Concrete Pavement Institute
  - **SARA** – Low Impact Development Training Program

Should recommendations of certification or training for low impact development be included in the technical manual?

Yes, this is a priority for me

Yes, but there are other revisions to the technical manual that take priority

Unsure

No, this is not a priority for me

No, I don't think it belongs in technical manual

WARRANTY AND INSPECTION REQUIREMENTS

- ASTM requirements
  - Applicable for biofiltration/filtration BMPs (i.e. bioretention, permeable pavers)
- Currently in existing manual
  - Inspection and maintenance requirements

2.7 Inspection and Maintenance Requirements

Table 2.1 Typical Maintenance Activities for Bioretention Areas

Activity	Schedule
• Pruning and weeding to maintain appearance. • Mulch replacement when erosion is evident. • Remove trash and debris.	As needed
• Inspect inflow points for clogging (off-line systems). Remove any sediment. • Inspect filter strip/grass channel for erosion or gullying. Re-seed or sod as necessary. • Trees and shrubs should be inspected to evaluate their health and remove any dead or severely diseased vegetation.	Semi-annually
• The planting soils should be tested for pH to establish acidic levels. If the pH is below 5.2, limestone should be applied. If the pH is above 7.0 to 8.0, then iron sulfate plus sulfur can be added to reduce the pH.	Annually
• Replace mulch over the entire area. • Replace pea gravel diaphragm if warranted (or when the voids are obviously filled with sediment and water is no longer infiltrating).	2 to 3 years

(Source: EPA, 1999)

Additional Maintenance Considerations and Requirements

The surface of the ponding area may become clogged with fine sediment over time. Core aeration or cultivating of unvegetated areas may be required to ensure adequate filtration.

NEXT STEPS

- **April 2020 –** Present final recommended updates to technical manual at Workshop #3 and to iSWM Implementation Subcommittee

For follow up questions or information contact:

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Select up to 3 of the following recommendations that you believe should be the highest priority for updates to the technical manual.

- Update of primary pollutant removal capabilities
- Update of BMP summary pages
- Addition of the vegetation list
- Reorganization
- Addition of new BMPs
- Addition of standard details, specification, and/or design check lists?
- Recommendations of public signage
- Recommendations for certification or training

Based on the potential changes to the technical manual discussed today, what kind of recommendations are needed in order to make the necessary updates to the technical manual?

Keep majority of existing manual and reorganize, revise, and update as needed

Eventually a committee will need to be formed to replace and re-write the technical manual

Would you like to attend a third workshop to go over the final recommendation that will be presented at the iSWM Implementation Subcommittee?

Yes

No

Unsure

Is there any updates or revisions to the technical manual you want to suggest that was not discussed in the workshop today?