



1

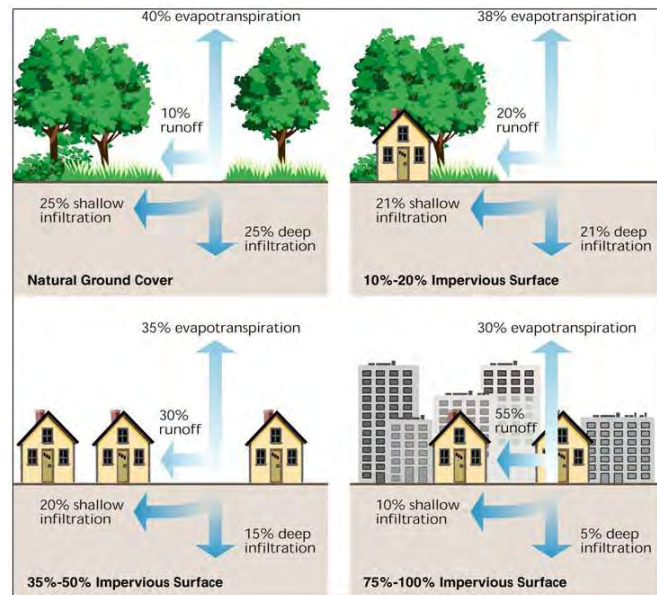
Common Acronyms & Definitions

- **SCM** – Stormwater Control Measures: Used to refer to practices or infrastructure for managing stormwater quantity or quality, also known as Best Management Practices (BMPs)
- **MS4** – Municipal Separate Storm Sewer System: Any conveyance or system of conveyances that are owned or operated by a state or local government entity and are designed for collecting and conveying stormwater
- **LID** – Low Impact Development: Refers to a method of development or actual structures that are implemented for restoring natural hydrology particularly for small storms
- **MDCIA** – Minimize Directly Connected Impervious Area: A strategy for reducing runoff volume and velocity
- **EDB** – Extended Detention Basin: Type of SCM
- **PICP** – Permeable Interlocking Concrete Pavers/Pavement: Type of SCM

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The Stormwater Problem

Urbanization changes the hydrologic regime of the watershed



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The Stormwater Problem

Increased flooding

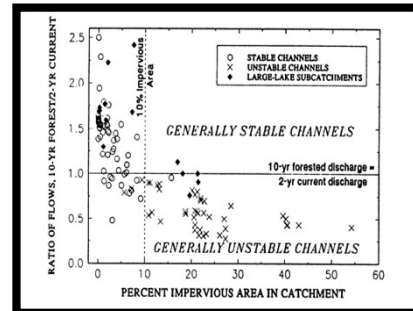


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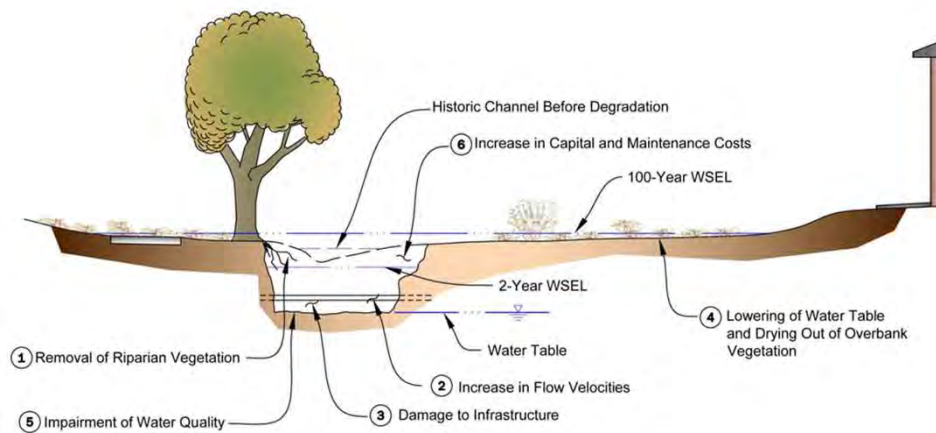
The Stormwater Problem



Increased channel instability

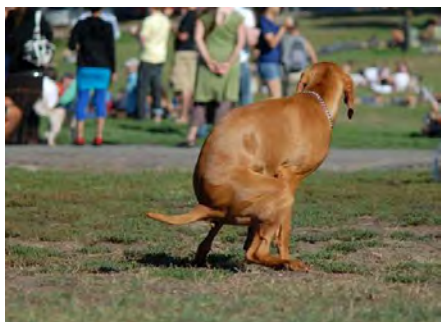


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Impairments to Natural Stream Function

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The Stormwater Problem

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DENVER AND THE WEST
Some Denver waterways too contaminated for safe summer play
 By Bruce Finley
The Denver Post
 PUBLISHED: 5/14/2014 10:00 AM | UPDATED: 5/14/2014 10:00 AM | 38 COMMENTS

The South Platte River and Cherry Creek deteriorate rapidly as they meander through the Denver area, picking up arsenic, ammonia and fecal contaminants at levels exceeding health standards by up to 50 times, the latest state and city data show.

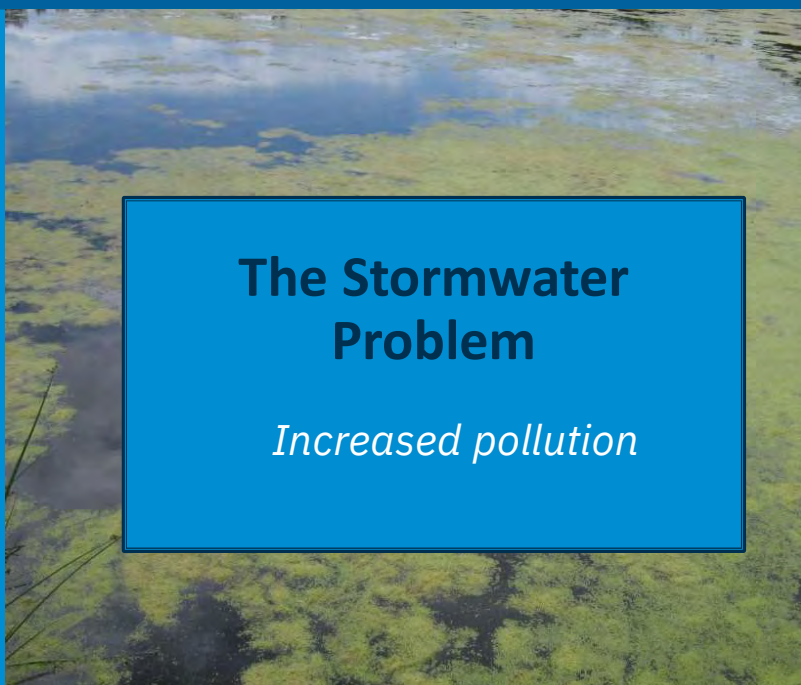
Denver Environmental Health officials have posted warnings at Confluence Park.

Yet residents, including parents with kids, splash and swim anyway to escape the heat, as many did in Saturday's 102-degree temperature.

"It's a concern," said Steve Gunderson, director of water quality for the Colorado Department of Public Health and Environment.

People sickened by contaminants such as E. coli while swimming often don't grasp the cause, linking stomach ailments to food instead of water, health officials say.

Water quality when mountain snowmelt enters the metro area generally rates superior. State data indicate no standards are violated in Chatfield Reservoir — at the metro area's southwestern edge.

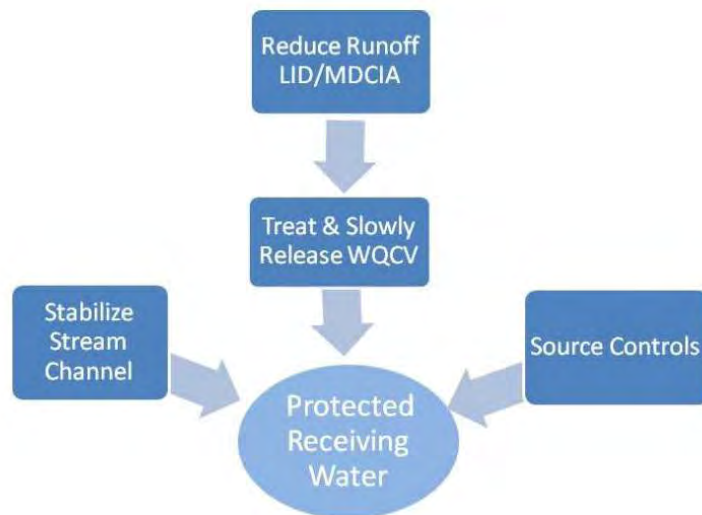


The Stormwater Problem

Increased pollution

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4-Step Process for Stormwater Management



Urban Storm Drainage Criteria
Manual, Volume 3 (USDCM 2010)

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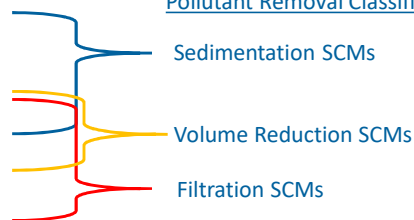
Role of SCMs

Stormwater Control Measure - *“A constructed facility that is desired to reduce stormwater runoff volume, peak flow and/or pollutants before discharging to receiving waters”*

Types of SCMs

- Extended Detention Basins
- Wet Ponds
- Constructed Wetlands
- Grass Swales/Grass Buffers
- Disconnection
- Rain Gardens
- Permeable Pavement
- Sand Filters
- Proprietary Systems

Pollutant Removal Classification



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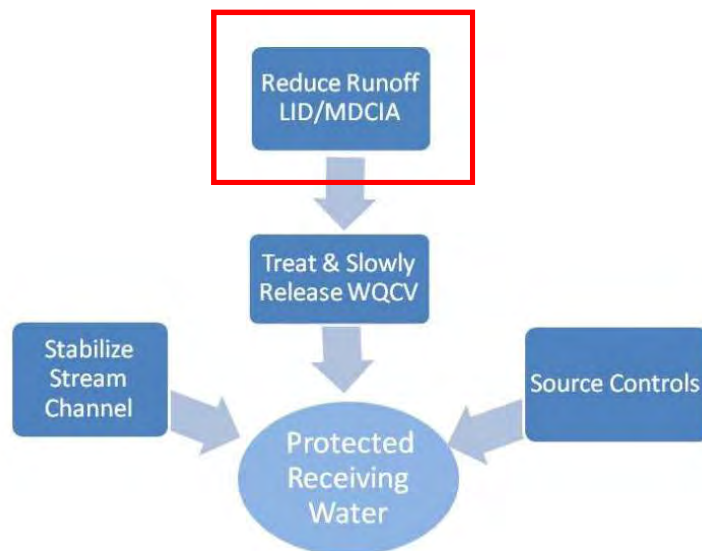


Temporary BMPs vs. Permanent SCMs

Engineered Structures designed to permanently treat highway run-off

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4-Step Process for Stormwater Management



Urban Storm Drainage Criteria
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Volume Reduction SCMs

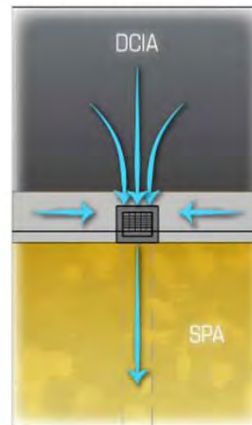
DCIA – Directly Connected Impervious Area

UIA – Unconnected Impervious Area

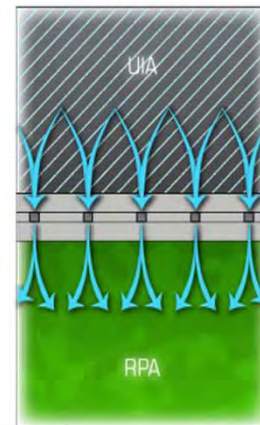
SPA – Separate Pervious Area

RPA – Receiving Pervious Area

Conventional
Curb and Gutter w/ Inlet



Runoff Reduction
Slotted Curb



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Grass Swale

Functions	
LID/Volume Red.	Yes
WQCV Capture	No
WQCV+Flood Control	No
Fact Sheet Includes EURV Guidance	No
Typical Effectiveness for Targeted Pollutants ³	
Sediment/Solids	Good
Nutrients	Moderate
Total Metals	Good
Bacteria	Poor
Other Considerations	
Life-cycle Costs	Low
³ Based primarily on data from the International Stormwater BMP Database (www.bmpdatabase.org).	



Benefits

- Removal of sediment and associated constituents through filtering (straining)
- Reduces length of storm sewer systems in the upper portions of a watershed
- Provides a less expensive and more attractive conveyance element
- Reduces directly connected impervious area and can help reduce runoff volumes.

Vegetative Swales

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Grass Buffer	
Functions	
LID Volume Red.	Yes
WQCV Capture	No
WQCV+Flood Control	No
Fact Sheet Includes EURV Guidance	No
Typical Effectiveness for Targeted Pollutants³	
Sediment/ Solids	Good
Nutrients	Moderate
Total Metals	Good
Bacteria	Poor
Other Considerations	
Life-cycle Costs	Low
<small>³ Based primarily on data from the International Stormwater BMP Database (www.bmpdatabase.org)</small>	



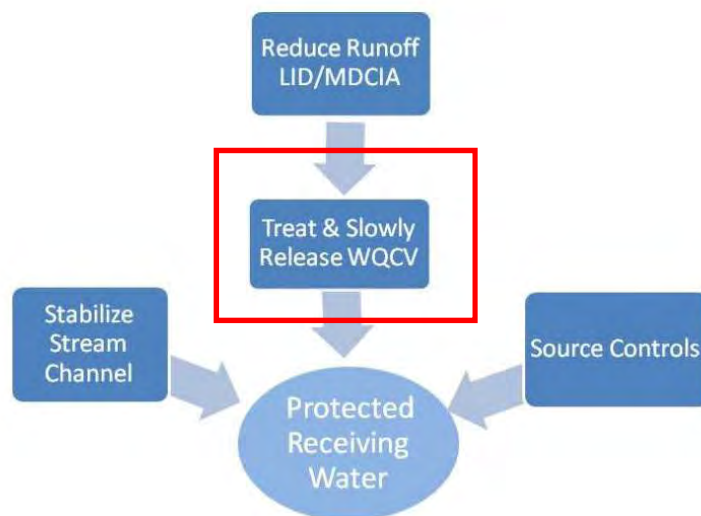
Benefits

- Filters (strains) sediment and trash.
- Reduces directly connected impervious area. (See Chapter 3 for quantifying benefits.)
- Can easily be incorporated into a treatment train approach.
- Provides green space available for multiple uses including recreation and snow storage.
- Straightforward maintenance requirements when the buffer is protected from vehicular traffic.

Vegetative Buffers

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4-Step Process for Stormwater Management

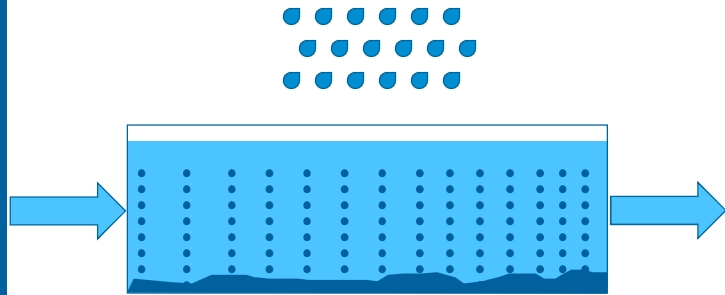


Urban Storm Drainage Criteria Manual, Volume 3 (USDCM 2010)

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Sedimentation SCMs

Capture/store runoff long enough for most particulate pollutants to settle out



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Extended Detention Basin

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Inlets

Remove sediment, trash, debris and large, woody vegetation from inlets

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Trickle channels typically
require maintenance at least
once per year



Trickle Channels

Remove sediment, debris and large, woody vegetation from trickle channel
Check for erosion and structural integrity

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Outlet Structure

Function:

- Controls discharge of EDB by slowly releasing treated water, component that primarily provides pollutant removal.

Components:

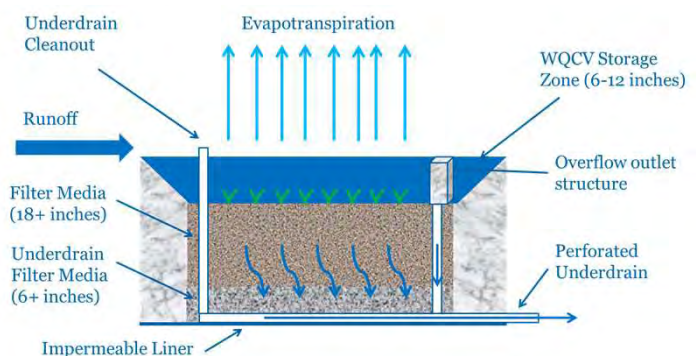
- Orifice Plate
- Trash Rack
- Safety Grate



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Filtration SCMs

Capture runoff and force through filter media to remove pollutants

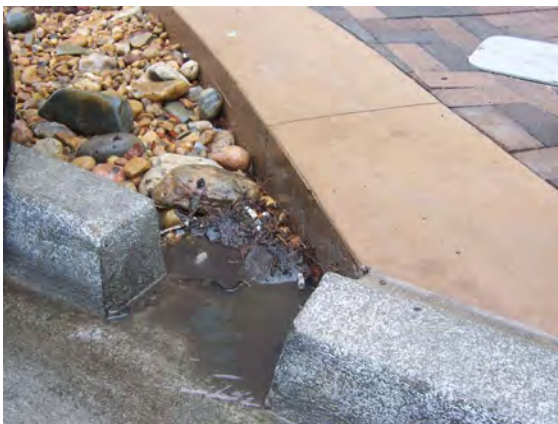


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Rain Gardens & Sand Filters

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Inlets

Remove sediment, debris & trash, provide 2" vertical step

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Filter Media

- **Function:**
 - Filter media removes pollutants before runoff infiltrates into groundwater or discharges through underdrain
 - Filter media will eventually clog and no longer allow water to pass through it
- **I & M Activities:**
 - Check for standing water or sediment accumulation
 - Promote healthy vegetation in rain garden
 - Keep media/mulch flat
 - Never use for snow storage



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Filter Media

Media mix for sand filter or rain garden

Sand Filter Media
Clean-course sand
AASHTO C-33
Or
CDOT Class C Filter Material

- Bioretention Media
 - 80-90% Clean Sand (0.05-2.0 mm)
 - 3-17% Silt (0.002-0.5 mm)
 - 3-17% Clay (<0.002 mm)
 - 3-5% Shredded Mulch

• **DO NOT USE:**

- Topsoil only
- Clay-grown sod

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Permeable Pavement SCMs

Permeable pavement provides a porous hardscape surface which stormwater can move through while still being useful for driving, parking, or walking.

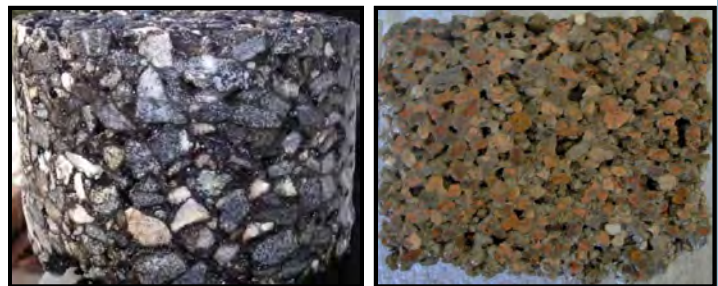


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Permeable Pavement SCMs

Types of Permeable Pavement

- Pervious concrete
- Porous asphalt
- Permeable interlocking concrete pavers



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Recommended Periodic Maintenance

- Consider site specific factors
 - Run-on ratio
 - Tree cover
 - Stability of the tributary area
- Consider the type of pavement
- Start with regenerative air vacuum 2x per year. Adjust based on considerations and observations.

Periodic
Maintenance

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Pressure Washing



Pressure washing is
**NOT CURRENTLY
RECOMENDED**

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PICP Reactive Maintenance

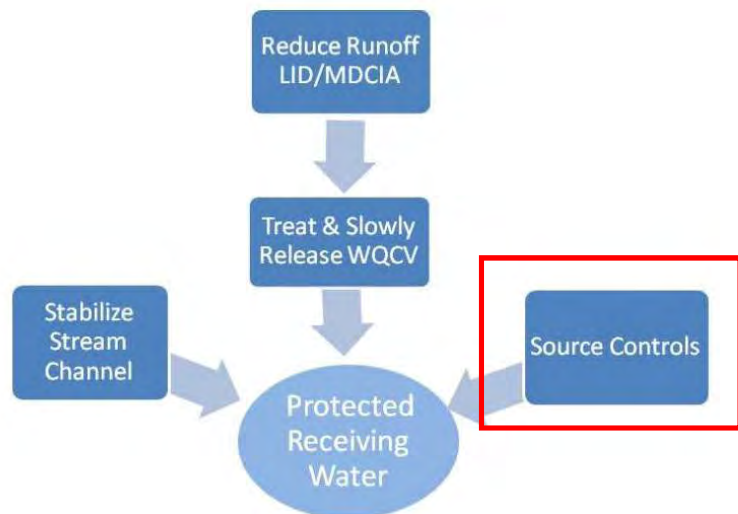
Solution:

- Removal all pavers manually
- Remove/replace bedding layer
- Replace pavers



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4-Step Process for Stormwater Management



Urban Storm Drainage Criteria
Manual, Volume 3 (USDCM 2010)

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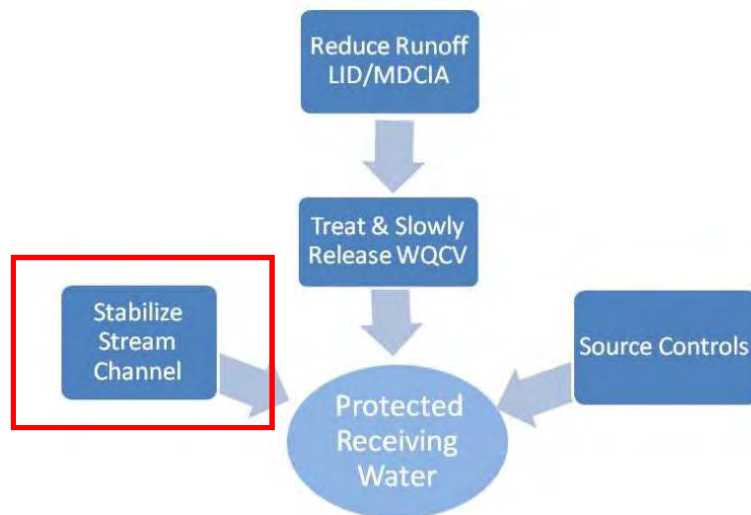


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4-Step Process for Stormwater Management



Urban Storm Drainage Criteria
Manual, Volume 3 (USDCM 2010)

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Natural Streams



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Full Spectrum Detention

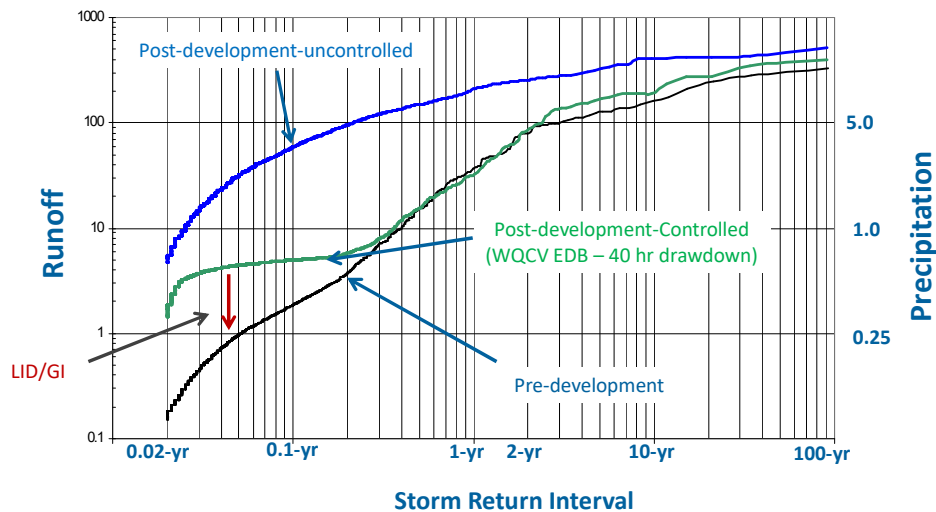
Addresses the flows responsible for carrying the most bed load

Better resembles pre-development flow conditions over an entire watershed, even with multiple independent detention facilities

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Pre and Post Development Hydrology



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Conclusions

- Development causes increased runoff, unstable channels, and water pollution
- The 4-step process seeks to address these problems
- All SCMs require maintenance, however the owner can decide what type of maintenance they want
- Full-spectrum detention seeks to fully manage both the increased flow rates and volumes from urbanization

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Thank you.

- **Contact**

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