Guidance in Construction for Successful Operation of Post-Construction BMPs

2017 Mountain States Chapter
Region Conference – November 16

Denver, Colorado

Colorado State University

One Water Solutions Institute

Colorado Stormwater Center

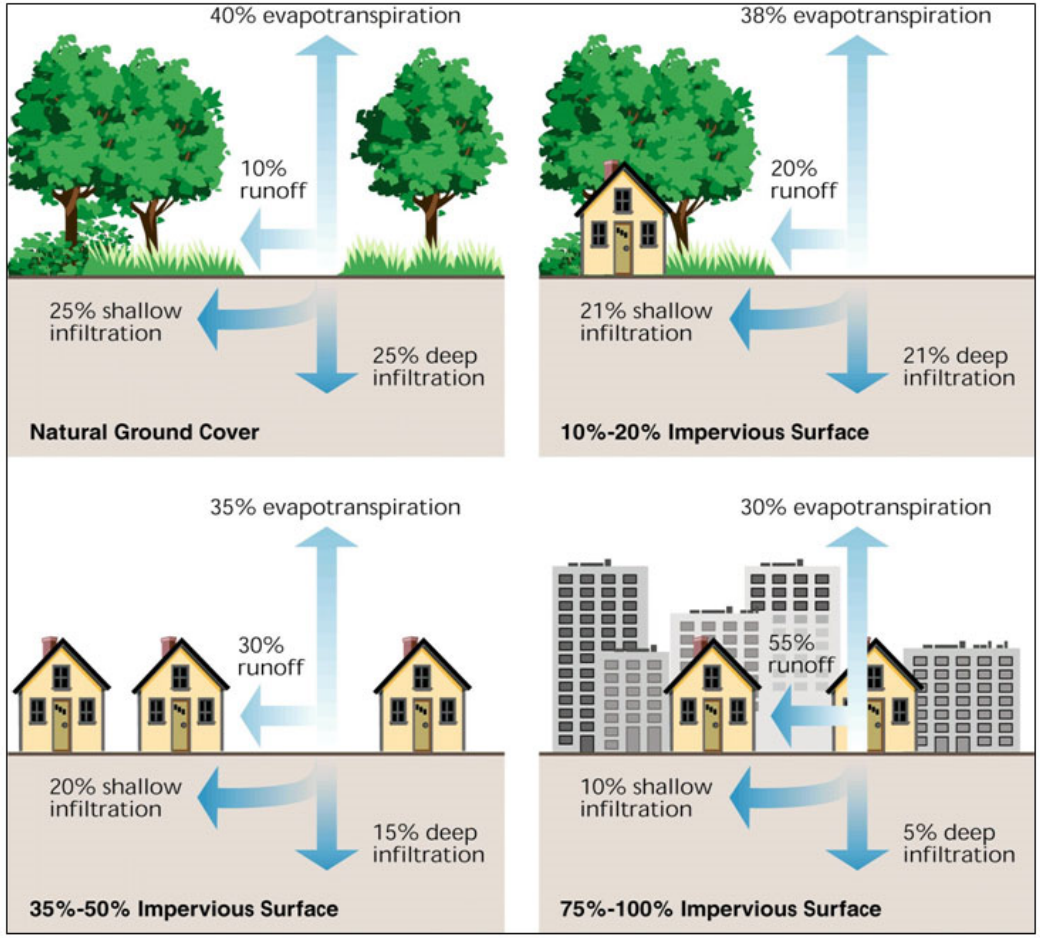
Common Acronyms & Definitions

- **BMP** – Best Management Practice: Used to refer to practices or infrastructure for managing stormwater quantity or quality
- **SCM** – Stormwater Control Measure: Used similarly to BMP and is less likely to be confused with non-structural practices
- **PWQ CM** – Permanent Water Quality Control Measure: Synonymous to BMP and SCM, term typically used by CDOT
- **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
- **EDB** – Extended Detention Basin: Type of permanent BMP
- **PICP** – Permeable Interlocking Concrete Pavement: Type of permanent BMP

Presentation Objectives

- Introduction to the Stormwater Problem
- Permanent Water Quality BMPs
- Extended Detention Basins
  - Function, Design, Construction
- Bioretention/Rain Garden
  - Function, Design, Construction
- Permeable Pavement
  - Function, Design, Construction

The Stormwater Problem

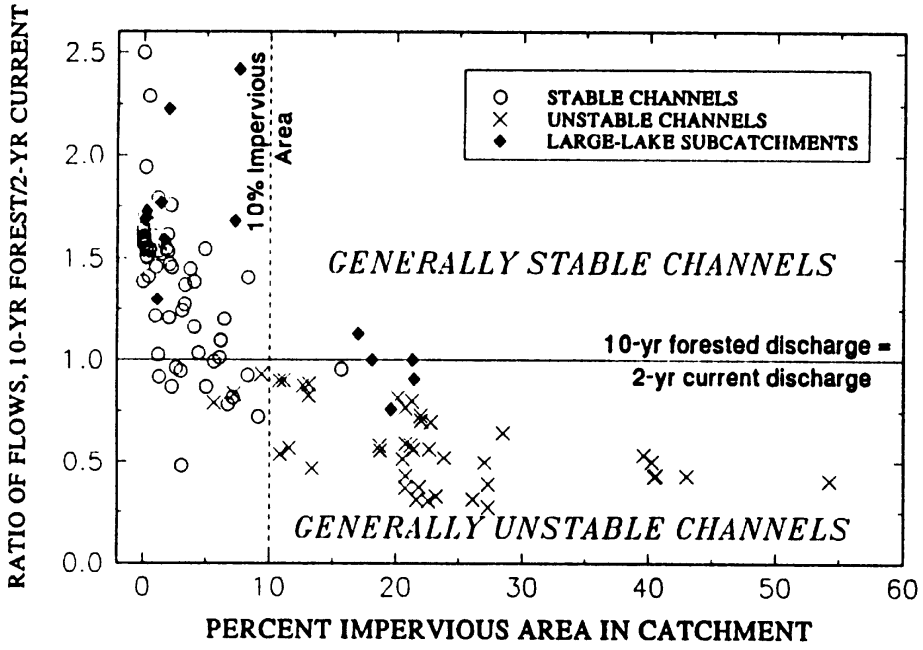


Urbanization changes the hydrologic regime of the watershed

The Stormwater Problem

Increased flooding

The Stormwater Problem



Booth and Reinelt (1993)

Channel instability and erosion

The Stormwater Problem

DENVER AND THE WEST

Some Denver waterways too contaminated for safe summer play

By Bruce Finley
The Denver Post

POSTED: 07/18/2010 01:00:00 AM MDT | UPDATED: 3 YEARS AGO 28 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.

Even at Chatfield, however, runoff from surrounding terrain sometimes pushes bacteria to levels where "you have a good chance you might get sick" if you drank it untreated, Gunderson said. (E. coli levels topping 235 colonies per 100 milliliters, the state standard for a single measurement at a designated beach, forced state rangers to close Chatfield beaches last week. E. coli indicates fecal and other bacterial pathogens.)

Increased pollution

Role of Stormwater BMPs

Permanent Water Quality BMP - "*A constructed facility designed to reduce stormwater runoff volume, peak flow and pollutants before discharging to receiving waters*"

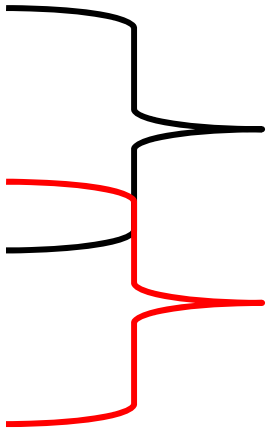
1. Helps mitigate the impacts of urbanization after construction is complete.
2. Does not mean temporary or construction BMPs for erosion and sediment control throughout the construction process

Role of Stormwater BMPs

Permanent Water Quality BMP - "*A constructed facility designed to reduce stormwater runoff volume, peak flow and pollutants before discharging to receiving waters*"

Types of BMPs

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



Pollutant Removal Classification

"Sedimentation" BMPs

"Filtration" BMPs

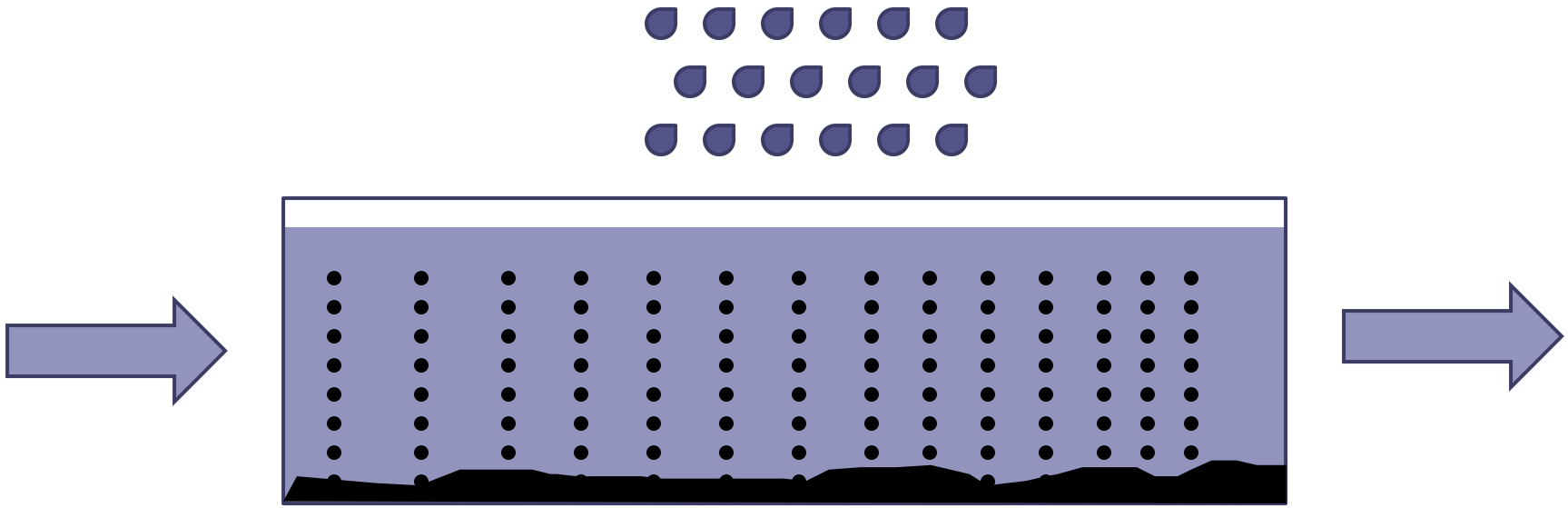
Stormwater BMP Regulations

- Stormwater BMPs are required by law under EPA Clean Water Act
- Municipal Separate Storm Sewer System (MS4) Permit issued/regulated by Colorado Department of Public Health and Environment (CDPHE)
- MS4 permits also require the long-term operability of all BMPs

Extended Detention Basins (EDBs)

Extended Detention Basins (EDBs)

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



Components of EDBs

- **Inlet** (to allow water to enter the facility)
- **Energy Dissipation** (to protect against erosion)
- **Forebay** (to capture debris and facilitate maintenance)
- **Trickle Channel** (to facilitate maintenance)
- **Initial Surcharge Volume** (to limit the area of standing water in the basin and facilitate management of vegetation)
- **Micropool** (to minimize clogging, limiting the area of standing water in the basin)
- **Outlet Structure** (to slowly release treated water)

Design Problems of EDBs

- During initial project scoping meeting
  - Stabilized maintenance access to each component
  - Consider including:
    - Forebay
    - Trickle channel
    - Initial surcharge volume
    - Micropool
  - Hard-bottom forebay and trickle channel
  - Trash rack sizing is correct (1 ¼ inch threshold)

Construction Problems of EDBs

Inlet/Forebay grade allowing ponding

Construction Problems of EDBs

Sediment control from the project depositing sediment in the inlet clogging riprap

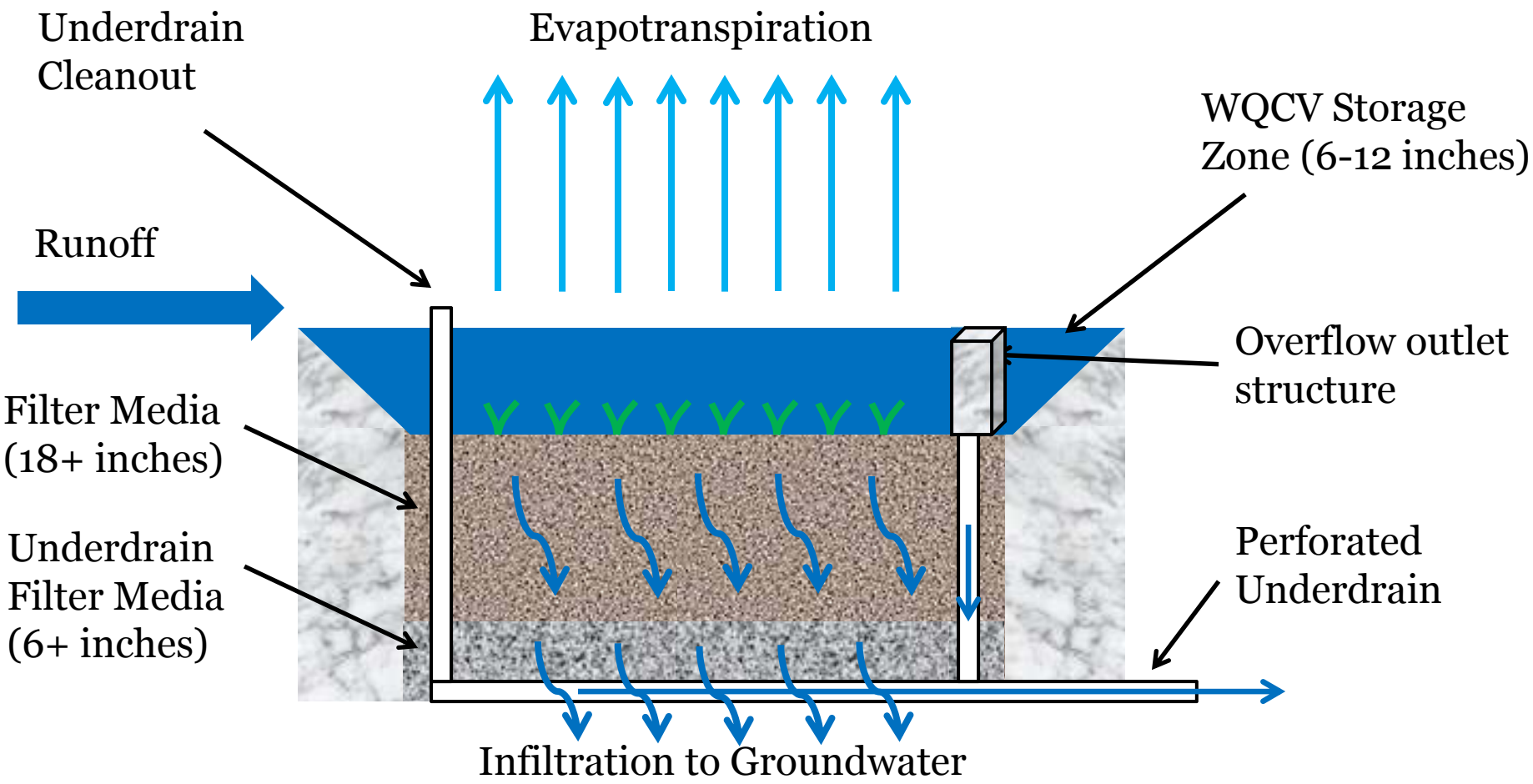
Construction Problems of EDBs

Orifice plate not installed correctly

Construction Problems of EDBs

- Other construction concerns…
  - Side-bank stabilization
  - Upstream sediment control
  - Grading near outlet structure

Rain Gardens



Components of Rain Gardens

- **Inlet** (to allow water to enter the facility)
- **Energy Dissipation** (to protect against erosion)
- **Forebay** (to capture debris and facilitate maintenance)
- **Filter Media** (to provide treatment)
- **Underdrain** (to allow water to exit the facility after receiving treatment)
- **Overflow Structure** (to allow larger storms to by-pass filter media to protect facility from damage)
- **Embankments** (to provide bank stabilization for ponded area)

Design Problems of Rain Gardens

- During initial project scoping meeting
  - Ensure a vertical step for inlet
  - Specifications for filter media
    - No topsoil
    - Filter media from applicable design criteria
    - Clean washed sand
  - Specifications for storage material
    - Clean washed sand/aggregate
  - Avoid placing filter socks on underdrain
  - PLAN TO PROTECT FROM SEDIMENT (especially if constructed toward the start)

Construction Problems of Rain Gardens

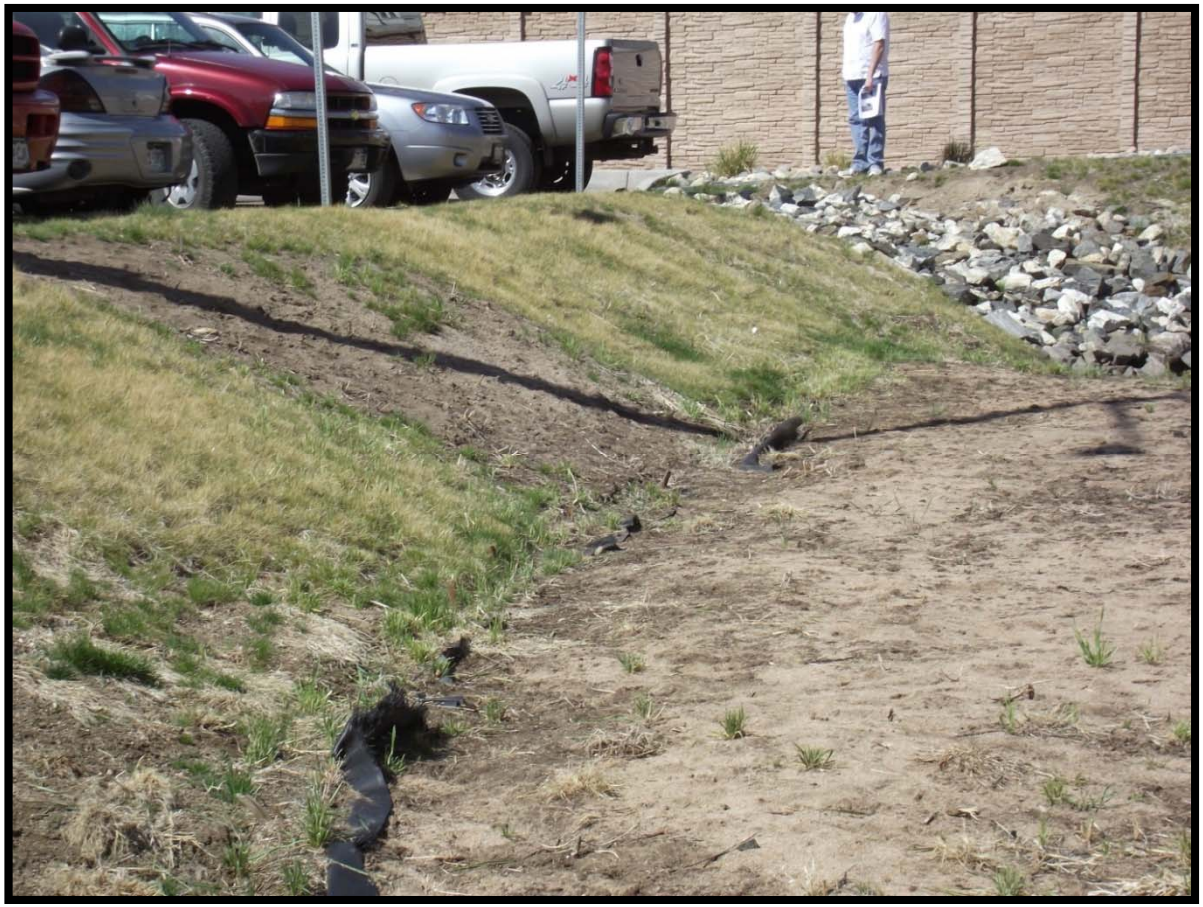
Filter media was filled to high, water can not enter the rain garden

Construction Problems of Rain Gardens

Filter media was not installed flat or graded properly and further channelization resulted in erosion and discolored mulch

Construction Problems of Rain Gardens

Unstable embankments results in erosion and large amounts of sediment entering the filter media



Construction Problems of Rain Gardens

Perforated underdrain allows water to completely by-pass the filter media

Construction Problems of Rain Gardens

- Other construction concerns…
  - Over-compaction of native soils
  - Over-compaction of filter media
  - No protection of the rain garden throughout construction
  - Elevations of components (inlet, overflow, underdrain)
  - Where applicable: geomembrane liner is attached incorrectly

Permeable Pavement

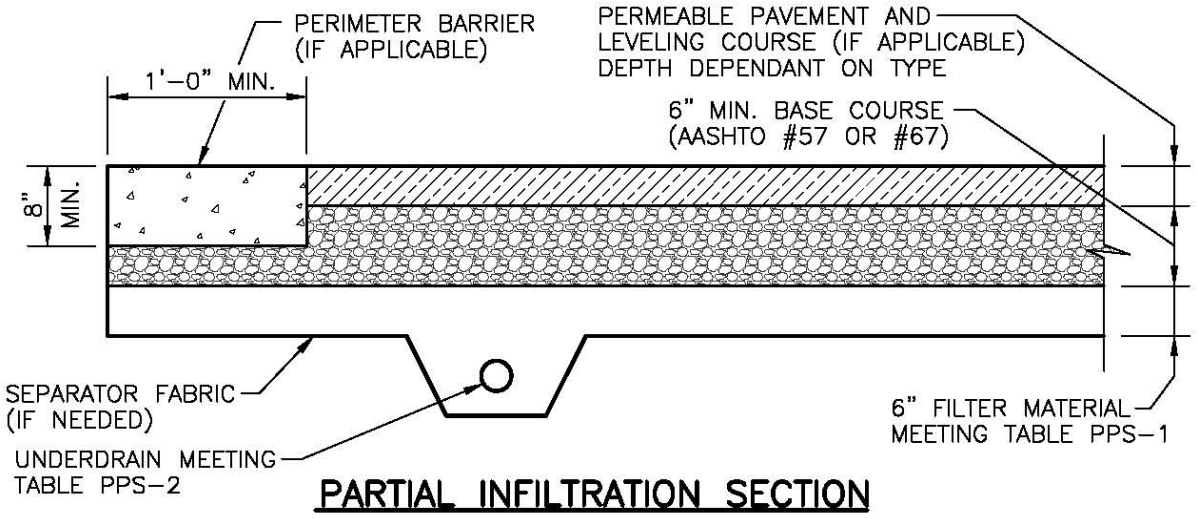
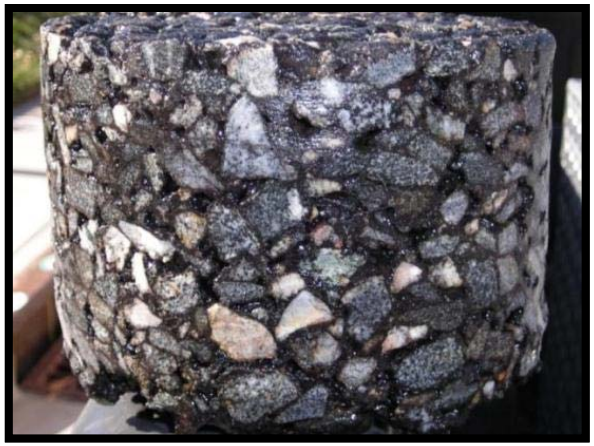


Figure PPS-1 from Volume 3 of the USDCM



Design Problems of Permeable Pavement

- Before construction begins…
  - PLAN TO PROTECT FROM SEDIMENT (especially if constructed toward the start)
    - Covers
    - Alternative construction vehicle access
    - Education
  - Ensure construction material is not stored on pavement
  - Protect native soils from compaction

Construction Problems of Permeable Pavement

Keeping PICP joints filled with washed 3/8” angular rock (ASTM No. 8, 89, or 9 Aggregate) will keep sediment closer to the surface

Construction Problems of Permeable Pavement

No protection has resulted in sediment flowing across pavers since they were installed quite early in the project and are now clogged.

Construction Problems of Permeable Pavement

Underdrain was wrapped in weed barrier. There also should be at least a 6” storage layer not just a trench.

Construction Problems of Permeable Pavement

- Other construction concerns…
  - Correct aggregate types
  - Protection, protection, protection!
  - May require periodic maintenance throughout the construction project
    - Maintenance is cheaper than replacement

Thank you!

COLORADO STORMWATER CENTER

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http://stormwatercenter.colostate.edu/resources/