



Stormwater Best Management Practices (BMPs)

Maintenance vs Repair, a Cost Comparison

September 13, 2018

REGFORM 2018 Water Seminar



Why do we have Rain Gardens in Missouri?



Why do we have Rain Gardens in St. Louis?



Why do we have Rain Gardens in St. Louis?



BREAKING NEWS Sewage Closes Long Beach Coastline **6:06 81°**
DOWNTOWN LA **2**



History of Rain Gardens in St. Louis

- ▶ Combined Stormwater/Wastewater Sewer System
 - ▶ Old infrastructure, with an old environment
 - ▶ Lack of stormwater absorption was not a problem, runoff entered combined sewer
 - ▶ New construction changed the environment (more roofs/parking lots)
 - ▶ Stormwater runoff from hardscapes increases, less open ground to provide absorption, more water ends up in the combined sewer
 - ▶ Additional Stormwater Runoff + Old, Combined Infrastructure = Overcharged System
 - ▶ An overcharged system would result in backups (basement and streets)
 - ▶ Original Solution: Overflow Relief Points
 - ▶ Overcharged System – Overflow Relief = Less Backups...but also Pollution
- ▶ New Solution: Separation of Stormwater and Wastewater Sewers

History of Rain Gardens in St. Louis

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF MISSOURI
EASTERN DIVISION

UNITED STATES OF AMERICA,)

and)

THE STATE OF MISSOURI,)

Plaintiffs,)

and)

MISSOURI COALITION FOR THE)
ENVIRONMENT FOUNDATION,)

Plaintiff/Intervenor,)

v.)

THE METROPOLITAN ST. LOUIS)
SEWER DISTRICT,)

Defendant.)

No. 4:07-CV-1120 (CEJ)

CONSENT DECREE



History of Rain Gardens in St. Louis

- ▶ Consent Decree
 - ▶ 2007 Lawsuit: State of MO & EPA vs Metropolitan St. Louis Sewer District
 - ▶ Overflows (Points of Overcharge Relief)...predate MSD's creation in 1954
 - ▶ 1992-2007 MSD spends \$2,300,000,000 to remove 300+ overflows (less than 400 remaining)
 - ▶ August 2011, Department of Justice filed settlement "Consent Decree"
 - ▶ MSD to spend \$4,700,000,000 over 23 years to address overflows and other improvements
 - ▶ Effective date: April 27, 2012
- ▶ More info (including revisions and reports) online:
<http://www.stlmsd.com/our-organization/organization-overview/consent-decree>

Implementation: Stormwater Treatment “Best Management Practices” (BMPs)

- ▶ What is a BMP?
- ▶ What types of BMPs are commonly utilized in Stormwater Treatment Systems?

- ▶ Above Ground vs. Below Ground

- ▶ Details in a minute on these types/terms:



Biodetention Basin (Rain Garden)



Porous Pavement



Retention Basin (Wet Pond)



Swale—Amended Soil—Level Spreader



Hydrodynamic Separator



Stormwater Quality Filter System



Underground Detention



Stormwater Quality Storage

A decorative graphic on the left side of the slide. It features a dark grey arrow pointing right at the top. Below it, several thin, curved lines in shades of blue and grey sweep across the page, creating a dynamic, abstract background element.

How do BMPs work?

- ▶ Intent
 - ▶ Filtration
 - ▶ Percolation/infiltration
 - ▶ Reduction of Speed
- ▶ Design
 - ▶ Underground
 - ▶ Porous Pavement
 - ▶ Retention (Wet Ponds)
 - ▶ Bio-detention (Rain Gardens)
- ▶ Construction



How do BMPs work? Intent

- ▶ Filtration
 - ▶ Active and Passive removal of pollutants from the water
 - ▶ Achieved with plants, filter materials (sand/gravel), and mechanical means
 - ▶ Various BMPs provide differing levels/types of filtration
- ▶ Percolation/Infiltration
 - ▶ Sending water back into ground to assume natural hydrological system function
 - ▶ BMPs may or may not allow for percolation/infiltration
- ▶ Speed Reduction—Detention vs Retention
 - ▶ Slowing the velocity of flowing of water to allow for solids to settle, reducing turbidity at the point of discharge into lakes, rivers, streams
 - ▶ Slowing the release of water into lakes/rivers/streams to reduce flash flooding

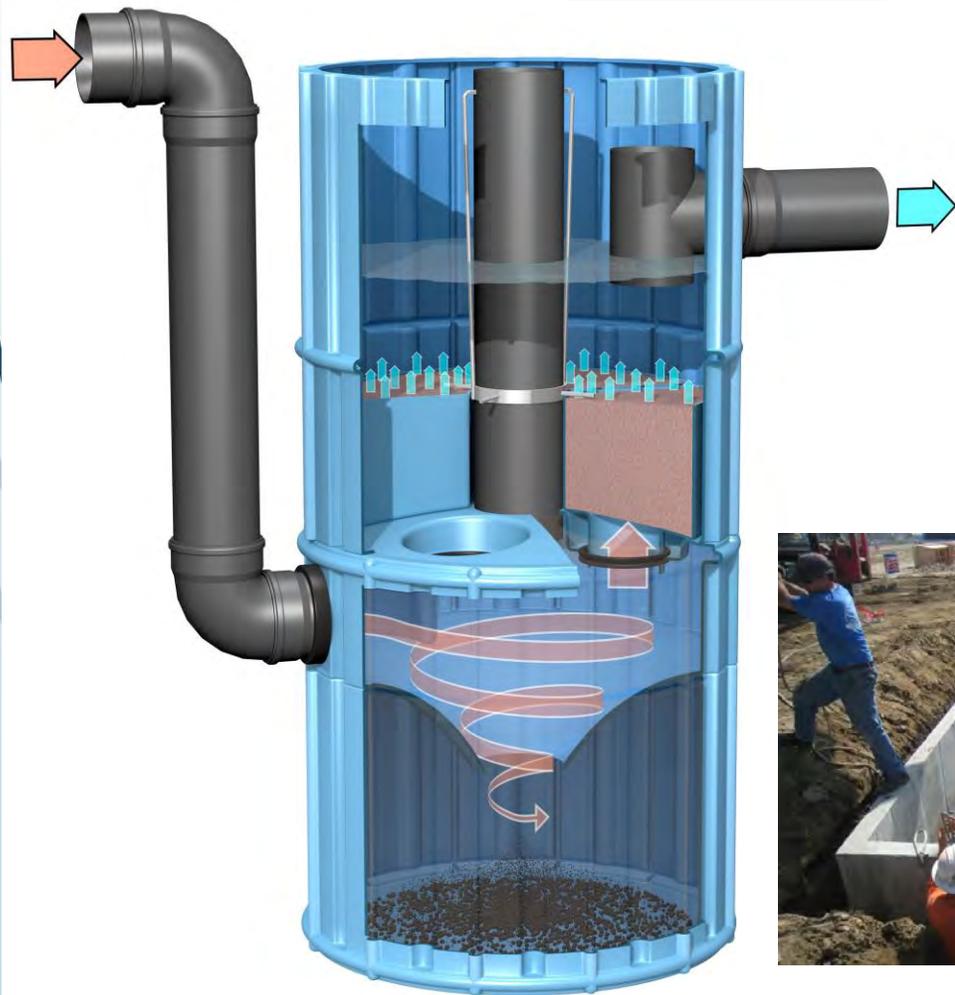


How do BMPs work?

- Underground components are typically pre-fabricated systems with specified installation procedures
 - Frequently found as a concert of BMPs (multiple components linked together)
 - Sometimes stand-alone components (smaller sites)
 - Filter, percolate, slow to settle solids, and store water, releasing slowly
 - Hydrodynamic Separators
 - Water Quality Filters
 - Stormwater Quality Storage
 - Stormwater Detention (vaults)



Construction—Underground



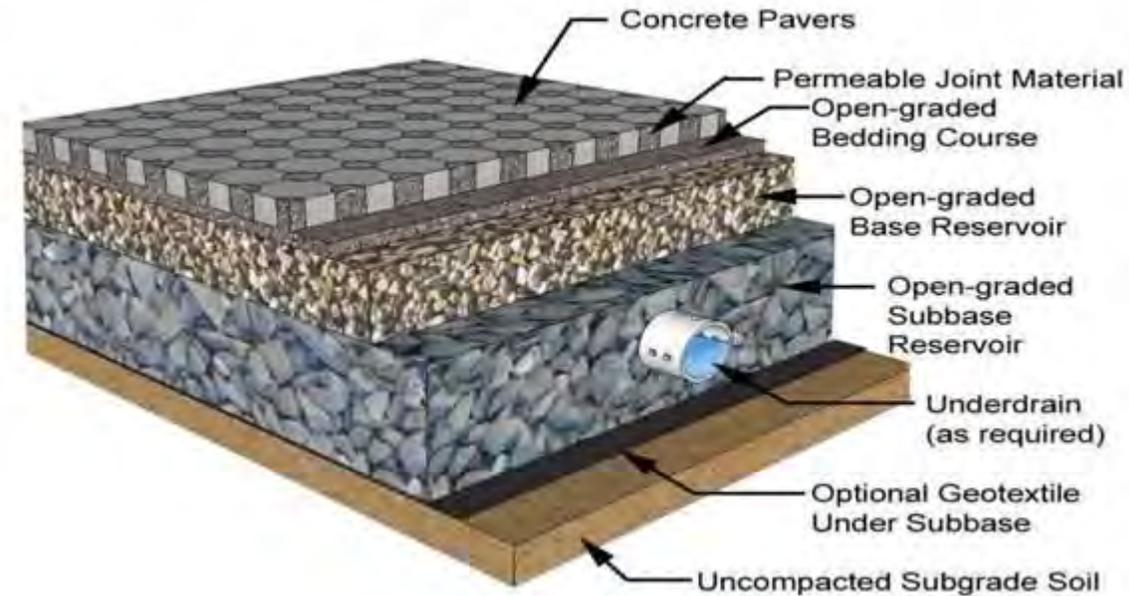


How do BMPs work?

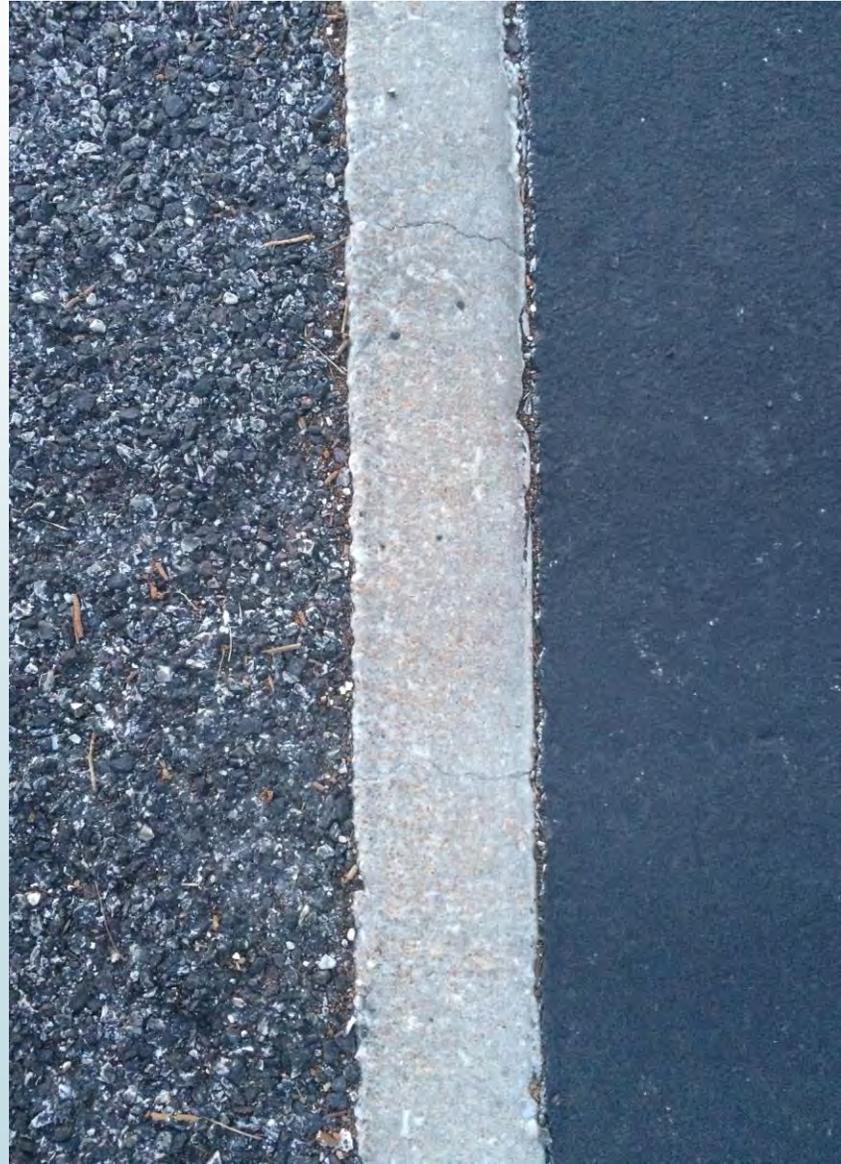
- ▶ Underground components are typically pre-fabricated systems with specified installation procedures
- ▶ Porous Pavement requires specialty application of concrete or asphalt materials that have larger aggregate sizes, less sand, and finishing that does not seal the open spaces between the aggregate
 - ▶ Concrete, Asphalt, or Interlocking Pavers installed over filter beds with underdrains
 - ▶ New pavement areas or replacement of existing conventional pavement
 - ▶ Sidewalks, Parking Spaces, Driveways
 - ▶ Filters and slows stormwater, sometimes allows for infiltration



Construction—Porous Pavement



Construction—Porous Pavement





How do BMPs work?

- ▶ Underground components are typically pre-fabricated systems with specified installation procedures
- ▶ Porous Pavement requires specialty application of concrete or asphalt materials that have larger aggregate sizes, less sand, and finishing that does not seal the open spaces between the aggregate
- ▶ Retention (Wet) Ponds are easy to excavate, but require installation of an outfall structure that regulates pool depth and release at “low flow” and “high flow” levels
 - ▶ Oldest form of stormwater treatment
 - ▶ Sedimentation and storage
 - ▶ One of the only BMPs to contribute to hydrological cycle through evaporation
 - ▶ May or may not have “pre-treatment forebays” for additional sediment collection/filtration



Construction—Wet Ponds





How do BMPs work?

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- ▶ Porous Pavement requires specialty application of concrete or asphalt materials that have larger aggregate sizes, less sand, and finishing that does not seal the open spaces between the aggregate
- ▶ Retention (Wet) Ponds are easy to excavate, but require installation of an outfall structure that regulates pool depth and release at “low flow” and “high flow” levels
- ▶ “Rain Gardens” are enclosed basins with filter beds (gravel/sand) with underdrains, and an additional filter media layer (engineered rain garden soil) where native plants with extensive root systems are planted



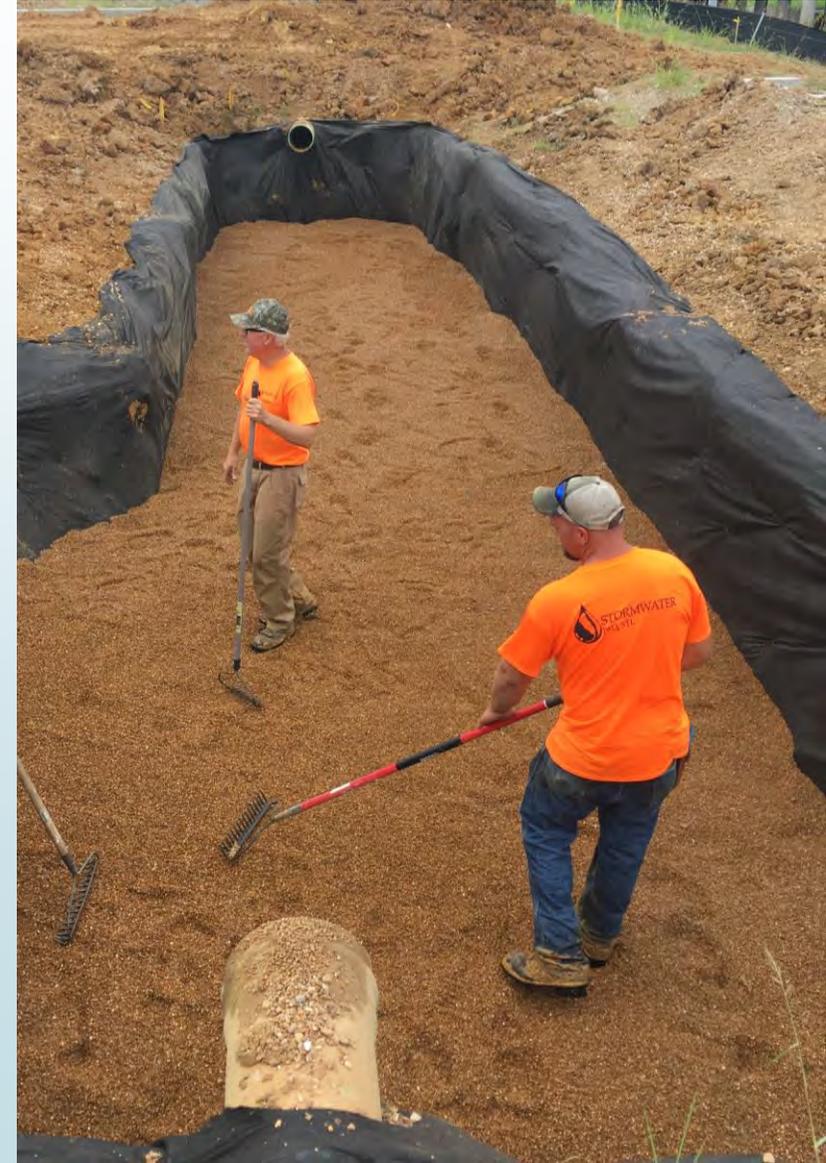
How do BMPs work?

- ▶ Bio-detention (Rain Gardens)
 - ▶ Set apart by use of native plants
 - ▶ Filters and slows stormwater, sometimes holds (perched underdrain) and allows for percolation
 - ▶ Popular BMP component as they can be aesthetically pleasing and viable alternatives to traditional landscaping beds
 - ▶ Additional ecological benefits
 - ▶ Native Plants
 - ▶ Biodiversity
 - ▶ Butterflies, Birds, & Wildlife

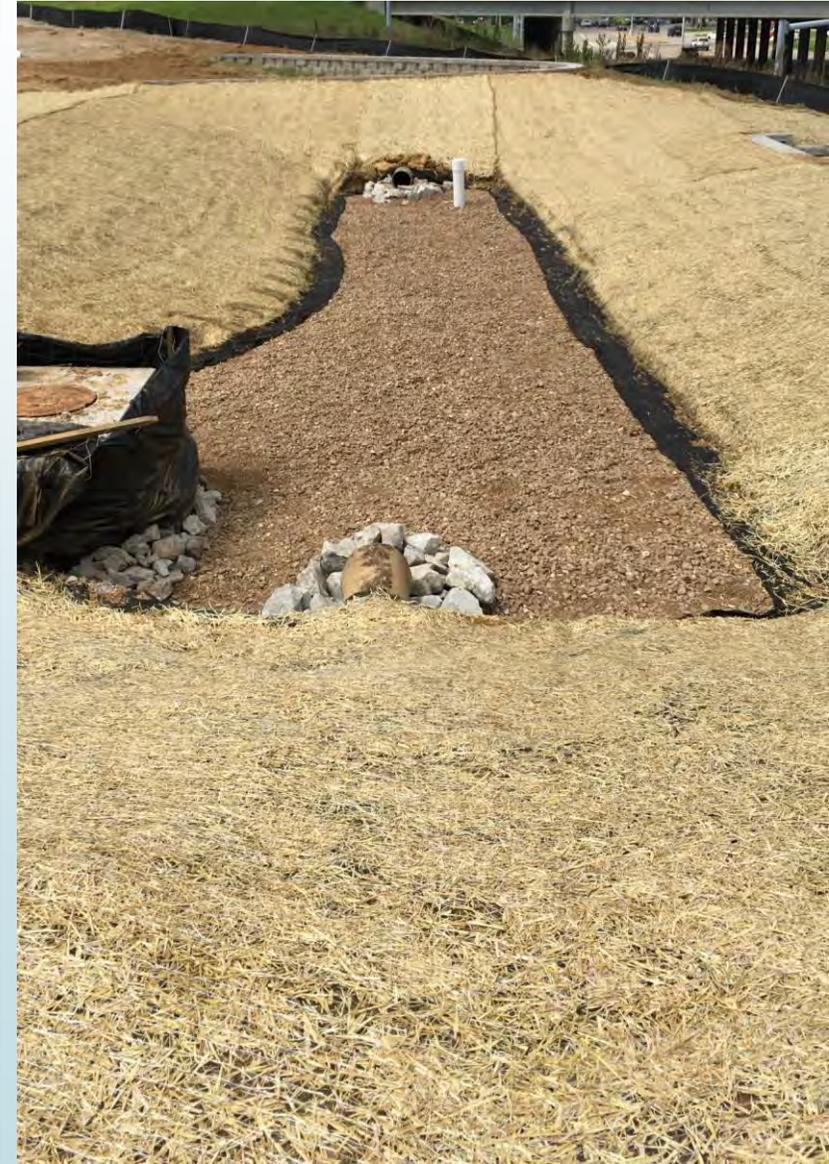




Construction—Rain Gardens



Construction—Rain Gardens



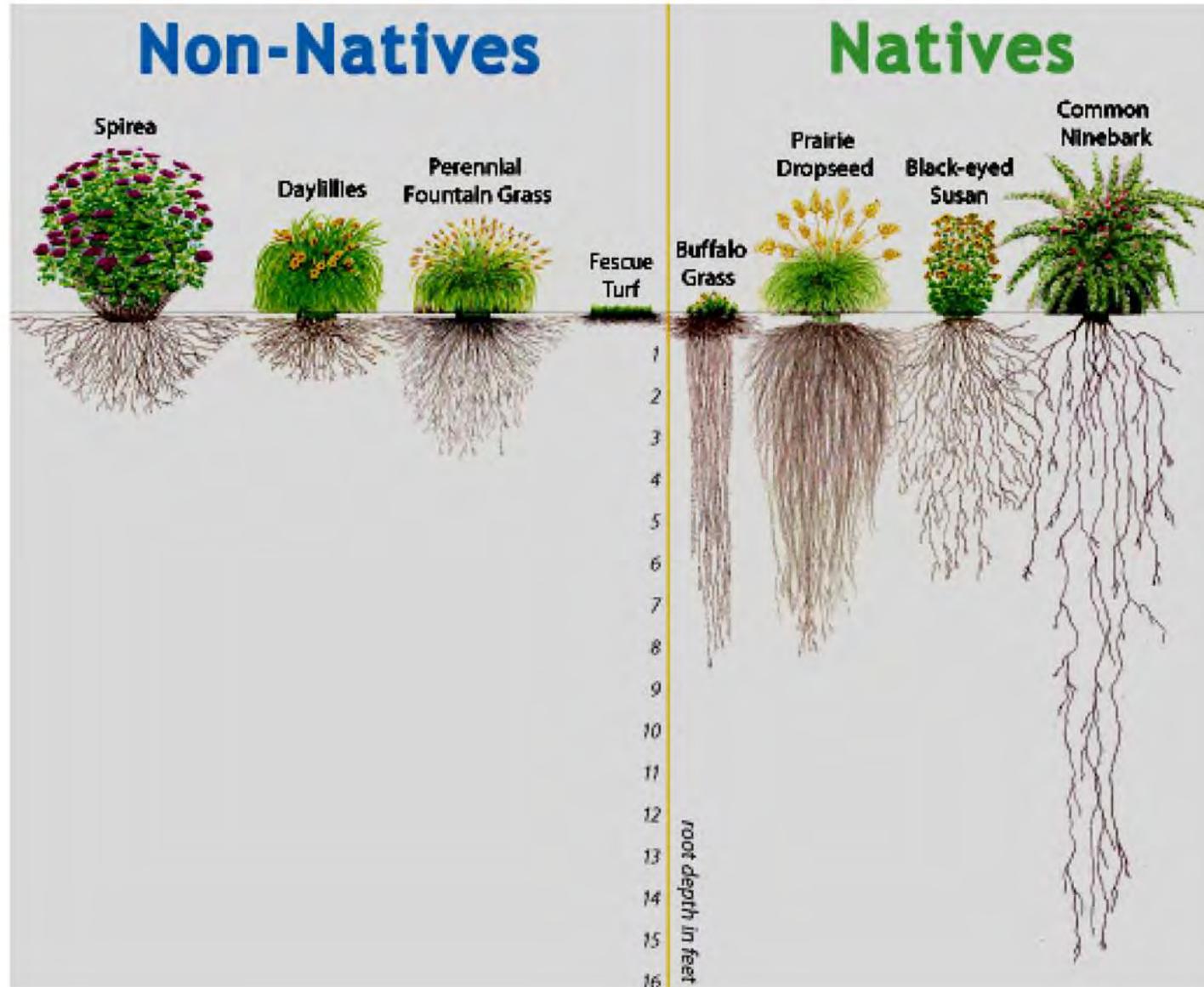
Construction—Rain Gardens



Construction—Rain Gardens



Construction—Rain Gardens





How do BMPs work?

- ▶ Others?
 - ▶ Filter Strips
 - ▶ Above ground areas of plants to catch debris, slow velocity, and allow infiltration
 - ▶ Swales
 - ▶ Similar to filter strips, but more dedication to channeling stormwater between components
 - ▶ Amended Soils
 - ▶ Addition of organic material (compost) to areas of soil to increase infiltration of water to the soil
 - ▶ Level Spreaders
 - ▶ Above ground systems that dissipate velocity of stormwater run-off to prevent erosion, allow infiltration, and allow sediment removal



How do BMPs fail?

- ▶ Intent and Design typically don't cause BMPs to fail, although poorly designed systems require more frequent maintenance to ensure performance
- ▶ Some flawed designs lead to failure, while other BMPs are designed to eventually fail (without maintenance)
 - ▶ BMP cannot handle volume of stormwater
 - ▶ Accumulation of silt in a pond, forebay, or underground component
- ▶ Construction Failures
 - ▶ Not following plans (anything from basin depth to underdrain connections)
 - ▶ Inadequate materials (sharp sand vs natural sand in rain garden filter media)
 - ▶ Not protecting from silt for remainder of construction phase
 - ▶ “Over finishing” porous pavement
 - ▶ Installation of ornamental plants instead of prescribed native plants
 - ▶ Leaking wet ponds



Bioretention and Organic Filter Criteria

- ▶ “The planting soil should be a sandy loam or loamy sand (should contain a minimum of 60 percent sand, by volume). The clay content for these soils should be less than 10 percent by volume.” – *Landscape Guide for Stormwater Best Management Practice Design, MSD May 2012*
- ▶ Soil Texture Analysis
 - ▶ Soil Classification: Loamy Sand
 - ▶ Percent Sand: 85%
 - ▶ Percent Silt: 7.5%
 - ▶ Percent Clay: 7.5%





How do BMPs fail?

- ▶ Maintenance Failures
 - ▶ BMP specific maintenance is needed to ensure performance
 - ▶ Without maintenance, BMP failure is inevitable
- ▶ Underground
 - ▶ Accumulation of silt
 - ▶ Clogging/dirtying of filters
 - ▶ Broken, damaged, or blocked components
- ▶ Porous Pavement
 - ▶ Clogging of pores / loss of paver fill aggregate
 - ▶ Deterioration of porous surface
 - ▶ Paint/Oil spills and stains



How do BMPs fail?

- ▶ Maintenance Failures Continued
- ▶ Wet Ponds
 - ▶ Accumulation of silt (reduced capacity)
 - ▶ Overgrown with vegetation
 - ▶ Broken, damaged, or blocked outflow structure
 - ▶ Leaks
- ▶ Rain Gardens
 - ▶ Invasion of non-native plants in the basin
 - ▶ Too few or too many native plants in the basin / dead plant material
 - ▶ Erosion of basin walls / accumulation of silt on top of the basin
 - ▶ Movement of mulch or filter media layer