Green Infrastructure Fundamentals:

Design, Functionality and Maintenance Insights

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Summit Soil and Water Conservation District

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Introduction: Brian Prunty

- District Administrator at Summit SWCD
- Team of 11 talented individuals
- Perform education, IDDE, construction site inspection, post-construction inspections and municipal facility inspections.
- Over 24 years in the stormwater industry
- 14 years as a Landscape Professional
  - Maintenance, installations, hardscapes, arborist work
- Managed stormwater programs and MS4 permits
- Hobbies: brewing beer, smoking meats and outdoor adventure sports

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THE OHIO STATE UNIVERSITY
Stormwater Management Program

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Presentation Outline

- Introduction of Green Infrastructure (GI)
- List of common GI practices and how they function
- Design and maintenance considerations for bioretention facilities and porous pavement systems

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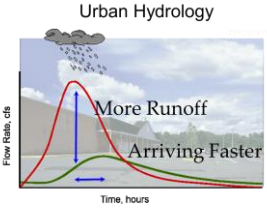
During this presentation, I am assuming…

- You understand what precipitation and stormwater runoff is
- You understand basic urban hydrology
- You know what typical pollution is found in urban runoff and sources
- You know the basics of stormwater management



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What is Green Infrastructure?

- "a collection of measures that use plant and soil systems, permeable surfaces, and landscaping to manage stormwater" – USEPA
- "an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly" - USEPA

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Where or How to Use Green Infrastructure?

Where:

- Proposed landscaping
- Rooftops
- Parking lots
- Open space
- Rights of Ways

How:

- Mimic natural sinks that slow down the runoff

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Benefits: Triple Bottom Line

- Environmental
- Economic
- Social impacts

- Ultimately you need grey and green infrastructure.

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GI Practice - Bioretention

- Concave soil and plant-based treatment system
- Reduces runoff volume
- Relies on soil microbial community, plants, and design characteristics to function, remove pollutants and self-maintenance
- Internal water storage
- Requires some grey infrastructure: Catch Basins and Pipes
- Benefits: provides ecosystem services, meet landscape zoning requirements, aesthetics, high performing, Nitrogen removal, temperature treatment and small footprint
- Limitations: smaller watershed and perched water table

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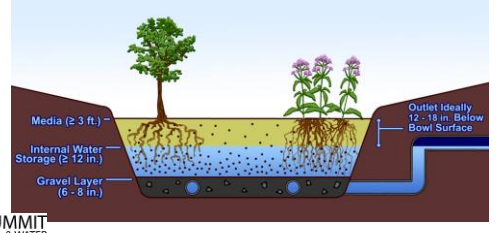
Parts of a Bioretention Cell



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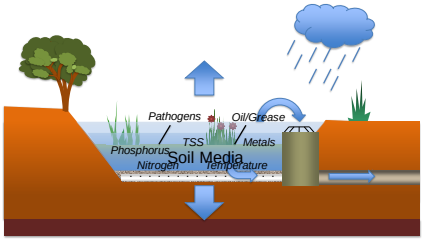
THE OHIO STATE UNIVERSITY Stormwater Management Program — Food, Agricultural, and Biological Engineering

How Bioretention *Should* Work



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Where are the Pollutants Trapped?

- Majority of Pollutants are removed in the top 3"- 4" of the filter media
- This includes traditional targeted pollutants but newer ones (micro plastics & PFAS)
- Performs better as they age
- Biological activity & soil food web (bioturbation)

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Permeable Pavements

- Concrete, asphalt, pavers & gravel filled grid
- Limited impervious to pervious ratio
- Reduces runoff volume
- Relies on clogging or choking sediment at the surface
- Requires grey infrastructure: catch basins , pipes, pavers, concrete, asphalt, and curb or ribbon curb
- Benefits: doesn't require additional land or space, design with IWS, reduce grey infrastructure, used with other BMPs (rainwater harvesting)
- Limitations: land use, slope, upslope areas (trees, mulch, unstable watershed, etc.) and traffic or vehicle usage

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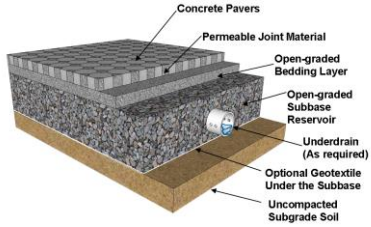
Permeable Pavement



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How Should it Work?

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Green Roof

- Soil media with plants on structurally supported rooftop
- Limited to treating what falls directly on rooftop (cleaner water)
- Soil media consist of organic matter & expanded shale
- Requires some grey infrastructure: roof drains, barriers and roof support
- Benefits: ecosystem services, reduces heating & cooling cost, extends the life of the roof, functions better in cooler climates (Ohio), & increases property and rental values.
- Limitations: exports phosphorus, roof structure, hot climates, irrigation required during summer, treats cleaner water and maintenance

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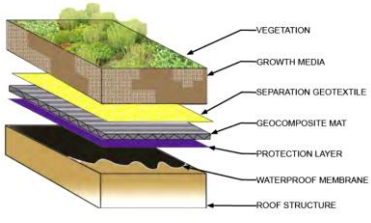
Morphology of a Green Roof



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Extensive Green Roofs

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Extensive Green Roof – Modular Trays

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Intensive Green Roofs

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Constructed Wetland

- It is a basin… everyone can design a basin!
- Manage small to large watershed
- Requires some grey infrastructure: outlet structure weir or pipes
- Benefits: habitat and ecosystem services, removes more pollution than other basins, relies on plants for nutrient uptake Provides other benefits related to ecosystem services
- Limitations: soils, invasive plants, perspective, cost compared to other basins

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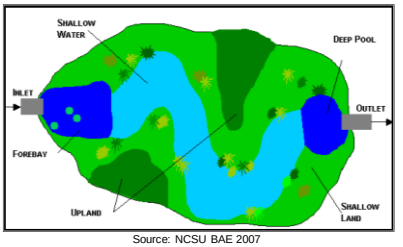
Stormwater Wetland Features



Source: NCSU BAE 2007

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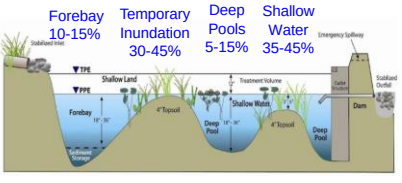
Diversity in Ponding Depth

Forebay 10-15% | Temporary Inundation 30-45% | Deep Pools 5-15% | Shallow Water 35-45%



Source: NCDEQ BMP Manual

*of the total wetland surface area

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Wetland Functions

- Forebays and deep pools
  - Collect sediment and trash (sedimentation)
  - Encourage biodiversity
  - Support fish during droughts
  - Dissipate energy of stormwater
- Shallow water and temporary inundation zones
  - Areas where dense vegetation will grow
  - Majority of pollutant removal occurs here (plant uptake, soil and microbial processes, filtration)

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Infiltration Basins & Trenches

- Trench narrow, filled with gravel with small surface area
- Basin has flat wide bottom to increase surface area
- Drain WQv under 24 hours
- Benefits: Runoff reduction, infiltration, pollutant removal, temperature treatment, peak flow infiltration
- Limitation: soils with high Ksat rates, require pretreatment, no compaction during installation, and maintenance

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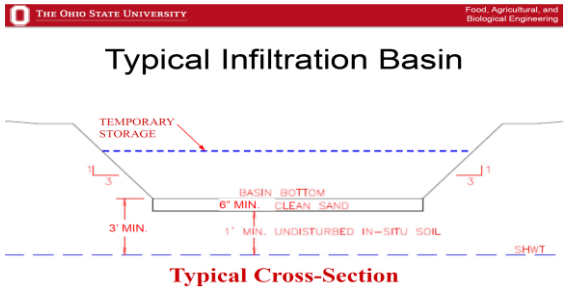

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Always Provide a High-flow Bypass!

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Always Provide a High-flow Bypass!

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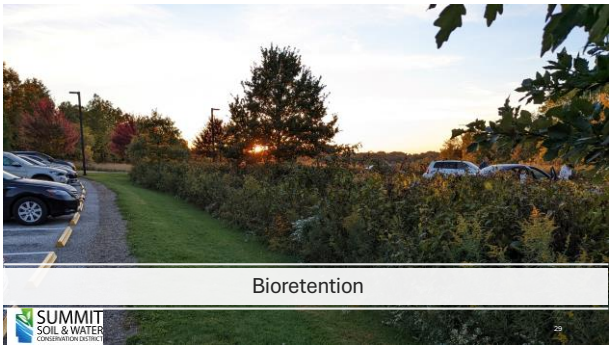

Bioretention

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Design Issue- Bioretention

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Pretreatment Design Considerations - Bioretention 33

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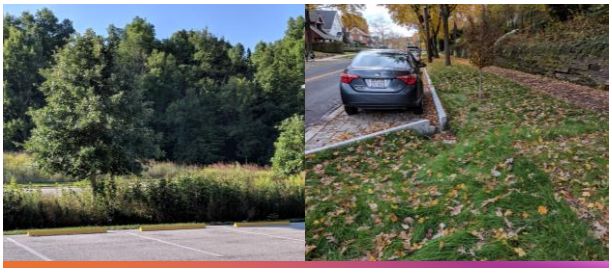

Pretreatment Considerations- Bioretention 34

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Precast Pretreatment Considerations - Rain Guardian 35

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Bypass Design Considerations- Bioretention

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Bypass Design Considerations- Bioretention

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Mulch Considerations- Bioretention

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Planting Considerations- Bioretention

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Side Slope Considerations- Bioretention

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Cleanouts - Bioretention

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Design Issue - Porous Asphalt

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Design Considerations- Porous Asphalt

- Old School Mix – Binder heats and drains
  - Causes accelerated raveling
  - Limiting/restrictive layer
- New School Remix - Asphalt binders (PG 76-22) and fiber reinforced

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Raveling Issue - Pervious Concrete

- Caused by improper mix or improper installation (plastic not placed over concrete as it cures)
- Street sweep to remove raveled material
- Does not affect infiltration rate

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Design Consideration – Impervious Contribution

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Design Consideration – Location

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Design Consideration – Location

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Design Consideration – Traffic and Turning

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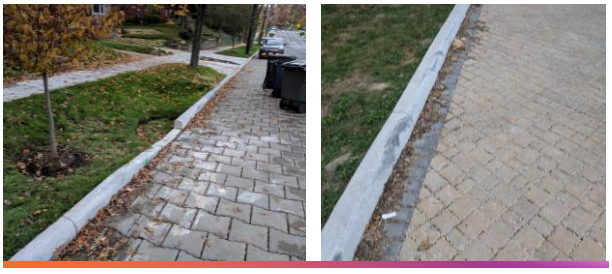

Design Consideration - Trees

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Design Consideration – Snow Storage

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No Curbing = Structural Challenges

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Maintenance of Concrete Grid Pavers

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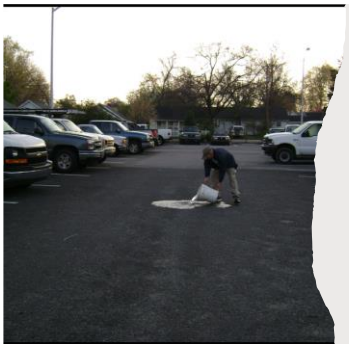

Maintenance of Porous Asphalt

- Routine or preventative maintenance: regenerative street sweeper
- Restorative Maintenance: milling or pressure washing

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Maintenance of Porous Concrete

- Routine or preventative maintenance: regenerative street sweeper
- Restorative Maintenance: vacuum truck or pressure washing

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Maintenance of Porous Pavers

- Routine or preventative maintenance: regenerative street sweeper
- Restorative Maintenance: vacuum truck or pressure washing
- Requires back filling with choker stone

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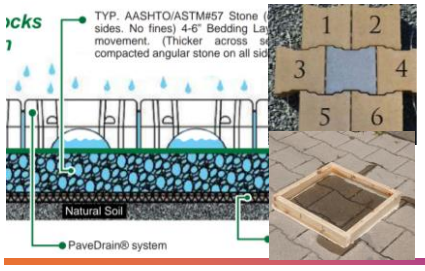

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Pave Drain vs Pavers

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The Take Home

- Green Infrastructure (GI)provides several more benefits than grey
- The pendulum swings, GI alone isn't the answer
- Consider how the practice treats stormwater when designing all BMPs
- Consider and plan for maintenance during the design phase
- Meet with local reviewer earlier to discuss GI projects
- It just isn't for the private developer
- Poor oversight during GI installation can ruin all the planning

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Questions

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Learn more at www.summitswcd.com

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