Low Impact Development: Design Considerations

Alabama Low Impact Development Summit

April 9, 2014

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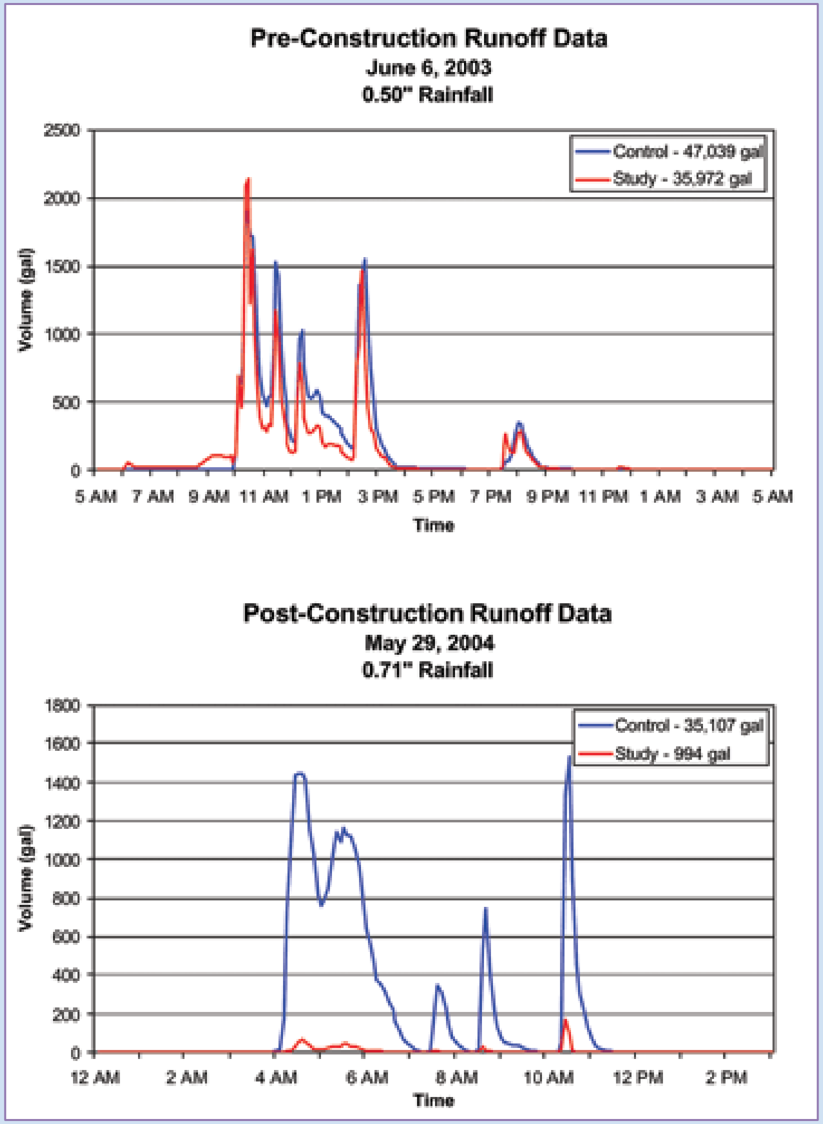
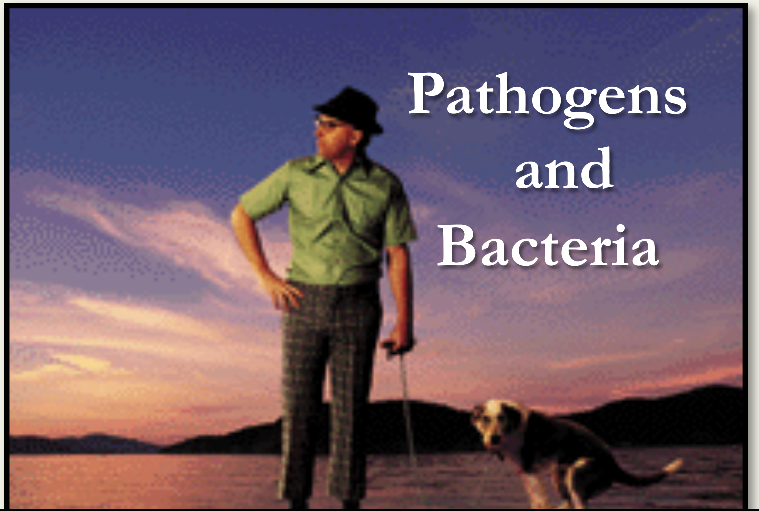
Fundamentals

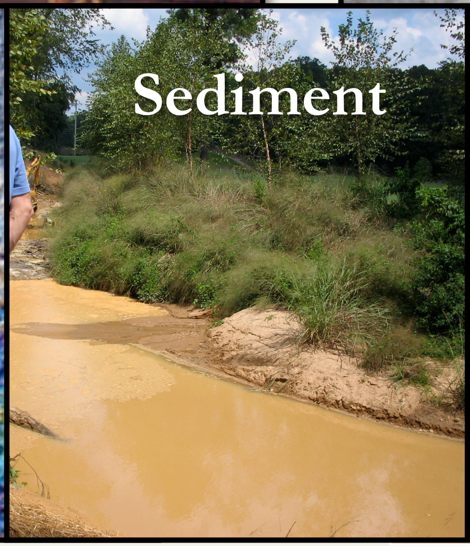
Replicate natural water balance and treatment processes

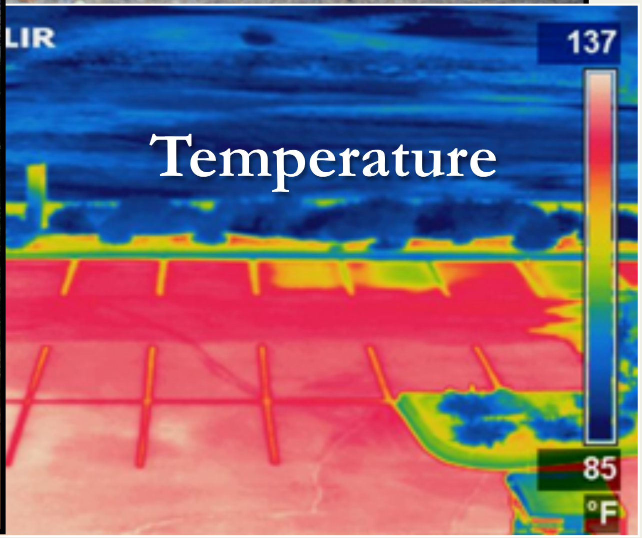
Goal: Water Balance



Goal: Treatment







LID Principles

Overall:

Decentralized/Integrated/Multi-functional/Multi-beneficial

Engineering:

Retain/Detain/Filter/Infiltrate/Treat/Prevent/Use

Text credit: Larry Coffman, Prince George's County, MD

Toolbox

Site planning

Conservation

Minimize clearing

Minimize grading

Save sandy soils

Save drainage patterns

Strategic grading

Practices (SCM/BMP)

Reduce impervious surface

Disconnect impervious surface

Vegetated swale

Rain garden/bioretention

Porous surface

Rainwater harvesting/cistern

Infiltration

Vegetated buffers

Green roof

Stormwater treatment wetland

Davenport Park, Asheville

- Narrow roads
- Porous pavers
- Vegetated swale
- Bioretention
- Preserve vegetation
- Cluster development
- Rain barrels/rain gardens/drought tolerant landscaping

Credit: David Tuch, Equinox Environmental

Davenport Park, Asheville

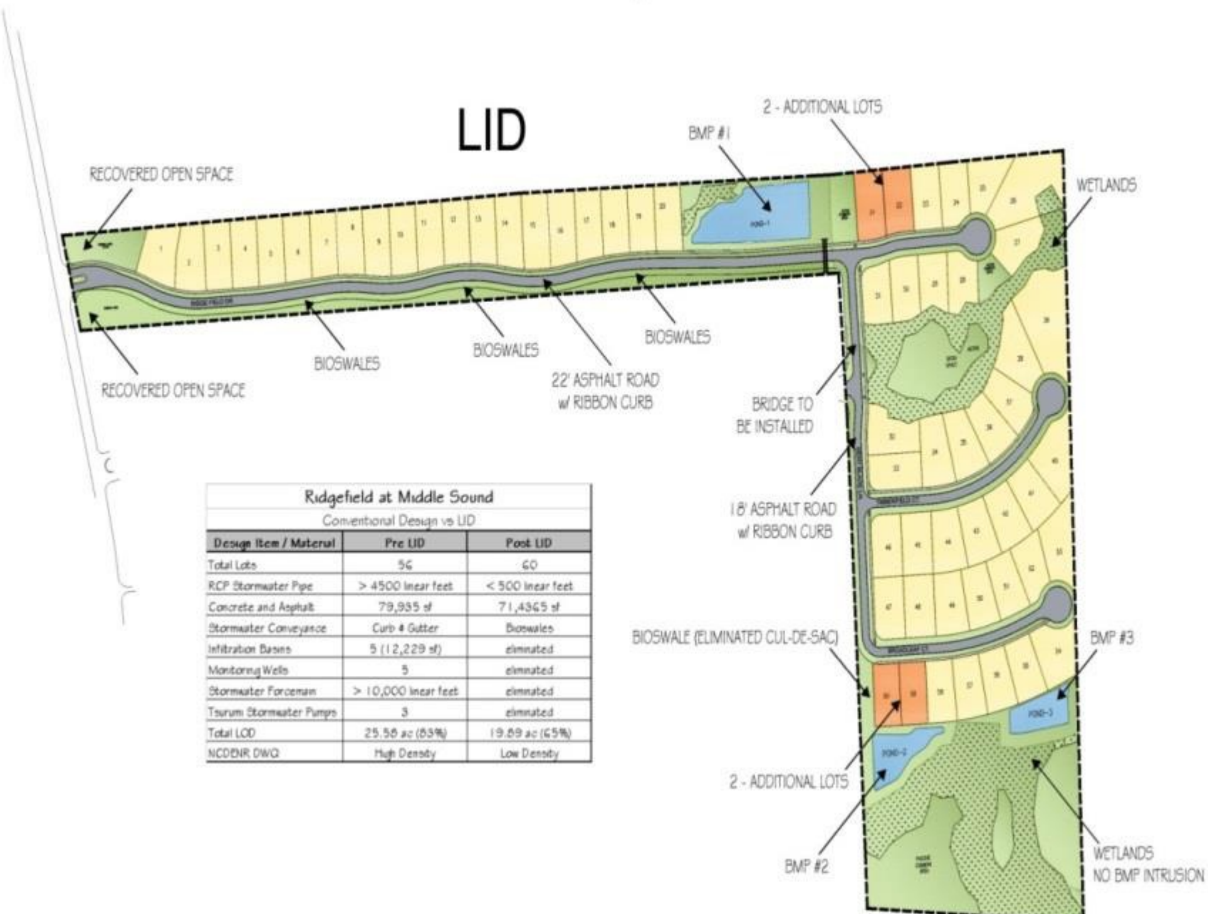
Credit: David Tuch, Equinox Environmental

Conventional vs. Low Impact

- Lower site prep costs
- Less paving
- Less conventional stormwater infrastructure
- Fewer ponds = more buildable lots
- Improve aesthetics, increase marketability and value
- If one BMP fails, less impact on water quality

CONVENTIONAL

LID



Ridgefield at Middle Sound

Conventional Design vs LID

Design Item / Material	Pre LID	Post LID
Total Lots	56	60
RCP Stormwater Pipe	> 4500 linear feet	< 500 linear feet
Concrete and Asphalt	79,935 sf	71,4365 sf
Stormwater Conveyance	Curb & Gutter	Bioswales
Infiltration Basins	5 (12,229 sf)	eliminated
Monitoring Wells	5	eliminated
Stormwater Forcemain	> 10,000 linear feet	eliminated
Tsurumi Stormwater Pumps	3	eliminated
Total LOD	25.58 ac (83%)	19.89 ac (65%)
NCDENR DWQ	High Density	Low Density

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Conventional vs. Low Impact

- Small BMPs instead of collection/ conveyance/treatment system
- Reduce stormwater pipe length 89%
- Eliminate 9000 feet curb/gutter
- Eliminate 5 infiltration basins
- Save $1 million grading
- Gain 4 lots

Conventional vs. Low Impact

Somerset subdivision, MD:

- ½ conventional, ½ LID
- Similar housing density, road length

Cost savings:

Eliminate 4 stormwater ponds: $650,000

Eliminate pipe and ditches: $150,000

Construct roads without curb/gutter: $350,000

Add $370,000 rain gardens/swales

Net savings $780,000

Conventional vs. Low Impact

- 15-80% savings (generally 20-30%) in capital stormwater costs

  (EPA, 2007: Study of 17 LID-based residential and commercial developments)

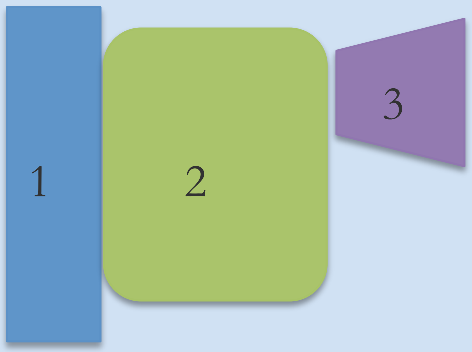
- $3500-4800 savings per lot

  (Maryland, Illinois, Arkansas)

- Lots sell at $3000-5000 premium

  (North Carolina, Arkansas)

Typical Components



1. Pretreatment
2. Primary Treatment
3. Overflow

Pretreatment:

- Suspended sediment removal
- Preventive maintenance
- Lowers velocity

Pretreatment

If concentrated flow:

Use forebay and/or vegetated swale

Pretreatment

If distributed flow:

Use vegetated filter strip and/or gravel verge

(8 inches gravel, 4 feet sod)

Overflow

- Existing Overflow Outlet Structure
- Weir and Grassed Swale
- Tie underdrains into overflow or outlet structure

Essential Information: Watershed

- Watershed area
- Composition
- Curve Numbers

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4

USDA Urban Hydrology for Small Watersheds
(June 1986)

Essential Information: Soils

- Individual Soil Types
- Depth to Water Table
- Hydrologic Soil Group (A, B, C, D)
- Infiltration Rate

Tools:

- Web Soil Survey
- County Soil Survey Maps

http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Essential Information: Design Storm

Design storm = First Flush = roughly equivalent to treating 80% of rainfall on an annual basis

First flush precipitation depths generally 1.0”-1.5”

****Check your location****

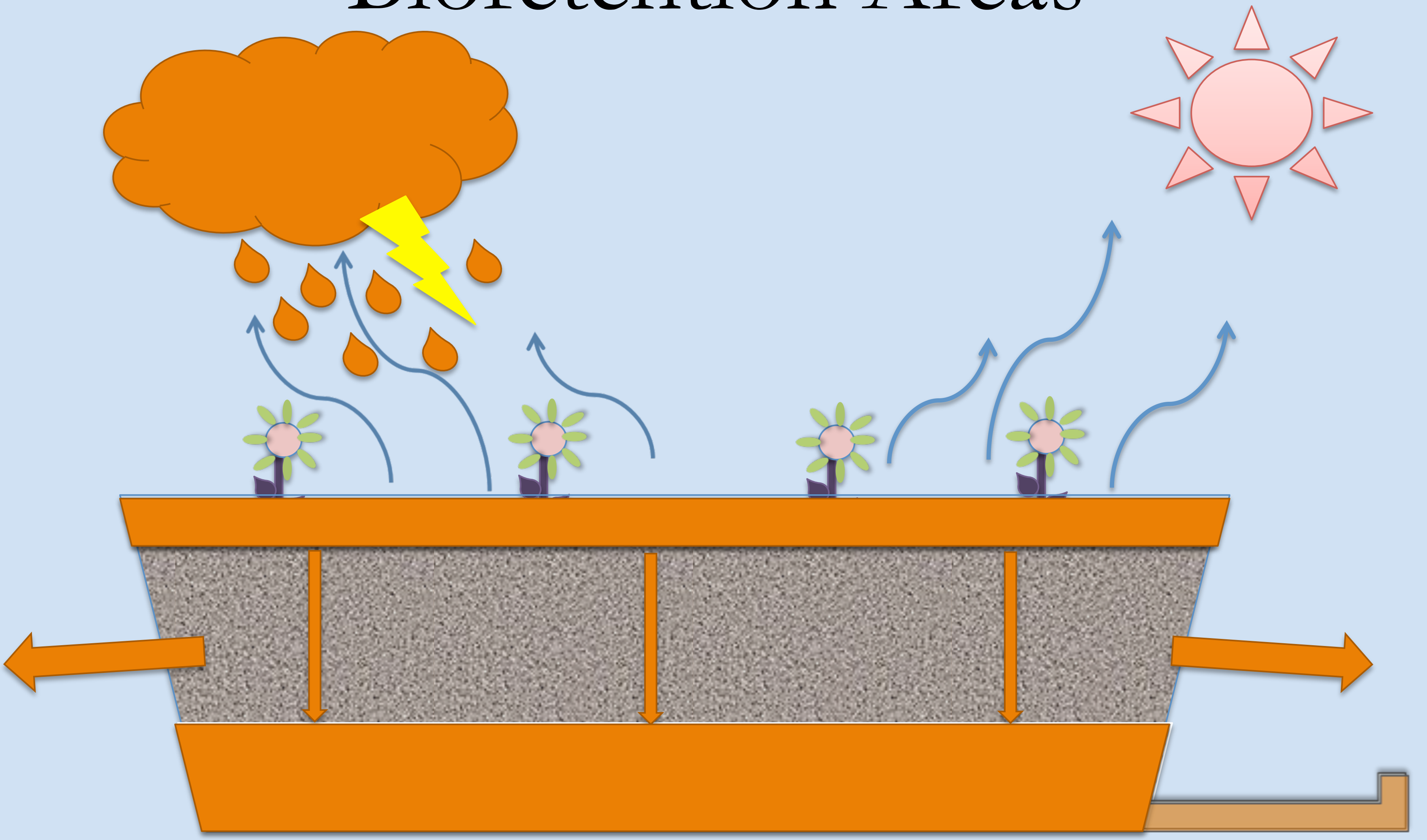
Bioretention Areas

A filtration and infiltration best management practice and landscape feature.

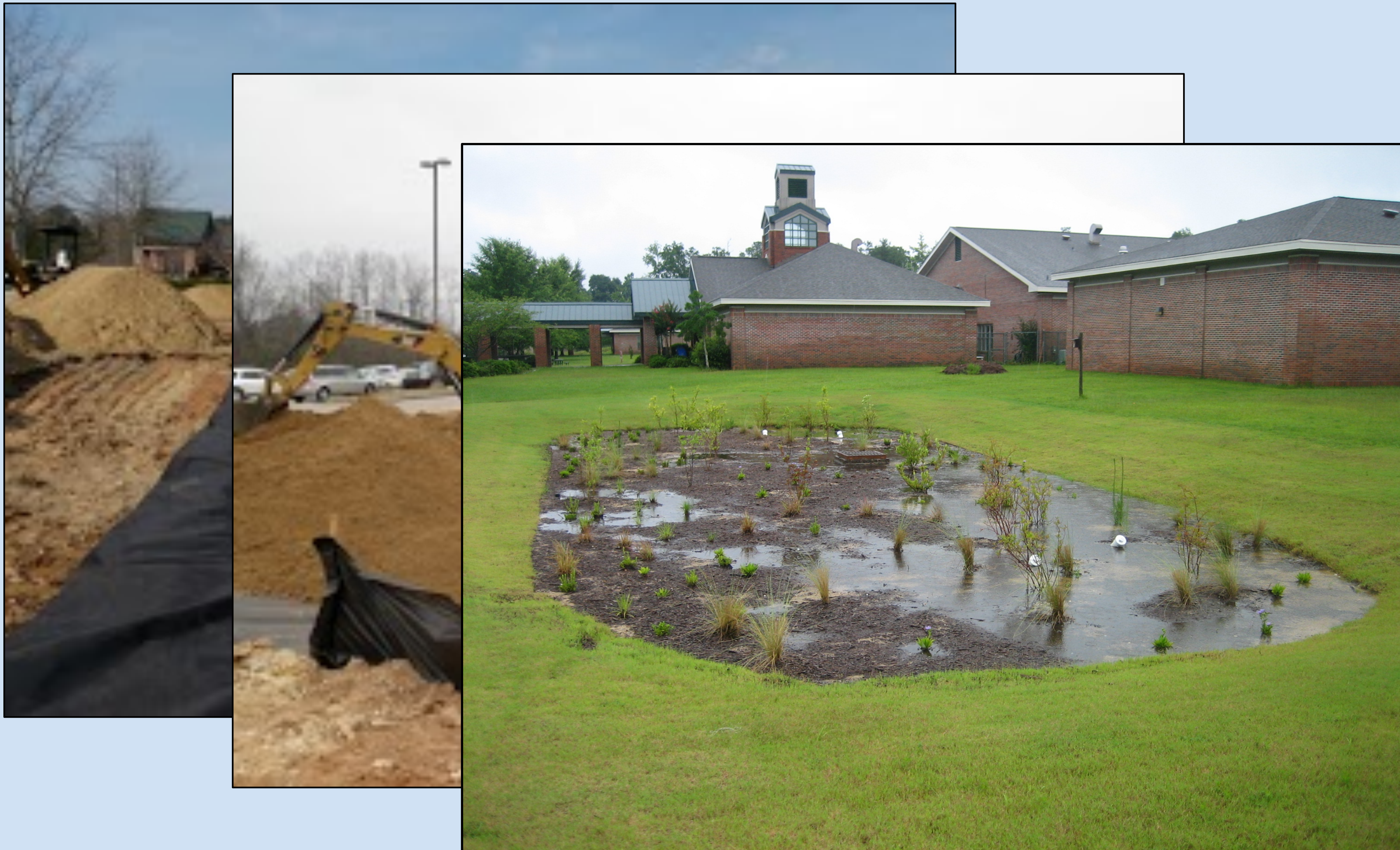
Focuses on **HYDROLOGY** and **POLLUTANT REMOVAL**

- Good choice for retrofits
- Can be aesthetically pleasing
- Great water quality treatment
- Water ponding typically <9 hours

Bioretention Areas



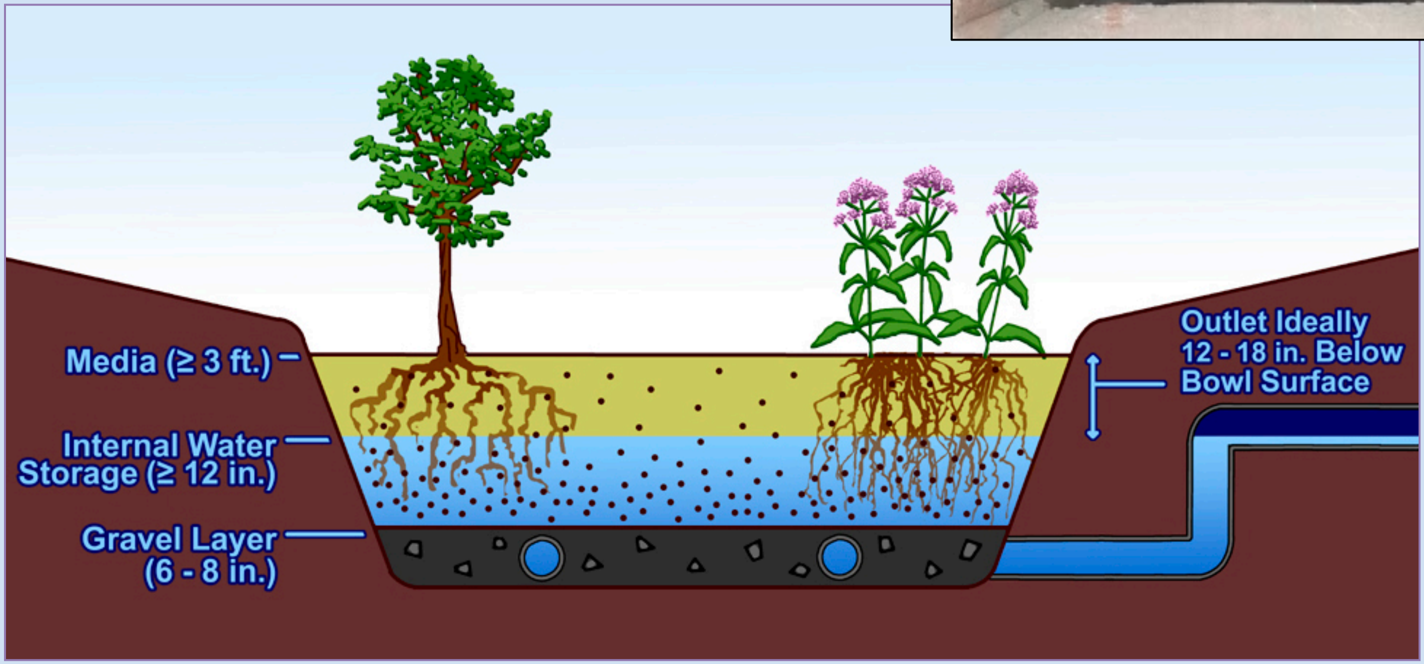
East Smiths Station Elementary School



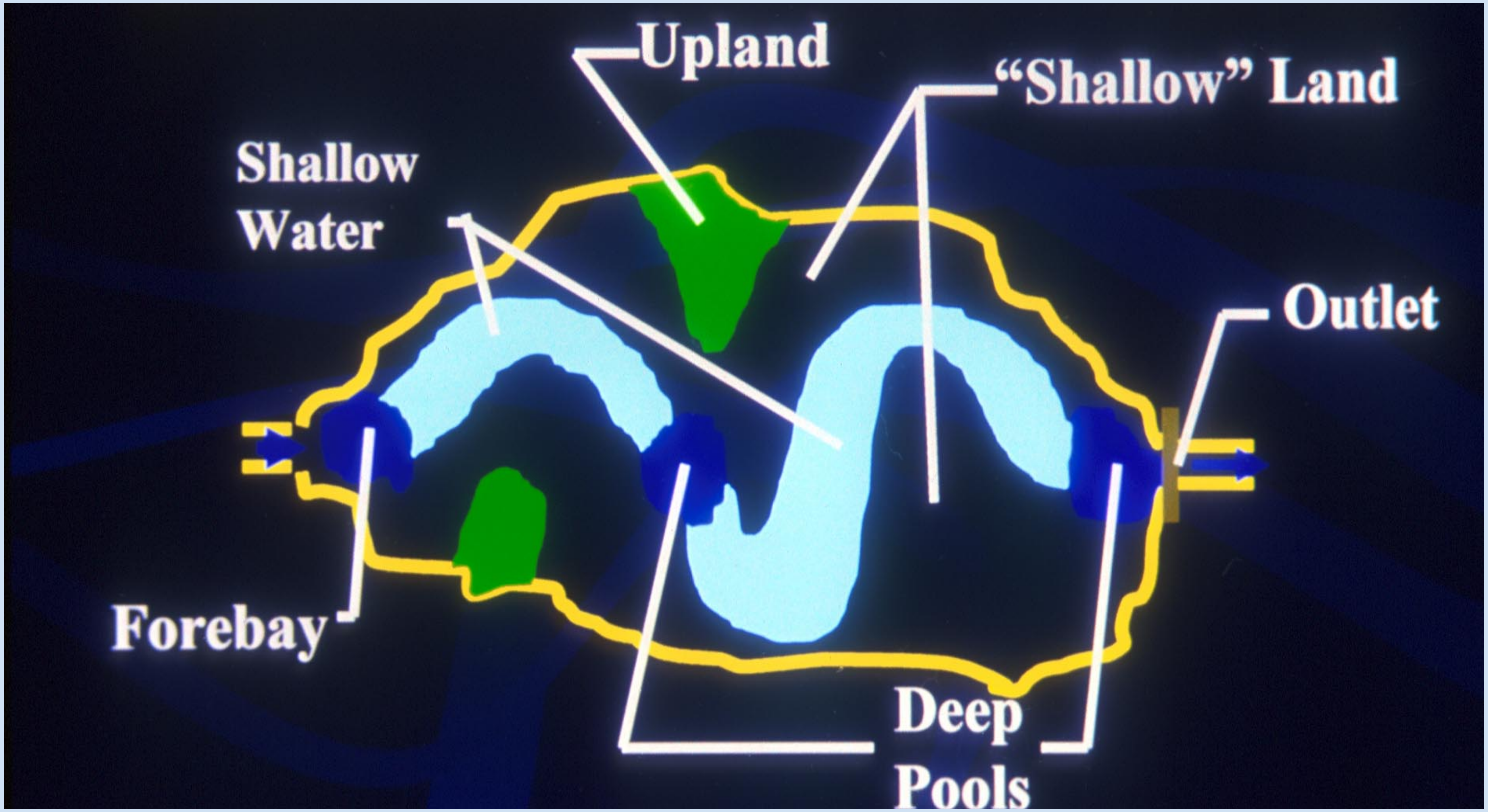

SPEED
LIMIT
25

Internal Water Storage

- 90-degree PVC upturned elbow, at least 12” below bowl surface
- Forces elevated outlet
- Promotes exfiltration and ET
- Significant volume reductions



Stormwater Wetland



Stormwater Wetland

Permeable Pavement

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- Low-traffic areas
- Only intended to treat water that falls on it
- Maintenance
- Three types:
  - Interlocking pavers
  - Porous asphalt
  - Porous concrete

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Rainwater Harvesting

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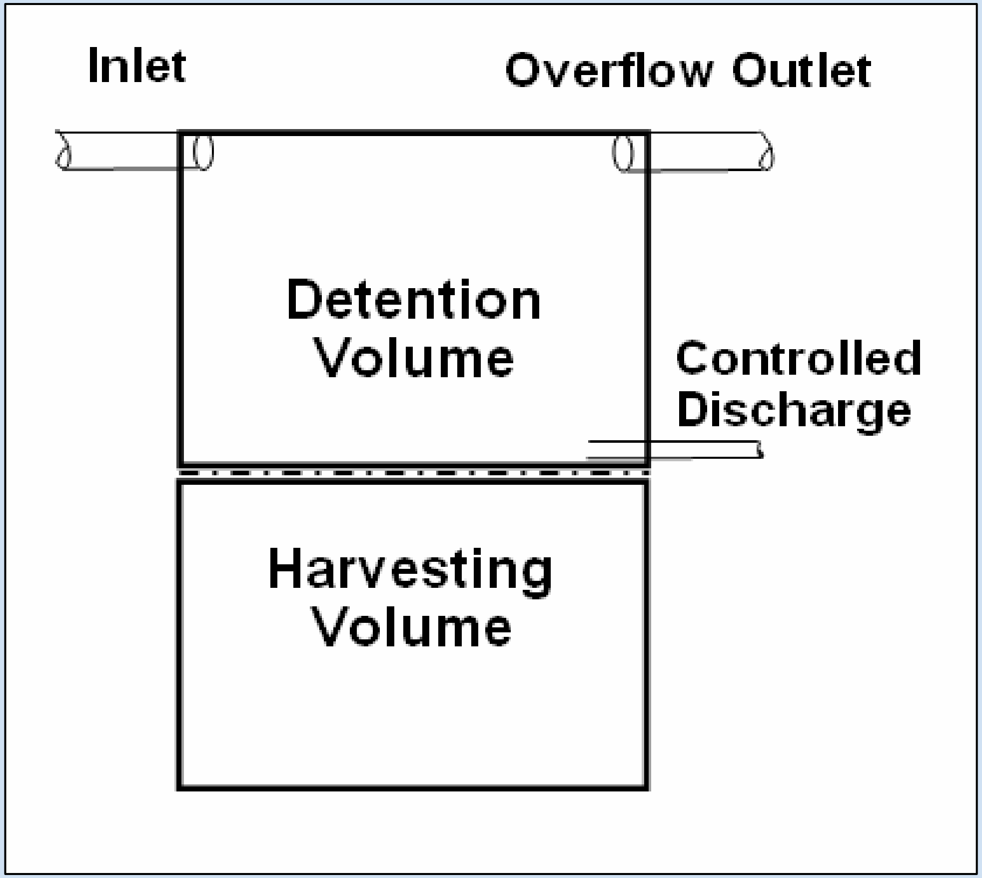


Rainwater Harvesting

Treatment Train

Mars Hill, NC

Photo credit: Tim Ormond, Hydrocycle Engineering

Inspection & Maintenance

- Design for maintenance (access)
- Written I&M agreement
- Education

Typical actions:

- Trash removal
- Mulch/plant replacement
- Check inlet/outlet

Inspection & Maintenance

In-depth analysis of 43 bioretention cells in NC:

- 53% need maintenance
- 44% had sediment deposition on top of mulch
- 65% undersized (mulch too deep or construction errors)

Essential:

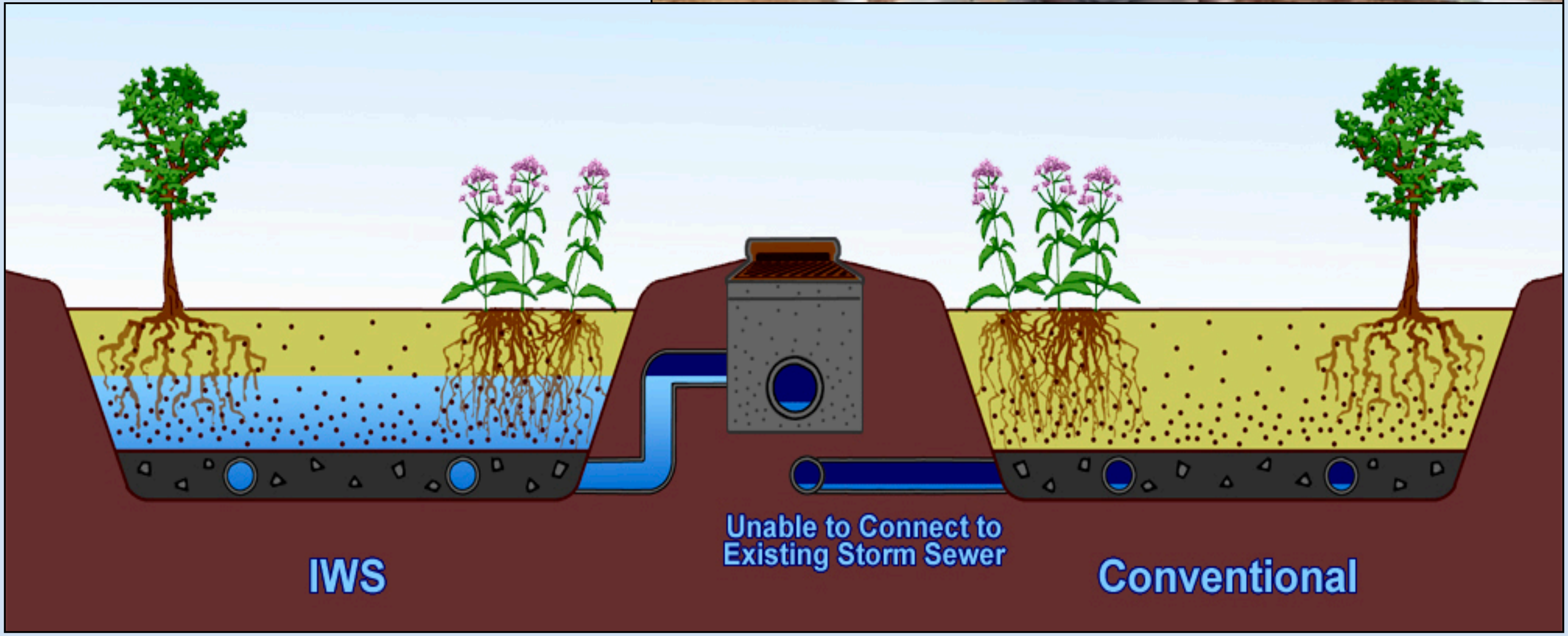
- Pretreatment
- Protect surface of media during construction
- Construction oversight

Constraints

Utilities?

Constraints

Elevations?



Constraints

Topography?

Constraints = Opportunities for Creativity

Photo credit: Tim Ormond, Hydrocycle Engineering