Evaluation of Bioretention and Wetland Retrofits for Improved Stormwater Control within an Institutional Landscape

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Some Background on Urban Runoff Effects on Greenville Streams
Land use & flood hazards linked to geology

- Large rivers have asymmetrical floodplains
- (NE flood risk > SW flood risk)
- Geology has strong influence on urban land-use patterns
- Poorly drained & flood prone areas, less developed

Tar River – Edgecombe & Pitt Counties

Previous Study – METHODS AND STUDY AREA

- Water level logging and riparian wells (sw and gw; 5 sites)
- Stable isotope and specific conductance sampling
  - Monthly stream baseflow and groundwater sampling at 5 sites
  - Stormwater sampling at 3 sites (8 events)
  - Bi-weekly rainwater sampling at 1 site
- Stable isotope analyses (D and $^{18}$O) at Duke Environmental Isotope Lab (Dr. Jon Karr)
- Lab sediment specific yield and recharge estimation by the water table fluctuation method.
Land-Use Change in Greenville Since the 1930s


RESULTS: Urban Stormwater Generation

$^{18}$O and Specific Conductance Hydrograph Separations

- Stormwater generation
- Urbanization

\[
R^2 = 0.93
\]
RESULTS: Urban Channel Incision

Fornes Branch (Urban, 37% TIA)
- Channel Downcut 1.28 m in 33 yrs
- Channel incision ~ 4 cm/yr (1.5 in/yr)

(Hardison et al. 2009)
RESULTS: Riparian Water Table Decline

Urban channel enlargement

RESULTS: Channel Incision, Overbank Flooding, and Riparian Groundwater Recharge

Urbanization and channel incision
Urban channel incision reduced recharge to urban riparian zones (TIA>20%) along low-order coastal plain streams (33-23% decline).

Urban channel incision can contribute to:
- drier riparian soils/deeper riparian groundwater
- reduced sediment and nutrient retention
- reduced riparian stormwater storage
- loss of wetland status in riparian zone
- decreased effectiveness of riparian buffers

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Or

Reducing stormwater inputs to Greens Mill Run by improving stormwater management on ECU Campus
Overview

- Background
- Site Consideration
- Site Evaluation
- Site Selection
- Design
- Construction
- Performance

Background: Greens Mill Run (GMR)

- Stream Length: 7.3 miles
- Watershed Area: 8600 ac.
- Tributary to Tar River
Background: GMR Development

- Approximately 70% developed
- Downstream development mostly prior to 1982
- Future upstream build out expected
- Largest single land owner: ECU
Site Prioritization and Selection

• Proximity to runoff sources
  – Positioned to receive runoff
  – Roofs and Pavement

• Approval from Facilities
  – Expected Land Use Change
  – Agreement with aesthetics

• Soil profiles

• Infiltration rates

• Feasibility Assessment
  – Existing Utilities

Targeted Sites

• Primary Sites:
  – 1, 3, 4, 7, & 9

• Alternate Sites:
  – 2, 5, 6, & 8
Site Selection

• 9 Initial Sites
  – Incompatible Future Landuse
  – Utilities Conflict
  – Bioretention Site
  – Wetland Site

Belk Bioretention Design
Bioretention Construction

- Free Draining
- “Rain Garden”
- Designed for runoff from 1” event
- When filled, parking lot runoff bypasses inlet pipe

Umstead Design

[Diagram showing 8,000 ft² Impervious area]
Umstead Bioretention Construction

- Underdrain with upturned elbow
- Between ECU Telecom and ECU Electrical Banks
- Narrowed underdrain area

Campus Rec - Design

13,000 ft² Impervious Area
Campus Rec – Round I
• First Storm → No infiltration
• Construction compaction?
• Restrictive Soil Layer?
• Geoprobing: unsuccessful
• Reconstruct w/ Underdrain

Campus Rec – Re-Design
• Underdrains w/ upturned elbow
• Underdrain run below telecom bank
• Shallow storm sewer limited separation between inlet and underdrain invert to 18 in.
  – 9 in. ponding depth
  – 9 in. media above invert
Campus Rec - Bioretention

- Surface ponding draws down within 18 hr
- Deep infiltration >> underdrain flow
- Media storage > capture storage depth

Belk Wetland Design

“This soil isn’t good for anything except holding the world together” – Grading Contractor
Belk Wetland

Retrofit Challenges

• Sufficient source (impervious) area upgradient of sufficient receiving (SCM/BMP) area
  – Retrofits may have to be under sized

• Restrictive utilities typically located in open/pervious areas

• Level post-construction grades limit drainage slopes

• Large open areas may have future land use plans
Educational Signage

Landscaping for Water Quality

Green infrastructure is the use of natural structures designed to reduce stormwater runoff generated from impervious surfaces, such as roofs and parking lots. These technologies utilize plants, soils, and natural processes to manage and create healthier urban environments. Examples of these on East Carolina University's campuses are rain gardens, stormwater wetlands, trees, and permeable pavement.

Stormwater Management on Campus

Build Your Own Rain Garden!

It's more than a lawn of grass. This specific design does not incorporate flowering plants, but rain gardens can be designed with arboreta in mind.

Rain Garden with flowering plants

Rain gardens can improve property value by increasing curb appeal. Additionally, these technologies provide a service by utilizing stormwater runoff that may contain pollutants.
Permeable pavers solve problem

The Starbucks mobile unit at ECU is shown on the permeable parking pad created to reduce stormwater runoff.

Thanks – Any Questions!

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