Division of Energy, Mineral and Land Resources

A New Approach to LID

Annette Lucas, PE
NC Division of Energy, Mineral and Land Resources

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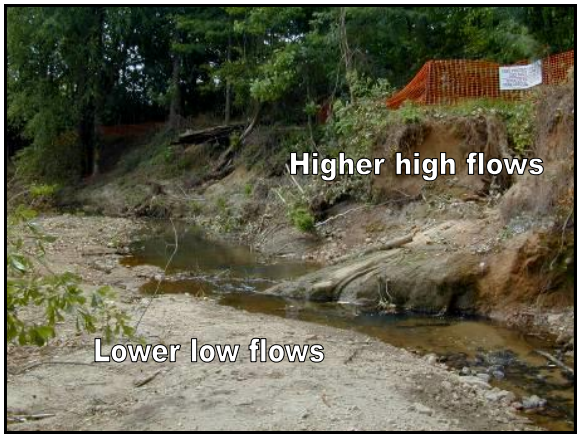
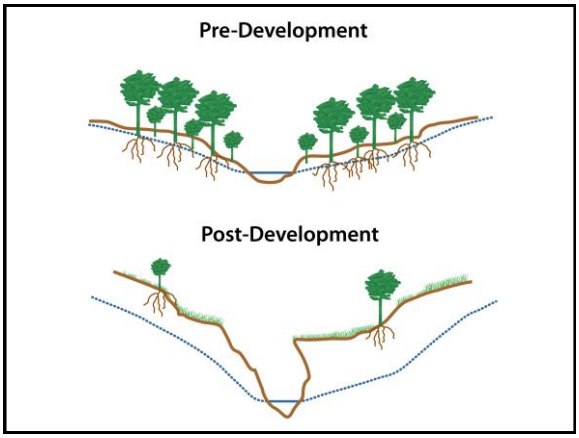
We all know we don't want when it comes to urban streams …





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We can avoid these problems if we:

… maintain and restore the hydrologic regime by creating a landscape that mimics the natural hydrologic functions of infiltration, runoff, and evapotranspiration.

- NC LID Guidebook

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But currently what % of sites are LID?
(rough estimation)

< 0.5%
(< 1 in every 200)

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What have we been missing?

- "Implementable" definition of LID
- Supporting calculations
- Clear LID policies
- An "EZ" tool for evaluating sites to see if they are LID
- BMP Manual Updates

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Quantitative LID Definition

Volume of runoff AFTER development = Volume of runoff BEFORE development

+

Streams and wetlands receive flow rather than piping stormwater to low point(s)

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Wooded Lot

Runoff

Infiltration & ET

Parking Lot

Runoff

ET

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Widely used in NC and continues to be an acceptable way to treat stormwater.

Status quo: wet pond

Treated Runoff

Infiltration & ET

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Permeable pavement infiltrates rain falling directly on it & runoff from adjacent rooftops.

Swansboro LID:
Infiltrate like crazy

Runoff

Infiltration

Bioretention, preserves green space & reduces impervious cover.

Tonbo Homes LID : Vegetation is crucial!

Runoff

Infiltration & ET & PFD

Parking lot drains to bioretention cells in series.

Wal-Mart LID: Lose that pond in back

Runoff

Infiltration & ET & PFD

Green roof, permeable pavement and underground infiltration system.

Green Square LID: Ultra-urban

Runoff

Infiltration & ET

So to summarize -

Volume of runoff AFTER development = Volume of runoff BEFORE development

We think this definition is BOTH specific & flexible!

What have we been missing?

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Computing Runoff Volume:

Simple Method: Just TOO Simple!

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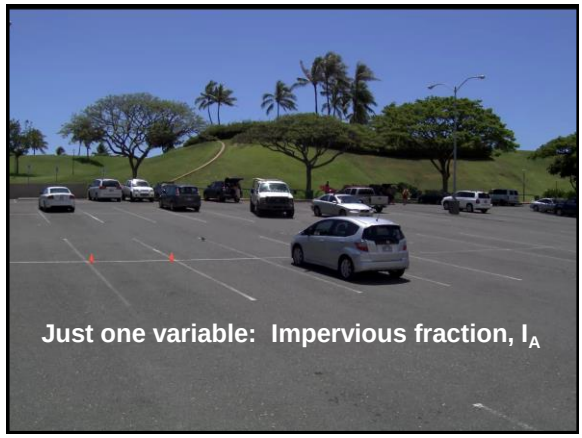
The Simple Method

$$R_v = 0.05 + 0.9 * I_A$$

R_v = runoff coefficient (runoff/rainfall)
I_A = impervious fraction (impervious/drainage area)

$$V = 3630 * R_D * R_v * A$$

V = runoff volume (cubic feet)
R_D = design storm depth (usually 1 or 1.5 inches)
A = drainage area (ac)



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Directly connected & disconnected impervious surfaces

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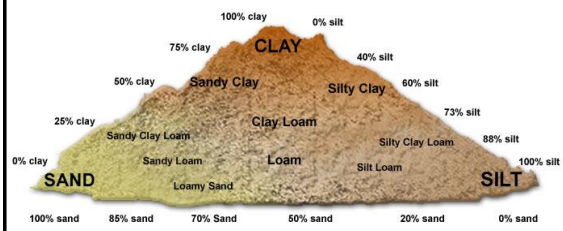
Soils make a HUGE difference!



www.sprinklertalk.com

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All pervious surfaces are NOT the same!

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Discrete SCS Method

$$Q^* = \frac{(P - 0.2S)^2}{P + 0.8S}$$

Q* = runoff depth (in)
P = rainfall depth (in)
S = (1000/CN) - 10
CN = curve number (unitless)

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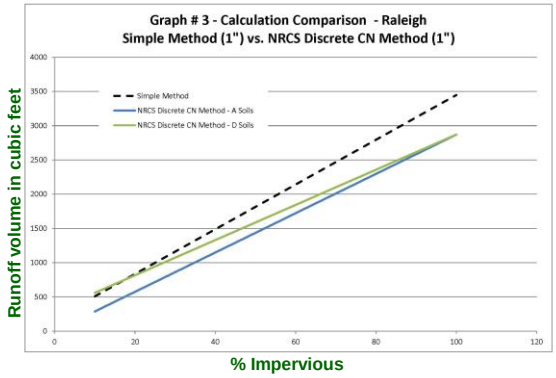
Discrete SCS Method

Runoff volume: Multiply the drainage area by the runoff depth and converting acre-in to ft^3.

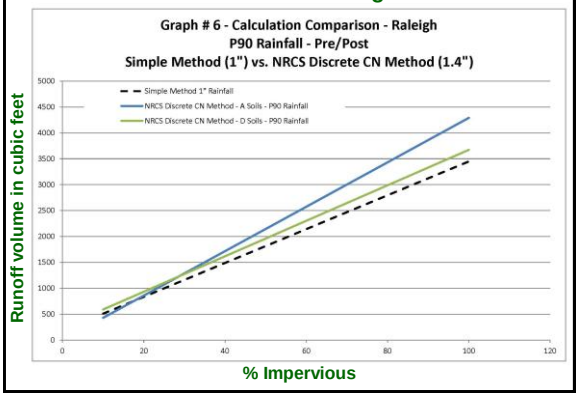
Run it twice:
- pervious surfaces
- impervious surfaces

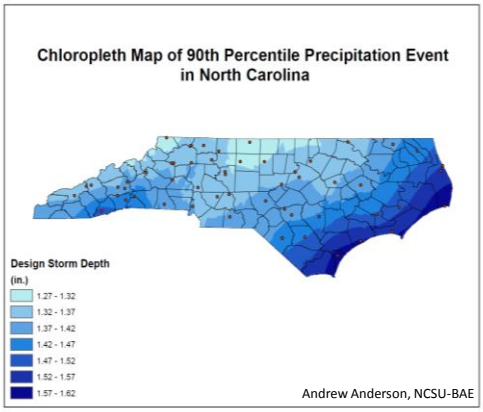
One CN between 30-98 for each land use on the site based on ground cover and soils.

For a One-acre Drainage Area



For a One-acre Drainage Area





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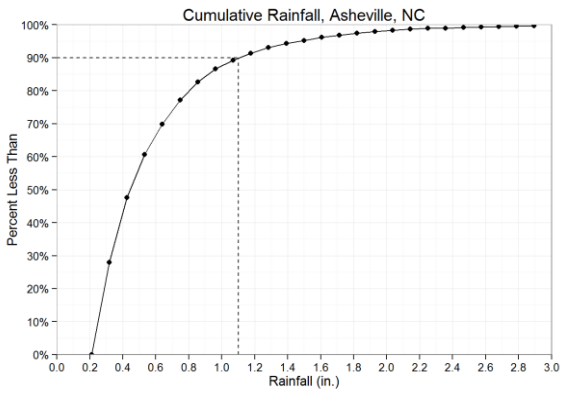
Since 3-7-14, the **SCS Discrete Curve Number Method** is allowed for ALL types of development if:

- 90th percentile storm event for non-SA waters & the 1-year, 24-hour storm for SA waters

AND

- Difference between runoff volume between pre and post development.



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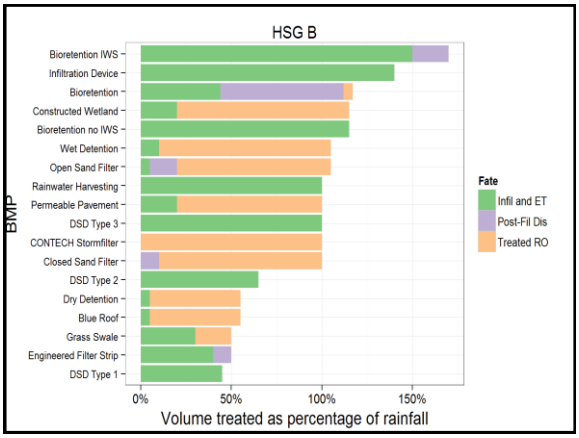
BMP Crediting:

85% TSS Removal: Just TOO Simple!

What is the "fate" of the rain after it enters the BMP?



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What have we been missing?

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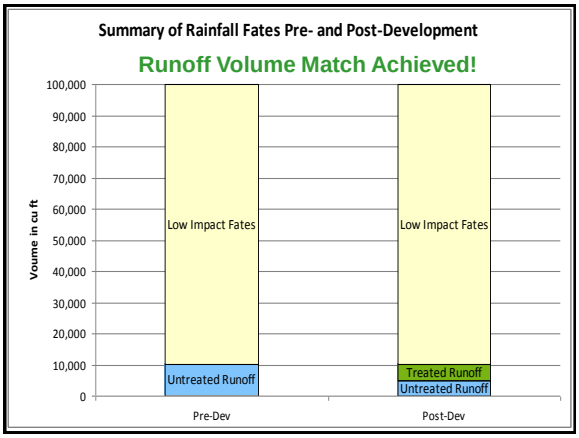

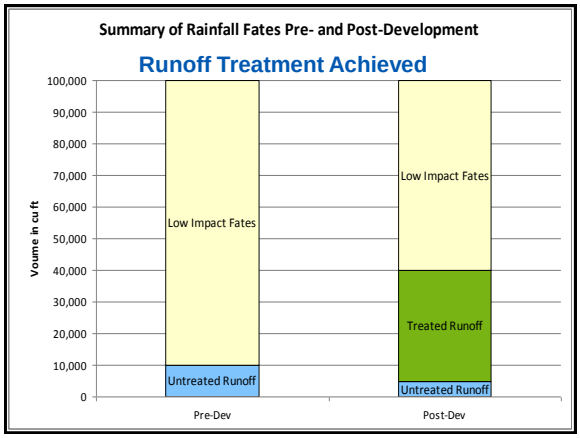

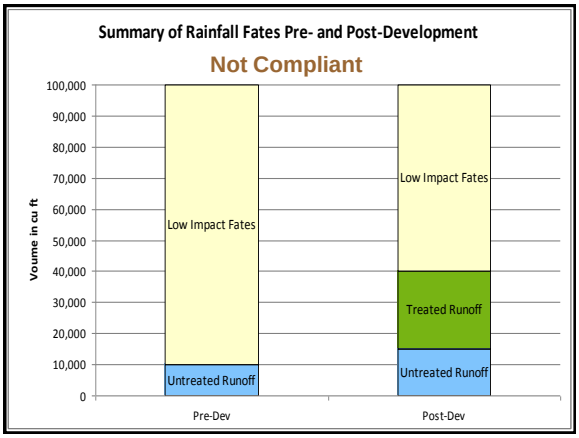

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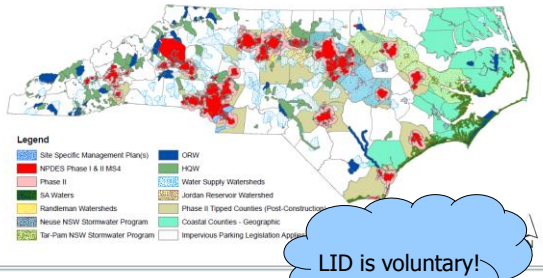
State and Local Stormwater Programs



LID is voluntary!

State programs – LID will be accept (an first)

Local programs – They decide but DEMLR encourages LID

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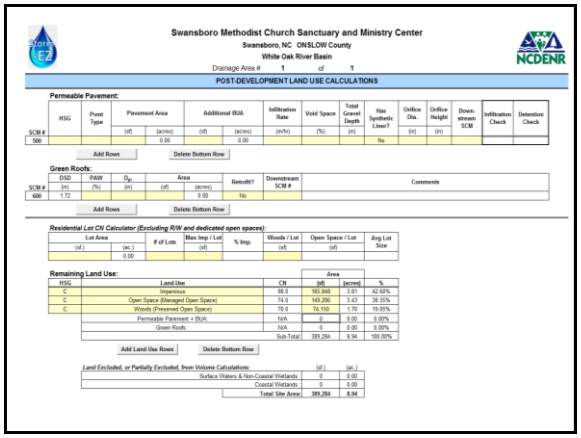


Swansboro Methodist Church Sanctuary and Ministry Center
Swansboro, NC ONSLOW County
White Oak River Basin
Drainage Area # 1 of 1

POST-DEVELOPMENT LAND USE CALCULATIONS

Permeable Pavement:

SCM #	HSG	Pvmt Type	Pavement Area (sf)	Pavement Area (acres)	Additional BUA (sf)	Additional BUA (acres)	Infiltration Rate (in/hr)	Void Space (%)	Total Gravel Depth (in)	Has Synthetic Liner?	Orifice Dia. (in)	Orifice Height (in)	Down-stream SCM	Infiltration Check	Detention Check
500				0.00		0.00				No					

Add Rows | Delete Bottom Row

Green Roofs:

SCM #	DSD (in)	PAW (%)	D_W (in)	Area (sf)	Area (acres)	Retrofit?	Downstream SCM #	Comments
600	1.72				0.00	No		

Add Rows | Delete Bottom Row

Residential Lot CN Calculator (Excluding R/W and dedicated open spaces):

Lot Area (sf)	Lot Area (ac)	# of Lots	Max Imp / Lot (sf)	% Imp.	Woods / Lot (sf)	Open Space / Lot (sf)	Avg Lot Size
	0.00						

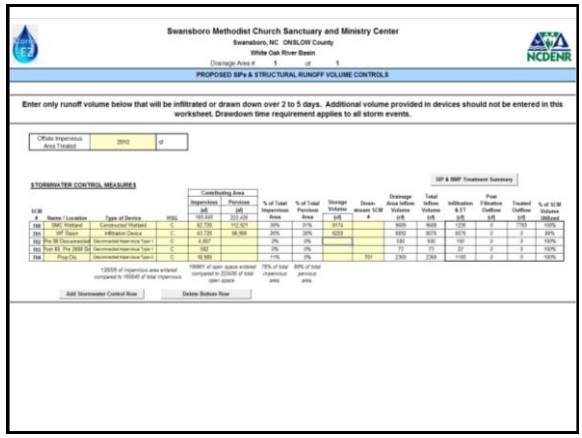
Remaining Land Use:

HSG	Land Use	CN	Area (sf)	Area (acres)	%
C	Impervious	98.0	165,648	3.81	42.68%
C	Open Space (Managed Open Space)	74.0	149,286	3.43	38.35%
C	Woods (Preserved Open Space)	70.0	74,150	1.70	19.05%
	Permeable Pavement + BUA	N/A	0	0.00	0.00%
	Green Roofs	N/A	0	0.00	0.00%
		Sub-Total	389,284	8.94	100.00%

Add Land Use Rows | Delete Bottom Row

Land Excluded, or Partially Excluded, from Volume Calculations:

	(sf.)	(ac.)
Surface Waters & Non-Coastal Wetlands	0	0.00
Coastal Wetlands	0	0.00
Total Site Area:	389,284	8.94



Swansboro Methodist Church Sanctuary and Ministry Center
Swansboro, NC ONSLOW County
White Oak River Basin
Drainage Area # 1 of 1

PROPOSED SW's & STRUCTURAL RUNOFF VOLUME CONTROLS

Enter only runoff volume below that will be infiltrated or drawn down over 2 to 5 days. Additional volume provided in devices should not be entered in this worksheet. Drawdown time requirement applies to all storm events.

Offsite Impervious Area Treated | 20510 | sf

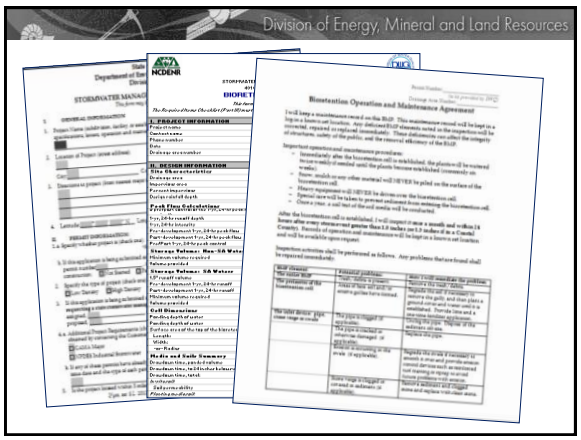
STORMWATER CONTROL MEASURES

SW & BMP Treatment Summary

SCM #	Name / Location	Type of Device	HSG	Contributing Area: Impervious (sf)	Contributing Area: Pervious (sf)	% of Total Impervious Area	% of Total Pervious Area	Storage Volume (cf)	Down-stream SCM #	Drainage Area Inflow Volume (cf)	Total Inflow Volume (cf)	Infiltration & ET (cf)	Post Filtration Outflow (cf)	Treated Outflow (cf)	% of SCM Volume Utilized
700	SWC Wetland	Constructed Wetland	C	62,720	112,527	30%	31%	8174		9689	9689	1228	0	7755	100%
701	WF Basin	Infiltration Device	C	43,128	56,168	20%	28%	6252		6892	6076	6076	0	0	98%
702	Pre 98 Disconnected	Disconnected Impervious Type 1	C	4,897		2%	0%			183	183	183	0	0	100%
703	Post 98, Pre 2000 Di	Disconnected Impervious Type 1	C	592		0%	0%			71	71	37	0	0	100%
704	Prog Dis.	Disconnected Impervious Type 2	C	16,989		11%	0%		701	2369	2369	1168	0	0	100%

139526 of impervious area entered compared to 220408 of total impervious | 156661 of open space entered compared to 155848 of total open space | 78% of total impervious area | 89% of total pervious area

Add Stormwater Control Row | Delete Bottom Row



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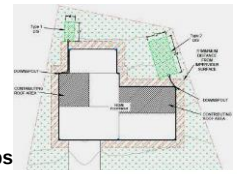
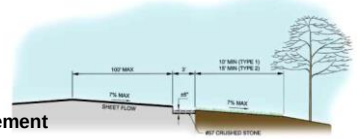
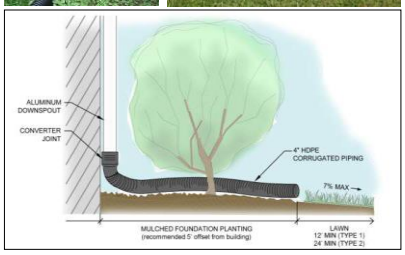
Disconnected Impervious Surface (DIS)



Disconnected rooftops



Disconnected pavement



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Rainwater Harvesting (RWH)

NC STATE UNIVERSITY
College of Agriculture and Life Sciences | College of Engineering

Stormwater Engineering Group

Biological & Agricultural Engineering

NC STATE UNIVERSITY A&T STATE UNIVERSITY COOPERATIVE EXTENSION
Helping People Put Knowledge to Work

LID & Storm-EZ Workshop

December 4-5, 2014 - Raleigh
NCSU Jane S. McKimmon Center
1101 Gorman Street
Raleigh, NC 27606

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Stakeholders:

Withers & Ravenel
NCSU Stormwater Group
Coastal Federation
Cities of Charlotte, Raleigh and Greensboro
Town of Morrisville
Tetra Tech
Red Line Engineering
Division of Water Resources
University of North Carolina – Chapel Hill
American Rivers

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A New Approach to LID

NCDENR

NPCA
Precast ... The Concrete Solution

Annette Lucas, PE
NC Division of Energy, Mineral and Land Resources

Precast ... The Concrete Solution

Super Bowl Pedestrian Promenade Precast Concrete Alternative

Presented by: Ronald E. Thornton, PE
Executive Director
Precast Concrete Association of New York
Binghamton, NY

Project Profile

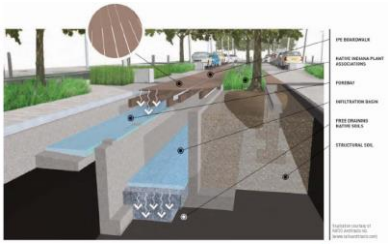
- Official Project name: A New Urban Outdoor Event Venue; Georgia Street Improvements
- Owner: City of Indianapolis, Indiana Department of Public Works
- Project Engineer: Crawford, Murphy & Tully, Inc., Indianapolis.
- Contractor: Hunt Construction Group, Indianapolis
- Architect: RATIO Architects, Inc., Indianapolis
- Precast Producer: Norwalk Concrete Industries, Norwalk, Ohio
- Precast Design Engineer: Delta Engineers, Architects, & Land Surveyors, PC, Endwell, New York

Project Scope

- Reconstruction of a three block stretch of Georgia Street leading to the entrance of Lucas Oil Stadium – site for the *2012 NFL Super Bowl*
  - Inverted crown road cross-section to eliminate curbs and shed water to forebays
  - Includes a pedestrian promenade in the median strip consisting of a wooden boardwalk constructed on precast support beams
  - Cast-in-place underground sluiceway to collect rainwater and melted snow into cisterns for irrigation of the architectural landscaping
  - Cast-in-place underground utility vaults

Project Scope

Project Scope



Project Scope

Challenge

- Complete construction and landscaping in time for the 2012 Super Bowl on February 5 between the New York Giants and the New England patriots
  - Over 68,000 attendees expected

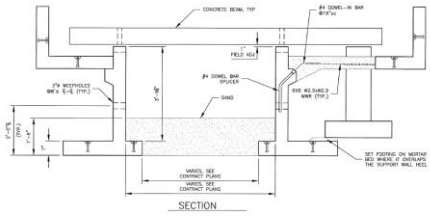
Precast Concrete Alternate

- 134 Inverted "Tee" shaped units with beam seats and forebay support corbels
- 96 "L" Shaped forebay units
- 132 Beam support pedestals
- 24 Box culverts "U" sections with separate lid
- 2 Electrical utility vaults 10' x 18' x 12' ID

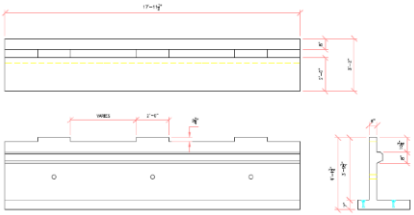
Precast Design Considerations

- Member size and weight for shipping and handling
- Forming system
- Lifting devices, capacity and location
- Joints and connections
- Location of existing utilities

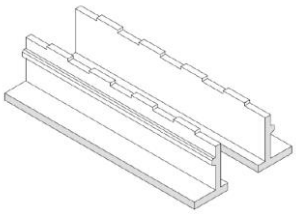
Precast Design Concept



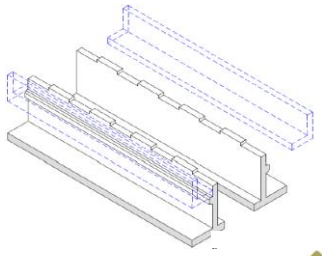
Inverted "Tee" Section



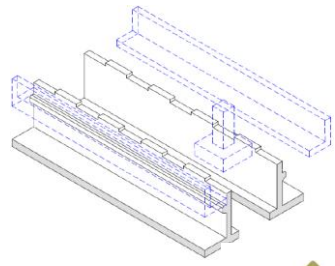
Inverted "Tee" Sections Set Back-to-Back



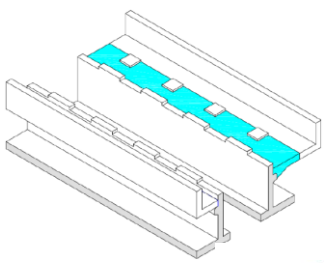
Forebay Units



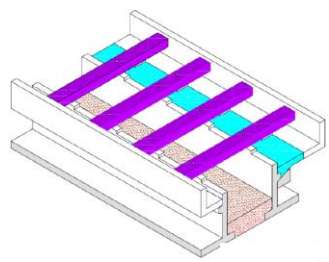
Pedestals



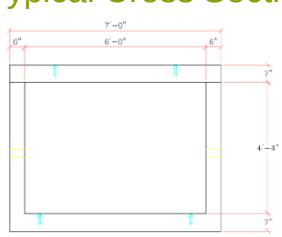
Cast-in-Place Closure



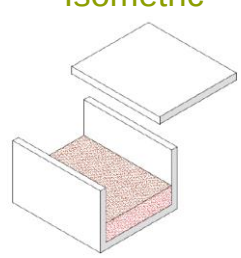
Sand Filter & Set Beams



Box Culvert Typical Cross Section



Box Culvert Isometric



Other Considerations

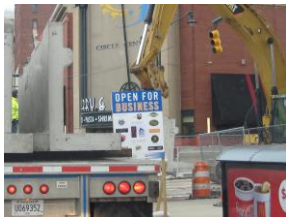
- Limited storage space for products on site
  - Deliveries had to be closely coordinated
  - Truck loads configured by station

Other Considerations

- Use of excavator for lifting and setting
  - Limited piece weights to 6 tons

Other Considerations

- Business Interruption
  - Many deliveries were made during late night hours



Other Considerations

- Underground Utility Obstacles
  - Crews quickly moved to a different part of the site in order to keep installation going

Other Considerations

- Safety
  - Reduced periods of open excavation
  - More efficient use of trench boxes

Other Considerations

- Inclement Weather
  - Concrete elements cast indoors in a controlled invironment
  - Installation not affected by cold weather

Other Considerations

- Small cast-in-place closure pours reduced the number of special sections.
  - Simple way to allow for varying trench widths

Installation

Installation

Installation

Installation

Super Bowl Pedestrian Promenade

Super Bowl Pedestrian Promenade

Installation

Installation

Finished Street

Finished Street

Finished Street

Georgia Street at Night

Specifying Precast

- Clear, concise specification is key to project success. Items to include in any specification:
  - Applicable industry reference standards
  - What should be expected with product submittal packages
  - Appropriate design loads
  - Concrete and material properties
  - Producer qualifications

Specifying Precast

- Stock Items
  - Many precasters stock various size items that are made to industry standards.
- Non-Stock Items
  - Custom utility structures can be made in unlimited sizes and shapes for a project.

Specifying Precast

Reference Standards and Submittals

- Applicable ASTM standard specifications
  - ASTM C857 – Min. Structural Design Loads for Precast Water and Watewater Structures
  - ASTM C913 – Standard Specification for Precast Water and Wastewater Structures
  - ASTM C891 – Practice for Installation of Precast Underground Utility Structures
  - ASTM C990 – Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections using Pre-formed Flexible Joint Sealants
  - ASTM C1037 – Practice for Inspection of Precast Underground Utility Structures

Specifying Precast

Quality Control – Producer Qualifications

- Producers should be expected to meet minimum QC standards to assure that products are made in accordance with drawings and specifications.
- Demonstrating quality standards through third party inspection is an option

Specifying Precast

- ASTM C858 - Standard Specification for Precast Concrete Water and Wastewater Structures
  - Contains a comprehensive list of ASTM standards for constituent materials and product testing. Included in the standard are:
    - Manufacturing Requirements
    - Design Standards
    - Permissible Variations
    - Repair Guidance
    - Rejection of products which do not meet the standard
    - Product Marking

Lessons Learned

- Precast is not limited to standard products
- Engage precast producers early in the design process
- Construction documents – More "Performance" than "Prescriptive"
- Conduct a thorough subsurface investigation

Precast Advantages

- Reduced overall construction time
- High quality due to plant controlled conditions
- Improved on-site safety due to fewer open trench areas
- Reduced site disruption thus minimizing the impact to local businesses
- More "Green" method of construction

Super Bowl Pedestrian Promenade

Super Bowl Pedestrian Promenade

??Questions??

Ronald E. Thornton, PE

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NPCA

Precast ... The Concrete Solution

Super Bowl Pedestrian Promenade
Precast Concrete Alternative

Presented by: Ronald E. Thornton, PE
Executive Director
Precast Concrete Association of New York
Binghamton, NY

NPCA

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What's New With NCDOT's Highway Stormwater Program

Andrew McDaniel, P.E.
Brian Lipscomb, P.E.
NCDOT Highway Stormwater Program

NCDOT Highway Stormwater PROGRAM

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Programs

1	Illicit Discharge Detection and Elimination Program
2	Stormwater System Inventory and Prioritization Program
3	BMP Retrofits
4	BMP Toolbox for Post-Construction Runoff
5	BMP Inspection and Maintenance Program
6	Post-Construction Stormwater Program
7	Vegetation Management
8	Encroachment Program
9	Construction Stormwater/Erosion Control
10	Industrial Facilities
11	Education and Involvement Program
12	Research and Program Assessment
13	Total Maximum Daily Loads
14	Falls and Jordan Lake Nutrient Management Strategy Compliance

Recent Updates

1	Illicit Discharge Detection and Elimination Program
2	Stormwater System Inventory and Prioritization Program
3	**BMP Retrofits**
4	**BMP Toolbox for Post-Construction Runoff**
5	BMP Inspection and Maintenance Program
6	**Post-Construction Stormwater Program**
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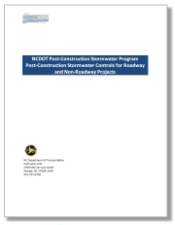
9	**Construction Stormwater/Erosion Control**
10	Industrial Facilities
11	Education and Involvement Program
12	**Research and Program Assessment**
13	**Total Maximum Daily Loads**
14	**Falls and Jordan Lake Nutrient Management Strategy Compliance**

Post-Construction Stormwater Program Update

- Updated stormwater management policy for new DOT projects
- Consolidated State SW permitting under this program



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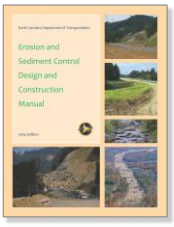
Construction Stormwater Program Update

- Updated Erosion & Sediment Control manual – avail. early 2015



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TMDL Program Update

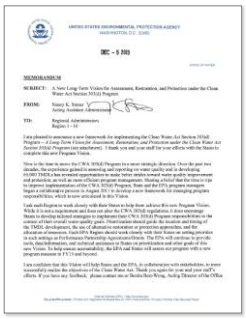
- Total Maximum Daily Loads
- Watershed based numeric "pollution diets"

TMDL(s)

Loading allowed at critical condition:

Waste Load Allocation (WLA)	1.12E+11 Colonies per day.
Load Allocation (LA):	2.40E+11 Colonies per day.
Margin of Safety (MOS):	5.06E+10 Colonies per day.
TMDL (WLA+LA+MOS):	4.03E+11 Colonies per day.

EPA's "New Vision"


UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DEC - 9 2013

MEMORANDUM

SUBJECT: A New Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program

FROM: Nancy K. Stoner
Acting Assistant Administrator

TO: Regional Administrators
Regions 1 - 10

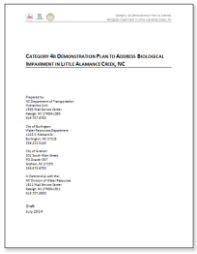
I am pleased to announce a new framework for implementing the Clean Water Act Section 303(d) Program — *A Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program* (see attachment). I thank you and your staff for your efforts with the States to complete this new Program Vision.

Now is the time to move the CWA 303(d) Program to a more strategic direction. Over the past two decades, the experience gained in assessing and reporting on water quality and in developing 40,000 TMDLs has revealed opportunities to make better strides toward water quality improvement and protection. Beginning in 2010, EPA and the States began a collaborative process to develop a plan to improve implementation of the CWA 303(d) Program. State and the EPA program managers began a collaborative process in August 2011 to develop a new framework for managing program responsibilities, which is now articulated in this Vision.

I ask each Region to work closely with their States to help them achieve this new Program Vision. While it is not a requirement and does not alter the CWA 303(d) regulations, it does encourage States to develop tailored strategies to implement their CWA 303(d) Program responsibilities on the watershed level. Such strategies could include, for example, the sequencing of TMDLs and the TMDL development, the use of alternative restoration or protection approaches, and the allocation of resources. Each EPA Region should work closely with their States on setting priorities and on the development of these strategies. Regions should also be ready to contribute to the data, data/information, and technical assistance States in prioritizing and implementation of this new Vision. To help ensure accountability, the EPA and States will assess our progress with a new program measure in FY13 and beyond.

I am confident that this Vision will help States and the EPA, in collaboration with stakeholders, to more successfully realize the objectives of the Clean Water Act. Thank you again for your and your staff's efforts. If you have any feedback, please contact me or Benita Best-Wong, Acting Director of the Office

TMDL Alternative: 4b Restoration Plan


CATEGORY 4B DEMONSTRATION PLAN TO ADDRESS BIOLOGICAL IMPAIRMENT IN LITTLE ALAMANCE CREEK, NC

Prepared for:
NC Department of Transportation
Division of Water Quality
1650 Mail Service Center
Raleigh, NC 27699-1617
919-733-5083

City of Burlington
Water Resources Department
425 Trollinger Street
Burlington, NC 27215
336-226-1322

City of Graham
222 South Main Street
PO Drawer 357
Graham, NC 27253
336-570-6705

In Partnership with the
NC Division of Water Resources
1617 Mail Service Center
Raleigh, NC 27699-1617
919-733-5083

Draft
July 2014

Nutrient Load Reduction Program

N.C. DEPARTMENT OF TRANSPORTATION
GREEN
Guided Reduction of Excess Environmental Nutrients

Stormwater BMP Toolbox

Objectives

i. Maintain and update as necessary a BMP Toolbox to aid in the siting, design, and construction of stormwater quality BMPs with guidance on the suitability of each for NCDOT applications.
ii. Evaluate BMPs for applicability to the linear highway system.
iii. Implement new and innovative technology on an experimental basis and in keeping with the current DWQ policy on new stormwater treatment technologies.

Stormwater BMP Toolbox

Toolbox History


NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
STORMWATER BEST MANAGEMENT PRACTICES TOOLBOX
Version 2, April 2014

- Current toolbox was approved by NCDOT and NCDENR in 2008
- Toolbox was updated and submitted to NCDENR in Spring 2014
  - Approved September 2014
  - Rollout anticipated by Spring 2015

Stormwater BMP Toolbox
Toolbox Chapters

2008 Chapters

- Level spreader
- Preformed scour hole
- Dry detention basin
- Swale
- Forebay
- Hazardous spill basin
- Bridge Best Management Practices
- Infiltration basin

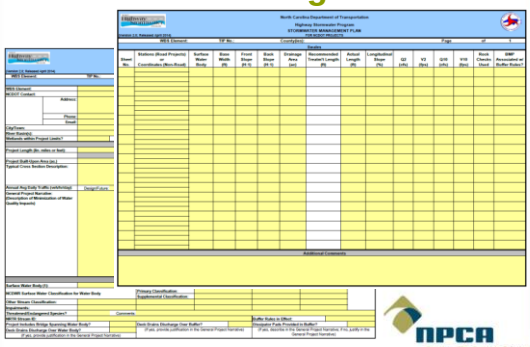
2014 New Chapters

- Media filters
- Wet detention basin
- Stormwater wetland
- Filter strip

Stormwater Management Plan
(SMP)

- SMP tool is an excel based form for documenting compliance with the PCSP
- SMP tool has been revised to address 2014 Toolbox component.
- SMP training modules will be available once the 2014 Toolbox is launched.

Stormwater Management Plan



BMP Retrofits
Objectives

i. Develop, implement and support the NCDOT program to be consistent with NPDES post construction control measures.

ii. Use retrofits to address pollutant loading from existing NCDOT activities.

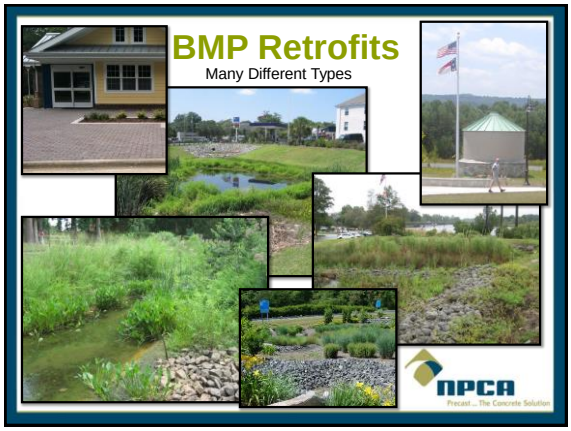
iii. Retrofits should not be associated with meeting the requirements of any other DWQ program, unless otherwise allowed.

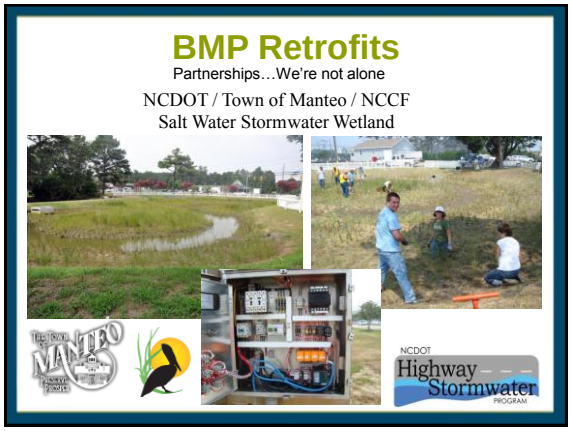
BMP Retrofits
Management Measures

a) Identify appropriate retrofit sites.
   - Locate 14 sites per year that are appropriate for retrofit

b) Implement/Install BMP Retrofits
   - 70 retrofits per 5yr permit term
   - 5 min. per year

BMP Retrofits
Different Types





Research
Objectives

a. Conduct research with faculty and staff at state universities or other designated institutions that result in independent quantitative assessment of stormwater from NCDOT permitted activities and/or measure structural BMP effectiveness.

b. Conduct research to enhance or improve existing practices or develop new methods or processes to meet future permit requirements.

NC STATE UNIVERSITY
UNC CHARLOTTE
USGS
Bio&Ag ENGINEERING
COASTAL CAROLINA UNIVERSITY
North Carolina Coastal Federation
NCDOT
Highway Stormwater
PROGRAM

Research

- Conducted ~35 research projects
- Term II (2005-2010) NCDOT invested $5.7M on research
- Typically $1M per NPDES permit term



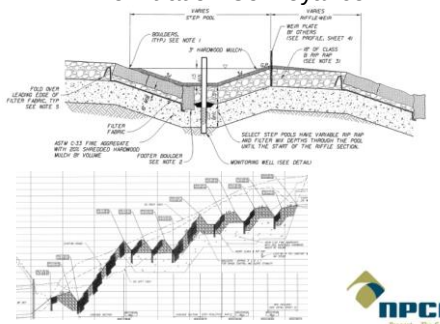
Picture source: NCSU

Retrofits & Research

Bio-filtration Conveyance


Retrofits & Research

Bio-filtration Conveyance



Retrofits & Research

Bio-filtration Conveyance

Watershed Characteristics
- Piedmont
- HSG D
- 3.5 acres, impervious

Monitoring *(Data from July 2013 to June 2014)*
- 24 inflow producing rainfall events
- Max. rainfall depth = 1.6 in.

~84% Volume Reduction
~80% Peak Flow Reduction
~72% TSS Reduction
~28-37% Nutrient Reduction
(TKN, NO_3, NH_3, TP, Ortho-P)

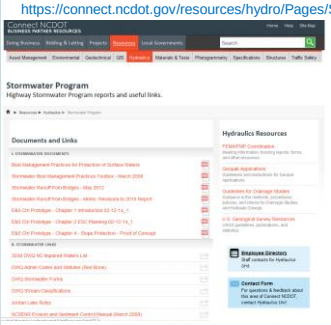
Retrofits & Research

SAFETY!!!

Communications

Connect NCDOT, Stormwater Program

https://connect.ncdot.gov/resources/hydro/Pages/Stormwater-Program.aspx



Information Available:
- Drainage Guidelines
- BMP Toolbox
- Stormwater Runoff from Bridges report
- Links to other resources
- Etc., etc.

Communications

GO!NC NCDOT GIS Online

http://ncdot.maps.arcgis.com/home/

- GIS data
  - Roads
  - AADT
  - TIP
  - Rail
  - Etc.

Coming Soon!
HSP Data

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Communications

NCDOT Highway Stormwater Program

Environmental Sensitivity Map

http://ncdotesm.ursokr.com/default.html

- GIS map service
  - Environment
  - Roadway
  - TIP
- 1st qtr. 2015 will no longer require authentication

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Communications

YouTube NCDOT Stormwater Program's YouTube Channel

ESM 'How To' Videos

Link directly from:
- Connect Site
- ESM

Not Searchable!!

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Communications

For other general NCDOT news you can check out:

http://www.ncdot.gov

or follow us on a number of social media sites.

YouTube flickr facebook twitter RSS & XML feeds

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