

Stormwater SCM Maintenance

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NC State University Extension

<http://www.nclandofwater.org/>



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North Carolina Land of Water

Our mission is to undertake activities that will contribute to long-term sustainable economic development based on the natural resources and cultural history of the region, integrate the diverse areas of the Inner and Outer Banks for their mutual benefit, and enhance the quality of life of its residents.



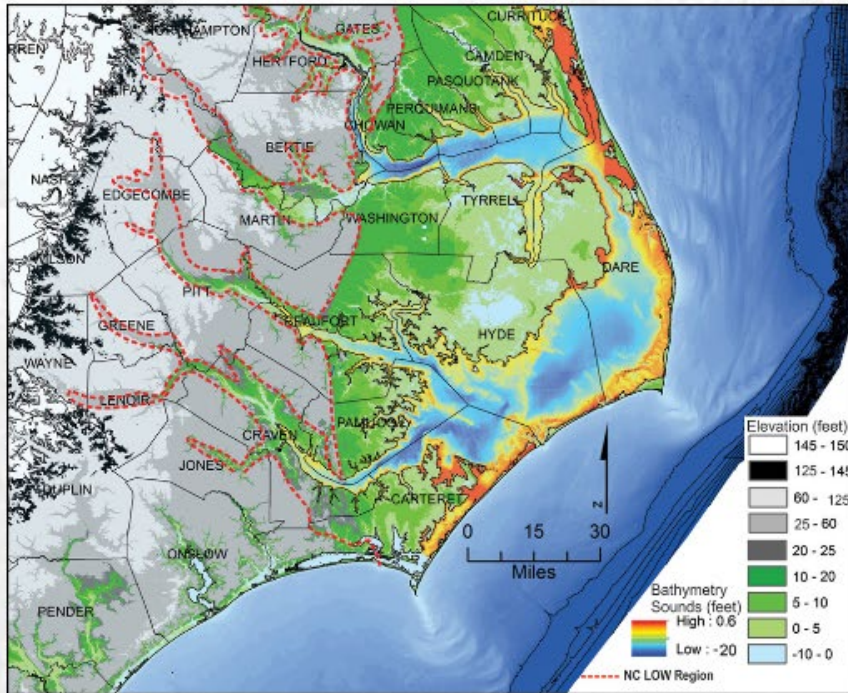


FIGURE 2. This is a color topographic map of the NC LOW coastal system which is outlined by and east of the red dashed line and includes the labeled counties. Land elevations and water bathymetry are color-coded in the lower right corner. The black area separating the gray and white map areas is the

(NC LOW) Coastal System as indicated on figure 1.

The NC LOW coastal system is dominated by the following general characteristics:

- More than 10,000 square miles of area within the NC LOW coastal system;
- 180 miles of barrier islands with ocean shorelines and multiple, ephemeral inlet-outlet systems;
- 3,500 square miles of estuarine waters;
- 10,000 miles of estuarine shorelines including vast marshes, extensive swamp forests, and abundant sediment banks;
- Four major Piedmont draining river basins with a vast network of Coastal Plain tributary streams that supply abundant fresh water;
- Rich and diverse plant and wildlife ecosystems that include brown-water trunk rivers, black-water tributary streams, pocosins and their lakes, fresh to salt-water marshes, Carolina Bays, etc.
- Numerous down-east coastal communities that have long histories in the region and unique water-based cultures that utilize the natural resources for both survival and enjoyment.

LOCATION OF THE NORTH CAROLINA LAND OF WATER COASTAL SYSTEM

The "North Carolina Land of Water" (NC LOW) coastal system is bounded on the east by the Outer Banks barrier island sand dam and extends westward through the Inner Banks to the Suffolk Shoreline, an ancient ocean shoreline

June 2017 Coastal Federation Building rain garden







2019



Stormwater Management vs. Landscaping

- Landscapers are trained to observe plant material and use soil and tissue analysis to fertilize to ensure good plant nutrition
- In stormwater we are trying to *remove* nutrients
- Plant growth is secondary or tertiary
- Adding fertilizer will cause most BMPs to *export* nutrients, defeating their purpose

Initial NCSU Research

- Relationship between P-Index (Soil Test P) and TP outflow load.

	Greensboro	Chapel Hill
TP	+240%	- 65%
P-Index	85-100	4-12

(Hunt 2003)

P-Index 50-100: High
P-Index 0-25: Low

We have a lot of practices in the ground

- Our university campus alone has over 110 practices



The City of Charlotte, NC


Bioretention	527
Cistern	1
Dry Pond	1217
Enhanced Grass Swale	33
Filter Strip	10
Grassed Channel	29
Infiltration Trench	9
Level Spreader	1
Rain Garden	1
Sand Filter	138
Underground Detention	234
Underground Sand Filter	4
Wet Pond	388
Wetland	59

- 2800 BMPs At last count
- Courtesy of Charlotte Stormwater Services

City of Philadelphia.... Green Infrastructure

Philadelphia Water

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Reveal banner highlights

YOUR WATERSHED WATERSHED ISSUES WHAT WE'RE DOING WHAT'S IN IT FOR YOU


Green City, Clean Waters

Green City, Clean Waters is Philadelphia's plan to reduce stormwater pollution currently entering our [Combined Sewer System](#) through the use of green infrastructure.

Green City, Clean Waters represents a major shift in the way we think about and deal with stormwater in Philadelphia. We're recreating the living landscapes that once slowed, filtered, and consumed rainfall by adding green to our streets, sidewalks, roofs, schools, parks, parking lots and more—any impermeable surface that's currently funneling stormwater into our sewers and waterways is fair game for greening. It's going to take decades of work, but when it's all done, we'll have reduced the stormwater pollution entering our waterways **by a stunning 85 percent**.

That means rivers and streams that are swimmable, fishable, drinkable on a level exceeding even the memory of Philadelphia's oldest residents.

By employing green tools instead of just relying on traditional infrastructure like



The Rain Check program helps residents manage stormwater and beautify their homes. [Learn more!](#)

\$2.4 billion
invested by PWD
by 25-year mark

More than
\$3 billion
full investment
in plan through
the addition
of leveraged
activities



BMP I&M

- We began teaching I&M in NC in 2006
- We average 6 classes per year in NC
- 3598 people certified as of May 2019
- We teach customized courses in other states and countries
- Demand continues to grow as urbanization continues and cities adopt stormwater management and Green Infrastructure

<https://www.bae.ncsu.edu/topic/bmp-im/>

NCSU Stormwater BMP Inspection & Maintenance Certification Workshops

Certification

Classes

List of Certified Professionals



Register Here!



In practice, who does the work

Inspections

- Engineers, Landscape Architects, and local govt. officials do annual inspections

Maintenance

- Private landscape companies
- Private BMP maintenance companies
- Local govt. maintenance crews

Annual SCM Inspections

- \$500 average cost
- Performed by Professional Engineer or Registered Landscape Architect
- Certifies that the practice is working properly

Professional Engineers Certification of Engineered Stormwater Control Structure

Specific type of Engineered Stormwater Control Structure(s):

I _____ as a duly licensed Professional Engineer, do hereby certify that the Engineered Stormwater Control Structure for the project entitled: _____ with Town of Cary Site/Subdivision #: _____ has been constructed within substantial compliance and intent of the approved construction plans, drawings, and specifications and that the associated infrastructure has been installed in compliance with the approved construction plans, drawings, and specifications. This statement is based upon reference and reviews of the record drawings prepared for this site and upon periodic field inspections and project reviews completed during the construction of the referenced Engineered Stormwater Control Structure, including a final inspection of the stormwater control structure made within 30-days prior to the signature date outlined below.

Signature _____ Date _____

Professional Registration NO. & Seal

Engineer/Inspector/Maintenance



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Stormwater

CONSULTING

CONSTRUCTION

STORMWATER

- › NPDES Inspections
- › BMP Inspection and Maintenance
- › SWPPP & Permits
- › Pond Maintenance

MORE

BMP Inspection and Maintenance

Federal, State, and Local laws regulate BMP inspection and maintenance of existing stormwater management BMP (Best Management Practice) facilities. As rigorous enforcement procedures are steadily gaining approval, owners of these facilities should protect themselves against a penalty, fine, or Notice of Violation (NOV) that can be easily avoided. Angler Environmental performs BMP Inspection and Maintenance services throughout the Mid-Atlantic Region, focusing on Virginia, North Carolina, and Maryland.

BMP Inspection

Angler Environmental provides annual or biannual BMP inspections of stormwater management (SWM) facilities for compliance with these regulations. With in-house resources including professional engineers in Virginia, certified E&S inspectors, and ecological construction crews, we monitor and maintain all types of BMPs for long-term, pro-active compliance with local, State, and Federal regulation.

RLA/Inspector



G2 Design, PA has been on the forefront of providing stormwater treatment facility (BMP) consulting throughout North Carolina and remains an industry leader for BMP Inspections and related services. The depth of our BMP consulting is evidenced by our extensive on-site experience, commitment to education and dedication of company resources. Additionally, our working relationship with local municipalities and understanding of the varying inspection protocol requirements enables us to provide efficient and thorough services.

Serving a diverse range of clients from the single BMP/property owner to clients with multiple BMP's such as HOA's, commercial management companies and national retail chains, our services cater to the specific and unique needs of each. A comprehensive approach separates us from other consultants that offer one-dimensional services providing only inspections. ***G2 Design*** provides a "cafeteria style" selection of BMP services that addresses issues on all levels. Ultimately this approach allows you the flexibility to choose what best accommodates your needs, benefiting you directly by reducing liability as well as saving you money on future repairs.

G2 Design is fully licensed, insured and certified to assist you throughout North Carolina with the following **BMP Services**:

- ◆ **Annual Maintenance Inspections**
- ◆ **Multi-BMP Site Inventory, Inspections and Administration for Municipal, Corporate and National Clients**
- ◆ **Pre-Certification Construction Observation**

Monthly SCM Inspections

- Performed by maintenance contractor
- Uses check list – often provided by the local government

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EnjoymentServices &
Publications

Projects & Initiatives

Business & Development

Mayor & Council

Connect & Engage

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+ Fire

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+ Make a Payment

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+ People with Disabilities

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+ Police

+ Residential Inspections & Permits

+ Plans, Publications & Reports

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STORMWATER BMP PAPERWORK

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Best Management Practices (BMPs) are used on sites to treat stormwater runoff from impervious surfaces from development. The Town of Cary requires paperwork for each bmp before a certificate of occupancy is issued for the site.

General BMP Paperwork

[Stormwater Acknowledgement for BMP Paperwork](#) [Professional Engineers Certification for BMP](#) [Owners List of Required Paperwork for BMP](#) [Evergreen Letter of Credit for Maintenance Security](#)

CONTACT

Charles Brown
Stormwater Program
Analyst
(919) 469-4038
[Email](#)

BMP Paperwork by Category



BIO-RETENTION INSPECTION CHECKLIST

Date: _____

Rev 1/2011

4

Time: _____

(Project Name): _____ Dry Pond # _____, Cary, NC

Check/Circle Condition Noted	Observations	Action Repair –	Action Monitor –	Action Investigative –
U/S Slope	Type:			
Vegetation/Riprap				
Rodent burrows				
Crest	Type:			
Ruts/erosion				
Cracks/settlement				
Poor alignment				
D/S Slope	Type:			
Vegetation/erosion				
Rodent burrows				
Sloughs/slides/cracks				
Seepage/wetness				
Pool	Type:			



Retention Pond Services, Inc.

Specializing in all phases of aquatic and wetland maintenance

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Take a look at what Retention Pond Services does best:

Click play to watch each slideshow.

Outfall Box Rebuild



STOP | PLAY

Monthly Maintenance Cut and Clean



Stormwater Management And Retention Pond Services

At Retention Pond Services, Inc. (RPS), we understand the complexities of the regulatory standards for stormwater BMPs and retention basins. We strive to adapt our services to stay up-to-date with the amendments made to those standards. Our ultimate goal is to help our clients understand the regulations and demonstrate to them how we are able to provide them with the most comprehensive, stormwater management program.

RPS evaluates each BMP structure and develops a regulatory-centered maintenance plan to most efficiently manage it. The appropriate equipment and maintenance or remediation specialists will be teamed up to ensure each structure is compliant and environmentally safe.

Stormwater BMP consulting

- Education on Federal, State, Local stormwater BMP regulations and maintenance methods
- Notification of Violation consultation, liaison, and remediation services
- Initial site inspections for HOA's in final phase of construction

Stormwater BMP Compliance and Repairs

- Slope stabilization and repairs
- Dredging
- Sediment and erosion control management





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Restoration and Recovery



Water Quality Excellence Through Superior Stormwater Management

Restoration and Recovery (R&R) is a full service stormwater management company serving the eastern United States – a one stop shop for all aspects of SWM, including consulting, designing, constructing, inspecting, maintaining, and repairing BMPs. R&R uniquely offers both comprehensive experience and an exclusive focus on stormwater.

[Read More](#)

Storm Water Control	NPDES Inspection
SWPPP Preparation	BMP Implementation
Permit Documentation	Watershed Planning
River Engineering	Regulator Response
Water Sampling	Streambank Protection
Erosion Control	Construction Inspection
Vegetation Control	Debris Removal
Filter Bed Maintenance	Structure Cleanings
Restoration and Maintenance	

*Water Quality Excellence Through
Superior Stormwater Management*

Stormwater Management

R&R has more than a decade of experience helping communities, businesses, and municipalities transition from traditional, quantity-based programs to comprehensive

Water Quality Practices

R&R integrates stormwater conveyance measures, flood control, floodplain management, and water quality goals to protect developed areas, preserve waterways, and expand

About BMP East, Inc

Retention Pond Maintenance, Service and Management

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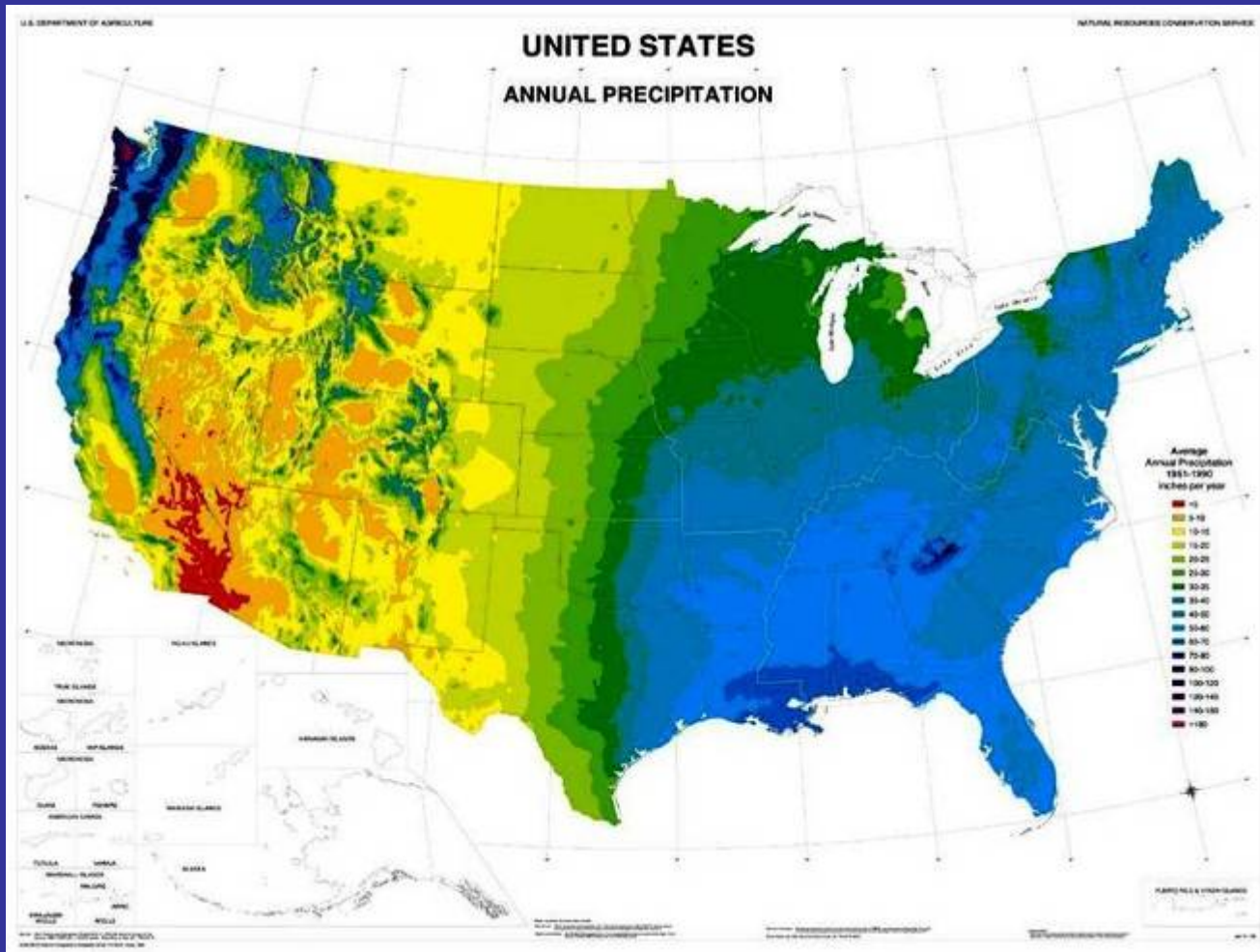
BMP East, Inc.

John Brown started BMP East, Inc. after years of living on the East Coast and observing, first hand, the damaging effects of poorly managed water resources. John's background is research-based, and his education is in applied cultural anthropology with a minor in oceanography. He has been involved in numerous water-based research grants and CAMA (Coastal Area Management Act) access issues. It was through this research John first realized how harmful poor water quality is to the environment and humans. As an ongoing effort to better the quality of water, improve coastal living, and protect the environment, John started BMP East, Inc. specializing in stormwater management.

Our staff is college educated and certified as BMP specialists. We have the highest level of certification by NC's DOT as level 1 NC DOT Erosion & Sediment Control Specialists, and we are certified as NC Stormwater Best Management Practices Inspection & Maintenance Professionals. We have an extensive background in research and implementation of regulatory issues. All of which, have built the foundations of our BMP management practices.

BMP East, Inc. cares about clean water for all.

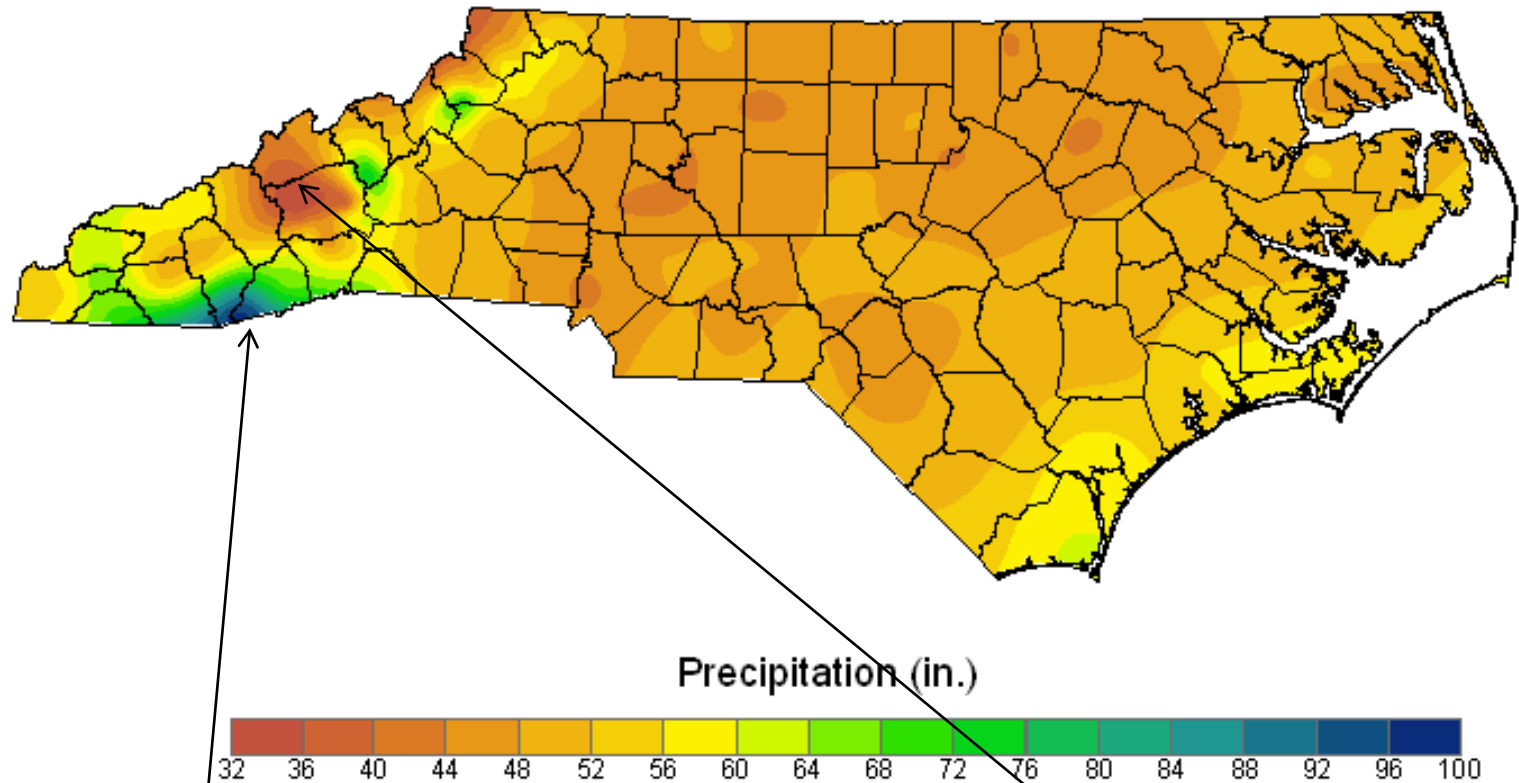
North Carolina is rainy!



Normal Precipitation

Based on 1971-2000 normals

Annual

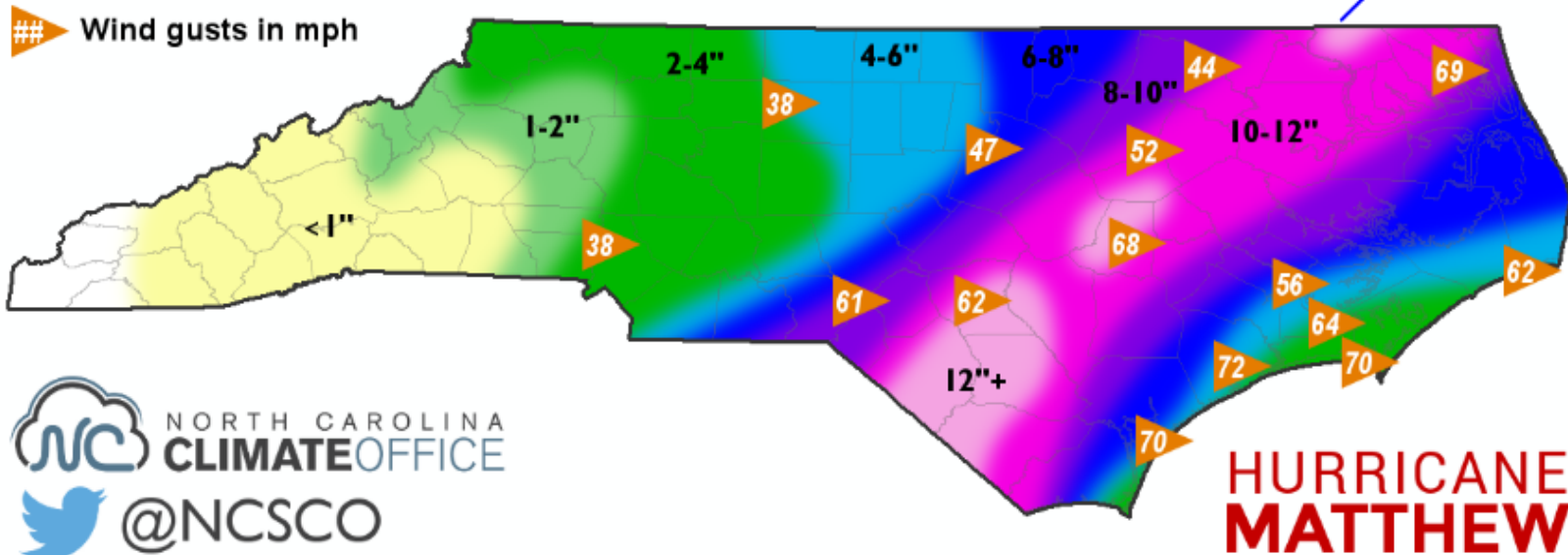


90 inches in Highlands

37 inches in Horseshoe....

Hurricane Matthew

Total Precipitation from October 7-9, 2016



Total precipitation and maximum wind gusts from Hurricane Matthew.

FLORENCE RAINFALL TOTALS

SEP. 13-17, 2018



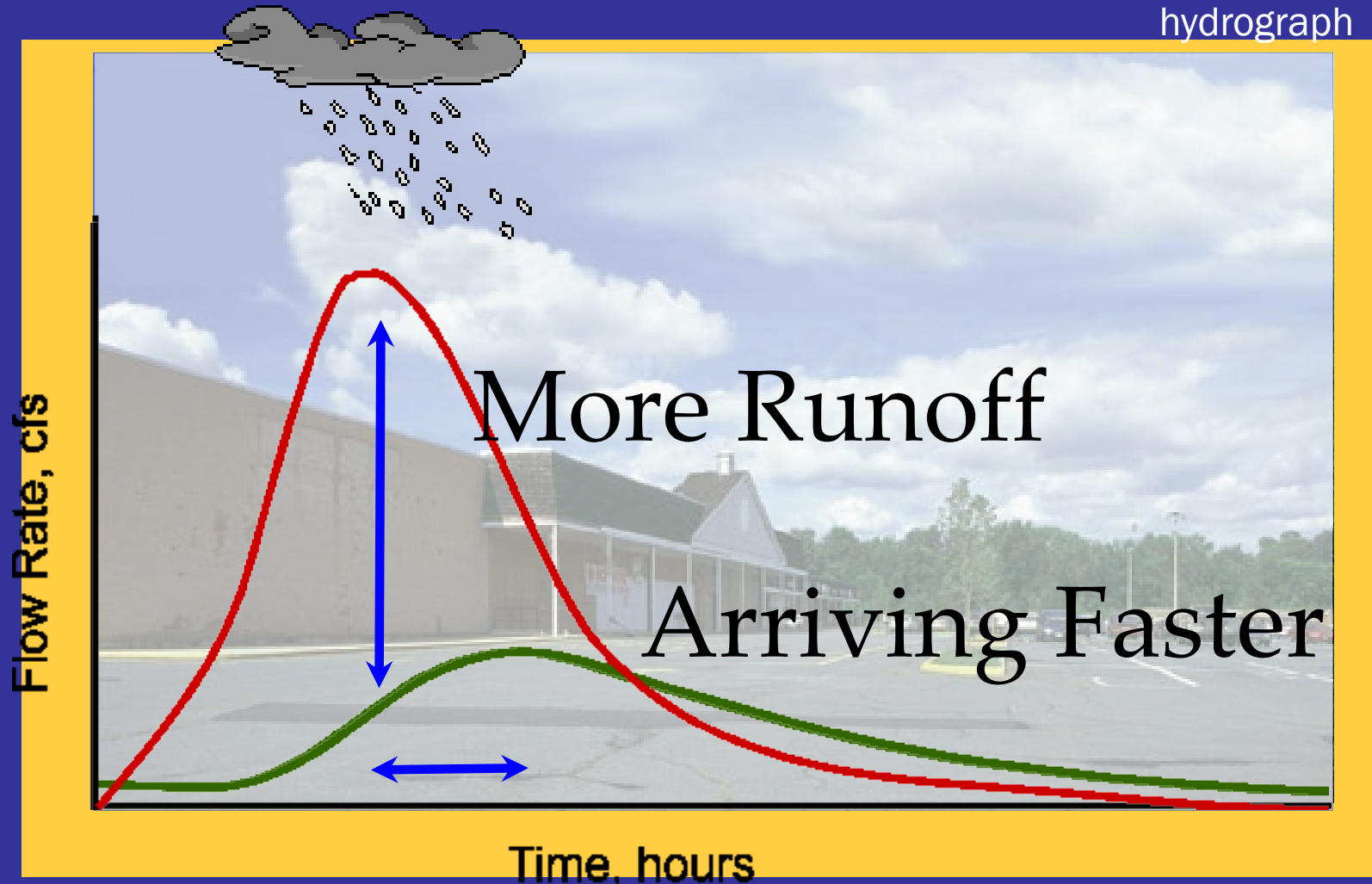
Why is N.C. 'Different'



- Second largest estuary in the U.S.
- Barrier islands restrict outflow

The Science of Stormwater...

hydrograph



Post-development streamflow

- Watersheds become 'flashy'
 - Almost every rain event creates a flash flood as water quickly runs off impervious surfaces
 - (listen for National Weather Service flash flood warnings in urban areas after significant rainfall events)
 - Streams dry out quickly after the flash flood as they are cut off from slowly infiltrating groundwater

“Flashy” Urban Streams:

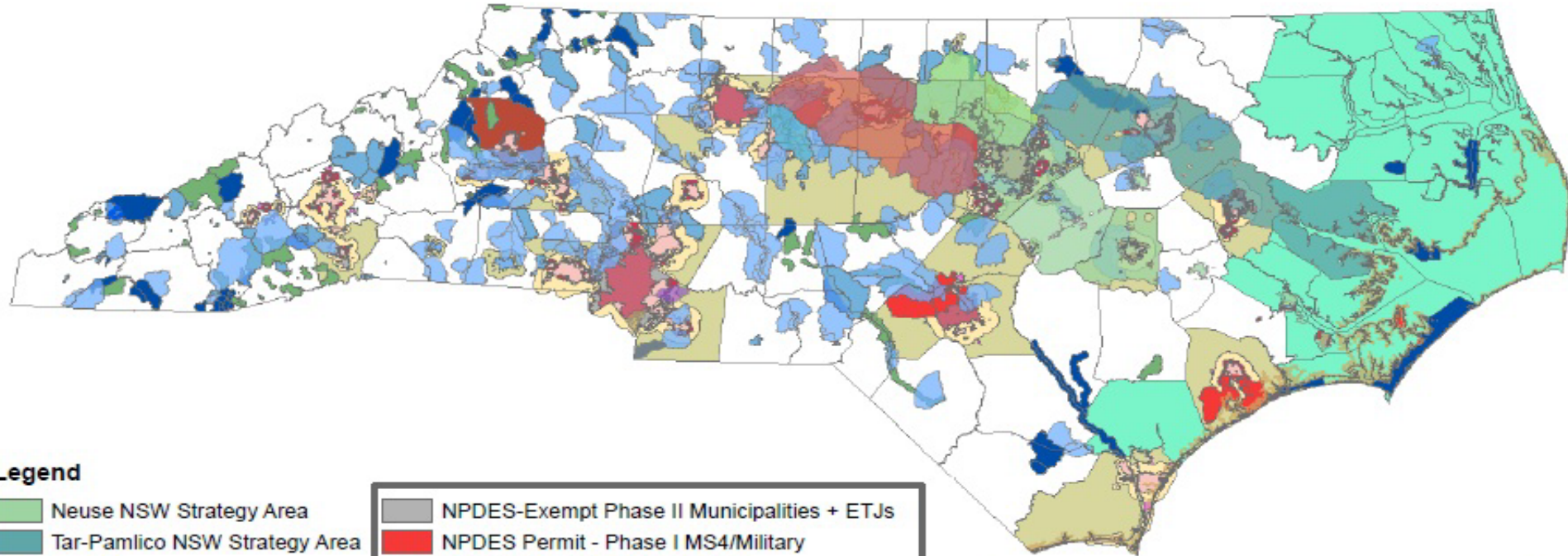


First Flush



Stormwater BMP
Stormwater BMP Ma
Maintenance & Inspe

Stormwater Regulated Areas of NC



Legend

- Neuse NSW Strategy Area
- Tar-Pamlico NSW Strategy Area

DESCRIPT

- Falls Lake Watershed
- Goose Creek Watershed
- Jordan Reservoir Watershed
- Randleman Reservoir Watershed
- Sixmile Creek Watershed
- Waxhaw Creek Watershed
- Counties
- ORW Reclassified Waterbodies
- Water Supply Watersheds
- ORW
- HQW (non-coastal)
- SA (Shellfish) Areas
- NPDES-Exempt Phase II Municipalities + ETJs
- NPDES Permit - Phase I MS4/Military
- NPDES Permitted Ph II MS4/Co
- NPDES Permitted Phase I MS4
- NPDES Permitted Phase I/II city ETJ
- NPDES Permitted Phase II MS4
- Phase II MSIs (from 2008 Boundaries)
- Designated Phase II Municipalities
- Future MSIs (2010 Delineations)
- Urbanizing Areas (2000 Census)
- Phase II Tipped Counties (Post-Construction)
- Coastal Stormwater (CAMA Counties)

Post-Construction Areas per Session Law 2006-246 and Coastal Stormwater Rules.

Note - Although Brunswick, New Hanover, and Onslow are Phase II Tipped Counties, projects there are subject to the Coastal Stormwater Rules.

0 20 40 80 Miles



BMP Water Quality Credits Neuse and Tar River Basins

	N	P
• Wet pond	25	40
• Wetland	40	35
• Bioretention	40	45
• Grass Swale	20	20
• Veg Strip w/LS	20	35
• 50' rip buff w/LS	30	30
• Permeable Pavements	40-60*	40-60*
* Coastal Plain & Sandhills Only		

What is Low Impact Development?

- Treating Runoff Locally
 - Bioretention, Rain Gardens, Cisterns, Permeable Pavement, Swales, etc.
 - PURPOSEFULLY EXCLUDES WET PONDS, DRY PONDS, & (often) WETLANDS



BMPs are designed to treat post-construction runoff



Stormwater BMP
Stormwater BMP Maintenance & Inspection
Maintenance & Inspection

Wet Ponds



15 years later.....



Wet Pond Costs

- Maintained at least once a month
- Avg cost with no mowing \$579 per acre per month
- Cost with mowing \$900 per acre per month
- Restorative:
 - Costs range from \$1,800 to \$20,000



Wet pond routine maintenance



Wet Pond Restoration



Thanks to Incompliance
Stormwater

Dry Ponds



Maintenance Costs: Dry Ponds

- Maintained monthly
- \$821/acre/month with no mowing
- \$1086/acre/month with mowing
- Restorative costs up to \$14,000



Dry pond mowing



Dry Pond Restoration





09/23/2008

W-S

Stormwater Wetlands



Maintenance Costs: Wetlands

- Maintained monthly
- \$679/acre/month with no mowing
- \$992/acre/month with mowing
- Restoration costs average \$20,000



Routine Maintenance



Restoration by dredging



Bioretention Maintenance Costs

- Mulched systems
- Monthly visits
- \$1395/acre/month with no mowing
- \$1131/acre/month with mowing
- Restoration \$20,000

Mulched systems



Bioretention Maintenance Costs

- Turf systems
- Monthly visits
- \$1244/acre/month with no mowing
- \$1471/acre/month with mowing
- Restoration \$20,000

Turf systems



Routine Maintenance



Bioretention Restoration



Preliminary Data- Sand Filters

- Maintained quarterly
- Routine costs vary between \$300 and \$1,600
- Maintenance assess is key
- Restorative tasks:
 - Cleaning by hand less expensive than renting vacuum truck
 - Will dig to “good” media and only replace “bad” media



Streambank Repair Costs

- Live stake only
- 1 live stake per square foot at \$.50 - \$1.00 each
- \$1.00 per linear foot of stream



Streambank Repair Costs

- Full repair:
- Lime, fertilize, seed, straw, live stake
- \$10 per linear foot + Labor and Equipment









BMP Maintenance & Inspection

Regenerative Stormwater Conveyance



RSC Pre-existing Condition



February 21, 2014: 0.77 inch Rainfall

Level Spreaders



Grassed Swales



Green Roofs



Green Walls



Infiltration Basin



Cisterns/ Water Harvesting



Permeable Pavement



Manufactured BMP Systems



SMURF case study

- Santa Monica California
- High value water resource: Beach
- High value urban landscapes
- Scarce and expensive irrigation water











Every day, water travels into the Santa Monica Bay from our storm drain system, collecting garbage, pollutants and germs along the way. When the Santa Monica Urban Runoff Recycling Facility (SMURRF) cleans the water from the Pico-Kenter and Pier Storm Drains, the Bay is cleaner. As a result, you, your family and our marine life are all healthier and safer.

HOW DOES SMURRF PROTECT THE BAY?

