NC STATE UNIVERSITY Stream Restoration Program

EcoStream

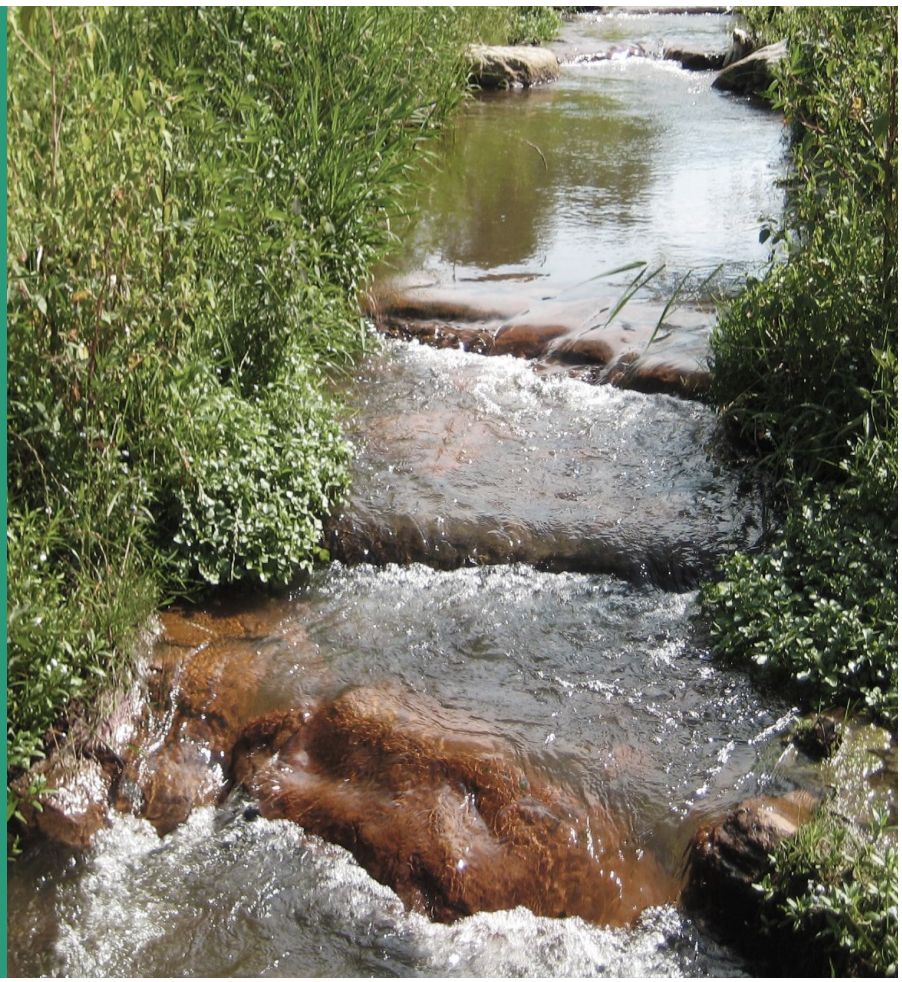
Stream Ecology and Restoration Conference

Adapting to a Changing Climate

November 17-20, 2014

Sheraton Charlotte Hotel

Charlotte, North Carolina



Hosted by:

NC State University Stream Restoration Program

NC Sea Grant

NCSU Department of Biological & Agricultural Engineering

North Carolina Cooperative Extension Service

www.ncsu.edu/srp/conference/

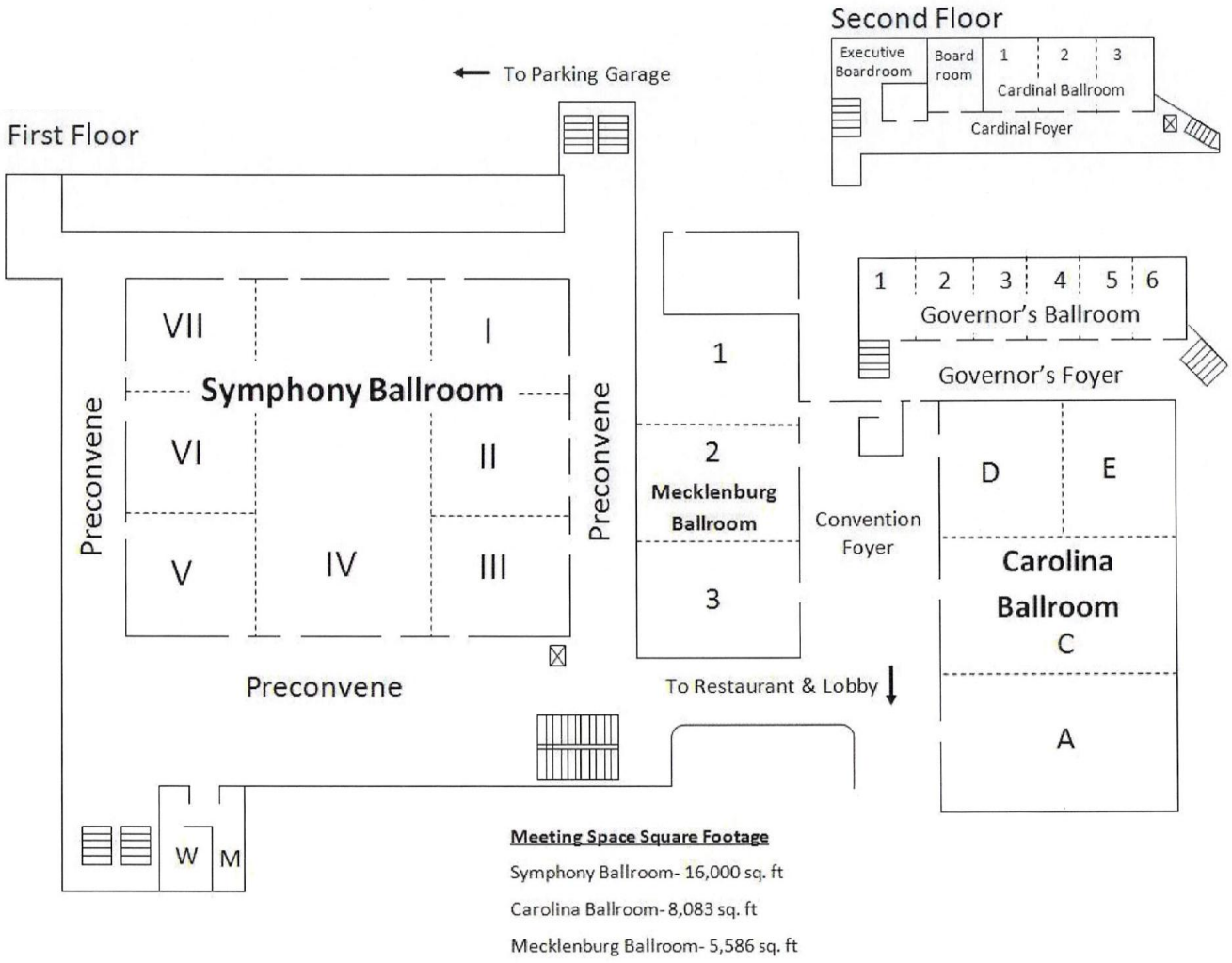
Sea Grant North Carolina

NC STATE UNIVERSITY Bio&Ag ENGINEERING

NC State University A&T State University COOPERATIVE EXTENSION *Empowering People · Providing Solutions*

Exhibit Space:

- Carolina: 38 (10x10) | 58 (8x10)
- Mecklenburg: 22 (10x10) | 43 (8x10)
  - Foyer: 21 (8x10)
- Symphony: 72 (10x10) | 100 (8x10)
  - Foyer 23 (8x10)



Conference Proceedings

EcoStream 2014

Stream Ecology and Restoration Conference

November 17-20, 2014
Sheraton Charlotte Hotel, Charlotte, North Carolina

Conference Hosts

North Carolina State University Stream Restoration Program
North Carolina Sea Grant
NCSU Department of Biological and Agricultural Engineering
North Carolina Cooperative Extension

Website: http://www.ncsu.edu/srp/conference/

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CONTINUING EDUCATION CREDITS

Up to 13 PDHs will be available for professional engineers for the main 2-day conference (Tuesday-Wednesday) and an additional 3 PDHs for pre-conference workshop #1 and 3 PDHs for any of the tours. 10 credit hours for the 2-day main conference are approved by the NC Board of Landscape Architects; Course # 10444. 3 additional credit hours for the Pre-con Workshop #2 has been applied for. Other professionals may appeal to their respective boards to obtain professional education credits.

About the Conference

Welcome to the 2014 EcoStream - Stream Ecology and Restoration Conference in Charlotte, NC. Formerly known as the Southeast Stream Restoration Conference, EcoStream is the new brand for NC State University Stream Restoration Program's biennial southeast stream restoration conference. The progression of stream restoration science clearly indicates the importance of preserving, enhancing, and restoring the entire riparian ecosystem. Therefore, through EcoStream, we hope to facilitate advancements in restoration that better achieve functional inter-connectedness of wetlands, streams, hydrology, riparian corridors and the biologic communities they support.

EcoStream 2014 is the 11th conference on this topic since 1998 and the second time we have convened in Charlotte. This conference includes more than 200 attendees representing 18 states and 94 affiliations. The continued goal of the conference is to provide a forum for sharing ideas, information, and experiences among natural resource professionals in the public and private sectors in order to improve the science and practice of stream restoration.

In light of global climate shifts coupled with changes in the social and political environment relative to ecological restoration, the focus for this year's conference is Adapting to a Changing Climate. The opening general session features a prestigious group of invited speakers from around the country with expertise in river science and management, climate change, hydrology, ecology, wetland management, watershed protection, forest hydrology, hydrodynamic modeling and innovative restoration design.

This year the conference will feature a drop-in discussion session after lunch on Wednesday. Seven topic stations will be spread throughout the meeting area allowing you to help us to identify information gaps and actions to advance the understanding and practice of stream restoration. The information gathered will be used to prepare a 2014 EcoStream discussion summary. In addition, the closing general session will again include multiple perspectives and information on stream mitigation programs and projects. We encourage you to take advantage of the opportunities to network with your colleagues during the discussion session and all the presenters on these and other important restoration issues.

We thank the conference sponsors and exhibitors who are listed in the program. More than 30 companies, nonprofit organizations, and government agencies involved in all

aspects of ecosystem restoration are providing sponsor support and exhibits throughout the conference. As a result of the tremendous support of the sponsors, we have a social event scheduled for all three nights of the conference which will feature downtown night life, a poster and exhibit social, and a tour of a local brewery with music. So, don't miss out on the fun.

Before you leave, please complete and return the conference evaluation forms to help improve future educational programs. Enjoy your time in Charlotte!

2014 EcoStream Conference Coordinators:
Barbara Doll, Karen Hall, Cathy Smith, and Christina Shepard

PLANNING COMMITTEE

Barbara Doll, Conference Co-Chair
Extension Assistant Professor, NC State University
Extension Specialist, North Carolina Sea Grant

Karen Hall, Conference Co-Chair
Extension Assistant Professor, NC State University
NCSU Water Quality Group

Cathy Smith, Conference Coordinator
NC State University

Christina Shepard, Conference Coordinator
NC State University

PROGRAM COMMITTEE

We gratefully acknowledge our Conference Partners for their help in planning and promoting the 2014 EcoStream Conference!

- Appalachian State University
- Arkansas Water Resources Center
- Auburn University
- City of Charlotte
- Clemson University, School of Agricultural, Forest and Environmental Sciences
- Duke University, Nicholas School of the Environment
- East Carolina University - Coastal Water Resources Center
- Hiwassee River Watershed Coalition, Inc.
- National Center for Earth-surface Dynamics
- NC Ecosystem Enhancement Program
- NC Water Resources Association (NCWRA)
- NCSU Forestry and Environmental Resources Extension
- North Carolina Association of Environmental Professionals (NCAEP)
- North Carolina Wildlife Resources Commission
- Pilot View, Inc.
- Resource Institute, Inc.
- Society of Wetland Scientists South Atlantic Chapter
- Southeast Watershed Forum
- Tennessee Stream Mitigation Program
- The Nature Conservancy
- UNC-Asheville - Environmental Studies Department
- UNC-Charlotte
- UNC Coastal Studies Institute
- UNC Environmental Finance Center
- University of Georgia, College of Environment and Design
- University of Kentucky, Biosystems and Agricultural Engineering
- University of Louisville - The Stream Institute
- USDA-NRCS
- Water Resources Research Institute
- Western Carolina University

EcoStream
Stream Ecology and Restoration Conference

Social Networking Events

Monday, November 17, 2014 – 6:00pm
After a full afternoon of great pre-conference workshops, join us for drinks, hors d'oeuvres, and networking as we kick off the conference with a welcome reception at Blackfinn Ameripub at 210 East Trade Street. Each conference attendee will be provided with two (yellow) drink tickets which will be available at the door. Make sure to thank our Mayfly Sponsors for drink tickets!

Tuesday, November 18 - 5:10–7:00pm
Join us for a reception in the Symphony Foyer among our exhibits and poster displays during the Poster Presentation session. Please be sure to visit our poster presenters and afterwards, with exhibits and colleagues. Enjoy hors d'ouvres and drinks, courtesy of our Stonefly Sponsors! Find your two drink tickets for this social event in your name badge pocket.

Wednesday, November 19 – 6:00pm
Meet at Unknown Brewing Co. for music and drinks, courtesy of Wildlands Engineering. Address: 1327 S. Mint Street. A Tin Kitchen foodtruck will be in the vicinity. The Tin Kitchen is a "freestyle" gourmet food truck and catering company serving unique and creative dishes in the downtown Charlotte area. A variety of tacos will be available for our conference participants. You will receive a food ticket for 2 tacos per person, courtesy of our Sponsors. Shuttles will be available from 5:30 to 9:30pm.

THE UNKNOWN BREWING CO
LIVE WITHOUT BOUNDARIES

THE TIN KITCHEN

A Special Thank You to our Sponsors!

This event could not occur without the generous support of our sponsors.

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KCI Technologies, Inc.
RiverMorph
RoLanka International
Storm Water Systems, Inc.
The Catena Group, Inc.
Tidewater Environmental Services, Inc.
W.K. Dickson

EXHIBITOR LIST:

ArborGen, LLC
168 Lenox Place
Athens, GA 30606
706-850-1429
http://www.arborgen.com

Backwater Environmental
P.O. Box 1654
288 East Street, Suite 2001
Pittsboro, NC 27312
919-523-4375
http://backwater.biz

Carolina Wetland Services, Inc.
550 E. Westinghouse Blvd.
Charlotte, NC 28273
704-527-1177
http://www.cws-inc.net/

Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 15205
800-365-2324
http://www.cecinc.com/

Conservation Services, Inc.
1620 North Delphine Ave
Waynesboro, Virginia 22980
540-941-0067
http://www.conservationservicesinc.com/

Ecological Engineering, LLP
1151 SE Cary Parkway, Suite 101
Cary, North Carolina 27518
919-557-0929
http://www.ecologicaleng.com

Environmental Banc & Exchange
909 Capability Dr., Suite 3100
Raleigh, NC 27606
(888) 781-7075
http://www.ebxusa.com/

Equinox Environmental
37 Haywood Street, Suite 10
Asheville, NC 28801
828-253-6856
http://www.equinoxenvironmental.com/

Ernst Conservation Seeds
8884 Mercer Pike
Meadville, PA 16335
800-873-3321
http://www.ernstseed.com

Filtrexx International
1101 Running Brook Road
Midland, NC 28107
704-562-4536
http://www.filtrexx.com/

HDR
3733 National Drive, Suite 207
Raleigh, NC 27612
919-785-1118
http://www.hdrinc.com/

JMT, Inc.
220 St. Charles Way, Suite 200
York, PA 17402
717-741-6212
http://www.jmt.com/

KCI Technologies
4601 Six Forks Rd., Suite 220
Raleigh, NC 27609
919-783-9214
http://www.kci.com

Kee Mapping & Surveying, PA
P.O. Box 2566
Asheville, NC 28802
828-575-9021
http://www.keemap.com/

Kimley-Horn and Associates, Inc.
2000 South Boulevard, Suite 440
Charlotte, NC 28202
704-319-7684
http://www.kimley-horn.com/

McCormick Taylor
Two Commerce Square
2001 Market Street, 10th Floor
Philadelphia, PA 19103
215-592-4200
http://www.mccormicktaylor.com/

Mellow Marsh Farm
1312 Woody Store Road
Siler City, NC 27344
919-742-1200
http://www.mellowmarshfarm.com

Michael Baker International
8000 Regency Parkway, Suite 600
Cary, NC 27518
919-481-5703
http://www.mbakerintl.com/

NC Division of Forest Resources
1616 Mail Service Center
Raleigh, NC 27699-1616
919-857-4856
http://www.ncforestservice.gov/

North State Environmental, Inc.
2889 Lowery Street
Winston-Salem, NC 27101
336-245-1249
http://www.nsenv.com

River Works, Inc.
6105 Chapel Hill Rd.
Raleigh, NC 27607
919-582-3574
http://www.riverwork.com

RiverMorph
10509 Timberwood Circle, Suite 100
Louisville, KY 40223-5301
866-748-6673
http://www.rivermorph.com

RK&K Engineers
81 Mosher Street
Baltimore, MD 21217
302 468 4880
http://www.rkk.com/

RoLanka International
155 Andrew Drive
Stockbridge, GA 30281
800-760-3215
http://www.geo-naturals.com/

S&ME, Inc.
1413 Topside Road
Louisville TN 37777
865-970-0003
http://www.smeinc.com/

Stantec Consulting
11687 Lebanon Road
Cincinnati, OH 45241-2012
513-842-8238
http://www.stantec.com

The Catena Group
410-B Millstone Drive
Hillsborough, NC 27278
919-732-1300
http://thecatenagroup.com/

Timmons Group
1001 Boulders Parkway, Suite 300
Richmond, VA 23225
(800) 588-7341
http://www.timmons.com/

Wildlands Engineering
1430 South Mint Street, Suite 104
Charlotte, NC 28203
704-332-7754
http://www.wildlandseng.com/

Wolf Creek Engineering
12 ½ Wall Street, Suite C
Asheville, NC 28801
828-449-1930
http://wolfcreekeng.com/

Shamrock Environmental Corporation
6106 Corporate Park Drive
Browns Summit, NC 27214
336-375-1989
http://www.shamrockenviro.com

Storm Water Systems, Inc.
196 Industrial Blvd.
Cleveland, Georgia 30528
(888) 730-5819
http://stormwatersystems.com/

Tidewater Environmental Services, Inc.
34 Ruskin Square
Greenville, SC 29607
864-884-5078
http://www.tidewaterenvironmental.com/

Wetland Plants, Inc.
3067 Conners Drive
Edenton, NC 27932
252-482-5707
http://wetlandplantsinc.com/

W.K. Dickson
616 Colonnade Drive
Charlotte, NC 28205
704.334.5348
http://www.wkdickson.com/

PRE-CONFERENCE WORKSHOPS – MONDAY, 1:00-5:30PM

Workshop #1

Establishing Best Engineering Practices for Stream Restoration Design and Construction

Description: Stream Restoration using Natural Channel Design (NCD) procedures is a relatively new field of practice. As such, NCD design and construction practices have been rapidly evolving over the past two decades. While substantial improvements have been realized through adaptive management and assessment efforts, some projects fail to reach projected or anticipated levels of ecological stability and function. Engineers have a responsibility to clients, society, employers, and to the engineering profession to ensure that quality restoration projects are being designed and constructed. Therefore, this workshop will focus on several aspects of stream restoration design and construction that are critical to ensuring that the best quality projects are implemented. The workshop will feature a number of design and construction experts with experience in multiple facets of stream restoration.

Schedule:

1:00-1:10	Introduction to Best Engineering Practices - Barbara Doll, NC State University
1:10-1:35	Ethics in the Ecosystem Restoration Industry: Fighting Against the Current - Scott Hunt, Michael Baker International
1:35-2:00	Project Management: Best Engineering Practices - Shawn Wilkerson, Wildlands Engineering
2:00-2:25	Three-Dimensional Survey, Design, and Construction: Best Engineering Practices. Mike Geenen, Stantec Consulting Services
2:25-2:50	Engineering Design Plans: Best Engineering Practices - Michael Adams, Stantec Consulting Services
2:50-3:00	Q&A
3:00-3:20	Break
3:20-3:45	Specifications and Bid Documents - Kevin Tweedy, EPR
3:45-4:10	Stream Restoration Construction: The Value in Pre-Qualifying – Phillip Todd, River Works, Inc.
4:10-4:35	Estimating Project Construction Costs - Darrell Westmoreland, North State Environmental
4:35-5:00	Construction Supervision: Working Effectively with Contractors - Daniel Taylor, Wildlands Engineering
5:00-5:25	Stream Restoration Construction Best Engineering Practices – Eric Dawalt, Ridgewater
5:25-5:30	Q&A
5:30 pm	Adjourn

CONTINUING EDUCATION:

3 PDHs are approved for professional engineers and land surveyors for this half-day workshop.

PRE-CONFERENCE WORKSHOPS (cont'd) – MONDAY, 1:00-5:00PM

Workshop #2

Stream Vegetation Installation and Maintenance Workshop

Description: This workshop is a hands-on demonstration and learning workshop where participants will actively participate in revegetating the Glassy Creek stream restoration project in Charlotte. Demonstrations of plant installations as well as discussions of current issues in riparian restoration are highlighted in this workshop. Plant industry professionals will be on hand to answer questions and assist participants. Professional credit hours will be provided for landscape architects, foresters, and pesticide applicators. Dress for field conditions. Waders not necessary but boots, gloves and raingear recommended.

Schedule:

1:00 pm:	Load vans and head to project site
1:30 pm:	Project overview by *Wildlands Engineering*
2:00-4:30 pm:	Discussion and demonstrations of vegetation installation and maintenance.
4:40 pm:	Load vans and return to hotel
5:00 pm:	Adjourn

Continuing Education:

3 credit hours are pending approval by the NC Board of Landscape Architects for this half-day workshop. CFE credits are also pending approval by the Society of American Foresters.

This workshop has been approved by the NC Pesticide Board for the following credits:
1 hours credit - A G H L N O D X
The Course Code is 485642.

PLENARY SPEAKERS, TUESDAY, NOVEMBER 18

Brian Richter

President, Sustainable Waters

Brian Richter has been a global leader in river science and conservation for more than 25 years. He is the Director of Global Freshwater Strategies for The Nature Conservancy, an international conservation organization, where he promotes sustainable water use and management with governments, corporations, and local communities. Brian has consulted on more than 120 water projects worldwide. He serves as a water advisor to some of the world's largest corporations, investment banks, and the United Nations, and has testified before the U.S. Congress on multiple occasions. He also teaches a course on Water Sustainability at the University of Virginia. Brian has developed numerous scientific tools and methods to support river protection and restoration efforts, including the Indicators of Hydrologic Alteration software that is being used by water managers and scientists worldwide. Brian was featured in a BBC documentary with David Attenborough on "How Many People Can Live on Planet Earth?" He has published many scientific papers on the importance of ecologically sustainable water management in international science journals, and co-authored a book with Sandra Postel entitled Rivers for Life: Managing Water for People and Nature (Island Press, 2003). His new book, Chasing Water: A Guide for Moving from Scarcity to Sustainability will be published by Island Press in June 2014. Brian recently launched a new organization, Sustainable Waters, focusing on water education.

Paul Wagner

Deputy Associate Director for Climate Preparedness, White House Council on Environmental Quality

Paul Wagner is currently the Deputy Associate Director for Climate Preparedness for the White House Council on Environmental Quality and an Ecologist with the US Army Corps of Engineers (USACE) Institute for Water Resources (IWR). Educated at the University of North Texas and Virginia Tech, Paul has served as an ecologist and group manager at USACE's Institute for Water Resources. He has developed decision support tools and worked on domestic and international wetlands issues, project and program management, climate change, and collaborations with other federal agencies and NGOs. Prior to coming to USACE, Paul was a research ecologist in EPA's Office of Research and Development. He also served as a senior aquatic ecologist for The Nature Conservancy's South-

central division. While at the Nature Conservancy, he worked in conservation planning and in a state natural heritage program. The natural heritage program experience prompted him to initiate collaboration with NatureServe, a non-profit conservation organization that seeks to provide a scientific basis for effective conservation action.

Lawrence Band
Professor, University of North Carolina, Chapel Hill

Dr. Lawrence Band is the Voit Gilmore Distinguished Professor of Geography and the Director of the Institute for the Environment at the University of North Carolina. Band's research and teaching focuses on the ecohydrology of watersheds, including the cycling of water, carbon and nutrients, co-evolution of forest ecological and hydrological systems, and human/environment interactions. His current research focuses on two Long Term Ecological Research (LTER) sites: the Coweeta LTER in western North Carolina, and the Baltimore Ecosystem Study. Past research has included projects in the Pacific Northwest, Rocky Mountains, China, Canada, and Australia. In 2010 he was Board Chair for the Consortium of Universities for the Advancement of Hydrologic Sciences (www.cuahsi.org), a consortium of approximately 130 US and foreign universities, non-profit institutes, and domestic and foreign water science and management agencies, and was a deputy editor for Water Resources Research. Band was a visiting scientist at the Australian Cooperative Research Center for Catchment Hydrology in 1992-1993 and at the Bureau of Meteorology and CSIRO in 2008, the latter on science and management response to the Australian drought. Dr. Band has published more than 130 papers, book chapters and technical reports. He has consulted with federal, state and municipal agencies in the US and Canada on watershed protection, forest health, stormwater and ecosystem restoration. In 2014 he has been the Geological Society of America Birdsall-Dreiss Distinguished Lecturer, delivering over 30 talks on the interactions of surface/groundwater hydrology with ecosystem development in forested and urban watersheds.

Brian Bledsoe
Professor, Colorado State University

Dr. Brian Bledsoe is Professor of Civil and Environmental Engineering at Colorado State University, where he conducts research and teaches courses on rivers and watersheds. Brian has over 25 years of

experience as an engineer, hydrologist, and environmental scientist in the private and public sectors, including over 20 years of experience in stream and wetland restoration. He earned degrees from Georgia Tech, North Carolina State University, and Colorado State University. Before joining CSU, he worked in the private sector as a consulting engineer, and for the State of North Carolina as a stream and wetland restoration specialist and as nonpoint source program coordinator. Brian's research is focused on the interface between hydrology and ecology with an emphasis on linkages among land use, hydrology, hydraulics, fluvial geomorphology, and water quality. He received an NSF CAREER Award in 2006, and served as a Fulbright Scholar in Chile in 2008. Brian's scientific advisory and peer-review activities include the Platte River and San Juan River Recovery Implementation Programs, the Everglades and Louisiana Coastal Area restoration efforts, and the EPA Environmental Monitoring and Assessment Program. He is a licensed professional engineer in NC and CO. His full CV can be viewed at http://www.engr.colostate.edu/~bbledsoe/Bledsoe_CV.pdf.

Art Parola
Professor, University of Louisville

Dr. Arthur C. Parola, P.E., is the director of the Stream Institute and a professor of civil and environmental engineering at the University of Louisville. He received his PhD in civil engineering, water resources, from The Pennsylvania State University in 1990. Dr. Parola has directed the design of more than 80,000 ft of stream channel restoration and the creation or restoration of hundreds of acres of associated wetlands. He and the team of students, staff, and faculty who make up the Stream Institute employ a multidisciplinary approach to the restoration of self-sustaining stream-and-wetland complexes. Through collaboration with engineering and construction firms, geomorphologists, biologists, and ecologists, the Stream Institute has pioneered numerous methods for assessment, design, construction, and monitoring of stream and wetland restoration projects. One of the fundamental components of their design approach has been the use of two-dimensional hydrodynamic modeling to design the floodplain topography and the planform characteristics of channels. A second fundamental component of their approach has been to restore both groundwater and surface water processes in the floodplain and channel. By reestablishing groundwater retention in valley aquifers, the Stream Institute has been able to restore hydrologic conditions that support extensive riparian wetlands and habitat for resident aquatic organisms, including threatened and endangered species.

PROGRAM AGENDA AND SCHEDULE OF ORAL PRESENTATIONS

EcoStream 2014 - Stream Ecology & Restoration Conference Schedule

		MONDAY, NOVEMBER 17, 2014	
1:00-5:00		**PRE-CONFERENCE WORKSHOPS**	
Location	**Symphony VI**	**Field**	
1:00-5:00	Workshop #1: Establishing Best Engineering Practices for Stream Restoration Design and Construction	Workshop #2: Vegetation Installation and Maintenance (this workshop will be entirely in the field; transportation provided.)	
2:15-2:30	*Break*	*Break*	*Break*
6:00pm	Social at Blackfinn Saloon, 210 East Trade St. - courtesy of Conference Sponsors		
		TUESDAY, NOVEMBER 18, 2014	
8:30-12:00		**GENERAL SESSION**	
Location	**Symphony Ballroom**		
8:30-8:45	Conference Welcome - **Barbara Doll**, Extension Assistant Professor, NC State University, and Extension Specialist, North Carolina Sea Grant		
8:45-8:55	Welcome to Charlotte - **Ron Carlee**, City Manager, City of Charlotte		
8:55-9:30	Chasing Water in a Rapidly Changing World - **Brian Richter**, President, Sustainable Waters		
9:30-10:00	The Federal Response to Climate Change - **Paul Wagner**, Deputy Associate Director for Climate Preparedness, White House Council on Environmental Quality		
10:00-10:30	*Break*	*Break*	*Break*
10:30-11:00	Green Infrastructure, Groundwater and the Sustainable City - **Larry Band**, Professor, UNC-Chapel Hill		
11:00-11:30	Addressing Key Uncertainties in Stream Restoration Projects - **Brian Bledsoe**, Professor, Colorado State University		
11:30-12:00	Integrated Valley and Wetland Restoration - **Art Parola**, Professor, University of Louisville		
12:00-1:00pm	*Lunch*	*Lunch*	*Lunch*
1:00-2:40		**CONCURRENT SESSION 1**	
Location	**Symphony V**	**Symphony IV**	**Symphony III**
Session Title	***A. Sediment Transport***	***B. Mitigation Process and Lessons Learned***	***C. Aquatic Invertebrates and Habitat***
Moderator	Jason Zink, NC State University	Mac Haupt, NC Ecosystem Enhancement Program	Wendi Hartup, NC Cooperative Extension
1:00-1:20	**Danvey Walsh** - Implications of the Geomorphic Drivers of Channel Instability along Little Ivy Creek, Western North Carolina to Stream Restoration Design	**Robert Bugg** - Your Destination is on an Unpaved Road: Mitigation Banking Starts with Land Acquisition	**Sean Miller** - Enhancing Aquatic Macroinvertebrate Communities Through Geomorphic Stream Restoration
1:20-1:40	**Doug Shields** - Managing Connectivity for Critical Floodplain Habitats: So Much Sediment, So Little Water	**Micky Clemmons** - When Agreements are Ignored.	**Eve Brantley** - Southern Piedmont Streams Eco-geomorphological Assessments
1:40-2:00	**Sean Collins** - Constructed and Restored Wetlands' Relationship to Stream Restoration Using Natural Channel Design	**Vicky Miller** - Overcoming Constraints on the Indian Run Stream Restoration Project	**Pat Barber** - Leaf Pack Restoration Techniques
2:00-2:20	**Periann Russell** - Legacy Sediment and Implications for Stream Restoration	**Daniel Johnson** - Developing a South Carolina Full-Delivery Mitigation Solution: The Cannon Creek Stream Mitigation Site	**George Morris** - Invasive Species in Riparian Buffers
2:20-2:40	**Mike Miller** - Stream Functions and Process-based Restoration	**Kristi Suggs** - Navigating the Mitigation Process: Trials, Tribulations, & Triumphs	**Erin McCombs** - Dam Removal and Freshwater Mussels: A Guide to Effective Restoration and Prioritization Through Case Studies
2:40-3:10	*Break*	*Break*	*Break*

3:10-5:10		CONCURRENT SESSION 2	
Location	Symphony V	Symphony IV	Symphony III
Session Title	*A. Modeling and Technology*	*B. Restoration Planning and Prioritization*	*C. Water Quality Planning and Assessment*
Moderator	*Kris Bass, Kriss Bass Engineering*	*Jon Calabria, University of Georgia*	*Periann Russell, NC Ecosystem Enhancment Program*
3:10-3:30	**Christine Blackwelder** - Observed Trends in Small Stable Urban Drainages around Charlotte, NC: The Charlotte Mini Curve	**Jeff Keaton** - Assessing Potential Stream Restoration Projects for Large-scale and Small-scale Watershed Planning Areas	**Joshua Gilman** - Another Reason to Do the Right Thing: Water Quality as a Driver for Stream Improvement
3:30-3:50	**Chris Yow** - A Cost Effective Approach to Hydrologic Modeling of Large Watersheds – Correlating Curve Numbers with the National Land Cover Dataset	**Tim Taylor** - Improving Restoration on Large Rivers	**Bobbie Swinson** - Motivations, Goals, and Potential Outcomes of a Habitat Restoration Project on the South Fork of the New River: A Mixed Methods Assessment
3:50-4:10	**Nathan Ober** - Advances in 3D Stream Restoration Design with AutoCAD® Civil 3D® 2014 Corridors	**Campbell McNutt** - Accounting for Restoration in the Water Quality Assessment Framework	**Mark Metzler** - Watershed Approach and Ecological Benefits of Restoration in the Conowingo Watershed
4:10-4:30	**Chris Dodson** - The Drones Are Coming - Technologies for the Stream Practitioner	**Jill Davenport** - Case studies of stream restoration incorporated into urban and suburban parks in Metro Atlanta	**Peter Raabe** - Green Infrastructure Build-Out: Redeveloping Urban Stormwater Infrastructure
4:30-4:50	**Scott Gregory** - Characterizing Stream Buffer Condition in GIS for the Neuse River Regional Watershed Plan	**Jana Stewart** - Greensboro's Stream Team: Prioritizing Stream Asset Repairs	**Daren Pait** - Urban Stream Restoration and Floodplain Reconnection as a Regional BMP to Meet TMDL Requirements
4:50-5:10	**Michael Geenen** - 3-D Optimization Case Studies	**William Swartley** - A Model for State Forest Agencies to Engage in Water Resource Restoration	**David Woodie & David Kroenig** - WQ planning & assessment in McDowell: Leaving No Stone Unturned
		WEDNESDAY, NOVEMBER 19, 2014	
8:00-9:40		CONCURRENT SESSION 3	
Location	Symphony V	Symphony IV	Symphony III
Session Title	*A. Regenerative Stream Channel Restoration*	*B. Mitigation Case Studies*	*C. The Science of Buffers*
Moderator	*Melonie Allen, NC Ecosystem Enhancement Program*	*Sean Connolly, SC Dept. of Transportation*	*Eve Brantley, Auburn University*
8:00-8:20	**Ward Marotti -** Regenerative Stormwater Conveyances: Giving Old, Perched Outfalls New Life	**Ian Turner -** Sink or SWVM: West Virginia's Stream and Wetland Valuation Metric (SWVM) and its use in the development of a large-scale stream mitigation bank	**Scott King -** Riparian Buffers: A 12-Year Retrospective Summary
8:20-8:40	**Bill Hunt -** RSC Research in North Carolina: Hydrology and Water Quality	**Kevin Verweire -** Application of the Savannah District Stream Functional Assessment Method for Large Scale Stream Mitigation in New York	**Erin Turner -** Stream Restoration Influences Floodplain Connectivity: Effects of Restoration on Soil Characteristics in Restored Urban Floodplains in the Piedmont of North Carolina
8:40-9:00	**Kevin Nunnery -** New Storm Water Control Measure Development, Urban Stream Restoration Performance Expectations, Regulatory Controls and Credit – How Does All This Interface? Case Studies and Observations	**Jarrod Karl -** The Model Mitigation Banking Project: Utilizing Stormwater Control Measures to Maximize Uplift and Generate Mitigation Credit in Urban Watersheds	**Nate Jones -** Floodplain Connectivity -- A Source or Sink of Nutrients?
9:00-9:20	**Ellen McClure** - Stream Restoration & Wetland Integration as a Cost-Effective Technique to Meet Functional Goals	**Joshua White -** Man or Machine: Who Do You Prefer to Construct Your Stream Restoration Project?	**Molly Welsh -** Quantification of In-Stream and Riparian Denitrification Potential and Environmental Drivers of Denitrification Following Agricultural Stream Restoration in the Piedmont Region of North Carolina
9:20-9:40	**Joe Berg** - Regenerative Design of Sand Seepage Wetlands for the Creation of a Wetland Agricultural Treatment Wetlands at an Abandoned Sand Mine Site	**Vickie Miller -** Constructing a Mitigation Project in a Design Build Setting	**Durelle Scott -** Nutrient Processing Within the Atchafalaya Swamp: The Role of Hydrologic Connectivity
9:40-10:00	*Break*	*Break*	*Break*

10:00-11:40		CONCURRENT SESSION 4	
Session Title	*A. Special Session: Refining Stream Design Criteria*	*B. Coastal Plain Restoration*	*C. Fish Habitat & Community Assessment*
Moderator	*Greg Melia, NC Ecosystem Enhancement Program*	*Robert Evans, NC State University*	*Robin Goodloe, U.S. Fish & Wildlife Service*
10:00-10:20	**Will Harman -** Reference Reaches and Beyond	**Kayne Van Stell -** Restoring Coastal Plain Headwater Systems in a Changing Regulatory Environment	**David Parise -** Restoration of Fish Communities on Longwall Mining Sites in Pennsylvania
10:20-10:40	**Will Wilhelm -** Implementing Diverse Natural Channel Design Practices in Urban Watersheds	**John Hutton -** Devils Racetrack: Restoration of a Large Coastal Plain Stream & Wetland Complex	**Aaron Svoboda -** Effects of Urban River Rehabilitation Structures on the Fish Community in the Ottawa River, Ohio
10:40-11:00	**Grant Ginn -** Sediment Transport for Restoration Design	**Kevin Tweedy -** Design Approaches and Considerations for Sand-Bed Channels	**George Athanasakes & Rob Lewis -** Hatchery Creek Stream Restoration Project - A Unique Opportunity to Maximize Trout Habitat, Create Recreational Opportunities and Provide Mitigation Credits (PART 1)
11:00-11:20	**Greg Jennings -** Eco-Geomorphological Relationships to Support Design	**Cameron Morris -** Relationships of Geomorphic Conditions and Woody Materials in Coastal Plain Streams	**Cody Fleece & Eric Dawalt -** Hatchery Creek Stream Restoration Project - A Unique Opportunity to Maximize Trout Habitat, Create Recreational Opportunities and Provide Mitigation Credits (PART 2)
11:20-11:40	**Will Harman -** Design Criteria for Restoring Headwater Mountain Streams	**Kris Bass -** Using Modeling for Innovative Coastal Stream Projects	**Steven Glickauf -** Designing for Threatened and Endangered Fish Species and Responses to Restoration; Raccoon Creek Stream Restoration Project
11:40-12:40	*Lunch*	*Lunch*	*Lunch*
12:40-2:10	*Dessert and Roaming Discussion Session*		
1:10-2:10	**Special Session: McDowell Creek Watershed: Water Quality Initiatives by Charlotte-Mecklenburg Stormwater Services - Planning and Project Case Studies**		
Moderator	*Emily Reinicker, Wildlands Engineering, Inc.*		
1:10-1:30	**David Kroenig -** McDowell Creek Watershed Management Plan		
1:30-1:50	**Jason Claudio-Diaz -** Torrence Creek, Torrence Creek Tributary #2, Torrence Creek Tributary #1, and McDowell Creek Stream Restoration		
1:50-2:10	**Emily Reinicker -** Torrence Creek at The Park: Design Case Study		
2:10-3:30		CONCURRENT SESSION 5	
Session Title	*A. Morphology and Design*	*B. Monitoring*	*C. Urban Case Studies*
Moderator	*Tucker Creed, SC Dept. of Transportation*	*Michael Shaffer, Watershed Science*	*Marc Recktenwald, City of Charlotte*
2:10-2:30	**Michael Adams -** A Return to Stream Restoration Engineering: The Current and Future State of Step Pool Design	**Scott McGill -** How Does Natural Channel Design Perform Long Term: Case Studies of Three Restoration Projects Approaching Adulthood	**Jeffrey Duke -** Urban Stream Restoration Following the Historic 2010 Middle Tennessee Flood
2:30-2:50	**Cade Kistler -** Characteristics of Southern Appalachian Plateau Step Pool Stream Systems	**Mark Southerland -** Using the "Kitchen-Sink" Approach for Restoration Monitoring in Red Hill Branch	**Steve Casey -** Reconstruction Efforts after the Middle Tennessee Flood of 2010
2:50-3:10	**Mark Secrist -** Headcut Stabilization Procedure on 1st and 2nd Order Streams	**Kyle Hall -** The Reedy Creek Restoration Study: Long Term Holistic Monitoring of a Watershed Scale, Urban Stream Restoration Project	**John Schrum -** From Disastrous Flooding to a Water Quality Showcase - Briar Creek – Chantilly Water Quality Improvement Project
3:10-3:30	**Rajan Jha -** Analysis of Scouring in River Bends	**Eban Bean -** Evaluating Spatial Density of Water Quality Data for Stream Assessment Using a Low Cost Approach	**Brett Kordenbrock -** Enhancement of Concretized Streams: Mill Creek
3:30-3:45	*Break*	*Break*	*Break*

3:45-5:05	**GENERAL SESSION**
Moderator	*Karen Hall, NC State University*
3:45-4:05	**Will Harman -** Advancing the Science, Policy, and Approach of Stream Restoration
4:05-4:25	**Norton Webster -** Mitigation Banking Opportunities for the Southeast Region
4:25-4:45	**Michael Ellison -** NC EEP Changes in How We Do Business
4:45-5:05	**TBA**
5:05pm	*Conference Adjourned*
	THURSDAY, NOVEMBER 20, 2014
7:30-2:00	**FIELD TOURS**
7:30-2:00	**Rural – Catawba County Stream and Wetland Restoration Tour**
7:45-12:00	**Suburban - McDowell Creek Watershed Water Quality Initiative Tour**
8:00-12:00	**Urban – Downtown Charlotte Stream Restoration Tour**

DIRECTORY OF POSTER PRESENTATIONS

Poster Number

1 **Using Stream Metabolism to Measure Shifts in Ecological Function in Impaired Stream Ecosystems -- Stacey Blersch** and Joseph Atkinson, PhD, State University of New York at Buffalo

2 **Southern Appalachian Bog Restoration -- Jon Calabria, PhD, RLA**, University of Georgia

3 **Avoid False Images in Restoring Urban Streams -- Kristen Cockerill, PhD,** and William P. Anderson, Jr., PhD, Department of Geology, Appalachian State University

4 **Nutrient Uptake in a Forested and Urban Stream in the Southern Appalachians: Implication for stream restoration --** Chuanhui Gu, PhD and **Laura Heinen**, Appalachian State University

5 **Macroinvertebrate Community Recovery From Flood Events in Urban Restored Streams -- Sara Henderson** and Sandra Clinton, PhD, University of North Carolina Charlotte

6 **Assessing Restoration Potential at Toccoa Creek -- Chris Morphis** and Jon Calabria, PhD, University of Georgia

7 **Allenbrook Drive Restoration Project - Constructing a Highly Urbanized Stream During Record Rainfall -- Eric Mularski**, HDR Engineering, Inc.

8 **Assessing the Success of DRAINMOD for the Prediction of Wetland Hydrology for Three Mitigation Sites in North Carolina -- Eric Neuhaus**, Kirsten Gimbert, Jeff Keaton and John Hutton, Wildlands Engineering

9 **Long-term Response of Benthic Macroinvertebrate Communities to Stream Restoration on Little Sugar Creek in Charlotte North Carolina -- Anthony Roux**[1], Sandra M. Clinton, PhD[1], and Sara McMillan, PhD [2]; [1]Department of Geography and Earth Sciences, University of North Carolina Charlotte, [2]Department of Agricultural and Biological Engineering, Purdue University

10 **Local Effectiveness of Stream Restoration Structures Measured by Benthic Macroinvertebrate -- Xueying Wang**, Civil Engineering Department, University of North Carolina Charlotte

FIELD TRIPS – THURSDAY, NOVEMBER 20, 2014

Meet in hotel lobby at least 15 minutes before departure time. Each bus has a different departure and return time – please see details for each tour below. Breakfast to-go will be provided for all tour participants.

Rural – Catawba County Stream and Wetland Restoration Tour

7:30am – 2:00pm (*this tour includes lunch*)

This tour will feature two large restoration projects located in rural Catawba County. The Lyle Creek Stream & Wetland Mitigation Project improved 6,795 feet of stream and 9.5 acres of wetlands on an active tree farm located on headwater tributaries to Lyle Creek. The restored tributaries transition from steep, colluvial headwater valleys to the flat, alluvial valley of Lyle Creek. Prior to restoration, the tributaries and wetlands were frequently mowed and dredged. Massive algal blooms and low dissolved oxygen concentrations regularly occurred and more than a foot of decomposed organic matter covered the streambeds. The project features log steps through the high gradient sections and an inner berm feature to maintain baseflow habitat and sediment transport. The North Fork Mountain Creek Stream and Wetland Restoration Project features 5180 feet of stream restoration, just over1 acre of wetland restoration and 3 acres of wetland creation. Located approximately 6.5 miles east of Newton, the work was initiated to restore ecological function to stream channels impaired by cattle operations. The project features channel realignment, floodplain reconnection and floodplain creation. Representatives from the design consulting firms, a mitigation banking company and the NC Ecosystem Enhancement Program will be on hand to share information about planning, design and construction of these two projects.

Suburban - McDowell Creek Watershed Water Quality Initiative Tour

7:45am – 12:00pm

This tour will feature three stream restoration projects in the McDowell Creek watershed. McDowell Creek is located in northwest Mecklenburg County and drains into Mountain Island Lake which serves as the City of Charlotte's drinking water source. Water Supply designation requires new development in most of the watershed to meet impervious, buffer and storm water detention requirements. Draining the towns of Huntersville and Cornelius, McDowell Creek Cove has poor water quality and McDowell Creek is listed as biologically impaired by the North Carolina Department of Environment and Natural Resources. As a result, the Town of Huntersville developed and implemented a proactive Water Quality Ordinance which places strict storm water runoff treatment requirements on all new development. To address pre-existing sources of pollution, a watershed management plan was developed and an associated capital improvement plan was implemented to focus on Best Management Practice (BMP) retrofit projects as well as the restoration of many miles of McDowell Creek and its tributaries. Representatives from Mecklenburg County Water Quality and from the engineering design firms will be on-site to share information about planning, design and construction of three recently completed projects located on McDowell Creek and Torrence Creek.

Urban – Downtown Charlotte Stream Restoration Tour
8:00am – 12:00pm

This tour will feature four downtown Charlotte stream restoration projects. For more than a decade, Charlotte-Mecklenburg Storm Water Services has been restoring sections of Little Sugar Creek, its tributaries and other downtown area creeks with primary goals of cleaning water and connecting people to nature. These highly urban restoration projects work to balance numerous objectives including reducing flooding, providing public access, revitalizing downtown development, improving ecology and enhancing the natural beauty of the city's heavily impacted streams. In addition to natural channel design restoration practices, projects visited will feature uncapped sections of the creek that were formerly covered (aka daylighting), greenway paths and removal of flood-prone buildings. Representatives from Charlotte-Mecklenburg Stormwater Services and from the stream restoration design firms will be on-site to share information about planning, design and construction of these four projects located in downtown Charlotte.

Continuing Education:

The half-day field trips are approved for 3 PDHs for professional engineers and land surveyors.

ORAL AND POSTER ABSTRACTS

Chasing Water in a Rapidly Changing World

Brian Richter
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Abstract: Cities, farms, and businesses around the world are running out of water. Worsening water shortages – caused by growing demands and competition for limited water supplies, inefficient and wasteful use of water, and exacerbated by climate change – are undermining economic productivity, human health, food supplies, political stability, and freshwater ecosystems. Some of the most promising solutions – including urban-rural partnerships for water sharing and local stakeholder involvement in water planning – will be highlighted.

About the Speaker: Brian Richter has been a global leader in river science and conservation for more than 25 years. He is the Director of Global Freshwater Strategies for The Nature Conservancy, an international conservation organization, where he promotes sustainable water use and management with governments, corporations, and local communities. Brian has consulted on more than 120 water projects worldwide. He serves as a water advisor to some of the world's largest corporations, investment banks, and the United Nations, and has testified before the U.S. Congress on multiple occasions. He also teaches a course on Water Sustainability at the University of Virginia. Brian has developed numerous scientific tools and methods to support river protection and restoration efforts, including the Indicators of Hydrologic Alteration software that is being used by water managers and scientists worldwide. Brian was featured in a BBC documentary with David Attenborough on "How Many People Can Live on Planet Earth?" He has published many scientific papers on the importance of ecologically sustainable water management in international science journals, and co-authored a book with Sandra Postel entitled Rivers for Life: Managing Water for People and Nature (Island Press, 2003). His new book, Chasing Water: A Guide for Moving from Scarcity to Sustainability will be published by Island Press in June 2014. Brian recently launched a new organization, Sustainable Waters, focusing on water education.

The Federal Response to Climate Change

Paul Wagner
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White House Council on Environmental Quality
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Abstract: Climate change is, undoubtedly, one of the most significant problems that we face now and into the foreseeable future. While legislators have been unable or unwilling to pass significant climate change legislation, the federal government is responding. The current administration has developed a climate action plan and a series of executive orders and is collaborating with the State, local, and tribal leaders taskforce to build stronger, safer, and more climate resilient communities. There are also significant efforts in federal agencies focused on responding to climate change.

About the Speaker: Paul Wagner is currently the Deputy Associate Director for Climate Preparedness for the White House Council on Environmental Quality and an Ecologist with the US Army Corps of Engineers (USACE) Institute for Water Resources (IWR). Educated at the University of North Texas and Virginia Tech, Paul has served as an ecologist and group manager at USACE's Institute for Water Resources. He has developed decision support tools and worked on domestic and international wetlands issues, project and program management, climate change, and collaborations with other federal agencies and NGOs. Prior to coming to USACE, Paul was a research ecologist in EPA's Office of Research and Development. He also served as a senior aquatic ecologist for The Nature Conservancy's South-central division. While at the Nature Conservancy, he worked in conservation planning and in a state natural heritage program. The natural heritage program experience prompted him to initiate collaboration with NatureServe, a non-profit conservation organization that seeks to provide a scientific basis for effective conservation action.

Green Infrastructure, Groundwater and the Sustainable City

Larry Band
Voit Gilmore Distinguished Professor of Geography
Director, Institute for the Environment
University of North Carolina
Visiting Professor, Chinese Academy of Science

Abstract: The management of water is among the most important attributes of urbanization. Provision of sufficient quantities and quality of freshwater, treatment and disposal of wastewater and flood protection are critical for urban sustainability. Over the last century, two major shifts in water management paradigms have occurred, the first to improve public health with the provision of infrastructure for centralized sanitary effluent collection and treatment, and the rapid drainage and routing of stormwater. A current shift in paradigm is now occurring in response to the unintended consequences of sanitary and stormwater management, which have degraded downstream water bodies and shifted flood hazard downstream. Current infrastructure is being designed and implemented to retain, rather than rapidly drain, stormwater, with a focus on infiltration based methods. In urban areas, this amounts to a shift in hydrologic behavior to depression focused recharge.

While stormwater is defined as surface flow resulting from developed areas, an integrated hydrologic systems approach to urban water management requires treatment of the full critical zone. In urban areas this extends from the top of the vegetation and building canopy, to a subsurface depth including natural soils, fill, saprolite and bedrock. In addition to matric and network flow in fracture systems, an urban “karst” includes multiple generations of current and past infrastructure, which has developed extensive subsurface pipe networks for supply and drainage, enhancing surface/groundwater flows and exchange. In this presentation, Band will discuss the need to focus on the urban critical zone, and the development and adaptation of new modeling and analytical approaches to understand and plan green infrastructure based on surface/groundwater/ecosystem interactions, and implications for the restoration and new design of cities.

About the Speaker: Dr. Lawrence Band is the Voit Gilmore Distinguished Professor of Geography and the Director of the Institute for the Environment at the University of North Carolina. Band's research and teaching focuses on the ecohydrology of watersheds, including the cycling of water, carbon and nutrients, co-evolution of forest ecological and hydrological systems, and human/environment interactions. His current research focuses on two Long Term Ecological Research (LTER) sites: the Coweeta LTER in western North Carolina, and the Baltimore Ecosystem Study. Past research has included projects in the Pacific Northwest, Rocky Mountains, China, Canada, and Australia. In 2010 he was Board Chair for the Consortium of Universities for the Advancement of Hydrologic Sciences (www.cuahsi.org), a consortium of approximately 130 US and foreign universities, non-profit institutes, and domestic and foreign water science and management agencies, and was a deputy editor for Water Resources Research. Band was a visiting scientist at the Australian Cooperative Research Center for Catchment Hydrology in 1992-1993 and at the Bureau of Meteorology and CSIRO in 2008, the latter on

science and management response to the Australian drought. Dr. Band has published more than 130 papers, book chapters and technical reports. He has consulted with federal, state and municipal agencies in the US and Canada on watershed protection, forest health, stormwater and ecosystem restoration. In 2014 he has been the Geological Society of America Birdsall-Dreiss Distinguished Lecturer, delivering over 30 talks on the interactions of surface/groundwater hydrology with ecosystem development in forested and urban watersheds.

Addressing Key Uncertainties in Stream Restoration Design and Decision-Making

Brian Bledsoe
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Abstract: Despite huge investments over the last quarter century in the US, it is widely recognized that the ubiquitous practice of stream restoration has produced few well-documented cases of long-term ecological benefits, especially at the watershed scale. This results from several factors including inadequate monitoring and feedback, an emphasis on small-scale projects that are not outgrowths of a watershed approach, disconnects between research and practice, and insufficient tools and understanding to address the formidable complexity and uncertainty that are commonly encountered. This presentation will primarily focus on the latter issue and suggest a few pragmatic approaches that may assist practitioners in addressing some of the key challenges and uncertainties that currently impede project effectiveness, as well as maturation of the practice of stream restoration. These challenges include addressing climate/land use changes, estimating sediment supply and transport capacity, integrating analog and analytical design approaches, and decision analysis at the watershed scale.

About the Speaker: Dr. Brian Bledsoe is Professor of Civil and Environmental Engineering at Colorado State University, where he conducts research and teaches courses on rivers and watersheds. Brian has over 25 years of experience as an engineer, hydrologist, and environmental scientist in the private and public sectors, including over 20 years of experience in stream and wetland restoration. He earned degrees from Georgia Tech, North Carolina State University, and Colorado State University. Before joining CSU, he worked in the private sector as a consulting engineer, and for the State of North Carolina as a stream and wetland restoration specialist and as nonpoint source program coordinator. Brian's research is focused on the interface between hydrology and ecology with an emphasis on linkages among land use, hydrology, hydraulics, fluvial geomorphology, and water quality. He received an NSF CAREER Award in 2006, and served as a Fulbright Scholar in Chile in 2008. Brian's scientific advisory and peer-review activities include the Platte River and San Juan River Recovery Implementation Programs, the Everglades and Louisiana Coastal Area restoration efforts, and the EPA Environmental Monitoring and Assessment Program. He is a licensed professional engineer in NC and CO. His full CV can be viewed at http://www.engr.colostate.edu/~bbledsoe/Bledsoe_CV.pdf.

Restoration of Stream and Wetland Complexes in Eastern US Headwater Streams

Art Parola
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Abstract: Reconstruction of historic surface and subsurface hydrologic processes is essential to the restoration of ecological functions in streams and floodplains in the Eastern US. Stream restoration design techniques implemented by the University of Louisville Stream Institute reinstate what may have been a very common pre-European settlement valley bottom ecosystem. These restorations reestablish morphological and hydrologic controls that restore the groundwater and surface water processes underpinning the channel and floodplain/riparian ecologic functions. This approach creates a sustainable, low-maintenance system that accommodates changes in peak flow, sediment load, debris load, beaver, and other natural agents of change. The approach is based on design of valley topography to produce a high frequency, high duration, and large extent of surface water and groundwater exchange between the channel and floodplain and to promote retention of organic matter, sediment, nutrients and water within the channel and floodplain. Parts of the valley bottom are re-contoured to create a floodplain and low-flow swales that evolve into channels. The floodplain surface and channels, which may be highly varied in dimensions and planform, are designed to evolve with vegetative succession and potential future beaver reestablishment. In both high- and low-slope valleys, the channels and floodplains typically develop into stream-and-wetland complexes. The approach requires an understanding of the valley groundwater and surface water hydrologic systems and the characteristics of sediment loads to predict the likely channel forms and floodplain topography that will evolve. Although general characteristics of channels in the region are considered, reference reaches are not used in the design process.

About the Speaker: Dr. Arthur C. Parola, P.E., is the director of the Stream Institute and a professor of civil and environmental engineering at the University of Louisville. He received his PhD in civil engineering, water resources, from The Pennsylvania State University in 1990. Dr. Parola has directed the design of more than 80,000 ft of stream channel restoration and the creation or restoration of hundreds of acres of associated wetlands. He and the team of students, staff, and faculty who make up the Stream Institute employ a multidisciplinary approach to the restoration of self-sustaining stream-and-wetland complexes. Through collaboration with engineering and construction firms, geomorphologists, biologists, and ecologists, the Stream Institute has pioneered numerous methods for assessment, design, construction, and monitoring of stream and wetland restoration projects. One of the fundamental components of their design approach has been the use of two-dimensional hydrodynamic modeling to design the floodplain topography and the planform characteristics of channels. A second fundamental component of their approach has been to restore both groundwater and surface water processes in the floodplain and channel. By reestablishing groundwater retention in valley aquifers, the Stream Institute has been able to restore hydrologic conditions that support extensive riparian wetlands and habitat for resident aquatic organisms, including threatened and endangered species.

Implications of the Geomorphic Drivers of Channel Instability along Little Ivy Creek, Western North Carolina to Stream Restoration Design

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Co-Authors: Jerry R. Miller, Western Carolina University, Kendall Walton, Western Carolina University

Abstract: The factors contributing to the geomorphic instability along Little Ivy Creek in western North Carolina were investigated in 2013-14 following multiple attempts to "restore" and stabilize the channel. Survey, photographic, and hydrologic data revealed that the channel is characterized by a downstream sequence of alternating transport- and deposition-dominated zones. Depositional zones, associated with changes in channel and valley morphology that reduced the competence/capacity of the reach, exhibit episodic periods of significant instability. Historical photos, for example, revealed that the restored reach was relatively stable in 1994. However, by 1998 significant sediment deposition and bar formation had begun, and by 2002 the nature and position of the channel had been completely altered. The response was coincident with the influx of coarse (gravel-sized) sediment from an upstream highway modification project and several large floods. Although bank erosion continued to occur, the banks were boarded by thick vegetation by 2005, and erosion was relatively limited until ~10-year flood occurred in 2012 following the restoration project. Both periods of instability appear to be largely driven by the deposition of coarse channel bed sediment, bar formation, and the subsequent erosion of the sandy, non-cohesive bank materials within a reach of inherently limited sediment transport capacity. The latter period of instability appears to have been promoted by modifications to the channel during project implementation that included the removal of the stream-side vegetation and the creation of a meandering pattern with inset, side-channel "benches" that promoted local deposition. The data demonstrate that it is critical to understand the geomorphic drivers of channel instability prior to designing a restoration project. In addition, the data support recently developed models that suggest that the restoration of streams characterized by high stream power, large sediment loads, and easily erodible banks will possess considerable risk.

About the speaker: A native of Western North Carolina, Danvey Walsh is a MS student in Environmental Chemistry and a Research Assistant at Western Carolina University. He is particularly interested in assessing stream restoration effectiveness from the hydrology and fluvial geomorphology perspectives. Danvey holds a BS in Geology from Western Carolina University.

Managing Connectivity for Critical Floodplain Habitats: So Much Sediment, So Little Water

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Abstract: The Apalachicola River, a large, rapidly migrating sand-bed stream, is a major ecological resource in the Southeastern U.S. Much of the river corridor remains under forested wetland cover, and is comprised of a rich complex of side channels, sloughs, distributaries, floodplain lakes, and wetlands that provide critical habitat for a diverse assemblage of plants and animals. Since cessation of main channel navigation channel maintenance about 10 years ago, the State of Florida has considered various management strategies for protecting and preserving the floodplain habitats. Quality of floodplain aquatic habitat is under pressure from drought, channel incision and reservoir regulation. The reach of concern for this study includes the Chipola Cutoff, a major distributary that captures about 30% of the mainstem discharge and Swift Slough, a smaller floodplain channel that exits the river downstream from Chipola Cutoff and provides endangered mussel habitat that has experienced dewatering at low river stage in recent years. Various strategies to improve the hydrologic connectivity between the Apalachicola River and Swift Slough during low-flow periods have been considered. A two-dimensional sediment transport computer model of the reach in question, supported by an extensive field data collection was developed and used to evaluate restoration design alternatives. Field data collection included water level monitoring, velocity/discharge measurements, characterization of the sediment regime, and a bathymetric survey of the study reach. Simulated alternatives included two dredging schemes and use of training structures to modify the geometry of the mainstem-Swift Slough confluence. Simulation results indicate local measures are likely to have short-lived effects; resource management must be based on strategies that work at a larger spatial scale.

About the speaker: Doug Shields has 37 years of experience in water resources and environmental engineering, including 12 years for the U.S. Army Corps of Engineers and 22 years as a Research Hydraulic Engineer at the National Sedimentation Laboratory in Oxford, Mississippi. He is a leading authority on stream and river restoration. Since 1990, Dr. Shields has been active in stream restoration research, particularly research focused on rehabilitation of stream and associated wetland habitats. His work has resulted design guidance in the form of an international text book, major sections of two national handbooks on stream restoration design, and a chapter within ASCE Manual 110. Design and performance of large wood structures for recovery of ecosystem services has been a key interest, with numerous journal and proceedings

papers published, participation in short courses and workshops, and leadership of a six-year-long multidisciplinary field experiment in this topic area. With two collaborators, Shields proposed and published a scheme for incorporating stream and riparian habitat simulations into watershed models used by the USDA for assessing benefits of government-funded conservation programs. Although Doug has lived and worked in the Southeast, his employment at national laboratories (ERDC with the Corps and NSL with USDA) has required involvement in many regions, and his research, consulting and professional society activities have given him major exposure in the West and Pacific Northwest and appreciation of the problems posed by anadramous fish populations. Overall, Doug's career has featured study of the response of fluvial systems to human influences and development of environmental design criteria for all types of channel stabilization and modification projects, including stream bank erosion controls and management of riverine backwaters. Doug has authored or co-authored more than 290 technical publications and has completed consulting projects dealing with stream restoration, erosion protection of riparian cultural resources sites, stream bank erosion, geomorphic assessment, and local flooding. He has delivered numerous invited lectures and seminars for university, short course and conference audiences. He has been employed by cbec since 2012.

Constructed and Restored Wetlands' Relationship to Stream Restoration Using Natural Channel Design

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Abstract: On May 14, 2003, a breach of the fuse plug occurred in the Silver Lake Basin of the Dead River, in the Upper Peninsula of Michigan. The subsequent release of an estimated 8 billion gallons of water caused erosion of the fuse plug foundation material and spillway channel. Erosion and the deposit of eroded sediments occurred in some areas downstream in the Dead River system. Sediment deposits filled in wetlands along the river corridor. Sediment competency analyses indicated that many downstream river reaches no longer had enough power to transport their current sediment loads. Aggradation was causing over-widening and negative plan form adjustments in the river. Pools were infrequent and mostly shallow. The recovery efforts in the impacted reaches of the Dead River used natural channel designs. As such, the goal was to create a stable channel (that is neither aggrading nor degrading) and that maximizes the river's biological potential. To achieve this, wetlands were created and restored in conjunction with the river restoration. Most of the wetlands are located in either the floodprone area or floodplain terrace depending upon the geomorphic stream type of the adjacent channel section. In either case a hydraulic connection was designed between the stream and the wetland. Proposed wetland areas were located, and their grades established, by examining the river valley with respect to the proposed horizontal alignment of the new channel. Points in areas suitable for wetlands were surveyed. The depth to water established an initial wetland grade. Once the vertical alignment (stream bed profile) was completed for the adjacent channel, the wetland grades were refined so the appropriate hydraulic connection between the river and wetland was maintained.

About the speaker: Mr. Collins is a civil engineer specializing in the study of watershed systems, identification of improvement needs, design of improvements, and construction oversight for a variety of clients and settings. His technical work includes hydrologic and hydraulic modeling, water quality modeling, habitat assessments, geomorphic characterizations, slope stability analysis and design, ice shear analysis, geometric design and layout, technical specification writing, cost estimating, and construction observation and management. Mr. Collins has completed numerous relevant projects and studies in the Great Lakes Region of the Midwest and southern United States over the last 19 years.

Legacy Sediment and Implications for Stream Restoration

Periann Russell
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NC Ecosystem Enhancement Program
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Abstract: Legacy sediment resulting from historical anthropogenic activities is well documented throughout the mid-Atlantic and southeastern US. Many of the processes associated with production, delivery, transport and storage of legacy sediment described by researchers are common in NC Piedmont and Mountain provinces, although very little of that work specifically relates to North Carolina. Legacy sediment is defined and described in a spatial and temporal context in two watersheds in the western Piedmont of NC. The presence of legacy sediment as well as related processes has implications for stream design and must be considered as the restoration industry continues to learn and improve stream restoration design and success.

About the speaker: Periann Russell is a geomorphologist for the NC Ecosystem Enhancement Program. She specializes in interactions between hillslope and fluvial processes and response to anthropogenic activities. Ms. Russell has 20 years of experience conducting applied research in varied landscapes across the east and west coasts of the US. She has a B.S. degree in Geology from UNC-Charlotte and an M.S. degree in Geomorphology from Oregon State University.

Stream Functions and Process-based Restoration

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Abstract: The 2008 Final Compensatory Mitigation Rule defines functions as physical, chemical, and biological processes occurring in ecosystems. Functional Objectives for Stream Restoration (Fischenich 2006) defines functions as dynamic and interrelated processes. In Process-based Principles for Restoring River Ecosystems, Beechie et al. (2010) describe process-based restoration as reestablishing normative rates and magnitudes of physical, chemical, and biological processes that create and sustain river and floodplain ecosystems. Various techniques exist for specifying functions depending on the scale of consideration. Commonly identified functions include (1) flow conveyance, (2) floodplain connectivity, (3) surface water/ groundwater exchange, (4) sediment transport, sorting and storage (bed material and suspended loads), (5) habitat formation and maintenance, (6) temperature, light and oxygen dynamics, (7) solute dynamics, (8) nutrient cycling, (9) organic matter cycling, (10) primary productivity and community respiration, (11) secondary productivity, and (12) stream food web interactions. Since functions represent processes and the goal of process-based restoration is to reestablish normative rates, evaluating stream functions should account for inputs, outputs, and overall change to the function of interest. For example, the amount of allochthonous organic matter present within a given reach is dependent on the amount of material supplied from upstream and the local riparian zone, retained or transported downstream during storm events, and biologically processed. Similarly, presence or absence of riffle and pool habitat is dependent on the local balance of sediment supply and transport capacity. The objective of this presentation is to (1) provide an overview of stream functions described in technical reports and the scientific literature, (2) describe analyses of stream functions and their influence on stream restoration, and (3) discuss function-based analyses that McCormick Taylor has conducted, including bed-material transport modeling in response to increased roughness following addition of large woody debris and suspended sediment modeling to predict fine sediment storage following floodplain reconnection.

About the speaker: Mike has over 13 years experience working on projects involving stream restoration, stream bioassessment, and watershed management. Key interests include detailed sediment transport analyses including transport sampling, transport formula calibration, effective discharge calculation, and capacity-supply assessment to examine sediment transport continuity. Experience with sediment transport modeling includes bed load and suspended load transport.

Your Destination is on an Unpaved Road: Mitigation Banking Starts with Land Acquisition

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Abstract: "Terra Firma," or "under all is the land," is a well-known phrase in the land brokerage and development business. It is especially applicable with mitigation banking. The science of stream and wetland restoration can't be accomplished until a site in need of restoration is identified and the landowner has agreed to sell a permanent conservation easement. The presentation will cover all bases of the mitigation site identification process, from initial GIS research, land owner outreach and contact, the legal and "sales" challenges of gaining land owner agreement to execute an option agreement for a conservation agreement, 1031 exchanges, death and taxes, surveys to closing the deal. Every deal is different, but all conservation agreements involve earning the trust of the landowner and considering all of their short and long term needs on the property. Intertwined in the presentation will be humorous stories from the road, which will include being offered a gun for self-protection by an urban land owner, dealing with the political opinions of rural land owners, charging bulls, marijuana stands, stills, getting shot at, getting stuck in the mud, and directions that end with, "you can't miss it."

About the speaker: Robert W. Bugg is the land acquisition manager for Wildlands Engineering, Inc. based in Charlotte, NC. Mr. Bugg is a licensed Realtor/Broker in North Carolina and South Carolina and holds the Accredited Land Consultant designation from the Realtors Land Institute. Mr. Bugg is also the Broker-in-Charge of Wildlands Realty, LLC, a Charlotte-based real estate firm focusing on land sales for both conservation and development. Since 2011, he has been responsible for the identification and negotiation of over 1,000 acres of land to be placed into conservation easements and the creation of over 89,000 stream mitigation units, 112 acres of wetlands and buffers and over $35 million dollars in mitigation banking credits issued.

When Agreements Are Ignored

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Abstract: In March, 2006 Baker entered into an option to purchase (a conservation easement) agreement with the landowner of a 700 acre tract of land in western North Carolina. The land was chosen for development based on the environmental and aesthetic values of the property, including hiking, rock climbing, and fishing. The landowner's development company (LDC), was interested in having a stream restoration project implemented at this property to address stream bank erosion issues along the largest stream on the property and to improve fisheries habitat. This project was submitted as a full delivery mitigation project to the NC Ecosystem Enhancement Program (EEP), and was selected and contracted later in 2006. Baker immediately moved forward with establishing a conservation easement on the site. This easement protected 20.75 acres, and contained 8,302 linear feet of stream and 1.70 acres of wetlands. It was expected that these resources would allow Baker to meet our contract obligation to EEP for providing 5,000 Stream Mitigation Units. The mitigation plan was prepared, submitted and approved by the spring of 2008. At this point permits were applied for from the various regulatory agencies. When the US Army Corps of Engineers (Corps) reviewed the project's 404 permit application they informed Baker that the project streams had already been used for mitigation by the LDC. We learned that when seeking permits for the various stream crossings within the development, the LDC used all the property streams in their mitigation plan. This created a "double-dipping" situation for the Corps that jeopardized Baker's ability to meet our contract obligations to EEP. This realization resulted in a four year process of negotiation which eventually required the filing of a law suit, before Baker and the LDC resolved the damages to the project. This presentation will present the results, the lessons learned from this situation and how to avoid similar pitfalls.

About the speaker: Micky Clemmons is a Senior Environmental Scientist and Office Manager with Michael Baker Engineering in their Asheville Office. He has been with Baker for 9 years. His responsibilities include office administration, marketing, stream restoration design and project management. Prior to joining Baker, Mr. Clemmons worked for 18 years as a fisheries biologist with the North Carolina Wildlife Resources Commission.

Overcoming Constraints on the Indian Run Stream Restoration Project

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Co-Authors: Jonathan Henderson, HDR

Abstract: The project on the unnamed tributary to Coddle Creek, referred to as Indian Run, off Rocky River Road in Cabarrus County, included 2,270 linear feet of stream restoration (Priority II & III) and preservation of an additional 1,540 linear feet. HDR has seen the project progress from the watershed planning phase all the way thru construction. The Coddle Creek watershed is one of the targeted high priority restoration areas within the EEP plan for the Lower Yadkin River Basin. In addition to the current non-supporting use classification for the lower portions of Coddle Creek, anticipated high rates of development in the watershed pose critical challenges in managing the region's aquatic resources. The goal of the restoration project was to restore approximately 3,700 linear feet of a degraded section of Indian Run to a stable channel using natural channel restoration methodologies. The objectives of the Indian Run Stream Restoration Project focused on improving local water quality, enhancing flood attenuation and restoring aquatic and riparian habitat. From early planning and development through construction of the Indian Run project several constraints were realized. The discussion will focus on determining the limitations one faces while planning a restoration project to the actual issues that may arise with installation. The Indian Run project will be used as an example to showcase the different types of issues that can develop and the solutions that EEP and HDR utilized to keep the project moving forward along with an update of the current status of the project.

About the speaker: Vickie Miller is a Sr. Environmental Scientist with HDR in Raleigh, NC. She has over 14 years of experience conducting investigations to evaluate terrestrial and aquatic resources. Vickie has prepared environmental reports, restoration plans, and permits including Environmental Assessments (EA), Environmental Impact Statements (EIS), Natural Resources Technical Reports (NRTR), and riparian/wetland restoration plans for the North Carolina Department of Transportation, North Carolina Ecosystem Enhancement Program, Tennessee Department of Transportation and numerous private clients. Vickie has a B.S. in Environmental Sciences (ecology emphasis) from University of North Carolina (Asheville, NC) and an M.S. in Natural Resources from N.C. State University. She holds a Professional Wetland Scientist certification with the Society of Wetland Scientist and is a certified planner with the American Institute of Certified Planners.

Developing a South Carolina Full-Delivery Mitigation Solution: The Cannon Creek Stream Mitigation Site

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Abstract: In January, 2013 Berkeley County (County), SC issued a Request for Proposals (RFP) for coastal stream mitigation to support projects funded by the County's One Cent Local Option Sales Tax. The 'full-delivery mitigation' solicitation was only the second to be issued in the state of South Carolina. The RFP, which follows a similar approach to the NC Ecosystem Enhancement Program's full-delivery program, allows mitigation providers to submit mitigation projects that are appropriate to offset the projected impacts of specific Department of Transportation (DOT) or municipal projects and has allowed local municipalities and the S.C. DOT to contract for turn-key mitigation and transfer the development and risk of mitigation to the private mitigation sector. The submitted mitigation sites are evaluated based on technical merit, provider experience and expertise, and cost. The mitigation site that provides the most value is selected for contracting. Once contracted, the provider is responsible for funding and delivering mitigation. The Cannon Creek Mitigation Site was selected to provide stream mitigation credits to compensate for impacts to jurisdictional linear features associated with two road improvement projects. The site is located within the Santee River Basin, Cooper River Watershed (Hydrologic Unit Code 03050201), and Middle Atlantic Coastal Plain Level III Ecoregion. Cannon Creek is a degraded and incised coastal plain stream system that confluences with the West Branch of the Cooper River, a 303d listed waterbody. The stream adjacent buffer is in poor condition and provides limited stormwater and nutrient filtering. Mitigation activities will entail Priority I and II restoration of approximately 4,500 linear feet of Cannon Creek and 300 linear feet of contributing tributaries. In addition, approximately 14 acres of wetlands will be perpetually protected via a conservation easement.

About the speaker: Daniel Johnson currently serves as the South Carolina Team Leader and as a Water Resources Engineer for Wildlands Engineering's Charleston, SC office. Daniel Johnson is a registered Professional Engineer (PE), AIH Professional Hydrologist (PH), and ASFPM Certified Floodplain Manager (CFM) with nine years of experience in the preliminary assessment, design, construction and monitoring of stream and wetland restoration projects; urban stormwater management; sediment transport analysis; hydrologic modeling and multi-dimensional hydraulic modeling. At Wildlands Engineering, he is responsible for managing environmental restoration and storm water quality Best Management Practice (BMP) projects, performing hydrologic and hydraulic modeling to support natural channel design and marketing and supporting environmental and water resources engineering and ecosystem restoration services in South Carolina. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

Navigating the Mitigation Process: Trials, Tribulations, & Triumphs

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Abstract: The UT to Town Creek Restoration Project is a current full-delivery stream and wetland mitigation project with the NC Ecosystem Enhancement Program. During the process of the development of the Mitigation Plan, this project has faced multiple challenges. Some of these challenges include enduring the loss of a significant amount of perennial and intermittent stream length and wetland acreage for potential mitigation credit, navigating an ever-evolving set of requirement criteria for obtaining wetland restoration and creation credit, and establishing a set of wetland success criteria from a self-contradicting data set that was collected as part of the existing conditions analysis. This presentation will provide an overview of these challenges and their innovative resolutions, as well as the negotiation process traversed to gain consensus with the Interagency Review Team.

About the speaker: Kristi Suggs is an Environmental Specialist with Michael Baker Engineering, Inc. (Baker). Ms. Suggs has worked at Baker for seven years in the Charlotte, NC office and serves as project manager on multiple stream and wetland restoration projects. Her expertise includes watershed management, environmental planning and permitting, citizen/agency facilitation, geomorphic, biological, & chemical assessments, and GIS mapping. She has a B.S. in Animal and Veterinary Science from West Virginia University and a M.S. in Earth and Environmental Resource Management from University of South Carolina.

Enhancing Aquatic Macroinvertebrate Communities through Geomorphic Stream Restoration

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Abstract: Stream restoration has become a valuable tool in the field of conservation. The majority of stream restoration that occurs in Georgia is done through the commercial mitigation banking process regulated by the US Army Corps of Engineers. This industry is based on the restoration of ecological function in streams and wetlands to offset permitted impacts to federally jurisdictional waters as defined in the Clean Water Act. Much of the focus of these restoration activities has been on creating geomorphically stable streams. The Natural Channel Design concept focuses primarily on the creation of a geomorphically stable patterns, profiles, and dimensions for stream reaches. Very little focus is placed on creating biological habitat. The purpose of this study was to determine what relationships existed between geomorphic variables and macroinvetebrate communities in order to incorporate a greater level of biological habitat creation in natural channel design methodology. The study was conducted in north Georgia along 12 stream reaches. A host of geomorphic variables was collected along each stream reach. Additionally, macroinvertebrate community samples were collected along these reaches using Georgia Department of Natural Resources, Environmental Protection Division methodology. Based on the results of this study, shear stress, shear velocity, and riffle D50 have a strong correlations with macroinvertebrate abundance. Additionally, little correlation exists between geomorphic variables and the diversity of Ephemeroptera, Plecoptera, or Trichoptera. These results suggest that biological habitat creation can be incorporated into natural channel design techniques. The incorporation of geomorphic parameters suitable for increased macroinvertebrate abundance may decrease the overall level of physical stability in the channel, but would lead to an overall higher level of ecological restoration.

About the speaker: Sean Miller is one of the Principals and founders of Headwater Science, LLC in Forsyth, GA. Headwater Science is an environmental consulting firm specializing in aquatic resources. Mr. Miller has participated in stream and wetland restoration projects throughout Georgia, with particular emphasis on habitat restoration for fisheries and macroinvertebrate communities. He has a B.S. degree in Environmental Science and a M.S. degree in Biology from Georgia College & State University.

Southern Piedmont Streams Eco-geomorphological Assessments

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Abstract: A set of eco-morphological stream design and assessment tools for the Piedmont region of Alabama was developed to support effective stream mitigation. The tools included development of hydraulic geometry relationships and drainage area and stream/floodplain eco-morphological relationships for predicting stream and riparian ecological functions related to morphological conditions. Based on field measurements from 21 reference streams with drainage areas ranging from 0.2 to 242.1 km2, bankfull channel cross-section area, width, mean depth, and estimated discharge were found to be strongly correlated to watershed drainage area: Abkf = 1.21 DA 0.653 (R2 = 0.96), Wbkf = 3.96 DA0.335 (R2 = 0.94), dbkf = 0.305 DA0.319 (R2 = 0.87), Qbkf = 1.17 DA 0.757(R2 = 0.92). Non-incised stream sites with a bank height ratio of <1.5 had vegetation dominated by species with a wetland indicator status of facultative, facultative wet (FACW) and obligate (OBL). Based on field measurements of 16 AL piedmont streams, multiple measures of fish assemblages (both taxonomic and functional) were strongly correlated with watershed drainage area as well as with measures of bankfull geomorphological dimensions. Crayfishes, which exhibit a considerably smaller species pool than fish, had strong taxonomic relationships with measures of drainage area and bankfull dimensions. Based on collections in 15 AL piedmont streams, aquatic insects showed functional but no taxonomic diversity relationships with drainage area and bankfull channel dimensions. Reference floodplain soil bulk density was significantly less than floodplains of incised streams at all sampling depths and percent nitrogen in reference floodplains was significantly greater than floodplains of incised streams at all sampling depths. Total soil organic carbon was significantly greater in reference floodplains as compared to incised stream floodplains at all depths except 0-5 cm. Pooled total organic carbon and organic nitrogen were greater in reference soils relative to incised soils.

About the speaker: Eve Brantley is an Associate Professor and Water Resources Extension Specialist in the Crop, Soil, and Environmental Science Department at Auburn University.

Leaf Pack Restoration Techniques

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Abstract: The first stream restoration projects worked under the premise that if you build a stable stream channel, then the aquatic fauna will return to the stream reach. The concept was that fish and large invertebrates can migrate upstream and downstream into restored stream reaches. The science of stream restoration has developed over the years such that a successful restoration project is now defined by the functional uplift provided to the stream. At the top of the functional lift pyramid is biology, including the biodiversity and life histories of the aquatic life and riparian life. The parameters of the biology function include macro-invertebrate and fish communities. In many areas of the United States, the regulatory environment is requiring a stream restoration project to have at least the biology studied as part of the pre- and post-restoration activity.

However, research has found that macrobenthics are extremely slow to re-populate any area. A study completed by the EPA in 2002 and updated for the NC Ecosystem Enhancement Program in 2008 found that even streams with healthy upstream and downstream populations of macrobenthics were very slow to re-populate. Post construction macrobenthic monitoring of restored stream found that many of these streams did not meet re-population goals or guidelines.

The biggest challenge that newly restored streams have in attracting macrobenthics is the lack of the proper medium/micro-habitat for them to grow. Most restoration streams lack the leaf pack that is mandatory for these organisms to live and reproduce.

Since May of 2013, we have developed and tested numerous techniques to best recruit, grow and hold bugs in leaf packs and to ultimately transfer these leaf packs to restored or impaired streams. This talk will discuss the techniques associated with the HabiTubes to recruit, grow and relocate macrobenthic organisms and the results of these studies.

About the speaker: Mr. Barber is a partner with Acer Enterprises, LLC. and has over 25+ years of experience with mitigation banking and ecosystem restoration. For the past two years he has been experimenting with various techniques to assist with habitat restoration for macrobenthic organisms and vertebrates in streams.

Invasive Species in Riparian Buffers

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Abstract: Riparian buffers are the lynch pin to successful stream restoration. The health and long term sustainability of the buffers are in jeopardy when invasive species are allowed to establish within the riparian area. Invasive plant species can overtake riparian buffers because there are no natural checks for the invasive species to keep them in balance with other species. The presentation will describe species that are of concern to riparian buffer establishment and give potential treatment options for these species.

About the speaker: Mr. Morris has over 25 years of experience in the planting industry. He holds a BS in Agriculture and Plant Science from the University of Delaware. He oversees soil bioengineering and riparian buffer, wetland and BMP planting for River Works restoration projects. He also oversees invasive plant species removal for various projects. He is a certified NC Landscape Contractor, and licensed NC Landscape and Aquatic Pesticide Applicator. Mr. Morris serves on the board for the North Carolina Invasive Plant Council. He represents the landscape industry on the North Carolina Invasive Plant Council.

Dam Removal and Freshwater Mussels: A Guide to Effective Restoration and Prioritization through Case Studies

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Abstract: Dam removal is gaining momentum as a restoration tool to increase aquatic connectivity, public safety, and recreational opportunities. With limited resources and thousands of small and medium sized dams to prioritize for removal, information to guide the process is of principal importance. Freshwater mussels are an imperiled group of aquatic organisms found across the country with frequently high richness and density below small dams. I will attempt to guide resource managers to the best practices for prioritizing and removing dams where freshwater mussels are present and offer case studies from completed projects in North Carolina as well as elsewhere in the Southeast, Northeast, and Midwest. The first step when approaching a dam for removal is to determine if the project will achieve effective restoration. American Rivers has assembled a suite of standards a project manager can use to determine whether the project achieves effective restoration. Within the framework of these restoration standards management options exist to address the presence of freshwater mussels at a dam removal which may include sediment management, mussel relocation, and equipment location management. While large information gaps in understanding dam removal effects on freshwater mussel populations exist, case studies have shown that adverse short term impacts to freshwater mussels can be reduced with proper planning, timing, and removal techniques. Additionally, a need remains for collaboration between resource managers and academics to get a better grasp of the complex ecological impacts of dam removal.

About the speaker: Erin Singer McCombs works at American Rivers as Associate Director of Southeast Conservation. American Rivers protects wild rivers, restores damaged rivers, and conserves clean water for people and nature. Since 1973, American Rivers has protected and restored more than 150,000 miles of rivers through advocacy efforts, on-the-ground projects, and an annual America's Most Endangered Rivers™ campaign. Erin works largely in the Carolinas and Tennessee to provide technical assistance, project management, and general guidance in the planning, development and implementation of projects like dam removals for the River Restoration and Clean Water Supply programs. Erin's first day with American Rivers in 2013 was spent witnessing the Smitherman's dam removal in North Carolina. Prior to joining American Rivers, Erin earned her Master of Science degree in Biology from Appalachian State University where she studied the relationship between small dams and freshwater mussels. She has worked at several other conservation nonprofits including the Western North Carolina Alliance, Southern Alliance for Clean Energy, and Audubon Society.

Observed Trends in Small Stable Urban Drainages around Charlotte, NC: The Charlotte Mini Curve

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Co-Authors: Kyle Hall, PE; Charlotte-Mecklenburg Storm Water Services

Abstract: It all began with a healthy field argument between practitioner and administrator. As we walked along the banks of a creek restored several years prior, we discussed urban channel sizing. One side believed that the industry has been historically oversizing urban streams while the other debated the effects of increased impervious watersheds on channel forming flow. The project formulated from there – let's scour our city for urban drainages in built out neighborhoods and measure the stream dimension. Let's plot the data and compare to the dimensions of the streams we've built and the monitoring data we have from those designs. Almost two years and countless GIS searches and field reviews later, we feel we are just beginning to scratch the surface of the complicated impacts of urban watersheds on our streams. This presentation explores our process for selecting study sites, reviews the field methods, and presents the measured hydraulic geometry for the selected sites. Regression relationships developed from the data will be reviewed and we will compare the hydraulic geometry of our study streams to the published regression relationships for our region. Observed similarities between the selected sites, such as channel material, downstream grade control, and stormwater control in the watershed, will be reviewed. We will also show how constructed stream projects in our area compare to the data sets and provide our thoughts on their performance. We will conclude with our 'next steps', and will open the floor for thoughts from the audience.

About the speaker: Christine Blackwelder currently serves as a senior environmental scientist for Wildlands Engineering's Charlotte, NC, office. She has 12 years of professional experience in environmental planning and restoration. She specializes in the assessment, design, and construction management of stream restoration and enhancement work throughout NC. Christine holds an environmental science degree from the University of Virginia and is working towards her master's in earth science at the University of North Carolina, Charlotte. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

A Cost Effective Approach to Hydrologic Modeling of Large Watersheds – Correlating Curve Numbers with the National Land Cover Dataset

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Abstract: Creating an accurate hydrologic model for a project specific watershed is an important step in the natural channel design process. Validating bankfull discharge, sizing culverts and other project infrastructure are dependent upon accurate hydrologic models for discharge estimates. Many practitioners rely exclusively on regional curve data for discharge approximation which may not be applicable, especially for large watersheds. Since the bankfull discharge calculation is an initial step in the design process, inaccurate estimates could set the stage for subsequent flawed design calculations.

Detailed hydrologic models are often not implemented due to the time consuming nature of collecting input variables. Typical input variables include drainage area, precipitation depth and duration, time of concentration, hydrologic soil group, and land use. Defining land use is the most time consuming variable to create, as it traditionally involves digitizing areas based on observations of aerial photography. The Natural Resources Conservation Service (NRCS) provides a national land cover database (NLCD), however it is most applicable for agronomy practices and its land cover classifications do not correlate well with classifications defined in the Curve Number (CN) Method.

The authors have concluded that assigning CN method land use classifications to categories within the NLCD provides an accurate and less time intensive process than traditional methods of creating land use coverages. The authors' conclusions are based on hydrologic models created for five case study watersheds, which include three urban watersheds located in the piedmont physiographic province of North Carolina, and two rural watersheds located in the valley and ridge physiographic province of Virginia. The authors will present conclusions of the case studies and how to most accurately correlate CN Method land use classifications within the NLCD.

About the speaker: Mr. Yow is an experienced professional engineer in stormwater, water quality and natural resources disciplines. His specific experience includes NPDES permit compliance, hydrologic and hydraulic stormwater modeling, watershed planning, stormwater best management practices (BMPs), wetland restoration and stream restoration. Mr. Yow has graduate and undergraduate degrees in civil engineering from North Carolina State University.

Advances in 3D Stream Restoration Design with AutoCAD® Civil 3D® 2014 Corridors

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Abstract: Streams are complex systems with multifaceted geometry. The continuous transitions through riffles, runs, pools, and glides present a challenge for 3D modeling. To improve efficiency and precision of stream restoration designs, CEC developed custom sub-assemblies (for high-gradient and low-gradient streams) for use within AutoCAD Civil 3D 2014 Corridors to handle the complex transitions of stream geometry. Utilizing corridors for stream modeling inherently and dynamically links the three components (pattern, profile, and dimension) of a stream, allowing a designer to make iterative changes with instantaneous and accurate three-dimensional updates. A workflow model was developed to provide optimization and balancing of earthwork volumes, accurate grading plans and quantities, precision construction grades, and cost savings during design and construction. Additionally, customized tools and processes have been developed to provide users with the capability to complete accurate, early stage design decisions with a minimal amount of training/expertise in AutoCAD and Civil 3D. This process has been implemented as a standard operating procedure nationwide at CEC and a number of staff, including engineers, biologists, geomorphologists, and ecologists, are now using AutoCAD Civil 3D to complete stream restoration designs.

About the speaker: Nathan (Nate) Ober is the ecosystem restoration practice lead and geomorphologist at Civil & Environmental Consultants, Inc. As a geomorphologist, Nate has managed and designed 40+ miles of stream restoration projects, drawing from more than 12 years of experience in fluvial geomorphology, natural channel design, construction management, and post-restoration monitoring. Tom DiVittis is principal at Cornerstone Engineering Group with 25 years of experience as an AutoCAD/Civil 3D operator, designer, manager, instructor and support specialist.

The Drones Are Coming - Technologies for the Stream Practitioner

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Co-Authors: Michael Aust, Timmons Group

Abstract: The effective use of technology can be challenge for the stream practitioner. Timmons Group tests and uses many different types of technologies while working on all facets of stream restoration. Keeping up with the latest and greatest can be time consuming and costly. We will discuss what we've tested, what hasn't been as effective as we thought, and what has made the biggest impact for our team. The need for rapid assessments and accurate monitoring lends to the use of technology.

We have seen the biggest contribution with the use of new technology in performance assessment. These new tools help our team perform their jobs more efficiently. Less time is spent in the office and more time is spent in the field with new mobile innovations. Aerial photography is now a task that can be completed the day our team is on-site; instantly providing us with an overall rapid assessment of our entire project. This would not have been cost effective a little more than a year ago.

If someone needs a document, map, or point with information, in the field, it is now easier than ever for them to receive that information instantly. Field teams and office teams can now interact seamlessly to avoid overlap and get projects finished on time and under budget.

About the speaker: Chris is Timmons Group's Director of Field Operations; he oversees Environmental, survey, Geotechnical and Construction Services. His 18 years of experience include environmental constraint analysis, wetland delineations, stream assessments and Section 401/404 permitting.

Characterizing Stream Buffer Condition in GIS for the Neuse River Regional Watershed Plan

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Abstract: The Neuse River Basin drains a land area of over 6,200 square miles from the central piedmont of North Carolina to the Pamlico Sound located off the coast. The basin includes the Raleigh-Durham-Cary area (aka, the Triangle). Rapid population growth and widespread development create a significant need for stream/wetland mitigation projects in this basin. Future completion of the I-540 loop is a major driver for mitigation credits with possible routes of the proposed interstate potentially impacting streams, wetlands, and habitat. As part of documenting stream corridor conditions for the Neuse River Regional Watershed Plan for NCEEP, riparian buffers within the 580 square mile project area of the upper Neuse 01 River Basin were characterized in GIS. Spatial Analyst was used to reclassify a land use raster from the 2006 NLCD into various buffer condition classifications.Euclidean distance, Focal, and Zonal Statistics were used to measure and attribute buffer widths of the NHD layer. Subwatersheds were prioritized for buffer condition using the resulting classifications of buffer width. This presentation will provide insights in the use of raster for modeling environmental stressors related to water resources using publicly available GIS data.

About the speaker: Scott Gregory is an environmental scientist in Wildlands Engineering's Asheville office. He has over fourteen years of experience using GIS for engineering projects related to site feasibility, transportation, environmental and water resources management. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

Assessing Potential Stream Restoration Projects for Large-scale and Small-scale Watershed Planning Areas

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Abstract: Watershed planning is often performed to identify and prioritize stream restoration and other watershed improvement projects. Stream corridor assessments must be designed with consideration of the size of the watershed area to be covered. This presentation will present the stream assessment techniques applied for two watershed planning studies at very different scales. The Neuse 01 regional watershed planning area encompasses approximately 580 square miles of urban, suburban, and rural areas in Wake and Johnston Counties, NC. The stream assessments were entirely performed through desktop GIS analysis using available datasets and various spatial analysis techniques. Multiple levels of prioritization at increasingly finer scales were performed to methodically and efficiently choose sites with the most mitigation value and water quality benefit. Various metrics such as buffer condition, frequency of obstructions, and apparent channelization were evaluated. This study performed for the NCEEP resulted in the selection and prioritization of 50 potential stream restoration sites in addition to other types of mitigation projects including wetland restoration, buffer and nutrient offset projects, dam removals, stormwater BMPs, and preservation of "targeted resource areas." At the other end of the spectrum, the Little Lick Creek watershed improvement plan covers an area slightly over 17 square miles. The stream assessments for this study were performed entirely in the field using tablets equipped with ArcGIS Mobile software and a customized database. Streams were walked by field crews who collected reach-scale data throughout the entire study area on channel stability, aquatic habitat, buffer condition, water quality indicators, and biological indicators. This data was used to prioritize stream restoration sites which can be implemented by the City of Durham to meet its water quality goals including compliance with the Falls Lake rules. In conclusion, streams can be effectively evaluated and prioritized for restoration of variety of scales, depending on the goals of the study.

About the speaker: Jeff Keaton is a senior water resources engineer and project manager in Wildlands Engineering's Raleigh office. He has fifteen years of experience in watershed planning, stream and wetland mitigation design, and water quality analysis and modeling. He has a master's degree in civil engineering from the University of North Carolina at Charlotte. Wildlands Engineering specializes in water resources engineering and planning with a particular focus on innovative engineering for ecosystem renewal.

Improving Restoration on Large Rivers

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Abstract: As a focus on restoring fisheries and aquatic linkages gains further momentum throughout North America (e.g. Dam removal), restoration activities on larger river systems (WSA > 25mi2) are coming into a spotlight and possess the power to play a vital role in advancing the cause. In many cases, these projects are highly visible with large price tags, demanding variable scales of goals and results. While large river restoration may not have the mileage experience as smaller systems, recognizing the differences, challenges, and opportunities in comparison to smaller streams can help in planning the ultimate success of these larger scale projects. Rivers often require considerations both in design and construction beyond that of smaller streams. The science and engineering of structures used for stream and bank stabilization continues to evolve, but to what extent is this knowledge transferrable and/or scalable? The purpose of this talk is to highlight such distinctions and differences between smaller stream construction and structures and those of larger rivers. Specifically, this presentation will focus on experience gained and lessons learned during design and construction of various larger stream projects. Overall, the goal of this presentation is to promote forward thinking in the design and construction of large river projects and to share what did and didn't work so as to promote the science, engineering and overall future project success.

About the speaker: Mr. Taylor is an engineer with Stantec. His experience includes design and analysis of rural and urban streams with regards to restoration and planning based on fluvial geomorphic processes. As a member of the Stantec Team, Mr. Taylor provides a range of support with various projects including design, construction, and monitoring of stream restoration and related water resource management.

Accounting for Restoration in the Water Quality Assessment Framework

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Abstract: Millions of dollars are invested in water quality restoration and protection projects in North Carolina each year. The monies are from mitigation, restoration grants, and from local governments. Although many projects are completed each year, rarely are water quality improvements documented. Often these projects are accounted for as "money spent" or "project complete" check boxes. The North Carolina water quality assessment framework is based on federal Clean Water Act requirements in Sections 303(d) and 305(b). The assessments determine if water quality is exceeding criteria and needs to be restored or is meeting criteria and needs to be protected. Data used to make the water quality assessments are mostly associated with large water bodies and drainage areas that are substantially larger than a typical stream restoration project. Because of these scale differences it is very difficult to measure water quality improvements associated with the projects at the sampling locations that originally detected the water quality problems. In addition many of the water quality measurements (both chemical and biological) may take many years to demonstrate the improvements associated with restoration. Non-traditional water quality improvement measurements provide a mechanism to document improvements in the short term that contribute to long-term water quality benefits for the larger watershed. DWR developed a workflow that would incorporate restoration projects into the assessment framework using non-traditional water quality improvement measures. The presentation will discuss the process, the measures and the assessment framework. The presentation will also provide information from a pilot that used the approach on NC Ecosystem Enhancement Program projects in the summer of 2014.

About the speaker: Cam McNutt has been with the Division of Water Resources (Water Quality) for 15 years as a basin planner and for the last 10 years as the water quality assessment coordinator. He develops the state 303(d) lists and other assessment reports and tracks implementation of various water quality programs in North Carolina. Current efforts include implementing TMDL alternatives including this effort to link restoration projects into the larger water quality assessment framework. He has a B.S in Biology from Texas Tech University and an M.S in Zoology from North Carolina State University

Case Studies of Stream Restoration Incorporated into Urban and Suburban Parks in Metro Atlanta

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Abstract: Recently completed stream restoration projects situated in Metro Atlanta's urban and suburban parks serve as a backdrop to discuss the issues and drivers currently converging in the market. These stream projects, set into existing and planned park settings, strive to balance not just dimension, pattern, and profile, but landscaped aesthetics, maintenance ease, safety metrics, and pedestrian interest and connectivity to create a multi-faceted amenity. Project goals included reducing streambank erosion, improving floodplain connectivity, and enhancing habitat and riparian composition. The layering of resources needed to execute these projects, including stakeholder and public input and the varied funding mechanisms will also be reviewed. Several of the stream restorations projects were implemented in conjunction with water quality BMPs and other low impact development techniques – the observed and measured performance and trending ecological lift since construction will be discussed during this presentation.

About the speaker: Jill Davenport is a Water Resources Engineer in the Charlotte Office of CH2MHILL. Jill is a design manager specializing in stream restoration and best management practice site evaluation, concepts, design, construction, and monitoring. During her 12 years at CH2M HILL, Jill has been involved in over 30 stream restoration, enhancement, and bank stabilization projects, focused in the eastern and midwestern United States. She has a B.S. degree in Biological Engineering from North Carolina State University.

Greensboro's Stream Team: Prioritizing Stream Asset Repairs

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Co-Authors: David Phlegar, City of Greensboro

Abstract: Stream stabilization projects are a large undertaking by any measure. Urban parameters, such as concerns for public parkland, neighborhood dynamics, community action groups, political and policy changes, public safety, and urban constraints, can further complicate a project. Justification for capital expenditures is a requirement and not always an easy task for stream stabilization and restoration projects. Intangible benefits of stream stabilization projects, such as long-term habitat restoration, are difficult to quantify. The City of Greensboro developed its Stream Team in response to many of these concerns, in an effort to help solidify support for and prioritize stream stabilization projects on public property. The Stream Team is made up of select individuals from the Stormwater Management Division, Water Resources Engineering, and Parks & Recreation. The Stream Team comes together to help select potential stream stabilization sites and rank them using a customized prioritization matrix. The prioritization matrix outlines 11 criteria that are used to rank a stream stabilization site. The criteria consider a range of urban concerns and water quality benefits. The establishment of a prioritization matrix allows stream stabilization sites to be ranked numerically and helps to provide justification for capital project locations and expenditures. The Stream Team has ranked 15 stream stabilization sites. The highest priority stream site, Ardmore Park, is currently under construction. Repairs have already been constructed at three other stream stabilization sites. This presentation will describe the process the City of Greensboro undertook to develop the Stream Team and prioritization matrix, along with prioritization outcomes.

About the speaker: Jana Stewart is a professional engineer with ARCADIS. She previously worked with the City of Greensboro designing stormwater improvements and managing design and construction of projects. Jana has a BS degree in Environmental Engineering and Masters in Biological and Agricultural Engineering from NC State. Her Masters degree focused on stormwater, BMP design and stream function and restoration. Jana has 8 years of experience in stormwater design and construction. David Phlegar leads the City of Greensboro's Stormwater Management Division. David has 20 plus years of experience in stormwater, including stream function, buffer management, BMP installation and maintenance, and stormwater regulations. David oversees Greensboro's MS4 program, including water quality, stormwater capital improvement projects, and stormwater operations and maintenance.

A Model for State Forest Agencies to Engage in Water Resource Restoration

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Abstract: Most state forest agencies actively engage in natural resource protection with environmental personnel and programs focused on delivering forestry best management practices to conserve soil and protect water quality during forest operations. Typically, these agencies also manage large tracts of state lands that are open to the public and used to demonstrate the importance of forest management and forest protection programs and services. However, there is a notable absence of state forest agencies efforts to enhance or restore waters degraded from land management practices that occurred prior to these lands coming into state ownership. In many instances, degraded streams and rivers originate and/or flow through present-day state forest lands thus providing an ideal opportunity for water resource restoration, public access and education. Pathways for planning water resource restoration projects on agency lands will be discussed, as will steps to develop key funding and technical partnerships needed to successfully complete restoration projects. An overview of NCFS's ongoing and completed stream and river restoration projects, including important lessons learned, will also be presented.

About the speaker: Bill Swartley is the Forest Hydrologist and Program Head of the Forestry Non Point Source Branch. He has worked at the NC Forest Service for 16 years delivering water quality protection products and services to NC's forestland operators, managers, and owners. Since 2003, Mr. Swartley has worked with educational state forest, state forest, and tree nursery supervisors to implement multiple stream and river restoration projects on NCFS-managed lands. He has a B.S degree in Biology from the Pennsylvania State University and completed M.S. studies in Aquatic Biology and Civil Engineering at Tennessee Tech University.

Another Reason to Do the Right Thing: Water Quality as a Driver for Stream Improvement

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Abstract: Most MS4s have a NPDES stormwater permit that requires them to implement structural BMPs toward improving water quality, and promoting the designated use classification for streams both within their political boundary as well as the adjacent receiving network. Oftentimes, these permits encourage responsible MS4s to focus on treating runoff before discharging to the receiving stream. That's good, but ultimately, the responsible MS4 may not necessarily achieve their goals, as demonstrated by the State monitoring site water quality data. While the municipality may capture and prevent runoff sources of pollution, much of the measured pollutant load may actually reside within the stream itself. The banks of the receiving streams may actually be a greater source of impairment than the contributing community. For this reason, water quality improvement projects should strongly consider assessing the conveyance network, in addition to other sources within the contributing watershed. Enhancement/restoration of the conveyance network may actually serve the permit goals more effectively and cost-wise efficiently than other more conventional structural BMPs. This talk will put into context the practice of stream restoration as a means toward realizing water quality benefits. While many agree that stream restoration promotes water quality benefits, few have successfully demonstrated those benefits directly. This talk will focus on: • Published literature regarding TSS, TN, and TP removal rates of stream restoration, • Guidance and Policy that outlines methods for computing load rate reductions, • Data needs to improve credibility and application of stream restoration toward meeting NPDES permit conditions Finally, this talk will encourage the audience to look outside of the mitigation box, toward the water quality mandates as a means to more efficiently promote cumulative water quality benefits to over time.

About the speaker: Josh Gilman is an engineer with Stantec. His experience includes regional curve studies and other stream research as well as rural and urban stream improvement projects. As a member of the Stantec Team, Mr. Gilman provides a range of support with various projects including design, construction, and monitoring of stream restoration and related water resource management.

Motivations, Goals, and Potential Outcomes of a Habitat Restoration Project on the South Fork of the New River: A Mixed Methods Assessment

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Abstract: Restoration projects aimed at enhancing water quality, improving in-stream habitat, and stabilizing eroding banks have exploded in the past decade, resulting in a multi-billion dollar a year industry. However, a growing body of literature indicates a lack of data for proper evaluation, lack of communication between researchers and practitioners, little coordination among restoration plans and projects, and uncertain results. In addition, restoration projects are often small scale and site-specific, often occurring where land is available rather than in areas that would have the most significant impact on water quality, or as part of a comprehensive watershed management plan. If resilient freshwater ecosystems are a goal, research should adopt a holistic perspective that includes not only ecological conditions but also evaluates social, behavioral and economic conditions. This research explores water quality data, management objectives, and public perceptions to assess motivations, goals, and potential outcomes of a $2.6 million dollar stream restoration project in Boone, NC. The project is a partnership among The National Committee for the New River, the U.S. Army Corps of Engineers, The Town of Boone, and Appalachian State University (ASU) with the goal of improving the riparian and aquatic habitat of the South Fork New River. Quantitative and qualitative data was collected from diverse sources to assess how well the project design aligns with pre-restoration baseline data and the goals of the state's New River Water Quality Plan. The results of this work highlight on-going water quality management issues and serve as a foundation for long-term assessment of restoration efficacy.

About the speaker: Bobbie Swinson received a B.S. in Appropriate Technology, along with a minor in community and regional planning, from Appalachian State University in 2012. She is currently pursuing her M.A. in Geography in the Department of Geography and Planning at ASU where she focuses on water resource management and environmental modeling with geographic information systems (GIS).

Watershed Approach and Ecological Benefits of Restoration in the Conowingo Watershed

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Abstract: In March of 2001, the Susquehanna River Basin Commission developed Total Maximum Daily Loads (TMDL) for the Conowingo Creek Watershed on behalf of the Pennsylvania Department of Environmental Protection (PADEP). The establishment of the TMDL were necessary to address the stream's listing on Pennsylvania's 1996 and 1998 Clean Water Act Section 303(d) impaired waters, and the 2000 305(b) report. PADEP biological surveys indicated impairment because of excessive amounts of sediments and nutrients, organic enrichment, and low dissolved oxygen.

The Donegal Chapter of Trout Unlimited (DTU) and RETTEW Associates, Inc. developed a TMDL Implementation Plan (now commonly referred to as a Watershed Implementation Plan) to guide Conowingo restoration efforts. The partners identified sediment and nutrient sources and prescribed Best Management Practices for discovered problem areas. The team then modeled anticipated sediment and nutrient loading reductions to insure previously established TMDL pollutant threshold limits could be achieved. Ultimately the implementation plan was reviewed and approved by PADEP and the Environmental Protection Agency (EPA) in 2006. Approval of the implementation plan resulted in the Conowingo Watershed being eligible to receive future Section 319 grants for plan implementation.

Since 2006, DTU, RETTEW, and local contractor Flyway Excavating, Inc. have designed and installed several projects to improve nearly 5 miles of stream. Many of these projects have taken place on Amish farms where, in addition to stream restoration activities, the farm's conservation and nutrient management plans were updated. DTU and RETTEW continue to monitor the aquatic community at several locations through the sampling of macroinvertebrates and fish. The presentation will review the preparation of the TMDL Implementation Plan, implementation of the plan, key projects completed thus far, and continuing planning and monitoring efforts.

About the speaker: Mr. Metzler has 24 years of extensive environmental experience in the areas of watershed protection, stream restoration, wetland delineation and mitigation, erosion control, and related environmental permitting. He specializes in dam removal and TMDL implementation planning projects. TMDL implementation plan clients include watershed organizations and trout unlimited chapters under the provisions of PA DEP and EPA.

Green Infrastructure Build-Out: Redeveloping Urban Stormwater Infrastructure

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Co-Authors: Chris Dreps, Ellerbe Creek Watershed Association; Lars Hansen, Triangle J Council of Governments

Abstract: Stormwater pollution is a pervasive threat to the nation's rivers. As one of the only growing sources of pollution, it impairs water quality and endangers drinking water supplies. Communities across the country are trying to reimagine their stormwater infrastructure to reduce the amount of pollution they contribute to our rivers, lakes and estuaries. The Ellerbe Creek Watershed in Durham, North Carolina exemplifies this challenge since it is the most urbanized watershed in the city with 80% of it already developed. It is impaired by urban stormwater runoff and is the greatest contributor of pollutants to the impaired Falls Lake Reservoir, the drinking water for over 550,000 people that has strict requirements for reducing nitrogen and phosphorous levels over the next decade. This presentation will review a new approach for stream restoration that has been developed using green infrastructure to manage stormwater pollution and begin to mimic natural hydrology. The project built upon the Ellerbe Creek Watershed Management Improvement Plan and identified all possible green infrastructure retrofits in the most urbanized areas of the city. These retrofits were then quantified to show the pollution reductions that could be achieved by implementing these low-cost, dispersed retrofits. Implementation of these practices would reduce volume by 7.7 million cubic feet/year, nitrogen by 814 lbs/yr., and phosphorous by 208 lbs/yr. Non-residential site retrofits such as green roofs and bioretention achieve the greatest reductions, while street rights-of-way and residential achieve significant reductions with great visibility to the public. The project results create essentially a green infrastructure "build out" plan for the 467 acre study catchment that can be promptly implemented through the City of Durham Stormwater Utility. This retrofit project could become a model for other communities around country who need quantify the benefits of large scale adoption of green infrastructure to reduce polluted stormwater runoff.

About the speaker: Peter Raabe leads American Rivers' work in North Carolina as the NC Conservation Director. He focuses on state level policy in the areas of water quality and quantity. His work advocates for more natural solutions to manage polluted stormwater run-off and using the limited clean water available in the state in the most efficient way practicable. Peter joined American Rivers in September 2001 in their Washington, DC headquarters and he moved to North Carolina in 2007. He is on the board of directors of the North Carolina Conservation Network and the Ellerbe Creek Watershed Association. He graduated from Franklin and Marshall College in 2000 with a B.A. in American Government and Environmental Studies specializing in watershed restoration.

Urban Stream Restoration and Floodplain Reconnection as a Regional BMP to Meet TMDL Requirements

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Abstract: A stream restoration and lake retrofit project is currently under design for the City of Newport News, VA. The project is being implemented for the purpose of providing Chesapeake Bay TMDL nutrient credits to the City, specifically for phosphorous, nitrogen, and total suspended solids. The stormwater facility will serve as a regional BMP for the 3,000 acre contributing urban watershed and will include retrofitting two lakes and restoration of the on-site stream channel. The project design will meet the Virginia Department of Environmental Quality's (DEQ) "Virginia Stormwater BMP Clearinghouse" design specifications for stormwater treatment facilities. In the spring of 2014 this project was awarded a Virginia DEQ Stormwater Local Assistance Fund grant in the amount of $629,000 to assist with project construction costs.

This presentation will review the methodology for calculating nutrient credits for stream restoration as it applies to this project according to the Chesapeake Bay Program expert panel findings as outlined in the "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects" dated February 2014. The presentation will also cover nutrient removal calculations and credits for providing floodplain connection, creating riparian stormwater wetlands, and retrofitting the on-site lakes.

About the speaker: Daren Pait is a surface water engineer at Kimley-Horn. Daren has 15 years of experience in ecosystem design, watershed management planning, stormwater design and floodplain management. He has a B.S. in Environmental Engineering from North Carolina State University, is a registered Professional Engineer in North Carolina and Virginia, and is a Certified Floodplain Manager.

Water Quality planning and assessment in McDowell: "Leaving no stone unturned"

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Co-authors: David Woodie and David Kroening, Charlotte-Mecklenburg Stormwater Services

Abstract: Mecklenburg County has implemented several projects in the McDowell Creek Watershed through its capital improvement program. This has included over 5 miles of stream restoration and multiple Best Management Practices to improve the overall water quality and stability of the watershed draining to Mountain Island Lake, Greater Charlotte's drinking water supply. We will detail the use of the County's McDowell Creek Watershed Plan to identify projects in addition to ongoing field assessments through stream analysis that direct our focus and funding to achieve the best projects.

About the speakers: David Woodie, PE, CPSWQ, currently serves as the Storm Water Services Project Manager for Charlotte/Mecklenburg County Government of Charlotte, NC. David has over 20 years of professional experience in construction, survey, water resources, bridge/hydraulic design, bmp design, and both bmp/stream construction. Working through private sector, State and Local Government, David has constructed major highway projects, 140+ Best Management Practices across the state of North Carolina as well as implemented over 10+ miles of stream restoration in Mecklenburg County. David is a Professional Engineer and Certified Profession in Storm Water Quality.

David Kroenig is originally from Green Bay, Wisconsin. He completed his bachelor's degree in Geology at the University of Wisconsin Milwaukee in December, 1990. Upon completion of his undergraduate degree he was employed by the Great Lakes Research Facility in Milwaukee, WI studying the interaction of ground water with Lake Michigan. David moved south in May of 1991 to accept a temporary appointment to the United States Geological Survey Field Office in Charlotte, NC. He investigated ground water and surface water interaction in Lincoln County, NC. Upon completion of his appointment he attended Clemson University where he received his Master of Science Degree in Hydrogeology in December of 1994. During his tenure at Clemson he investigated the potential migration of contaminants from the Department of Energy Savannah River Site in South Carolina to water supply aquifers in Georgia. Upon graduation from Clemson, David was employed in the private sector as an environmental consultant to several large corporations in the southeast. In July 1999 David accepted a position with the Mecklenburg County Water Quality program. David's responsibilities included mathematical modeling and development of Geographical Information.

Regenerative Stormwater Conveyances: Giving Old, Perched Outfalls New Life

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Abstract: Linear biofiltration conveyance systems, also known as regenerative stormwater conveyances (RSCs), provide effective end-of-pipe treatment in an otherwise constrained linear environment. They are becoming more widely used in the Southeast and Mid-Atlantic to reduce nutrient and sediment loads, especially from 'first flush' flows. RSCs improve water quality by removing 90 percent of total suspended solids, 50 percent of total nitrogen, and 60 percent of total phosphorous. RSCs combine the features and treatment benefits of more traditional stormwater BMPs, including swales, infiltration, filtering and wetland structures. They use a series of shallow aquatic pools, riffle weir grade controls, native vegetation and underlying sand and woodchip beds to detain, treat, and convey storm flows. In addition to the water quality benefits provided for first flush events, RSCs are designed to not only safely convey large flows (e.g. 100-year event) over and through their step-pool sequence, but to also create a series of energy dissipaters that decrease downstream velocities and overall shear stress, which results in a reduction of downstream erosion impacts often associated with more conventional stormwater outfalls. WK Dickson & Co. is currently designing a demonstration RSC in the western NC piedmont. The site is currently a twenty foot deep eroded gulley with ephemeral flow that contributes significant sediment and nutrient loads to its receiving perennial stream, which flows into an impaired (303d-listed) receiving water. The design includes a series of baffles and monitoring devices to document the structure's efficacy. In order to effectively account for infiltration losses and surface flow attenuation, WK Dickson & Co. created an RSC-specific model that routes an inflow hydrograph through each RSC cell. For each cell the model calculates key hydraulic parameters, including: volume lost through infiltration, maximum WSEL, pool surface storage volume, underlying sand storage volume and a complete system outflow hydrograph. This model can guide engineers and scientists through the RSC design process and help estimate overall RSC hydraulic performance.

About the speaker: Ward Marotti has been involved in successful ecological restoration project planning, design, implementation, oversight, and monitoring for over 23 years. He has identified, proposed, negotiated, won, and managed a wide variety of wetland, stream, riparian buffer, and upland restoration and reclamation projects on private and governmentally owned properties in North Carolina, South Carolina, the Intermountain West (Montana to Arizona), and South America (Bolivian and Peruvian Altiplano to Chilean and Peruvian Pacific coasts). In addition to the environmental documentation and permitting/approval required for mitigation projects, Mr. Marotti has authored and managed many Environmental Assessments (EAs), Biological Evaluations (BEs), and Categorical Exclusiuons (CEs) in support of public infrastructure project approval and funding by multiple local, state, and federal agencies. EAs that he has completed have varied widely in scope, location, and relevant issue(s). All are currently under review, or have received Findings of no Significant Impact (FONSIs), or similar

approval, from the appropriate review entity (government agency or international private funding consortium). By serving as president of the North Carolina Association of Environmental Professionals for the past five years, Mr. Marotti has successfully planned, organized, funded and executed numerous professional development courses, seminars, and field trips. These events have provided much-needed Professional Development Hours to scores of environmental scientists, engineers, and governmental professionals.

RSC Research in North Carolina: Hydrology and Water Quality

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Abstract: Regenerative stormwater conveyance (RSC) is an emerging vegetated, media-based approach to stormwater management. Limited research on these systems in Anne Arundel County show potential for peak flow and volume reductions, but conflicting and inconclusive results for pollutant removal. RSCs in Alamance & Brunswick Counties, North Carolina, were monitored for hydrologic and water quality performance. Hydrologically, the RSCs reduced volume and peak flow, while partially mimicking both predevelopment shape and hydrologic flow pathways. The Alamance RSC was also able to remove pollutants via physical treatment, and the potential exists for further nutrient reduction if vegetated, wetland-like conditions are present. This research concludes with identifying several design aspects important to RSC performance as a tool in the Low Impact Design (LID) toolbox.

About the speaker: Dr. William F. Hunt ("Bill") is actively involved with Best Management Practices (BMP) research in the Biological and Agricultural Engineering Department and is the leader of the Stormwater Engineering Research Group. He is a Professor, Extension Specialist, & University Faculty Scholar. He is an active member of the American Society of Civil Engineers (ASCE) and the American Society of Agricultural and Biological Engineers (ASABE), where he has many committee leadership roles. Hunt conducts 20-25 workshops and other training events per year across NC and the USA. In 2010-11, he was an Honorary Research Fellow at the University of Auckland in New Zealand and in 2012, a CUGE Research Fellow for Singapore National Parks.

He has two B.S. (Civil Engineering and Economics) and one M.S. (Biological and Agricultural Engineering) degrees from NC State. Bill received his Ph.D. from Penn State in 2003.

New Storm Water Control Measure Development, Urban Stream Restoration Performance Expectations, Regulatory Controls and Credit – How Does All This Interface? Case Studies and Observations

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Abstract: The latest data from North Carolina installations of regenerative storm water conveyances (RSC) will be presented and findings from elsewhere will be reviewed. Comparisons between RSC design and natural channel design (NCD) will be made, as well as comparisons of the ecological functional benefits that can be derived from each, under certain circumstances. The presentation will explore where RSC designs are logically appropriate vs. NCD and what types of functional benefits have been documented from RSC installations. A more general review of urban storm water/stream restoration goals and challenges will be presented, and the role that regulatory agencies play in achieving potential solutions will be discussed also.

About the speaker: Kevin has been a Senior Ecologist at Biohabitats for the past 9 years, performing various tasks associated with stream restoration, wetland restoration, stormwater innovation and ecological assessment projects that Biohabitats undertakes.

Stream Restoration & Wetland Integration as a Cost-Effective Technique to Meet Functional Goals

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Abstract: An ongoing challenge to the restoration industry is to incorporate measurable and economical improvements to natural and social capital through design. Local, regional, state, and federal organizations are looking to stream and wetland restoration as cost-effective means to achieve mitigation requirements and meet sediment and nutrient reduction goals associated with MS4 permits and regional TMDL goals. Creative design approaches can drive functional improvements in hydrology (e.g., reduced peak discharge, increased time of concentration, and groundwater recharge), hydraulics (e.g., increased floodplain inundation), and geomorphology (e.g., sediment retention). Where monitoring results are available, these physical changes have been associated with water quality improvements and increases in wildlife diversity/abundance. The presentation will include examples of functional uplift provided by creating strong linkages between enhanced stream and wetland systems. As one example, the Nixon Farm site was designed to restore surface and groundwater hydrology, while preserving existing on-site floodplain forest and wetlands. The design was based on minimal grading and modifications to surface water drainage patterns to raise the groundwater table and extend near-surface saturation.

About the speaker: Ms. McClure acts as project manager and technical lead for stream and wetland restoration projects out of the Chesapeake/Delaware Bay Bioregional office of Biohabitats, Inc. in Baltimore, MD. She is also a bird nerd and considers herself especially lucky when conducting avian surveys for Biohabitats. Biohabitats is a 60-person firm that specializes in ecological restoration, conservation planning, and regenerative design.

Regenerative Design of Sand Seepage Wetlands for the Creation of a Wetland Agricultural Treatment Wetlands at an Abandoned Sand Mine Site

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Co-Authors: Keith Underwood, Underwood & Associates, Inc.

Abstract: An approximately 30-ac exhausted sandmine was 'restored' to a stream flowing through an upland-wetland mosaic of sand seepage forested wetlands, shallow open water wetlands, and forested uplands using elements of regenerative design. This included covering the clay bottom of the sandmine with a 3-ft thick layer of imported sand and mulch to create the opportunity for hyporheic zone flow across the site. The treatment approach uses water stage differences to support seepage flow through a 3-ft thick layer of coarse sand combined with a carbon source (coarse mulch) at a 5:1 volume ratio to establish and drive denitrification and other microbially mediated water quality improvement processes. Water moves through the hyporheic sand seepage treatment bed discharges into the stream through subsurface seepage. There it forms a pool and supports another seepage reservoir driving hyporheic treatment in a repeating sequence until the water exits the site and enters Buntings Branch, a tidal tributary of the Saint Marten's River, draining to the Ocean City Sound before entering the Atlantic. The primary project goal was to provide wetland water quality treatment and stream conveyance for approximately 400-ac of ditched agricultural fields normally used to 'waste' chicken manure from broiler houses. This project site is located in one of the worst nutrient-contaminated drainages in the coastal bays of Maryland and Delaware. In addition to the water quality benefits, this design approach has demonstrated significant stormflow peak attenuation, reduced water temperature, and increased duration of flow. This project won a national restoration award from the Federal Highway Administration in 2012. We have recently been involved in evaluating a similar approach for Portland's Clean Water Services as a means to protected treated discharge water from thermal gain using subsurface hyporheic zone seepage flow as the discharge to the receiving stream.

About the speaker: For the past 30 years, Joseph Berg has focused on restoring integrated stream, wetland and floodplain function to deliver ecosystem services and increase natural capital. Joe creates restoration designs that offer multiple benefits, from watershed plans that achieve nutrient load reductions through restoration to green infrastructure solutions that repair outfalls while providing water quality treatment and flow attenuation. Experienced in Rosgen's natural channel design and other widespread approaches, he was also one of the original architects of the regenerative stormwater conveyance (RSC), which employs a pool and riffle system to slow water flows and increase water storage. In addition, he has reconnected streams to their floodplain by elevating the stream channel. Whether in urban or forested systems, his projects seamlessly integrate the goals of improving water quality and creating wildlife habitat. Joe is an officer and board member for the Society for Ecological Restoration and past officer for the mid-Atlantic Chapters of the Society of Wetland Scientists and the Ecological Society of America.

Sink or SWVM: West Virginia's Stream and Wetland Valuation Metric (SWVM) and Its Use in the Development of a Large-Scale Stream Mitigation Bank

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Abstract: West Virginia's Interagency Review Team developed the Stream and Wetland Valuation Metric (SWVM) in 2010 so as to provide a functional, data-driven evaluation of stream and wetland impacts. The SWVM is a multivariate system that combines the EPA's Habitat Assessment Value (HAV), the USACE's HGM evaluation for high-gradient streams, water chemistry data, and benthic macroinvertebrate diversity in order to assess mitigation credits or debits based upon stream quality and function. The purpose of this presentation is to explore the successes and challenges associated with the use of the SWVM in the determination of crediting scenarios for a 9800 acre, multi-watershed stream mitigation bank. Civil and Environmental Consultants, Inc. and the Canaan Valley Institute were tasked with evaluating over 250,000 ft. of ephemeral, intermittent, and perennial streams in the Appalachian Plateau of West Virginia; this venture, owned by Ecosystem Investment Partners, Inc., will upon completion represent the largest stream mitigation bank in the state. A project of this size has provided a unique test of the SWVM and its effectiveness in assessing mitigation credit/debit projections across a variety of stream types.

About the speaker: Ian Turner is a staff scientist with Civil and Environmental Consultants, Inc. in Bridgeport, WV. He works primarily on mining-related stream restoration projects in West Virginia and Pennsylvania. Mr. Turner holds a B.S. in Natural Resources from Sewanee: the University of the South and a M.S. in Soil Science from Auburn University.

Application of the Savannah District Stream Functional Assessment Method for Large Scale Stream Mitigation in New York

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Abstract: Compensatory stream and wetland mitigation was required as a result of construction of an intermodal rail transfer facility in Mechanicville, New York in 2010. Currently, there are no widely accepted stream functional assessment methods for determining mitigation requirements or credits in New York State. For this project the USACE Savannah District Stream Functional Assessment method was used to assess stream mitigation requirements and restoration credits which ultimately led to planning and permitting compensatory mitigation projects at three stream locations, totaling 6,300 feet of perennial stream and riparian habitat. Construction at the stream mitigation sites was completed in 2011 and included Rosgen Priority 2 restoration, riparian corridor restoration, and stream stabilization measures with the installation of J-hooks, Cross-vanes, and W-weirs. Site designs were developed from dimensionless ratios surveyed from a reference reach upstream of the impact site. The completed stream restoration projects support the functions and values of improved water quality, aquatic and wildlife habitat, recreation, education, and visual quality for the Anthony Kill watershed. Additional mitigation credit was given for a detailed 5-year post-construction monitoring program at the three restored streams and one reference stream, which includes stream geomorphic surveys, rapid bio-assessment, electrofishing surveys, vegetation monitoring, riparian community mapping, and streamflow monitoring. Results of the monitoring to date have shown utility for monitoring restored stream stability, and fish and benthic communities, relative to the reference reach. The monitoring data have also been used to confirm the restoration of a more diverse riparian community at each of the sites, and to confirm the increase in streamflow at one of the restoration sites, meeting a project objective. During the monitoring phase Hurricane Irene and Tropical Storm Lee provided an opportunity to observe the resilience of the newly constructed stream restoration projects. Additional project challenges and successes will be discussed.

About the speaker: Kevin Verweire is a Project Manager at HDR, Inc. During his eight years at HDR Mr. Verweire has managed project teams working on the preparation of state and Federal permit applications, wetland/stream delineations for Section 404 permitting, managed development of wetland and stream mitigation plans, completed threatened and endangered species habitat assessments, and led hydrologic monitoring and modeling studies. He has a B.S. degree in Environmental and Forest Biology from the State University of New York College of Environmental Science and Forestry, and an M.S. degree in Watershed Management from the University of Arizona.

The Model Mitigation Banking Project: Utilizing Stormwater Control Measures to Maximize Uplift and Generate Mitigation Credit in Urban Watersheds

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Co-Authors: Adam McIntyre, Senior Project Scientist, Cardno Entrix

Abstract: The Monteith Park Mitigation Site (MPMS) represents a unique project that integrates all the principles of watershed restoration, public environmental education, and an ideal public/private joint venture that utilizes the mitigation banking model for project funding. The MPMS incorporates stormwater control measures (SCMs) with stream and wetland restoration to holistically restore a small urbanized watershed for inclusion in the City of Charlotte Umbrella Stream and Wetland Mitigation Bank. MPMS is only the second project approved by Charlotte's Umbrella Bank Interagency Review Team that will generate stream mitigation credits through non-traditional means and the first to use the "Charlotte Method," a pilot methodology used to assign stream mitigation values to SCMs when implemented alongside traditional mitigation measures. This provides an incentive for mitigation providers to construct SCMs that will provide functional uplift to receiving waters while covering the capital costs of constructing and maintaining these devices.

The Monteith Park subdivision was the perfect place to implement this integrated project idea. Located in the headwaters of Charlotte's water supply, Monteith Park already ranked high on Charlotte-Mecklenburg Storm Water Services' list of restoration sites. After gaining the confidence of the homeowner's association and securing the non-traditional credits with the IRT, the project was born. The stream channel was restored through the previously altered valley, and five SCMs were constructed in the buffer to treat runoff from neighborhood impervious surfaces. A large wetland was restored near the confluence with Torrence Creek, an existing walking path was integrated into the project, and an environmental education plan was developed for the neighborhood to help residents understand the values of streams, wetlands and environmental restoration projects.

This presentation will provide an overview of the unique features of the project, the methodology for generating credit through non-traditional measures and monitoring that will be done to benchmark success.

About the speaker: Jarrod Karl currently serves as the Permitting and Mitigation Administrator for Charlotte-Mecklenburg Storm Water Services. Over the past 10 years, he has been responsible for growing the City of Charlotte Umbrella Stream and Wetland Mitigation Bank to include over 14 miles of stream mitigation and 10 acres of wetland mitigation. He has 17 years of professional experience in environmental planning, permitting and stream and wetland mitigation project development. Jarrod holds an environmental studies degree from the University of North Carolina at Asheville.

Man or Machine: Who Do You Prefer to Construct Your Stream Restoration Project?

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Abstract: CFFN project was an onsite stream restoration project used to offset stream impacts associated with the construction and operation of a natural gas plant in West Virginia. A couple landslides occurred during construction of the plant causing unconsolidated soil, rock, and woody debris to flow several hundred feet into the East and West stream valleys. A majority of the material was contained on-site; however, some of the material flowed into the receiving mainstem. These landslides completely covered both stream valleys which resulted in loss of stream function and habitat for terrestrial and aquatic species.

Immediately, the natural gas plant started removing the overburden from the landslides on the West stream valley but the Regulatory officials determined that the East stream valley was too confined and steep to use mechanical equipment for the removal. So the natural gas plant had to remove and restore the East valley with *shovels and wheelbarrows,* while the West valley was reconstructed with traditional mechanical equipment used for stream restoration practices. This presentation will evaluate each valley and their construction technique based on cost, time, quality of work, current condition, and also discuss the advantages and disadvantages of each technique.

About the speaker: Joshua White is a geomorphologist with Civil and Environmental Consultants (CEC), based in Columbus, Ohio. He received a M.S. in Geomorphology from West Virginia University and a B.S. in Geology from Northern Kentucky University. Josh fell in love with rocks and streams at an early age on his parent's farm in Kentucky. Josh's first experience with stream design; as a child; was piling stones in the creeks. His education continued as he rode his horse around his home state – noticing differences within the landscapes and wondering about the types of processes that had sculpted them. Josh later found out that he could make a career out of restoring streams. He is a professionally licensed geologist, professionally licensed engineer, certified floodplain manager, and certified professional in erosion and sediment control and works in all aspects of ecological restoration.

Constructing a Mitigation Project in a Design Build Setting

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Abstract: The NCDOT's Goldsboro Bypass Design Build (R-2554 BB&C) project included provisions for natural channel designs as part of the design build scope of work. Two stream reaches were proposed for restoration and relocation on the roadway project. The first, the Benton Site, was on an unnamed tributary to West Bear Creek which involved 1,038 linear feet of stream relocation and restoration of 3.19 acres of Neuse Buffer. The other stream reach, referred to as the Marks Edwards Road Site, was also an unnamed tributary to West Bear Creek. This site involved restoring a total of 1,322 linear feet and 2.27acres of Neuse Riparian Buffer. This presentation will focus on the process of implementing a stream restoration project as part of a DB project and discuss how the DB team worked with the NCDOT to investigate the feasibility of the mitigation sites. Constraints for the projects included a nearby dam, material concerns, high water tables, utilities, and road construction. HDR created final design plans, specifications, cross-sections, and permit drawings to include with the federal/state permit applications based on coordination between the Team, the Department of Transportation, and the permitting Agencies.

About the speaker: Vickie Miller is a Sr. Environmental Scientist with HDR in Raleigh, NC. She has over 14 years of experience conducting investigations to evaluate terrestrial and aquatic resources. Vickie has prepared environmental reports, restoration plans, and permits including Environmental Assessments (EA), Environmental Impact Statements (EIS), Natural Resources Technical Reports (NRTR), and riparian/wetland restoration plans for the North Carolina Department of Transportation, North Carolina Ecosystem Enhancement Program, Tennessee Department of Transportation and numerous private clients. Vickie has a B.S. in Environmental Sciences (ecology emphasis) from University of North Carolina (Asheville, NC) and an M.S. in Natural Resources from N.C. State University. She holds a Professional Wetland Scientist certification with the Society of Wetland Scientist and is a certified planner with the American Institute of Certified Planners.

Riparian Buffers: A 12-Year Retrospective Summary

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Co-Authors: Deanna Osmond, NCSU Dept. of Soil Science; Joy Smith, NCSU Dept of Statistics; Michael Burchell, NCSU Dept. of Biological and Agricultural Engineering; Michael Dukes, Univ. of Florida Dept. of Biological and Agricultural Engineering; Robert Evans, NCSU Dept. of Biological and Agricultural Engineering

Abstract: Riparian buffers are a common Best Management Practice (BMP) implemented to improve water quality and are an integral part of stream restoration projects. Multiple studies in North Carolina conducted over a 12-year period assessed how buffers reduce groundwater nutrient pollution by evaluating the importance of key variables such as width, vegetative species selection, and soil organic carbon. The studies also assessed how buffer functionality changes over time from establishment. This talk will discuss the results of several of those studies in a summary analysis.

About the speaker: Scott King is an environmental consultant with Baker Engineering, specializing in wetlands and soils in their Ecological Restoration Group. He's worked previously as a watershed planner at the Ecosystem Enhancement Program (EEP), as a researcher at NC State University, and as an environmental consultant in Virginia and California. He is an NC Licensed Soil Scientist with an MS in Soil Science from NC State University and a BS in Biology from the College of William and Mary.

Stream Restoration Influences Floodplain Connectivity: Effects of Restoration on Soil Characteristics in Restored Urban Floodplains in the Piedmont of North Carolina

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Abstract: Floodplains are critical components of freshwater systems because they provide ecosystem services such as flood control, nutrient retention, and habitat for a diversity of organisms. In urban systems, there have been few studies focused on floodplain soils and how these soils change over time as restoration activities reconnect urban streams to their adjacent floodplains. We hypothesized that hydrologically re-connected/restored floodplains will possess more total carbon and increasingly available carbon as vegetation ages and soil ecosystems re-establish with time. We collected floodplain soils using cores in September 2013, January 2014, and May 2014 from 12 urban floodplains that span a restoration age gradient of unrestored-10 years. Cores were analyzed for carbon content, chlorophyll-a concentrations, and soil bulk density. Carbon content ranged 1.82-16.26% with the highest content at a forested, unrestored site. Soil chlorophyll-a had a positive linear correlation ($R^2=0.5204$, 0.2438, $p<0.01$) with restoration age while bulk density had a negative linear relationship ($R^2=0.2395$, $p<0.01$). Soil carbon exhibited a negative quadratic relationship with restoration age ($R^2=0.2804$, 0.2997, $p<0.05$). It is however, necessary not to look solely at the characteristics of these soils as they change over time but also at how these soil characteristics drive biological processes. Therefore, future analyses will be directed at investigating differences in soil characteristics like grain size with depth and differences in biodegradability of dissolved organic carbon in the soils and what these variables could mean for major ecosystem processes like denitrification.

About the speaker: Erin Turner is a Master's student in the department of Geography and Earth Sciences at UNC Charlotte in her third semester working with restored, urban floodplains. Ms. Turner received her Bachelor's degree in Environmental Science with a minor in Biology from Appalachian State University in May of 2013 and chose to continue her education at UNC Charlotte directly thereafter. Upon her graduation from the Master's program at UNC Charlotte she hopes to continue her work related to stream restoration outside of academia.

Floodplain Connectivity -- A Source or Sink of Nutrients?

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Abstract: Floodplain wetlands provide many valuable ecosystems services, and it is generally accepted that hydrologic connectivity between rivers and their floodplains can decrease the downstream flux of pollutants such as excess nitrogen (N) and phosphorus (P). This occurs because of the increased residence time of floodwaters and biogeochemical processing that takes place at the sediment-water interface when redox gradients form. However, in low-order streams where many restoration activities occur, the residence times experienced in the floodplain are relatively short, suggesting restricted biogeochemical processing. We conducted a year-long study within the floodplain of a recently restored 2nd order stream. Inundation experiments were conducted on a seasonal basis (e.g. spring, early summer, late summer, fall, and winter). During each experiment, stream water was pumped into a 450 m2 floodplain slough for 3 hours. Flow was measured at the inlet and outlet of the slough, and stage was measured at three cross sections within the slough. For the first two hours of each experiment, water quality samples were taken at the three cross sections, and during the third hour, nitrogen uptake was measured using a bulk injection. During each flood, a measurable “first flush” of soluble reactive phosphorus (SRP), dissolved organic carbon (DOC), and ammonium (NH4+) was observed. While particulate fractions were not measured, the floodplain was a source of SRP, a sink of total dissolved nitrogen, and variable source/sink of DOC during the five experiments. Nitrogen uptake was variable, but was an order of magnitude higher than typically seen within the stream channel. The results from the seasonal experiments were extrapolated to the entire floodplain of the associated restored reach using a simple inundation model. Because of the short periods of inundation, model results suggests less than 1% of the annual nitrate load is removed by the floodplain.

About the speaker: Nate is a doctoral candidate in the Biological Systems Engineering department at Virginia Tech. His research focuses on floodplain hydrology and biogeochemistry.

Quantification of In-Stream and Riparian Denitrification Potential and Environmental Drivers of Denitrification Following Agricultural Stream Restoration in the Piedmont Region of North Carolina

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Abstract: Streams in agricultural watersheds often experience channel degradation via incision, decreased geomorphic complexity and increased erosion resulting from altered hydrology. Additionally, elevated nutrient (nitrogen (N) and phosphorus (P)) concentrations frequently exist because of fertilizer application to row crops, grazing of livestock, and confined animal feeding operations. Best management practices, including re-establishment of and conservation of riparian vegetation and stream restoration, have been implemented to reverse the impacts. This project investigates the potential for stream restoration in agriculturally influenced watersheds to improve water quality, particularly regarding in-stream N retention and removal. Study sites included four stream reaches (agricultural restored, agricultural unrestored with and without forested buffer, and forested reference) in the Piedmont region of North Carolina.
In both agricultural watersheds, seasonal nitrate concentrations were highest in shallow groundwater at the field edge and decreased to less than 1 mg/L in the stream highlighting the importance of the riparian zone in reducing nutrient transport. In the forested stream, low concentrations (<0.5 mg/L) were measured in groundwater, however higher concentrations (>3.0 mg/L) were observed in the stream, which were attributed to intensive agricultural land use in the headwaters. This presentation will also include results from reach-scale experiments to characterize the relationship between stream geomorphology and nitrogen retention. Observations of natural streams have shown that geomorphological features (e.g., pools, riffles) create varied flow paths and increase contact with biologically active sediments. Preliminary results showed lower N removal in the newly restored agricultural stream; however increased complexity at all sites resulted in greater N removal. Understanding the role of geomorphology may improve stream restoration efforts in agricultural areas with regard to water quality by identifying those features that facilitate N retention.

About the speaker: Molly Welsh is a graduate student at the University of North Carolina at Charlotte pursuing an M.S. in Earth Sciences. Her research interests include nutrient removal in agricultural streams, stream restoration, and coupled biogeochemical cycles. She received her B.S. in Environmental and Science and Management from the University of Rhode Island and will pursue her Ph.D. in Wetland and Water Resources at the State University of New York College of Environmental Science and Forestry.

Nutrient Processing within the Atchafalaya Swamp: The Role of Hydrologic Connectivity

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Abstract: The diversion of nutrient-rich river water through forested wetlands, especially within the Lower Mississippi River Basin, is one proposed approach to reduce nutrient export to coastal estuaries. However, the effects of large-scale diversions are not well understood. We have explored nutrient retention and transport during both historic and annual floods within the Atchafalaya swamp. The Atchafalaya River is a distributary of the Mississippi River, and flows through the largest swamp in the United States prior to entering the Gulf of Mexico. Our results illustrate the role of residence time and hydrologic connectivity on nutrient processing. Promoting connectivity results in significant nitrogen removal from the entire system (>15%), highlighting the potential for increased river diversions to mitigate excess nitrogen delivery to the coast.

About the speaker: Durelle (to most known as Scotty) is an Associate Professor in the Biological Systems Engineering Department. His work focusses on material fate and transport through the river network, focussing on both hydrologic transport and biogeochemical transformations. Research areas range from glaciated watersheds to human-dominated landscapes, from small streams to rivers to floodplains and riparian zones.

Reference Reaches and Beyond

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Abstract: The natural channel design approach advocates the use of reference reach surveys to develop dimensionless ratios for channel dimension, pattern, and profile. These ratios are used as a scaling function to design the new channel. In the humid Southeast, most reference reaches are found in mature bottomland hardwood forests where the channel pattern is heavily influenced by woody vegetation. Conversely, most restoration sites are located on land that is devoid of woody vegetation. We have learned that using ratios from reference reaches can lead to instability when applied to restoration projects with bare floodplains. A preferred approach is to develop design criteria using a combination of approaches that includes, but is not limited to, reference reach surveys. When reference reach ratios are used, they should come from several sites rather than just a single reach. Other approaches include ratios derived from project monitoring data, other empirical relationships, and computer modeling. In the end, design criteria should be selected from a variety of approaches based on the restoration goals and project constraints.

About the speaker: Mr. Harman is the founder of Stream Mechanics, a small company dedicated to advancing the science and application of stream restoration. Prior to forming Stream Mechanics, he was Vice President of Ecosystem Restoration with Michael Baker Corporation. In the course of his 23-year career, he has participated in hundreds of stream restoration projects, representing a wide variety of settings and techniques. He teaches stream restoration workshops to federal, state, and local agencies, universities, and private engineering firms. He has a Master's degree in Geography from the University of North Carolina at Charlotte and Bachelors degree in Geography from Appalachian State University. He is a licensed Geologist in North Carolina and Texas.

Implementing Diverse Natural Channel Design Practices in Urban Watersheds

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Abstract: In the past year, new research, policies, and regulations have focused on the impacts of diverse natural channel design (NCD) practices on nutrient loads delivered to downstream resources. As a result, NCD is gaining more momentum as an urban stormwater best management practice (BMP) to solve multiple objectives of water quantity and quality. This research and policy coupled with the regulatory drivers from TMDLs, MS4 permits, Category 4b Plans, FEMA, compensatory mitigation, and water supply rules will create a need for quality watershed projects including NCD in urban environments. Many natural channel design projects implemented to date have been in mostly rural watersheds. These projects have allowed the design and research community to advance both restoration science and NCD techniques. Many of these positively documented NCD techniques from rural projects can be applied to urban projects with additional considerations about urban hydrology, sediment budgets, valley types and soil types. To ensure the best NCD techniques are used and that the natural environment and human environment properly intersect, the design process may need to be re-thought. This presentation will discuss a design framework for urban NCD projects and many of the common mistakes made in developing urban design criteria. Specific project examples and design criteria from projects in Charlotte, Atlanta, Wilmington, Alexandria, Greensboro, Huntersville and Raleigh will be provided. Lessons learned shared from each project will allow attendees to have a better understanding of urban NCD processes and challenges.

About the speaker: Will Wilhelm is a water resource professional who manages numerous watershed projects involving natural channel designs and best management practices for water quality and quantity. Mr. Wilhelm is one of the driving forces behind Kimley-Horn's watershed and natural systems practices. He has been involved in all aspects of urban and rural watershed and stormwater management projects, including master planning, site feasibility, permitting, public involvement, modeling, design, construction management and monitoring. He has been involved in the design of more than 200,000 linear feet of completed stream restoration projects. Mr. Wilhelm is register professional engineer in North Carolina and Tennessee, a certified floodplain manager, and certified professional in erosion and sediment control. Mr. Wilhelm holds bachelor of science degrees in both civil engineering and environmental engineering from North Carolina State University.

Sediment Transport for Restoration Design

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Abstract: Sediment transport is typically divided into competence and capacity calculations for the purpose of evaluating the ability of a channel to manage its sediment load. Competence calculations often take a dominant role in the determining the design of a channel due, in part, to the simplicity of the calculations and the apparent ease of interpreting the results, while capacity calculations tend to play a diminished role, at least in part, because they are more complicated, difficult to interpret and nearly impossible to calibrate. This reality of natural channel design is in contrast to the belief that sediment transport and, in particular, capacity calculations hold one of the keys to designing the perfectly balanced and functioning stream.
Understanding the proper role of sediment transport calculations in the design process begins by first understanding the limitations of the computational models. This includes the limitations associated with available sediment data, variability in sediment transport rates, and difficulty in calibrating the models. Proper implementation of sediment modeling requires integration throughout the design process; not just performed as an isolated component of the design. Beginning with the site assessment and data collection, the sediment load of the stream on-site and upstream must be evaluated and considered for its effect on the design. Competence and capacity calculations should not be merely handled as separate design components, but should be reintegrated into a unified analysis of sediment transport. Subsequent design iterations should weigh the confidence of the computational results against the other defining elements of the design.

This presentation will discuss the proper role of sediment transport analysis and, in particular, capacity analysis in the design of small streams for restoration projects. Included will be a description of how computational modeling can be integrated into the entire design process and methods for calibrating the models.

About the speaker: Grant Ginn, PE is the founder and president of Wolf Creek Engineering, located in Asheville, North Carolina, which specializes in stream and wetland restoration. Grant has over twenty-five years of experience in the morphologic, hydrologic and hydraulic design of streams and wetlands associated with restoration, mitigation, remediation and infrastructure projects.

Eco-geomorphological Relationships to Support Design

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Co-Authors: Jason Zink, Zink Environmental, Zan Price, Altamont, Eve Brantley, Auburn University, Brian Helms, Auburn University

Abstract: Reference stream physical and biological data were used to create eco-geomorphological relationships for the Piedmont and Plateau Ecoregions of Alabama and Tennessee to support stream assessment and restoration design. Hydraulic geometry regional curves for bankfull channel cross-section area, width, mean depth, and estimated discharge were strongly correlated to watershed drainage area. Piedmont regional curves for bankfull dimensions were similar to those measured in other states, while the Plateau streams were found to be typically larger than Piedmont streams. Small high-gradient step-pool streams in the Plateau have a unique regional curve relationship with a steeper slope for watersheds less than 0.1 square mile in drainage area. Instream biota (fishes, crayfishes, and aquatic insects) can be used as "ecological endpoints" in restoration design and assessment efforts. Multiple measures of fish assemblages (both taxonomic and functional) were strongly correlated with watershed drainage area as well as with measures of bankfull geomorphological dimensions. Most fish responses were strongly asymptotic, with rapid initial change as system size increases. Overall, fishes appear to have more promise than crayfishes or aquatic insects as ecological endpoints for restoration design and assessment tools. All three groups have value in determining the 'biological ceiling' of reference conditions. The lack of strong taxonomic relationships with aquatic insects may be a result of a disparity in scales, as macroinvertebrates are small-bodied organisms responding to fine-scale environmental phenomena, and the measures of geomorphology were at the reach scale. However macroinvertebrates did exhibit significant and predictable functional changes associated with drainage area which have use for restoration design and assessment. More information on this project is available at: www.aces.edu/waterquality/EGM/index.php

About the speaker: Dr. Jennings is a professional engineer with 30 years of experience in water resources engineering, ecosystem restoration, and watershed management. He holds B.S. and M.S. degrees in engineering from The Pennsylvania State University and a Ph.D. from the University of Nebraska. From 1990-2013, Dr. Jennings was a Professor of Biological and Agricultural Engineering at North Carolina State University, where he taught courses and workshops on watershed hydrology, stream assessment and restoration, ecological engineering, erosion and sedimentation control, and stormwater management. He worked on more than 50 demonstration and research projects statewide focused on natural channel design techniques for restoring stream functions and ecosystem services. Since retiring from NCSU, he has worked as a consultant providing expertise on planning, design, and implementation of ecosystem restoration projects throughout the USA. Dr. Jennings has taught over 200 professional

development workshops in 25 states and abroad on stream assessment, ecosystem restoration planning, natural channel design, watershed management, construction practices for stream restoration, restoration monitoring, and watershed management.

Design Criteria for Restoring Headwater Mountain Streams

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Abstract: Restoring headwater mountain streams is prevalent in the Appalachian Mountains and is often associated with compensatory mitigation requirements from coal mine impacts. Beyond mitigation, government and non-government funding is used to restore native and non-native trout streams. These headwater mountain streams are characterized by steep stream gradients (typically greater than 3%), step-pool bedform morphology and confined valleys. Furthermore, headwater mountain streams can be subdivided into perennial, intermittent, and ephemeral flow regimes. Depending on the funding mechanism and project goals, restoration may take place in all three flow regimes. However, the restoration approach should vary between these flow regimes. Current restoration approaches often over simplify the step-pool bedform morphology and apply design criteria equally among different slope ranges and flow regimes. More specifically, restoration projects often design step-pool bedform morphologies that do not represent reference conditions. The goal of this applied research is to improve design criteria for headwater mountain streams through more detailed characterization and stratification of bed form parameters like pool-to-pool spacing, feature length, percent of feature length to stream length, and pool depth. The more detailed characterization includes splitting bed forms into riffle-pool, cascade-pool, step-pool, riffle-step-pool, and cascade-step-pool. Strict criteria are used to aid in the identification of pools. Then, the data are stratified by perennial, intermittent, and ephemeral flow regimes. Preliminary results show that stream length is dominated by riffles and cascades, not steps. This is contrary to most stream restoration designs, which are dominated by steps with few riffles/cascades. This trend was observed in perennial and intermittent channels. Ephemeral channels were almost one hundred percent cascade and bed form diversity decreased as channels moved from perennial to intermittent to ephemeral. Pool-to-pool spacing variability decreased using the characterization and stratification described above for perennial channels. This is critically important because pool-to-pool spacing is critical to designing these channels. These results provide designers with more detailed information (and flexibility) and should result in a shift from overly simplified bed profiles to bedforms that are more consistent with reference conditions.

About the speaker: Mr. Harman is the founder of Stream Mechanics, a small company dedicated to advancing the science and application of stream restoration. Prior to forming Stream Mechanics, he was Vice President of Ecosystem Restoration with Michael Baker Corporation. In the course of his 23-year career, he has participated in hundreds of stream restoration projects, representing a wide variety of settings and techniques. He teaches stream restoration workshops to federal, state, and local agencies, universities, and private engineering firms. He has a Master's degree in Geography from the University of North Carolina at Charlotte and Bachelors degree in Geography from Appalachian State University. He is a licensed Geologist in North Carolina and Texas.

Restoring Coastal Plain Headwater Systems in a Changing Regulatory Environment

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Abstract: Michael Baker Engineering, Inc. provided the design, construction oversight, and monitoring for over 4,200 linear feet of impaired headwater streams located in the Coastal Plain (CP) of North Carolina. The Unnamed Tributary (UT) to Mill Swamp project was implemented through the North Carolina Ecosystem Enhancement Program (NCEEP) and was identified as a unique opportunity to provide numerous water quality and ecological improvements within a NCEEP Targeted Local Watershed (TLW), as well as an opportunity for evaluating the project success using a headwater restoration approach. The primary objective of the project was to reduce bank erosion and nutrient loading to the Mill Swamp sub-watershed and restore a stable, high functioning headwater stream and wetland system.

This presentation will focus on lessons learned from the project, including site constraints, mitigation considerations from CP regulatory guidance, and preliminary monitoring results. The presentation will further explain the various restoration methods incorporated at the site in order to reconnect historic flow paths, while minimizing stream corridor excavation, in order to reduce damage to mature canopy trees and headwater valley topography during construction.

Additional project challenges included gaining regulatory approval based on existing and draft guidance documents in order to generate compensatory mitigation assets for the NCEEP. The post-construction monitoring efforts have involved documenting surface flows across the restored multi-thread channels, while evaluating wetland hydrology and flow regime characteristics that meet the overall performance standards. Project construction was completed in the spring of 2013 and the hydrogeomorphic conditions continue to improve as the vegetation becomes established and groundwater saturation levels increase over time.

About the speaker: Mr. Van Stell holds a BS in Biology from Northern Michigan University and currently serves as a Project Manager for Michael Baker Engineering in Cary, NC. He has worked for the past eleven years on environmental projects throughout the US, with an emphasis on improving functions to impaired stream and wetland systems. He has been involved in all aspects of ecosystem restoration and watershed management projects, including geomorphic site assessments, mitigation planning, design and construction, stormwater management, regulatory permitting, as well as post-construction monitoring.

Devils Racetrack: Restoration of a Large Coastal Plain Stream & Wetland Complex

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Abstract: Devils Racetrack is a large scale Coastal Plain mitigation project with over 18,700 feet of restored stream and over 62 acres of restored wetland. The project involved restoration on steep headwater stream systems as well as lower slope systems with associated wetlands - more typical of the Coastal Plain. The low slope systems were designed to mimic the natural pattern variability and oxbow features observed in reference conditions, maximize wetland connectivity, and maximize woody debris in the system. The headwater stream design involved the collection and analysis of eight months of pre-construction discharge data to determine stream flow characteristics onsite. In addition to the flow study, a detailed analysis of reference systems was conducted to assess drainage area and slope combinations that naturally form stream systems in this region. The goal of these studies was to confirm that these were natural stream systems and not ditched wetland features - as is often the case in the Coastal Plain. This data will be presented for reference on future Coastal Plain headwater design projects. Other challenges that we faced on this project included coordinating multiple contractors, balancing earthwork between two sides of the site that was separated by a state road, coordinating construction agreements with seven adjacent landowners to reroute the stream systems, and permitting a NCDOT encroachment agreement to replace a culvert under a state road. The culvert replacement was necessary to allow for Priority 1 construction and wetland connectivity. Project construction was completed in February 2014 and the project is in the first year of monitoring. The end result is a restoration project that raised stream elevations by as much as 12 feet, which will reconnect the streams to extensive drained hydric soils.

About the speaker: John Hutton is Vice President and senior project manager in Wildlands Engineering's Raleigh office. He has over thirteen years of experience in stream and wetland mitigation, watershed planning, and water quality analysis and modeling. He has a master's degree from Old Dominion University. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

Design Approaches and Considerations for Sand-Bed Channels

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Abstract: Stream systems that are dominated by sand and finer sized particles are common in many regions across the United States. From eastern Coastal Plains to the arid Southwest, sand-bed streams present special challenges to the stream restoration practitioner. Designing for channel stability, sediment transport, appropriate habitats, and other ecosystem-based functions requires different approaches and considerations than gravel-bed stream systems. This presentation will build on previous presentations that have focused exclusively on NC Coastal Plain sites by exploring a variety of sand-bed stream data developed from several regions across the US. The presentation will focus on commonality - what characteristics of sand-bed channels are consistent across regions and can be predicted from watershed and site conditions? Better understanding of the conditions and processes that drive sand-bed channel form and functions will lead to better restoration designs that provide stability and improved function. Data from both reference sites and completed restoration projects will be presented. Reference site data will be presented that documents the stable ranges of conditions observed in sand-bed systems. Data from completed restoration projects will be evaluated to determine which restoration practices and approaches are most effective in restoring functions similar to reference sites.

About the speaker: Mr. Tweedy serves as Principal Engineer and Office Manager for the North Carolina office of Ecosystem Planning and Restoration. He has worked for the past 16 years with environmental restoration projects that focus primarily on the design of stream and wetland systems, with emphasis on the restoration of site hydrology and habitat functions. He has a MS in Biological and Agricultural Engineering from North Carolina State University, and a BS in Agricultural Engineering from Virginia Tech.

Relationships of Geomorphic Conditions and Woody Materials in Coastal Plain Streams

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Abstract: Geomorphic conditions in natural streambeds are extremely complex with several physical attributes that directly impact the dimensions, pattern, and profile of the river channel. For streams of the coastal plain, in-stream woody material has been a constant for millions of years, resulting in local effects on stream channel morphology as well as integrated influences on channel form and dynamics over a wide range of spatial and temporal scales. Owing to the increased flow resistance provided by the addition of large woody material (LWM) to a stream, the potential for a net increase in sediment storage, changes in bed texture, and changes in sediment transport increase substantially. Because bed texture, pool geometry, the variability of local stream flow, and LWM all affect both fish and macroinvertebrate habitat, quantifying the various processes associated with LWM in streams is important for guiding stream protection and restoration efforts. Data will be presented on regional LWM characteristics in relation to stream channel hydraulic geometry (i.e., width, depth, and cross sectional area) and the relationship to bankfull discharge and watershed area. Information on LWM channel distribution, volume, density, and channel orientation will be presented as well. These results will be compared to the recently restored Anderson Branch (Eglin Air Force Base) as a comparison site for LWM and its fluvial geomorphological impact post restoration.

About the speaker: Cameron Morris has 9 years of experience in fisheries and restoration working both internationally and throughout the Southeast and Western United States. Mr. Morris is presently the Vice-President for Coastal Hydrology, Inc., providing project management and oversight for environmental restoration projects, watershed threats assessments and inventories, as well as biological samplings, assessments, and analysis. He has a B.S. degree in Ecology from the University of Georgia and an M.S. degree in Civil Engineering from Florida State University.

Using Modeling for Innovative Coastal Stream Projects

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Co-Authors: Dani Wise Johnson, Blueline Environmental, Ryan Smith and Jason Doll, Moffat and Nichol

Abstract: Designers frequently wrestle with issues such as flooding, slopes, urban constraints, and sediment transport on stream projects. These problems are only further emphasized in coastal areas where hydrologic trespass and stream stability are extra sensitive. Hydraulic modeling can provide insight into these questions, but is not typically used in the most effective ways. This presentation will introduce the latest tools in hydraulic modeling and show application to new complex coastal projects. Examples include a highly constrained urban stream with flashy hydrology and flooding problems, and a rural stream with steep slopes and a constrained valley. A modeling approach will be presented that can be used to identify problem areas, target analysis, and efficiently develop the best design for a project.

About the speaker: Kris had the honor of working on a number of innovative projects while at the NCSU Water Quality Group. He has now moved on to a new adventure as the owner, principal, and digging specialist for Kris Bass Engineering. There he provides consulting, modeling, training, and support for design teams. He gets especially excited about helping find innovative solutions to challenging projects, and less excited about keeping his books.

Restoration of Fish Communities on Longwall Mining Sites in Pennsylvania

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Co-Authors: Tim Nuttle, Mark Haibach, Civil & Environmental Consultants, Inc.

Abstract: Longwall mining can cause surface subsidence as the mine roof collapses behind the advancing mine panel. When streams cross subsided areas, a dam can develop at the unmined "gates" between panels and the resulting deep pool may alter stream communities. Gate cutting is a procedure designed to mitigate these effects. Consol Pennsylvania Coal Company LLC (CPCC) contracted with Civil & Environmental Consultants, Inc., (CEC) to design the restoration and monitor post-restoration success at 15 gate cut sites in southwest Pennsylvania. At each site, CEC established monitoring stations to assess response of biological communities to post-mining subsidence and its restoration. As part of a holistic biological monitoring program, fish communities were sampled with backpack electrofishing, generally two or more times during each period: pre-mining, post-mining subsidence, and post-restoration. CEC computed number of fish, species richness, and percent abundance of dominant species for each station and compared these between periods with linear mixed models. Overall, each metric differed significantly between monitoring period, fish metrics decreasing significantly ($P < 0.05$) after subsidence and then increasing significantly after restoration. Importantly, fish abundance and richness after restoration were statistically equivalent ($P > 0.05$) to those before mining. These results indicate that where fish communities are altered due to subsidence pooling, they can be effectively restored by gate cutting.

About the speaker: David Parise is a project manager in the Ecological Services Practice at Civil & Environmental Consultants, Inc. He has worked at CEC for 10 years serving as a project manager on numerous stream restoration and wetland mitigation projects. These projects included geomorphic surveying; groundwater monitoring; natural stream channel design; project planning; environmental permitting; construction oversight; and post-restoration monitoring. He has a B.S. degree in Wildlife & Fisheries Science from Pennsylvania State University.

Effects of Urban River Rehabilitation Structures on the Fish Community in the Ottawa River, Ohio

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Co-Authors: Johan Gottgens - Co-investigator and research adviser Todd Crail - Co-investigator and thesis research committee member

Abstract: A river rehabilitation project to improve ecological conditions of the Ottawa River located on the University of Toledo campus was completed in 2013. We employed a before/after-control/impact assessment to quantify impacts of the rehabilitation structures on the resident fish community. Assessment began in 2013 prior to rehabilitation and concluded in July 2014 with post-installation surveys. The rehabilitation utilized bendway weirs, lunkers, locked logs, hydraulic cover stones, structural transitioning stones, stone toe protections, and arcing stone formations known as "smiles". Using standardized electroshock and bag seine capture techniques, fish community data were collected and analyzed in eight 20m river segments with four control and four impacted sites. Each impacted site contained multiple rehabilitation structures while control sites were not altered. A total of 1,284 fish belonging to 26 species, including an Ohio listed species of concern, were sampled in 2013. Index of Biotic Integrity scores ranged from 12 (very poor) to 24 (poor), while Qualitative Habitat Evaluation Index scores ranged from 36.5 (poor) to 46 (fair). Individual site richness ranged from five to 15 species, with 18 to 157 fish sampled per site. The collection included five gravid species, two exotics, and 11 species displaying DELTs. Bluntnose minnows and round gobies dominated, comprising ~50% of the catch. Sediment composition data from 72 surface cores revealed that very coarse and coarse sands (0.5mm-2mm) were the dominant substrate type prior to installation with little organic debris (0.5-2.4% by weight). Submerged vegetation was recorded at only one site in 2013. Contour GIS images were created to visually demonstrate changes in depth, flow, and sediment particle size of sites for both years. Final results depend upon completion of the 2014 post-installation sampling in July and will be discussed during this presentation.

About the speaker: Aaron Svoboda is a graduate student at the University of Toledo Department of Environmental Sciences seeking his Master's degree in Ecology. Mr. Svoboda also works as a teaching assistant at UT, educating first-year students in an introductory environmental sciences course. He has a B.S. in Biology with a specialization in Marine and Aquatic Sciences from Bowling Green State University.

Hatchery Creek Stream Restoration Project - A Unique Opportunity to Maximize Trout Habitat, Create Recreational Opportunities and Provide Mitigation Credits

Two Part Presentation

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Abstract: The Hatchery Creek Stream Restoration project is a unique opportunity to utilize the latest stream restoration techniques to maximize trout habitat, create recreational opportunities for the citizens of Kentucky, and provide mitigation credits. The project is located immediately downstream of the Wolf Creek Dam US Fish & Wildlife National Trout Hatchery near Lake Cumberland in Jamestown, Kentucky. The project will extend an existing 400 foot long channel, which is the outflow from the trout hatchery to create approximately 6,000 feet of trout stream habitat. In an effort to maximize habitat and recreational opportunities, the project is being designed to provide a variety of habitat for all life stages of trout and will include a variety of stream types including A, B, C and DA channels. This project has several unique aspects, which are not typical to natural channel design projects in the southeast, including a constant flow of approximately 35 cfs, which is approximately 70% of the upstream bankfull flow, limited sediment supply, and the need to maintain imported spawning gravels. This talk will focus on the design and implementation of this project under a design/build project format. In particular the development of the habitat features will be discussed in detail including the stream type and habitat type selection process and how the different stream types and habitat features relate to the various trout life stages. In order to maximize the habitat and recreational features the design team included aquatic biologists as well as avid fishermen. In addition, input from key project stakeholders was sought throughout the design process including through a two-day QAQC meeting. Project implementation will also be discussed including the coordination with numerous stakeholders, project staging, and construction methods utilized.

About the speakers: George Athanasakes serves as the Ecosystem Restoration Services Leader for Stantec. He has a broad range of experience in Ecological Restoration including the use of natural channel design, stream and wetland restoration, watershed master planning and dam removal. George also led the development of the RIVERMorph Stream Restoration Software

and is responsible for software content, new releases and training. George holds Bachelor's of Science and Master's of Engineering Degrees from the University of Louisville.

Designing for Threatened and Endangered Fish Species and Responses to Restoration; Raccoon Creek Stream Restoration Project

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Co-Authors: Kathleen Owens, The Nature Conservancy; Anita Goetz, US Fish and Wildlife Service; Brett Albanese, PhD, Georgia Department of Natural Resources

Abstract: Raccoon Creek is one of The Nature conservancy's (TNC) high priority watersheds in the greater Etowah River Basin because it is the only known habitat for the federally endangered Etowah darter downstream of Lake Allatoona and supports one of the largest populations of the federally threatened Cherokee darter in the species' genetically-distinct lower evolutionary species unit. The Raccoon Creek Stream restoration project consisted of improving aquatic habitat for the Etowah and Cherokee darters through the restoration, enhancement, stabilization, and preservation of approximately 6,441 feet of channel. The long term goals of the project are to protect and enhance wildlife habitat, reduce streambank erosion and sedimentation, and improve stream stability through the use of natural channel design and bioengineering. The first phase of the project, which was designed in 2010 and constructed in the winter of 2011, consisted of approximately 1,000 feet of restoration along Raccoon Creek and riparian buffer planting for approximately 3,100 feet of Raccoon Creek. The second phase of the project was designed in 2012 and constructed in the winter of 2013, consisted of the restoration of approximately 1,000 feet of Raccoon Creek and associated riparian buffer plantings. This presentation will focus on two components of the restoration. First, we will discuss the design changes to riffle structures to improve species specific habitat for both the Etowah and Cherokee darters from the first phase to the second phase of construction (lessons learned to create better habitat). Second, we will discuss the pre-and post-restoration fish sampling results from six years of data. Post restoration sampling has shown that the stream restoration had no negative effect on the existing populations of Etowah and Cherokee Darters, and that there has been an increase in abundance in each of these species, depending on the year and drought effects.

About the speaker: Steve Glickauf presently serves as a Senior Project Manager for Corblu Ecology Group, LLC in Lawrenceville, Georgia. He specializes in stream restoration from endangered species habitat to mitigation banking development, permitting and management. He has a B.S. degree in Natural Resources Ecosystem Assessment from NCSU and a M.S. degree in Forest Ecology from Southern Illinois University.

McDowell Creek Watershed Management Plan

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Abstract: The McDowell Creek Watershed is located in northwest Mecklenburg County and drains portions of the Towns of Huntersville and Cornelius. McDowell Creek empties into Mountain Island Lake at McDowell Creek Cove, which is just upstream of the main Charlotte Mecklenburg Utilities drinking water intake. As such, most of the watershed has been designated as Water Supply, which requires new development to observe certain impervious, buffer and storm water detention requirements. Despite the Water Supply Designation, McDowell Creek Cove has some of the worst water quality conditions of any of the reservoirs (Lake Norman, Mountain Island Lake and Lake Wylie) comprising Mecklenburg County's western border. McDowell Creek has been listed by the North Carolina Department of Environment and Natural Resources as being biologically impaired, which means that populations of aquatic insects are not diverse and/or plentiful. Because of the degraded conditions in McDowell Creek and McDowell Creek Cove, a proactive Water Quality Ordinance was developed and implemented by the Town of Huntersville, which places strict storm water runoff treatment requirements on all new development. The ordinance was designed to prevent continued degradation of the creek and cove, however, pre-existing sources of pollution from development that occurred prior to the implementation of the Water Quality Ordinance was not mitigated. In order to address the pre-existing sources of pollution, watershed management efforts including production of this Watershed Management Plan have been undertaken. Already, several cooperative efforts between public and private interests have resulted in several Best Management Practice (BMP) retrofit projects as well as the restoration of many miles of McDowell Creek and its tributaries.

About the speaker: David is originally from Green Bay, Wisconsin. He completed his bachelor's degree in Geology at the University of Wisconsin Milwaukee in December, 1990. Upon completion of his undergraduate degree he was employed by the Great Lakes Research Facility in Milwaukee, WI studying the interaction of ground water with Lake Michigan. David moved south in May of 1991 to accept a temporary appointment to the United States Geological Survey Field Office in Charlotte, NC. He investigated ground water and surface water interaction in Lincoln County, NC. Upon completion of his appointment he attended Clemson University where he received his Master of Science Degree in Hydrogeology in December of 1994. During his tenure at Clemson he investigated the potential migration of contaminants from the Department of Energy Savannah River Site in South Carolina to water supply aquifers in Georgia. Upon graduation from Clemson, David was employed in the private sector as an environmental consultant to several large corporations in the southeast. In July 1999 David accepted a position with the Mecklenburg County Water Quality program. David's responsibilities included mathematical modeling and development of Geographical Information

System (GIS) capabilities. David developed Total Maximum Daily Loads (TMDLs), which are assessments of polluted water bodies, for Sugar, Little Sugar and McAlpine Creeks in Mecklenburg County. These represented the first TMDLs developed by local government in the Southeastern United States. Moreover, these TMDLs were among the first to present findings on the impact of contaminants in ground water and their impact on surface waters. David was also responsible for the flow of technical information to the Post Construction Ordinance Stakeholder Group, which developed land development ordinances for all of the jurisdictions in Mecklenburg County. The information provided included impact analysis of proposed ordinance provisions, cost benefit analysis of specific management techniques, GIS support and interpretation of numerical modeling results. David has supervised the preparation of Watershed Management Plans, which are strategies to restore degraded waters. Additionally, he has secured grants for assessment and improvement of degraded waters in the Mecklenburg County Region. Recently, David was selected to lead Mecklenburg County's storm water planning and mitigation team where he identifies projects for both water quality improvement and flood mitigation.

Torrence Creek, Torrence Creek Tributary #2, Torrence Creek Tributary #1, and McDowell Creek Stream Restoration

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Abstract: In 2009, Kimley-Horn was selected by Mecklenburg County to restore 7,600 linear feet of Torrence Creek from McCoy Road to the confluence with McDowell Creek and 8,200 linear feet of Torrence Creek Tributary #2 from I-77 to the confluence with Torrence Creek. Kimley-Horn completed the planning, grant application, permitting, public involvement, construction documents, construction phase services, and post construction documentation and monitoring. Design challenges included no-rise requirements from FEMA, sediment transport considerations (due to a high volume of sand and silt from contributing reaches), a wooded corridor, multiple existing (sanitary sewer) and proposed (gas) utility crossings, and adjacent parallel lines. Portions of this project were used to generate compensatory mitigation for inclusion into the City of Charlotte's mitigation bank. Construction on these reaches was completed in 2010.

About the speaker: Jason Claudio-Diaz graduated from NC State with a BS in Environmental Engineering. Jason is a water resources engineer and floodplain manager who manages numerous watershed restoration projects including stream restoration and best management practices for water quality and flood protection. He has permitted and designed stream restoration projects in 8 states including NC, SC, TN, GA, WV, TX, NY and VA. Jason works on mitigation and non-mitigation stream projects in both urban and rural settings. He is involved in projects from conception through construction and monitoring. Mr. Diaz approaches projects using a multi-disciplinary approach that includes incorporating data collected in the field, detailed modeling, and design validation.

Torrence Creek at The Park: Design Case Study

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Abstract: Building on Kimley-Horn's successful stream work along Torrence Creek at the Bradford Hill Greenway, Wildlands Engineering was selected to complete a feasibility study and construction documents for 4,100 linear feet of Torrence Creek and a tributary that flow through The Park commercial business park site in Huntersville, NC. This reach of stream is immediately upstream of Kimley-Horn's project that was constructed in 2010. Reach 1 of the project is tightly constrained and has been enhanced within the existing channel. A landscaped look was selected for this reach that is located in the center of the business park, adjacent to a popular walking trail. Reach 2 flows through an undeveloped, wooded wetland area and allowed for a meandering restoration approach. Design challenges included maintaining consistency with The Park's established landscape palette, a sanitary sewer crossing at bed grade dictating profile elevation, and sediment transport considerations for a channel with a high volume sand load. Permitting challenges included no-rise requirements for the FEMA floodplain. Construction was completed in 2013. Charlotte-Mecklenburg Storm Water Services with the Town of Huntersville has funded design and a Clean Water Management Trust Fund grant helped to fund construction. Following the successful completion of this project, Wildlands Engineering has recently conducted a feasibility study on 11,000 LF of Torrence Creek and tributaries immediately upstream of the initial Park site.

About the speaker: Emily Reinicker currently serves as a water resources engineer for Wildlands Engineering's Charlotte, NC, office. She has 15 years of professional experience in water resources and civil engineering, including hydrologic and hydraulic modeling, natural channel design, watershed analysis and storm water management. She specializes in the design of stream restoration and enhancement work in urban and rural settings of NC. Emily holds a biosystems engineering degree from Clemson University and is a registered Professional Engineer and Certified Floodplain Manager in NC. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

A Return to Stream Restoration Engineering: The Current and Future State of Step Pool Design

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Co-Authors: Eric Dawalt, Ridgewater

Abstract: Peer reviews of multiple stream restoration projects involving step pool sequences reveal a wide range of fundamental design approaches including reference analogs, traditional hydraulic threshold design, mimicking relationships referenced in published articles, grade control structure sequences as well as other methods. This presentation will compare multiple step design procedures to published relationships for step pools and will also discuss an evolving technique for step pools that drops grade over discreet locations as well as short, steep sequences. This engineered approach to step pools may provide a viable alternative for future restoration projects.

About the speaker: Mike Adams, PE is a Senior Associate Engineer with Stantec Consulting Services, Inc. in Chantilly, VA. He has 16 years of experience as an engineer and has focused is career on stream restoration assessment, design and project management for the past 12 years. Eric Dawalt, PE is the president of Ridgewater, LLC, a construction firm focusing in stream restoration and other water resources projects. Eric has 15 years of experience as an engineer and contractor.

Characteristics of Southern Appalachian Plateau Step Pool Stream Systems

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Abstract: Better understanding of how valley and stream morphology control step-pool characteristics, specifically, composition, spacing, and height of steps is important for stream restoration efforts. 18 alluvial stream reaches in or near the Bankhead National Forest in the Appalachian Plateau physiographic region of Alabama were surveyed and morphological data including longitudinal profile, channel dimension, step characteristics and step composition were gathered. The drainage areas of the sites ranged from 0.05 to 1.09 km2. Preliminary data are presented. Stream slope varied from 0.005-0.026 m/m. Bankfull cross-section dimensions were moderately correlated to drainage area of the streams. The strongest correlation was between drainage area and channel depth (R2 = 0.72) followed by the correlation between drainage area and channel cross-sectional area (R2 = 0.68). Of the 54 steps surveyed, primary grade control was comprised of rocks in 59%, live roots provided primary grade control in 35%, and dead wood provided primary control in 6% of steps. Mean step height was highest for dead wood steps at 0.26 m followed by 0.21 m for live root steps, and 0.15 m for steps composed of rock. At channel widths greater than 3 m live roots were not found to be primary step controls. In addition some plant species were more frequently found to be contributing roots to step control. Of live root steps, 26% were hophornbeam (Ostrya virginiana), 26% were red maple (Acer rubrum), and 21% were tulip poplar (Liriodendron tulipifera).

About the speaker: Cade Kistler is a Masters student in the Crop, Soil, and Environmental Science Department at Auburn University. He has a B.S. degree in Environmental Sciences from Auburn University.

Headcut Stabilization Procedure on 1st and 2nd Order Streams

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Abstract: The U.S. Fish and Wildlife Service Chesapeake Bay Field Office (Service) has developed a innovative and cost saving approach to stabilize headcuts in headwater streams. Headwater streams represent a large portion of stream drainage network and are being degraded or lost at an alarming rate. Typically they are located in steeper sections of the watershed with erodible soils and are very sensitive to disturbance. In order to address the challenges found in the headwater streams, the Service has taken a cost wise, whole systems approach using natural channel design methods (NCD) to stabilize the headcuts. The strategy is to install grade control structures on first and second order streams to halt headcuts from migrating farther up the stream valleys. As the headcuts progress upstream, a large volume of sediment is released from bed degradation and bank erosion. Stopping the headcut, will prevent additional miles upstream of the headcut from becoming incised with vertical eroding banks, help maintain forest integrity, and keep excessive suspended sediment and associated nutrients from entering downstream reaches. The stabilization of the headcuts will jumpstart the natural recovery processes of streams. Typically instability from the headcuts is localized and stable sections of stream exist upstream and downstream. Once the instability of the headcut is removed, the stream will be able to stabilize on its own. The headcuts will be addressed through the use of small equipment, hand labor, and hardwood logs or natural sandstone rock. This implementation approach will reduce the construction costs by limiting the amount of channel work and structures. The Service has developed typical headcut design solutions based on the typical headcuts occurring within the project watershed. The typical designs would then be applied to all of the headcuts proposed to be addressed under this watershed restoration effort. The Service is also currently working with the Anne Arundel County Maryland - Department of Parks and Recreation to implement this procedure in an unnamed tributary to Bacon Ridge Branch in Crownsville, MD. Construction will occur in summer 2014.

About the speaker: Mr. Secrist is biologist with the U.S. Fish and Wildlife Service - Chesapeake Bay Field Office in Annapolis, MD; where he is currently the program leader for the Stream Habitat and Restoration group. He has nearly 20 years of experience conducting stream and watershed assessments, developing stream restoration designs, project design review, and providing construction management on restoration projects.

Analysis of Scouring in River Bends

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Co-Authors: Dr Panos Diplas, Lehigh University

Abstract: Analysis of river meander geometry can be broadly classified into two categories: Numerical approach & Statistical approach. Numerical modeling approach can be traced back to the era of 1868 when "Boussinesq" made a theoretical analysis of curved laminar flow. Since then a significant advancement has been made in this numerical model field and researchers have succeeded in finding relationships for Transverse Bed slope, transverse shear stress, position of maximum scour etc. This research mainly revolves around the numerical models developed in 1980s (Odgaard & Ikeda) and statistical models developed in 2001 (Soar & Thorne). Odgaard Model was one of the first models which apart from predicting the maximum scour depth, could also make a prediction for the maximum scour location. Interestingly, when Odgaard numerical/mathematical model was used on the 71"Red River" bend data points, a strong linear relationship was obtained for "location of maximum scour" and the corresponding average "aspect ratio" of the rivers. However, based on Odgaard, Engelund, Falcon & Kennedy, Bridge and Talman Model, there doesn't lie any strong relationship between "maximum scour depth value" and corresponding average "Aspect ratio". But when "maximum scour depths divided by mean depth" from these models is plotted against the corresponding "radius of curvature divided by mean width", similar trend is observed for all the models (fig2). Also for Odgaard model, when predicted scour depth is multiplied by a factor of 1.5, the Odgaard model do show some overlap on the field scour data plot. Looking at the complexities involved in solving through a numerical approach, Thorne & Soar based on red river data, in 2001 came up with empirical based relationship for maximum scour depth and its location. This research serves as a comparative study between these Numerical & Statistical approach and there accuracy based on Red river data.

About the speaker: Rajan Jha is a water resource engineer working with Arcadis at their Richmond office, VA. He obtained his master's degree in environmental and water resources from Virginia Tech in July 2013. He is member of Phi Kappa Phi and Chi Epsilon Honor society and has been awarded with several graduate research awards during his academic years.

How Does Natural Channel Design Perform Long Term: Case Studies of Three Restoration Projects Approaching Adulthood

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Abstract: Natural channel design approaches to stream restoration were first implemented in the early 1990's on the U.S. East Coast. Very little long term monitoring has been performed on natural channel design projects, as most monitoring requirements are for a maximum of 5 years. Using original design criteria, available pre- and post-construction monitoring data, photo histories, and present day assessments, three natural channel design projects which have been in the ground for a minimum of 12 years were assessed for the their long term stability and resiliency. Both in-stream and riparian conditions were evaluated for stability, habitat, and overall ecological function. Bank stabilization treatments, including hard methods and bioengineering, were assessed for their long term performance. The effects of long term changes in watershed condition will also be discussed in the context of a 10-20 year time period.

About the speaker: Scott McGill received a B.S. in Natural Resource Management from the University of Maryland, College Park in 1989. His 24 year career has focused on the assessment, design, construction and monitoring of stream, wetland, riparian restoration projects throughout the East Coast. In 1998 he co-founded Ecotone, Inc., a river and wetland restoration company headquartered in Forest Hill, Maryland. Originally established as a design firm, in 2003 Ecotone expanded its operations to include restoration construction and adaptive management, specializing in vertically integrated ecological design/build projects. Utilizing the design build process, Ecotone strives to integrate sustainable principles into its design and construction methods and strategies. In 2005, he co-founded Albemarle Restorations, LLC, a North Carolina based company which focuses on large scale restoration of coastal plain wetlands and streams. His firms have designed and/or constructed over 14 miles of stream restoration work and 700 acres of wetlands in the Mid-Atlantic and Southeastern regions of the U.S.

Using the "Kitchen-Sink" Approach for Restoration Monitoring in Red Hill Branch

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Abstract: Howard County, Maryland, in cooperation with the Columbia Association, received grant monies through the Chesapeake and Atlantic Coastal Bays Trust Fund for restoration in the Little Patuxent Watershed. In 2009, the Red Hill Branch subwatershed was identified as a priority for restoration in the Upper Little Patuxent River Watershed Management Plan. The Trust Fund program requires evaluation of effectiveness of the implemented restoration projects, and tracking of progress toward meeting overall watershed restoration goals. Therefore, a monitoring program was initiated in 2009 for the Red Hill subwatershed. Between 2010-2012, a stormwater management facility retrofit and a stream restoration project were designed and constructed within the subwatershed. Pre- and post-restoration monitoring is intended to demonstrate the effectiveness of retrofits in reducing loading of primary pollutants and to evaluate success of restoration efforts at the subwatershed scale. Monitoring protocols were developed to evaluate existing conditions of channel geometry and sediment load, macroinvertebrate and fish colonization, and water quality conditions, and to detect changes over time owing to restoration activities. This presentation will focus on the multi-faceted stream monitoring being conducted, highlighting results of two years of pre- and one year of post-restoration monitoring. Geomorphic assessment techniques include annual surveys of permanently-monumented cross-sections, longitudinal profile surveys, particle size analyses, substrate facies mapping, bulk-bar sieve analyses, and assessment of bank pins and scour chains. Ecological assessment includes benthic macroinvertebrate and fish sampling and evaluation of physical habitat. Sediment transport is monitored through the use of siphon samplers and pit trap samplers. Finally, water quality is assessed through dry-weather (base-flow) and wet-weather (storm-flow) monitoring. By incorporating so many types of assessments into one monitoring effort, we hope to identify the most efficient suite of parameters to detect changes in stream and ecological condition that might be overlooked using fewer monitoring techniques.

About the speaker: Mark Southerland, Ph.D., PMP, CSE, is Director of Ecological Sciences and Applications at Versar, Inc., and has been supporting federal, state, and local water quality programs since 1988. He was the primary author of the EPA national program guidance on biological criteria and has been the lead consultant on the Maryland Biological Stream Survey for the Maryland Department of Natural Resources (DNR) since 1993. He also supports the impaired waters, stressor identification, and TMDL programs for the Maryland Department of the Environment (MDE). Since 1996, he has helped 16 counties and cities in Maryland, Virginia, Delaware, and South Carolina develop stormwater programs and comply with the Chesapeake Bay and local TMDLs. Mark currently serves as chair of the Maryland Water Monitoring Council Board and was the co-chair of the Howard County Commission on Environmental Sustainability. He is also a member of the Science Council of the Maryland Academy of Sciences.

The Reedy Creek Restoration Study: Long Term Holistic Monitoring of a Watershed Scale, Urban Stream Restoration Project

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Abstract: It's started! The first year results are in for a ten-plus year study of the Reedy Creek restoration project. The Reedy Creek Restoration Study, a partnership between Charlotte-Mecklenburg Storm Water Services and UNC Charlotte, measures multiple stream functions through all phases of a watershed scale stream restoration.

Charlotte-Mecklenburg Storm Water Services (CMSWS) and The University of North Carolina at Charlotte (UNCC) have developed the Reedy Creek Restoration Study (RCRS). The RCRS is a multi-year study focused on understanding the effects of stream restoration in a forested urban watershed. The Reedy Creek stream restoration project is part of the City of Charlotte Umbrella Stream and Wetland Mitigation Bank and will produce approximately 28,000 stream mitigation units and 3.1 wetland mitigation units all within a 2 square mile watershed. This project presents a unique opportunity to investigate the effects of watershed scale stream restoration on macroinvertebrate recovery, watershed hydrology, groundwater/surface water interactions, water quality, organic matter and sediment characteristics. With the interconnected nature of our natural systems, the RCRS will supplement traditional stream restoration monitoring to provide a holistic look at the effects from such a large scale restoration effort. The first year of monitoring is complete and will provide a baseline of the pre-restoration conditions within the watershed. This presentation will cover the history of the project, monitoring plan, year one results and the future direction of our efforts.

About the speaker: Kyle Hall is the Water Quality Modeler for Charlotte-Mecklenburg Storm Water Services. He has 10 years of professional experience in natural resources inventory, TMDL development, GIS analysis, groundwater monitoring and surface water modeling. He currently specializes in statistical analysis and water quality modeling. Kyle holds a B.S. in Fisheries and Wildlife Sciences from North Carolina State University and a M.S. in Biological Systems Engineering from Virginia Polytechnic Institute and State University.

Evaluating Spatial Density of Water Quality Data for Stream Assessment Using a Low Cost Approach

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Co-Authors: Michael Griffin, Ph.D. Student, Coastal Resources Management Program, East Carolina University

Abstract: Water quality assessment is of the most uncertain and costly, but valuable aspects of understanding drivers and influences on stream hydrologic and water quality functions. Logging water quality sensors are frequently deployed for data collection. Data points are limited to a fixed point in time and space, while water quality processes are often spatially and temporally variable. Increased sampling density can reduce spatial and temporal uncertainty and modern equipment typically allows users to specify sampling frequency. However, increasing sensor locations can be cost limiting and there is often a question of necessary spatial density. In this study we approached the spatial aspects of this problem from a low cost perspective by synchronizing water quality measurements (temperature, specific conductivity, turbidity (optical), dissolved oxygen (optical)) with GPS position logs. Seven water quality surveys were conducted between July 2012 and May 2014. Our study site was Lower Blounts Creek (Herring Run to Blounts Bay, 6.4 miles), a tidally (wind and diurnal) influenced, frequently brackish tributary to the Pamlico River in Eastern North Carolina. An engine powered boat towed an YSI 6920 V2-2 water quality sonde alongside the hull at approximately 12 miles per hour, resulting in 0.2 miles between measurements. Each survey was approximately 1 to 1.5 hours. This sampling density was greater than necessary for determining high confidence trends in temperature, dissolved oxygen, and specific conductivity. While the sampling density was likely more than sufficient for turbidity as well, these series had a higher frequency of localized anomalies. A higher spatial density would be necessary to determine whether these values are erroneous or due to localized variability. This low cost approach could be a valuable tool to efficiently assessing spatial distribution of water quality and helping to understand stream processes.

About the speaker: Eban Bean is an Assistant Professor in the Department of Engineering and the Institute for Coastal Science and Policy at East Carolina University. He has worked at ECU since 2012 and focuses on urban stormwater management and coastal plain stream processes. Dr. Bean is a Professional Engineer in North Carolina. He has a B.S. and M.S. from the Biological and Agricultural Engineering department at North Carolina State and a Ph.D. Agricultural and Biological Engineering from the University of Florida.

Urban Stream Restoration Following the Historic 2010 Middle Tennessee Flood

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Co-Authors: Steve Casey, P.E., Civil & Environmental Consultants, Inc.

Abstract: Abstract: The City of Franklin, Tennessee performs watershed based assessments as required by their Municipal Separate Storm Sewer System (MS4) permit. Franklin's storm water utility fund is partially earmarked for urban stream restoration and water quality initiatives. Ralston Creek watershed was selected for restoration and enhancement following the historic May 2010 flood that occurred in Middle Tennessee and since the receiving stream (Harpeth River) is on the state's 303(d) list for siltation and habitat impairment. The purpose of the project was to create meaningful improvements to the non-assessed stream that will have measurable positive impacts to downstream reaches. The City selected three sections of Ralston Creek for restoration and water quality improvements and CEC was awarded contracts for two sections of Ralston Creek. The first project was located in Buckingham Park subdivision and proved to present numerous constraints to construction and restoration activities and the second was at Cheswick Farms. The stream had been channelized during the development of the subdivision and was in the process of degrading and trying to reform meanders. The goals of the project were to stabilize eroding, failing banks; improve in-stream habitat; restore a healthy riparian buffer that would reduce thermal impacts and provide filtration of overland runoff. The channel restoration, stabilization, and re-vegetation project provides long term stability by reducing vertical banks and providing a flood prone area to dissipate the energy of flood flows. Several areas of the stream were in need of more traditional engineering stabilization methods in order to protect infrastructure and personal property. These areas were treated with stacked stone walls and rock toe protection. The majority of the channel received natural channel design treatments such as log vanes, rock ledges, coir roll bank protection, sloping banks, creating a bankfull floodplain shelf, and riparian plantings.

About the speaker: Jeff Duke is an ecologist with over 25 years of experience managing and performing ecological and ecosystem restoration projects. He has experience in the regulatory permitting and compliance arena dealing with Section 404/401 of the Clean Water Act. His areas of expertise include ecosystem restoration, stream restoration, wetland ecology and delineation, mitigation banking, fisheries, benthic macroinvertebrate surveys, threatened/endangered species, and ecological assessments. He has a M.S. degree from the University of Alabama in Aquatic Ecology.

Reconstruction Efforts after the Middle Tennessee Flood of 2010

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Abstract: As a result of the historic Nashville flood on May 1 and 2, 2010, Richland Creek (a tributary of the Cumberland River which flooded downtown Nashville) overtopped a natural barrier separating the creek from the REOSTONE quarry in west Nashville. Richland Creek filled the quarry with an estimated 3-4 billion gallons of water in about 5 hours, ironically protecting adjacent properties by dropping the flood stage of Richland Creek but simultaneously causing significant property damage for the quarry's owner, Rogers Group, Inc. The natural barrier contained sanitary sewer pipes, which broke and began discharging raw sewage. An estimated 300 feet of Richland Creek fell into the quarry – the channel was gone.

Rogers Group hired CEC days after the flood to assist in the complex process of seeking the required permits for permanently repairing Richland Creek. The design and permitting was complicated by factors such as the presence of TVA power lines, sanitary sewer pipes (which had to be relocated), and the need for a permanent berm separating the creek from the quarry located a sufficient distance from the fault line believed to have been the main contributor to the failure. CEC worked closely with Rogers Group and the permitting authorities to design a natural stream within the myriad of constraints.

Permitting included §401 Water Quality Certification from the Tennessee Department of Environment & Conservation and §404 Department of the Army Permit from the Nashville District Corps of Engineers. Local permitting through the Metro Nashville Storm Water Division for a grading permit was also secured. All permits issued were highly dependent upon the results of a HEC-RAS flood study.

Upon issuance of the final permit, construction began in November 2010 with three construction projects occurring simultaneously in a site less than 15 acres. The project was successfully completed 2 years ago.

About the speaker: Steve Casey has over 15 years of civil engineering consulting experience. His focus has been within the water resources field. His experience includes performing hydrologic and hydraulic modeling for small site projects and for large stream restoration projects, complex drainage basin analysis and design, floodplain management, and erosion prevention and sediment control design. He also provides NPDES compliance services and specializes in small MS4 permit compliance.

From Disastrous Flooding to a Water Quality Showcase - Briar Creek – Chantilly Water Quality Improvement Project

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Abstract: Briar Creek – Chantilly Water Quality Improvement Project goes beyond even a showcase Watershed Enhancement Project. It is an example of successful collaboration between multiple organizations and multiple funding sources and a model for holistic, collaborative watershed enhancement projects which are necessary to maximize watershed uplift opportunities.

Doral Apartments and Cavalier Apartments once sat on each side of the banks of Briar Creek, just upstream of Monroe Road. Each apartment complex sustained millions of dollars in damage from flooding that occurred three times in nine years in the late 1990's and early 2000's.

After having been demolished in the late 2000's thanks to a Flood Plain Buyout Program from FEMA and Mecklenburg County Storm Water Services, the same area that was once known for frequent disasters is set to become a showcase of Water Quality Enhancement, public education and outreach and public open space and recreation.

This holistic project features approximately 4,500 linear feet of stream restoration, an extended detention wetland and a wet pond. The extended detention wetland will treat over 27 acres of existing, built-out single family housing. The wet pond will treat more than 92 acres of existing development, the majority of which is commercial property.

This presentation will focus on the exceptional collaboration of multiple organizations with multiple objectives and benefits as well as a description of the holistic conceptual design of the project

About the speaker: John Schrum is the Senior Water Resources Engineer for Charlotte-Mecklenburg Storm Water Services. He has 14 years of professional experience in storm water management with a focus on water quality. This experience includes design of over 60 structural stormwater control measures that are in the ground and functional. John currently specializes in two major areas of water quality for the City. John oversees the City's Pond Program and also oversees other capital water quality improvement projects. In addition, John specializes in stream restoration and works with others on the City's water quality team to evaluate and improve natural channel design projects that are carried out by the City. John has a Masters of Civil Engineering in Water Resources and Environmental Engineering as well as a Bachelor of Science in Environmental Engineering from North Carolina State University.

Enhancement of Concretized Streams: Mill Creek

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Abstract: A growing awareness of the anthropogenic impacts to waterways has spurred much interest in ecological stream restoration. Billions of dollars are entering this field as municipalities and developers bend to societal and regulatory pressures. But research suggests that stream restoration projects only consider aesthetics and economic growth as key goals, failing to consider how streams function holistically or ecologically. The techniques currently used, which include bank stabilization, erosion control, stormwater management, and re-vegetation (Bernhardt and Palmer, 2007), act as a mere cloak over the true function of the restoration project. Additionally, research suggests that stream restoration funds are greatly misused, funding only stream restoration projects where space, politics, and infrastructure allow (Nilsson et al 2003, and Niezgoda and Johnson 2005). Meanwhile, the most heavily degraded portions of our urban waterways lie untouched.

The goal of this project is to show how “restoration” might occur in concrete-lined (concretized) waterways where the degree of changes and demands that have been placed on the watershed by urbanization prevent a return to a naturalized condition. Objectives within this study focus on improvements to water quality, in-stream habitat, accessibility, and connectivity for communities.

I catalog traditional stream restoration techniques from the United States Department of Agriculture (USDA) and the United States Army Corp of Engineers (USACE) to understand their tectonics, positioning, and effectiveness. I then hybridize these traditional techniques to apply broadly to concretized stream conditions, and I further develop geographically specific hybrids in Sections 3 and 4A of the Lower Mill Creek, Cincinnati, Ohio. Sectional and vignette drawings help illustrate the materiality, connections, and interactions of the hybrid types. This method of investigation yields a catalog of 30 hybrid interventions for the enhancement of concretized waterways.

Finally, this project considers what could become of the Mill Creek if thought of as a critical infrastructure—one that has to accommodate industrial and flood control concerns, as well as ecological and social concerns. Through this lens, new layers emerge, upon which the Lower Mill Creek can be engaged and re-imagined.

Sources:

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About the speaker: Brett earned his Bachelor of Urban Planning from the University of Cincinnati, and his Master of Landscape Architecture degree from Ohio State University where he focused on productive and performative landscapes as well as ecological urbanism. While at the Knowlton School of Architecture, Brett received national and regional design awards for 'Augmenting Systems'—a project focused on the reutilization of process wastes at coal-fired power plants. His past experiences have focused on urban ecological interventions, landscape on structure, and design development for a range of large public and private projects. Brett's current interests include ecological engineering and landscape performance, and their assimilation in urban environments.

Advancing the Science, Policy, and Approach of Stream Restoration

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Abstract: We have seen tremendous change in the last 30 years regarding the management of our streams and rivers. Throughout the 1800s and much of the 1900s river management was focused on "improvements" for the purposes of drainage, flood control, and navigation. In the late 1900s, scientists and engineers began to incorporate principles of fluvial geomorphology into river restoration, and the term "Natural Channel Design" was born. In the early 2000's, stream mitigation regulations began to shift the focus to restoring physical, chemical, and biological functions. The restoration of stream functions goes beyond the stability focus of natural channel design. Amid these changes, however, traditional methods of flood control and channelization remain. And even with a focus on restoration-based methods, uncertainty remains about the effectiveness of these newer approaches. Some research shows that restoration is effective and other studies show it is not. Confounding the issue, most research studies do not specify the restoration approach or techniques used. Stream Mechanics has been working with the Environmental Law Institute, through a grant from the US Environmental Protection Agency, to evaluate the science of stream restoration, the approaches used, and the policy guiding stream mitigation activities. The purpose of the project is to develop a stream restoration/mitigation handbook that can be used to apply the best-available science to achieve better stream restoration results. This presentation will provide what we've learned so far from examining stream mitigation protocols from across the country, the science behind stream restoration, and a new framework for organizing stream restoration approaches and techniques, including suggestions about how to match approaches/techniques with watershed problems.

About the speaker: Mr. Harman is the founder of Stream Mechanics, a small company dedicated to advancing the science and application of stream restoration. Prior to forming Stream Mechanics, he was Vice President of Ecosystem Restoration with Michael Baker Corporation. In the course of his 23-year career, he has participated in hundreds of stream restoration projects, representing a wide variety of settings and techniques. He teaches stream restoration workshops to federal, state, and local agencies, universities, and private engineering firms. He has a Master's degree in Geography from the University of North Carolina at Charlotte and Bachelors degree in Geography from Appalachian State University. He is a licensed Geologist in North Carolina and Texas.

Mitigation Banking Opportunities for the Southeast Region

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Abstract: Stream mitigation has been around in the Southeast since the late 1990's. The Wilmington District was one of the first districts in the Southeast to require stream mitigation. In the beginning stream mitigation sites were readily available throughout the region but as the demand for sites has increased and State and Federal programs to protect water quality have also increased, fewer traditional sites will be available in the future. Also, stream restoration approaches have evolved as we have made modifications to in-stream structures to harvesting bed material on-site. Regenerative stormwater channels are going to become more common. Best Management Practices to further improve water quality will be a standard for all stream mitigation projects.

About the speaker: Mr. Webster serves as the Technical and Regulatory Director at Environmental Banc & Exchange. Mr. Webster works with engineers, consultants, client representatives and regulatory officials during the concept, proposal, design, construction and monitoring phases of all EBX projects throughout the Southeastern United States. Mr. Webster is the past President of the North Carolina Environmental Restoration Association and on the executive board of the Piedmont Research Conservation & Development Council. Before joining EBX, Mr. Webster served as an Environmental Scientist with various environmental consulting firms where he managed natural resource investigations, ecological assessments, wetland delineations, wetland mitigation feasibility studies and wetland mitigation searches. Mr. Webster holds a B.S in Business from Wake Forest University and a M.S. in Forestry with a concentration in Soil Science from North Carolina State University. Mr. Webster works in the North Carolina office of EBX.

Stream Mitigation ≠ Stream Restoration

Michael Ellison
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Abstract: In North Carolina, most stream restoration projects are produced to generate stream mitigation credits. The 2008 Federal mitigation rule is replete with good intentions that would have mitigation replace aquatic functions lost to permitted impacts. In reality, thorough evaluations of ecosystem functions rarely occurs at permitted sites or mitigation sites. Permitted impacts are measured in linear feet and mitigation credits are determined by a quasi-arbitrary function that factors the intensity of work performed by the length of stream receiving the work. In short, the law requires that most impacts be permitted under certain general conditions, and the regulatory apparatus must determine how many pounds of flesh are to be excised from the permit applicant. Federal rule allows permit applicants the privilege of paying surrogates to provide the pound of mitigation flesh.

Thus it falls to mitigation providers to persuade regulators as to the gross, tare and net weights of their projects to maximize mitigation pounds for sale. This is especially challenging for stream mitigation projects because regulatory acceptance is based on grossly simplified assumptions regarding channel form. The fixation on channel form is codified in USACE guidelines promulgated in 2003, and over ten years of practice have failed to wean regulators from the fallacy that a particular stream aesthetic manifests all ecological functions. The regulatory shackles forged by morphologic hobgoblins impede innovation and preclude restoration excellence. There are also lost opportunity costs: when mitigation dollars cannot be fully leveraged to optimize functional uplift, the citizens are shortchanged.

Stream mitigation outcomes can be improved if the regulatory community embraces the spirit of the 2008 rule and enforces the letter of that rule. Doing so requires some measure of the functional uplift generated at mitigation sites. Measurement methods need not be overly complex, merely objective and reproducible, but complex methods should not be proscribed when useful. Reasonable tools to determine functional gains would logically provide a basis for function-based credit structures. If functional credits are adopted, consistently applied, and cost-effective to construct, stream mitigation outcomes should begin to reflect the potential of restoration science and practice, and the tens of millions of dollars spent every year on mitigation would eventually pay real dividends.

About the speaker: Michael Ellison is the Director of the NCDENR Ecosystem Enhancement Program, the statewide in-lieu-fee mitigation provider. Prior work includes twenty-five years as a consultant and contractor restoring natural systems on drastically disturbed sites in the eastern United States.

Posters

Using Stream Metabolism To Measure Shifts In Ecological Function In Impaired Stream Ecosystems

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Abstract: Re-directive in-stream structures are used to restore habitat in impaired streams. By manipulating flow direction, redirecting energy, and causing changes in bed and bank erosion, these installations usually result in increased habitat heterogeneity and bank stability. While changes in habitat structure as a result of these installations is fairly well documented, understanding the level of ecosystem response to these changes is not as clear. This research investigates stream metabolism as a method for measuring these shifts in the ecological function post restoration, expressed as relative changes in production and respiration.

Two different methods are compared at five different cross sections in Elton Creek, a gravel-bed stream in Western New York. The first methods uses two YSI 6920 V2 Sondes to measure dissolved oxygen (DO), resulting in a set of diel curves for two unrestored reaches and two restored reaches. Measurements of DO were made over a 24 hour period to determine day time primary productivity and night time respiration rates in the spring and the fall. This method is based on the premise that DO is directly related to the rate of photosynthesis, respiration and exchange of O2 with the atmosphere. The second method used metabolic chambers in controlled laboratory experiments on subsamples of stream benthos cultivated in the field. Ceramic tiles were deployed for benthic colonization at five cross sections in Elton creek to quantify stream metabolism at the same reaches. These tiles were then transferred into the lab into sealed chambers over a 24 hour period, with conditions controlled in the laboratory to simulate appropriate day and night light intensities. Specific primary productivity and respiration were determined for each sample using light and dark bottle DO measurements. Results from both experiments will be presented and compared, and a metric for measuring shifts in ecological function using stream metabolism discussed.

About the Speaker: Stacey Sloan Blersch has over 20 years experience working in ecological restoration & environmental planning both in the private and government sectors. For seven years, she worked as a project manager and restoration specialist for large scale ecosystem restoration projects in the Chesapeake Bay for the US Army Corps of Engineers and the District of Columbia's Watershed Protection Division. She is currently working on her PhD in environmental engineering as a NSF fellow in the Ecosystem Restoration through Interdisciplinary Exchange (ERIE) program at SUNY at Buffalo. Her dissertation is focused on developing predictive tools and models for ecosystem restoration that link changes in ecosystem structure to shifts in ecological function. Her work is supported in part by the US Army Corps of

Engineers Engineering Research and Development Center in Vicksburg, MS. She is also currently a research collaborator with Auburn University's Biosystems Engineering Department on ecological engineering and water resource issues.

Southern Appalachian Bog Restoration

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Abstract: Former land use practices in the Southern Appalachians included historic land conversion activities to increase the success of agriculture, particularly in the floodplains. Many wetlands were modified through drainage and channelization activities to create arable land. Alterations of these areas has resulted in the listing of several endangered plant and animal species due to habitat loss. Efforts to restore these areas are underway and utilize techniques to improve habitat by restoring the predevelopment hydrology. This case study evaluates several alternatives developed by students to address restoration options for a bog located in North Georgia. Students examined options ranging from taking no action to restoring the bog in hopes of reconnecting the hydrology to promote habitat beneficial to animal and plant species, such as Bog Turtles and pitcher plants.

About the speaker: Dr. Jon Calabria, ASLA, holds degrees from Clemson and University of Georgia where he has returned to teach landscape architecture at the College of Environment and Design. He relies on service-learning approaches to educate students and stakeholders about sustainability and restoration to improve environmental quality.

Avoid False Images in Restoring Urban Streams

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Abstract: Despite the prevalence of stream restoration projects throughout the world, efforts to assess the efficacy and impacts from these projects remain limited. The studies that do exist show that stream restoration efforts tend to be opportunistic, with funding availability and land owner willingness driving efforts. Additionally, urban stream restoration tends to focus on small scale, specific sites without considering broader land use patterns. The authors present a case study that utilizes pre- and post-monitoring data from several restoration projects on an urban headwaters stream to assess how well stream conditions, publicly stated restoration project goals, and project impacts align. This study advances an understanding of urban stream restoration by documenting that although improving ecological conditions is a stated goal for projects, the implemented measures are not always focused on those issues that data suggest are the most ecologically salient. What these projects have accomplished is to protect the built environment, improve aesthetics, and promote positive public perception. We argue that these outcomes are valuable, but that the disconnects among publicized goals for restoration, the implemented features, and actual stream conditions may create a false image of what an ecologically stable stream looks like. This can have far reaching impacts, including perpetuating a false sense of optimism about the feasibility of restoring urban streams and potentially reducing support for protecting high quality streams. Additionally, suggesting that these restoration projects are promoting improved ecological conditions continues to ignore the impacts that urbanization has on waterways. Our findings suggest that implementing urban stream restoration projects can often be valuable, but that they need to be promoted honestly with attention to what is causing the degradation and what can realistically be accomplished with a restoration project.

About the speaker: Kristan Cockerill is an Assistant Professor in the Department of Cultural, Gender, and Global Studies at Appalachian State University. Her research focuses on the intersections of science, culture, and water policy.

Nutrient Uptake in a Forested and Urban Stream in the Southern Appalachians: Implication for stream restoration

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Co-Authors: Laura Heinen, Appalachian State University

Abstract: Stream nutrient uptake is an important ecosystem function that retain nutrients during in-stream transport. The objective of this study was to better understand and quantify the extent of stream nutrient uptake in a context of urbanization. Nutrient uptake were quantified through tracer injection experiments in an urban stream, Boone Creek, and a forested stream, Winkler Creek in the Southern Appalachians. In this study, we applied a newly developed TASCC technique for characterizing continuous spiraling response curves from ambient to saturation with a single tracer addition experiment. Boone Creek was found to have an uptake length 10-fold longer than Winkler Creek; while, Winkler Creek was found to have an uptake velocity over 14 times faster than Boone Creek. The results show a higher nutrient uptake capacity in the forested stream than the urban stream, which indicate that urbanization can deteriorate stream ecosystem functions by reducing nutrient retention capacity, primarily due to the reduced hyporheic exchange. Thus, hyporheic restoration is crucial and has to be taken into account in restoring the ecosystems of urban streams.

About the speaker: Dr. Chuanhui Gu is an assistant professor of Geology. He has earned his PhD in environmental sciences with focus on hydrology in University of Virginia. His expertise includes hydrochemistry and biogeochemistry. One of his research focuses is to understand watershed hydrogeochemical “hot spots”, i.e. riparian/hyporheic zones and wetlands, where coupled hydrologic and biogeochemical processes play a key role on regulating quality of groundwater and surface waters. He has more than ten-year experience working on riparian buffering capacity that controls non-point source pollution in headwater watersheds. He also worked as a research assistant at University of California at Berkeley in projects that address climate change impacts on water sustainability in California’s Central Valley. He has been working on a project that investigates the impacts of land use changes on hydrology and water quality of headwaters while in Appalachian State University.

Macroinvertebrate Community Recovery from Flood Events in Urban Restored Streams

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Co-Authors: Sandra Clinton, UNC Charlotte

Abstract: Flooding is an important disturbance that structures stream communities. While flooding has been investigated in a diversity of freshwater ecosystems, there are fewer studies focused on urban streams. Urban systems are undergoing rapid change from the increased density of human populations. To counteract some of these damages, some streams are undergoing the process of restoration. There is little research on how well these restoration efforts are functioning and what effects they are having on the biota. The purpose of this study is to help quantify macroinvertebrate community changes in restored urban streams in Charlotte, NC after large flood events. This information can allow more appropriate management schemes to be implemented in an effort to maintain the integrity of urban ecosystems.

Urban streams in Charlotte, NC are attractive experimental systems since many small streams with similar watershed characteristics have been restored over the previous decade and potentially have differences in community responses due to restoration age. The chosen experimental streams have similar watershed drainage areas, channel size, climatic interactions, and macroinvertebrate diversities. Overall, older restored systems recovered more slowly than new or unrestored systems. This may reflect the changing restoration strategies used on the newer sites. Results from flood events revealed little change in diversity between pre- and post-flooding with an average 22% decrease ten days post flood. We hypothesize that urban systems are prone to frequent flooding and only disturbance resistant species can persist. Abundance trends reflected other published disturbance studies with a 66% increase ten days post-flood. This results shows the recolonization from upstream areas and refugia. We predict that flooding has a greater impact on abundance than diversity because of the already disturbed state of the urban study sites. Further studies will help to define these trends further and will reveal implications for other environments.

About the speaker: Sara Henderson is a Master's Student in Earth science at UNC Charlotte. She works on a watershed restoration project within the city of Charlotte, NC. She also holds a B.S. in Biology from UNC Chapel Hill.

Assessing Restoration Potential at Toccoa Creek

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Co-Authors: Jon Calabria, University of Georgia

Abstract: Toccoa Creek cascades off of the Appalachian Plateau into the Georgia Piedmont with a waterfall as high as Niagara Falls. The watershed is largely forested, but development encroaches just downstream of the 186 foot high Toccoa Falls. The mile-long stretch of Toccoa Creek which flows through Toccoa Falls College's campus is extensively armored with rip rap and bank patched with inert rubble. The stream's condition can be attributed to a massive flooding event caused by the failure of an upstream dam in 1977 that scoured the channel. The stream assessment and restoration potential will ideally be developed further by Toccoa Falls College as a curriculum component intended to provide students with opportunities for environmental stewardship through participation in the design and implementation of a stream restoration project.

About the speaker:

Allenbrook Drive Restoration Project - Constructing a Highly Urbanized Stream During Record Rainfall

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Abstract: The Allenbrook Drive Tributary Restoration Project consisted of restoration of approximately 1,265 linear feet of degraded stream channel to enhance aquatic habitat and water quality in a highly urbanized watershed in Charlotte, North Carolina. Priority II stream restoration activities were utilized and consisted of channel relocation, bank grading and stabilization, floodplain bench excavation, wetland initiation depressions, installation of in-stream structures, and riparian buffer establishment. These activities were submitted for mitigation credits under City of Charlotte's Mitigation Bank Instrument (MBI) to the Interagency Review Team (IRT). In addition, over 4,000 linear feet of stream enhancement activities were constructed upstream of the mitigation reach to benefit water quality in the watershed and extensive culvert and storm sewer upgrades for conveyance improvements, as part of the City of Charlotte's Allenbrook Westridge Capital Improvements Project (CIP). HDR was responsible for the development of the existing conditions analysis and development of a Site Specific Mitigation Plan (SSMP), restoration design, Section 404/401 permitting, and construction inspection. Construction was completed in the Spring of 2014. Construction of this stream was exposed to multiple 100-year storm events, subjecting the stability of the improvements at its most vulnerable time. Design strategies, and lessons learned through construction, while working with a rookie Contractor, will be shared, along with strategies utilized to collaborate between Designer and Owner during construction.

About the speaker: Eric Mularski is an Environmental Scientist with HDR Engineering in Charlotte, NC. He has 10 years experience as a biologist working on stream/wetland mitigation projects for City of Charlotte, Mecklenburg County, and the N.C Ecosystem Enhancement Program. Duties include pre and post construction monitoring (riparian vegetation, benthic macroinvertebrates, and fish), restoration plan development, conceptual design, Section 404/401 permitting, GIS services, and construction inspection. Eric has a B.S. in Zoology (fisheries emphasis) from Eastern Washington University (Cheney, WA) and holds a Professional Wetland Scientist certification with the Society of Wetland Scientists, and is Rosgen Level 2 Certified.

Assessing the Success of DRAINMOD for the Prediction of Wetland Hydrology for Three Mitigation Sites in North Carolina

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Abstract: Many of the complex interactions that occur in a wetland are dictated by the hydrology. For wetland mitigation to be successful accurate hydrology needs to be restored to reproduce high functioning ecological systems. Wetlands not only need to be wet and ponded, but also need to experience fluctuating hydroperiods with times of saturation and drawdown. To estimate how stream and wetland restoration designs will affect the hydrology and hydroperiod of proposed projects, modeling techniques have been implemented. DRAINMOD has been used to predict the effect of proposed restoration work on the hydrology of wetlands.

This study compares DRAINMOD results of predicted hydrology for three wetland restoration sites in North Carolina to corresponding monitoring data collected for each site. The Lyle Creek Stream & Wetland Mitigation Project improved 9.5 acres of wetlands on an active tree farm located in the headwaters of Lyle Creek in rural Catawba County, NC. The Little Troublesome Creek Mitigation Project restored 18.0 acres of wetlands in Rockingham County, NC. The Underwood Mitigation Project in northwestern Chatham County, NC restored and created a total of 13.8 acres of riparian wetlands and restored and enhanced 1.5 acres of non-riparian wetlands. DRAINMOD was used on all three sites to predict how construction of the project would improve wetland hydrology. By comparing post-construction monitoring data to results of calibrated model runs for the post-construction period, modeling strengths and weaknesses can be identified and applied to future projects.

About the speaker: Eric Neuhaus is an environmental designer for Wildlands Engineering's Charlotte office. He has 2 years of experience working on a variety of projects including stream and wetland restoration, stormwater management, erosion and sediment control, surface water modeling, groundwater modeling, and wetland water budget modeling. He has a master's degree in biological systems engineering from the Virginia Tech University. Wildlands Engineering specializes in water resources engineering and planning with a particular focus on innovative engineering for ecosystem renewal.

Long-Term Response of Benthic Macroinvertebrate Communities to Stream Restoration on Little Sugar Creek in Charlotte North Carolina

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Abstract: Most stream restoration projects are monitored for a relatively short period of time (5 years or less) which may not be long enough for the recovery of the benthic macroinvertebrate community and stream ecosystem function. We investigated this relationship between stream restoration impacts on stream benthic macroinvertebrates over time by analyzing data collected by Mecklenburg County Water Quality Program from three stream restoration projects located on Little Sugar Creek, an urban stream located in Charlotte, North Carolina. The three stream restoration projects span a gradient of restoration approaches: stream bank stabilization (Huntingtowne Farms), in stream habitat and riparian enhancements (Westfield), and natural channel design plus riparian wetland enhancements (Hidden Valley Ecological Garden). The Huntingtowne Farms Project was completed in 1997 and the Westfield and Hidden Valley Projects were completed in 2004. Qualitative benthic macroinvertebrate monitoring was conducted at each project prior to construction and for 3 years post-construction. No significant changes between the pre- and post-construction benthic macroinvertebrate communities were seen at each project. We will be resampling the benthic macroinvertebrate communities in Little Sugar Creek at each of these locations during the Summer of 2014. We will examine the recovery of stream ecosystem function at each project reach by comparing species ecological traits such as functional feeding groups, thermal preferences and habit preferences and compare these functional data to the original pre/post data. This research will fill an important gap in evaluating the success of stream restoration projects with regard to the recovery time of benthic macroinvertebrates, which are often a key criteria used to determine success. It may take longer than the typical 3-5 years post construction monitoring time period for the stream ecosystem to recover from the restoration activities.

About the speaker: Anthony Roux is a Senior Environmental Specialist in the Water Quality Program of the Mecklenburg County Land Use and Environmental Services Agency and a Ph.D. Student in the Infrastructure and Environmental Systems Program at the University of North Carolina at Charlotte. He has worked at MCWQP for 29 years serving as the supervisor of the Mecklenburg County State Certified Biological Laboratory for the past 20 years coordinating the stream bioassessment program (fish and benthic macroinvertebrate). Mr. Roux has worked with the Charlotte-Mecklenburg Storm Water Services to evaluate the various stream restoration projects in Charlotte and Mecklenburg County. Mr. Roux is currently pursuing a Ph.D. in Environmental Engineering at UNC Charlotte studying the impact of stream restoration projects

on stream benthic macroinvertebrate communities. He has a B.S. in Biological Life Sciences, a B.S. in Zoology, and a M.S. in Zoology from North Carolina State University and a M.S. in Aquatic Ecology from the University of Notre Dame.

Local Effectiveness of Stream Restoration Structures Measured by Benthic Macroinvertebrate

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Abstract: The restoration of freshwater streams aims to reestablish the environmental health of the targeted stream or river. Restoration efforts include, but not limited to, channel modifications, such as creating meanders to reduce degradation; log jams, which are designed to prevent in-stream erosion by reducing flooding and high velocity flows, it also creates various micro habitats for larger aquatic organisms such as pools and riffles; lastly, physical placement of structures such as cross-vanes and J-Hook vanes works towards flow reduction and ultimately improve the quality and quantity of aquatic organisms. For the purpose of our research benthic macroinvertebrate samples are collected seasonally and identified to the family taxa, then the results are subjected to series of statistic test to indicate the presence or absence of trends and, or relationships. Our aim for this is to measure the effectiveness by analyzing the quantity as well as diversity of the macroinvertebrate collected from the chosen stream.

About the speaker: Xueying Wang is currently a biology undergraduate pursuing a master's degree in civil engineering with ecology concentration.

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