Restoring Urban Streams
To Create Healthy and Happy Cities

27 Years of Experience in 27 Slides

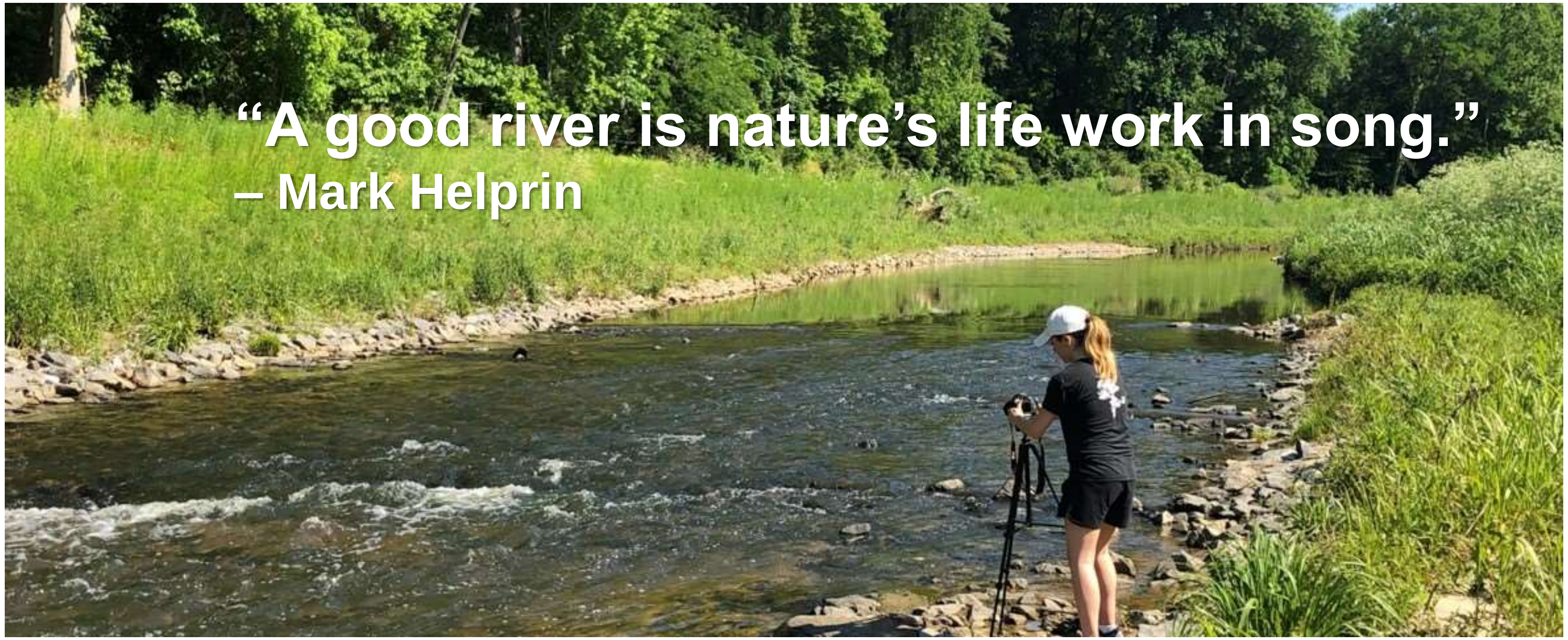
Presented at:

National Stream Restoration Conference

Presented by:

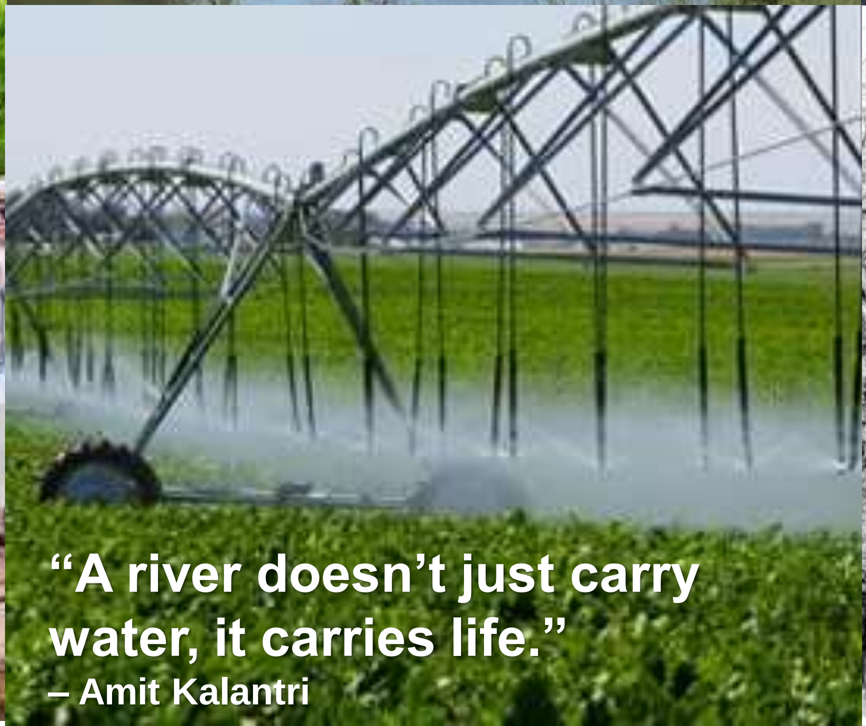
Will Wilhelm, P.E., CFM

Kimley»Horn


"A good river is nature's life work in song."
– Mark Helprin


nrdc.org

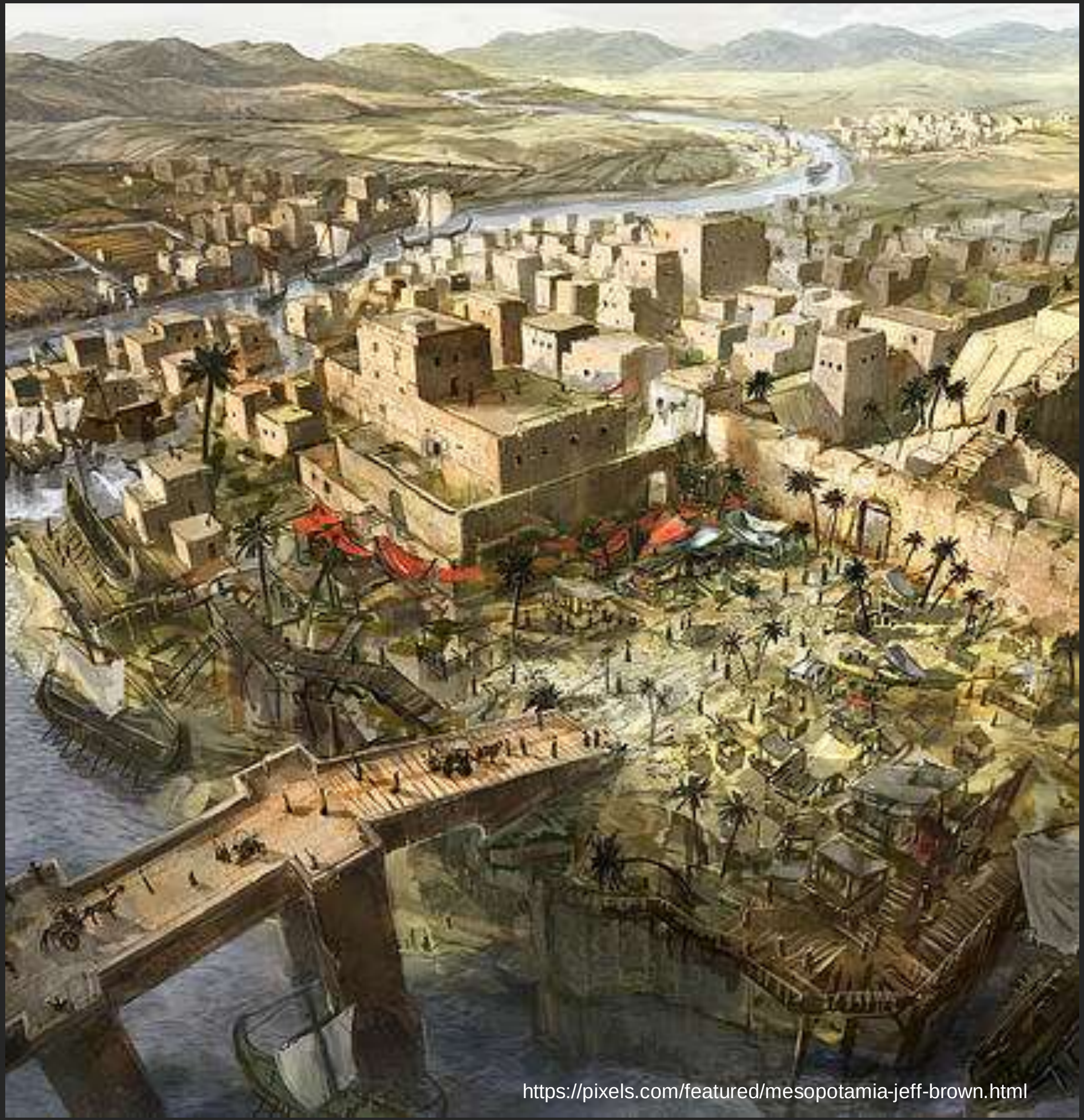

Colorado.edu


“A river doesn’t just carry water, it carries life.”
– Amit Kalantri


Courtesy: Mecklenburg County, NC

We are naturally inspired, calmed, and just generally made happier by being on or around water – playing in it, walking next to it, hearing it, painting it, fishing in it, writing about it, and creating memories around it.

Adapted from Bluemind @wallacejnichols


https://pixels.com/featured/mesopotamia-jeff-brown.html


Smithsonianmag.com


"We steer the boat, we don't alter the river."
- J. Earp
reddit.org


Denverpost.com

Rushing rainwater fills the Los Angeles river near downtown Los Angeles on Dec. 6, 2018. (AP Photo/Richard Vogel)

ENVIRONMENT

LA River restoration project to receive $28M from infrastructure law

BY CITY NEWS SERVICE | LOS ANGELES
PUBLISHED 3:55 PM PT JAN. 19, 2022

LOS ANGELES (CNS) — The Los Angeles River Ecosystem Restoration project will receive $28 million in funding from the federal Infrastructure Law, Mayor Eric Garcetti announced Wednesday.

"The LA River is one of Los Angeles' crown jewels — a foundational piece of our city's story. Now, it's on us to make it shine for ourselves and future generations," Garcetti said.

LOCAL POLITICS

South Platte River restoration plan signed by officials

The Waterway Resiliency Program will provide millions of dollars for flood system management, ecosystem restoration and recreation in the Denver area.

Author: Wilson Beese (9NEWS)
Published: 12:30 PM MDT May 8, 2023
Updated: 12:30 PM MDT May 8, 2023

NewsCenter

Restoring Streams to Help the Environment

Published on 05/30/2023

Environment and Energy

QUICK SUMMARY

- More than 20 miles of stream restoration has been completed since 2010.
- There are 22 stream restoration projects currently in design, totaling roughly 19 miles.
- Nine stream restoration projects, totaling four miles, are under construction.

Fairfax County is home to more than **750 miles of perennial streams**, of which about 70% to 80% are in fair to very poor biologic… health. To address this, our Department of Public Works and Environmental Services regularly restores these streams to improve…

INNOVATION | MARCH 15, 2023

How 'Daylighting' Buried Waterways Is Revitalizing Cities Across America

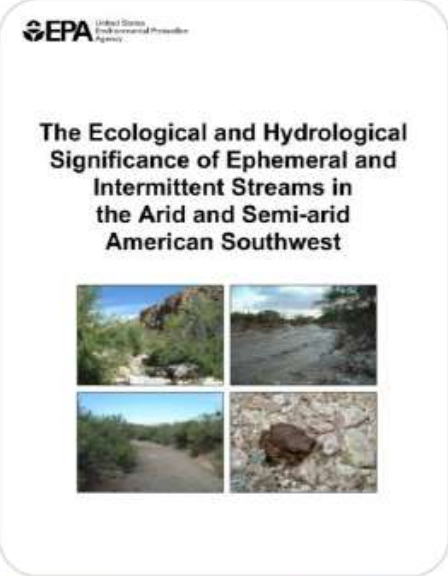
Urban centers are exhuming creeks and streams once covered up to control floodwater—and bringing life back in the process

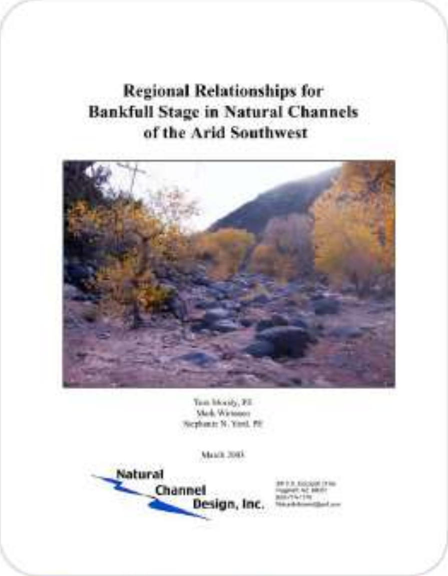
TOBY CREEK: RESTORATION AND AN OPPORTUNITY FOR LEARNING

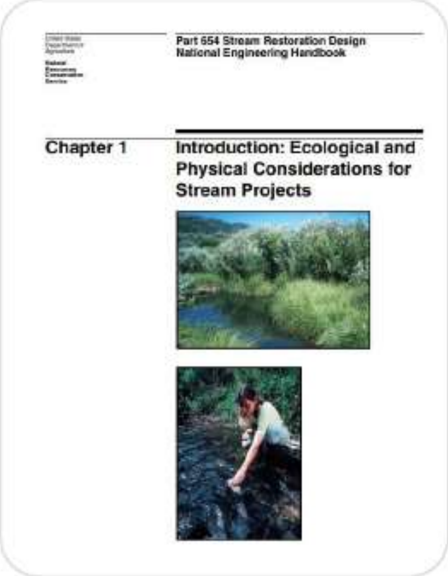
NEWS

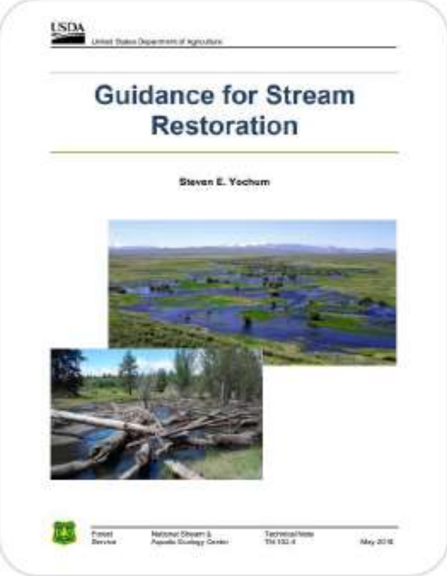
- News and Features
- Toby Creek: Restoration and an opportunity for learning
- Faculty Spotlights
- Student Spotlights
- Research
- Newsletter Archives

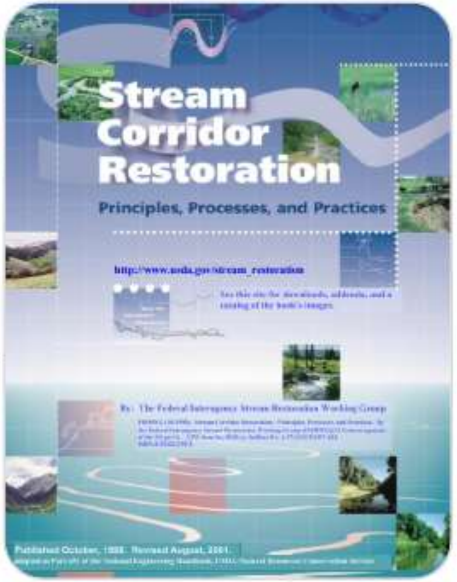
Design and Assessment Procedures

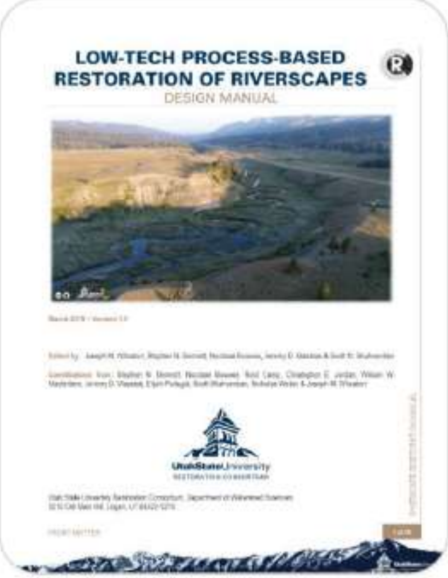












Clear Goals and Objectives

Project Goals

- Improve the hydraulic and geomorphic function of Toby and Mallard Creek to create a foundation for potential improvements of water quality and aquatic/terrestrial habitat of the site's streams and floodplain.
- Create a more resilient stream reach whose hydraulic geometry and geomorphology can better withstand changes in the climate, adjacent land use changes, and development in the watershed.

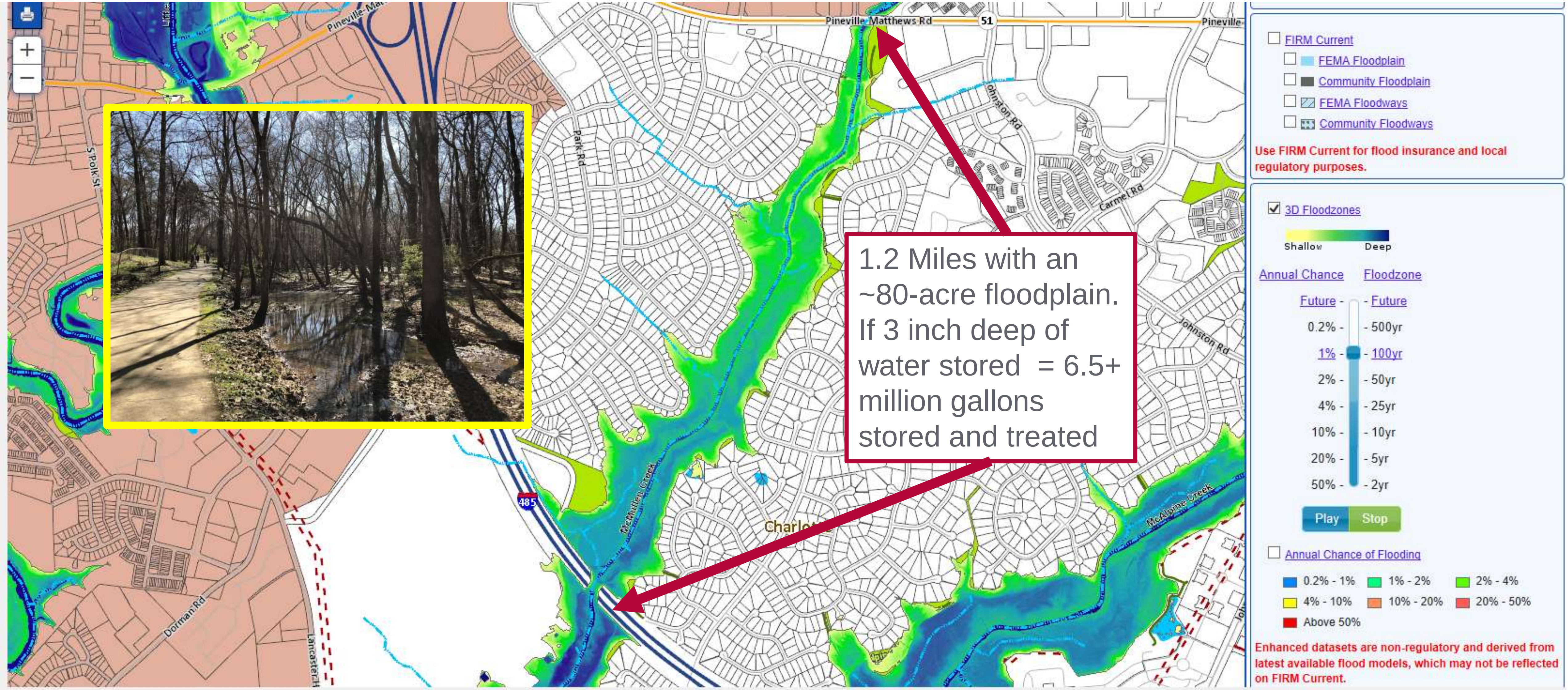
Objectives Cont.

- Create local slope and bed-depth variability in the stream profile by adding instream structures like rock and log vanes, J-hook vanes, variable rock log riffles, and toe wood.
- Increase dissolved oxygen concentrations through in-stream structures and the turbulence they produce.
- Stabilize stream banks using bioengineering and/or specific natural channel design techniques for each reach based on constraints and opportunities.
- Reduce bank source sediment by implementing bank stabilization and natural channel design techniques.
- Retrofit direct discharge points (e.g., channels and pipes) with pocket wetlands, level spreaders, regenerative stormwater conveyances (RSCs), or stabilized rock-step outfalls.

Solve $$$ of Problems With $

Source: The Millennium Ecosystem Assessment defined these four categories of ecosystem services that contribute to human well-being, each underpinned by biodiversity

Floodplains and buffers – love them, protect them and restore them.

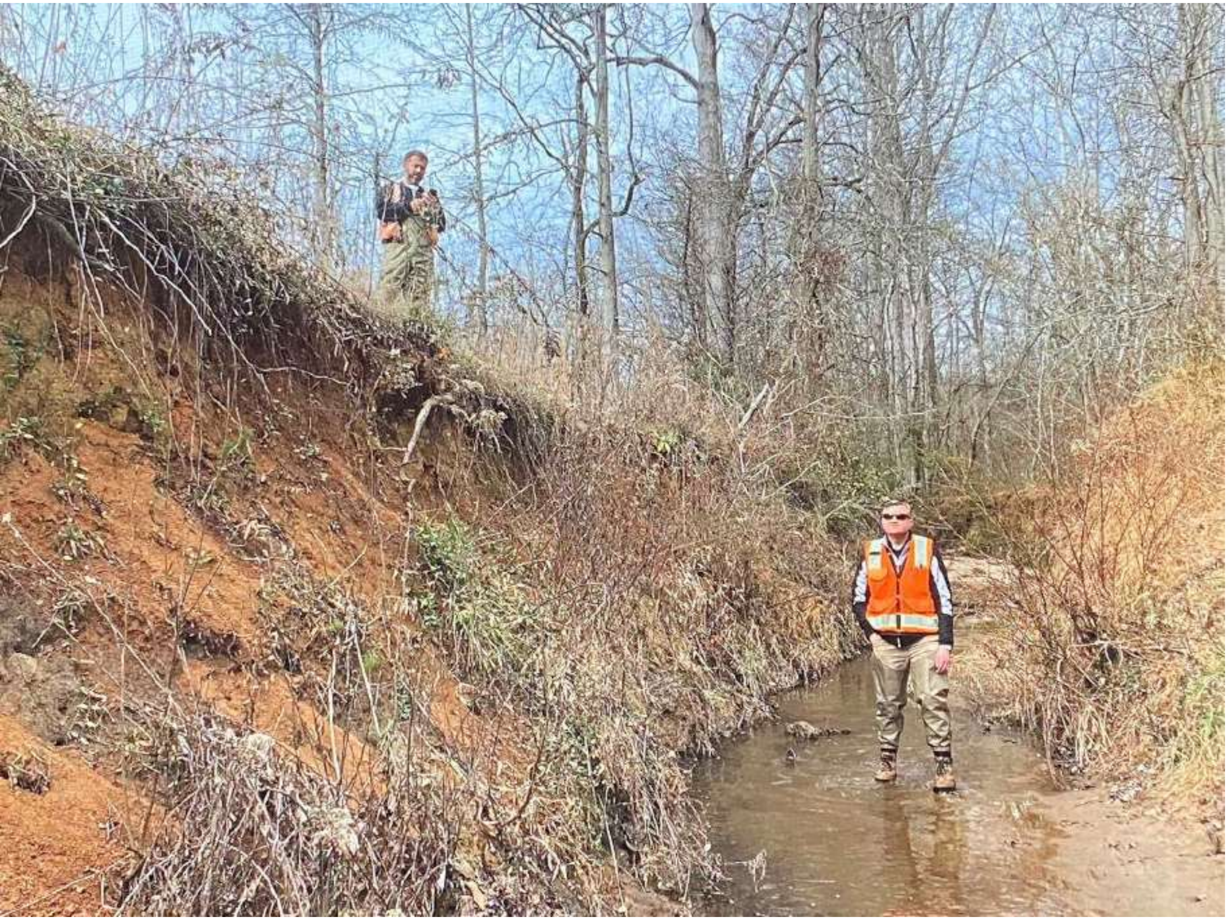


Floodplains and buffers – love them, protect them and restore them.

1.2 miles of protected or restored floodplain

=

500-700 bioretention basins




Threshold vs Alluvial Channel Design

Meandering vs Step Pool

More and Bigger is Not Always Better

Understand Momentum and Velocity Relative to Geometry and Resistance for YOUR System

Table 8-3. Design parameters for naturalized channels

Design Parameter	Design Value
Maximum 100-year depth outside of bankfull channel	5 ft
Roughness values	Per Table 8-5
Maximum 5-year velocity, main channel (within bankfull channel width) (ft/s)	5 ft/s
Maximum 100-year velocity, main channel (within bankfull channel width) (ft/s)	7 ft/s
Froude No., 5-year, main channel (within bankfull channel width)	0.7
Froude No., 100-year, main channel (within bankfull channel width)	0.8

Return Intervals are Used to Assign Risk, Not to Design Streams

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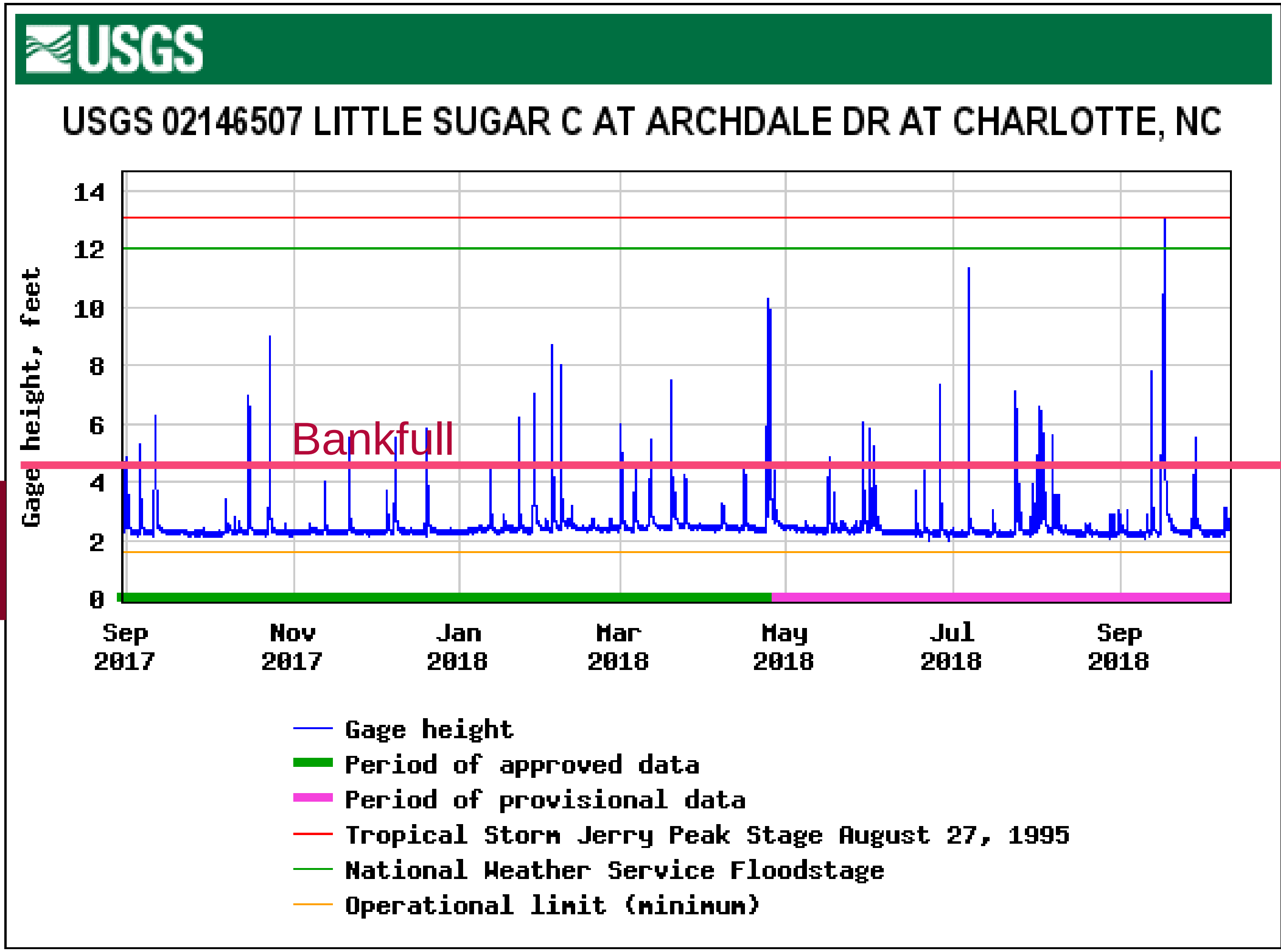
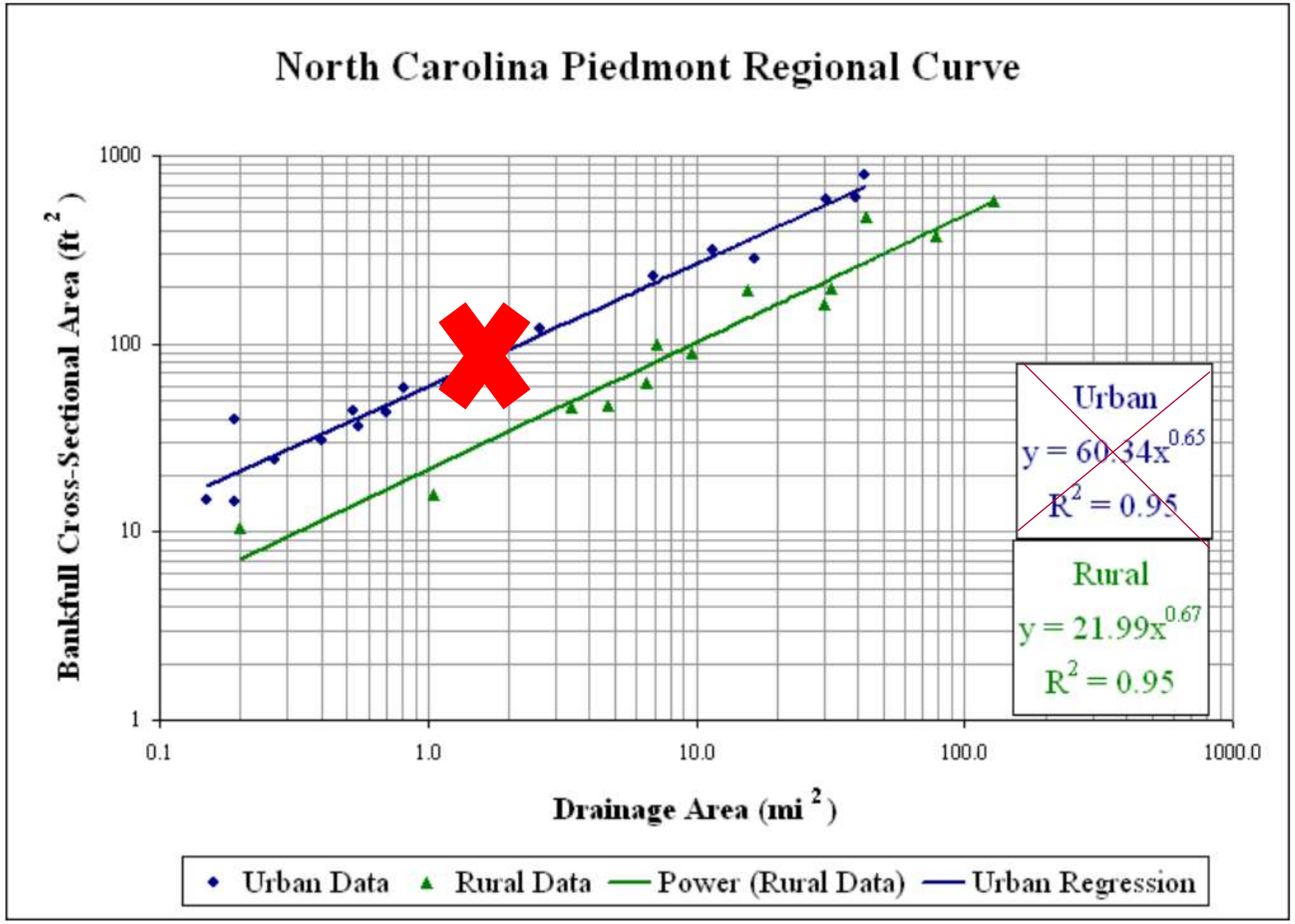
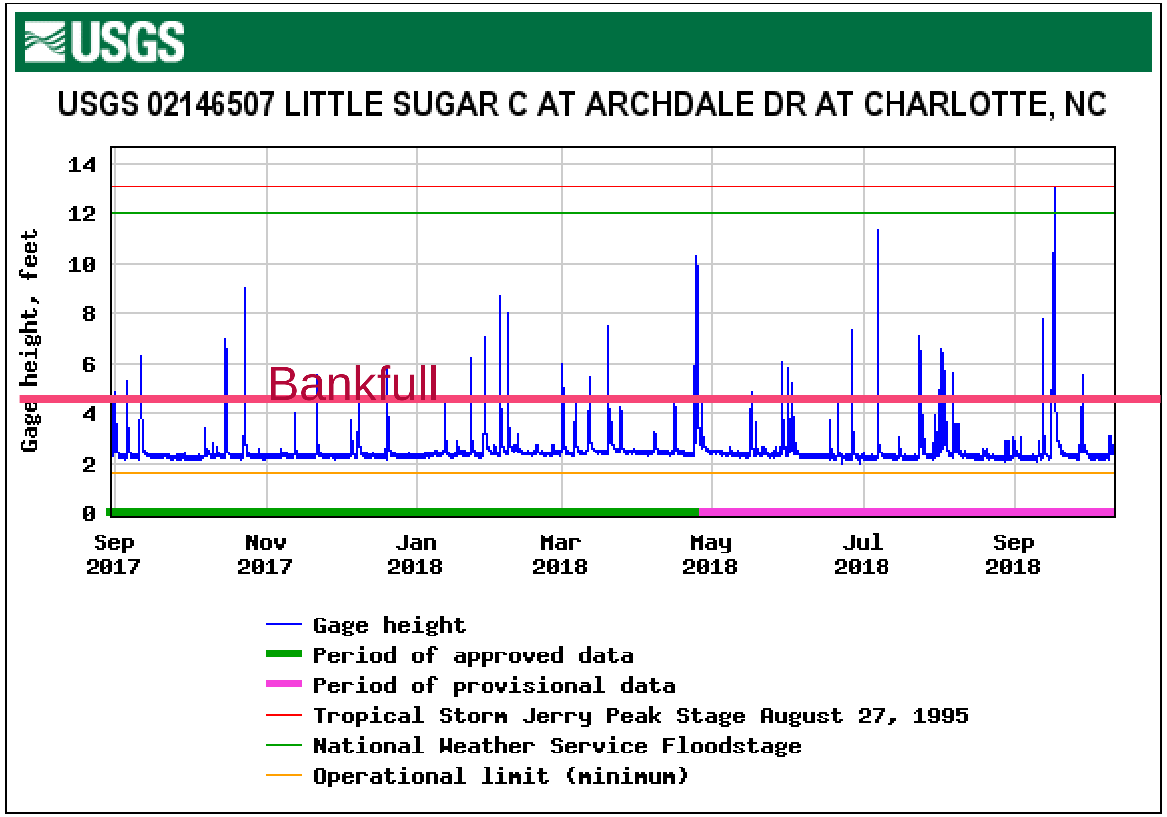
Froude No., 100-year, main channel (within bankfull channel width)	0.8
Maximum shear stress, 100-year, main channel (within bankfull channel width)	1.2 lb/sf
Minimum bankfull capacity of bankfull channel (based on future development conditions)	70% of 2-year discharge or 10% of 100-yr discharge, whichever is greater[1]
Minimum bankfull channel geometry	Per Table 8-2
Minimum bankfull channel width/depth ratio (Equation 8-3)	9
Minimum entrenchment ratio (Equation 8-4)	3
Maximum longitudinal slope of low flow channel (assuming unlined, unvegetated low flow channel)	0.2 percent
Bankfull channel sinuosity (Equation 8-5)	1.1 to 1.3
Maximum overbank side slope	4(H):1(V)
Maximum bankfull side slope	2.5(H):1(V)
Minimum radius of curvature	2.5 times top width

[1]Roughly equivalent to a 1.5-year event based on extrapolation of regional data.

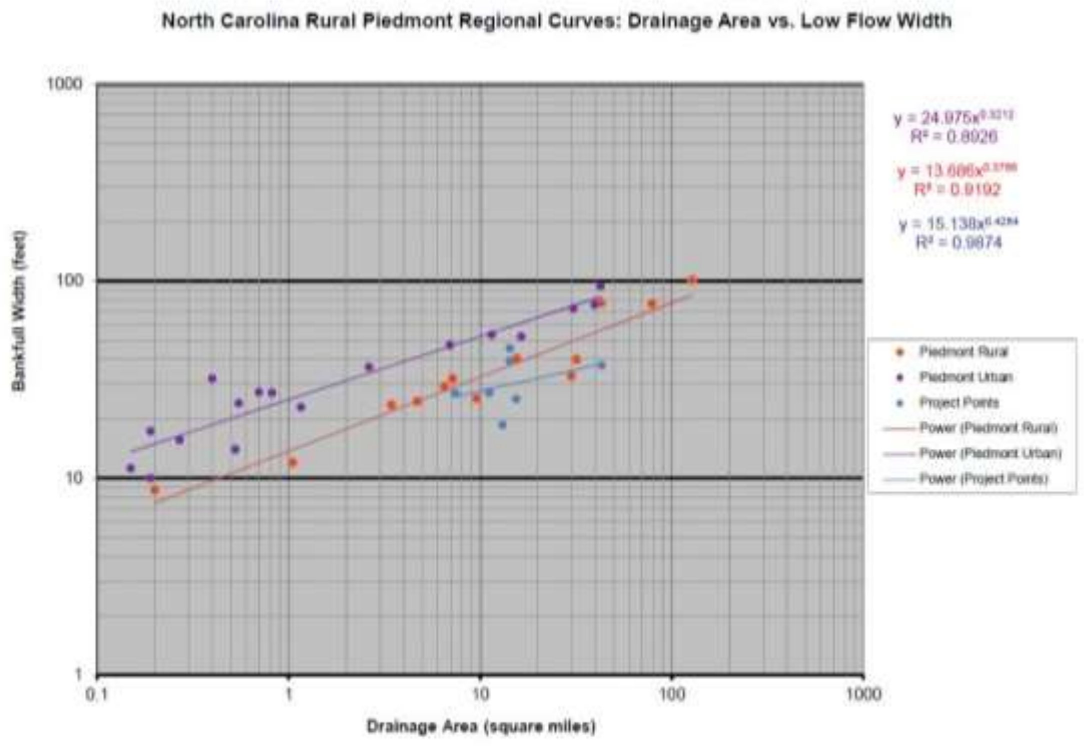


Urban curves should match rural curves if geology and climate are the same for the region. Bankfull events will just occur more frequently.





You can make a stream more stable and healthier by making the low flow base flow channel smaller




Build in natural variability and variety

Adjust the bed and bank material to match the plan, profile, cross-section

Adjust the bed and bank material to match the plan, profile, cross-section

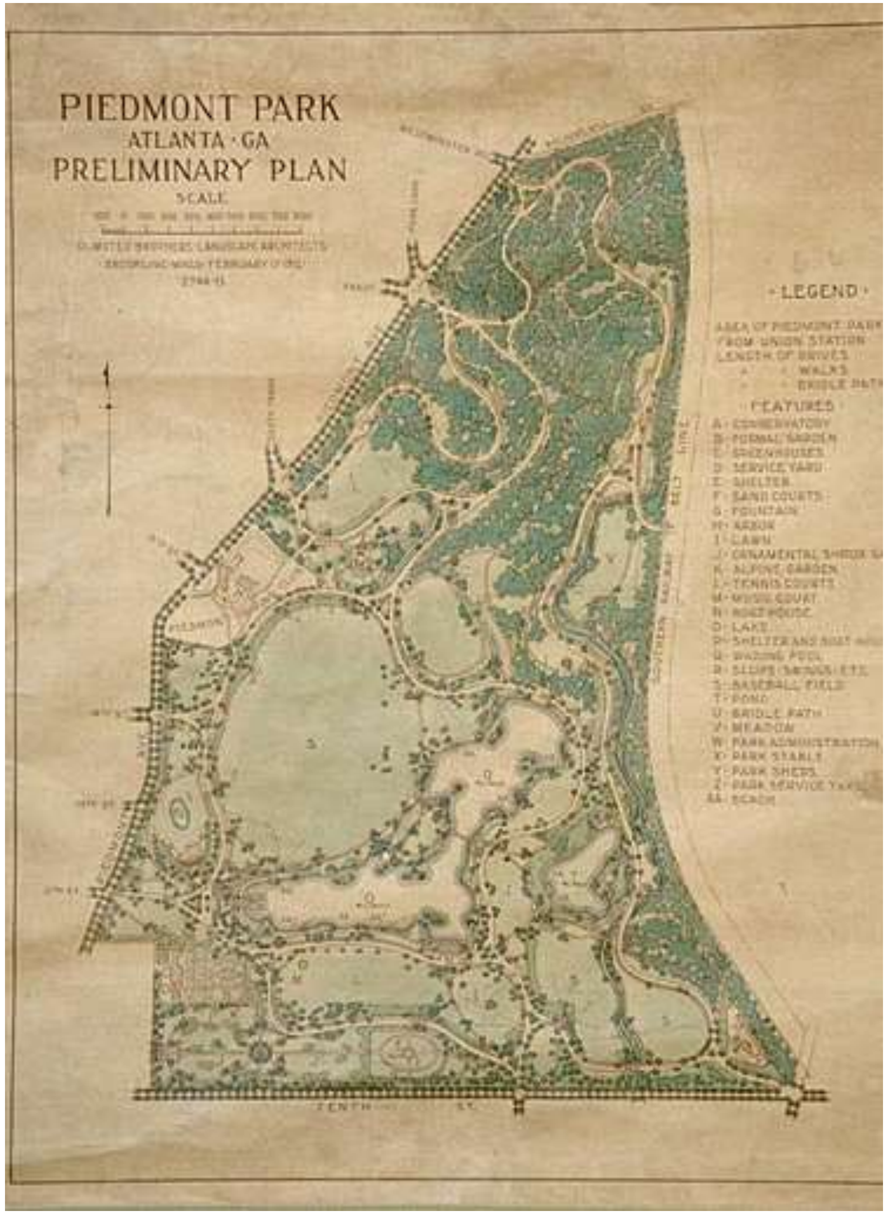
Adjusting plan and profile can minimize bank stabilization



I’ve never seen a pipe outfall in the wild – mixing green and grey in urban designs

Transitions from Built Environment to Natural Environment

Respect the Past and Plan for the Future



The Past Wasn't Always That Great

A Tip: Don't Go Near The Water

(Editor's note: Reporter Pat Stith spent six weeks investigating pollution in Little Sugar Creek. This is the first of his four reports.)

By PAT STITH
News Staff Writer

A Sewer Named Sugar

Hidden Valley and heads southwest, through industrial North

walk a mile to throw something in the creek.

Lammers says that someone is going to have to clean it up.

The News identified three points where raw, domestic sewage is flowing into the creek.

One involves a leaking sewer

Loopholes Can't Halt Pollution

Continued From Front Page

and sides were lined with brown muck.

Waste Pollutes County Creeks

Some of those who are discharging wastes into creeks in Mecklenburg County are as

and estimated the total volume of wastes during the past year at 50 gallons.

Pat Stith Looks At Pollution In Sugar Creek (Left) And Rusting Bedsprings Add To Unsightliness

Pollution's Cheaper Than Cleaning Up

(Editor's note: This is the third of four articles on Little Sugar Creek's pollution problem.)

By PAT STITH
News Staff Writer

A Sewer Named Sugar

would be tied down for the next two years."

THE OTHER AGENCY responsible for pollution abatement, the State Board of

A Sewer Named Sugar

Law Loopholes Allow Pollution Leak

(Editor's Note: This is the second of four articles by Pat Stith on Little Sugar Creek and the extent of its pollution.)

By PAT STITH
News Staff Writer

There are loopholes in the North Carolina law through which pollution flows into Little Sugar Creek.

The manager of the Minit Car Wash on E. Fourth St. says its wash water is piped into the creek. That water contains soap and oil but nobody does anything about it because it's not against the law.

STITH

Minit Car Wash is not by itself, of course.

A tributary of Irwin Creek, near W. Independence Blvd., is black with wastes from a heavy industry nearby. But, apparently, no law has been violated.

A polluter that was dumping untreated wastes into the creek prior to March 1, 1962, isn't violating the law unless it's been told by the N.C. Board of Water and Air Resources to stop.

If that agency doesn't know about it—and it didn't know about the W. Independence industry—then there is no violation.

In part, Little Sugar is an open sewer because the state has assigned it the lowest classification allowed by the federal government.

It must carry the runoff from city streets so the state reasons that it's not fit for fishing or

Charlotte News Headlines – 1969

Courtesy of Mecklenburg Co.

People are a Species of Concern





Urban Stream Restoration Works

NONPOINT SOURCE SUCCESS STORY

North Carolina

Basinwide Efforts Improve the McDowell Creek Watershed

Waterbody Improved McDowell Creek was listed as impaired by the North Carolina Division of Water Resources (NCDWR) in 1998 because of poor biological conditions. Since then, Mecklenburg County Storm Water Services (MCSWS) and the towns of Huntersville and Cornelius implemented programs to restore water quality. A low impact development (LID) ordinance was adopted by the Town of Huntersville in 2003 to mitigate the impact of new development. Nonpoint pollution sources continue to be addressed by implementing stream restoration projects and installing retrofit stormwater control measures (SCMs). These efforts have led to improved benthos populations, prompting a change in the water quality status of a 2.7-mile stretch upstream from the mouth of Mountain Island Lake from 4b (impaired, with management strategy in place) to 1b (meets water quality criteria, with management strategy in place) in 2020.

Problem

The McDowell Creek watershed is in northern Mecklenburg County, with 82% and 18% of the watershed in Huntersville and Cornelius, respectively (Figure 1). Approximately 80% of the watershed is regulated as a water supply watershed due to its proximity to Charlotte Water's drinking water intake. Urban sprawl in the 1990s and early 2000s led to increased stormwater runoff and deterioration of water quality in McDowell Creek. The pollution sources consisted mainly of sediment from construction sites, upstream bank erosion, and runoff from impervious areas, which resulted in poor instream habitat conditions.

In 1998, NCDWR added a 5-mile segment of McDowell Creek to the Clean Water Act (CWA) section 303(d) list of impaired waters due to a decline in the benthos population. Detailed analysis and water quality models developed in the early 2000s predicted increases in sediment and nutrient loading, peak flow rates, and runoff volumes with ongoing development. If left unmitigated, the increases could further degrade water quality and affect the downstream drinking water intake.

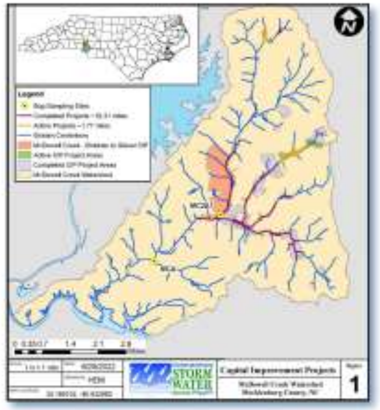


Figure 1. The McDowell Creek watershed is in southwestern North Carolina.

Story Highlights

MCSWS and the towns of Huntersville and Cornelius have partnered to implement watershed programs to protect and restore water quality. Efforts have focused on structural and management controls to treat stormwater runoff and stabilize the stream channels.

An LID ordinance adopted in 2003 by the Town of Huntersville placed strict stormwater runoff treatment requirements on all new development, beyond what is required by the water supply watershed requirements. As part of this ordinance, high-density developments must install LID SCMs that can achieve an average annual total suspended solid (TSS) removal of 85% from the first 1 inch of rainfall.

In 2008, MCSWS developed the McDowell Creek Watershed Management Plan to address pre-existing sources of pollution. The plan identified and prioritized areas for stream restoration and enhancement to improve water quality conditions. Restoration of more than 2.1 miles of the main stem of McDowell Creek, from Birkdale Village to Gilead Road, was completed in 2016 and encompassed habitat improvements in a severely eroded section of the stream (Figure 2). This project, similar to other restoration projects in the watershed, involved stabilizing stream banks and adding in-stream structures that provide diverse habitats for aquatic organisms. To date, a total of 10.3 stream miles have been restored in the watershed, with an additional 1.8 miles in active construction (Figure 1).

MCSWS' capital improvement program (CIP), with partial funding from the North Carolina Clean Water Management Trust Fund (now known as the North Carolina Land and Water Fund [NCLWF]) and the CWA section 319 program, has supported the installation of retrofit SCMs. More than 25 SCMs have been retrofitted into previously untreated areas through the CIP. In total, more than 550 individual SCMs have been constructed, mostly to comply with land development ordinances in Huntersville and Cornelius. Other initiatives, such as wetland restoration and targeted land acquisitions, have also been implemented.

Figure 2. McDowell Creek (Birkdale to Gilead) stream restoration project.

Results

In 2017, NCDWR sampled the benthos in McDowell Creek. NCDWR used the presence of Ephemeroptera, Plecoptera and Trichoptera (EPT), which are pollution-sensitive benthos, to assess the condition of the stream. The abundance of EPT in 2017 was significantly higher than the value for the previous three assessments, leading to a jump in the bioclassification of the stream from *fair* to *good-fair* (Table 1). As a result of the *good-fair* rating, NCDWR removed the benthos impairment for a 2.7-mile stretch of McDowell Creek in 2020.

Table 1. McDowell Creek benthos data.

Year	EPT	EPT BI*	Bioclassification
2017	15	5.77	Good-Fair
2012	8	6.02	Fair
2007	8	5.78	Fair
2002	8	5.9	Fair

*BI = Biotic Index

MCSWS also conducts annual benthic macroinvertebrate assessments at two monitoring locations (see Figure 1) on the main stem. Monitoring data from these sites, one of which coincides with the NCDWR sampling location, shows higher average EPT indices between 2017 and 2021 compared to the previous five years.

Water chemistry data also continues to show reduced sediment and nutrient loading. Long-term trend analysis indicates significant reductions in TSS (48%), total phosphorus (34%), and nitrate/nitrite (13%) between 2005 and 2021. Together, improvements in McDowell Creek indicate the effectiveness of the numerous watershed initiatives. Planned future stream restoration projects, SCMs, and ongoing implementation of LID practices will ensure the long-term restoration and protection of water quality.

Partners and Funding

Many watershed partners have contributed to restoration efforts. Work began in 2009, and projects have been directly funded by the towns of Cornelius and Huntersville, MCSWS, the City of Charlotte's Stream and Wetland Mitigation Bank, and private wetland mitigation bankers. Approximately $12 million in capital investment has come from MCSWS and funding partners. Funding has also been provided by the NCLWF, CWA Section 319 Grant Program, North Carolina Water Resources Development Grant Program, and the American Recovery and Reinvestment Act. MCSWS received a total of $1.1 million in section 319 grant money for several projects in the watershed.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-22-001AA
November 2022

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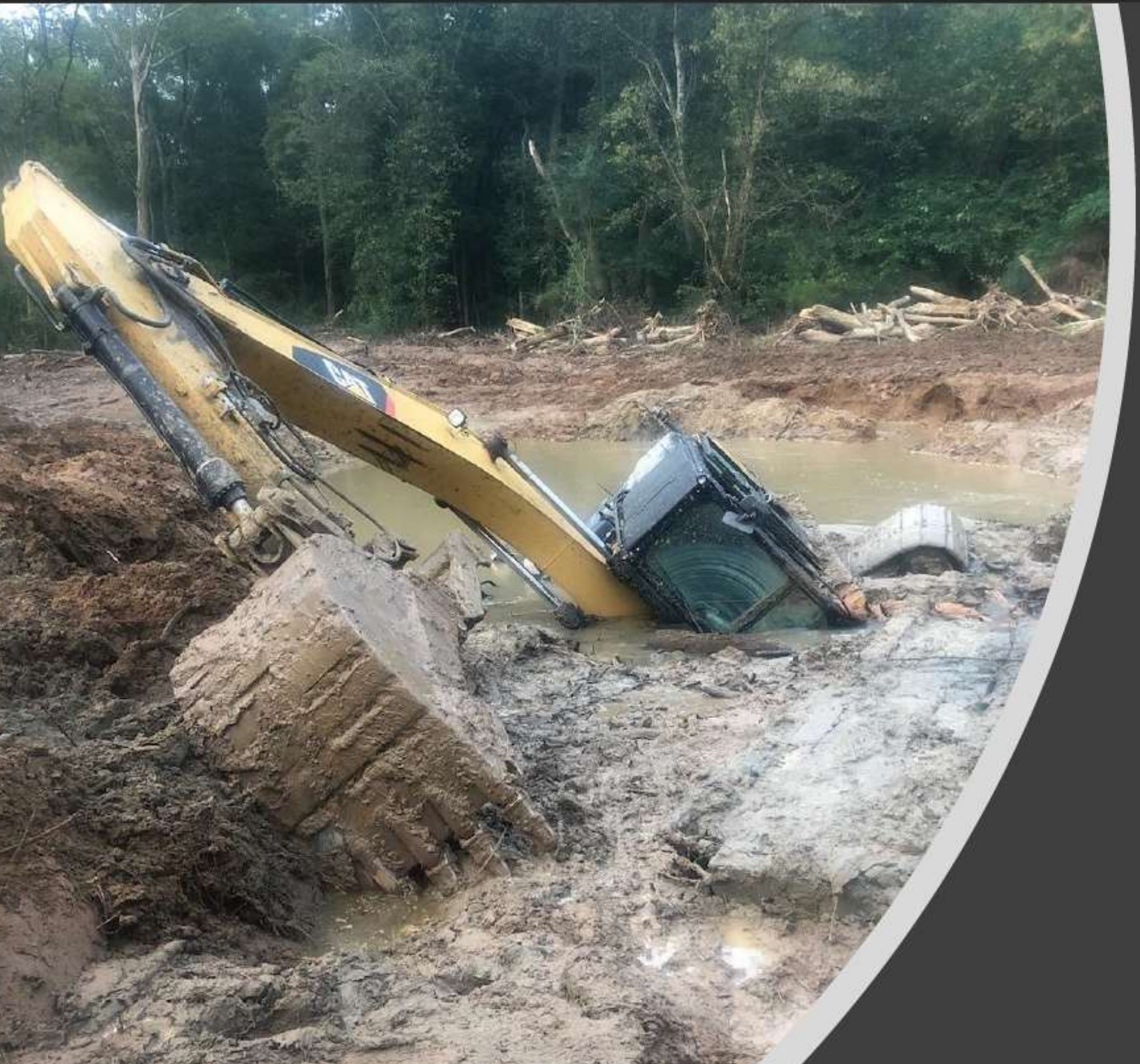
Remember That an Urban Stream Will Be the Only Stream in Many Kids' Lives



Questions?