Climate Change Impacts on Stream Restoration

Greg Jennings, PhD, PE
Professor Emeritus,
NC State University
Jennings Environmental
Greg@jenningsenv.com

NC STATE UNIVERSITY

Department of Biological and Agricultural Engineering

Jennings Environmental

What Do We Know About Stream Morphology?

Streams and floodplains adjust through erosion and deposition in response to:

- **Boundary conditions**
- **Forcing functions**

Boundary Conditions *Resistance to Erosion*

1. *Natural:* Soil and rock strengthened by vegetation
2. *Artificial:* Rock, concrete, metal, plastic, fiber

Forcing Functions: *Hydraulic Action*

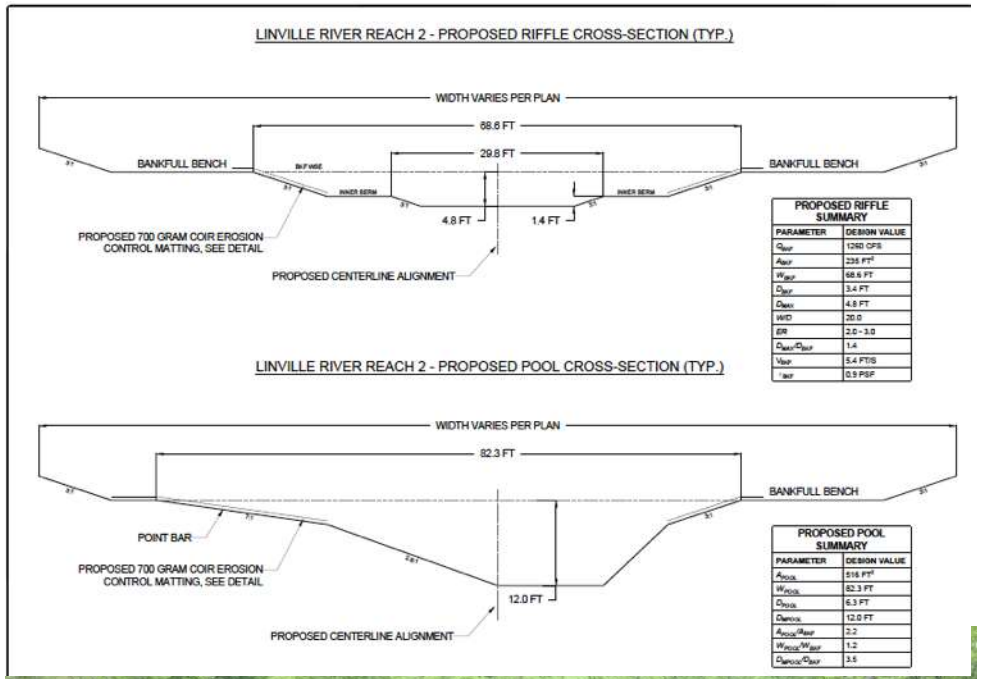
1. Water from the watershed (***hydrology***)
2. Sediment supplied from upstream and locally

What is Stream (Morphology) Restoration?

1. Adjusting boundary conditions and forcing functions to achieve sustainable equilibrium
2. Planning for an uncertain future

Certainties:
Stream (Morphology) Restoration

1. Design parameters are <u>uncertain;</u> therefore all projects have <u>risk</u>
2. Construction and vegetation will occur during bad weather
3. Adaptive management will be required



Risk in Stream Restoration?

Risk Definition: Potential failures having negative impacts as a part of deficiencies or flaws in design or engineering.

What is Risk in Stream Restoration?

- Erosion and/or deposition
- Infrastructure threats
- Ecological functions sub-optimal
- Human disappointment

I got a call from a resident adjacent to MAFC, claims design is flawed or contractor is really bad. He wanted to let me know the actual stream bed was not consistent throughout. There were areas that were holding more water than others..... no joke....

How Do We Reduce Risk in Stream Restoration?

1. **Boundary Conditions:** ***Soil Strengthening***
   - Earth (soil, rock)
   - Artificial supplements (concrete, plastic, fiber)
   - Vegetation (bio-engineering)
2. **Forcing Functions:** ***Hydraulic Force Reductions***
   - Watershed hydrology (retention, LID)
   - Shear stress (depth, slope): ***FLOODPLAIN***
   - Sediment supply (stream power)

Reducing Risk:
Boundary Conditions

Soil Strengthening:

- Wood Toe Revetment,
- Matting
- Vegetation

Reducing Risk: *Forcing Functions*

Hydraulic Force Reductions:

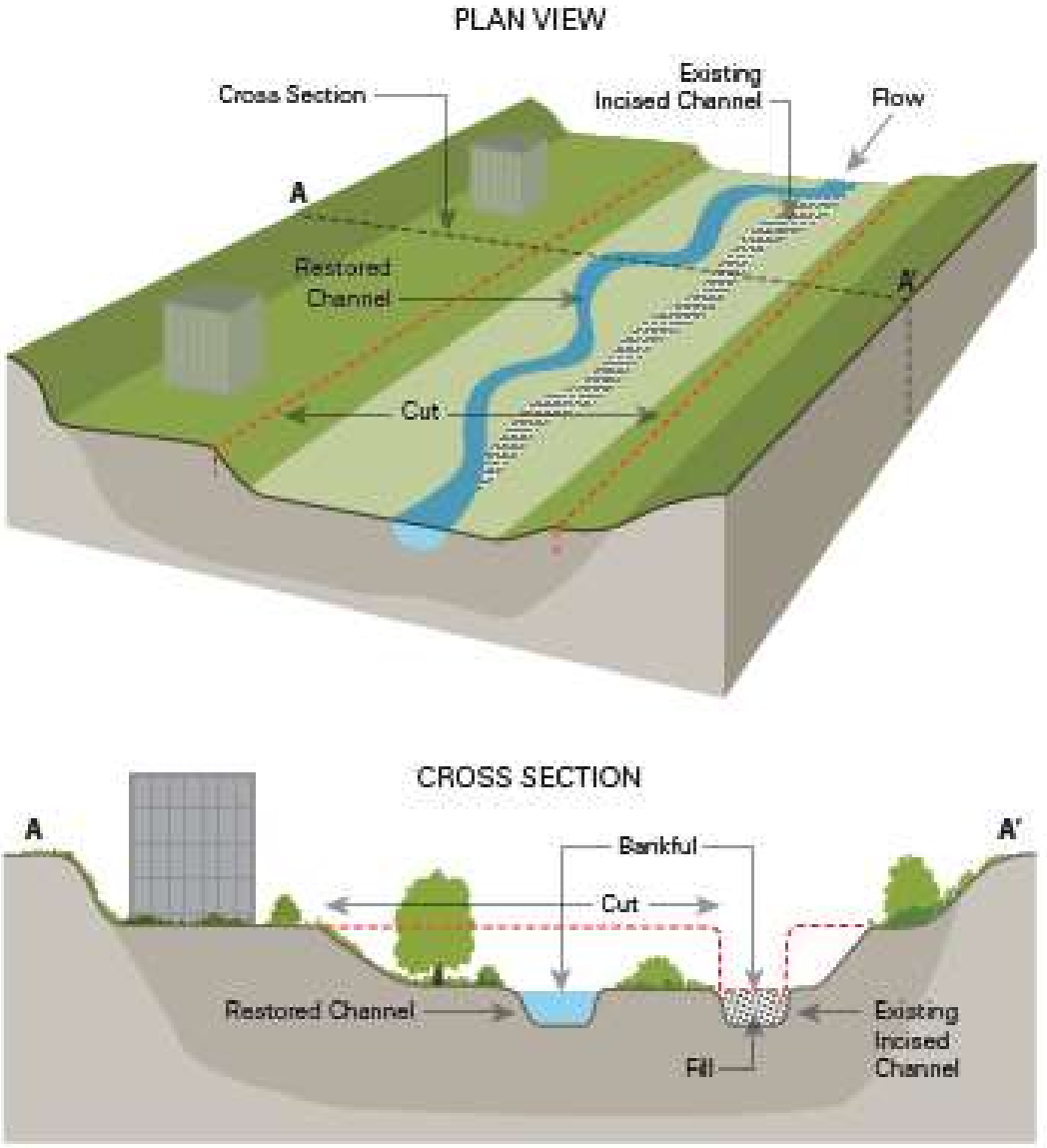
- Watershed hydrology (retention, LID)
- Shear stress (depth, slope): ***FLOODPLAIN***
- Sediment supply (stream power)

When in Doubt, Spread it Out!

Reducing Risk: *Forcing Functions*

Floodplain Expansion for Shear Stress Reduction

When in Doubt, Spread it Out!



Harman, W., R. Starr. 2011. Natural Channel Design Review Checklist. US Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD and US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Wetlands Division. Washington, D.C. EPA 843-B-12-005

Stream Restoration in an Urban Tributary:
Morrisville Aquatic and Fitness Center, Morrisville, NC

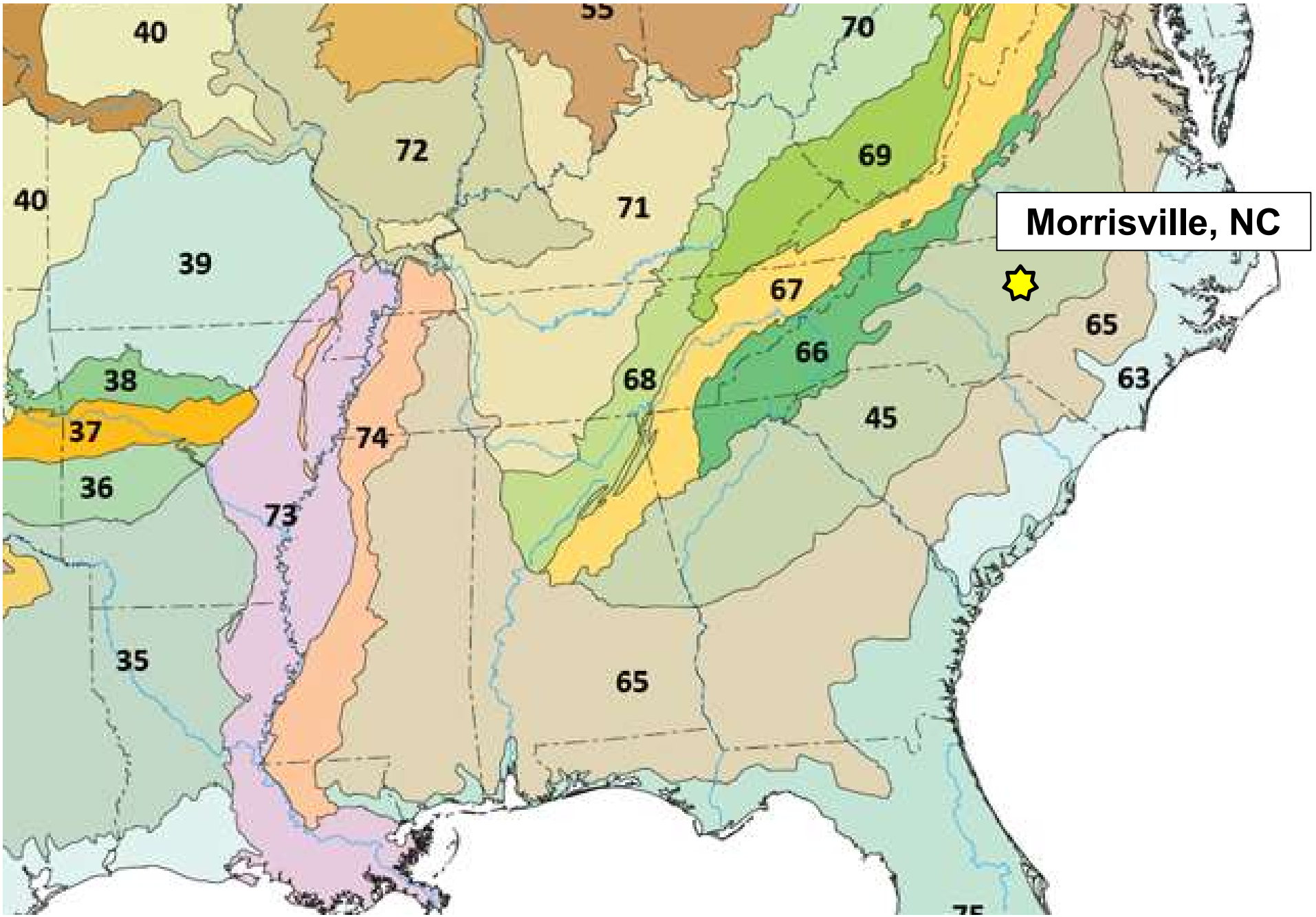
Greg Jennings
Jennings Environmental
Greg@jenningsenv.com

Joshua Baird
Town of Morrisville, NC
JBaird@townofmorrisville.org

Morrisville
Live connected. Live well.

Jennings
Environmental

Project Location (EPA Level III Ecoregions)

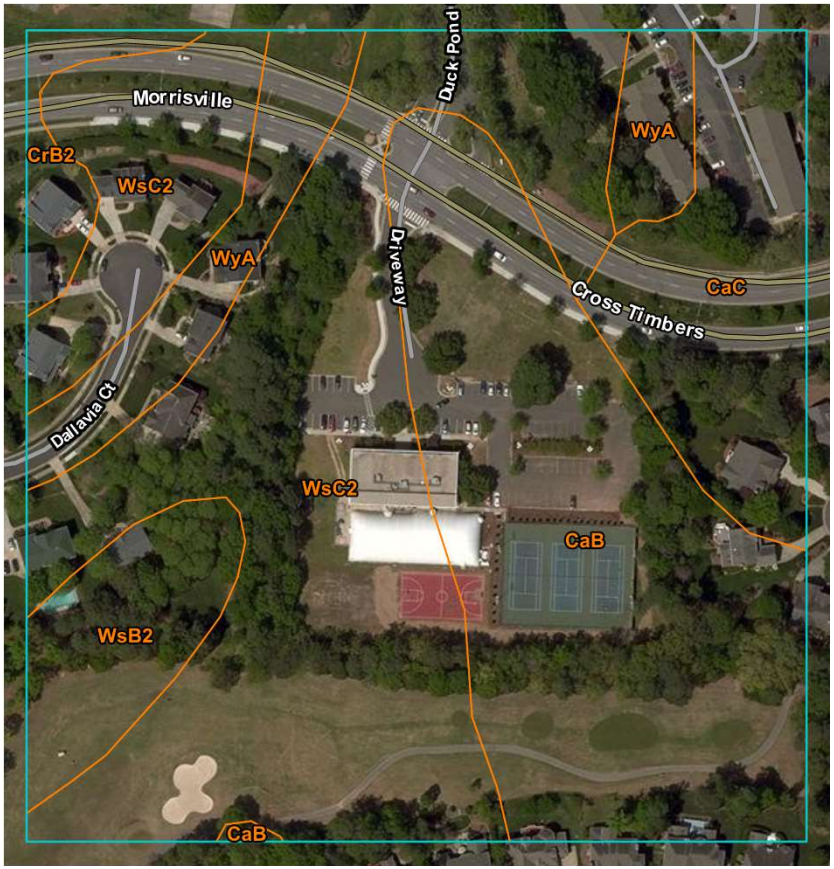


UT Crabtree Creek, MAFC, Morrisville, NC

- Urban headwater stream in Neuse River Basin
- Drainage Area = 0.2 square miles

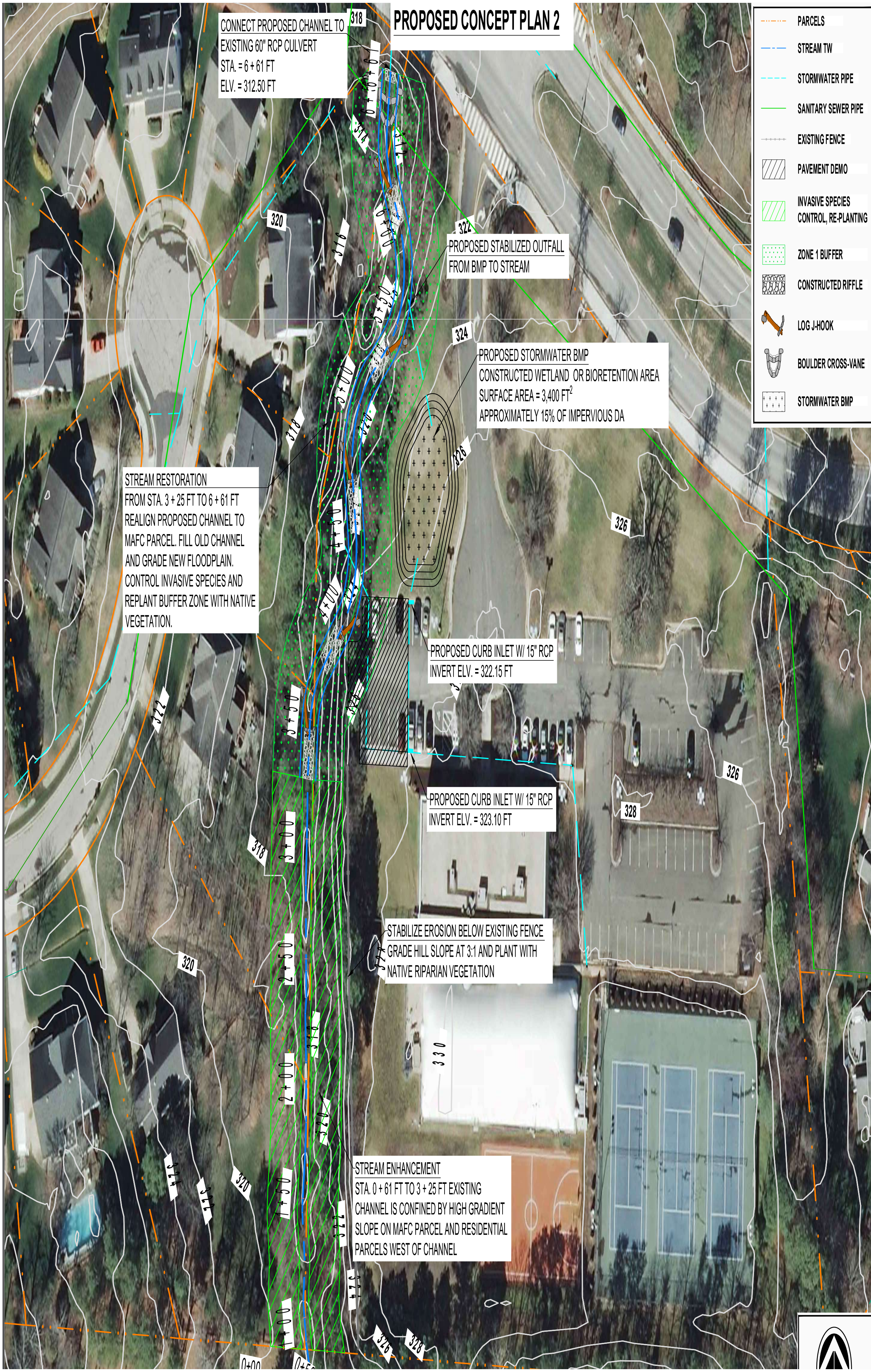
Stream Problems

- Erosion
- Infrastructure
- Vegetation



MAFC Opportunities

- Stream Restoration
- Outfall Stabilization
- Stormwater BMP
- Education



JENNINGS ENVIRONMENTAL
Natural Solutions for Sustainable Watersheds

SEAL:

Morrisville
NORTH CAROLINA

PROJECT NAME: MAFC FEASIBILITY SD.
SCALE: 1" = 60'
DATE: AUGUST 31, 2016

CONCEPT PLAN

Evaluating Alternative Solutions

- **MCDA:** ***Multiple-Criteria Decision Analysis***
- Consider stakeholder input & implementation factors (constraints, cost, timing, practicality)
- Evaluate alternatives based on **Objectives**:
    - *Risk Management* (Safety, Infrastructure, Flooding)
    - *Ecosystem Functions* (Habitats, Water Quality, Floodplains, Buffer)
    - *Stream Stability* (Streambanks, Equilibrium, Sed Trans)
    - *Community* (Stormwater, Aesthetics, Access & Education)

Multiple-Criteria Decision Analysis (MCDA)

Multi-Criteria Decision Analysis (MCDA): Morrisville Aquatics and Fitness Center, Morrisville, NC	Risk Management			Ecosystem Function Objectives				Stream Stability Objectives			Community Objectives								
	Safety	Infrastructure Protection	Flooding	Aquatic Habitats	Water Quality	Floodplain Functions	Native Riparian Buffer	Streambank Stability	Natural Equilbrium Channel	Balanced Shear Stresses	Watershed Protection	Aesthetics	Access and Education	Length of Project (ft)	Cost Estimate ($)	Unit Cost ($/ft)	MCDA Matrix Score	MCDA Score per $	MCDA Rank
Objective Weighting Factor (0 to 3)	3	3	3	2	2	1	2	2	2	2	2	2	2						
Option 1. Plant Buffer and Manage Invasives, stabilize outfall	0	2	0	1	1	1	3	1	0	0	2	3	2	583	$ 44,358	$ 76	33	0.43	1
Option 2. Realign unstable reach, stormwater BMP, maintain existing driveway	5	5	1	4	4	3	4	4	4	4	5	5	5	583	$226,789	$ 389	114	0.29	2
Option 3. Realign unstable reach, larger stormwater BMP, relocate driveway	5	5	1	4	5	4	5	4	4	4	5	5	5	583	$305,951	$ 525	119	0.23	3
Option 4. Realign maximum reach length, larger stormwater BMP, relocate driveway	5	5	1	5	5	5	5	5	5	5	5	5	5	583	$428,549	$ 735	128	0.17	4

Design Plan for Bid: March, 2018

Construction: *June - August, 2018*

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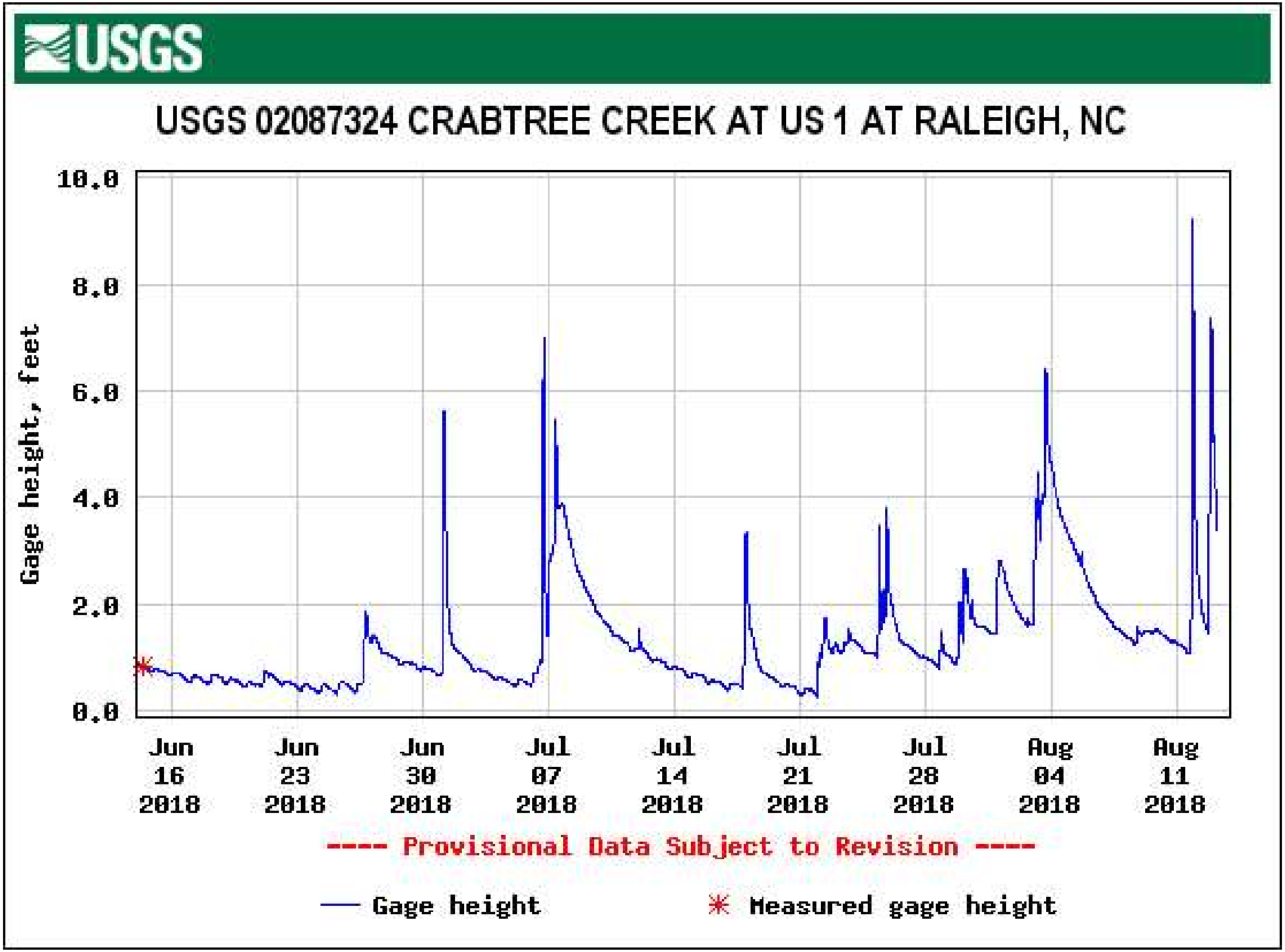
Construction: *June - August, 2018*

Flow Conditions: *June - August, 2018*



Construction: *June - August, 2018*

Summary: Risk Management

Boundary conditions (vegetation)

Forcing functions:

- Watershed hydrology
- ***Floodplain***
- Local shear stress
- Sediment supply

Thank you,
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