Greenville
NORTH CAROLINA

Town Creek Culvert: The Model Marriage Between Green and Grey Infrastructure

Marc Horstman, PE, PH, CFM

Technical Manager

WK Dickson & Co., Inc.

SeSwA Southeast Stormwater Association

WK DICKSON
community infrastructure consultants

October 20, 2016

Find yourself in good company

Greenville, NC

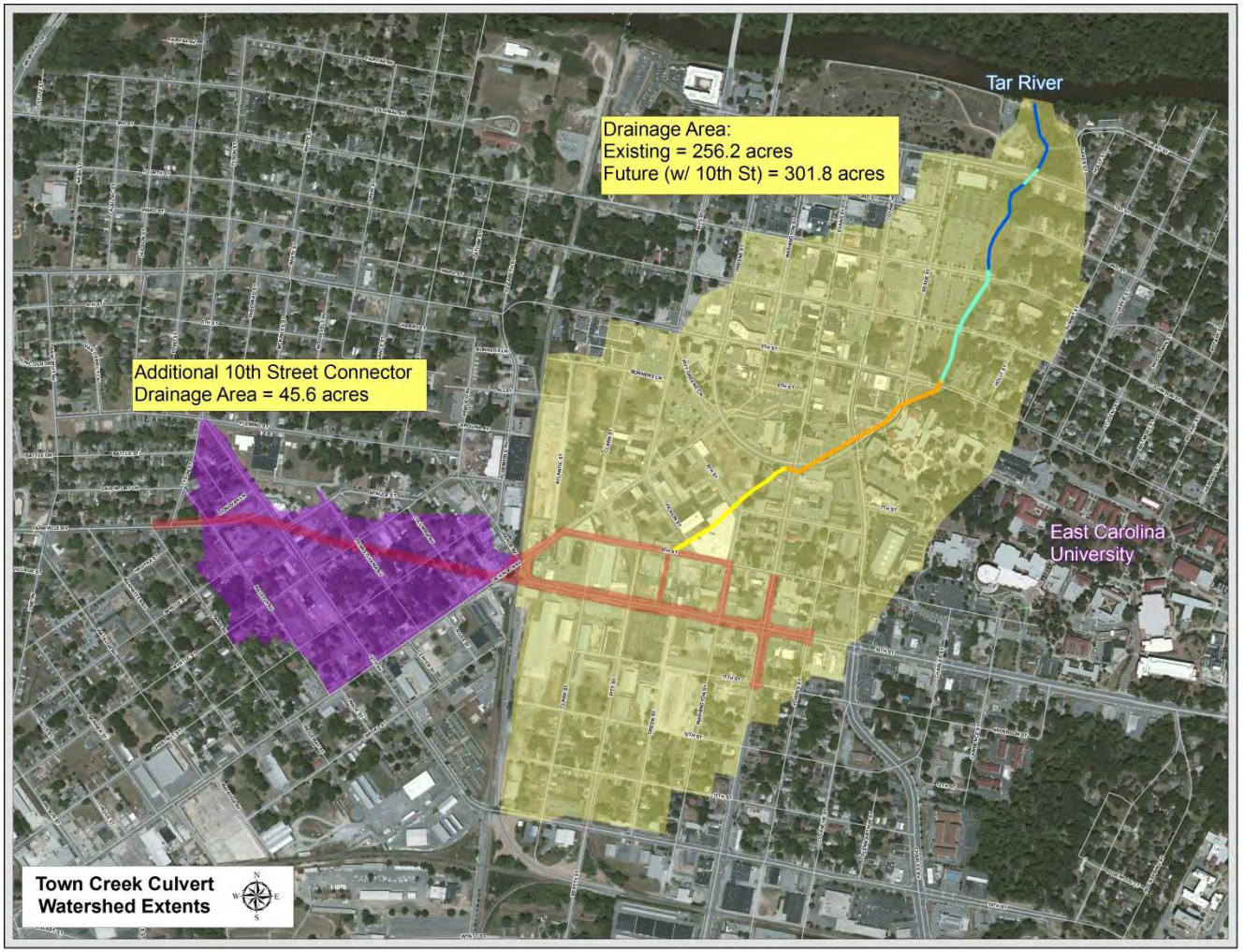
- Pitt County Seat(35°36′6″N,77°22′21″W)
- Population: ~90K
- 10th Largest City in NC
- Home of East Carolina University (ECU Pirates)
- Slight Flooding Issue

Town Creek Culvert

Why Town Creek?

- Existing flooding conditions
- Aging infrastructure
- Diverted flow from NCDOT 10th Street Connector

Town Creek Culvert-Watersheds



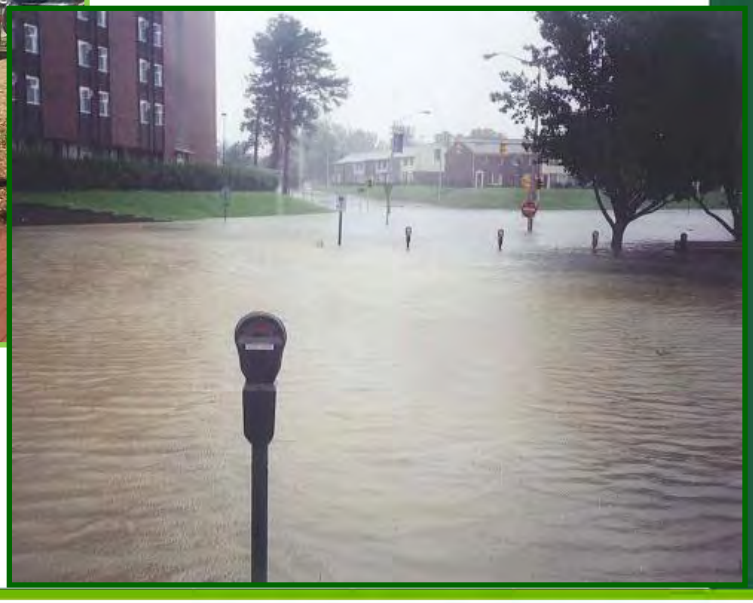
Aging Infrastructure

- Brick Masonry Material Failure
- Poor Concrete Construction Practices
- Design Deficiencies
- Slab Deformations
- Tap in locations with no patching/sealing
- Utility conflicts


HYUNDAI

Flooding

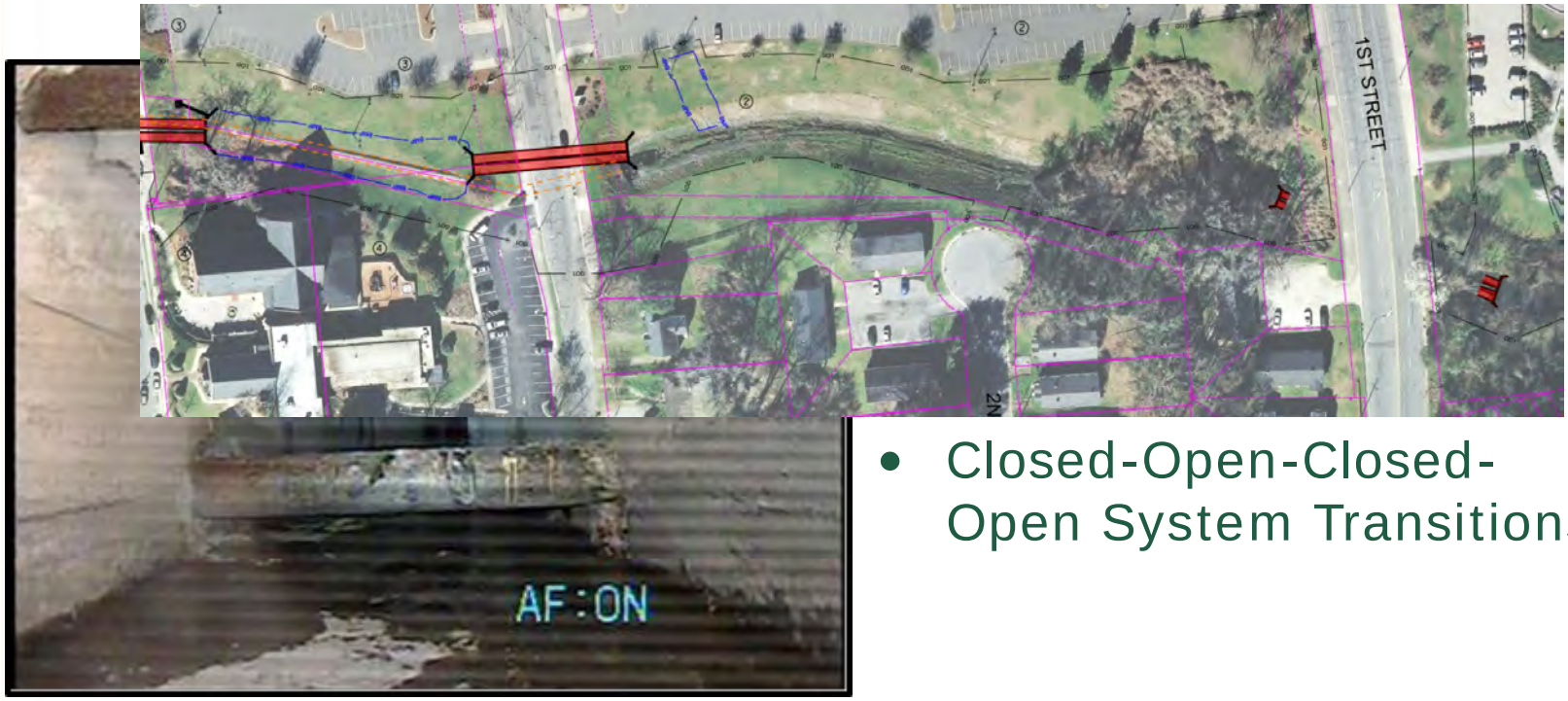

JIMMY JOHN'S
GOURMET SANDWICHES
BICYCLE
POST
JIMMY JOHN'S
DO NOT
ENTER
Hurricane Irene
(Aug 2011)



SWMM Modeling

- Hydrologic and Hydraulic modeling routines are contained within the same platform.
- Change in Pipe sizes and obstructions are easily modeled with associated losses.
- Dynamically balances overland flow with closed pipe system flow.
- Also calculates the duration of flooding, an important component in retrofit cost/benefit analysis.

SWMM Modeling

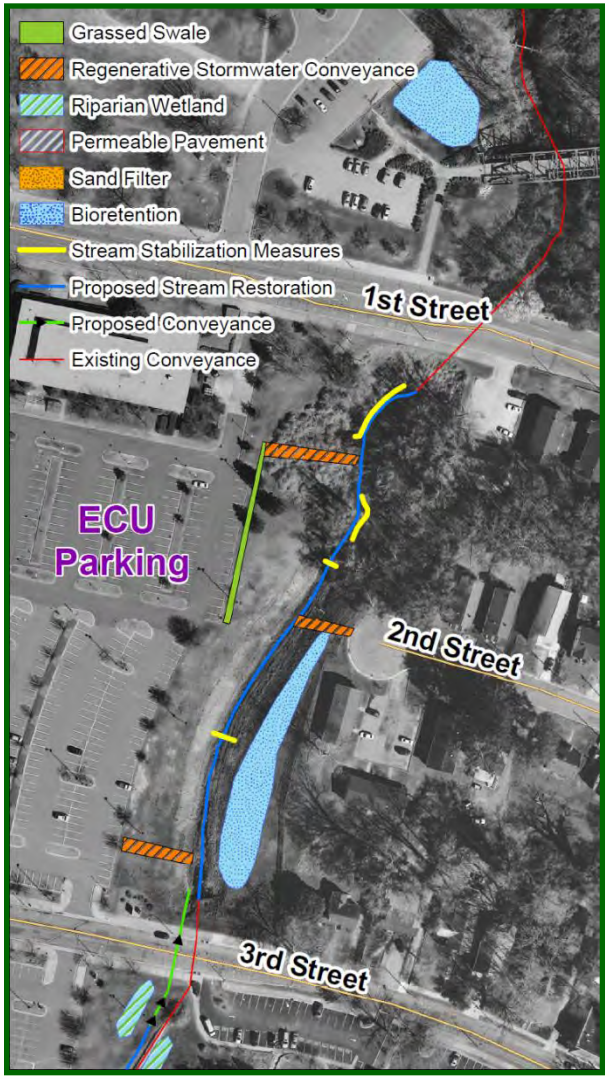


- Closed-Open-Closed-Open System Transitions


CAT
CAT

Green Infrastructure

- $13.34 M in funding from SRF (0% Int Loan)
- Savings of $4.5 M in interest
- 6 SCMs
- Nitrogen removal goal



Wetlands

Bio-retention

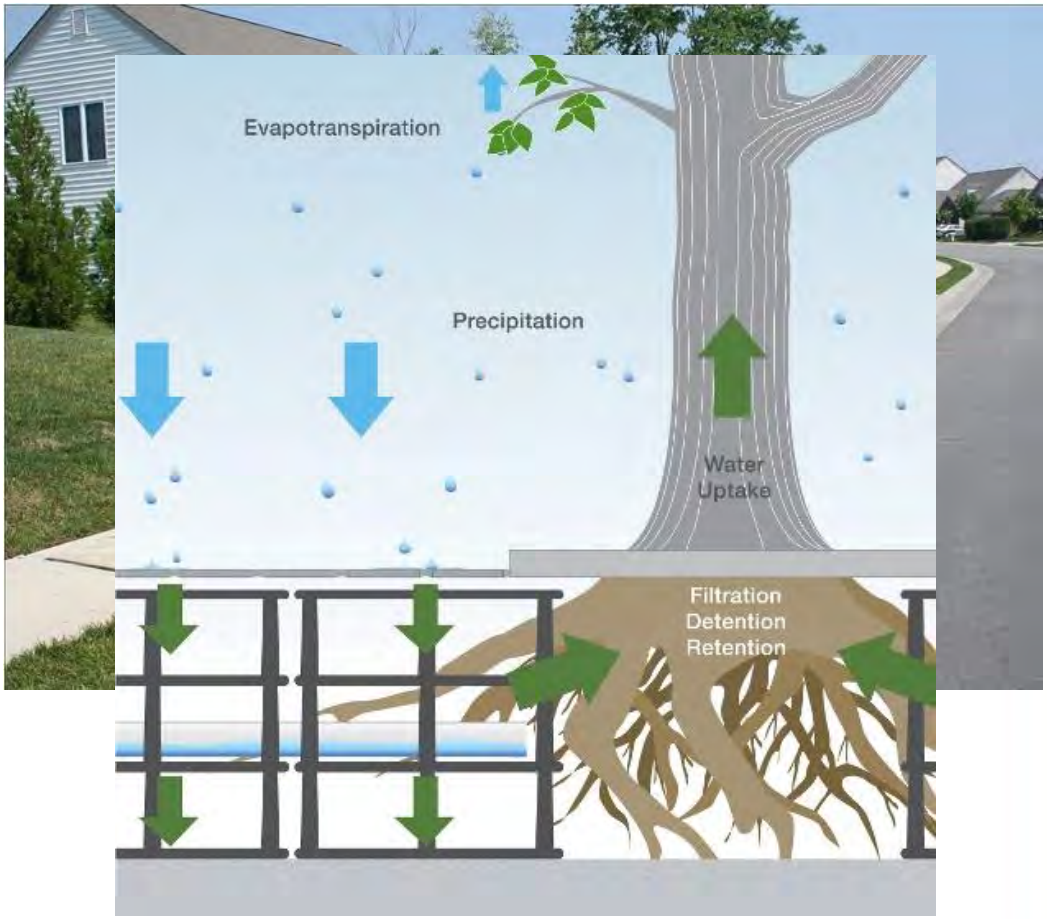
Permeable Pavers

Inlet Capture Devices

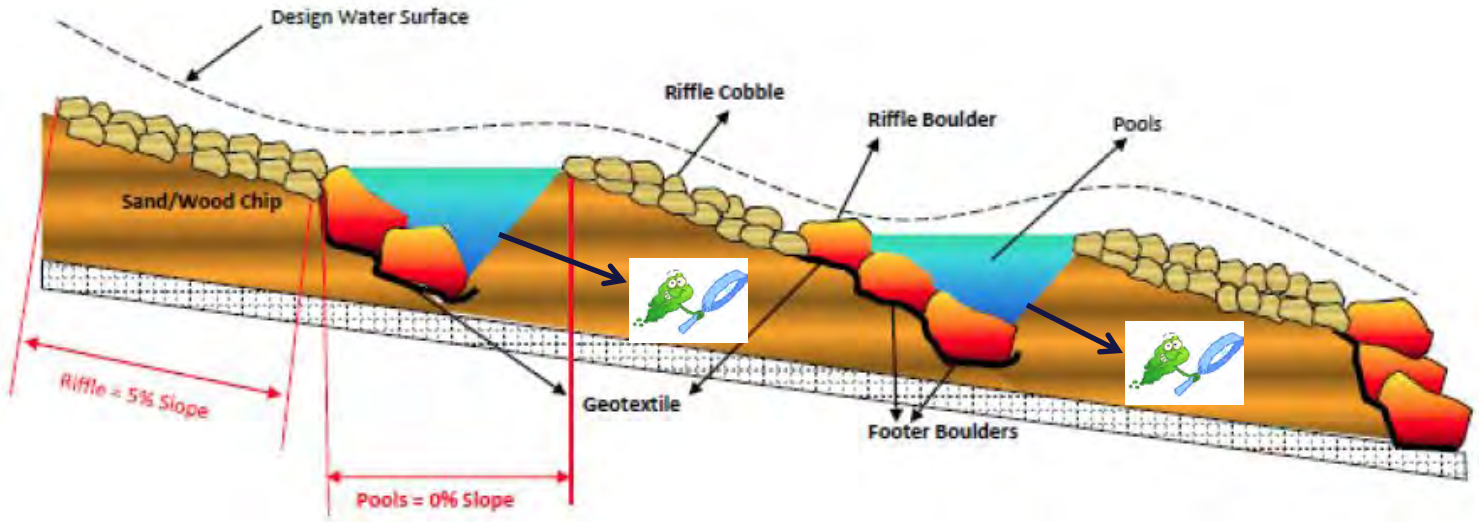
-Filterra© or Silva Cells should be used to promote ET and Filtration.

-Can be used in place of double catch basins to capture and treat runoff.

-Adds aesthetic and community value while removing pollutants behind-the-scenes.



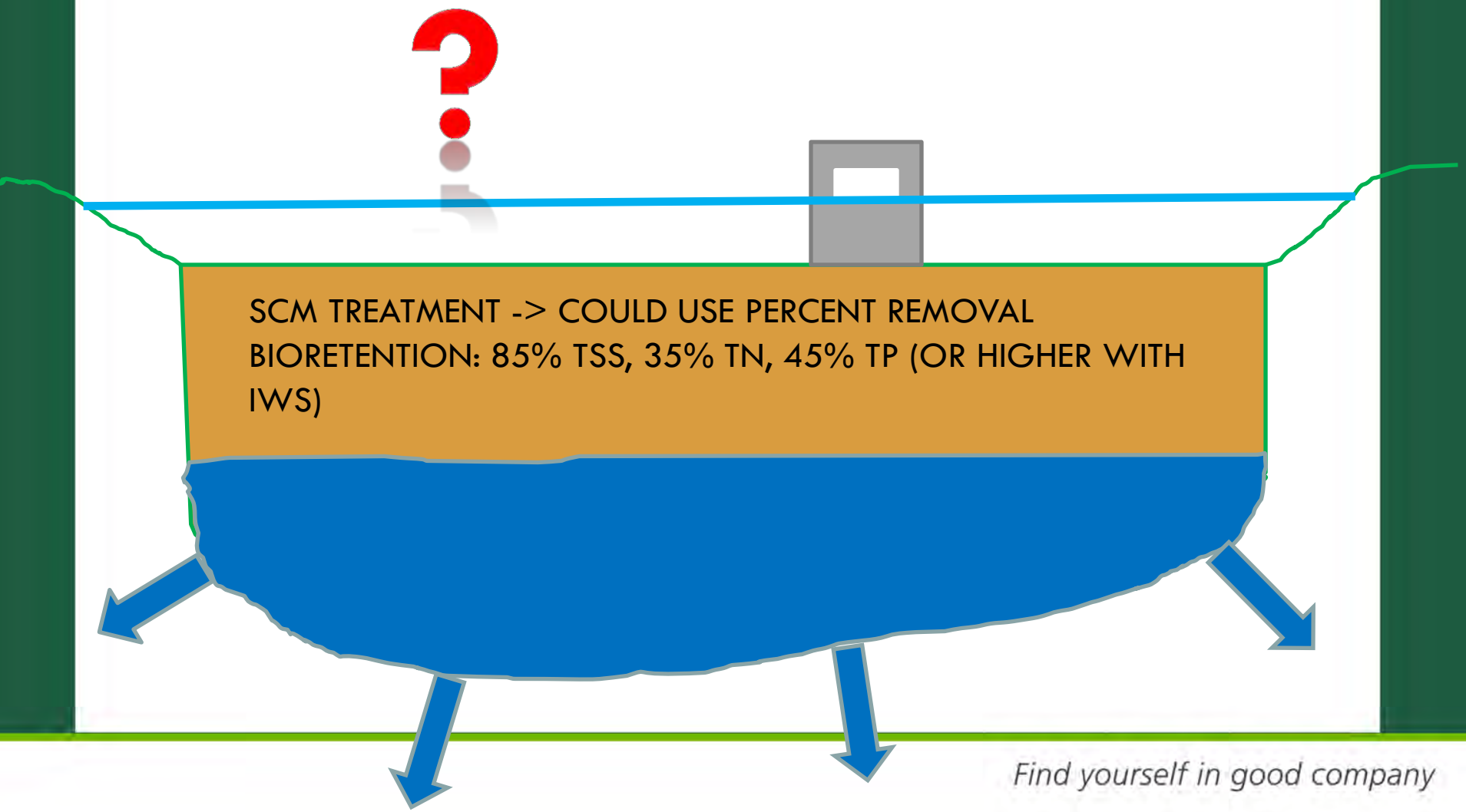
Regional RSC



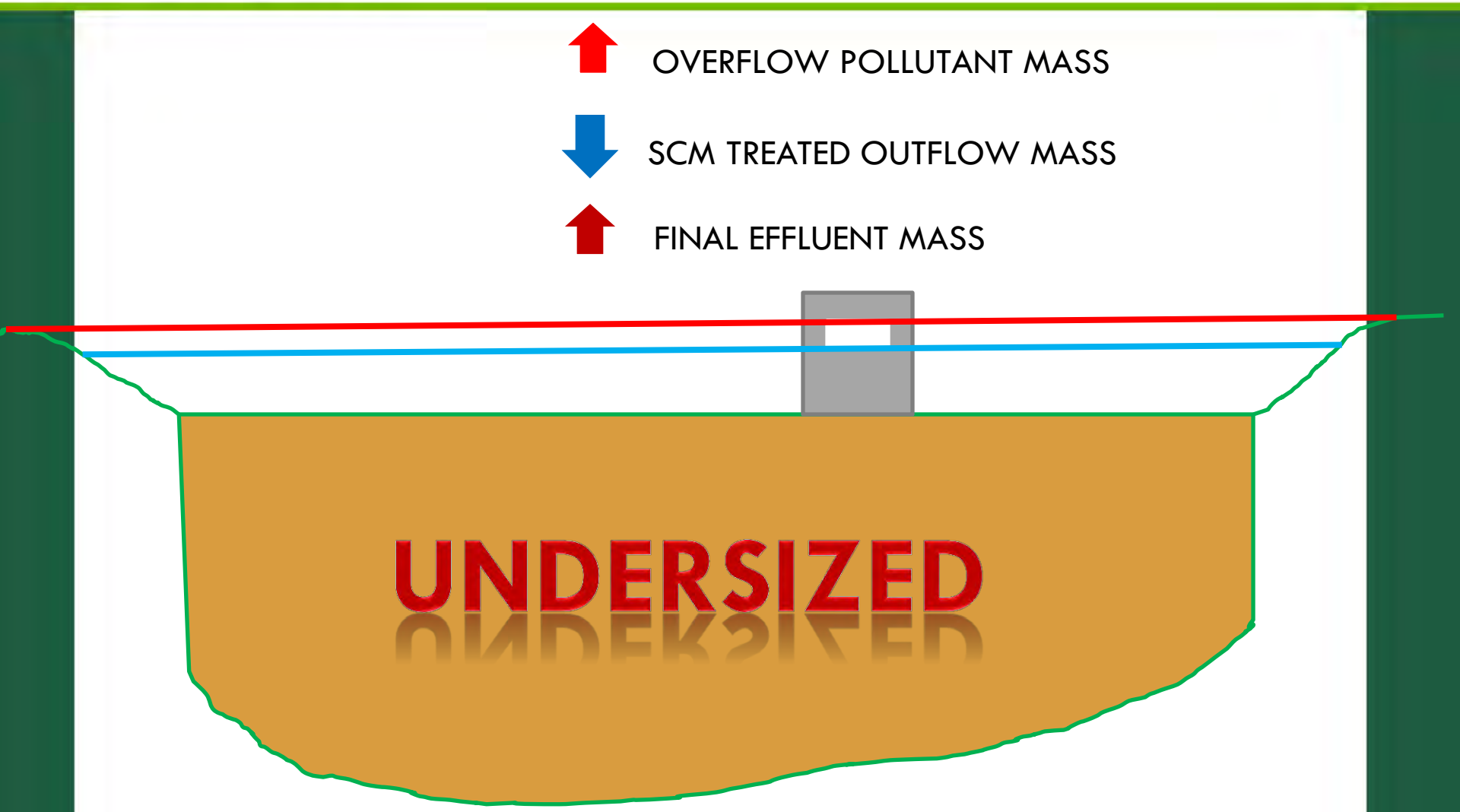
- Boulders and cobble will line the entire riffle
- Boulders will be structurally supported with rebar and concrete
- Larger cobble will be used to minimize cell erosion

Source: *West Virginia Stormwater Management & Design Guidance Manual*

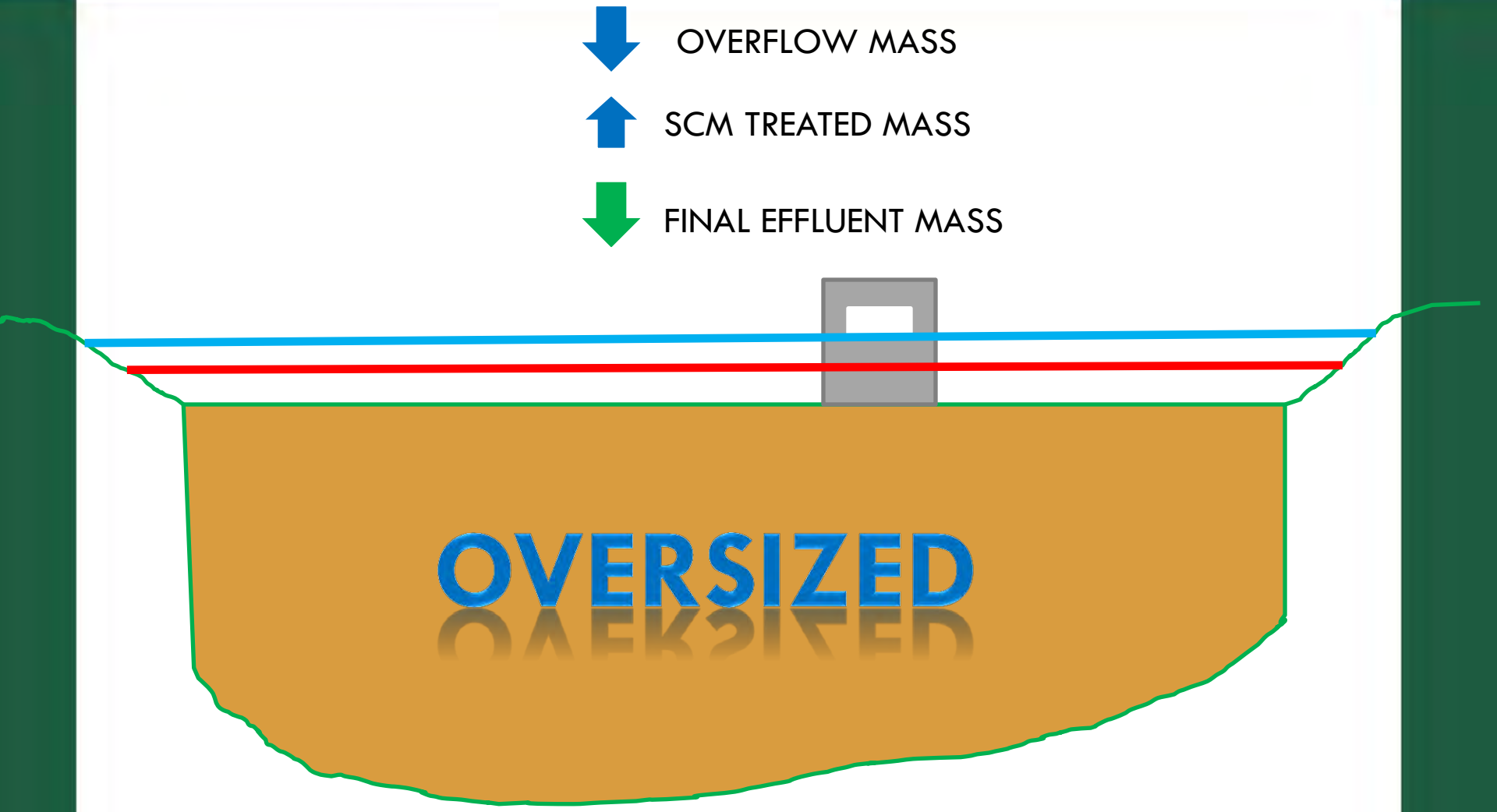
WATER QUALITY VOLUME (WQV) DESIGN RATIO: 1.0



WQV DESIGN RATIO: <1.0



WQV DESIGN RATIO: >1.0



Conservation of Mass

$$Mass\ Out = Mass\ Overflow + Effluent\ Mass$$

$$Mass = Volume\ (V) * Conc.\ (\frac{mg}{L})$$

$$Volume\ (V) = Flow\ (Q) * dt$$

Overflow Mass: Controlled by SCM sizing.

SCM: Mean Effluent Concentration

Inflow Mass: Inflow Volume and Concentration Dependent on Watershed Characteristics

Final Effluent Mass

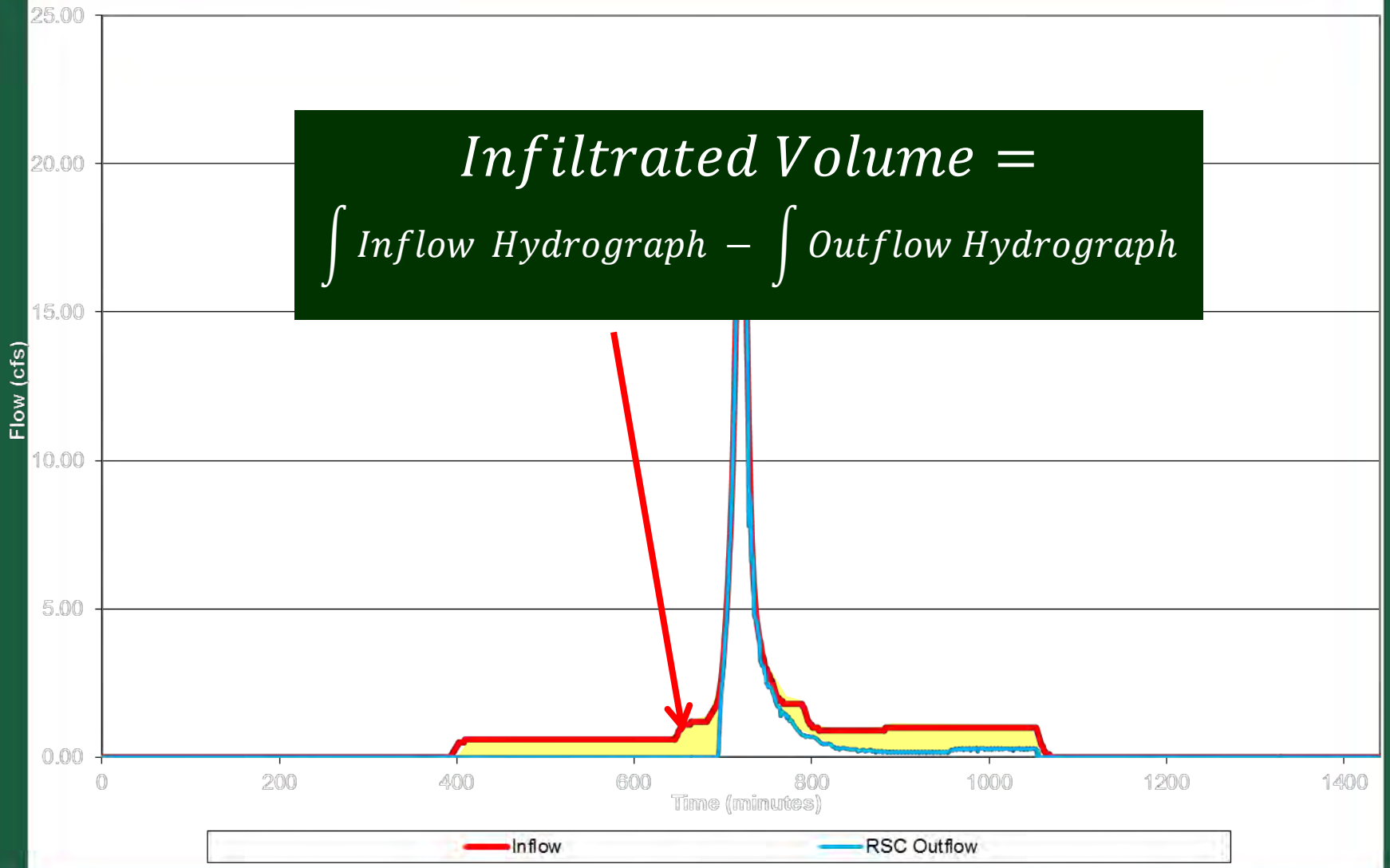
SCM Treated Mass: Dependent on SCM Effluent Concentration

$$q = -K\frac{dH}{ds}$$

$$\iint f(q + SCM + O)dMdV$$

RSC Flow Mitigation for the 1-yr Event

$$Infiltrated\ Volume = \int Inflow\ Hydrograph - \int Outflow\ Hydrograph$$



Basin Names	Stormwater Control Measure	Total Nitrogen Removal (lb/yr)
3rd/4th St RSC	RSC	190.9
3rd St RSC	RSC	10.8
4th/5th St Bioretention	Bioretention w/ IWS	39.7
Inlet Capture Device	Filtera/Silva Cell	3.6
City Park Wetland	Wetland	5.5
Reade St. PP	Permeable Pavement	1.2
	Total TN Removed (lb/yr)	**251.7**

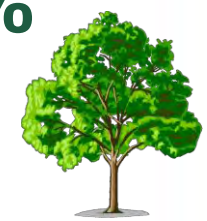
Project BMPs will convert about 10% of Town Creek Watershed (8-10 city blocks) to Coastal Plain Forest (from a treatment perspective)

On-line Regional Treatment

- Daylighting Pipe between 3rd and 4th Streets
  - Regenerative Stormwater Conveyance (RSC)
    - Treats ~258 acres of impervious watershed
    - Infiltrates 30% of all Inflow Volume
    - Provides 38% Reduction in Total Nitrogen Loads
    - Optimal Location for GI General Public Education.

Green Infrastructure Conclusions:

- Equitable distribution of SCMs
  - Total Pollutant removal (~252 lb N/yr)
  - Similar to converting **10%** of this watershed to a forest.
- Overall Estimated SCM costs: $0.5 Million
- Use of Green Infrastructure allowed a **0% interest free 20-yr loan** for the *entire infrastructure project*.



Overall Project Conclusion:

- Overall Project Costs: ~$15.5 Million
  - Estimated Construction Costs: ~$12.5 Mil
  - Surveying, Study, Design and CA Fees: ~$2 Mil
  - Easements, Legal and Admin Costs: ~$1 Mil

$15.5 Mil + $4.5 Mil (Interest) = **$20 Million**

- With the SRF Green Infrastructure Loan:

$15.5 Mil + $0.5 Mil (GI) + $0 Mil (Interest) = **$16 Million**

Greenville
NORTH CAROLINA

WK DICKSON
community infrastructure consultants

Questions?

Marc Horstman, PE, PH, CFM
Technical Manager
WK Dickson & Co., Inc.

mhorstman@wkdickson.com

www.wkdickson.com