McCORMICK TAYLOR

An Ounce of Prevention is Worth a Pound of Cure!

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First National STREAM RESTORATION Conference

Current mitigation crediting observations within the Chesapeake Bay and the state of North Carolina

- Maryland
  - Protocol 5 (Alternative Prevented Sediment for Outfalls) was accepted by the expert panel (10/15/2019)
  - Method to calculate nutrient retention with these types of projects
- North Carolina
  - Current nutrient crediting doesn't include headwater outfalls and are underrepresented in stream restoration arena.
  - They don't fit in the current system. (Agricultural buffer (lb/ac/yr), SNAP 4.1)
  - Barbara Doll presented about the NCDWR considering adopting a similar crediting system borrowed heavily from Chesapeake Bay Protocols at the CWP in 2019

Can We Quantify the Significance of Headwater Erosion Reduction/Prevention in Comparison to Existing Nutrient and Stream Restoration Crediting?

Chesapeake Bay Protocol 5

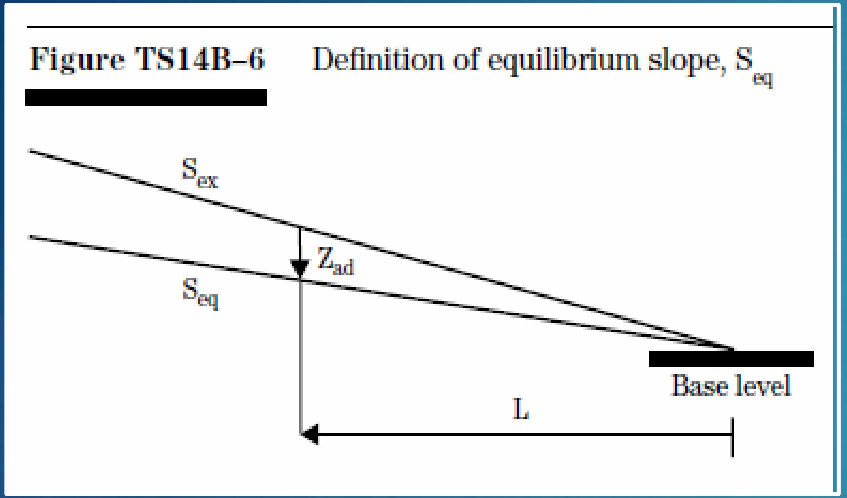
- The headwater transition zone acts as a watershed "hotspot" for sediment erosion and downstream delivery (Lowe, 2018)
- Protocol Steps
  - 1. Define the Existing Channel Conditions
  - 2. Define the Equilibrium Channel Conditions
  - 3. Calculate Total Volume of Prevented Sediment Erosion
  - 4. Convert Total Sediment Volume to Annual Prevented Sediment Load
  - 5. Determine Annual Prevented Nutrient Loads

Headwater Erosion Reduction Calculation Method

- Compares existing condition versus future equilibrium state
- Sediment load reduction is computed by comparing the difference between the existing surface and the equilibrium surface.
- Future surface is based on:
  - Equilibrium Bed Slope
  - Base Level Selection
  - Bank Angle
  - Bottom Width
- Output = Total Sediment Yield per Year (CF/CY)

Headwater Erosion Reduction Calculation Method

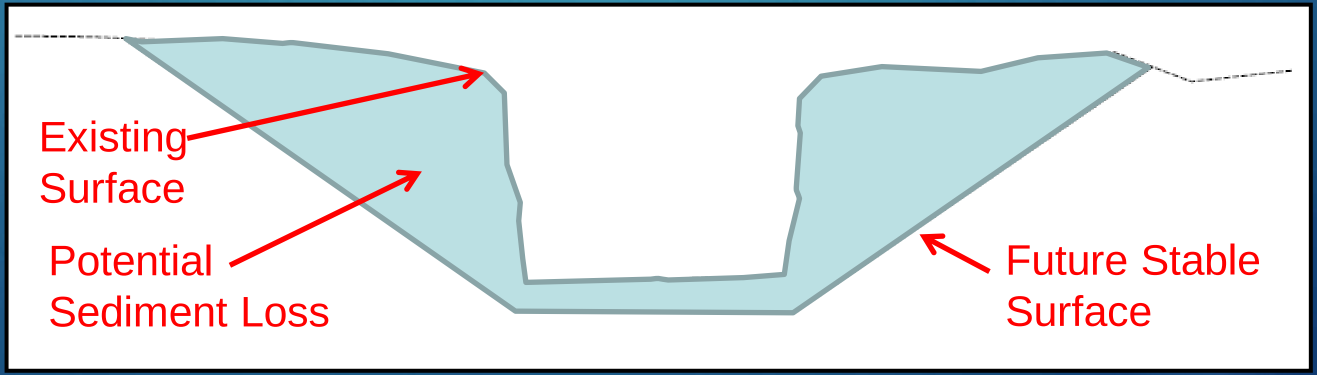
Base level & Equilibrium Slope



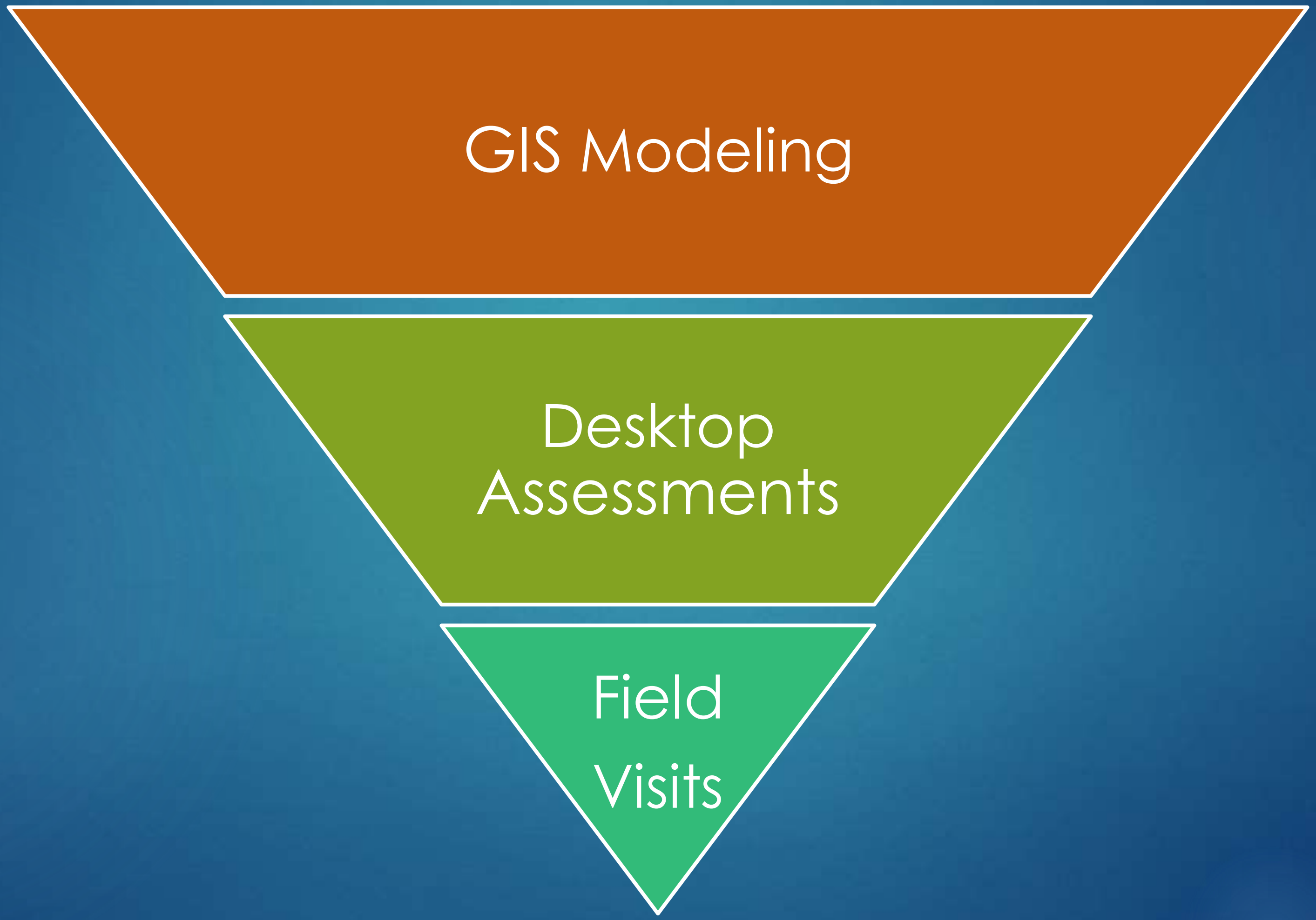
Future Surface is Dependent Upon Equilibrium Slope and Width with Base Level Control

Equilibrium Slope: *When sediment transport capacity exceeds sediment supply, channel degradation occurs until an armor layer forms that limits further degradation or until the channel bed slope is reduced so much that the boundary shear stress is less than a critical level needed to entrain the bed material.*

Comparative Cross Section



Project Site Selection Approach



Gather Modeling Data

Approach 1
Using Storm Drainage Network

- Pipes
- Inlets
- Outfalls
- Stream Channels
- NCDOT Right-of-Way
- Digital Elevation Model (DEM)

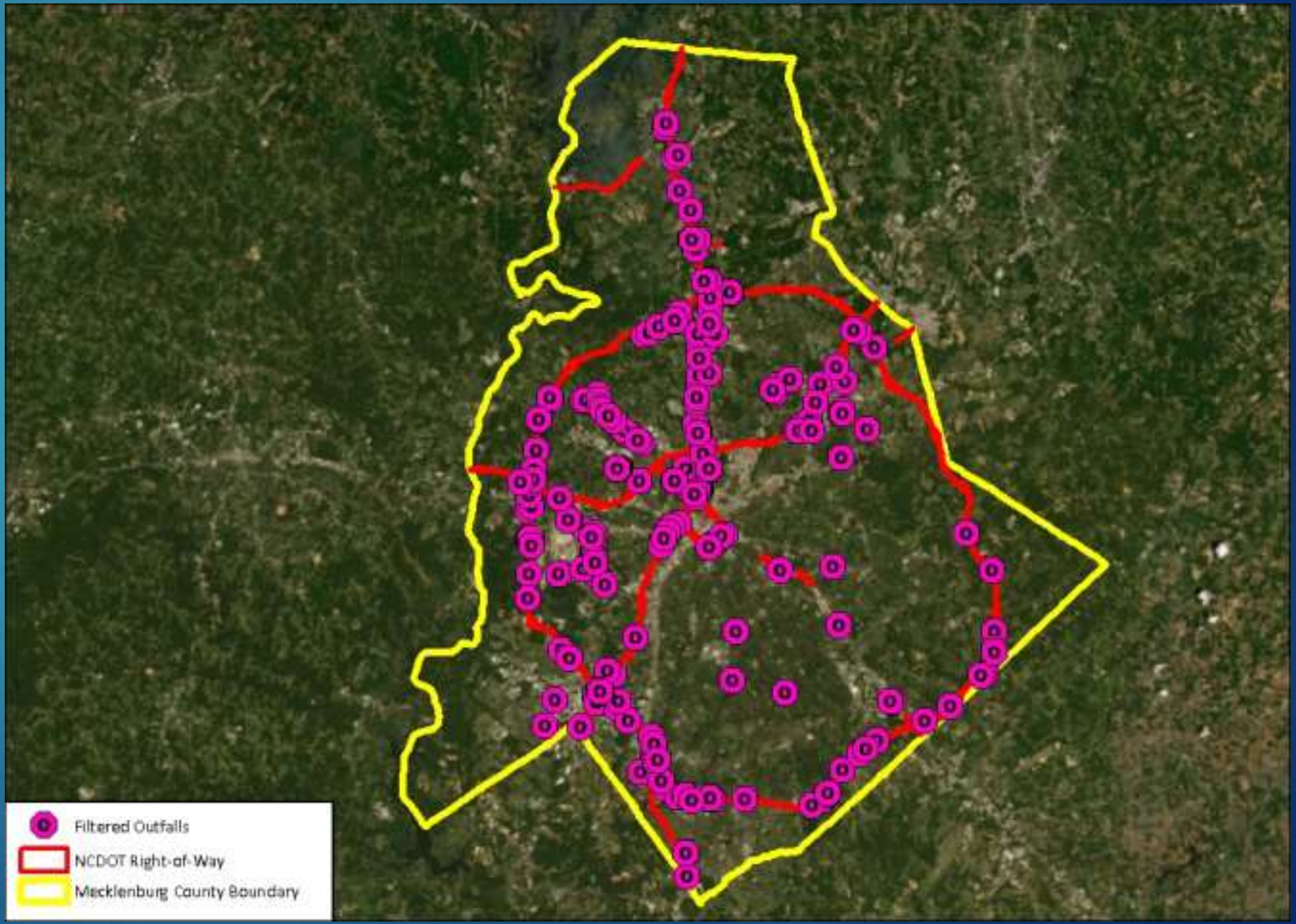
Approach 2
Using Only LIDAR Data

- NCDOT Right-of-Way
- Digital Elevation Model (DEM)

GIS Modeling - Approach 1

Filter Outfalls for Analysis

- Total countywide outfalls = 24,617
- Outfalls within 50 feet of edge of NCDOT right-of-way = 258



GIS Modeling - Approach 1

Detail View of Stormwater Data

- Highly accurate stormwater infrastructure data.

- Full connectivity from inlet > pipe > outfall > stream channel.

GIS Modeling - Approach 1

Generate Flowpath from Outfall

- Extends to second downstream confluence

GIS Modeling - Approach 1

Generate Flowpath from Outfall

- Clip to NCDOT Right-of-Way. Evaluate length, elevation change, and slope.
- Clip to first adjacent parcel. Evaluate length, elevation change, and slope.

Flowpath	Length	Elevation Change
Full Flowpath (Yellow)	3,851.0	-54.5
Clipped to First Adjacent Parcel	806.5	-23.8
Clipped to NCDOT ROW	114.3	-7.6

GIS Modeling - Approach 2

Detail View of Stormwater Data

- Highly accurate stormwater infrastructure data.

- Full connectivity from inlet > pipe > outfall > stream channel.

GIS Modeling - Approach 2

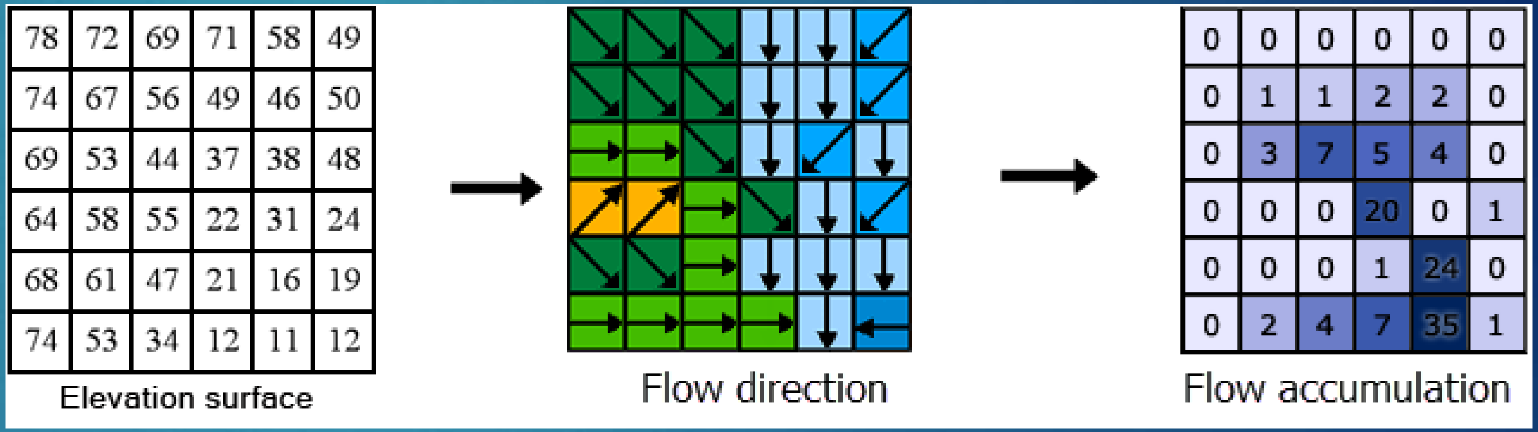
Raster Analysis

- Create flow direction raster

  "Where a rain drop would go if it fell on the surface"

- Create flow accumulation raster

  "Where those rain drops would gather".



GIS Modeling - Approach 2

LIDAR Interpolated Stream Channels

- 1,000 sq. meters = ~.25 acres
- Very high detail flow network. Some artificial flowpaths identified

GIS Modeling - Approach 2

LIDAR Interpolated Stream Channels

- Identify segments between .75 and 2.5 acres of accumulation.
- 391 segments identified on NCDOT Right-of-Way
- Compute length and elevation change for all segments.

Flowpath	Length	Elevation Change
Segment 1984	257.3	-20.9

Desktop Assessments

- Step 1
  - Reviewed length and percent slope of site
  - Reviewed length within NCDOT ROW
- Step 2
  - Model verification through Google Earth Review
  - Existing Utility Review
  - Construction Access Review
- Step 3
  - Land Owner Review
  - Endangered Species Review
  - 303d List Review
  - Any other potential obstacle review (Hazardous waste sites, etc.)

POTENTIAL SITES TO REVIEW

BASIN	ID	ELEVATION CHANGE	LENGTH	303D	ADJACENT PARCEL	NOTES
LOWER CATAWBA	159	14	1312	Yes	City of Charlotte	Potential MOW
	86	6	1142	Yes	Mecklenburg County	Might be too flat
	6	19	1025	No		Might be better stream restoration with Mecklenburg County
	141	19	988	No		
	63	22	269	No		Cant tell much from aerial, noise wall., no access
	56/84	10	759/360	Yes		May be wetland stream complex
	34/125	6	703	Yes		part of same interchange
	90	18	697	Yes		May be the one!!
	26	9	529	No	City of Charlotte	2,300 with city of charlotte; potential stream restoration
	22	5	107	Yes	DDR Carolina Pavilion LP; Meck County Parks and Rec	560 LF to Little Sugar Creek; good access off ramp, no guardrail
	138	2.6	121	No	City of Charlotte; CLT Industiral LLC	Potentially up to 900 ft; Good access, no guardrail
	148	0.4	102	Yes	Vulcan Lands (Quary)	Stream Restortaion Potential? 2,700 feet from outfall to next culvert
	66	0.1	102	Yes	Mecklenburg County (Greenway trail adjacent)	McAlpine Creek. Stream Restortaion Potential? 5,700 feet from outfall into McCullen Creek. Both on 303d
	2	1	132	Yes	city of charlotte	6,700 total; adjacent to greenway trail
	112	8	160	Yes	All within ROW	good access

Field Visits

- Narrowed list through Desktop assessments
  - First iteration we selected 13 sites to review in the field
    - Found most had too large of a watershed and were not typical outfalls/headwater streams
    - Found 1 site that connected to a selected site
      - Completed field work on site 160
    - From this first iteration, we narrowed down the variables to put into the GIS model

Field Visits

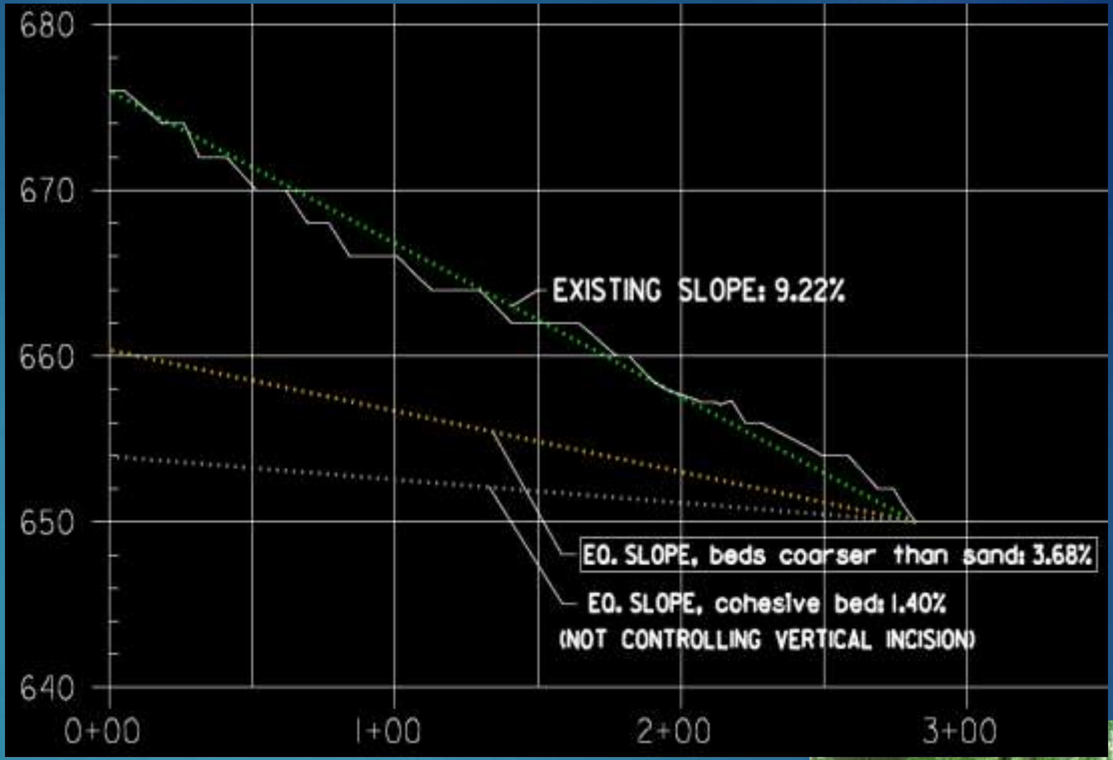
- Second iteration we selected 12 sites to review in the field
  - Found 2 sites in the field that we thought would be good candidates
    - Completed field work on sites 14, and 1984

Site Locations

Decision Process

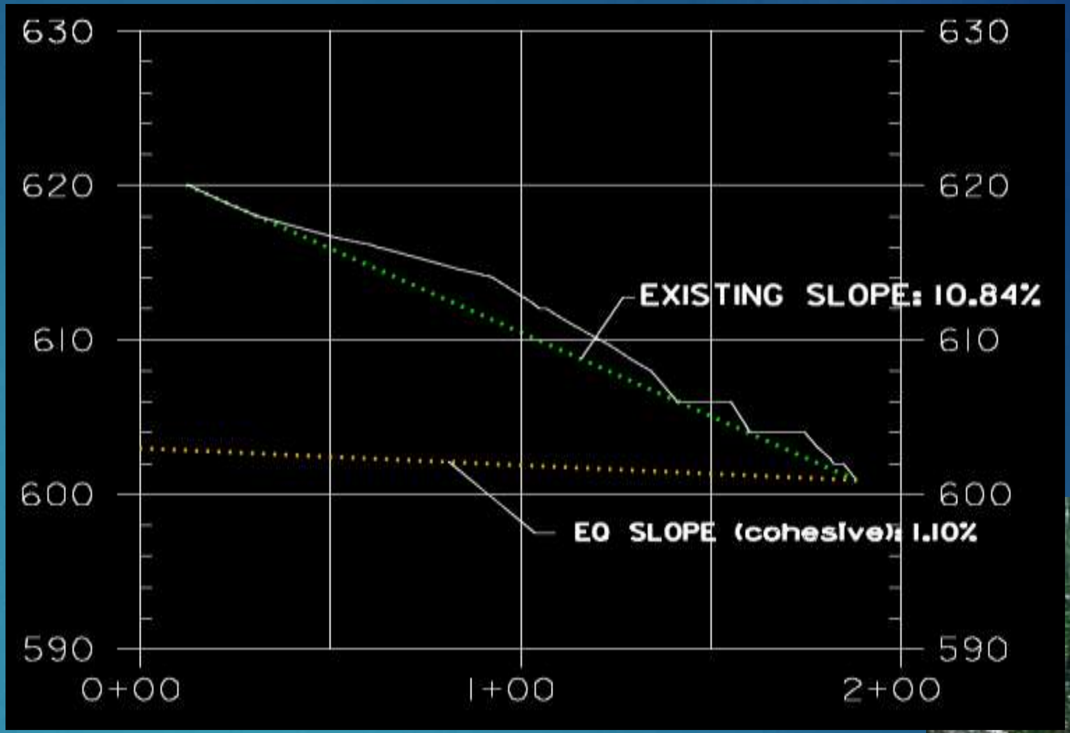
- DTM from Mecklenburg County GIS was used to determine 3D surface
- Existing alignment based on GPS points taken in field and longest flow paths from DTM
- Bulk Densities were taken from US Web Soil Survey data based on soils at each individual site.
- Hydrology was modeled using TR-55 method
- Total Nitrogen (1.34-1.78 lbs/ton) and Total Phosphorus (0.46-0.65 lbs/ton)estimates were taken from Barbara Doll's study with existing Chesapeake Bay Protocols or site measurements near the project site. These were the Tetra Tech estimates taken from 109 samples in the piedmont
  - Torrence Creek – located in Huntersville (nearest site Dr. Doll had to Charlotte)
- All other data used were collected in the field

Site #1984 (Rocky)	
Outfall size	18" CMP
Drainage area	1.9 ac
Impervious area	1.62 ac
Proposed Stabilized Length	225 lf
Estimated erosion	3,251 cy 4,191 tons
TSS (based on 50% efficiency)	140 tons/yr (70 tons/yr)
TN (based on 50% efficiency)	188 lbs/yr (94 lbs/yr)
TP (based on 50% efficiency)	64 lbs/yr (32 lbs/yr)

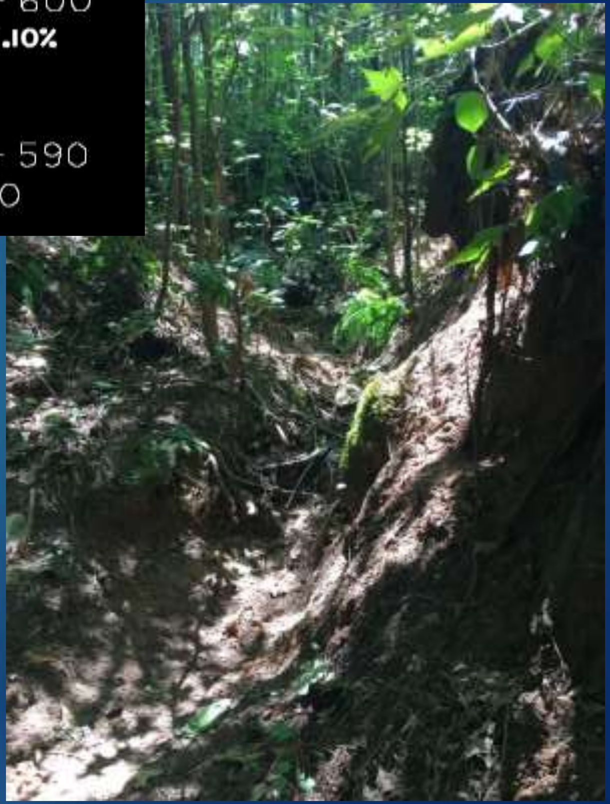


Equilibrium Slope	3.68%
Bottom Width	3.9 ft
Bank Slope	1.91:1

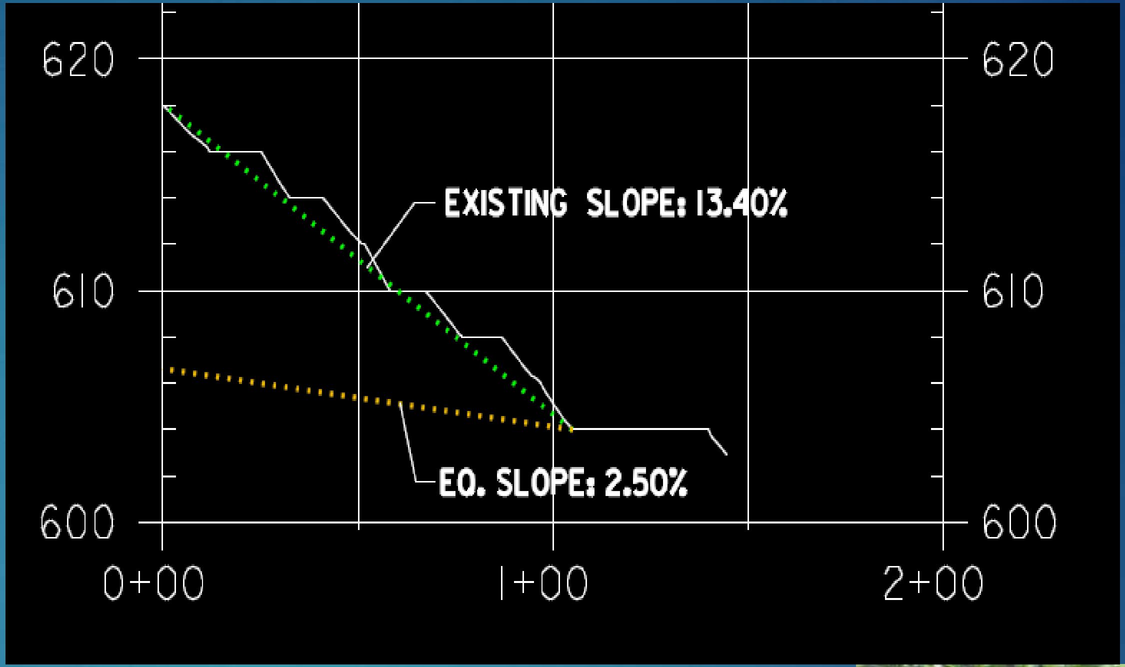
Site #14 (Lower Catawba)	
Outfall size	18" CMP
Drainage area	4.0 ac
Impervious area	1.2 ac
Proposed Stabilized Length	352 lf
Estimated erosion	2,246 cy 2,797 tons
TSS (based on 50% efficiency)	93 tons/yr (47 tons/yr)
TN (based on 50% efficiency)	125 lbs/yr (63 lbs/yr)
TP (based on 50% efficiency)	43 lbs/yr (22 lbs/yr)



Equilibrium Slope	1.1%
Bottom Width	4.3 ft
Bank Slope	1.91:1

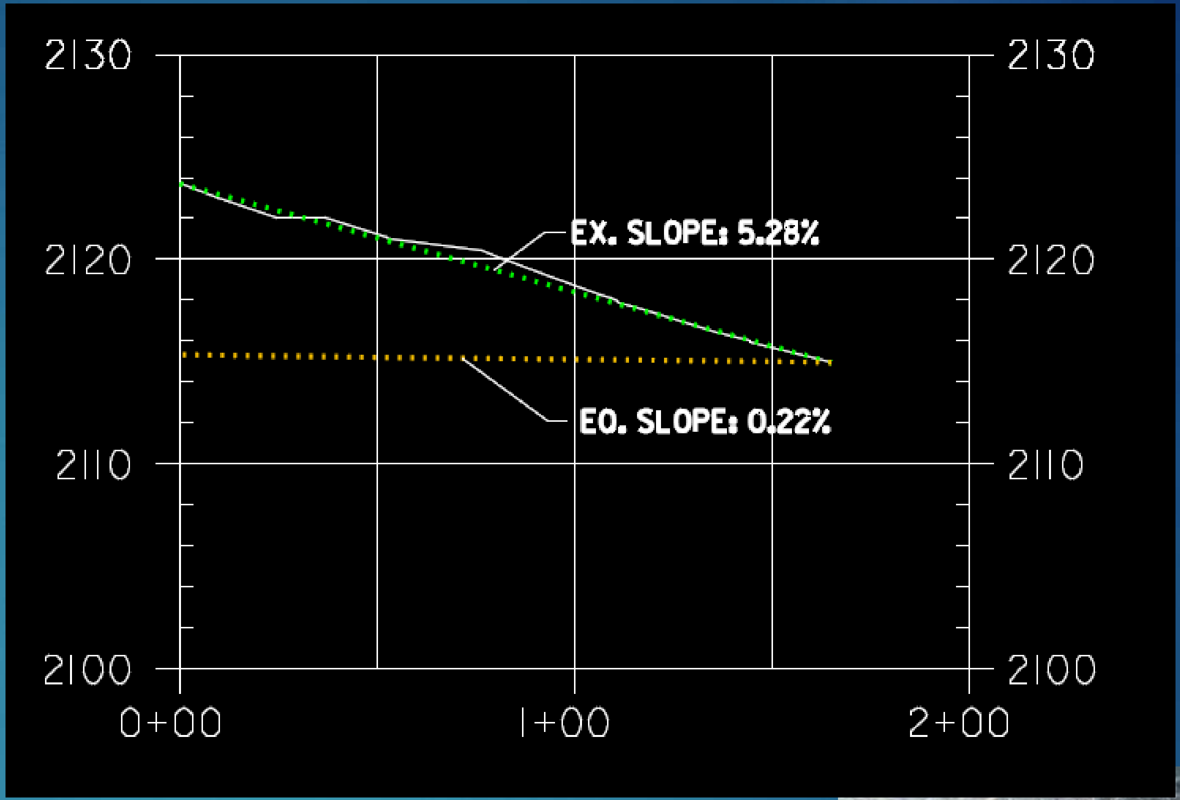


Site #160 (Rocky)	
Outfall size	18" CMP
Drainage area	0.9 ac
Impervious area	0.41 ac
Proposed Stabilized Length	105 lf
Estimated erosion	713 cy 841 tons
TSS (based on 50% efficiency)	28 tons/yr (14 tons/yr)
TN (based on 50% efficiency)	38 lbs/yr (19 lbs/yr)
TP (based on 50% efficiency)	12.9 lbs/yr (7.5 lbs/yr)



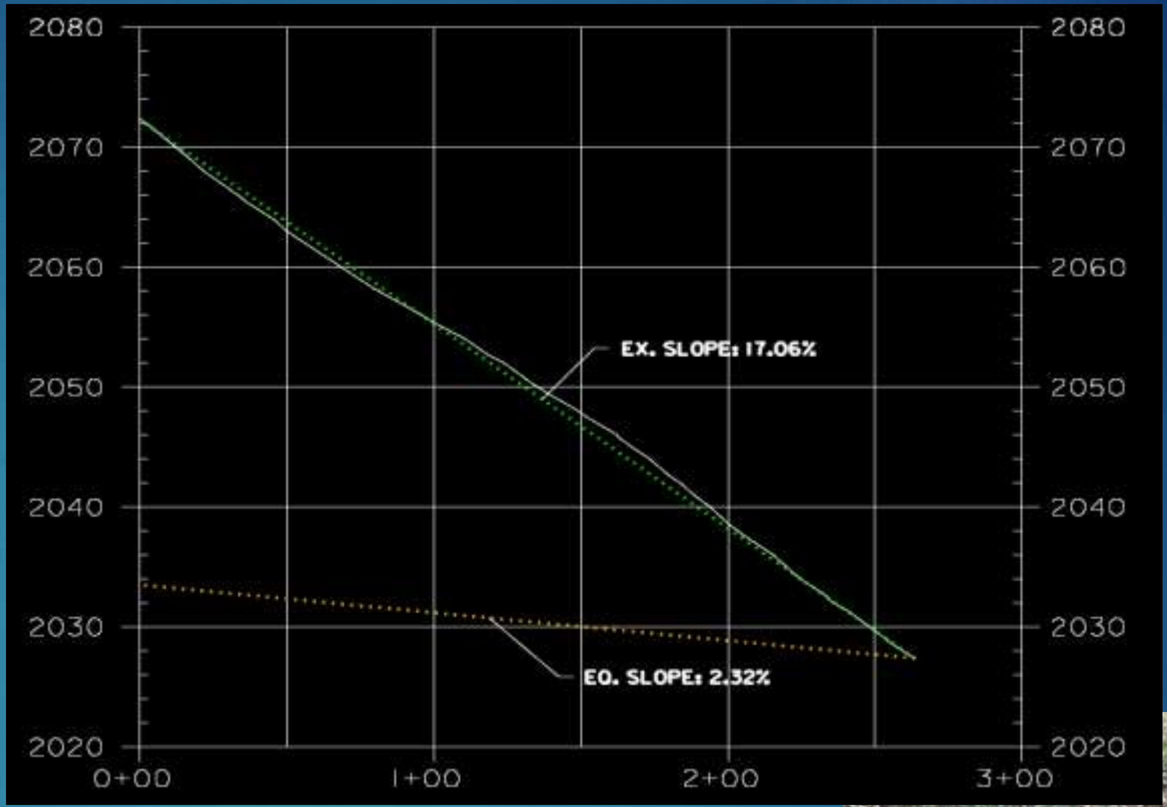
Equilibrium Slope	2.5%
Bottom Width	6.4 ft
Bank Slope	1.91:1

Site #POI 6	
Outfall size	36" CMP
Drainage area	29.8 ac
Impervious area	17.9 ac
Proposed Stabilized Length	165 lf
Estimated erosion	410 cy 489 tons
TSS (based on 50% efficiency)	16 tons/yr (8 tons/yr)
TN (based on 50% efficiency)	22 lbs/yr (11 lbs/yr)
TP (based on 50% efficiency)	8 lbs/yr (4 lbs/yr)



Equilibrium Slope	0.22%
Bottom Width	5.5 ft
Bank Slope	1.91:1

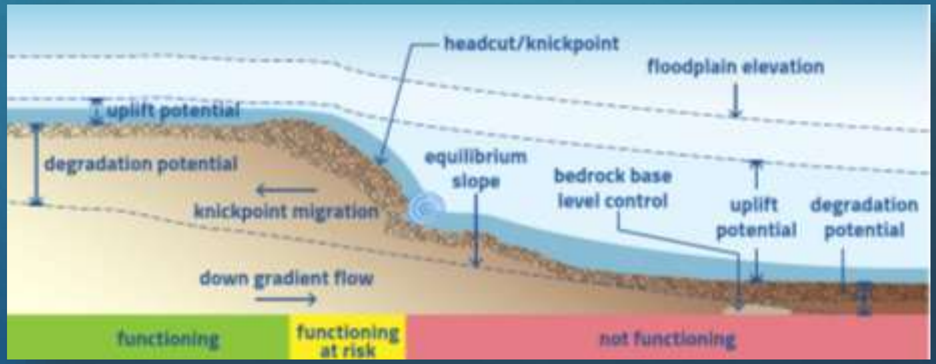
Site #POI 15	
Outfall size	48" CMP
Drainage area	17.3 ac
Impervious area	4 ac
Proposed Stabilized Length	264 lf
Estimated erosion	11,986 cy 14,938 tons
TSS (based on 50% efficiency)	498 tons/yr (249 tons/yr)
TN (based on 50% efficiency)	667 lbs/yr (333 lbs/yr)
TP (based on 50% efficiency)	229 lbs/yr (115 lbs/yr)



Equilibrium Slope	2.32%
Bottom Width	5.8 ft
Bank Slope	1.91:1

Prevents the Greatest Degradation Potential

- Significant functional retention by addressing headwater headcut channels and outfalls
- Reducing sediment delivering downstream
- Ultimately improving stream functions throughout watershed
- Current priorities address degraded conditions
- Preventative solution addressing significant and long-term sediment impacts at the source



Credit: McCormick Taylor

Next Steps

- Determine average TN and TP retention potential, along with uplift based on SQT for all stream restoration sites in the mountains, piedmont, and coastal plain.
- At each new headwater and outfall site complete bulk density, TN, TN measurements, and degradation potential based on SQT and CBP 5.
- Analyze individual sites to determine a mitigation factor for headwater and outfall sites for nutrients and stream credits.
- convert headwater and outfall restoration sites into a linear feet equivalent to accurately capture credit generated by these highly impactful projects.

Questions?