McCORMICK TAYLOR

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

Use of Protocol 1 for Preventive Sediment Credit

National Stream Restoration Conference

Craig Carson

August 2, 2022

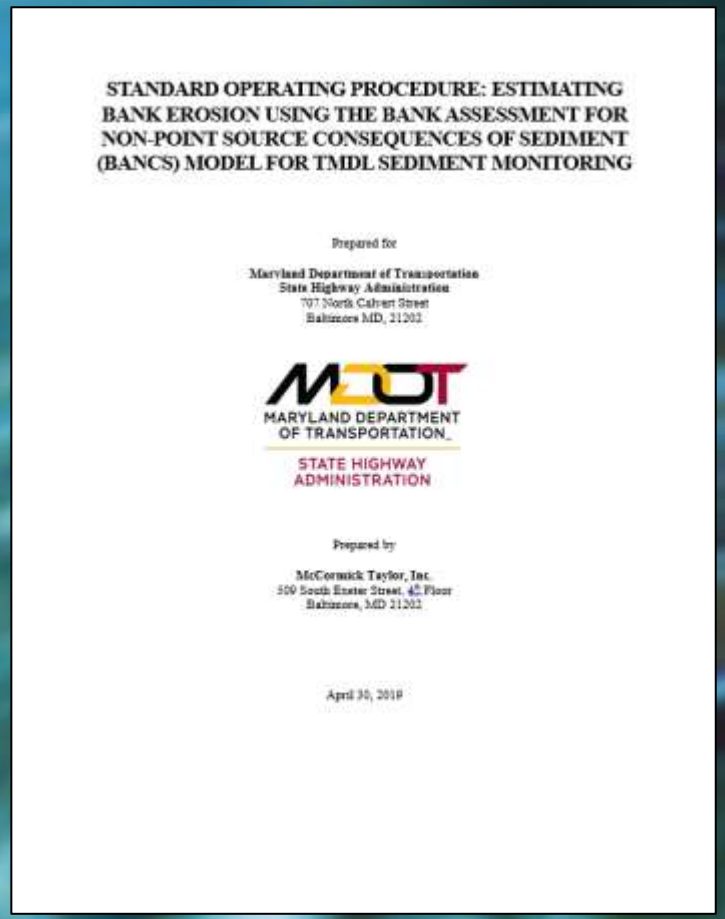
Overview

- Project Description
- Methodology
- Results
- Lessons Learned
- Future Considerations

Site: Gramies Run

Project Description

- Develop a SOP using Protocol 1 for the BANCS model
- MDOT SHA Team performed and or managed 35 sites:
  - Stream assessments
  - Monitoring
  - TMDL Crediting
  - Reporting
- Over 40 miles of stream channels
  - Task 1 included ~15 miles SHA stream and outfall sites
  - Task 2 included ~28 miles Full Delivery stream sites



STANDARD OPERATING PROCEDURE: ESTIMATING BANK EROSION USING THE BANK ASSESSMENT FOR NON-POINT SOURCE CONSEQUENCES OF SEDIMENT (BANCS) MODEL FOR TMDL SEDIMENT MONITORING

Prepared for

Maryland Department of Transportation
State Highway Administration
707 North Calvert Street
Baltimore MD, 21202

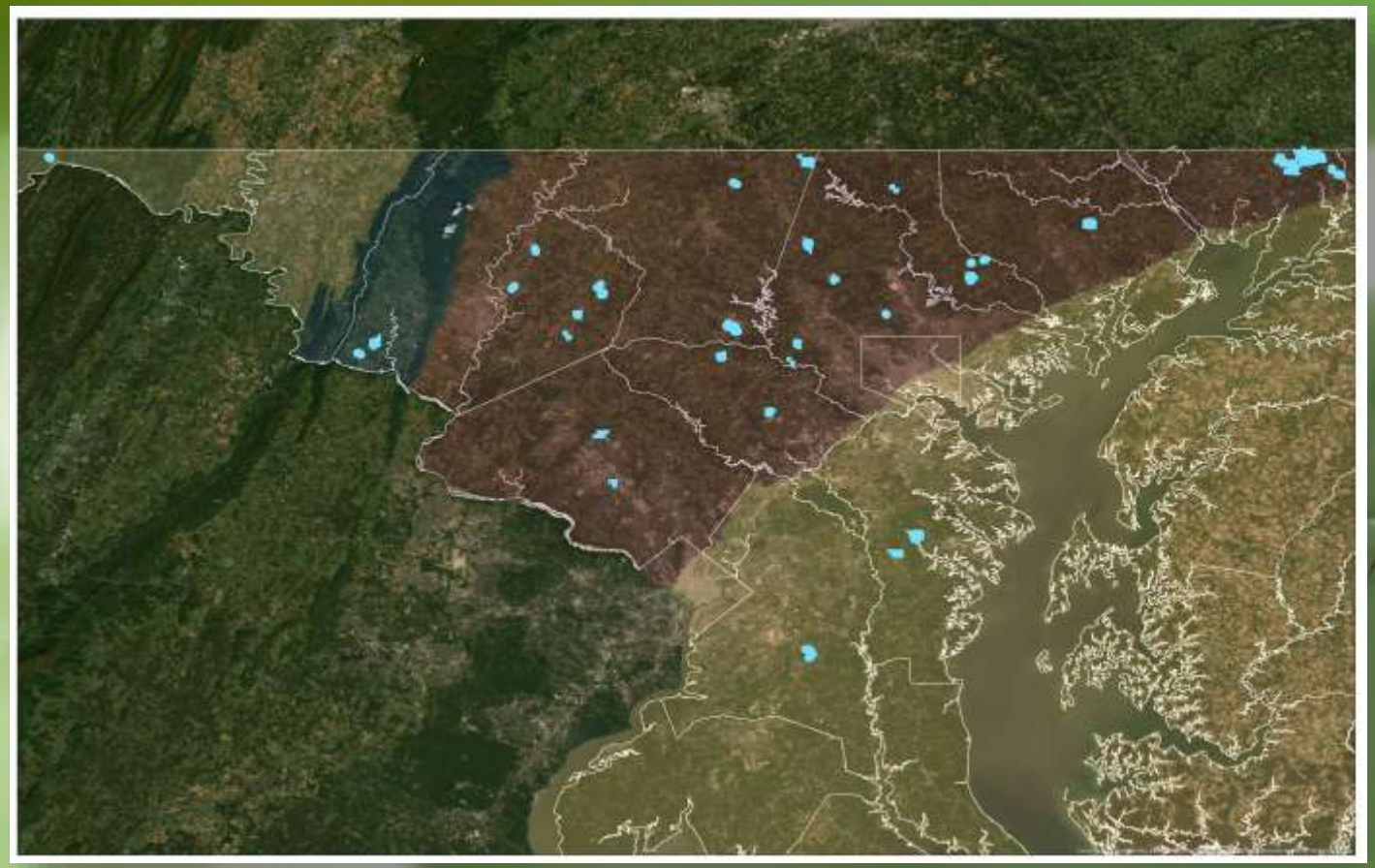
MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

Prepared by

McCormick Taylor, Inc.
500 South Exeter Street, 4th Floor
Baltimore, MD 21202

April 30, 2019

Project Locations Across the State



Methodology

Bankfull Depth and Discharge: calculated using project drainage area

1B. Calculate Bankfull Mean Depth

- USFWS MD Piedmont Region
- USGS Coastal Plain Region

$$d_{bkf} = 1.145 * DA^{0.27345}$$

- USGS Valley and Ridge Region

$$d_{bkf} = 1.001 * DA^{0.2881}$$

Equation Key:

d_{bkf} = Bankfull mean depth

DA= Drainage Area (mi^2)

Methodology

BANCS Method - Bank Assessment for Non-Point Source Consequences of Sediment

- Used BEHI worksheet from Rosgen's River Stability Field Guide
- Indexed factors: study bank height, bankfull height, root depth, weighted root density, bank angle and surface protection
- Occasional bank material and stratification adjustments

Site: Bens Branch

Methodology

- **Near Bank Stress (NBS): Method 5**
  - Uses ratio of Near-Bank Maximum Bankfull Depth to Mean Bankfull Depth
  - Baseflow Condition measurements:
    - Measure maximum water depth within 1/3 of the width of the channel closest to the study bank
    - Add mean bankfull depth (d_{bkf})
    - Measure and subtract water depth of the closest riffle to the study bank
    - NBS Value = $\frac{d_{nb}}{d_{bkf}}$

Near-Bank Stress (NBS) Ratings	Value from NBS Method 5
Very Low	<1.00
Low	1.00-1.50
Moderate	1.51-1.80
High	1.81-2.50
Very High	2.51-3.00
Extreme	>3.00

Methodology

- **Cross Sections:**
- At least one cross section is taken per BEHI type
- Survey cross section with detailed measurement of streambanks
- Take LB, RB, US and DS photos

Whiterock Court

Soil Sampling:

- Take bulk density core soil sample (NRCS, 2001)
- Collect 1.5 cups of soil for nutrient soil sampling (TN and TP)

Park Drive BD Sample

2.5 ft headcut – Prince George's County MD

Methodology

Data Collection

Hosted Feature Services on ArcGIS Online

Reference Data

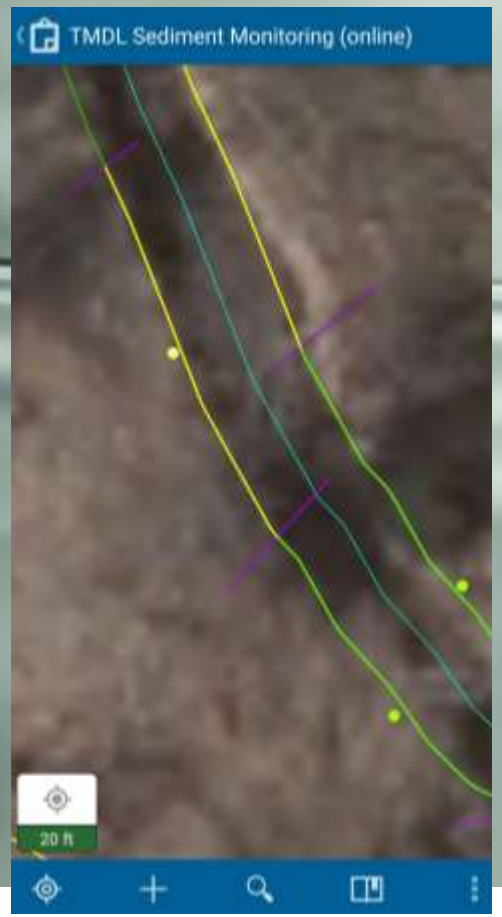
- Transect Line
  - Change of BEHI and/or NBS
- BEHI/NBS Point

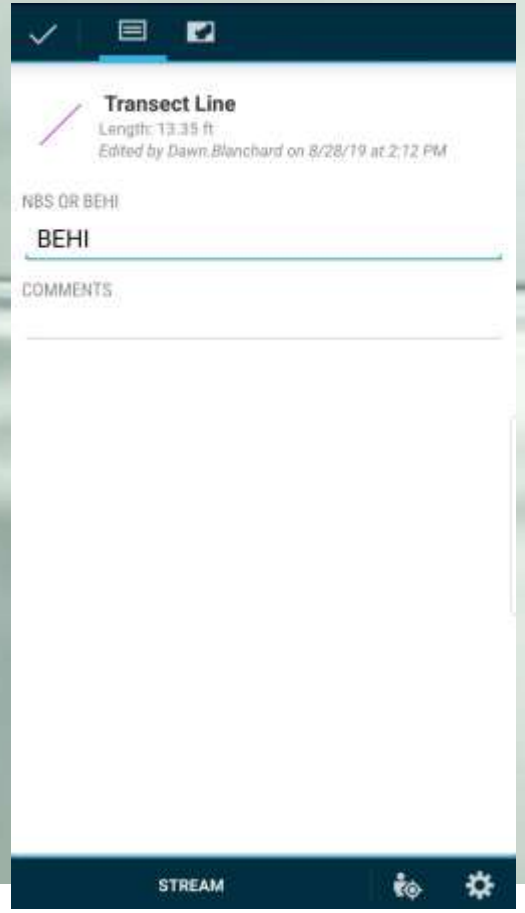
Collector for ArcGIS was used for data collection

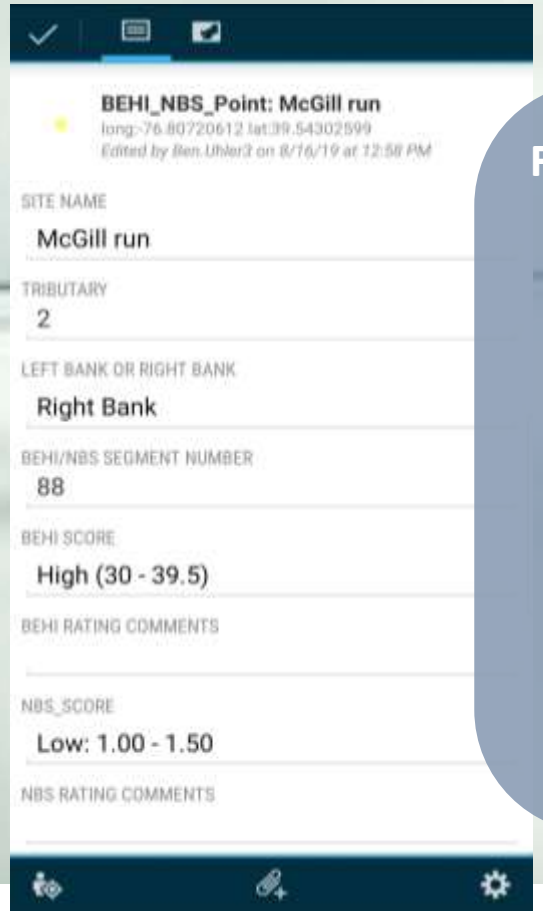
Attached all field forms and pictures from the field to the hosted features.

2.5 ft headcut – Prince George's County MD

Methodology





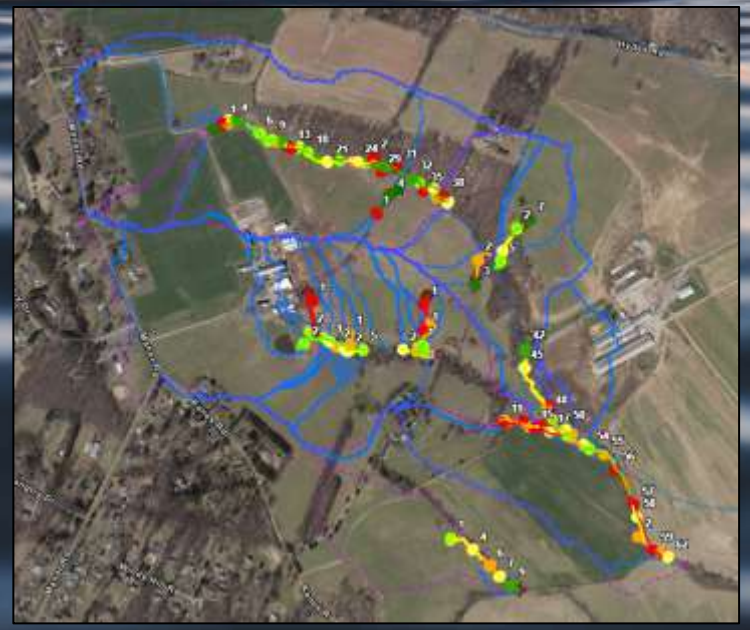


Field work

- Place a transect at the location the BEHI and/or the NBS segment changed
- BEHI/NBS Point
  - Place between the transect lines
  - Entered BEHI and NBS data
- Attach photos of the study bank and stream perspective
  - Taken for documentation and QC process

2.5 ft headcut – Prince George's County MD

Methodology



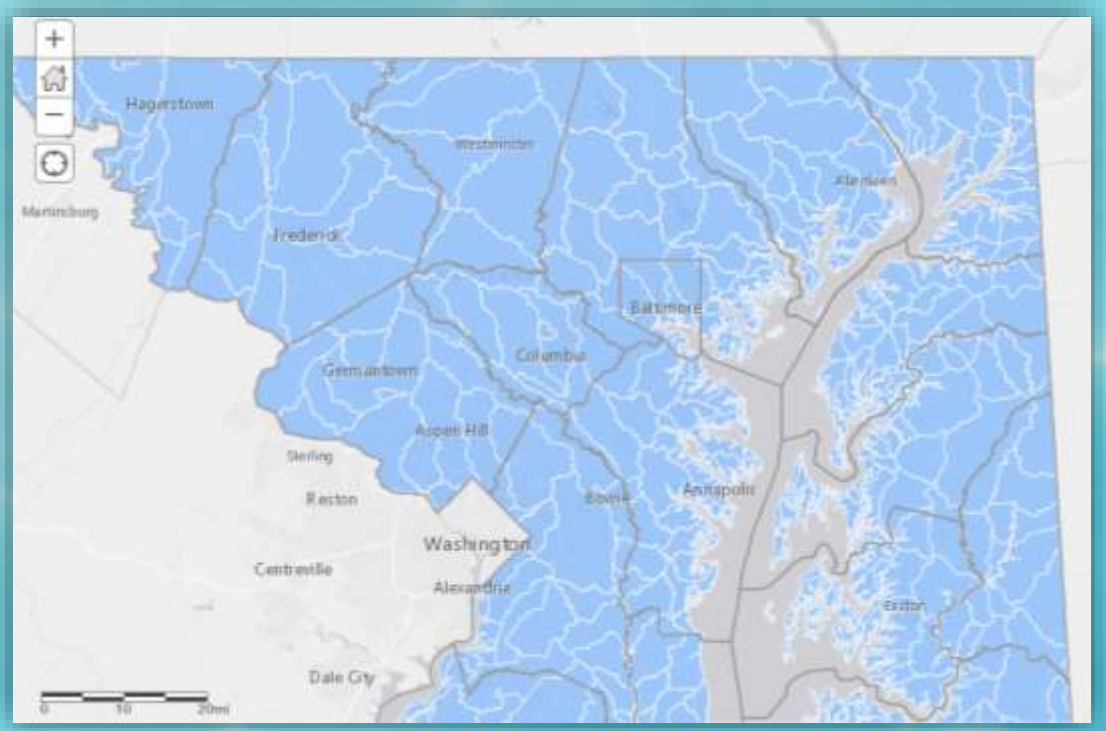
Post Processing

- Cut the stream buffer at each transect
- Associate the BEHI/NBS point data with each segment between transect lines
  - Final Product BEHI and NBS calculations symbolized for each segment of the stream

Methodology

Delivery Factor

- Results provided for Protocol 1
  - with delivery factors applied
  - without delivery factors applied
- Site-specific delivery factors are applied to sediment, TN and TP
- Delivery factors are found using MDE's "Maryland Chesapeake Bay Land-River Segment Map" and the Phase 6 CAST-Source data spreadsheet.



Methodology

Convert sediment and nutrient pollutant reduction loads to impervious acre credit:

Average Pollutant Load Reduction (lbs/acre/year)= $\frac{Total\ Annual\ Pollutant\ Load\ Reduction\ (\frac{lbs}{year}\ or \frac{tons}{year})}{Drainage\ Area\ (acres)}$

Impervious Acre Conversion Factor (acre /acre) = $\frac{Average\ Pollutant\ Load\ Reduction\ (\frac{lbs/acre}{year}\ or \frac{tons/acre}{year})}{Delta\ Impervious\ Surface\ and\ Forest\ (\frac{lbs/acre}{year}\ or \frac{tons/acre}{year})}$

Average Acre of Treatment for Nutrient and Sediment per LF (acre/LF) =

$$Average\ Impervious\ Acre\ Conversion\ Factor\ \left(\frac{acre}{acre}\right) * \frac{Drainage\ Area\ (acre)}{Site\ Length\ (LF)}$$

Average Acre of Treatment for Nutrient and Sediment (acre)

$$= Average\ Acres\ of\ Treatment\ for\ Nutrients\ and\ Sediment\ per\ LF\ *\ Site\ Length\ (LF)$$

2.5 ft headcut – Prince George's County MD

Example Results

TMDL Water Quality Results

GRAMIES RUN

POI	Protocol 1 TMDL Credit			Site Length (Linear Feet)	Total Watershed Area (Acres)	Impervious Watershed Area	Delta Impervious Surface and Forest			Average Pollutant Load Reduction			Impervious Acre Conversion Factor (AC/AC)				Average Acres of Treatment for Nutrients and Sediment per Linear Foot	Average Acres of Treatment for Nutrients and Sediment per 100 Linear Feet	Calculated Total Impervious Acre Treatment (Acres)
	TN (lbs/yr)	TP (lbs/yr)	TSS (tons/yr)				TN (lbs/acre/yr)	TP (lbs/acre/yr)	TSS (tons/acre/yr)	TN (lbs/acre/yr)	TP (lbs/acre/yr)	TSS (tons/acre/yr)	TN	TP	TSS	Average			
Gramies Run	599	90	189	5160	1990	123	7.69	1.91	0.43	0.30	0.05	0.10	0.04	0.02	0.22	0.09	0.04	3.7	188.6

Calculations excluding sediment delivery ratio

POI	Protocol 1 TMDL Credit			Site Length (Linear Feet)	Total Watershed Area (Acres)	Impervious Watershed Area	Delta Impervious Surface and Forest			Average Pollutant Load Reduction			Impervious Acre Conversion Factor (AC/AC)				Average Acres of Treatment for Nutrients and Sediment per Linear Foot	Average Acres of Treatment for Nutrients and Sediment per 100 Linear Feet	Calculated Total Impervious Acre Treatment (Acres)
	TN (lbs/yr)	TP (lbs/yr)	TSS (tons/yr)				TN (lbs/acre/yr)	TP (lbs/acre/yr)	TSS (tons/acre/yr)	TN (lbs/acre/yr)	TP (lbs/acre/yr)	TSS (tons/acre/yr)	TN	TP	TSS	Average			
Gramies Run	763	150	542	5160	1990	123	7.69	1.91	0.43	0.38	0.08	0.27	0.05	0.04	0.63	0.24	0.09	9.3	479.6

Delta impervious Surface and Forest – MDE 2014

2.5 ft headcut – Prince George's County MD

Summarized Data

Reach/Site	Total Sediment Load w/ DF (lbs/ft/yr)	Total Sediment Load w/out DF (lbs/ft/yr)
Charles Branch Tribs - Rosaryville	68	188
Gramies Run	74	210
Gunpowder Near MD165	63	183
Gunpowder Near MD145	44	126
Little Tonoloway	87	192
Big Pipe Creek	54	90
North Fork Linganore	42	88
Little Catoctin at MD340	128	292
Piney Run at MD32	39	170
Israel Creek at MD550	96	198
Israel Creek at Stauffers	49	101
Jones Falls at Salt Dome	67	173

MDOT SHA Stream Data (2018)

- Total Sediment Load with DF Applied = *810 lbs/ft/yr*
- Total Sediment Load without DF Applied = *2,011 lbs/ft/yr*
- Average Total Sediment Load with DF Applied = *68 lbs/ft/yr*
- Average Sediment Load without DF Applied = *168 lbs/ft/yr*

2.5 ft headcut – Prince George's County MD

Summarized Data

Reach/Site	Total Sediment Load w/ DF (lbs/ft/yr)	Total Sediment Load w/out DF (lbs/ft/yr)
Fourth Mine	5	80
Long Green Creek	27	125
Bacon Ridge	35	102
Bens Branch	57	123
Bush Creek	61	128
Little Elk Creek	50	139
Mardella Branch	22	97
Marylea Farm	37	108
McGill Run	5	79
Muddy Creek	1	129
NE Creek	63	111
North Creek	59	125
Plymouth Woods	101	215
Rolling Ridge	2	31
Tarnans Branch	32	94
UT Patapsco Creek	33	148
UT Broad Run	64	118
UT Talbot Run	66	141
UT Little Patuxent	82	232
UT South Branch Patapsco	31	135

MDOT SHA Full Delivery Stream Data (2019)

- Total Sediment Load with DF Applied = *831 lbs/ft/yr*
- Total Sediment Load without DF Applied = *2,462 lbs/ft/yr*
- Average Total Sediment Load with DF Applied = *42 lbs/ft/yr*
- Average Sediment Load without DF Applied = *123 lbs/ft/yr*

Summarized Data

Comparison with Chesapeake Bay Expert Panel Interim Rates

Source		TN (lbs/ft/yr)	TP (lbs/ft/yr)	TSS (lbs/ft/yr)
Chesapeake Bay Interim		0.075	0.068	248
MDOT SHA	Average	0.136	0.051	141
	Max Value	0.310	0.134	292
	Min Value	0.030	0.009	31

Comparison of TN and TP with North Carolina Date in Piedmont Region

Source/Method	Nitrogen (lbs/ton)	Phosphorus (lbs/ton)
NC State University	1.34*	0.65*
Tetra Tech (NC Piedmont)	1.78**	0.46**
Chesapeake Bay Interim	2.28	1.05
MDOT SHA	2.00	0.87

NC State University Data presented by Barbara Doll, PhD, PE (2018)
*3 samples (n=12)
**Tetra Tech – 128 samples, TN (n=19) and TP (n=109)

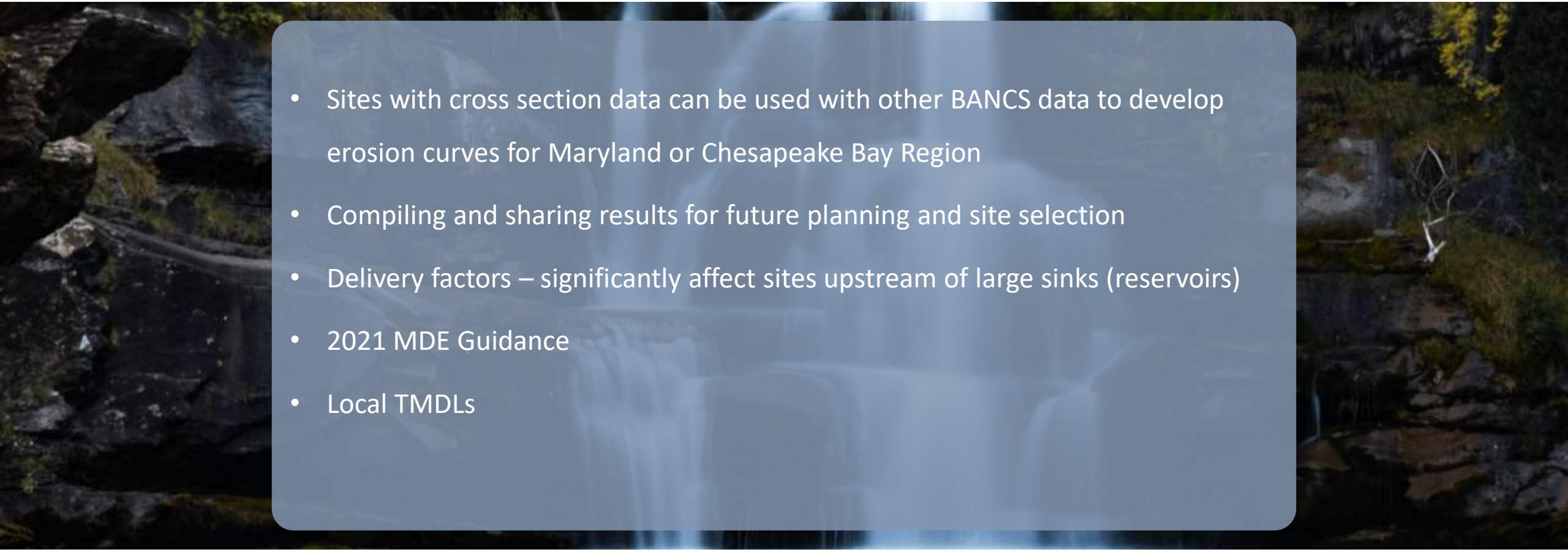
Lessons Learned

Standardizing Bankfull

- Prior to field work, confirm site extents and drainage areas
- Backup data on arc collector if not online
- Make sure to take photos of the banks every 200 ft even if the bank features remain the same
- Verify assessment lengths with restoration lengths
- Bulk Density Results

	Bulk Density (lbs/cf)
Average	75.7
Max Value	141.3
Min Value	29.7

Future Considerations



- Sites with cross section data can be used with other BANCS data to develop erosion curves for Maryland or Chesapeake Bay Region
- Compiling and sharing results for future planning and site selection
- Delivery factors – significantly affect sites upstream of large sinks (reservoirs)
- 2021 MDE Guidance
- Local TMDLs


Thank you!
McCORMICK TAYLOR
MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION