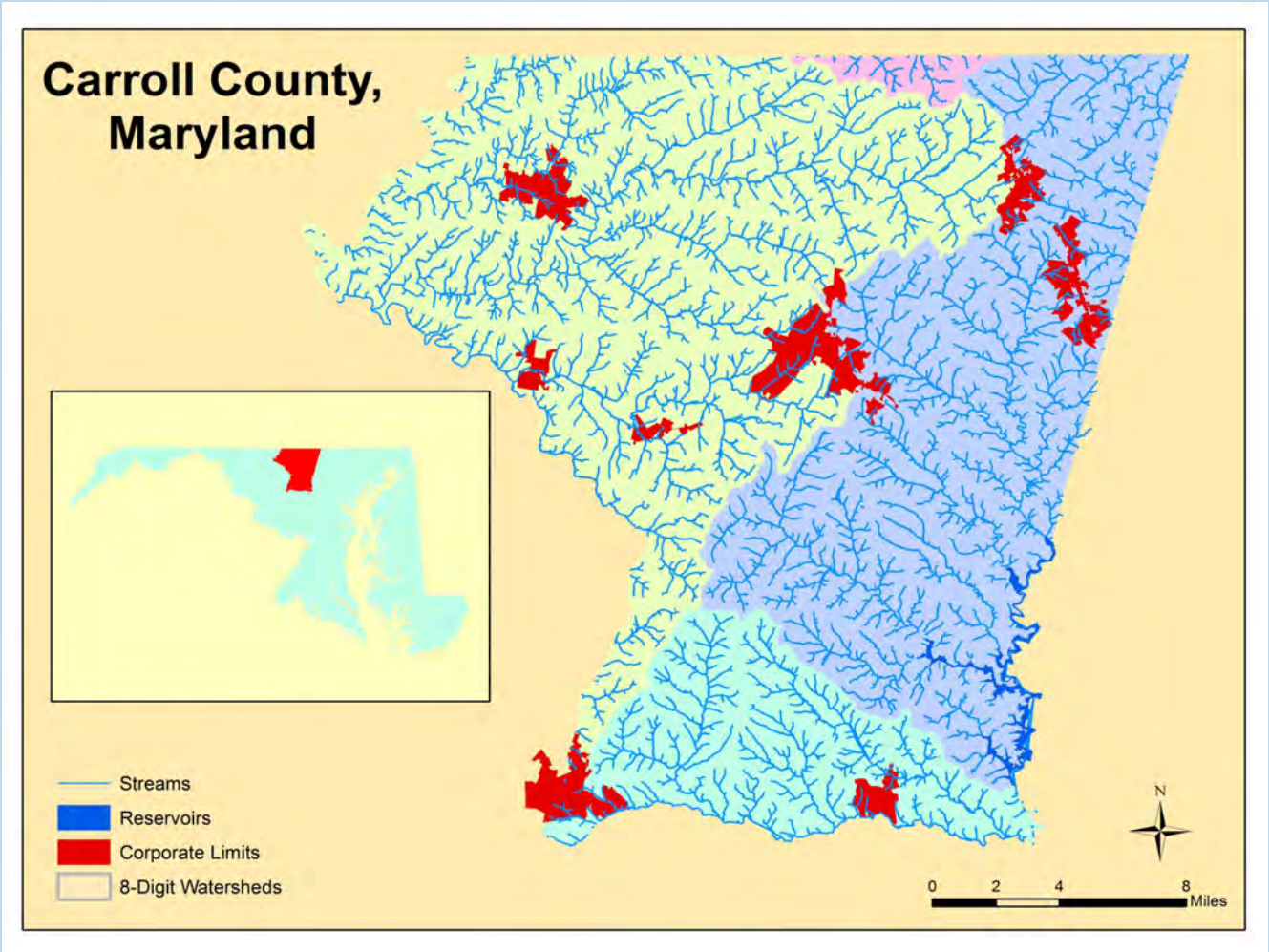
The Self-Recovery of Stream Channel Stability in Urban Watersheds

Byron Madigan
Carroll County Government

- Background and Location
- Headwater County
- 4 Chesapeake Bay Segments



Shannon Run, August 2020

Research Question(s)

Will the implementation of specific retrofits create hydraulic conditions that lead to the self-recovery of channel stability and decrease sediment loadings downstream as a result of reduced bank erosion?

Hypothesis(es):

Hypothesis 1 - Hydrology

- The implementation of BMPs as retrofits will modify the runoff response from the watershed (hydrograph) resulting in a reduction of the magnitude, duration and frequency of erosive flow rates that meet and or exceed Maryland Department of Environment (MDE) performance standards for stream channel protection.

Hypothesis 2 - Geomorphology

- The implementation of BMPs as retrofits will create hydraulic conditions that lead to self-recovery of channel stability.

Hypothesis 3 – Load Estimation

- The implementation of BMPs will decrease sediment loadings downstream as a result of reduced bank erosion rates.

Monitoring Setup

H1 Hydrology

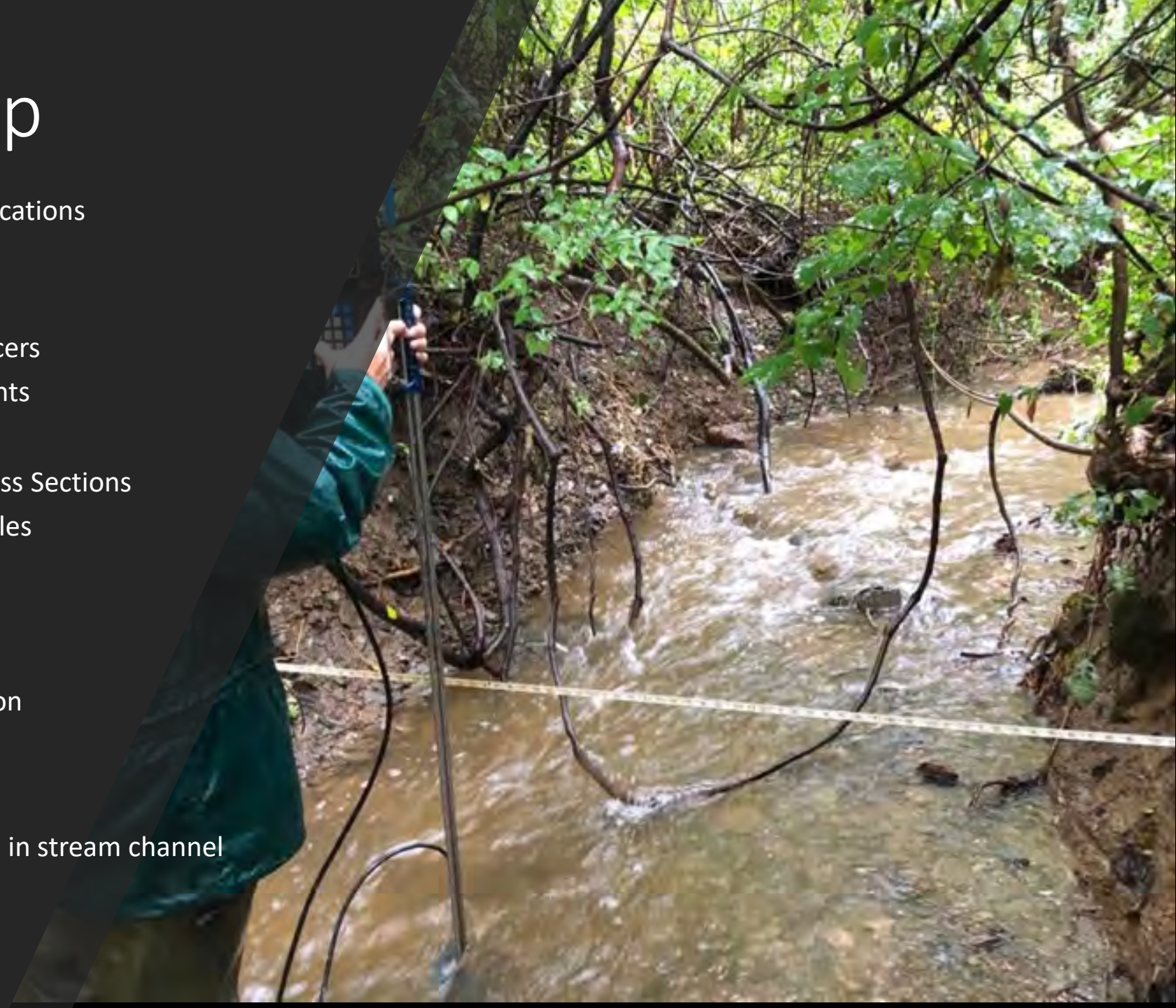
- Rain gauge at 3 locations
  - Central MD
  - Roberts Field
  - Blue Ridge
- Pressure Transducers
- Flow measurements

H2 Geomorphology

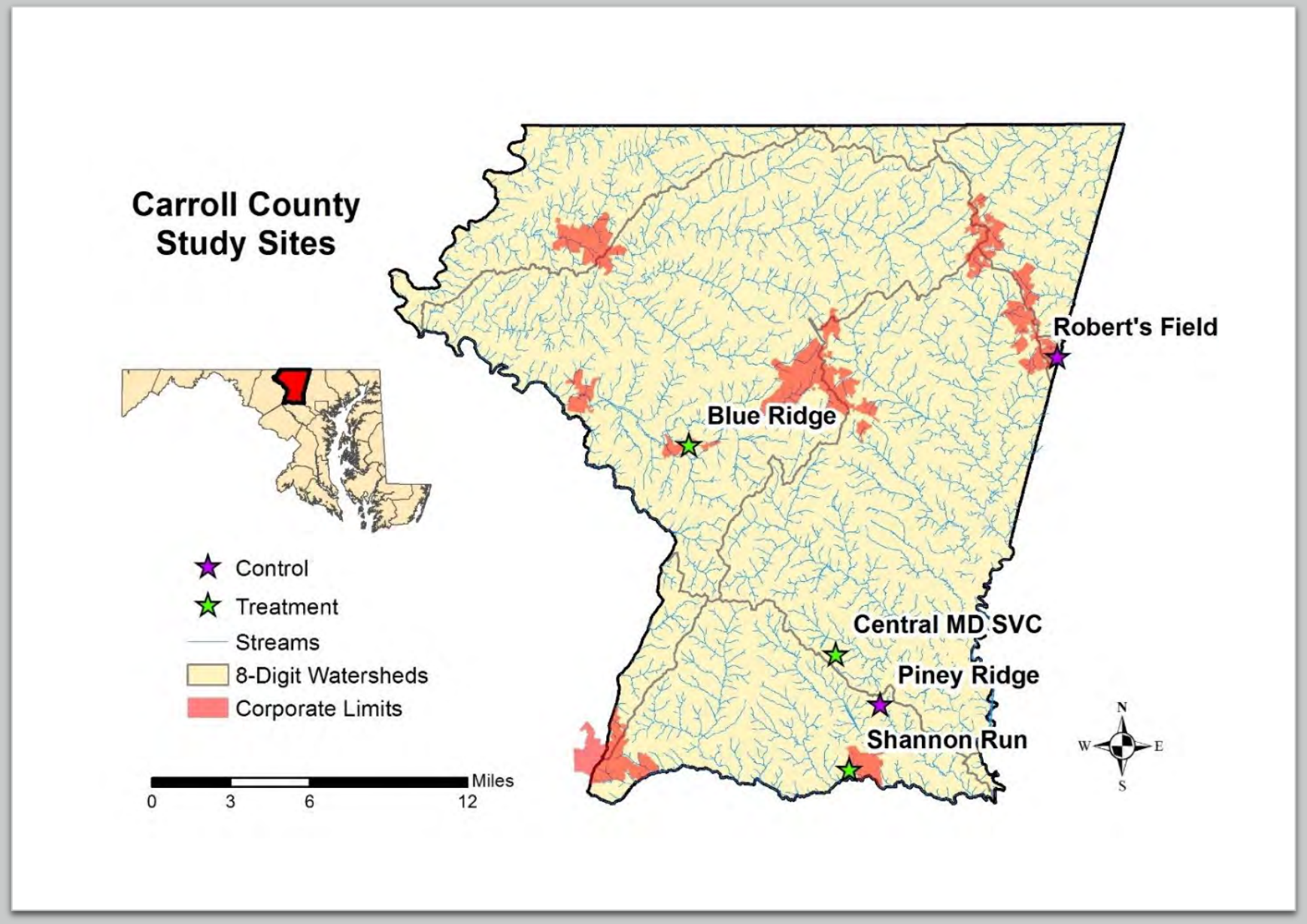
- Monumented Cross Sections
- Longitudinal Profiles
- Bank Pins
- Pebble Count
- Bulk density
- Riparian Vegetation

H3 Load Estimation

- BANCS
- Measured change in stream channel

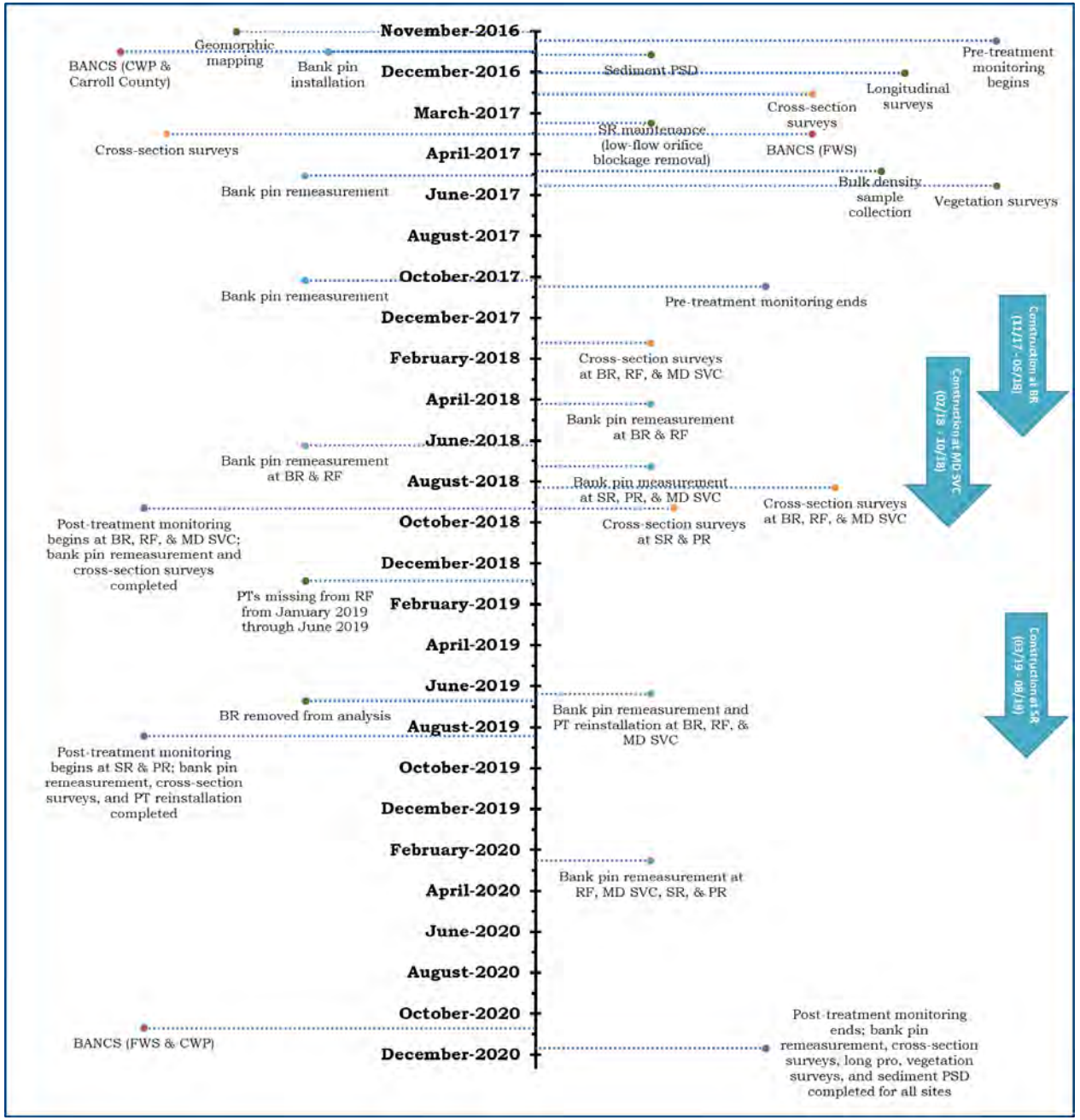


Paired Watershed Study Sites



Timeline

- Grant Awarded 2016
- Monitoring Plan/Baseline Field-work
  - Summer/Fall 2016
- Pre-Treatment Monitoring
  - November 2016 – October 2017
- Post-Treatment Monitoring
  - October 2018 – December 2020



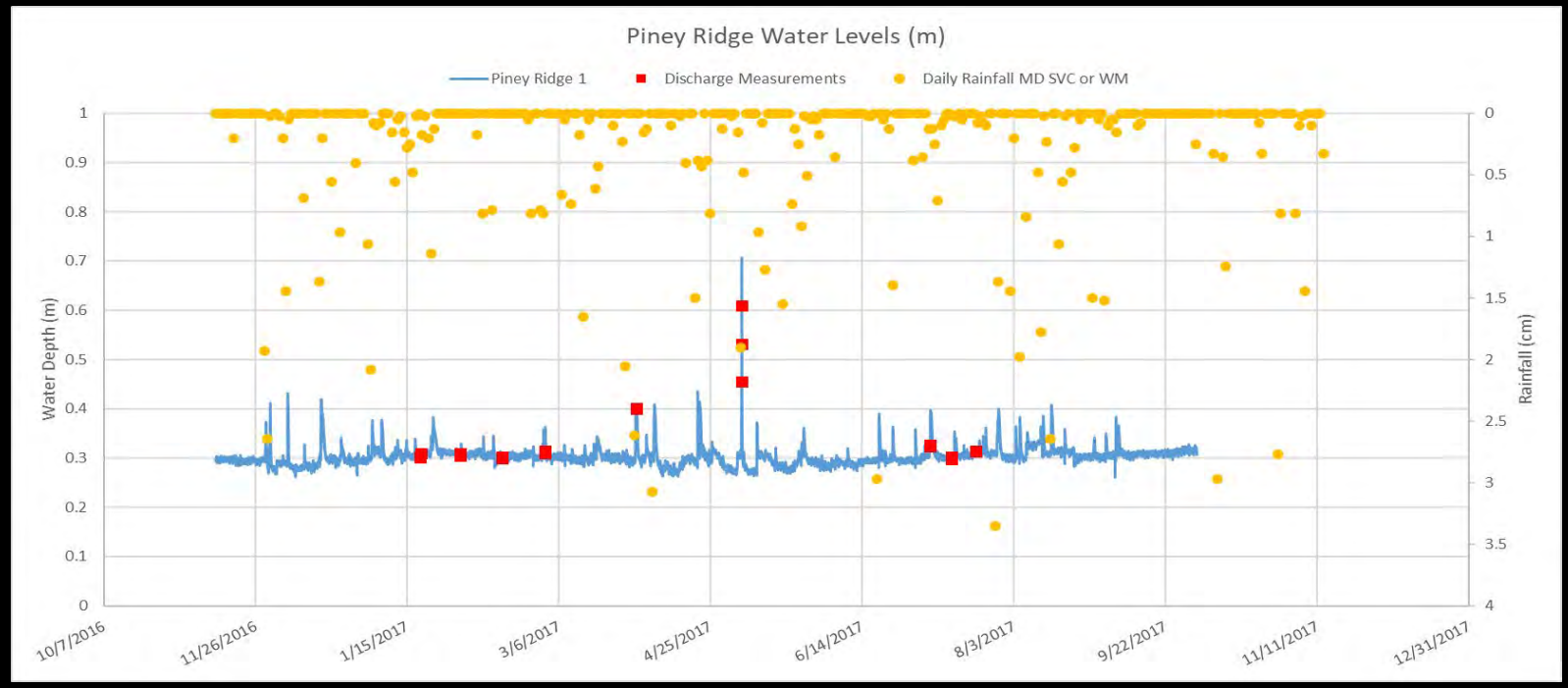
Hypothesis 1:

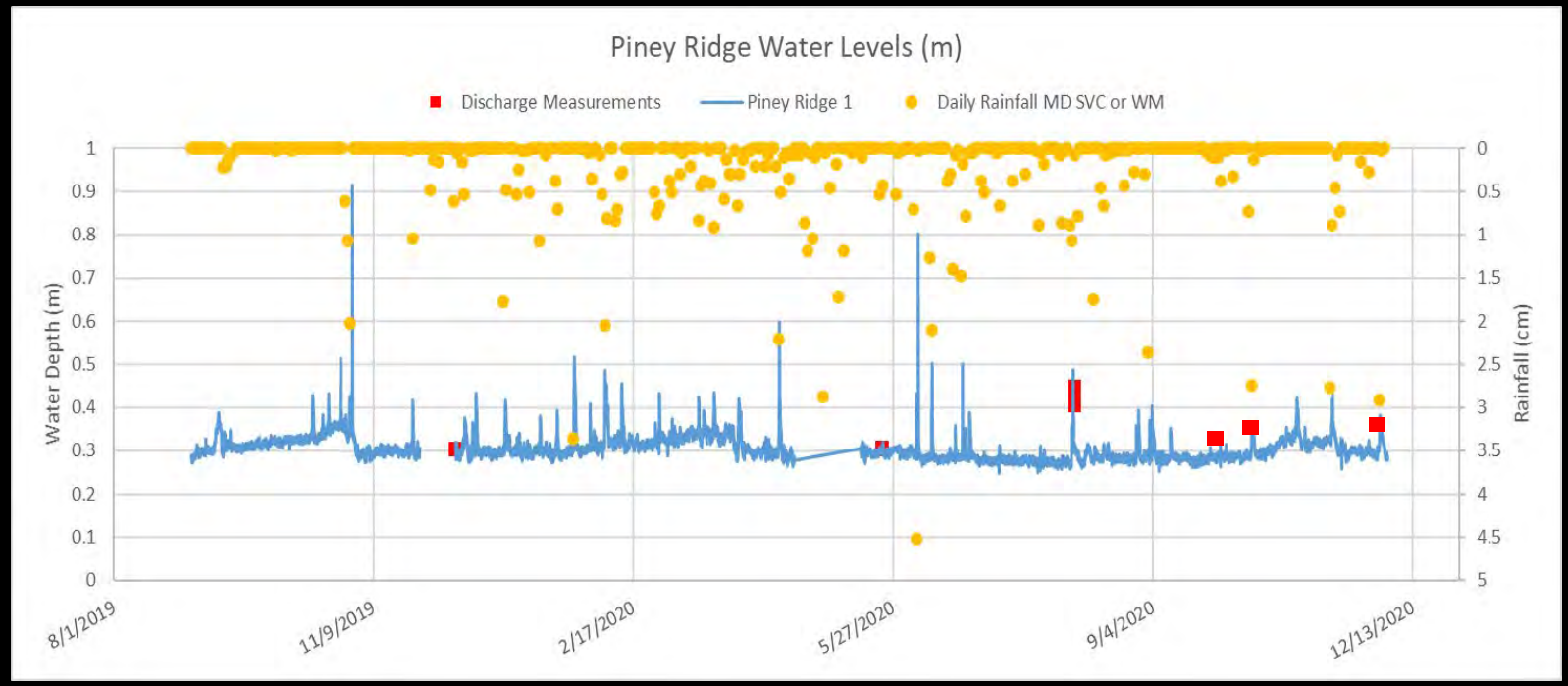
Hydrology-Hydraulics

H1: Hydrology

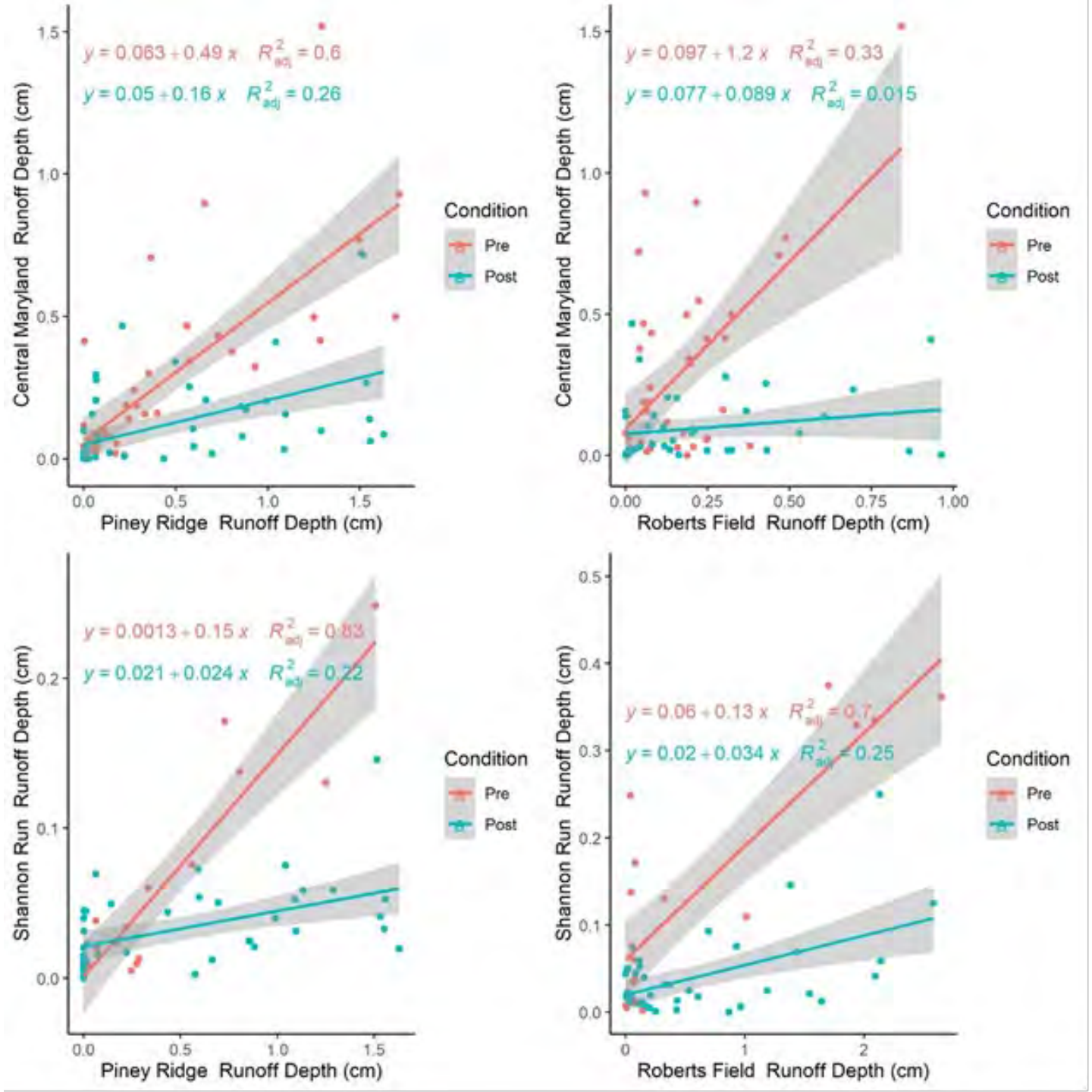
Pre-treatment

Piney Ridge Village Control Site





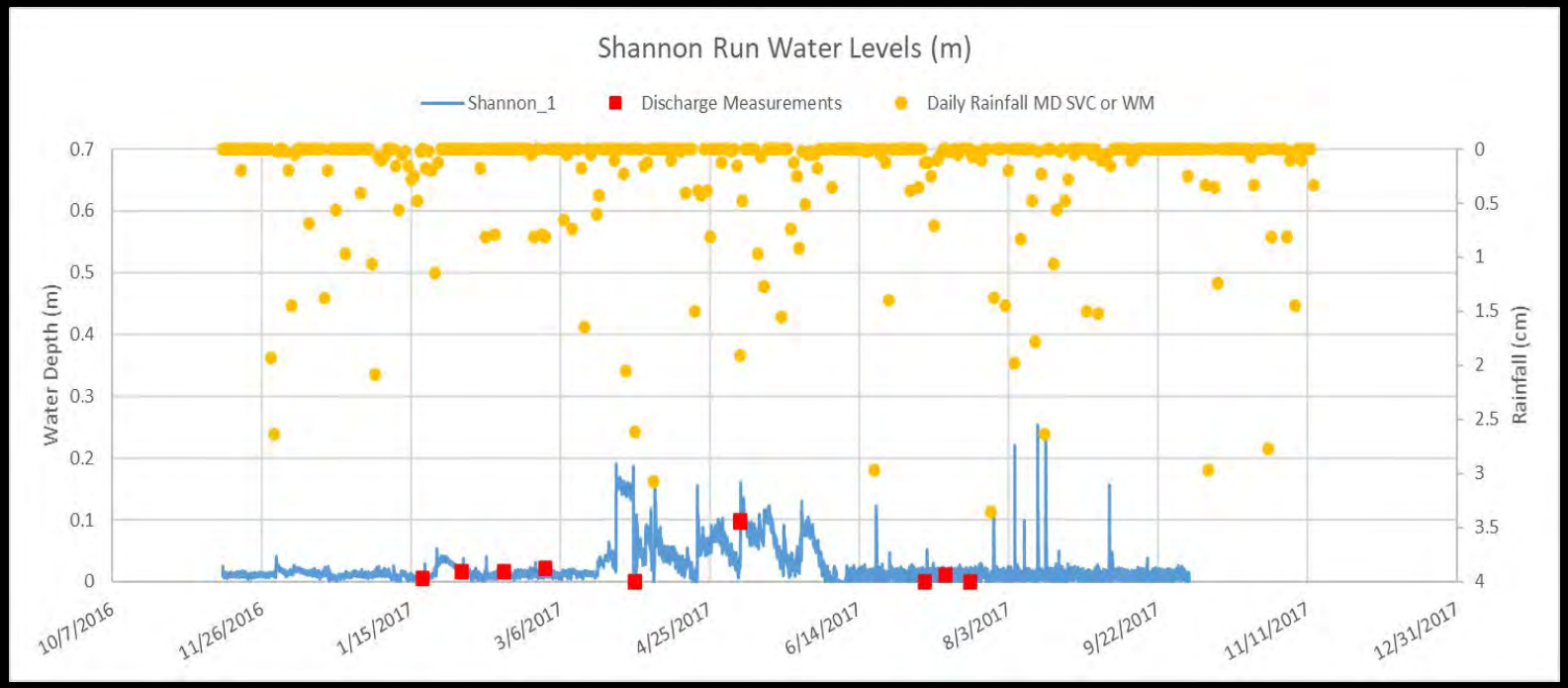
Runoff Response Relationship

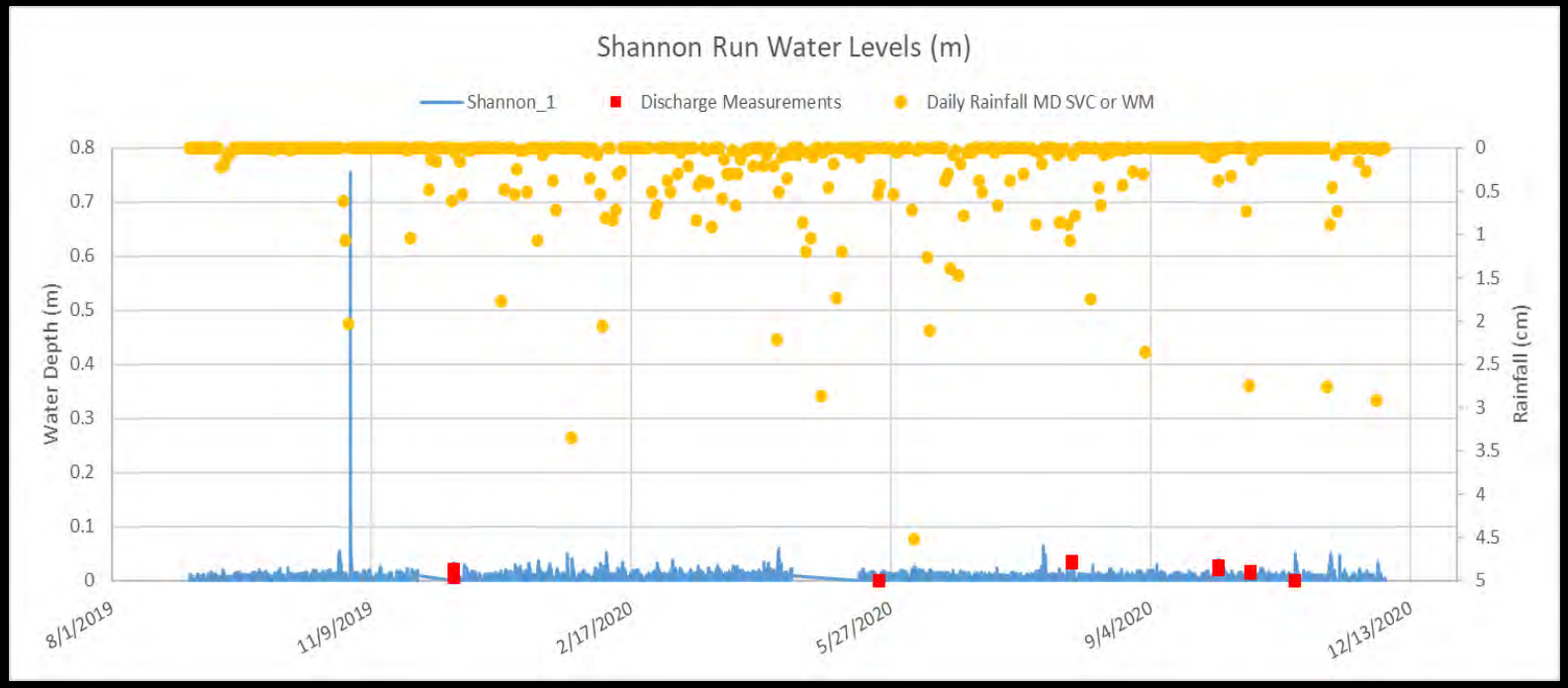


H1:Hydrology

Post-Treatment

Shannon Run Treatment Site





Hypothesis 2:

Geomorphology

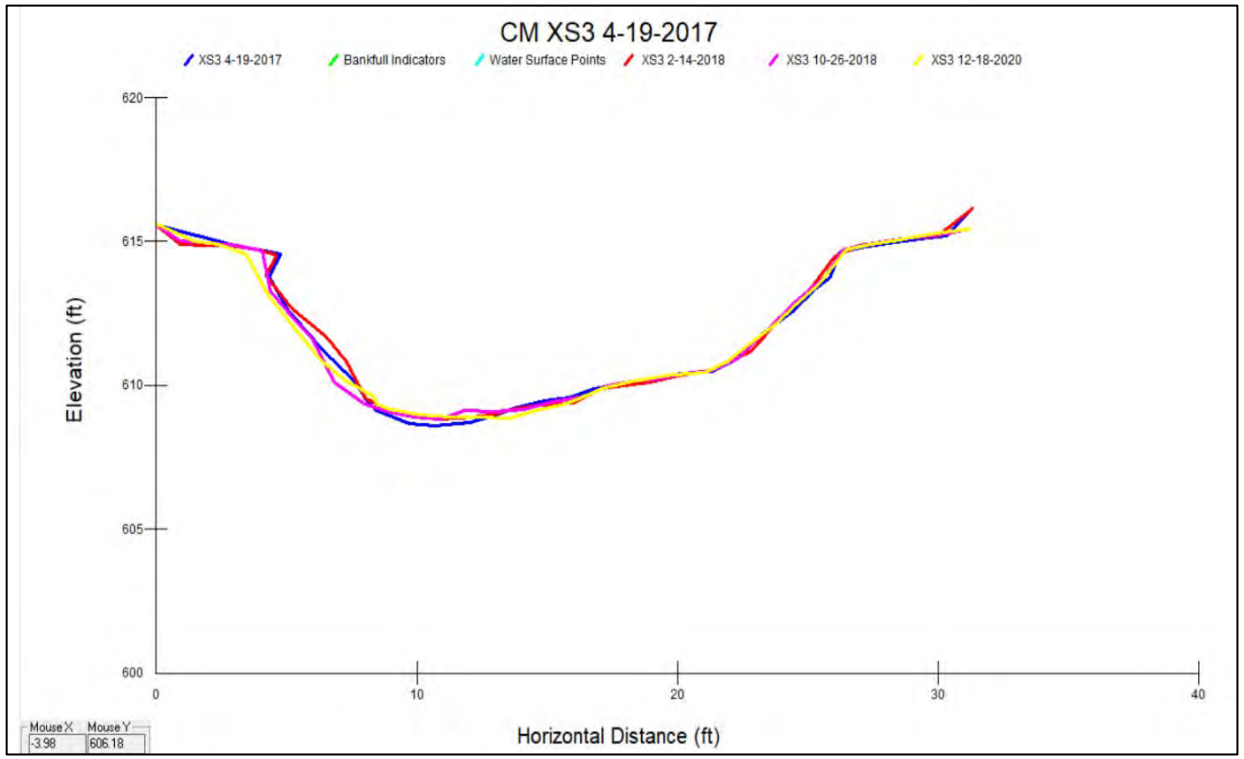
H2: Geomorphology

- Cross Section Surveys
- Central Maryland (T)
- Robert's Field (C)

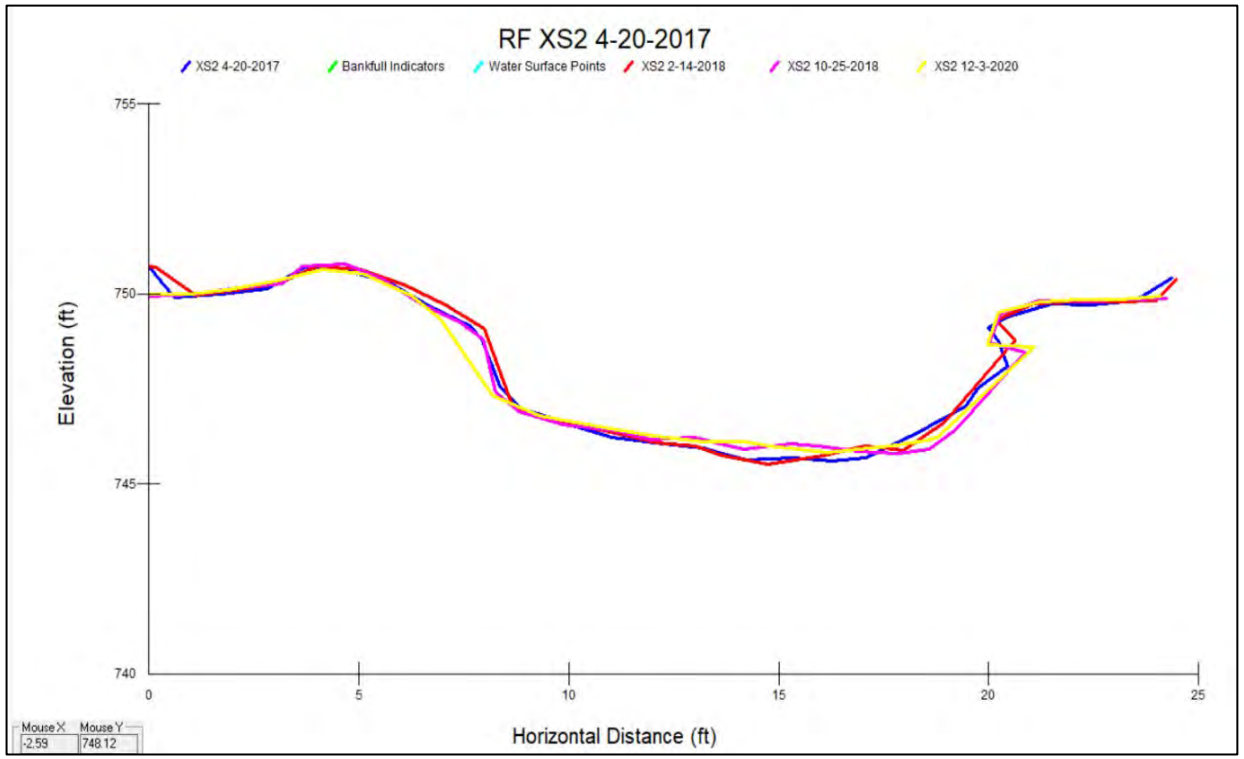
Central Maryland

Robert's Field

Central Maryland – Treatment Site



Robert's Field – Control Site



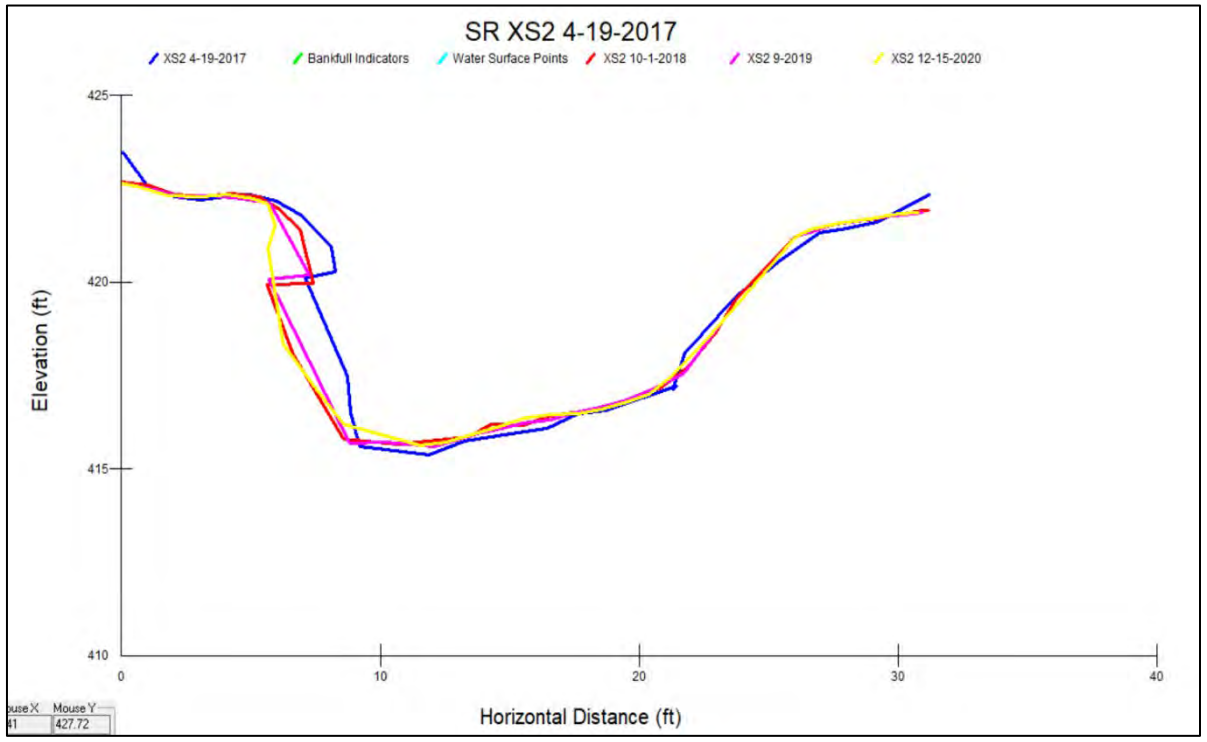
H2: Geomorphology

- Cross Section Surveys
- Shannon Run (T)
- Piney Ridge (C)

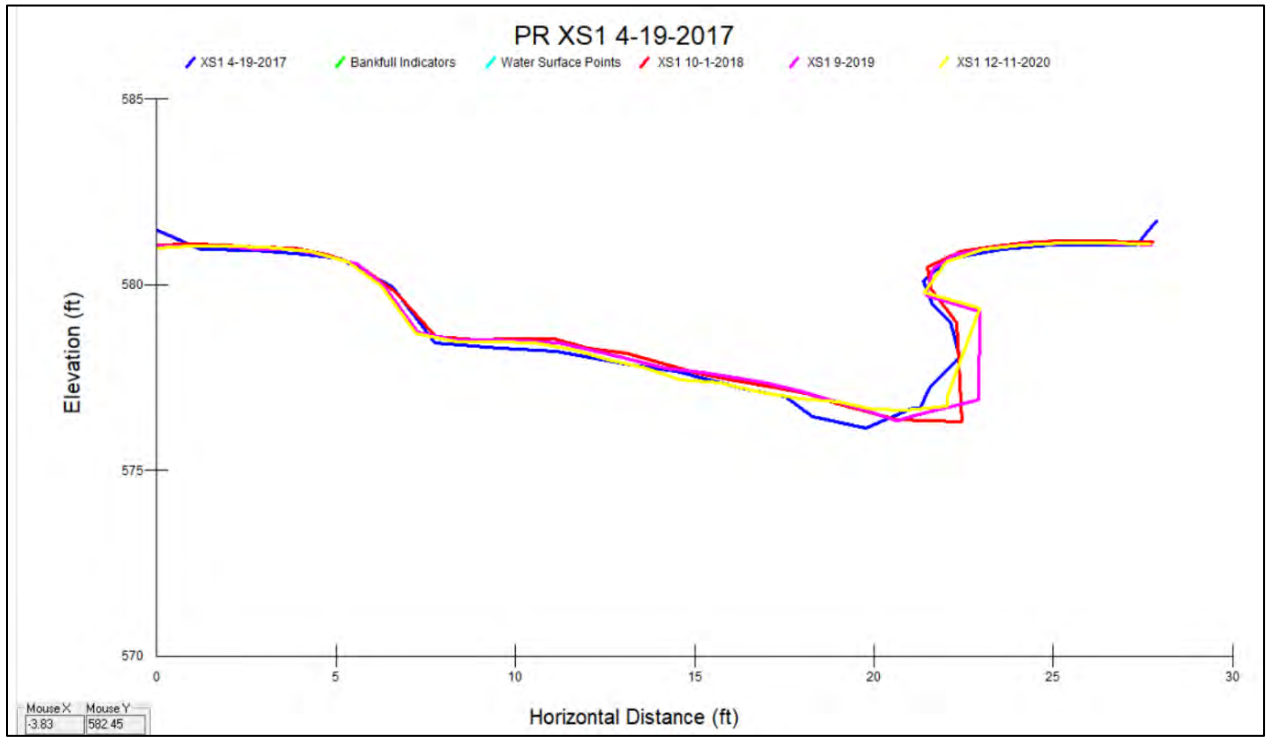
Shannon Run

Piney Ridge Village

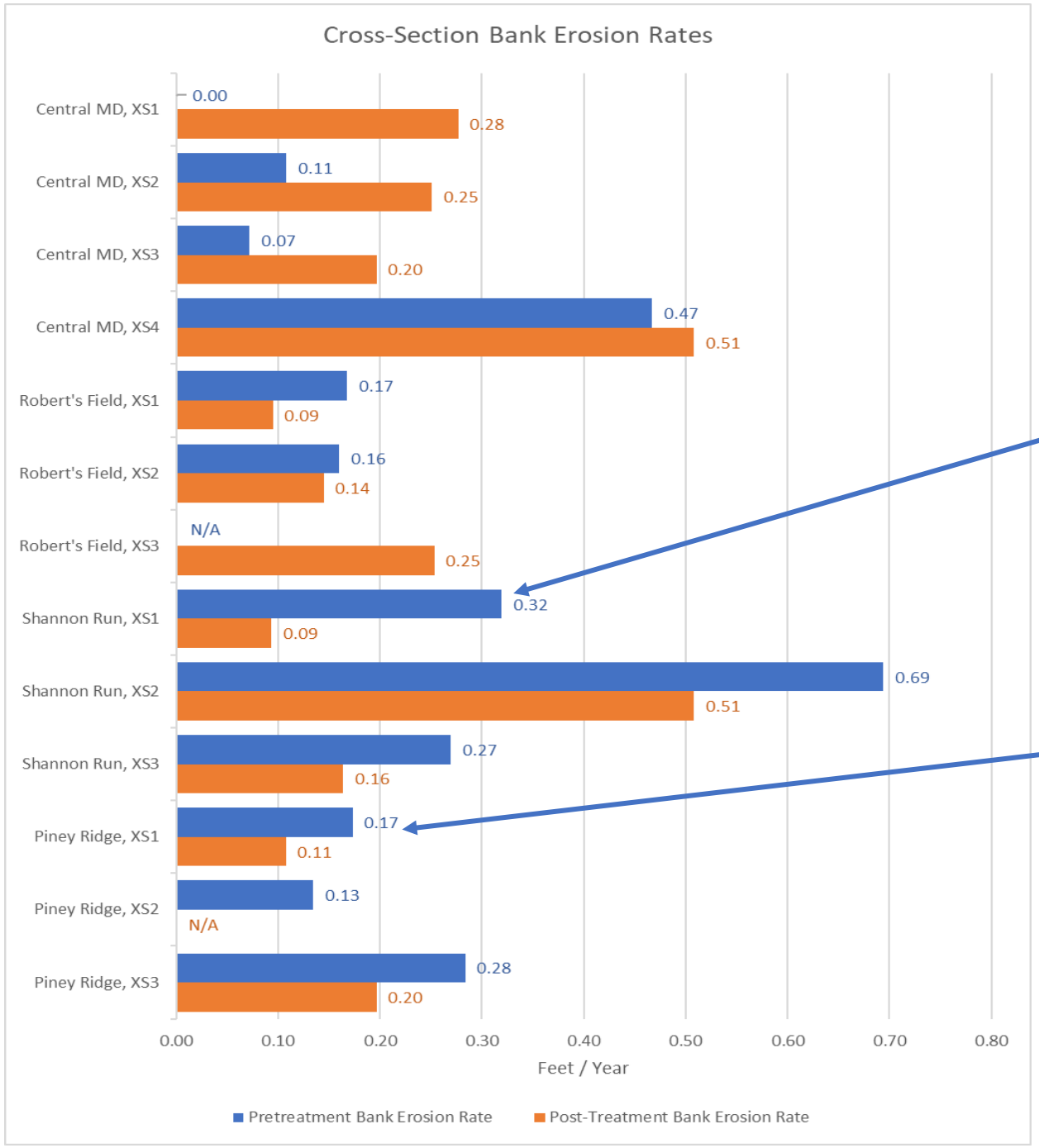
Shannon Run – Treatment Site



Piney Ridge– Control Site

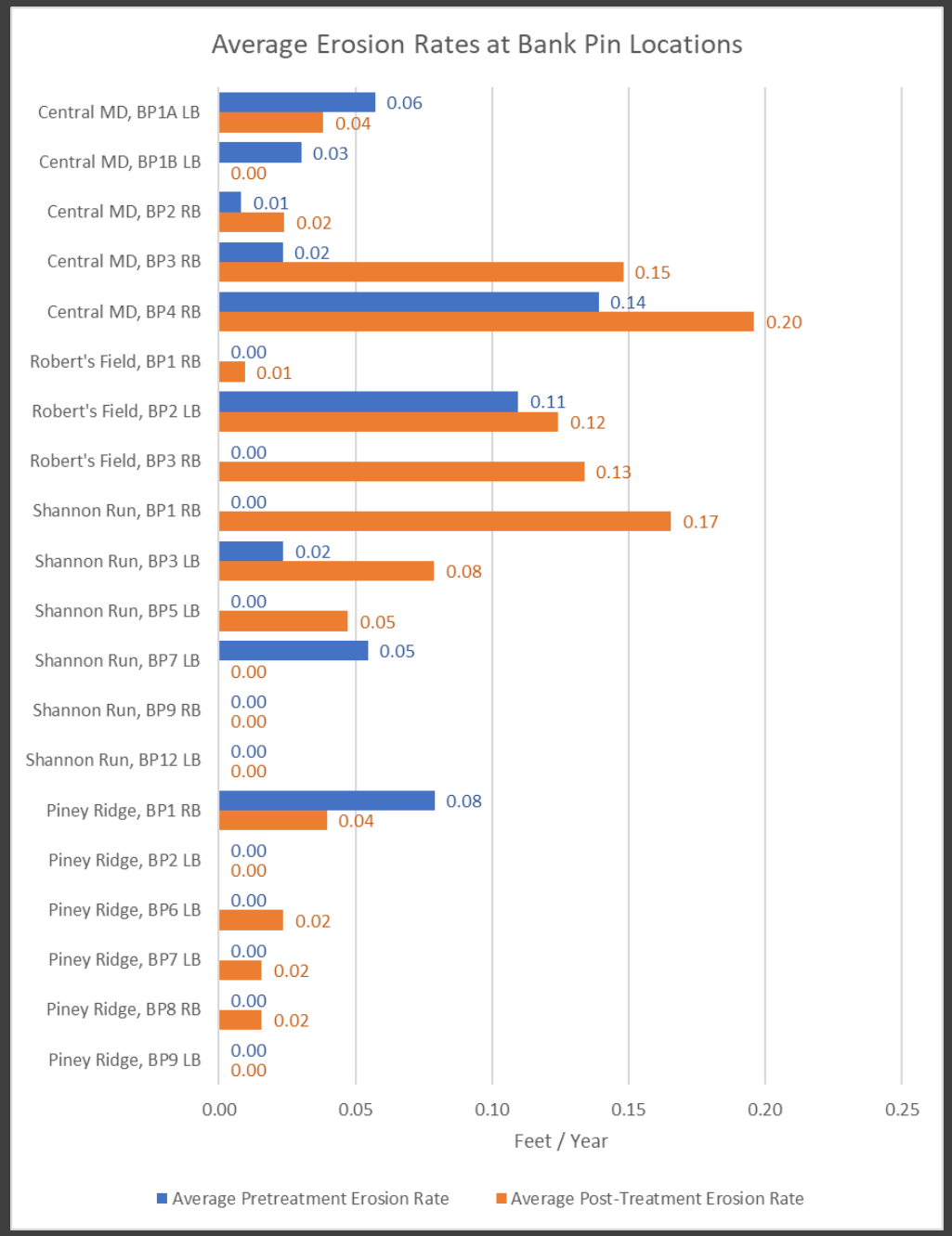


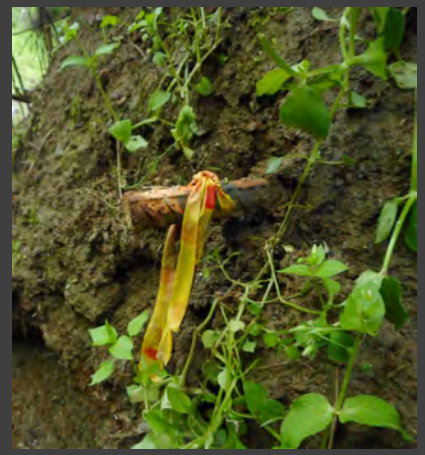
Cross Section Erosion Rates



Shannon Run Treatment Site XS 1

Piney Ridge Control Site XS 1

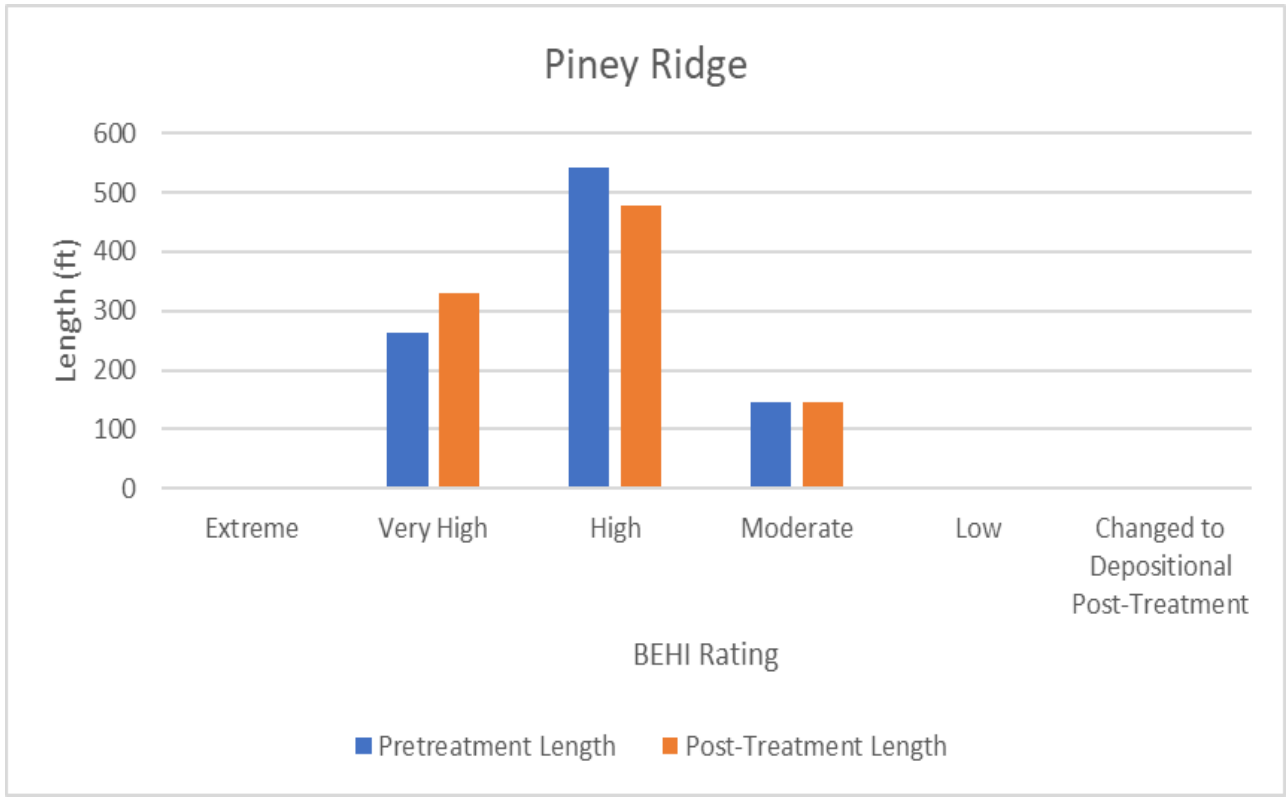




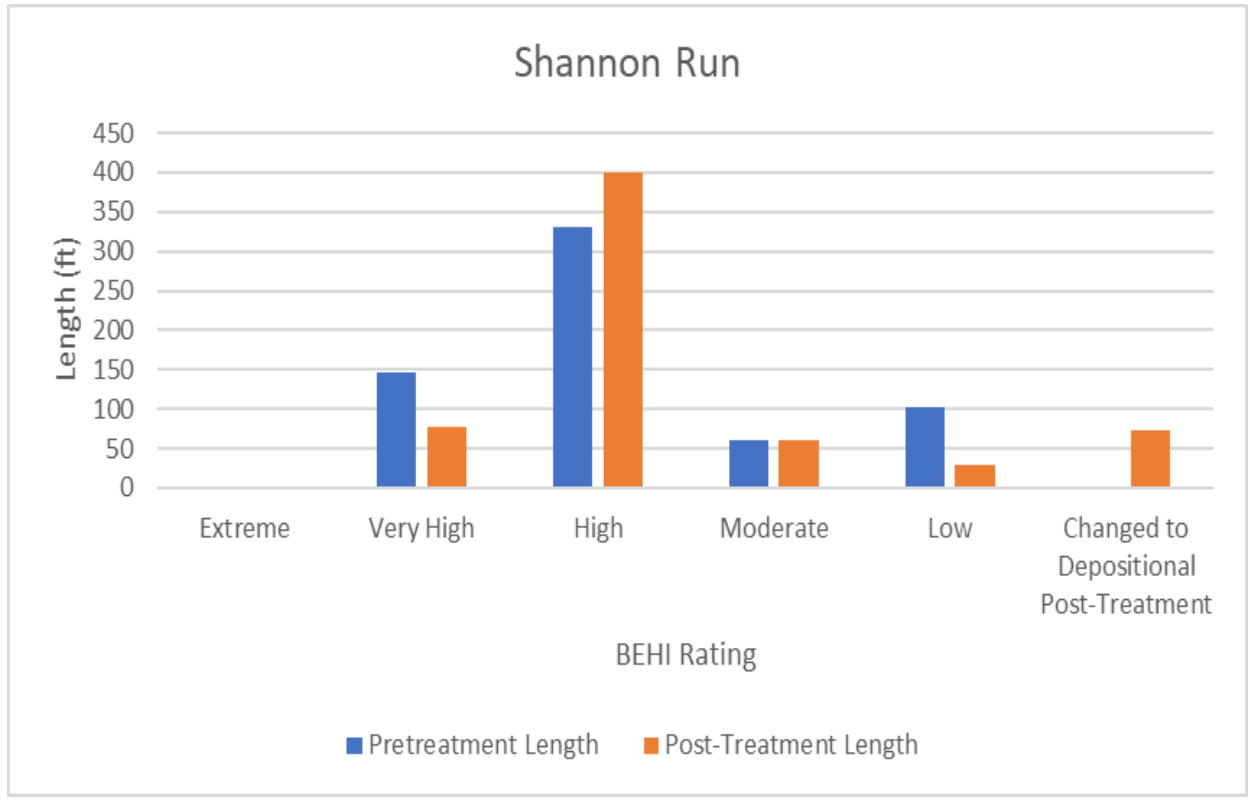
Bank Pin Erosion Rates

Hypothesis 3:

Load Estimation



Control Site



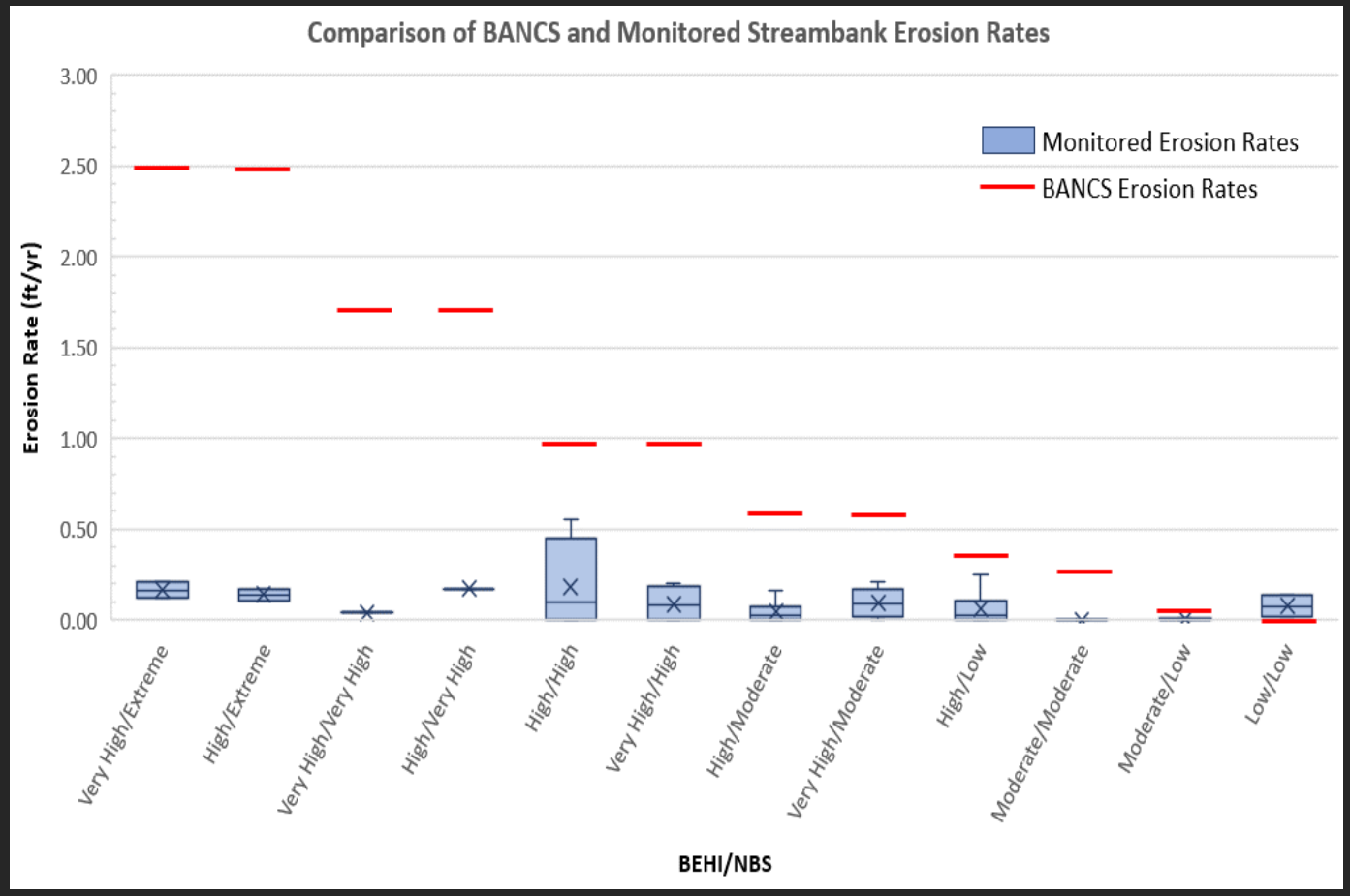
Treatment Site

BEHI Lengths

Pre and Post Treatment

H3: Load Estimation

BANCS vs. Monitoring



H3: Load Estimation

BANCS vs. Monitoring Data

Mark Secrist FWS

Table 17. Sediment loads estimated from BANCS and monitoring data for the study sites.

	BANCS		Monitoring Data		
Study Site	Pretreatment Total TSS Load[1] (tons/yr)	Post-Treatment Total TSS Load[1] (tons/yr)	Pretreatment TSS Load (tons/yr)	Post-Treatment TSS Load (tons/yr)	% of Total Bank Length with Representative Monitoring Location[2]
Central MD SVC (T)	42.11	45.04	3.42	8.92	89.8%
Piney Ridge (C)	59.25	75.9	0.72	0.40	31.3%
Shannon Run (T)	54.49	56.54	11.06	7.35	52.5%
Robert's Field (C)	24.26	27.21	1.01	1.83	91.5%

[1]The loads represent the total load at edge-of-stream without a sediment delivery factor or stream restoration efficiency applied as per the CBP stream restoration crediting protocols.
[2]Total bank length obtained from the top of bank survey from the longitudinal profile and includes both the left and right bank lines.

Next Steps

- Continue Pressure Transducer Downloads
- Additional Storm Event Monitoring/Rating Curve Development
- Annual Cross Section Surveys

Shannon Run
November 2016

Shannon Run
October 2020

Final Thoughts

Partnerships…

- Chesapeake Bay Trust
- MD, Department of Natural Resources
- Center for Watershed Protection
- Carroll County Government

Special Thanks

- Ecosystem Planning & Restoration
- U.S. Fish and Wildlife Service

What does this mean for me?

- Monitoring has shown that stormwater BMP's designed to a certain criteria indicate self-recovery down stream.
- More time and monitoring is needed to show this for all indicators.
  - Peak discharge and flashiness show reductions at treatment sites.
  - Load estimation needs more monitoring to demonstrate impact.

What does this mean for me?

What do I take from this if I am a practitioner:

- Installing BMPs that maximize runoff treatment depths and provide channel protection volume will have a greater positive effect downstream on self-recovery of channel stability.
- Monitoring was done on first order streams. The downstream self recovery impacts of BMPs would be lessened on 2nd order streams and above.

What do I take from this if I am a regulator:

- Results are promising for effects of BMPs on downstream conditions.
- More monitoring is needed to understand load estimations and how far downstream effects are felt.