Performance Monitoring Development for Impoundment Removal Projects

Bree Stephens

June 2024

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Outline

- Impoundment Removal Projects in Virginia
- Virginia CWA 404 Mitigation Overview
- Virginia CWA 404 Mitigation Template Performance Standards
- Expanding Monitoring and Performance Standards to Dynamic Stream Systems
- Proposed Performance Monitoring for Dynamic Alluvial Valleys/Impoundment Removals
- Adaptive Management
- Questions/Discussion

Impoundment Removal Projects in Virginia

- Two Clean Water Act (CWA) 404 mitigation projects in Virginia:
  - One Permittee Responsible Mitigation (PRM) – Preparing to go to construction
  - One through The Nature Conservancy Virginia Aquatic Resources Trust Fund (VARTF) – Waiting on comments on the concept site development plan
- Both are small headwater systems in the Coastal Plain of Virginia with earthen dams.
- Design plan for both projects is to remove the earthen dams, grade a pilot channel through the dam footprint, and allow the channels to reestablish through natural hydraulic and geomorphic processes within the old pond bottom.

Virginia CWA 404 Mitigation

Impacts calculated using the Unified Stream Methodology (USM)

1. Channel Condition: Assess the cross-section of the stream and prevailing condition (erosion, aggradation)

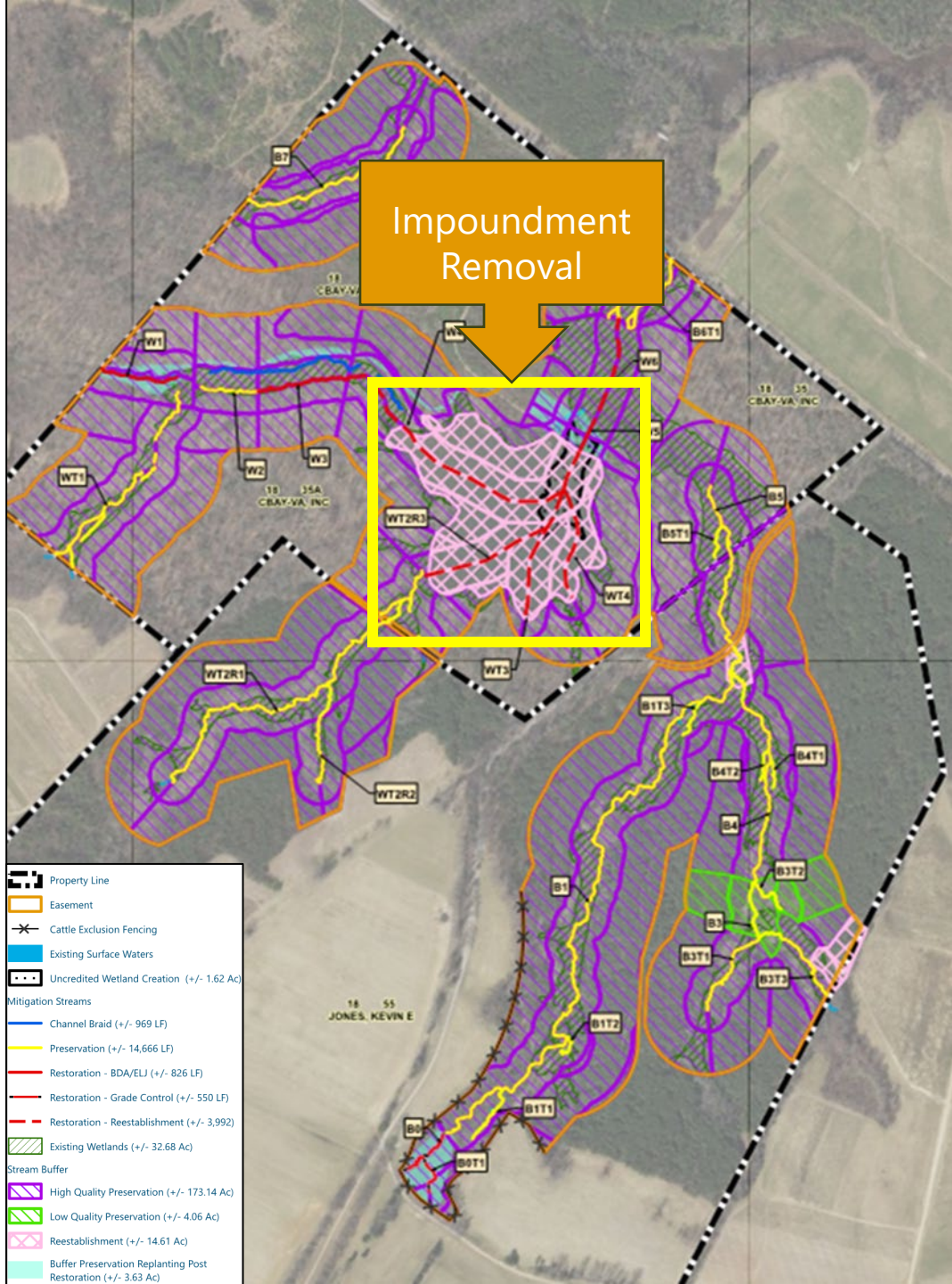
Conditional Category	Optimal	Suboptimal	Marginal	Poor	Severe
Channel Condition	Very little incision or active erosion; 80-100% stable banks. Vegetative surface protection or natural rock, prominent (80-100%). AND/OR Stable point bars/bankfull benches are present. Access to their original floodplain or fully developed wide bankfull benches. Mid-channel bars, and transverse bars few. Transient sediment deposition covers less than 10% of bottom.	Slightly incised, few areas of active erosion or unprotected banks. Majority of banks are stable (60-80%). Vegetative protection or natural rock prominent (60-80%) AND/OR Depositional features contribute to stability. The bankfull and low flow channels are well defined. Stream likely has access to bankfull benches, or newly developed floodplains along portions of the reach. Transient sediment covers 10-40% of the stream bottom.	Often incised, but less than Severe or Poor. Banks more stable than Severe or Poor due to lower bank slopes. Erosion may be present on 40-60% of both banks. Vegetative protection on 40-60% of banks. Streambanks may bevertical or undercut. AND/OR 40-60% of stream is covered by sediment. Sediment may be temporary/transient, contribute instability. Deposition that contribute to stability, may be forming/present. AND/OR V-shaped channels have vegetative protection on > 40% of the banks and depositional features	Overwidened/incised. Vertically/laterally unstable. Likely to widen further. Majority of both banks are near vertical. Erosion present on 60-80% of banks. Vegetative protection present on 20-40% of banks, and is insufficient to prevent erosion. AND/OR 60-80% of the stream is covered by sediment. Sediment is temporary/transient in nature, and contributing to instability. AND/OR V-shaped channels have vegetative protection is present on > 40% of the banks and stable sediment deposition is absent.	Deeply incised (or excavated), vertical/lateral instability. Severe incision, flow contained within the banks. Streambed below average rooting depth, majority of banks vertical/undercut. Vegetative protection present on less than 20% of banks, is not preventing erosion. Obvious bank sloughing present. Erosion/raw banks on 80-100%. AND/OR Aggrading channel. Greater than 80% of stream bed is covered by deposition, contributing to instability. Multiple thread channels and/or subterranean flow.
Score	3	2.4	2	1.6	1

Determine mitigation category for streams and buffers

Mitigation Categories	
Streams	Buffers
Restoration	Reestablishment
Enhancement	Heavy Planting
High Quality Preservation	Light Planting
Low Quality Preservation	High Quality Preservation
	Low Quality Preservation

Credits calculated based on mitigation type, stream LF, and buffer Ac

(Stream LF x Mitigation type ratio) + (Buffer Ac x Mitigation type ratio) = Credit Yield



VA 404 Template Performance Standards

Forested Buffer Vegetation Choose 2	Floodplain Connectivity Choose 1	Lateral Stability/Bank Migration Choose 4	Vertical Stability/Bed Form Diversity Choose 2	Structure Stability Required	Aquatic Habitat Required for Perennial Streams
Woody stems per acre (plots)	Bank Height Ratio	Bank Erosion Hazard Index (at cross sections)	Pool-to-pool spacing	Structure Assessment	Habitat Assessment
Tree Height (% increase)	Entrenchment Ratio	Width/Depth Ratio	Max Pool Depth Ratio		
Tree Height (5 foot min by Year 5)		Cross-sectional Area	Average Riffle Slope		
Stem Area at Groundline		Meander Width ratio	Average Bankfull Slope		
		Sinuosity	Pebble Count (D50)		
		Radius of Curvature/Bankfull Width Ratio			
		Number of Livestakes and Woody Stems			
		Native Herbaceous Cover			
		Bare Ground Coverage			

* **Bold** are required

MBI Template Performance Standards

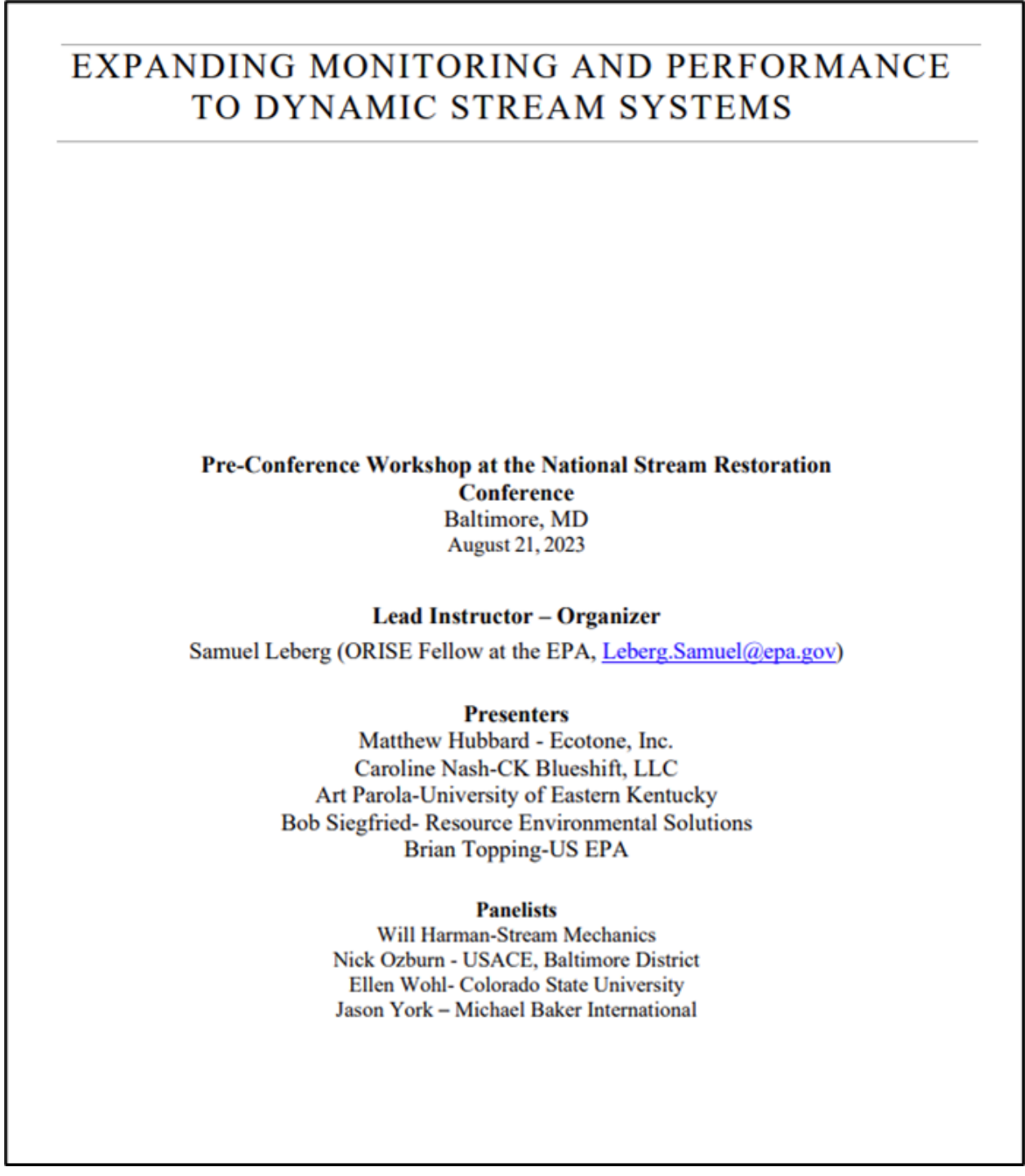
- Stability Based, compared to As-built
- Focused on single thread channels
- Based on NCD design parameters

Limitations for Impoundment Removal Projects

- Does not allow for dynamic channel reestablishment
- Not structured for multi-thread or braided systems
- Does not highlight the ecological uplift provided by impoundment removal

Enter the "Expanding Monitoring and Performance Standards to Dynamic Stream Systems"!

- Defines Dynamic Alluvial Valleys and provides recommendations for alternative performance standards and monitoring to show uplift
- Dynamic Alluvial Valleys (DAV)
  - Retentive systems that maximize ecological uplift
  - Single and multi-channel systems
  - Mix of floodplain /riparian habitats
  - Changes over time – seasonal/annual
  - Changes over space – expand/contract
  - Change due biological agent - beaver
- This definition applies to most stream systems in the Coastal Plain of Virginia



EXPANDING MONITORING AND PERFORMANCE TO DYNAMIC STREAM SYSTEMS

Pre-Conference Workshop at the National Stream Restoration Conference
Baltimore, MD
August 21, 2023

Lead Instructor – Organizer
Samuel Leberg (ORISE Fellow at the EPA, Leberg.Samuel@epa.gov)

Presenters
Matthew Hubbard - Ecotone, Inc.
Caroline Nash-CK Blueshift, LLC
Art Parola-University of Eastern Kentucky
Bob Siegfried- Resource Environmental Solutions
Brian Topping-US EPA

Panelists
Will Harman-Stream Mechanics
Nick Ozburn - USACE, Baltimore District
Ellen Wohl- Colorado State University
Jason York – Michael Baker International

Performance Monitoring for Dynamic Alluvial Valleys

Allow for Flexibility in Stream Formation and Function – Set performance standards and monitoring to reflect a dynamic stream system that evolves over time toward an ecologically health condition

Holistic Monitoring – Focus on providing big picture, more transparent approach to monitoring, move away from point focused data collection

Track Failure Modes– Based on holistic monitoring, provide detailed data for problem areas if they arise, focus resources where there are concerns

DAV Key Processes as Performance Standards

Lateral and Vertical Connectivity

Creation and Maintenance of Diverse Habitats

Retention of Materials

Support Biological Communities

Floodplain Connectivity

Lateral and Vertical Connectivity

Monitoring – On the ground

- Stream gage measuring flood events – direct measurement
- Photos of flood evidence - indirect

Timeline

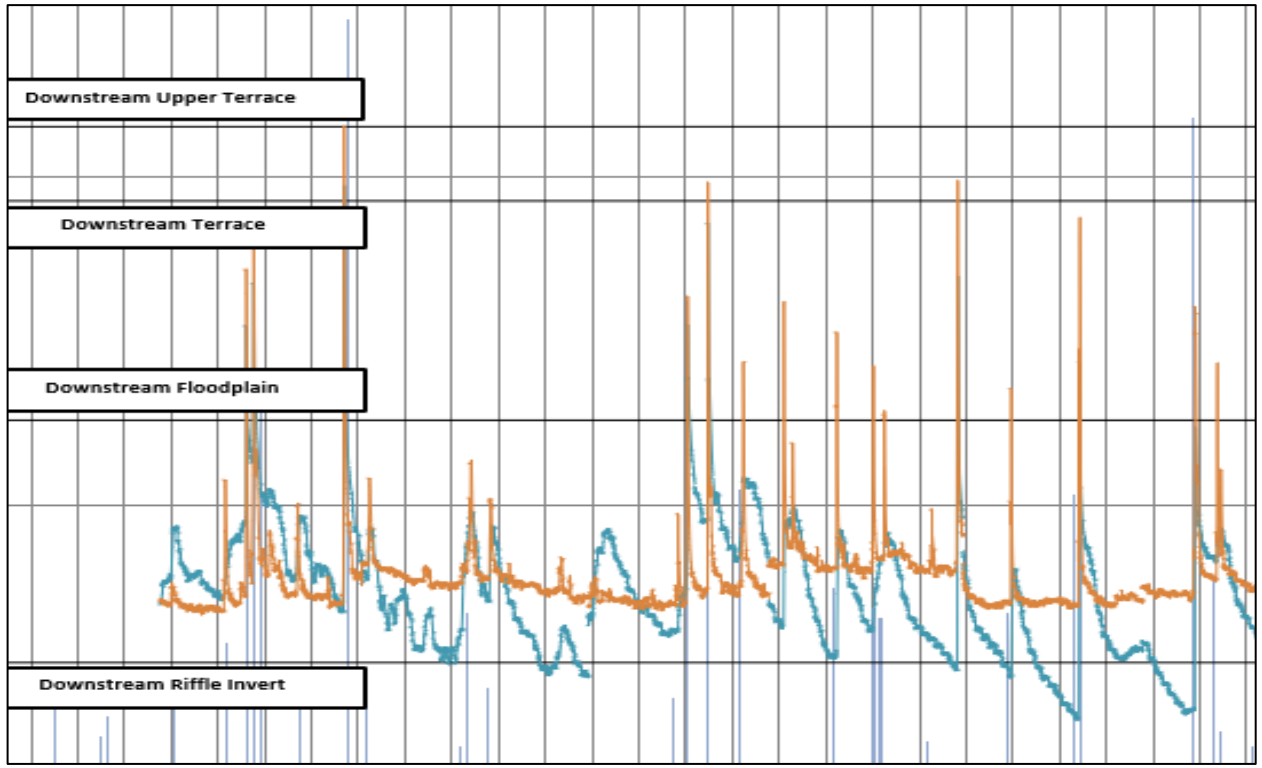
- Starting in Year 2 for impoundment removal projects, each monitoring year

Failure Mode

- *Flows do not exceed top of bank at least once per year*

Reporting

- Graphs, # floods per year, photos



Groundwater and Surface Water Exchange

Lateral and Vertical Connectivity

Monitoring – On the ground

- Groundwater Wells in floodplain

Timeline

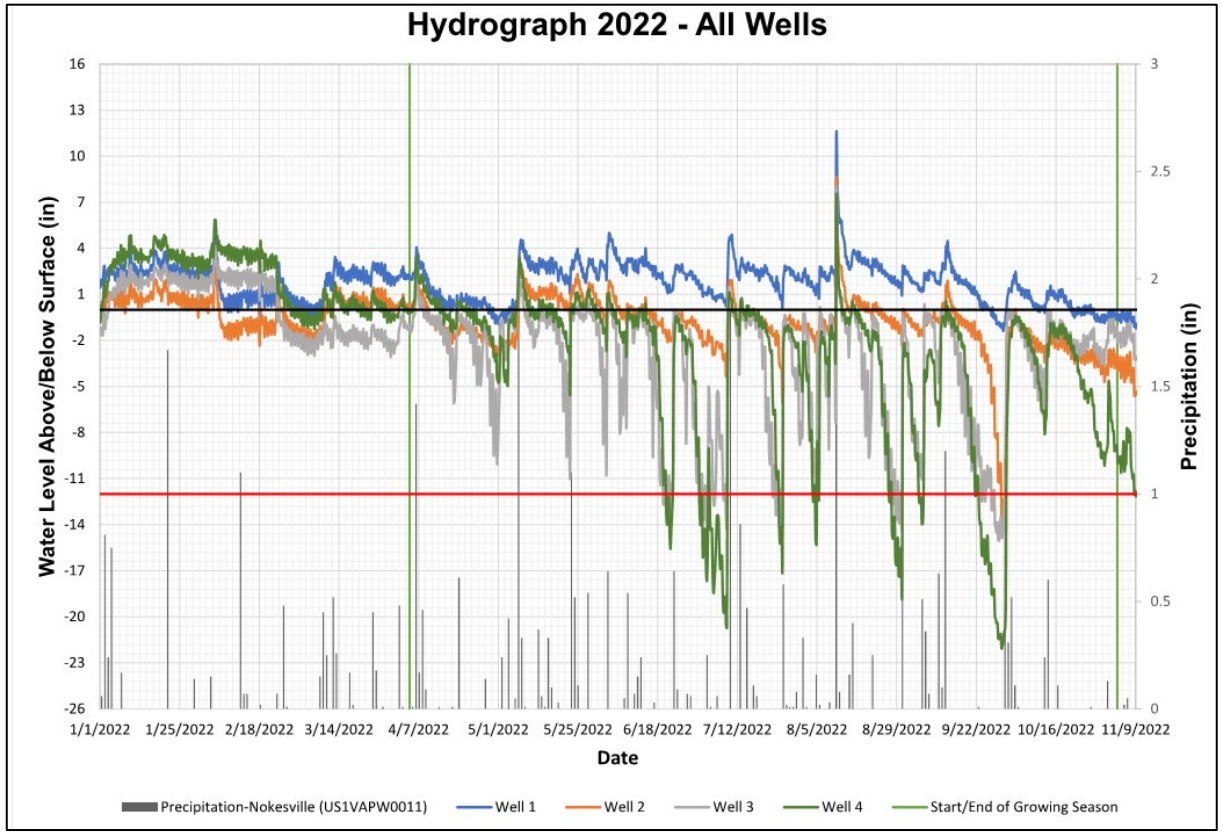
- Starting in Year 2 for impoundment removal projects, each monitoring year

Failure Mode

- *Groundwater is not within 18 inches of surface elevation within floodplain for more than 30 days in the growing season in years of average or wetter rainfall*

Reporting

- Graphs and associated tables



Lateral Migration

Lateral and Vertical Connectivity

Monitoring – On the ground

- Conduct BEHI/NBS on entire reach

Timeline

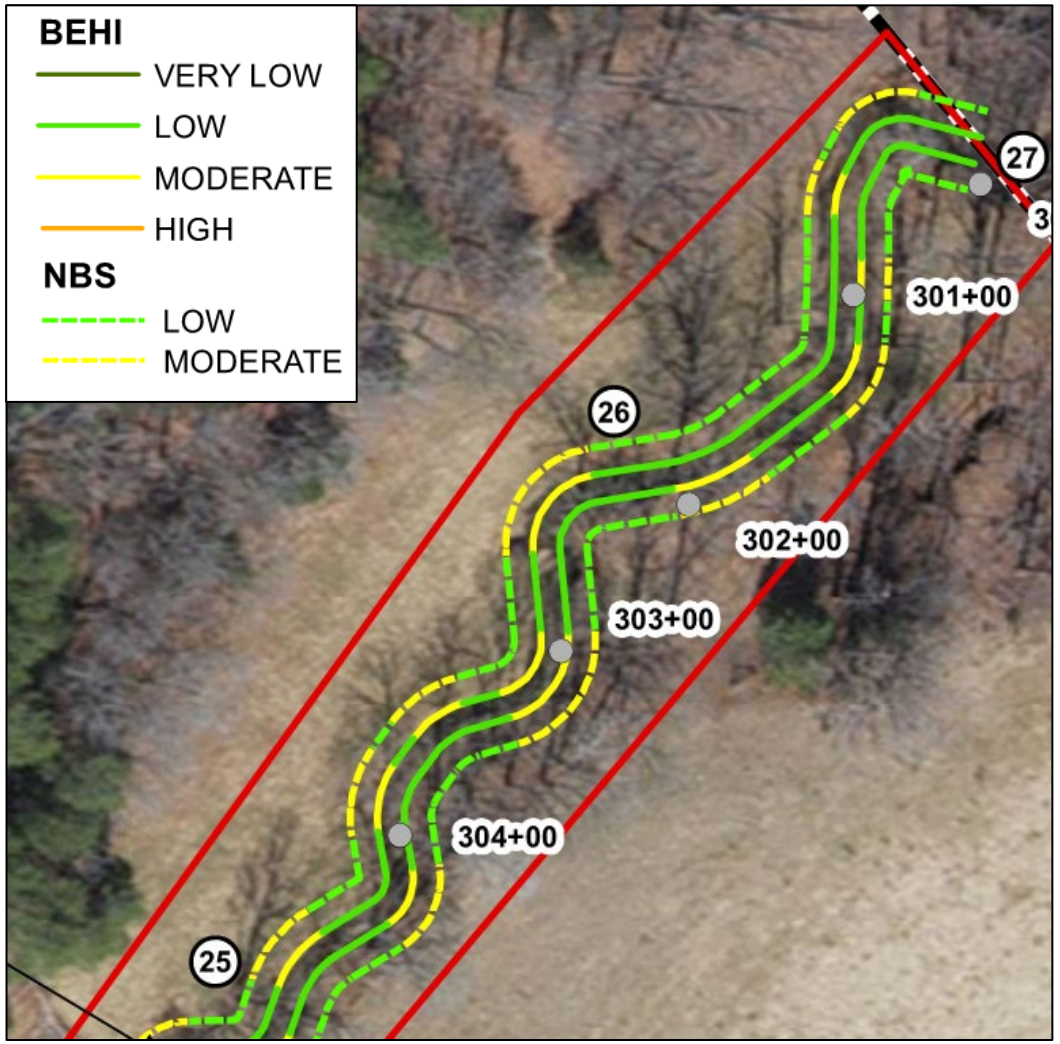
- Years 3, 5 and 10

Failure Mode

- *Year 3: 50% of each reach has a BEHI/NBS of "high/high" or worse*
- *Year 5 and 10: BEHI/NBS average is "moderate/high" or worse*

Reporting

- Map of BEHI/NBS results on growing season aerial



Temperature

Lateral and Vertical Connectivity

Monitoring – On the ground

- Temperature loggers set pre-construction, reset post-construction

Timeline

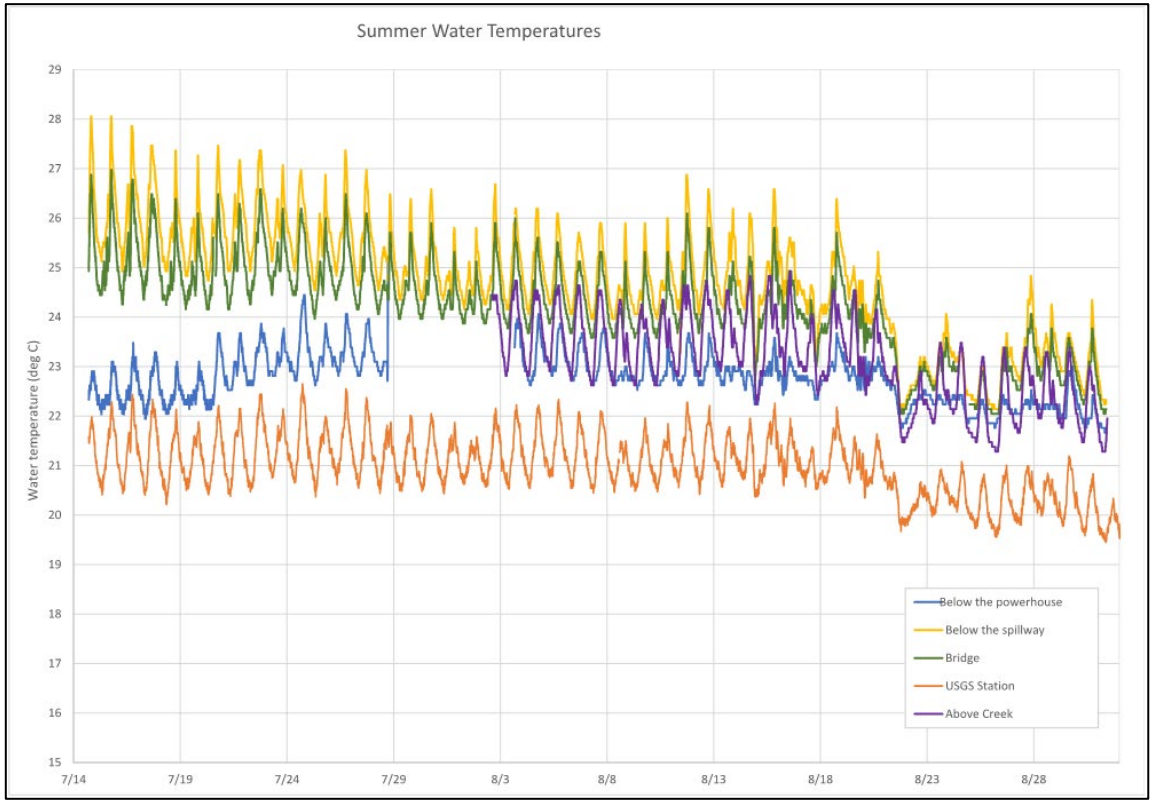
- Starting Year 2, each monitoring year

Failure Mode

- *Surface water temperatures are above pre-project values*

Reporting

- Graph comparing pre- and year to year



Stream Channel Formation

Creation and Maintenance of Diverse Habitats

Monitoring – Aerial photos

- Aerial photos taken quarterly in first year, winter aerial photos each monitoring year

Timeline

- Starting Year 1, each monitoring year

Failure Mode

- *Identifiable channels do not develop*

Reporting

- Aerial with top of bank lines drawn and year to year comparisons

Aquatic Habitat Diversity

Creation and Maintenance of Diverse Habitats

Monitoring – On the ground

- Coastal Habitat Assessment (HA) per Mid-Atlantic Coastal Streams Workgroup

Timeline

- Starting at Year 1, each monitoring year

Failure Mode

- *The total score of the HA for each reach does not show improvement in narrative class initially from pre-project condition and scores fair or worse at Year 5.*

Reporting

- Compare HA scores from pre- and year to year

	Excellent	Good	Fair	Poor
1. Channel Modification	natural channel, bends frequent, good diversity of runs and bends 20-16	natural channel, long runs, bends infrequent 15-11	modified channel with bends, OR stream meanders within straight channel 10-6	modified channel with no bends 5-0
2. Instream Habitat snags vegetated banks undercut banks macrophytes riffles	3-4 types present > 50 % coverage 20-16	3-4 types present < 50 % coverage 15-11	1-2 types present > 50 % coverage 10-6	1-2 types present < 50 % coverage 5-0
3. Pools abundant: >5 /100m shallow: >1 ft deep: 2-3 ft (> prevailing depth)	deep and shallow pools present and pools are abundant 20-16	deep and shallow pools present and pools are rare, OR stream is uniformly deep 15-11	all pools shallow and pools are abundant 10-6	all pools are shallow and rare, or pools are absent 5-0
4. Bank Stability (⇒ while facing downstream)	very stable, no evidence of erosion or bank failure left 10-9 right 10-9	moderately stable, areas of erosion healed over 8-6 8-6	moderately unstable, 5-10% of the bank shows signs of active erosion 5-3 5-3	very unstable, many eroded areas along both runs and bends; > 10% of the bank shows signs of erosion 2-0 2-0
5. Bank Vegetative Type (⇒ while facing downstream)	dominant vegetation is shrubs left 10-9 right 10-9	dominant vegetation is trees 8-6 8-6	dominant vegetation is grass and herbaceous plants (briars) 5-3 5-3	stream bank dominated by non-vegetation (rock, soil, bulkhead, etc.) 2-0 2-0
6. Shading sun overhead full leaf-out	25-90% of the water surface shaded; a mixture of conditions; areas fully shaded, fully open, and degrees of filtered light 20-16	> 90% of water surface shaded, full canopy; entire water surface receives filtered or no light 15-11	no scoring in this category 10-6	< 25% of water surface shaded; lack of a canopy; full sunlight reaches water surface 5-0
7. Riparian Zone Width (⇒ while facing downstream)	no evidence of human activity within 18 meters (60 feet) left 10-9 right 10-9	no evidence of human activity within 12 meters (40 feet) 8-6 8-6	no evidence of human activity within 6 meters (20 feet) 5-3 5-3	evidence of human activity within 6 meters (20 feet) 2-0 2-0

US Environmental Protection Agency; 1997; "Field and laboratory methods for macroinvertebrate and habitat assessment of low gradient nontidal streams"; Mid-Atlantic Coastal Streams Workgroup, Environmental Services Division, Region 3, Wheeling, WV; 23 pages with appendices.

Structure Stability

Retention of Materials

Monitoring – On the ground

- Ground level photos documenting structure condition

Timeline

- Starting at Year 1, each monitoring year

Failure Mode

- *Structures functioning are not functioning designed.*
  - Burial of structures at dam breach not a performance issue

Reporting

- Photos each monitoring year and narrative description of the structure function

Percent Native Cover

Abundant Biological Communities

Monitoring – Aerial and on the ground

- Color growing season aerial photos
- Semi-quantitative inventory of species

Timeline

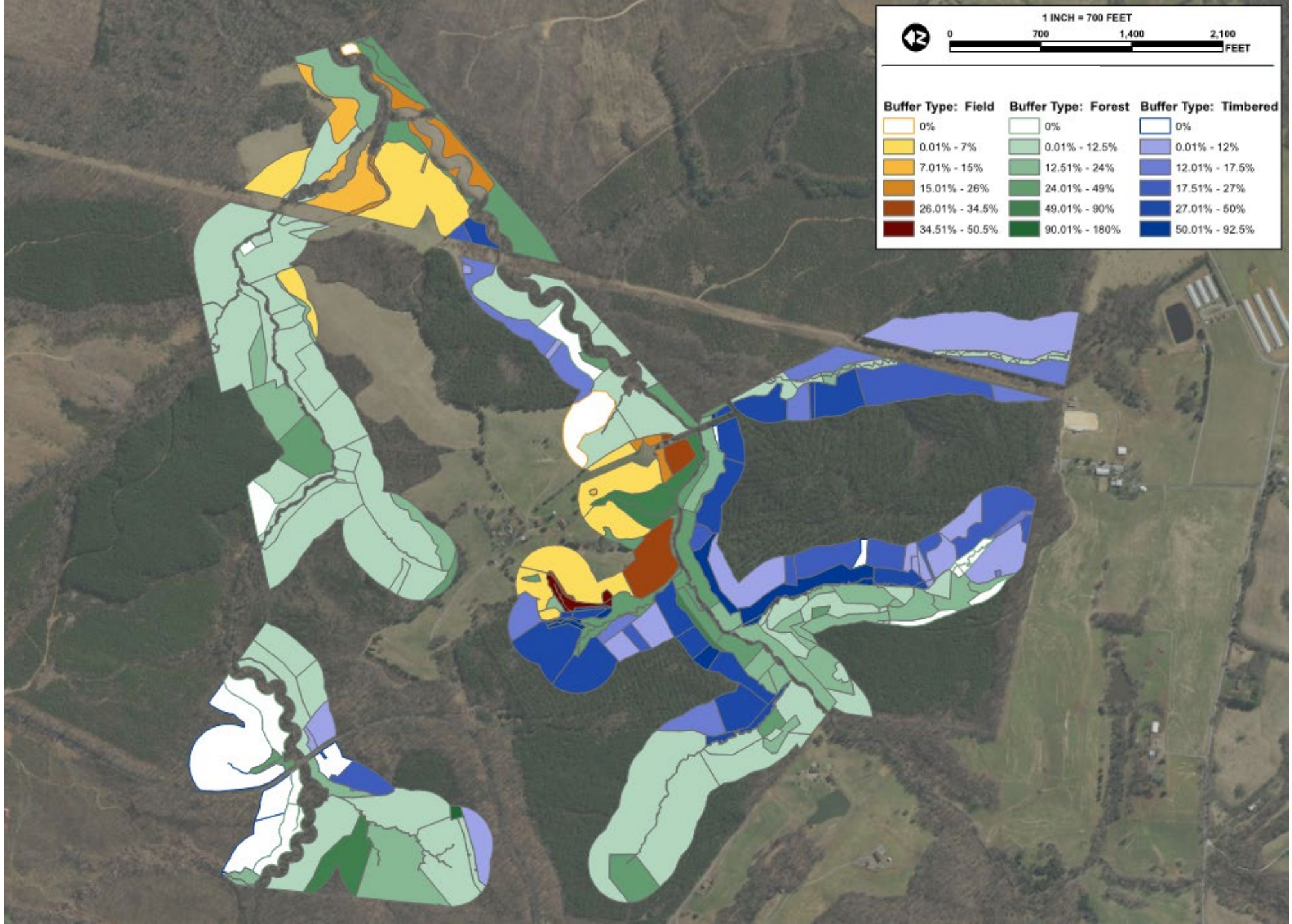
- Starting at Year 1, each monitoring year
- Only percent coverage requirement for Year 1 of the impoundment removal

Failure Mode

- *Less than 60% native herbaceous cover at the end of the first growing season, less than 80% coverage of site each monitoring year after*

Reporting

- Maps showing vegetation cover and heat map of percent native herbaceous, species inventory list


1 INCH = 700 FEET
0
700
1,400
2,100
FEET
Buffer Type: Field
0%
0.01% - 7%
7.01% - 15%
15.01% - 26%
26.01% - 34.5%
34.51% - 50.5%
Buffer Type: Forest
0%
0.01% - 12.5%
12.51% - 24%
24.01% - 49%
49.01% - 90%
90.01% - 180%
Buffer Type: Timbered
0%
0.01% - 12%
12.01% - 17.5%
17.51% - 27%
27.01% - 50%
50.01% - 92.5%

Biological Monitoring

Abundant Biological Communities

- For informational purposes only, conducted before and after construction and including a control reach
- Includes:
  - Benthic Macroinvertebrate sampling, identified to Genus as outlined by the DEQ Biological Monitoring Program Quality Assurance Project Plan for Wadeable Streams and Rivers
  - eDNA for fish species presence/absence
  - Water chemistry monitoring during biological sampling events, including temperature, dissolved oxygen, pH, and conductivity

Adaptive Management Plan

Key Process	Expected/Designed Endpoint	Alternative Endpoints	
		Acceptable Endpoints	Unacceptable endpoints
Extensive Lateral and Vertical Connectivity/Abundant Biological Communities–Vegetation	Riparian forested wetlands	Wet meadow	Upland community
		Scrub-shrub	Minimal or bare vegetation community
		Vegetation managed by beaver/impounded	
Retention of Materials–Morphology	Stable functional single-thread reach with active floodplain	Stable functional multithread retentive system with active floodplain	Unstable or non-functional system with single or multi-thread channels
		Stable, functional system managed by beaver	Unstable or non-functional system managed by beaver
Creation and Maintenance of Diverse Habitats	Single-thread stream-wetland complex	Multithread stream-wetland complex	Non-functional channel habitat
		Beaver wetland complex	Non-functional off-channel habitat

Key Process	Parameter	Indicator	Starting Year/Timing
Extensive Lateral and Vertical Connectivity	Floodplain Connectivity	Stream gage, photos of floodplain access evidence	Start: Year 2 for impoundment removal Frequency: Each Monitoring Year
	Groundwater and Surface Water Exchange	Groundwater wells	Start: Year 2 for impoundment removal Frequency: Each Monitoring Year
	Lateral Migration	Bank Erodibility Hazard Index (BEHI)	Start: Year 3 Frequency: Year 3, Year 5, and Year 10
	Temperature	Mean surface temperature - temp loggers	Start: Year 2 Frequency: Each Monitoring Year
Creation and Maintenance of Diverse Habitats	Stream Channel Formation	Visual inventory with winter aerial imagery	Start: Year 1 Frequency: Each Monitoring Year
	Instream Habitat Diversity	Coastal Plain Habitat Assessment	Start: Year 1 Frequency: Each Monitoring Year
Retention of Materials	Structure Stability	Photos and assessment	Start: Year 1 Frequency: Each Monitoring Year
Abundant Biological Communities	Vegetation	Percentage of bare ground (Yr 1), Percentage of native vegetation - growing season aerial and ground verification	Start: Year 1 Frequency: Each Monitoring Year
	Vegetation	Percentage INU species - aerial and ground verification	Start: Year 1, on the ground survey starts at Year 2 for impoundment removal Frequency: Each Monitoring Year
	Vegetation	Woody Stem Establishment	Start: Year 1, Year 2 for impoundment removal Frequency: Each Monitoring Year

*Highlighted cells are selective Year 1 monitoring protocols for the impoundment removal reaches

Where are we now?

- Have received positive feedback from regulators but still waiting on comments
- Plan to continue pushing forward alternative performance monitoring for other types of projects:
  - Beaver dam analogs and engineered log jams
  - Floodplain restoration projects
  - And hopefully all other stream restoration projects!

Thank you

Bree Stephens

Stream Scientist

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