



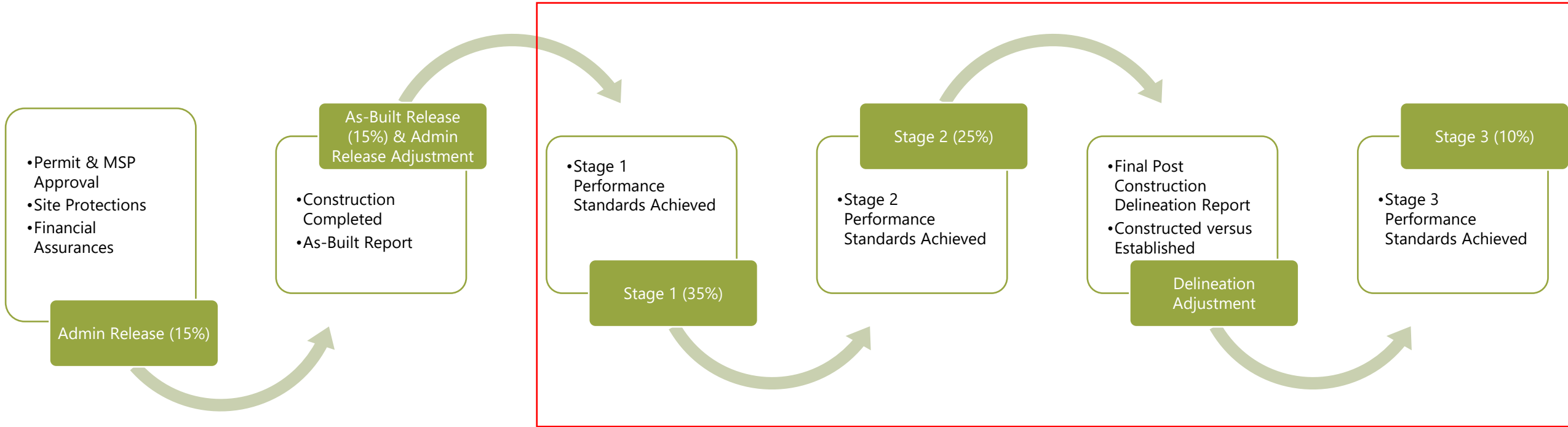
Observed Project Outcomes Monitoring Large Scale Project and Results

Shawyn Yeamans – Project Manager

March 2026



Performance Monitoring Phase / Credit Release Process



Monitoring & Performance – Old Methodology

Monitoring

- **Streams**
 - Full long-pro survey across restored channel
 - Cross-sections installed at 1,000 ft intervals
 - Bank Plot
 - Stream Gauge
 - BEHI
 - Survey
- **Wetland**
 - Vegetation Plots and/or Monitoring wells (Re-established Wetlands)
 - 2 per acre
 - 3 x 3 herbs and 400 sq ft woody



USRMBI – First Commercial Mitigation Bank in Pennsylvania

Performance Standards

Resource	Function	Stage 1	Stage 2	Stage 3
Stream	Bank Vegetation	1 stem per 50 sq ft or until 30% cover	1 stem per 50 sq ft or until 40% cover	1 stem per 50 sq ft or until 50% cover
		1 ft in woody height	2 ft in woody height	4 ft in woody height
	Hydrology	1 bankfull event	2 bankfull events	2 bankfull events
	Bank Stability	BEHI low or very low	BEHI low or very low	BEHI low or very low
	Channel Stability	less than 20% sinuosity change from As-Built	less than 10% sinuosity change from previous year	less than 10% sinuosity change from previous year
less than 15% thalweg movement from As-Built		less than 10% thalweg movement from previous year	less than 10% thalweg movement from previous year	
less than 0.4 Bank Width Ratio change from As-Built		less than 0.2 Bank Width Ratio change from previous year	less than 0.2 Bank Width Ratio change from previous year	
Wetland	Vegetation	At least 200% stem density relative to reference community	At least 175% stem density relative to reference community	At least 150% stem density relative to reference community
		Less than 15% invasive cover	Less than 10% invasive cover	Less than 10% invasive cover
		At least 60% native cover	At least 70% native cover	At least 85% native cover
		Tree height 3 ft	Tree height 5 ft	40% canopy cover
	Hydrology	Saturation of the upper 12 in for 12.5% of growing season	Saturation of the upper 12 in for 12.5% of growing season	Saturation of the upper 12 in for 12.5% of growing season

Problems – Old Methodology

Monitoring

- Monitoring efforts intensive
- Time consuming
- Repetitive

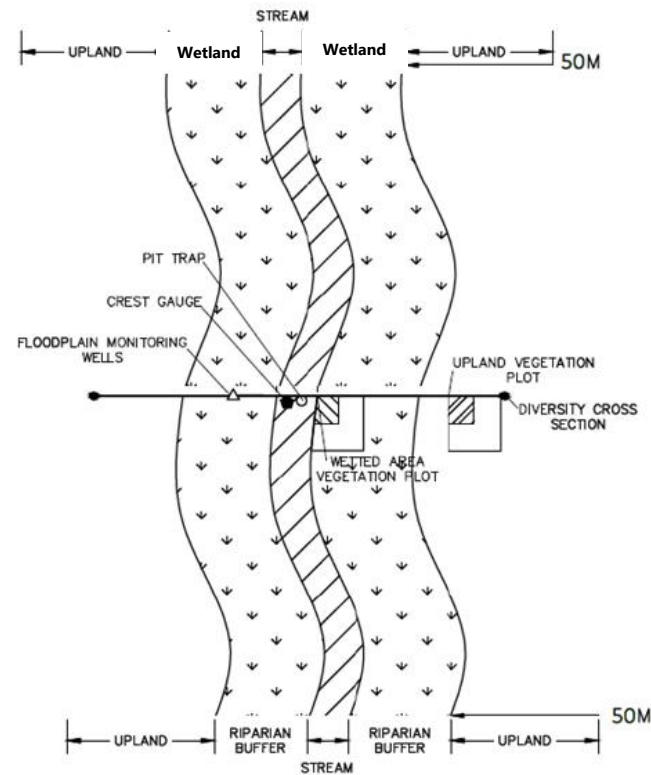
Performance Standards

- **Stream**
 - Channel stability standards ridged and based on NCD metrics
 - Discourages natural evolution of channel
- **Wetland**
 - Reference communities difficult to compare and even locate
 - **Woody growth and establishment unpredictable**



USRMBI – First Commercial Mitigation Bank in Pennsylvania

Current Methodology – Monitoring Station Design

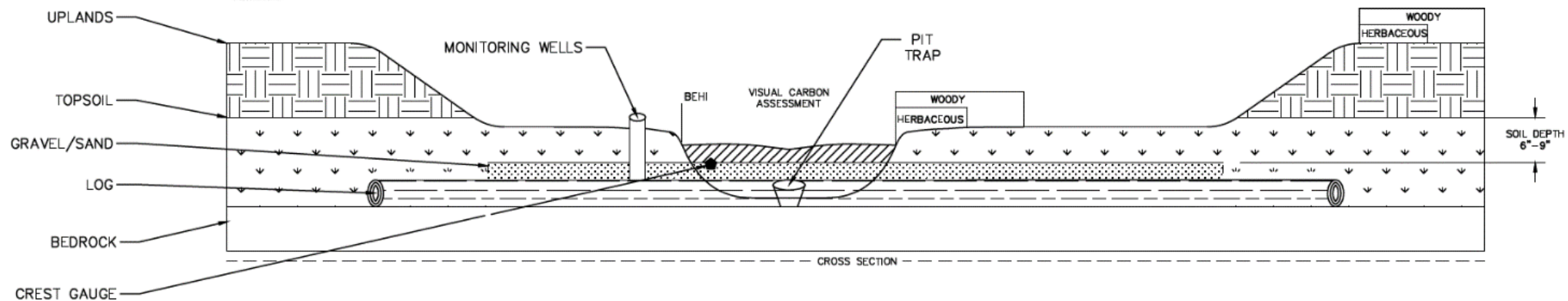


Wetlands/Uplands

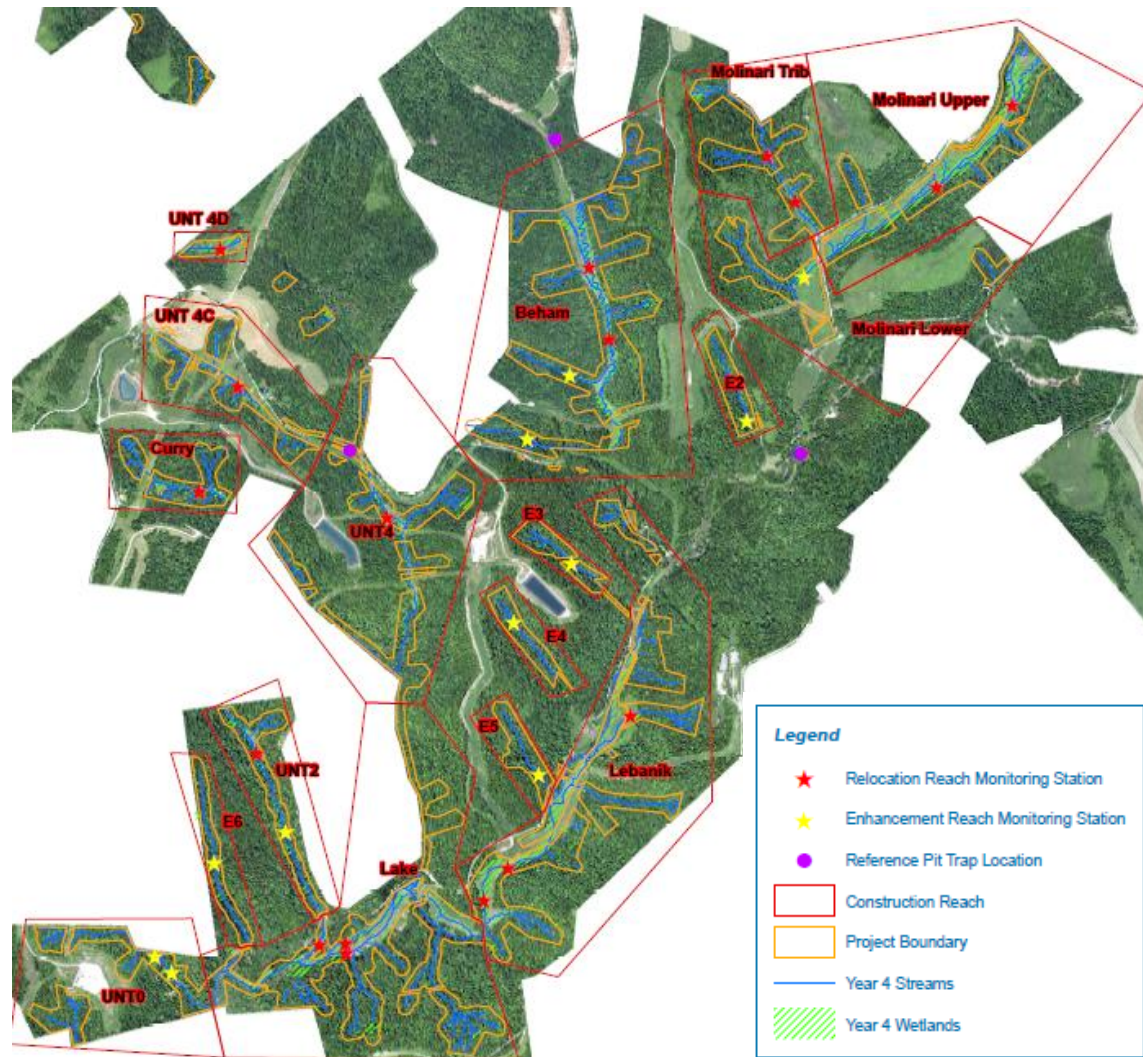
- Wetland/Upland Herbaceous Plot - 3' x 3'
 - Species and Cover
 - Photos (C)
- Wetland/Upland Woody Plots - 20' Radius
 - Species, Cover, Heights, Condition
 - Photos (N, S, E, W)
- Wetland Monitoring Wells (Water Level Logger)

Streams

- Stream Gauge (Water Level Logger)
- BEHI Evaluation
- Pebble Counts
- LWD Volumes – 100 Meter Reach
- Long Pro Survey – 100 Meter Reach
- Fish and Macroinvertebrate Surveys – 100 Meter Reach
- Visual Estimates
 - Carbon/Sediment Retention
 - Instream Habitat Types
- Photos (Up, Down, Left, Right)



Current Methodology – Monitoring Station Layout



Robinson Fork Phase 1 Example

Principle

- Divide Project into representative reaches
 - Based on similarities in:
 - Valley Type
 - Landscape Position
 - Land Use
 - Degradation Severity
 - Stream Size
 - Design Approach
- Establish Monitoring Stations
 - Gather baseline data to compare against in performance phase in order to show uplift

Robinson Fork Layout

- 17 Unique Construction Reaches
 - 17 Restoration (Relocation/Rehabilitation) Reach Monitoring Stations
 - Headwater vs Mid-Order vs High Order
 - Confined vs Unconfined Valleys
 - Forested vs Non-Forested
 - 11 Enhancement (Geomorphic/Habitat) Reach Monitoring Stations
 - Headwater
 - Mechanical vs Manual Work

Performance Standards – Current Methodology

Performance Standards and Goals Summary					
Resource Type	Functional Subgroup	Evaluation	Performance Standard Value		
			Stage 1	Stage 2 If Different	Stage 3 If Different
Stream System	Vertical Bed Stability	Vertical Deviation	<0.5'	Same	Same
	Channel Pattern	Sinuosity	+/- 20% of As-Built	+/- 10% previous event	Same
	Channel / Floodplain Stability	BEHI	≤Low	Same	Same
	Floodplain Connectivity	Stream Hydrology	Bankfull ≥1/yr	Bankfull ≥2/yr	Same
Retention	Epifaunal substrate	Bed Mobility	N/A	D50 size class same as Year 1	Same
	Carbon / Sediment	Visual Observation	≥ 60% carbon and/or sediment retention	Same	Same
	Habitat Diversity	LWD Volume	25% ↑ LWD habitat and/or substrate diversity	Same	Same
		Pebble Count Diversity			
	Biological	Fish	N/A	↑ species richness or 10% ↑ biomass, or #; and/or	Same
Macros		N/A	10% ↑ IBI score		
Stream / Floodplain	Riparian Wetland	Invasive Vegetative Cover	≤15%	≤10%	≤5%
		Native Vegetative Cover	≥30%	≥50%	≥70%
		Woody Vegetative Cover	N/A	≥15% or 3' Height	≥30% or 5' Height
	Root Saturation	Groundwater Hydrology	12 consecutive days or 12% of growing season upper 1' soil saturation	Same	Same
	Stream / Floodplain Diversity	Cross Section Diversity	↑ habitat diversity & depth/velocity regimes	Same	Same
Upland	Habitat	Invasive Vegetative Cover	≤15%	≤10%	≤5%

Results from Baseline – Robinson Fork

Comparable Data Review - BEHI												
Reach	Cross-section	Baseline Value	2017		2018		2019		2020			
			Value	Improvement?	Value	Improvement?	Value	Improvement?	Value	Improvement?		
4D	1	Extreme	Low	Yes	Low	Yes	Not Sampled		Low	Yes		
McCulley	1	High	Low	Yes	Low	Yes			Low	Yes		
	2	High	Low	Yes	Low	Yes			Very Low	Yes		
Upper Molinari	1	High	Low	Yes	Low	Yes			Low	Yes		
	2	High	Low	Yes	Low	Yes			Low	Yes		
Molinari Trib	1	Very High	Low	Yes	Low	Yes			Low	Yes		
	2	High	Low	Yes	Low	Yes			Very Low	Yes		
Lebanik	1	High	Not Sampled		Low	Yes			Very Low	Yes	Low	Yes
	2	Moderate			Low	Yes			Low	Yes	Very Low	Yes
	3	Moderate			Low	Yes			Low	Yes	Low	Yes
Lake Reach	1	High			Very Low	Yes	Low	Yes	Low	Yes		
	2	Very High			Low	Yes	Low	Yes	Low	Yes		
Beham	1	Very High			Low	Yes	Low	Yes	Low	Yes		
	2	Moderate			Low	Yes	Low	Yes	Very Low	Yes		
UNT2	1	Extreme			Low	Yes	Low	Yes	Low	Yes		
Curry	1	High			Low	Yes	Low	Yes	Very Low	Yes		
UNT4	1	High			Low	Yes	Low	Yes	Low	Yes		
UNT4C	1	Extreme	Low	Yes	Low	Yes	Very Low	Yes				

Comparable Data Review – LWD (m³/m²)												
Reach	Cross-section	Baseline Value	2017		2018		2019		2020			
			Value	Improvement?	Value	Improvement?	Value	Improvement?	Value	Improvement?		
4D	1	0	0.0032	Yes	0.0032	Yes	Not Sampled		0.0032	Yes		
McCulley	1	0.0025	0.0147	Yes	0.0147	Yes			0.0147	Yes		
	2	0.0007	0.0337	Yes	0.0337	Yes			0.0337	Yes		
Upper Molinari	1	0.0066	0.0011	-	0.0084	Yes			0.0084	Yes		
	2	0.0066	0.0074	Yes	0.0080	Yes			0.0080	Yes		
Molinari Trib	1	0.0009	0.0157	Yes	0.0157	Yes			0.0158	Yes		
	2	0	0.0016	Yes	0.0016	Yes			0.0016	Yes		
Lebanik	1	0.0002	Not Sampled		0.0249	Yes			0.0249	Yes	0.0249	Yes
	2	0.0012			0.0049	Yes			0.0049	Yes	0.0049	Yes
	3	0.0012			0.0062	Yes			0.0062	Yes	0.0062	Yes
Lake Reach	1	0.0001			0.0097	Yes	0.0103	Yes	0.0103	Yes		
	2	0.0001			0.0144	Yes	0.0144	Yes	0.0145	Yes		
Beham	1	0.0002			0.0107	Yes	0.0111	Yes	0.0111	Yes		
	2	0.0003			0.0048	Yes	0.0048	Yes	0.0048	Yes		
UNT2	1	0.0011			0.0317	Yes	0.0358	Yes	0.0358	Yes		
Curry	1	0.0031			0.0246	Yes	0.0263	Yes	0.0263	Yes		
UNT4	1	0.0064			0.0085	Yes	0.0095	Yes	0.0095	Yes		
UNT4C	1	0	0.0327	Yes	0.0327	Yes	0.0327	Yes				

Results from Baseline – Robinson Fork

Comparable Data Review – Macroinvertebrate IBI											
Reach	Cross-section	Baseline Value	2017		2018		2019		2020		
			Value	Improvement?	Value	Improvement?	Value	Improvement?	Value	Improvement?	
4D	1	35.10	Not Sampled		47.53	Yes	Not Sampled		49.54	Yes	
McCulley	1	49.92		37.08	-	49.58	-	67.46	Yes		
	2	40.77		42.76	Yes	60.10	Yes	73.59	Yes		
Upper Molinari	1	47.52		65.16	Yes	Not Sampled		55.29	Yes		
	2	47.52		52.38	Yes			62.53	Yes		
Molinari Trib	1	48.32		62.61	Yes	Not Sampled		68.25	Yes		
	2	35.19		70.73	Yes			65.61	Yes		
Lebanik	1	37.08		Not Sampled		Not Sampled		56.82	Yes	56.73	Yes
	2	42.83						42.97	Yes	47.08	Yes
	3	42.83						45.56	Yes	48.18	Yes
Lake Reach	1	42.41		Not Sampled		Not Sampled		39.07	-	50.77	Yes
	2	33.65						46.57	Yes	71.70	Yes
Beham	1	62.67		Not Sampled		Not Sampled		47.91	-	62.69	Yes
	2	54.48						57.37	Yes	66.89	Yes
UNT2	1	53.16		Not Sampled		Not Sampled		47.72	-	67.38	Yes
Curry	1	31.63						51.99	Yes	66.37	Yes
UNT4	1	50.53		Not Sampled		Not Sampled		51.18	Yes	65.10	Yes
UNT4C	1	35.1						66.71	Yes	49.64	Yes

Comparable Data Review – Fish													
Reach	Cross-section	Baseline Value	2017		2018		2019		2020				
			Value	Improvement?	Value	Improvement?	Value	Improvement?	Value	Improvement?			
4D	1	None	Not Sampled		None	-	Not Sampled		None	-			
McCulley	1	None		None	-	None			-				
	2	None		None	-	None			-				
Upper Molinari	1	Fish Present		Richness Increase	Yes	Not Sampled			Richness Increase	Yes			
	2	Fish Present		No Change	-				Richness Increase	Yes			
Molinari Trib	1	None		Range Expansion	Yes	Not Sampled			None	-			
	2	None		Range Expansion	Yes				Range Expansion	Yes			
Lebanik	1	None		Not Sampled		Not Sampled			None	-	None	-	
	2	Fish Present							No Change	-	No Change	-	
	3	Fish Present							No Change	-	No Change	-	
Lake Reach	1	Fish Present		Not Sampled		Not Sampled			Range Expansion/Biomass Increase	Yes	Range Expansion	Yes	
	2	None							Range Expansion	Yes	Range Expansion	Yes	
Beham	1	Fish Present		Not Sampled		Not Sampled			Richness Increase	Yes	Species Quality Increase	Yes	
	2	Fish Present							Richness/Biomass Increase	Yes	Richness Increase	Yes	
UNT2	1	None		Not Sampled		Not Sampled			Range Expansion	Yes	Range Expansion	Yes	
Curry	1	None							None	-	None	-	
UNT4	1	Fish Present		Not Sampled		Not Sampled			Biomass Increase	Yes	Biomass Increase	Yes	
UNT4C	1	None							None	-	None	-	

Advantages – Current Methodology

Monitoring

- Monitoring efforts streamlined
- Easily digestible
- Less time consuming

Performance Standards

- **Stream**
 - Encourages natural evolution of channel to a greater extent
 - Based on showing uplift above baseline conditions
- **Wetland**
 - Based more on native species development



Robinson Fork – Large Stream



Robinson Fork – Mid-Sized Stream

Problems – Current Methodology

Performance Standards

- **Stream**
 - Natural evolution of the channel could be promoted more
 - Fish and Macro improvements are unpredictable
- **Wetland**
 - Woody vegetation development is unpredictable and highly variable
 - Hydrology across the site can vary significantly – if very wet - woody species won't develop well
 - Climate highly variable across the region – can slow growth
 - Sunlight exposure highly variable across sites
 - If to shaded success drops
 - If to exposed success drops



Robinson Fork – Stream Channel Evolution - Beaver



Robinson Fork – Beaver Pond

Suggestions – Current Methodology

Performance Standards

- **Stream**
 - Eliminate standards that discourage channel evolution
- **Wetland**
 - Encourage woody plantings but eliminate standards that make them a must
 - Should be viewed as a bonus... what ends up developing in the end is what the site wants to be there

Alternatives

- **Stream**
 - "Evidence of channel evolution (survey or photography) without instability (structural failure or eroding banks)."
 - "Bank height remains less than or equal to designed target."
- **Wetland**
 - "Plantings will exhibit a positive progression in growth (DBH, Cover, and/or Height)."
 - Crediting bonus if PSS/PFO develop but no penalty if they don't?
 - Encourage strategic woody planting schemes.
 - More early successional species
 - Larger streams/floodplains (greater hydrology) – PEM with PSS/PFO plantings on the fringes.
 - Smaller streams/floodplains (less hydrology) – PSS/PFO plantings
 - Lower densities to allow Sponsor's to purchase bigger material

Questions?

