Stream Restoration: Planning & Site Selection, Crediting and Implementation

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3 Rivers Wet Weather
Stream Symposium

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Agenda

- Identifying Potential Stream Restoration Sites
  - *Watershed Planning Process*
  - *Site Selection Process*
- Prioritizing Sites
- Determining Credit
  - *Chesapeake Bay Expert Panel Protocols*
- Project Implementation

Identifying Potential Stream Restoration Sites

How do you start identifying potential projects?

— Review existing watershed plans / PRPs

— *Start by reviewing existing data*

— *Determine what data is available, particularly related to stream stability and riparian buffers*

— *If stream stability assessments have not been completed, start with GIS desktop analyses to identify stream segments with highest potential*

— Develop new watershed plans

— *Look for partners*

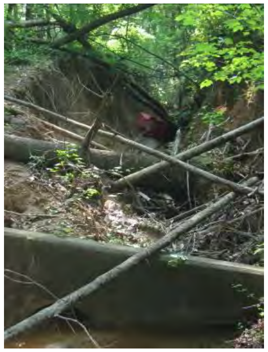
— *Watersheds do not follow municipal boundaries*

— *Co-jurisdictional watershed plans will be most beneficial for improving water quality*

— Review citizen/agency complaints

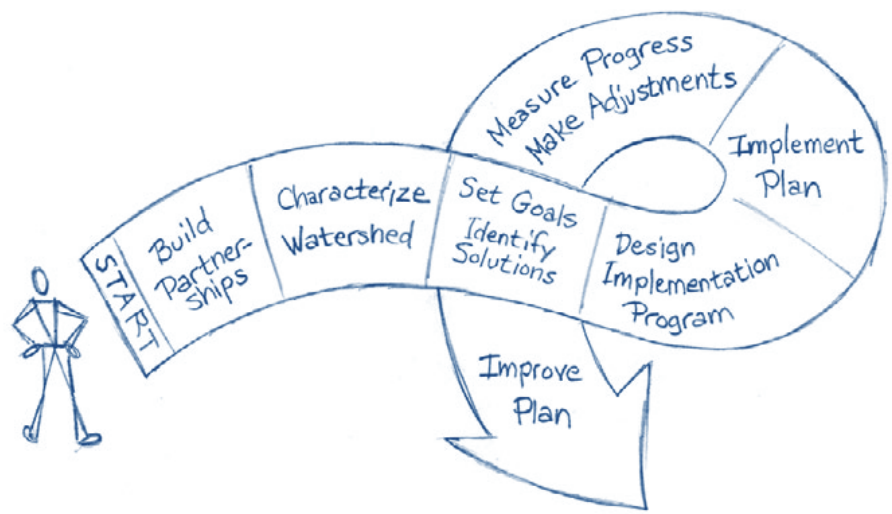
A Watershed Approach – Key For Success

- Hydrologically defined & geographically focused
- Involves all stakeholders
- Strategically addresses priority water resource goals
- Involves assessment and prioritization of area's water quality concerns defined by watersheds
- Design and Implementation of Best Management Practices (BMPs) to treat and improve water quality.



Watershed Approach – 5 Guiding Principles

1. Place-based focus
2. Stakeholder involvement
3. Environmental goals
4. Problem identification and prioritization
5. Integration of actions



http://www.epa.gov/owow/nps/watershed_handbook/

Elements of A Watershed Plan
US EPA A through I Criteria

— Identification of the causes and sources of pollution

— Estimates of pollutant load reductions of proposed BMPs

— Description of the BMPs

— Estimates of technical and financial assistance needs

— Public outreach & participation

— Schedule of implementation

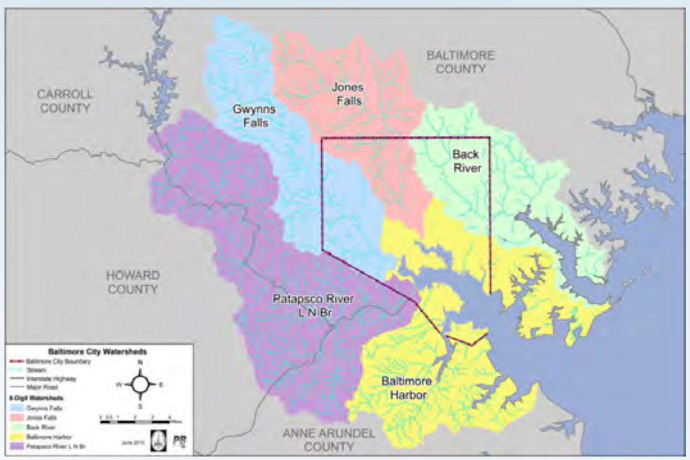
— Description of interim milestones

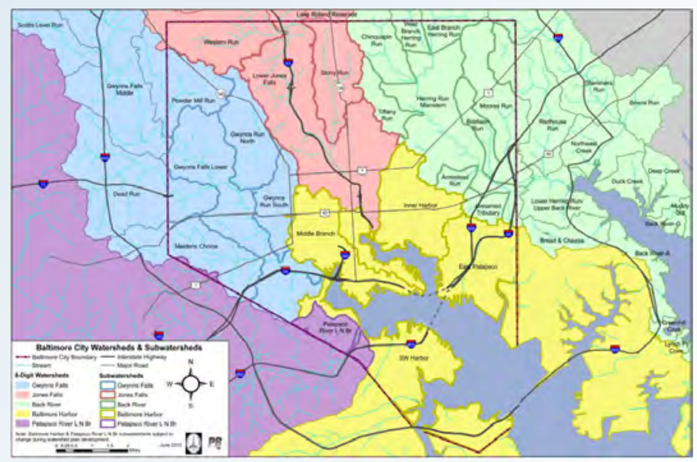
— Development of performance criteria

— Monitoring of BMPs effectiveness

Watershed Scale

SCALE	DESCRIPTION	SIZE	EXAMPLE
Basin	Large river, estuary, lake systems	> 1,000 sq mi	Chesapeake Bay
Sub-basin	State-defined, 6-digit sub-basins	> 100 sq mi	Patapsco/Back River
Watershed	State-defined, 8-digit watersheds	20 – 100 sq mi	Jones Falls
Subwatershed	Specific/named streams, 3rd order or smaller	≤ 11 sq mi	Western Run





Conducting Watershed Assessment

- Desktop analysis; rapid assessment and detailed field evaluations;
- Upland assessments;
  - *Includes stream stability, neighborhood, pervious area and institutional assessments*
- Stormwater hot spots;
- Natural resources inventories;
- Pollutant loading estimation – modeling, monitoring and TMDL baselining

Potential Sources for Identification of Potential Stream Restoration Sites

— GIS Data Models

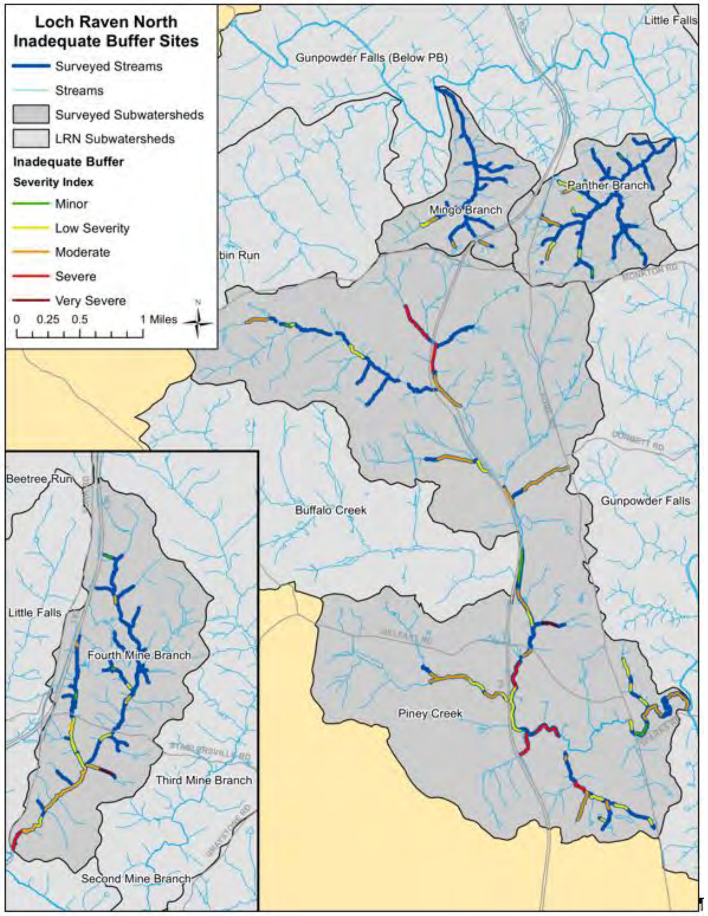
— Aerial Imagery

— Field Assessments

— Municipal/County/State Coordination

— Watershed Reports

— Citizen Complaints



Desktop Analysis – Looking Stream Restoration Potential

- Aerial images
- GIS Layers
  - *Pasture land*
  - *303d/Impaired streams*
  - *Contours*
  - *Land use*
  - *Tree cover/canopy*
  - *Stream buffers*
  - *Soil erodibility*
  - *Parcel layers/property ownership*
  - *Aerial images*
  - *Species of State Concern*
- Review of Previous Studies

- Reasons to exclude potential sites based on desktop analysis
  - *Restoration already complete*
  - *No stream channel showing*
  - *Difficult access*
  - *Stream reach too short*
  - *Heavily forested*
  - *Stream may not be perennial*
  - *Drains to reservoir*
  - *Property owner denied access*
  - *Appears to be a drainage ditch (swale)*
  - *Proximity to utilities and/or railway (CSX)*
  - *SWM pond onsite*

Field Assessments – Stream Stability Assessments

- Rapid stream assessments
  - *~1 mile per day*
- Key parameters:
  - *Fish blockages*
  - *Bank erosion*
  - *Outfalls*
  - *Channel alterations*
  - *Flood or infrastructure concerns*
  - *Potential for habitat enhancement*

Site Considerations that May Impact Stream Restoration Potential

- Pros
  - *Moderate to severe bank erosion*
  - *Limited riparian buffer*
  - *Minimal or no utilities*
  - *0 to 2nd order stream*
  - *Local TMDLs*

- Cons
  - *High quality forest present*
  - *Limited access*
  - *Steep slopes*
  - *Minimal sediment and nutrient loading*
  - *Wetland creation opportunity*
  - *Site planted/in forest conservation*
  - *Utility/infrastructure constraints*
  - *3rd order stream, too large*
  - *Reservoir downstream*

Site Prioritization: Key Weighting Parameters

— TMDL Potential
— Constructability
— Watershed Characteristics
— Other Considerations

TMDL Potential

— Bank Erodibility Potential – Are there active headcuts or high potential for new headcut migration? High channel incision?

— Stream Bank Erosion Potential Percentage – Higher percentage of bank erosion provides greatest pollutant reductions. Need to look at both banks.

— Sediment Storage / Nutrient Treatment Potential – includes treatment of upstream sources, floodplain storage and/or nutrient treatment potential

— Potential to incorporate other BMP strategies – strategies could include reforestation, wetland creation, trash removal, outfall restoration, upland BMPs

1. Streambank Erosion %				
Options:	75-100%	50-74%	25-49%	0-24%
Rationale:	Targeting sites with high streambank erosion will decrease large amounts of nutrients and sediment from being transported downstream to the Bay.			

Watershed Characteristics

— Stream Length (LF) – longer stream lengths are typically more cost effective and result in increased nutrient/sediment reductions

— Drainage area – smaller drainage areas (< 1 square mile) have higher probability for success.

— Stream order – 1st order systems are optimal

— % Impervious – optimal is < 10% impervious, however many urban systems fall in suboptimal category of 10-29%

— Biologic Uplift – look for streams that have potential for biologic uplift or habitat improvements in addition to stabilization

Category:	Optimal	Suboptimal	Marginal	Poor
1. Stream Length				
Options:	>2,000 LF	1,500 to 2,000 LF	1,000 to 1,500 LF	<1,000 LF
Rationale:	Target longer stream lengths, which are more cost effective and result in increased nutrient and sediment reductions.			

Constructability

— Access – Optimal

— Forest / Tree Cover

— Utilities (Visible)

— Constraints

— Proximity to State/County Road

— Bank Erodibility Potential

1. Access				
Options:	Adjacent, Unrestricted	Minor Constraints	Moderate Constraints	Significant Constraints
Description:	Access is relatively flat, open, dry, within 100 ft of a public road.	Access is relatively flat, open, dry, within 100-500 ft of a public road, may require special construction road treatments.	Some steep slopes, some vegetation clearing, some wet areas, between 500-1,000 ft of a public road, may require special construction road treatments.	Steep slopes, heavily vegetated, wet areas, over 1,000 ft from a public road, may require special construction road treatments.
Rationale:	Unrestricted access increases the constructability of site, reducing overall project costs and impacts to existing resources			

Other Key Considerations

- Property Ownership
  - *Working on public land is typically easier than pursuing private properties*
  - *Agencies need to decide if they can work on private property and if they are willing to pay for easements/access*
  - *Higher number of property owners typically increases the amount of time in the planning and design process*
- County/Watershed Group Coordination
  - *Permitting agencies typically favor projects that*
- Cost

Chesapeake Bay Expert Panel Crediting

Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects

Joe Berg, Josh Burch, Deb Cappuccitti, Solange Filoso, Lisa Fraley-McNeal, Dave Goerman, Natalie Hardman, Sujay Kaushal, Dan Medina, Matt Meyers, Bob Kerr, Steve Stewart, Bettina Sullivan, Robert Walter and Julie Winters

Accepted by Urban Stormwater Work Group (USWG): **February 19, 2013**
Approved by Watershed Technical Work Group (WTWG): **April 5, 2013**
Final Approval by Water Quality Goal Implementation Team (WQGIT): **May 13, 2013**
Test-Drive Revisions Approved by the USWG : **January 17, 2014**
Test-Drive Revisions Approved by the WTWG: August 28, 2014
Test-Drive Revisions Approved by the WQGIT: September 8, 2014

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FREQUENTLY ASKED QUESTIONS:

URBAN STREAM RESTORATION BMP

Expert Panel Stream Restoration Crediting Opportunities

Summary of Stream Restoration Credits for Individual Restoration Projects [1, 2]					
Protocol	*Name*	*Units*	*Pollutants*	*Method*	*Reduction Rate*
1	Prevented Sediment (S)	Pounds per year	Sediment TN, TP	Define bank retreat using BANCS or other method	Measured N/P content in streambed and bank sediment
2	Instream Denitrification (B)	Pounds per year	TN	Define hyporheic box for reach	Measured unit stream denitrification rate
3	Floodplain Reconnection (S/B)	Pounds per year	Sediment TN, TP	Use curves to define volume for reconnection storm event	Measured removal rates for floodplain wetland restoration projects
4	Dry Channel RSC as a Retrofit (S/B)	Removal rate	Sediment TN, TP	Determine stormwater treatment volume	Use adjustor curves from retrofit expert panel

[1] Depending on project design, more than one protocol may be applied to each project, and the load reductions are additive.
[2] Sediment load reductions are further reduced by a sediment delivery ratio in the CBWM (which is not used in local sediment TMDLs)
S: applies to stormflow conditions, B: applies to base flow or dry weather conditions

Protocol #5 – Alternate Headwater and Outfall Channel Protocol, is currently under review by the Urban Stormwater Work Group

- 0 & 1st Order Channels
- Quantifies potential sediment loss prevented
- Converted to Annual Load reduction

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Edge of Stream Interim Approved Removal Rates per Linear Foot of Qualifying Stream Restoration (lb/ft/yr)

Table 3. Edge-of-Stream 2011 Interim Approved Removal Rates per Linear Foot of Qualifying Stream Restoration (lb/ft/yr)

Source	TN	TP	TSS*
Interim CBP Rate	0.20	0.068	56.11
Revised Default Rate	**0.075**	**0.068**	**44.88** non-coastal plain **15.13** coastal plain

Derived from six stream restoration monitoring studies: Spring Branch, Stony Run, Powder Mill Run, Moore's Run, Beaver Run, and Beaver Dam Creek located in Maryland and Pennsylvania

*To convert edge of field values to edge of stream values a sediment delivery ratio (SDR) was applied to TSS. The SDR was revised to distinguish between coastal plain and non-coastal plain streams. The SDR is 0.181 for non-coastal plain streams and 0.061 for coastal plain streams. Additional information about the sediment delivery ratio is provided in Section 2.5 and Appendix B.

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Basic Qualifying Conditions for Stream Projects

— Watershed Based Approach for Prioritizing and Screening

— Stream reach > 100 lf and still actively enlarging/degrading

— Most located on 1st to 3rd order streams

— Comprehensive approach to stream restoration including addressing long term stability of channel, banks and floodplain

— Special consideration given to projects designed to reconnect channel with floodplain

— Project not designed solely to protect public infrastructure by bank armouring or riprap (these do not qualify)

Environmental Considerations

— Comply with all state and federal permitting requirements including 404 and 401 permits

— May require pre- and post-construction monitoring

— Project must include one or more of the following:

— Before credits are granted, projects will need to meet post-construction monitoring requirements, exhibit successful vegetative establishment and have undergone initial project maintenance.

Protocol 1: Credit for Prevented Sediment during Storm Flow

- *"Protocol provides an annual mass nutrient credit and sediment reduction credit for qualifying stream restoration practices that prevent channel or bank erosion that would otherwise be delivered downstream from an actively enlarging or incising urban stream"*

- Most commonly used protocol for stream restoration projects

Protocol 2: Credit for Instream and Riparian Nutrient Processing during Baseflow

- *"Protocol provides an annual mass nitrogen reduction credit for qualifying projects that include design features to promote denitrification during base flow"*

- Nitrogen removal credit only

Protocol 3: Credit for Floodplain Reconnection Volume

— *"Protocol provides an annual mass and nutrient credit for qualifying projects that reconnect stream channels to their floodplain over a wide range of storm events"*

— Although a goal of many stream restoration projects, the protocol does not typically yield high credit amounts.

— Therefore, not frequently used.

— Research currently being conducted to improve quantification of credit that is observed in practice

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Protocol 4: Credit for Dry Channel RSC as an Upland Stormwater Retrofit

— *"Protocol provides an annual nutrient and sediment reduction rate for the contributing drainage area to a qualifying dry channel RSC project"*

— *Works well for outfall and headwater channels*

— *May have difficulty permitting in perennial streams*

Protocol 5: Alternate Headwater and Outfall Channel Protocol – CURRENTLY UNDER REVIEW

- *Protocol provides an annual nutrient and sediment reduction rate based on the difference between actual site conditions and a stable equilibrium condition*
- *Developed by the Maryland Department of Transportation's State Highway Administration*

- Alternate to Protocol 1
- Applies to headwater channels where vertical incision is a dominant mechanism for erosion of system
- Credit is for prevention of future sediment loss, not loss experienced to date

Protocol 1, Sediment Prevention: Three Step Process

1. Estimate stream sediment erosion rates and annual sediment loadings
   a) *Monitoring – cross sections, bank pins, repeat topographic surveys*
   b) *BANCS method – involves assessment of BEHIs and Near Bank Shear stress*
   c) *Alternative modeling approach – BSTEM (Bank Stability and Toe Erosion Model developed by USDA-ARS)*
2. Convert erosion rates to nitrogen and phosphorus loadings
3. Estimate stream restoration efficiency
   a) *Typically use 50% efficient unless monitoring data shows otherwise*

$$S = \frac{\Sigma(cAR)}{2{,}000}$$

where: S = sediment load (ton/year) for reach or stream
c = bulk density of soil (lbs/ft^3)
R = bank erosion rate (ft/year) (from regional curve)
A = eroding bank area (ft^2)
2,000 = conversion from pounds to tons

Above Computation requires Bulk Density samples – site specific

Recommend site specific nitrogen/phosphorus samples

Protocol 2, Hyporheic Zone:

1. Determine the total post construction stream length that has been reconnected using a bank height ratio of 1.0 or less
2. Determine the dimensions of the hyporeic box
3. Multiply hyporeic box mass by the unit denitrification rate
4. Check to make sure watershed cap is not exceeded (40% cap)

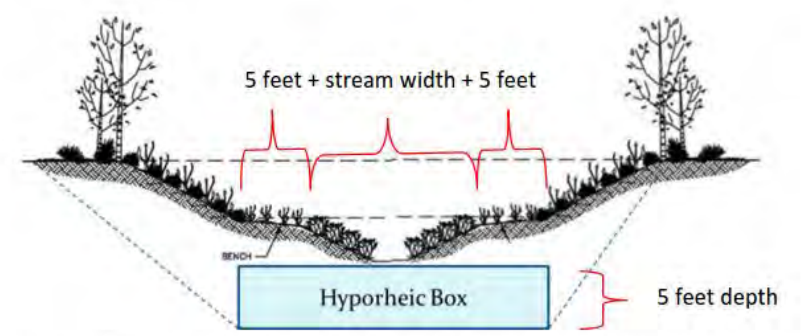

Figure 2. Hyporheic box that extends the length of the restored reach

Protocol 3, Floodplain Reconnection:

1. Estimate the floodplain connection volume
2. Estimate the nitrogen/phosphorus removal rate attributable to floodplain reconnection
3. Compute annual N, P and TSS loads
4. Multiple pollutant load by the project removal rate to define the reduction credit

— Typically provides small credit values

— MDOT SHA not routinely computing for projects since results are so small proportionately to Protocol 1 and 2

Duration of Stream Restoration Removal Credit

- Maximum recommended duration for removal credits is 5 years (MD requires triennial verification of alternate BMPs)
  - *Typically have 1 year to correct any deficiencies found during inspections or need to reduce claimed credit*
- Credit can be renewed indefinitely based on field performance that project is operating as designed
- Initial verification of performance: typically provided by designer, inspector or state permit authority
- Restoration reporting required to appropriate state agency

Implementing Stream Restoration Projects

Sample Project Implementation Timelines

- Planning Process
  - *6 to 12 months*
- Design Process (for Traditional Design Bid Build Projects)
  - *18 to 24 months*
  - *Can be longer if complex right of way and/or land use*
- Construction Process
  - *Account for your agency's procurement timeframe*
  - *Once contractor receives NTP*
    - Time for materials and other municipal approvals, access road set up (1 to 3 months)
    - In stream construction window (assume up to 200 lf of instream work per week, new contractors may be much slower)
    - Last phase is planting and site clean up (1 to 3 months)

Property Access – Critical Path Item!

- Right of Way Acquisition
  - *Easements*
  - *Purchase in Fee*
- Pros
  - *Provides protection of site in perpetuity*
  - *Restricts property owners ability to use site*
- Cons
  - *Often requires payment to property owner*
  - *Adds time to design process*

- Right of Entry
  - *Temporary access for construction of project*
- Pros
  - *Easier to obtain*
  - *Lower or no fees*
- Cons
  - *Property owner still owns parcel*
  - *No restrictions about future use and/or development*

Sample Project Implementation - Construction

- Account for your Agency's procurement timeframe
- Once Contractor Receives NTP
- Consider any time of year restrictions for instream work
  - *If these occur during your construction window, allow extra time for contractor*
- Consider sensitive habitat/constraints
- Construction Process
  - *Initial Setup – material approvals, site inspections/walk throughs, access road set up (1 to 3 months)*
  - *Instream Construction – varies due to complexity of job and experience of contractor (~200 lf of instream work per week on average)*
  - *Planting and site cleanup/acceptance (1 to 3 months)*

Construction Phase

- Important to have owner representative familiar with the stream restoration design on-site during construction
  - *Ideally stream restoration designer who designed project*
  - *Do not need full-time, recommend 2-3 days/week on average*
  - *Only during the instream work period*
  - *This is in addition to typical construction inspection staff who manage day to day activities*
- Consider requiring contractor to have their own stream restoration specialist on-site if you're unable to prequalify contractors
- Prepare as-built drawings or at least marked up plan set to document any field changes

Alternate Delivery Techniques

— Design Build
  — *Shifts risks to contractor*
  — *Allows for innovation in design, particularly in challenging locations*
  — *Provide potential bidders with sites*
  — *Best value*

— Full Delivery
  — *Offer provides complete range of services*
  — *Identify sites*
  — *Obtain permits*
  — *Secure Right of Way*
  — *Conduct monitoring*
  — *Turn over to Agency at completion of monitoring phase*
  — *Can be used for streams, wetlands and reforestation*

Questions?

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