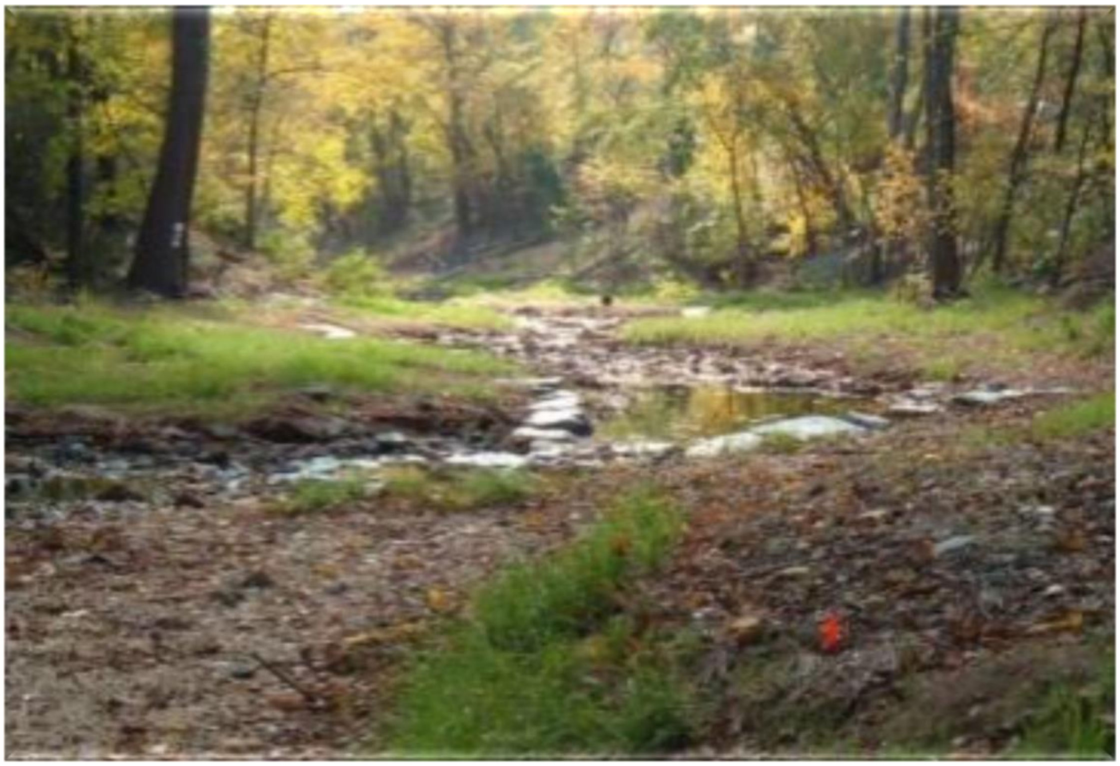
*DRAFT FOR URBAN STORMWATER WORK GROUP REVIEW**

Recommended Methods to Verify Stream Restoration Practices Built for Pollutant Crediting in the Chesapeake Bay Watershed



Submitted By:
Stream Restoration Group 1: Verification

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A Report to the Urban Stormwater Work Group

Date: April 10, 2019

** Changes may be made to memo as a result of final group meeting on 4/11/2019*

A group of experts was formed last year to recommend methods for verifying the pollutant reduction performance of individual stream restoration projects built to meet the Chesapeake Bay TMDL (USWG, 2018). The group met five times and developed the consensus recommendations that are outlined in this technical memo. The memo is organized as follows:

Section 1 Group Charge and Roster

The expert panel report on stream restoration practices was completed prior to the adoption of BMP verification requirements (USWG, 2014 and CBP, 2014). Given the large number of projects constructed since then, there is a critical need for more detailed guidance on how to verify them.

This need has been reinforced by several recent reports and memos developed within the Bay stream restoration community (CSN, 2018a and Wood et al 2018). The charge and membership of a special group to recommend improved guidance was approved by both the Urban Stormwater Work Group and the Stream Health Work Group earlier in the year (USWG, 2018).

The charge for the group is to recommend general guidance on how the private and public sector can verify stream restoration projects in the Chesapeake Bay watershed. More detail on the charge is summarized below:

1. Define what constitutes an adequate as-built drawing for stream restoration projects, who is qualified to do them, and how they are to be used for verification purposes going forward.

2. Decide what, if any, quantitative data collected during project assessment and design should be retained to assist in future verification efforts.

3. Establish visual indicators that can rapidly determine whether an individual stream restoration project is still performing the water quality functions it was originally designed for.

4. Decide whether the condition and quality of the post-construction riparian and floodplain plant community still meets its project objectives over time.

5. Define specific thresholds for project failure that trigger the need for either (a) project repair, (b) follow-up forensic reach investigations or (c) or partial or complete loss of pollutant reduction credits.

Table 1 presents the roster for the group.

Table 1: Membership of Group 1 (Verification)		
Name	*Affiliation*	*E-mail*
Rich Starr	Ecosystem Planning and Restoration	rstarr@eprusa.net
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Group Facilitators: Tom Schueler and David Wood. Chesapeake Stormwater Network		

Section 2 Urban BMP Verification in the Context of the Bay TMDL

The Chesapeake Bay Partnership endorsed a policy that all urban BMPs must be verified in the field to ensure they are still earning their pollutant reduction credit towards the Bay TMDL (CBP, 2014). Verification is needed to ensure that the practices used for pollutant reduction credit in the Bay:

(1) actually exist
(2) are working as intended, and
(3) are maintained properly over their design life.

The broad details of urban BMP verification have been agreed to by the CBP Partnership (USWG, 2014). Each expert panel has recommended a maximum credit duration for each class of BMPs (see Table 2).

The credit duration can be renewed if the BMP is inspected using visual field indicators that confirm the practice is still providing its designed water quality function. Individual states have the responsibility, however, to develop more specific procedures to verify BMPs used for removal credits.

Table 2: Credit Duration Depends on Urban BMP Type

Urban BMP	*Credit Duration (years)*
Stormwater Retrofits	10
New LID Practices	10
Individual Nutrient Discharges	10
Residential Stewardship Practices	5
Urban Nutrient Management Plans	3
Street Cleaning	1
Stream Restoration Practices	5
Source: USWG (2014) and individual EPRs	

General Verification Requirements for Stream Restoration Projects

The urban stream restoration expert panel outlined the broad requirements for verifying reduction credits for individual projects (USR EP, 2013). Further guidance on BMP verification was subsequently approved by the USWG (2013) and specific guidance for stream restoration practices was developed by CWP (2014).

The expert panel acknowledged that most restoration projects undergo monitoring for several years after construction, based on required state and federal permit conditions. Once the original permit expires, however, the panel offered no specific guidelines on how to verify project performance going forward. They did suggest that:

- The installing agency needs to conduct visual inspections once every 5 years (after the original permit conditions expire) to ensure that individual projects are still capable of removing nutrients and sediments.
- The duration of the credit is shorter than other urban BMPs, since these projects are:
    - subject to catastrophic damage from extreme flood events
    - already have requirements for 3 to 5 years of post-construction monitoring to satisfy permit conditions
- If a project does not pass inspection, sponsors have one year to take corrective action before credit is lost.

Some typical requirements for verifying stormwater retrofit and stream restoration practices are compared in Table 3:

Table 3: Typical Verification Requirements

for Stormwater Retrofit and Stream Restoration Projects [1]		
Factor	*Stormwater Retrofits*	*Stream Restoration*
Verification Authority	Legal maintenance agreements w/ owner and MS4 permit	Project permit condition and Bay TMDL reporting agency
Credit Duration	10 years	5 years
Field Inspection	Yes, required under MS4 Permit	Not currently required after construction permit expires
Inspector Qualifications	Trained field techs w/ engineer oversight	Not yet defined, but an approach outlined in this memo
Visual Indicators?	Yes	Proposed in this memo
As-Builts?	Yes	No industry standards (yet)
Required Record Keeping?	Location, plans, past inspections,	Maintain project files, but no other details provided
[1] General comparison only, actual requirements vary among different Bay jurisdictions		

Section 3 Key Principles for Stream Restoration Verification

This section outlines some key principles for how stream restoration projects should be inspected in the Chesapeake Bay watershed in order to verify stream restoration credits. The principles are intended to meet the following objectives:

1. Craft a technically sound field method to assess whether the pollutant reduction function of stream restoration projects continues to be performed over time.

2. Account for inherent differences in restoration design approaches (e.g., NCD, RSC, LSR) and the three crediting protocols, as they are actually applied to individual restoration projects.

3. Establish, going forward, an industry standard for post- construction drawings and/or surveys that can provide critical benchmark data on what should be inspected within the project reach to verify individual stream restoration projects.

4. Develop a rapid, consistent and repeatable method to inspect visual indicators within a project reach against its original design intent to determine whether it is still meeting its water quality function.

5. Provide numeric triggers that define management actions needed to restore project function (e.g., reach passes, is compromised or fails). The triggers, in turn, prompt subsequent project investigations to confirm, reduce or eliminate the original pollutant reduction credit.

6. Enable a two-person crew to inspect a 1,000 ft project reach in less than 4 hours (including time spent on file documentation and reporting)

7. Be developed in an inclusive process that involves stakeholders across the stream community, including regulators, project sponsors, practitioners, researchers, watershed advocates and others.

8. Provide useful data to inform the design and increase the longevity of future stream restoration projects so that we can generally learn from our mistakes and reinforce our successes.

9. Impose reasonable and predictable costs for project sponsors that are consistent with those used to verify other urban BMPs.

10. Provide managers clear direction on how to adaptively manage future stream restoration projects to achieve more reliable pollutant reduction and ecosystem service enhancement.

Section 4 Recommended Inspection Approach

Important Caveat: While the group recommends methods to effectively verify stream restoration practices, state and federal agencies have the discretion to modify them to meet their unique regional, environmental or regulatory conditions.

The group acknowledges that typical urban stream dynamics are such that some design elements within a project reach may adjust or even become compromised over time. These minor changes do not necessarily mean, however, that the entire water quality benefit is lost. Indeed, urban streams experience some "natural" rate of movement, which varies based on the type of stream, its physiographic region, intensity of past watershed development and presence of any legacy sediments. The existing crediting protocols were intentionally designed to be conservative to reflect a certain amount of project adjustment over time.

The basic approach for inspecting stream restoration projects follows the general BMP inspection model developed for bioretention (Scott et al, 2013) and stormwater ponds (Lucas et al, 2016). The approach includes the following elements:

> *Focus on the dominant protocol in the project reach.* If more than one crediting protocol is used on a project, the protocol that provides the greatest contribution to overall nutrient reduction in the project reach should be the one that is assessed.
>
> *A two-stage inspection process is utilized*. The first stage involves a rapid inspection of the project reach to assess BMP condition. Projects are graded on a pass/action needed/fail basis. The guiding rule is that inspectors are looking for <u>severe</u> departures from its intended design that may be compromising pollutant reduction function. Should a project appear to fail, a second forensic inspection is undertaken to diagnose the nature and cause(s) of the problem, and whether project functions can be recovered by additional work.

Trained field technicians rely on simple indicators along the reach to rapidly assess project function in the first stage. The list of indicators is relatively short and emphasizes conditions that are easy to observe (e.g., exposed earth on banks, deep channel incision, etc.) and can be consistently interpreted in the field (see Section 5). In most cases, the field technicians take geo-referenced photos to document problems for quality control purposes. In general, the field technicians will take channel or bank measurements as needed, with locations based on field judgement, plan review or at any pre-selected control stations or monumented cross-sections shown on the plans (see Sections 7).

Numeric failure thresholds for the reach. After initially determining the proportion of the project reach that may be compromised, the field technicians compare their outcomes to numeric thresholds that may predict unacceptable project failure (see Section 6). If project failure is found to be a possibility, then a second forensic investigation by a more experienced stream restoration professional may be needed to confirm the diagnosis

The quality of inspections is greatly improved when inspection crews have access to good documentation on the original project construction. Good post construction documents identify critical areas where future problems might be expected and show control sections, photo stations or monuments along the project reach where key project changes can be reliably measured (e.g., bank height, bank stability, condition of the hyporheic box or reconnected floodplain). Some potential standards for post-construction project documents are provided in Section 7.

Remote unmanned aircraft (drones) could potentially be a valuable inspection tool to help measure visual indicators along a project reach, however, inspection protocols and interpretation have not yet been satisfactorily tested.

Section 5 Indicators to Define Functional Performance

The basic field verification approach utilizes a two-stage inspection process.

The first step involves a rapid inspection of the project reach to assess its condition, relying on simple indicators, as shown in Tables 4 to 6. The basic approach is to walk the entire project reach to assess the dominant restoration crediting protocol. The rapid initial inspection is intended to look for any potential loss of pollutant reduction function in some or all of the project reach.

The guiding rule is that inspectors are looking for <u>severe</u> departures from the intended design that are possibly compromising pollutant reduction functions. While minor problems should be noted for future re-inspection or maintenance, they are not the primary focus of the verification assessment.

Some photos that show what visual indicators look like at problem sites can be found in Figures 1 and 2.

Table 4 Defining Loss of Pollutant Reduction Function for Protocol 1 (Prevented Sediment)

Criteria for Loss	Key Visual Indicators
Evidence of bank or bed instability such that the project delivers more sediment downstream than designed, as defined by exposed soils/fresh rootlets	• Severe bank erosion (bare earth exposed or extreme undercutting) • Departure of more than 20% from average post-construction design bank height [1] • Incising bed (bed erosion resulting in the loss of defined pools and riffles and/or presence of active head cut • Flanking or scour of in-channel structures • Failure or collapse of allowable bank protection practices • Less than 80% ground or canopy cover in the restoration zone [2]

[1] as measured at riffles from the project as-built drawing, preferably from pre-designated control sections established at its most vulnerable locations
[2] depending on the long-term vegetative community objectives established for the project, may be expressed as a measure of exposed surface soil (>20%) or canopy cover (<80%)

Table 5 Defining Loss of Nitrogen Reduction Function for Protocol 2 (Denitrification in the Hyporheic Box)

Criteria for Loss	Key Visual Indicators
Evidence that the reach is no longer fully meeting the design assumptions for expanding the hyporheic box (such as when channel incision reduces access to hyporheic zone)	• Departure of more than 20% from average post-construction design bank height [1] • Observable aggradation in streambed (as measured by embeddedness, loss of riffles or bed heterogeneity or excessive deposition, such as lateral and mid-channel bars) • Less than 80% ground or canopy cover [2] found in the project's designed hyporheic zone [3] • Stream de-watering (lack of any observable baseflow in the stream channel)

[1] as measured at riffles from the project as-built drawing, preferably from pre-designated control sections established at its most vulnerable locations
[2] depending on the long-term vegetative community objectives established for the project, may be expressed as a measure of exposed surface soil (>20%) or canopy cover (<80%)
[3] usually a short distance from the edge of the stream to the top of bank (and occasionally extending into the floodplain). The location of the transects are typically shown on the as-built or project monitoring plan

Table 6 Defining Loss of Pollutant Reduction Function Loss for Protocol 3 (Floodplain Reconnection)

Criteria for Loss	**Key Visual Indicators**
Channel incision or floodplain sediment deposition increases effective bank height, thereby reducing intended annual stream flow volume diverted to floodplain	• Departure of more than 20% from average post-construction design bank height [1] or presence of active head cuts • Features used to divert flows to or from floodplain are obstructed and no longer work • No evidence of floodplain retention, as signified by a lack of sediment deposition, terraces, wrack-lines or leaf clumps in floodplain • Unable to meet intended wetland or tree canopy cover targets with the project floodplain [2]

[1] as measured at riffles from the project as-built drawing, preferably from pre-designated control sections established at its most vulnerable locations.
[2] measured from the edge of the stream across the reconnected portion of the floodplain, as shown in the as-built drawing or project monitoring plan. Cover is expressed as the fraction of exposed surface soil in the designed habitat area, and if the designed vegetative community allows for it, tree canopy cover.

Figure 1: Visual Indicators Showing Failures in the Field for Protocol 1

Exposed Soil on Banks

Extreme Undercutting

Outflanking of Instream Structures

Bank Armoring Collapse

Photo sources: clockwise from upper left, Tim Schueler and Josh Running

Figure 2: Visual Indicators Showing Failures in the Field for Protocols 2 and 3	
In prep—need good photos from group	*In prep—need good photos from group*
Protocol 2 indicator	Protocol 2 indicator
In prep—need good photos from group	*In prep—need good photos from group*
Protocol 3 indicator	Protocol 3 indicator
Photo sources:	

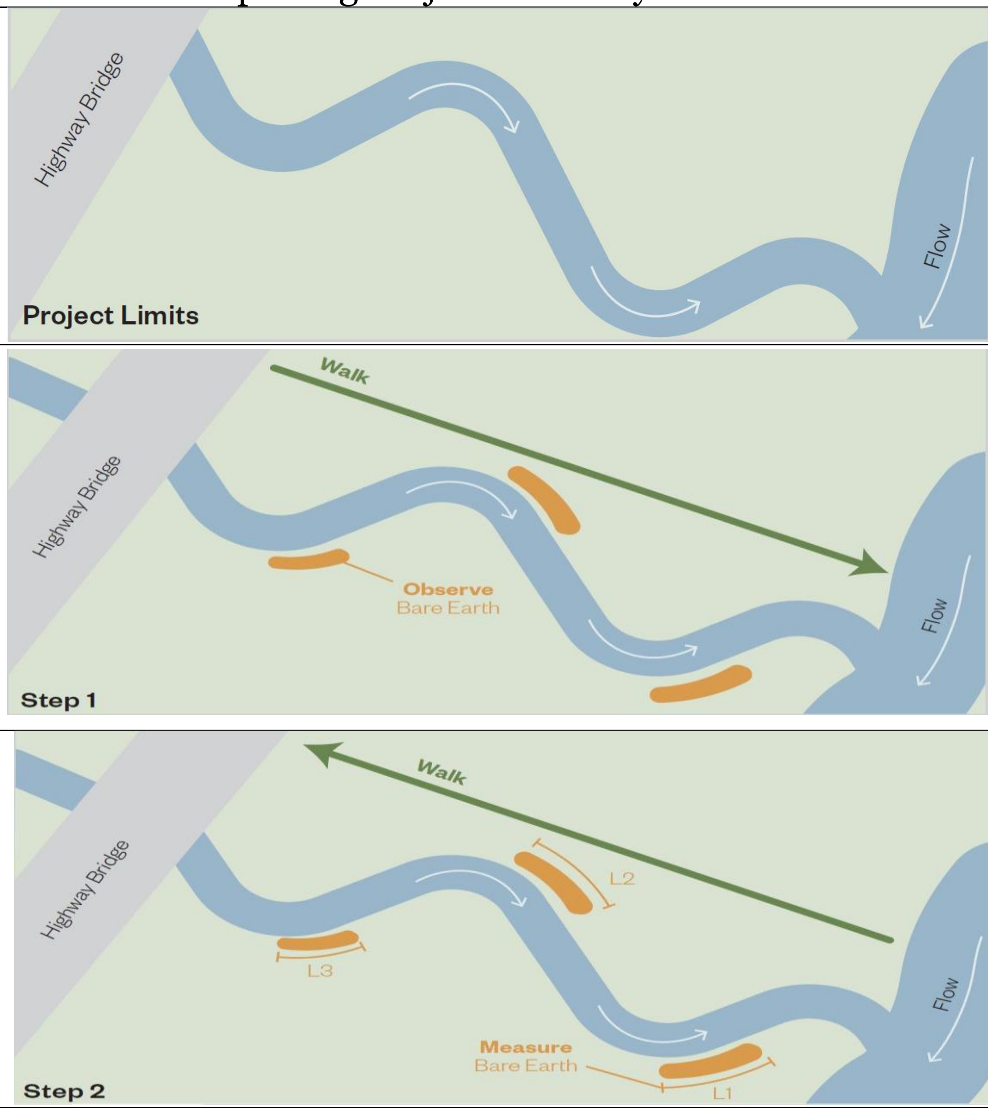
Project Fieldwork for Protocol-Specific Rapid Verification Inspections

The next step is to rapidly determine the proportion of the project reach that is compromised, based on the visual indicators. Each of the protocols has its own unique work flow to inspect and verify the stream restoration project, as shown in Figures 3 to 5.

Should a potential "fatal project flaw" be discovered during any inspection leg, the field technicians should document it with geo-referenced photos and share them with a more experienced stream assessor. The group defined a fatal flaw as a "systematic problem that does not trigger failure now, but could potentially compromise the entire reach in the near future."

If the stream assessor concurs that the reach appears to be compromised or contains a fatal flaw, they can return to the site to conduct a second, more in-depth forensic inspection to determine what additional work may be needed.

Figure 3:
Fieldwork for Inspecting Projects to Verify Protocol 1 Performance

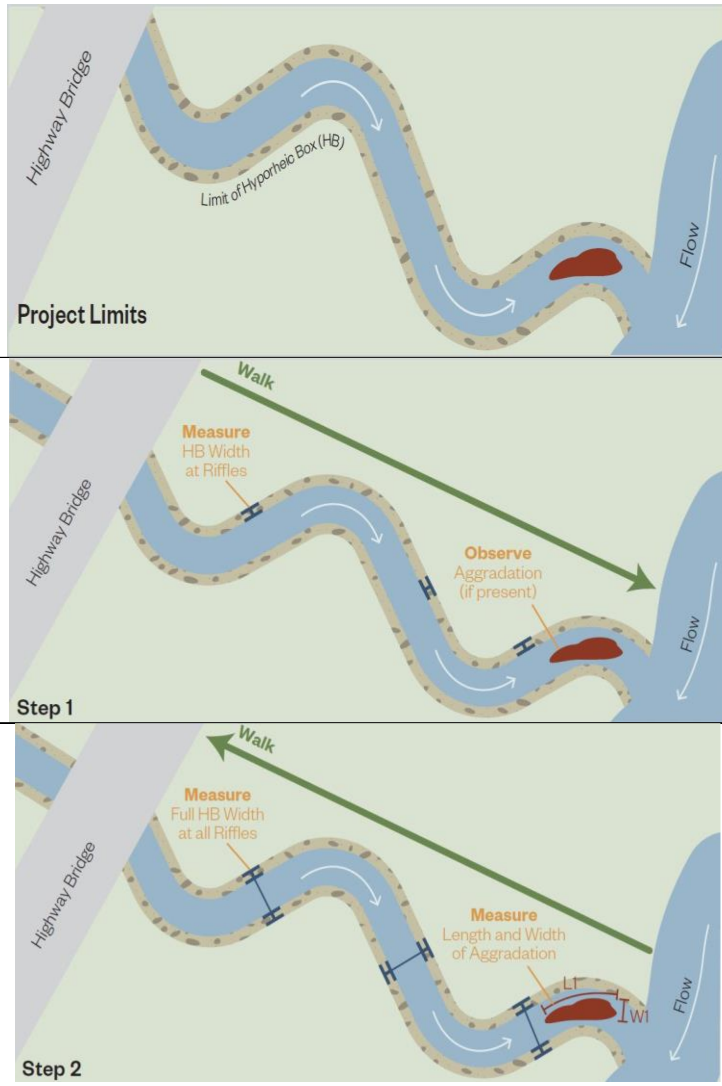


The project reach is walked in an "out and back" manner. In the "out" leg (Step 1), the crew rapidly assesses the visual indicators established for Protocol 1, and temporarily flags any location where more detailed measurements need to be taken.

If problems are encountered, more detailed measurements are taken in the "back" leg of Step 2. The crew may measure bank height, exposed soil cover, tree canopy cover or the linear extent of any problem areas (e.g., eroding bed or banks)

Photos are taken to document any suspected problem areas and at any pre-defined cross-sections or photo-stations shown on the project drawings.

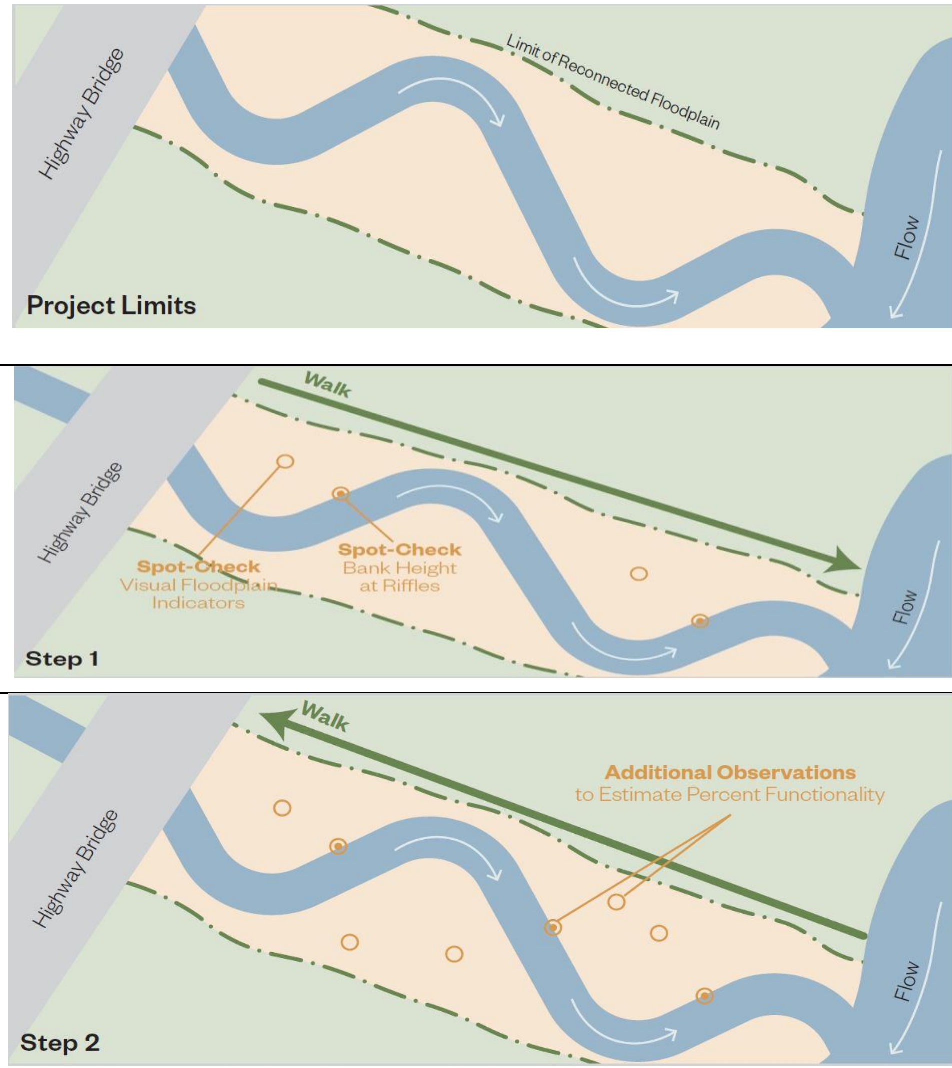
Figure 4:
Fieldwork for Inspecting Projects to Verify Protocol 2 Performance



The rapid survey uses the same general "out and back" method used for protocol 1, but emphasizes the condition of the hyporheic box within the project limits. The crews:

- Inspect riffles for indicators that show diminished streambed quality
- Measure current bank height at pre-designated stations shown on project as-built or project monitoring plan.
- If no stations are designated, then geo-document the desired bank height measurement.
- Inspect the box from edge of stream to top of bank approx. every 100 to 200 feet of channel riffles.
- The box transect may extend further into the floodplain for certain reconnection projects.
- Shorter projects may need to assess the condition of the box over shorter intervals (e.g., 50 ft).

Figure 5:
Fieldwork for Inspecting Projects to Verify Protocol 3 Performance



The rapid survey combines the same "out and back" reach assessment with an inspection of the reconnected or restored floodplain within in the project limits.

Spot checks may also be conducted across the floodplain to confirm the reconnection and assess its visual indicators.

The crew may also choose to assess Protocol 2 indicators to determine if channel incision is compromising the project.

Section 6: Thresholds for Defining Management Actions

The project is analyzed to determine if the degree of change, relative to the original design, is severe enough to warrant management action. All stream restoration projects fall into one of three possible categories:

Functioning (Pass),
Showing Major Compromise (Action Needed)
or Project Failure (Fail), as shown in Table 7 below.

The group deliberately made the categories non-overlapping so there would be room to judge the entire system as a whole. The method for calculating the percentage of the project reach in poor condition for each protocol is described in Table 8.

Table 7:
Framework for Relating Reach Conditions to Management Decisions

Status	*% Failing*	*Inspections*	*Management Actions*
Functioning or Showing Minor Compromise	0 to 10% of project reach	Re-inspect in 5 years	None Needed Credit Renewed for 5 Years
Showing Major Compromise	20 to 40% of project reach	Conduct immediate forensic investigation to identify cause(s)	Re-do channel analysis to evaluate energy conditions
Project Failure	50% or more of reach	Lose credit and abandon the project or reconstruct a new stable channel	

If the rapid reach assessment indicates the need to lose or reduce credit, the owner or sponsor can respond with several management options, such as:

(a) Intensive forensic investigations
(b) Project maintenance/repairs
(c) Reduction in pollutant crediting
(d) Project abandonment (and full loss of credit).

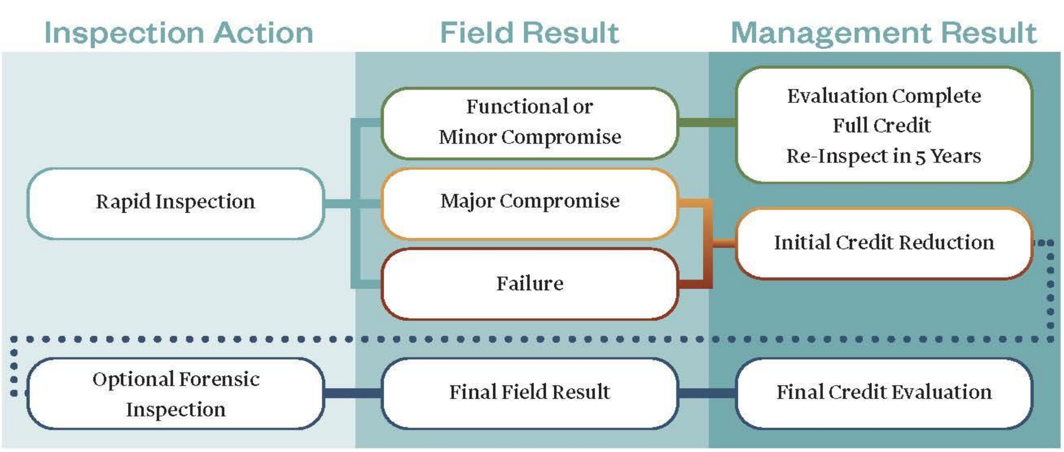
Figure 6 presents a flow chart that outlines the process for making management decisions when a project exceeds its given thresholds.

Table 8
Examples of how Percent Failure is Defined Along a Project Reach for Each Protocol

Protocol 1	Protocol 2	Protocol 3
A. Define Restored Banks Over Reach Length[1]	*A.* Define Hyporheic Zone Over Reach Length[2]	*A.* Define Area of Reconnected Floodplain[3]
Example: 1000 ft reach has 2000 LF of restored banks	*Example: 1000 ft reach has 400 LF of reconnected hyporheic zone, both banks would be 800 LF*	*Example: 1000 ft reach has reconnected floodplain on right bank by an additional 10 ft, and additional 20 ft on the left bank = 30,000 ft²*
B. Estimate Total Impaired Reach Length, for all indicators [4]	*B.* Estimate Length of Impaired Hyporheic Zone, for all indicators [5]	*B.* Estimate Length/Area of Diminished Connection [6]
Example: 100 ft of right bank and 50 ft of left bank are compromised, for a total of 150 ft *(150/2000=7.5%)*	*Example: 100 ft of tight bank and 300 ft of left bank are compromised, for a total of 400 ft* *(400/800 = 50%)*	*Example: 300 LF of right bank and floodplain have washed out and are now exposed soil (3000/30,000 =10% of floodplain and 300/2000 = 15% of stream) Total = 25%*
C. Compute Percent Function Loss Over Reach and Compare to Decision Thresholds in Table 7.		
Functioning or showing minor compromise	*Project Failure*	*Showing Major Compromise*

[1] Restored bank length can be up to two times greater than the restored reach length
[2] Length of the hyporheic box along the channel from its initial disconnection extending downstream until connection is resumed, excluding bedrock sections,per design.
[3] Area of floodplain with new or increased reconnection with the channel, per design
[4] Calculated by dividing estimated linear feet of eroding/bare earth by the linear feet restored banks (e.g., 400 feet of eroded bank observed over a 1,000 feet restoration project would be 400/2000=20%).
[5] Done in the same general manner as Protocol 1
[6] Can be measured as % bank height length exceeding design tolerances or % floodplain area not vegetated or otherwise connected

Figure 6: Flow Chart Relating Inspection Results to Management Actions



Section 7 Standards for Post-Construction Project Documentation

Better project documentation is essential to support future verification efforts for stream restoration practices. In general, project sponsors usually require one of three kinds of construction documentation, depending on the era in which the project was constructed:

1. Design Drawings: projects without any sort of "as-built" or other construction documentation rely on original design drawings.
2. "Red line": Copy of design plans w/ info pertaining to installation of actual work documented by the contractor, engineer, third party or some combination thereof.
3. Professionally surveyed as-built: Surveyor conducts a topographic survey for the completed project, tied to the original design datum
4. Project monitoring plan: a narrative plan that guide post-construction monitoring activity at individual restoration projects before and after its permit expires. For a good example, see Appendix C.

The original expert panel outlined some minimum record-keeping requirements for stream restoration projects (USR EP, 2013):

- "The installing agency should maintain an extensive project file for each stream restoration project installed (i.e., construction drawings, as-built survey, credit calculations, digital photos, post construction monitoring, inspection records, and maintenance agreement).

- The file should be maintained for the lifetime for which the load reduction will be claimed"

The group recommends adopting industry "best practice" standards for post construction plans and documents to support more rapid and cost-effective verification inspections in the future.

- Depending on the project design, all post-construction plans should clearly demarcate the following features:

  - Locations and extent of the restored banks and riffles
  - Design limits of the hyporheic box and/or reconnected floodplain, if used
  - Locations and elevations for bank height measurement stations
  - Any other locations for bank pins, random checks of floodplain or hyporheic box, or vegetative cover plots needed to evaluate the project (see Figure 7).

- Post-construction plans should identify fixed photo stations or cross-sections along the project reach. If possible, these should be monumented at reach locations to facilitate measurement. Designers should emphasize vulnerable reaches, if they occur, that are subject to high energy conditions or stream corridor project constraints.

- While it is desirable to focus on fixed sections, failure can occur at any point along a project reach. Consequently, it is important to inspect the entire project reach during this rapid stream assessment. Geo-referenced digital photos should be taken at all areas where problems are observed or suspected.

- The design objective(s) for each stream restoration project should be clearly and concisely referenced in project construction documents. This information provides future inspectors with a better sense of the goals and objectives that the project was intended to solve (especially when they are numeric or quantitative).

- Designers and owners should retain data on the original project design that can assist in future forensic investigations. Some examples might include BANCs data such as BEHI/NBS scores, channel plans, cross-section and profile views, and any groundwater or well data collected as part of the initial project assessment.

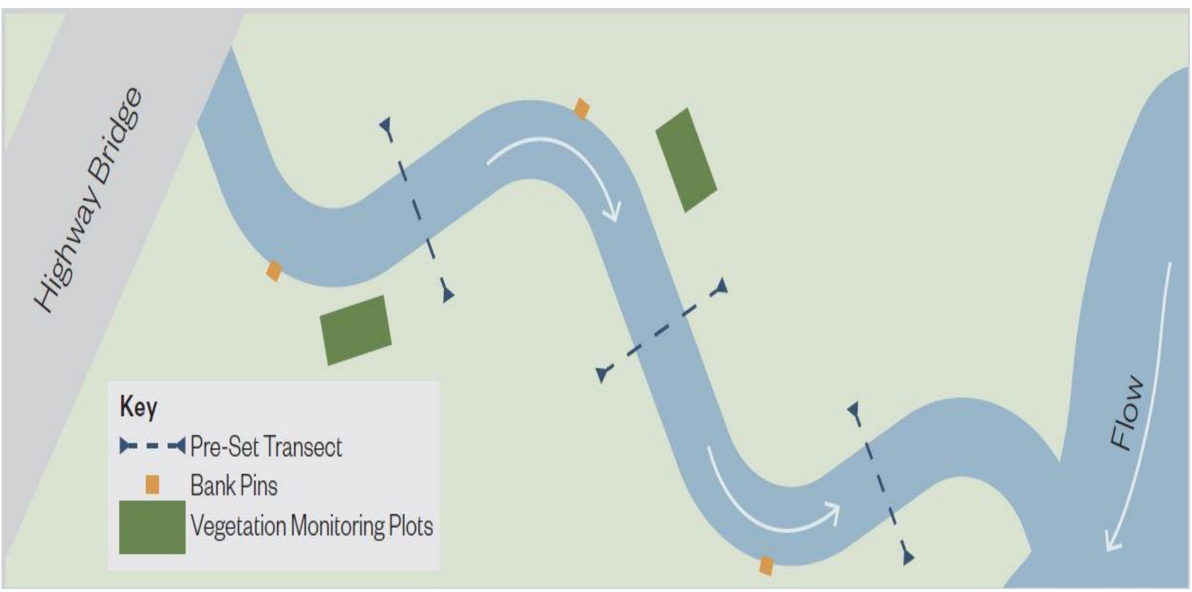


Figure 7: Concept of how key protocol data is shown on post-construction project plans

Section 8 Sample Tracking Systems to Verify Projects

The group agreed that it was important to establish good systems to track inspection data over time to make better management decisions for individual projects. Several examples drawn from the public and/or private sector show effective ways to keep track of stream restoration project data.

The first approach relies on a simple spreadsheet template to track critical points of potential vulnerability along the project reach. Appendix B documents how spreadsheets could be used to store and analyze inspection data for a typical project designed using Protocol 1).

A second approach relies on parts of existing stream assessment tools, such as the Rapid Stream Restoration Monitoring Protocol (USFWS, 2014). Geomorphic and channel data collected as part of this rapid method can quantify several visual indicators. As with the previous method, a spreadsheet has been developed to track project assessment data collected using the rapid protocol (See Appendix B for a spreadsheet for managing stream assessment data).

The third approach involves a concise project monitoring and maintenance plan. A good example of a real-world stream restoration project plan is provided in Appendix C. The plan outlines the project goals and objectives, as well as the schedule, map and procedures for field monitoring and long-term maintenance.

The fourth approach involves an asset management system developed by Fairfax County, Virginia. Stream restoration projects are tracked by the public works maintenance division that already oversees other stormwater features (such as wet ponds, extended ponds, green infrastructure and outfalls). Easements are in place prior to construction to have continued access and maintenance responsibility in perpetuity, especially for features that are not owned by the County.

Projects are tracked as built infrastructure and receive 5- year monitoring. Maintenance systems were developed for other stormwater assets and adapted for use for stream projects. Given the complicated nature of stream projects, the maintenance process was upgraded to a two-stage monitoring. With the first level monitoring being conducted by field staff to observe and document. No action decisions are made without further review by subject matter experts including ecologists, landscape architects, engineers and construction experts, which may or may not require additional measurement.

A simple reference card for each feature which includes many of the details outlined elsewhere, allow for ready access to project construction details. As-builts, planting plans and construction documents are also archived. A geo-referenced scorecard is housed in a GIS database will allow project tracking through time. The template for a stream maintenance score card is provided in Appendix D, as well as a prototype for an individual project.

Section 9 Suggested Environmental Assessment Resources

Long-term reach monitoring is often required as a permit condition (which can vary among state agencies) but no specific monitoring is currently required for purposes of Bay credit verification (i.e., after the construction permit expires and the stream restoration project has been accepted by the appropriate agency). Some recent research has shown that poorly designed stream restoration projects can have unintended consequences for some stream parameters, and may not always achieve desired levels of functional uplift.

The original expert panel strongly endorsed the need to show functional uplift for stream projects primarily built for pollutant reduction credit (USR EP, 2103). They generally recommended the stream function pyramid developed by Harman et al (2011) as the preferred method to define functional uplift for individual stream restoration projects (see Table 8). The panel, however, did not make any recommendations on the specific parameters or number of pyramid levels that should be sampled before and after projects are constructed. This omission has created some confusion among sponsors, designers and regulators as to what exactly is expected when it comes to post-permit project monitoring.

A Scientific and Technical Advisory Committee (STAC) workshop was held that developed a general framework for defining how functional uplift may be assessed for stream projects implemented for the Chesapeake Bay TMDL (Law et al, 2015). Key to assessing stream restoration project functional lift is understanding the project goals and objectives such that project expectations correspond with the intended project outcomes and the extent to which stressors impact stream health. For example, a project designed to address stressors affecting stream stability, higher level functional restoration may not be achieved.

The CBP Stream Health Work Group (SWHG) has defined a need to develop guidance to implement the recommendations of the STAC workshop that address this gap through the identification of practicable metrics to assess a full suite of stream functions, adding to those identified in this report. The intent of such guidance is look at individual projects at their potential to restore stream health, rather than singular functions. The verification group strongly endorses their efforts, particularly given how many hundreds of miles of stream restoration projects are currently in the pipeline.

Table 8 Recommended Stream Assessment Resources to Define Functional Uplift
Some important resources include: Harman et al. 2011. A function-based framework for developing stream assessments, restoration, performance standards and standard operating procedures. U.S. Environmental Protection Agency. Office of Wetlands, Oceans and Watersheds. Washington, D.C. Starr, R., W. Harman and S. Davis. 2015. Function-based rapid stream assessment method. CAFÉ S-15-06. Chesapeake Bay Field Office. U.S. Fish and Wildlife Service. Annapolis, MD. See also further work by Starr et al (2015) and Starr and Harman (2016) and the US EPA Rapid Bioassessment Protocol (RBP)

Section 10 References

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Technical Appendices

Appendix A Template for Chesapeake Bay Nutrient Removal Credit Verification

Appendix B Spreadsheet for Storing Rapid Stream Monitoring Protocol Data

Appendix C Example of Monitoring/Maintenance Plan (River Run SRP)

Appendix D Fairfax County Stream Restoration Scorecards