West Virginia Nonpoint Source Program: Natural Stream Channel Design & Riparian Improvement Project Monitoring Protocol

Prepared for:

West Virginia Department of Environmental Protection Nonpoint Source Program

2006

Table of contents

Note: The procedures Quality Assurance Project Plan (QAPP) is available upon request.

WV Dept. of Environmental Protection
Nonpoint Source Program
601 57th Street, SE
Charleston, WV 25304

http://www.dep.wv.gov/nonpoint

Note: The survey data sheets have been modified since the writing of the original protocols in 2006. There are slight differences from the examples provided within the manual and the new data sheets.

Introduction

WV's Nonpoint Source Program (NPS) funds projects that focus on preventing water pollution from diffuse sources such as erosion from runoff and eroding streambanks. In addition NP funds projects that attempt to restore water quality to streams impaired by nonpoint pollution. Many projects focus fully or in part on stabilizing eroding streambanks. Monitoring is an essential component of stream restoration because it allows stakeholders to see what progress is being made, provides load reduction estimates and provides information on the types of restoration that can best achieve goals. However obtaining quantifiable results from streambank restoration projects has been difficult. There is a wide range of monitoring techniques to document erosion or sedimentation but often they focus on other activities such as agriculture or are intended to provide data for project design not environmental results. A monitoring protocol to address the data needs of the NPS while considering the limited resources of the program was needed. The following monitoring system is a combination of other proven techniques modified for the special requirements of the NPS. This protocol is a combination of photo point documentation, a volume assessment of bank loss, pebble count and the Bank Erosion Potential Rating.

Objectives

The overall goal of this protocol is to provide quantifiable environmental results for projects implementing natural designed streambank stabilization projects. These reports are important for evaluating the level of impact such projects have.

The sub-objectives of this monitoring are:

- Evaluate the erosion risk potential of banks in order to set priorities for streambank stabilization projects.
- Determine the tons per year of soil loss from eroding streambanks. This involves the establishment of baseline conditions and then comparison of later conditions for environmental results.
- Determine changing/improving conditions in streambed habitat.
- Record photographic evidence of improving conditions.
- Provide a protocol that can acquire these results with available staff, resources and training.

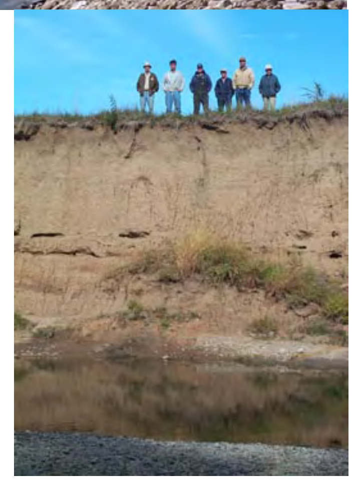
Project and landowner information

A good record of project and landowner information is necessary to accurately track a project's success. Collect as much contact information as possible including: phone numbers, physical address, mail address and email. All projects should have signed landowner permission before requesting funding. If monitoring on a site that is not a project use publicly accessible area or acquire landowner permission. A GPS unit should be used to record the project's latitude and longitude. Set the GPS unit to the datum North American Datum 1983 (NAD83) and record the coordinate in degrees, minutes and seconds.

Photo point documentation

Photographs provide a qualitative record of conditions and documentation of a project's success. Photographs can be used to document the general condition of a stream reach over time (see cover). Photographs can be critical additions to reports or for public relations to promote natural stream bank stabilizations. For each project reach record information at a minimum of three photo points.

A photo point is position where photographs are taken at the same position, angle and bearing over time. To set the points of view stand at spots you can easily find later or set markers that will not be disturbed. When taking the photo try to include landscape features that are unlikely to be changed or affected by the restoration project. These could include buildings, trees or mountain peaks. One of the photo points should be taken to include the long view, which is the view down or up the project reach. One of the photo points should include the medium view or close up view of the worst erosion site or structures and plantings. When taking the close up shots it is helpful to include in the photo something that will provide scale and perspective to the bank or structure (right). One or more photo points should be at the bank pin/cross sectional location.



Take photos immediately before and after the project construction or planting. Long term monitoring should allow for at least five years of annual photography. From the five to 10 year period take photos every two years. Photos should be taken at roughly the same time of year and at roughly the same flow conditions.

It is important to be able to find the photo point as well as points where reference bank pins were set. If the landowner approves a semi-permanent marker can be set. If that's not possible then all photo and reference points should be mapped with latitude and longitude readings taken. Sometimes it may be necessary to triangulate a point. To do this temporarily mark the point or have someone stand on the point. Find a permanent feature that will not be disturbed by the project or any other activity. Stand at that point with a compass to take and record a directional reading and measure the distance to the point. Then repeat this at least one more time from a different location, it is preferable to get three readings.

Record the photos taken in the photo log. Briefly describe the location of each photo point. Then record the date of each photo and a brief description. After downloading the photos the file designation should be recorded or the filename changed to reflect the subject.

PHOTOGRAPH LOG

Project/Landowner Information				
Stream name			Latitude	Longitude
Landowner name				
Landowner address				
Phone:		E-mail		
Survey completed by				
Notes				

Photo Information Location 1				Photo descriptions
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Photo Information Location 2				Photo descriptions
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Photo Information Location 3				Photo descriptions
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		

Sediment measuring methods

EPA Region 5 Bank Stabilization Model

The easiest and least time consuming method of estimating stream bank erosion rates available is the EPA Region 5 Bank Stabilization Model. This model uses height of bank, length of bank, soil type and a rating of slight to very severe with different lateral erosion rates assigned to each adjective. Each adjective has a written description, which the user can easily determine what category or categories the project reach falls into. This model can be used when the technician does not have sufficient pre-project time to set bank pins. This model should be used primarily when developing watershed based plans and project proposals or on sites where pre-project monitoring did not occur. This model was developed on stream bank data collected by the Illinois EPA and the Michigan DEQ. It is unknown how this data compares to West Virginia data. It is preferable to use the bank pinning method to determine pre and post project erosion rates.

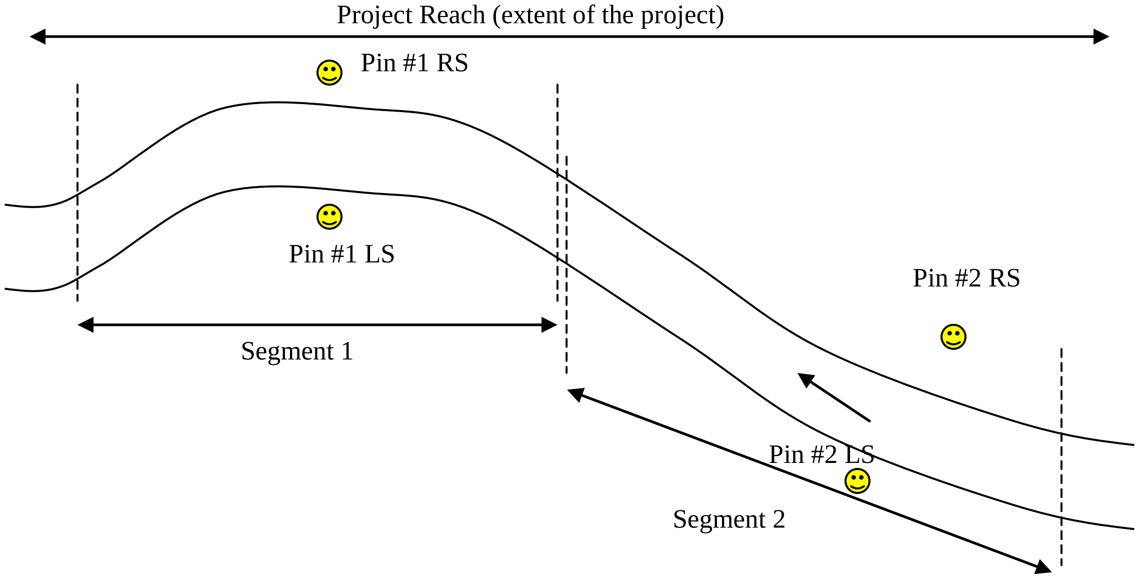
EPA Region 5 Model Ratings		
(ft/year)	Category	Description
0.01-0.05	Slight	Some bare bank but active erosion not really apparent. Some rills but no vegetation overhangs.
0.06-0.2	Moderate	Bank is predominately bare with some rills and vegetative overhang.
0.3-0.5	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some change in cultural features such as fence corners missing and realignment of roads or trails. Channel cross section becomes more U shaped as opposed to V shaped.
0.5+	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross-section is U shaped and stream course or gully may be meandering.

Steffen, L.J., 1982. (Pollutants Controlled Calculation and Documentation for Section 319 Watershed Training Manual).

Bank Pinning

For each project reach install an appropriate number of bank pins at locations that have different characteristics. Each pin will be the permanent reference point for the segment that exhibits that characteristic that differentiates it from other segments within the reach. Certain projects may require the bank pins to be moved during construction or at landowner request. Take measurements from the pin to several permanent features to replace the pin after construction. In some cases the project will only affect one bank where one bank is stable (for example a cliff) only the eroding bank needs assessment.

Example of project reaches with differentiated segments



At each pin measure a bank profile, this will involve 6 measurements. If possible stretch the measuring tape across the stream and attach to the far bank in as level position as possible. Place the rod at the base of the bank where the slope changes from steep to gradual.

- Take and record the following measurements:
    1. Pin to rod
    2. Top of bank to rod (TB to rod)
    3. Mid-bank to rod (MB to rod)
    4. Bottom of bank to rod (BB to rod)
    5. Rod to thalweg (rod to TW)
    6. Top of bank to stream bed (TB to SB, bank height)
- Measure the length of bank that has the characteristics of that segment.

In taking measurements of the bank it is critical to hold the rod as vertically level as possible.

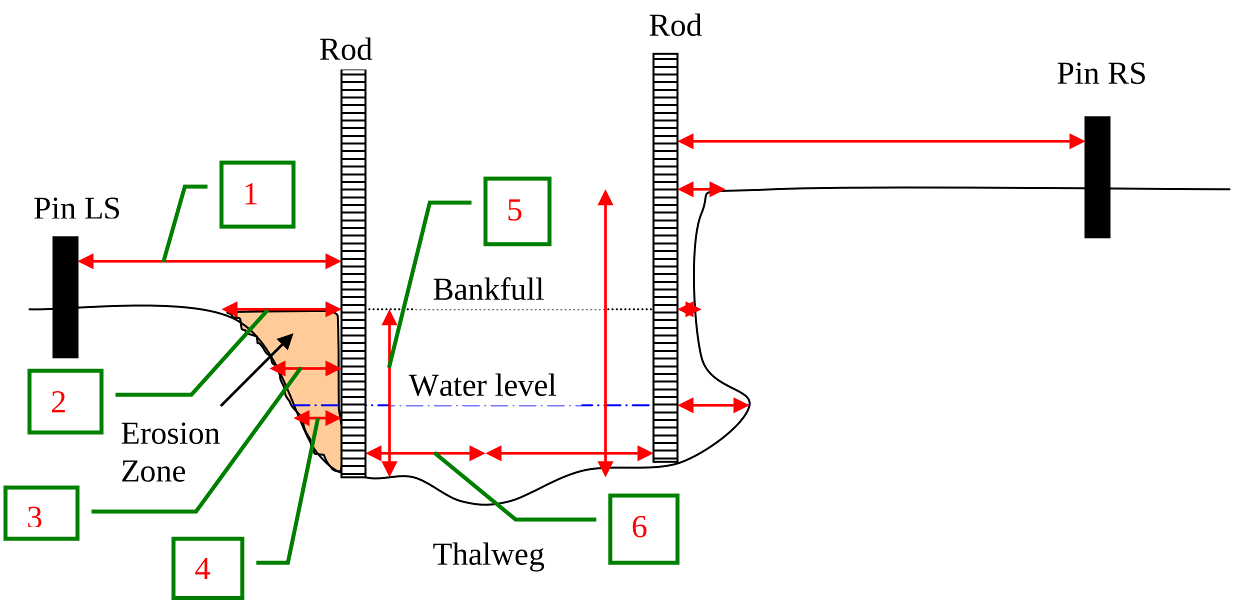
Average the three banks to rod measurements then multiply that number by the bank height. Take that number and multiply by length of the segment to get the volume of sediment. At the next assessment set the rod at the same distance from the pin as the previous time. Follow the above procedure then subtract the first volume from the second one. Divide this total by the time frame to get the erosion rate. For example you get the following three measurements: 1.5 ft for TOB, 1 ft for MB and .5 ft for BB that averages to 1 ft. The bank height measurement was 2 ft, which when multiplied by the average bank measurement will give an area of 2 ft^2. If the length is 100 ft multiply that by 2 ft^2 for a total erosion zone of 200 ft^3. Let's say that six months later you get a total erosion zone of 300 cubic feet. The difference is 100 cu ft now divide that by 0.5 yr to get 200 cu ft/yr.

In order to obtain an adequate assessment of the erosion problem and sediment load estimate two bank profiles should be done prior to the project starting at least six months apart. The first assessment is the baseline and the second one will provide the difference from the baseline that when divided by the time frame will give the amount of soil loss. If inadequate time is available before construction then use the Region V model to estimate pre-project loads. Do another assessment after the project has been constructed, which because of the altered bank profile will be a new baseline. Do other assessments as the vegetation takes hold. The optimal time to re-measure the profile is a year or more. The minimal time between measurements is six months.

Measure the bank profile immediately before and after the project construction. Long term monitoring should allow for at least five years of annual measurements. From the five to 10 year period take measurements at a two-year interval.

Obtaining the mid-bank measurement

Surveying a bank profile



Measurement ⟷
1. Pin to rod 2. TB to rod 3. MB to rod 4. BB to rod 5. TB to SB 6. TW to rod

Initials	
LS – Left Side facing downstream	
RS – Right Side facing downstream	
U/S – Upstream	D/S - Downstream
TW – Thalweg	
MB – Mid Bank	BB – Bottom of Bank
TB – Top of Bank	SB – Stream Bed

Equipment needed:

100 meter tape measure
Camera
Compass

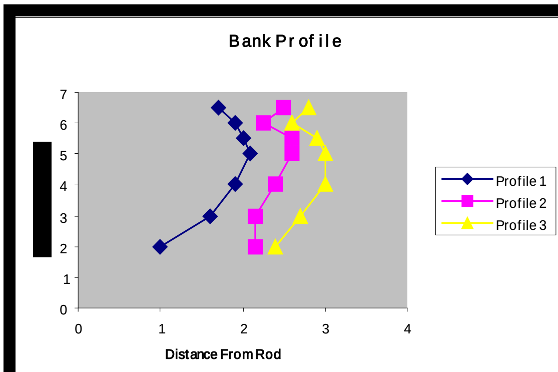
Surveyor's rod
Rebar & hammer
Clipboard, calculator & pencil

Example

Cross Sectional Measurements

Bank Pin Location 2				250' from U/S start of project reach		
	Pin distance from U/S pin	120'		Bank segment length	110'	
	Left Side Pin				Right Side Pin	
Date:	7/13/05			Date:	7/13/05	
Measurement	Distance	Notes		Measurement	Distance	Notes
Pin to rod	25'			Pin to rod	36'	
TOB to rod	3.2'	bankfull		TOB to rod	.8'	
MB to rod	1.8'			MB to rod	.5'	bankfull
BB to rod	.6'			BB to rod	1.3'	undercut
Rod to TW	5.3'			Rod to TW	7.2'	
TOB to SB	6.2'			TOB to SB	10.2'	
Date:	7/13/06			Date:	7/13/06	
Measurement	Distance	Notes		Measurement	Distance	Notes
Pin to rod	25'			Pin to rod	36'	
TOB to rod	5.3'	bankfull		TOB to rod	4.2'	
MB to rod	2.6'			MB to rod	3.4'	bankfull
BB to rod	.8'			BB to rod	2.1'	No undercut
Rod to TW	5.5'			Rod to TW	7.0'	
TOB to SB	6.2'			TOB to SB	10.2'	

Bank Profile



Left: This series of bank profiles taken from Sand Fork from November 2005 to July 2006 illustrates the severe erosion of that bank and the formation of an undercut bank.

Total Reach Bank Erosion Calculations

Load Reduction Results

Example

Project	Whatamess Creek Streambank Restoration				
Pin #	2 LS	Date	7/13/05		
Measurement	Erosion Area (ft)		Bank Height (ft)	Section Length (ft)	Total Erosion (cu ft)
TB to rod	3.2				
MB to rod	1.8				
BB to rod	.6				
Averaged Width	1.86'		6.2'	110'	1273.1
Divide Total Erosion by 27 cu ft/cu yd = Total Erosion in cu yards					47.15
Multiply Total Erosion by 1.3 = Total Erosion in tons					61.3
Time Frame (years)	0	Total Erosion in tons/year			

One year later:

Project	Whatamess Creek Streambank Restoration				
Pin #	2 LS	Date	7/13/06		
Measurement	Erosion Area (ft)		Bank Height (ft)	Section Length (ft)	Total Erosion (cu ft)
TB to rod	5.3				
MB to rod	2.6				
BB to rod	.8				
Averaged Width	2.9		6.2'	110'	1977.8
Divide Total Erosion by 27 cu ft/cu yd = Total Erosion in cu yards					73.25
Multiply Total Erosion by 1.3 = Total Erosion in tons					95.2
Time Frame (years)	1	Total Erosion in tons/year			33.9 t/y *

* To get total erosion in tons/year subtract the previous assessment's "Total Erosion in tons" from the latest assessment and divide by the time frame in years.

Pebble count method

The composition of the streambed and banks is an important facet of stream character, influencing channel form and hydraulics, erosion rates, sediment supply, and other parameters. Each permanent reference site includes a basic characterization of bed and bank material. For studies of fish habitat, riparian ecosystems or stream hydraulics, the characterization of substrates and bank materials may require greater detail than can be covered here.

Observations tell us that steep mountain streams with beds of boulders and cobbles act differently from low-gradient streams with beds of sand or silt. You can document this difference by collecting representative samples of the bed materials using a procedure called a pebble count.

The most efficient basic technique is the Wolman Pebble Count. This requires an observer with a metric ruler who wades the stream and a note taker who wades or remains on the bank with the field book. Particles are tallied according to size classes in the appropriate habitat categories listed in the columns. Pebble counts can be made using grids, transects, or a random step-toe procedure.

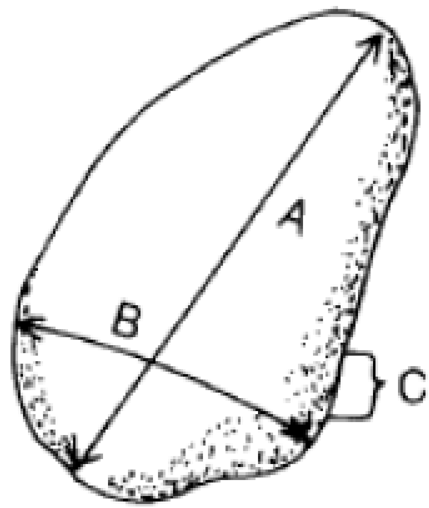
Collection Procedure

Stretch out the tape the length of the segment being assessed. For stream characterization you should set up a sampling grid with a transect every 10% of the reach. For example, in a 100-meter reach your transects would be set every 10-meters. Take ten samples at each transect to measure a minimum of 100 particles to obtain a valid count. Use a data sheet to record the count.

1. Start the transect at one of the bankfull elevations (not necessarily the present water level).
2. Averting your gaze, pick up the first particle touched by the tip of your index finger at the toe of your wader.
3. Measure the intermediate axis (neither the longest nor shortest of the three mutually perpendicular sides of each particle picked up) (Figure 1).
4. Measure embedded particles or those too large to be moved in place. For these, measure the smaller of the two exposed axes.
5. Call out the measurement. The note taker tallies it by size class in the habitat column and repeats it back for confirmation.
6. Take one step across the channel that approximates 1/10th the width of the channel (bankfull to bankfull) in the direction of the opposite bank and repeat the process. Traverse across the stream perpendicular to the flow.
7. Continue your traverse of the cross-section until you reach an indicator of bankfull stage on the opposite bank so that all areas between the bankfull elevations are representatively sampled. You may have to duck under bank top vegetation or reach down through brush to get an accurate count.
8. Move upstream or downstream at the predetermined distance and make additional transects to sample a total of at least 100 particles.
9. The note taker keeps count.

Note: on rivers and large creeks it may be necessary to stretch a tape across the stream in order to approximate 1/10th the width of the stream. In such streams it may be advisable to record more than 100 samples.

Figure 1. Axes of a pebble



A. Long axis
B. Intermediate axis
C. Short axis

Equipment needed:

2 100 meter tapes
Sand card
A clear ruler with millimeters
Clipboard & pencil

Calculations to be made:

Habitat percentages: Count the total number sampled in each column (riffle, run and pool) then divided by the total sampled. This is an estimate of the composition of habitat types within the segment.

D_{50}: This is the mean of particle sizes sampled. Tracking the D_{50} should show improvements in the streambed composition that results from less sediment.

Percentage of fines: This is a calculation of the number of sampled particles that are 2mm or less (sand and silt) against the total number of sampled particles. Add all the particles sampled in the sand and silt classes and divide by the total particles sampled then multiply by 100. This is a measurement of sediment, by percentages, in the stream. Tracking this will provide an environmental result of changes in sediment deposition.

Example

Pebble Count Data Sheet

<table>
<tr><th>Project/Segment</th><th colspan="2">Whatamess Creek #2</th><th>Date</th><th>7/13/05</th></tr>
<tr><td rowspan="2">Materials</td><td rowspan="2">Size ranges (mm)</td><td colspan="3">Count</td></tr>
<tr><td>Riffle</td><td>Run</td><td>Pool</td></tr>
<tr><td>Silt/clay</td><td>< 0.06</td><td></td><td></td><td>|||</td></tr>
<tr><td>Very fine sand</td><td>0.06 – 0.125</td><td></td><td></td><td>||||| |</td></tr>
<tr><td>Fine sand</td><td>0.126 – 0.25</td><td>|||</td><td>||||| |||</td><td>|||||</td></tr>
<tr><td>Medium sand</td><td>0.26 – 0.5</td><td>|</td><td>|||</td><td>||</td></tr>
<tr><td>Coarse sand</td><td>0.5 – 1</td><td>||||| ||||| |||</td><td>||||</td><td>|</td></tr>
<tr><td>Very coarse sand</td><td>1 - 2</td><td>||</td><td>|</td><td></td></tr>
<tr><td>Very fine gravel</td><td>2 - 4</td><td>||||</td><td>||</td><td></td></tr>
<tr><td>Fine gravel</td><td>5 - 8</td><td>||</td><td></td><td></td></tr>
<tr><td>Medium gravel</td><td>9 - 16</td><td>||||| |</td><td>||||</td><td></td></tr>
<tr><td>Coarse gravel</td><td>17 - 32</td><td>||||| |||</td><td>|</td><td></td></tr>
<tr><td>Very coarse gravel</td><td>33 - 64</td><td>||</td><td></td><td></td></tr>
<tr><td>Small cobble</td><td>65 - 90</td><td>||||</td><td></td><td></td></tr>
<tr><td>Medium cobble</td><td>91 - 128</td><td>|||||</td><td></td><td></td></tr>
<tr><td>Large cobble</td><td>129 - 180</td><td>|||</td><td></td><td></td></tr>
<tr><td>Very large cobble</td><td>181 - 255</td><td>|||</td><td>||</td><td></td></tr>
<tr><td>Small boulder</td><td>256 - 512</td><td>||</td><td></td><td></td></tr>
<tr><td>Medium boulder</td><td>513 - 1024</td><td></td><td></td><td></td></tr>
<tr><td>Large boulder</td><td>1025 – 2048</td><td></td><td></td><td></td></tr>
<tr><td>Very large boulder</td><td>> 2048</td><td></td><td></td><td></td></tr>
<tr><td>Bedrock</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Woody debris</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Totals</td><td>58</td><td>25</td><td>17</td></tr>
</table>

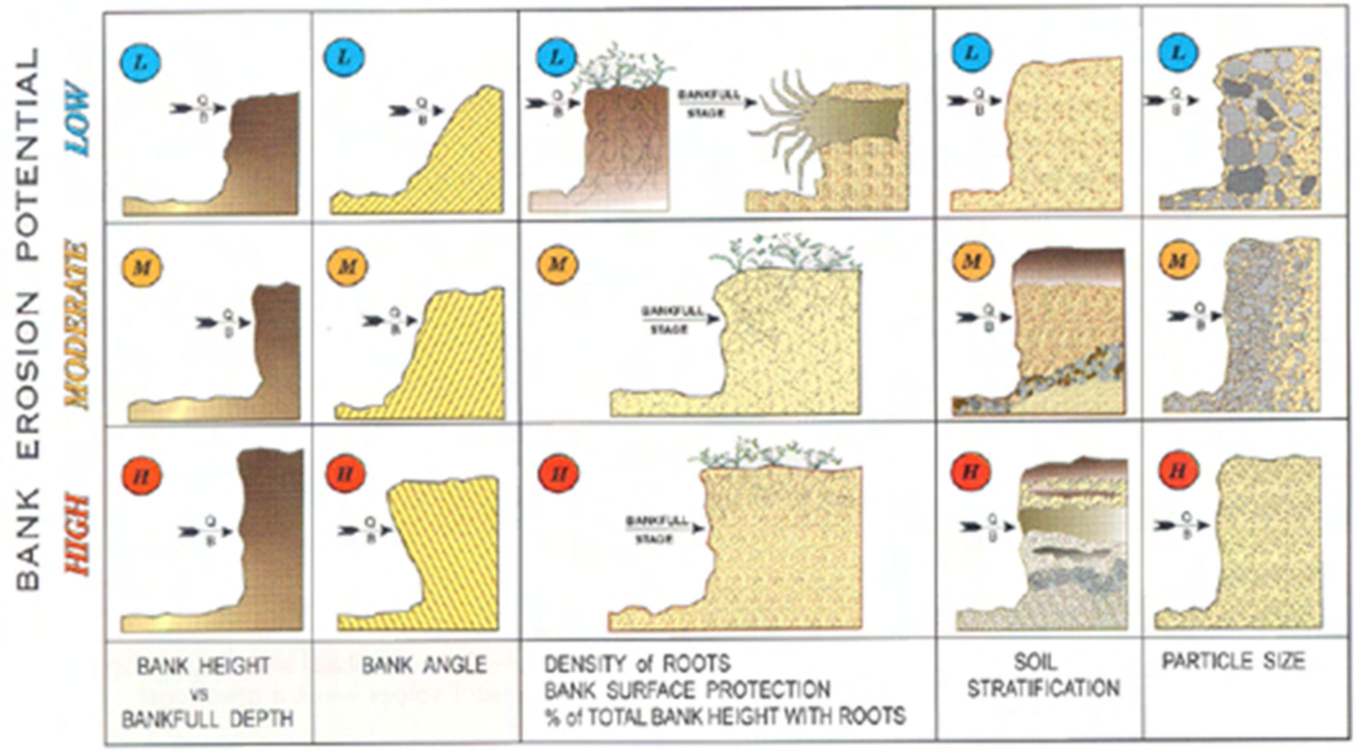
Habitat Percentages	Riffles	58%	Runs	25%	Pools	17%
D_{50}	2-4mm					
% Fines	52%					

Stations	
1	11′
2	22′
3	33′
4	44′
5	55′
6	66′
7	77′
8	88′
9	99′
10	110′

Indicate the location of your transects (stations) along your tape measure.

Bank Erosion Potential Rating

Elevation **Angle** **Root density** **Composition**



Stream Bank Erodibility Factors
(Rosgen 1993d)

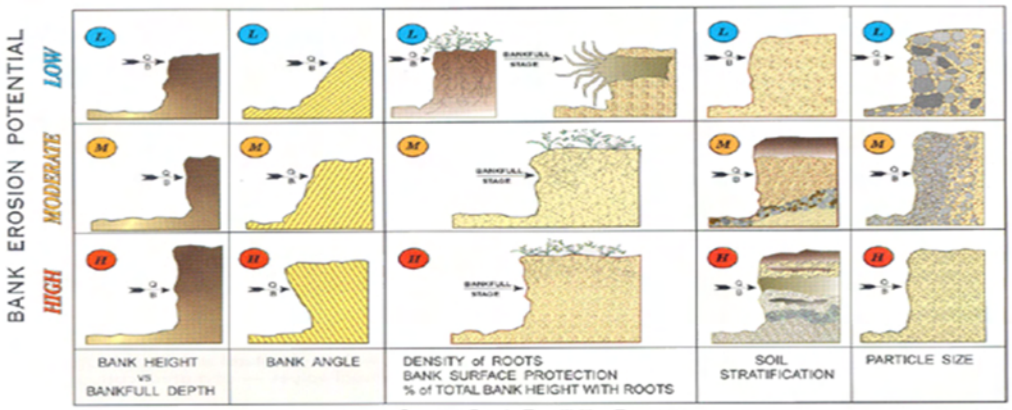
A useful tool for prioritizing sites for selection of project planning is the Bank Erosion Potential Rating. Bank erosion potential is determined by using the illustrations and descriptions provided to evaluate the conditions of both sides of the stream banks within your reach. Choose the illustration and descriptions that most closely matches what you see. Compare your selection to the scale (high scores indicate better conditions) to determine your score for each side. You should record the most dominant condition and use the space of page four to provide additional comments that better describe the bank conditions within the reach. Determine the average from the left and right side scores; compare these scores to the scale below to determine your bank erosion potential rating. You can keep the left and right side scores separate to focus on problem areas or combine them and then average to select priority reaches on large streams.

10	9	8	7	6	5	4	3	2	1
Low			Moderate				High		

A low rating describes banks that have little potential for erosion; a moderate rating describes banks with some problem areas but certain conditions may be adequate; a high rating describes banks have a great deal of erosion and contribute large amounts of sediment to the channel.

Bank Erosion Potential Rating

Elevations Angle Root density Composition

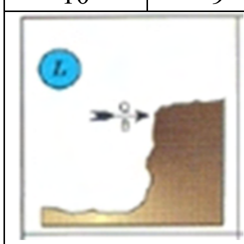
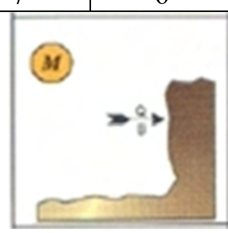
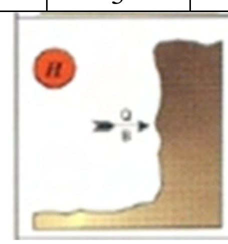


Stream Bank Erodibility Factors
(Rosgen 1993d)

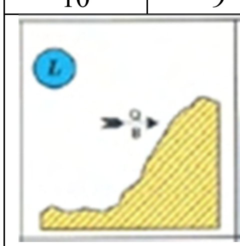
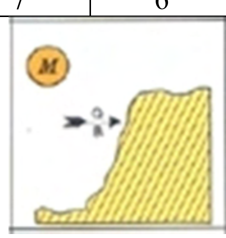
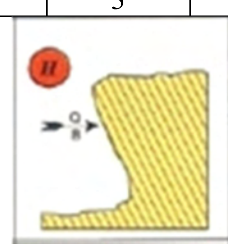
Evaluate each condition for both the right and left banks throughout your designated study area. Use the table at the bottom of the next page to record your scores. The study areas are defined as the length of your project site or if you are determining general conditions the length of your reach. The length of the reach is determined by the pattern and profile of the stream or the project length, at a minimum it should be 100 meters.

Stream name Muddy Creek
Watershed Greenbrier River
Site name
Sub-watershed Muddy Creek
Surveyed by: FLGR, WVNPS Program
Date 08/23/11
Site description Representative conditions (baseline)
RR-miles
Latitude
Longitude
Reach length 275 ft

Bankfull elevations

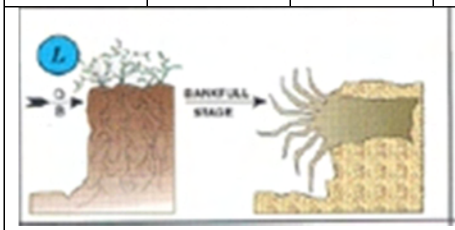
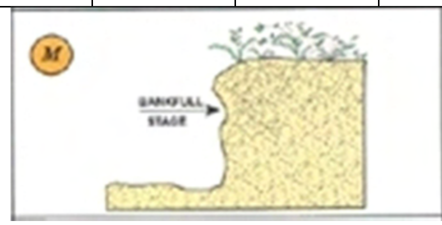
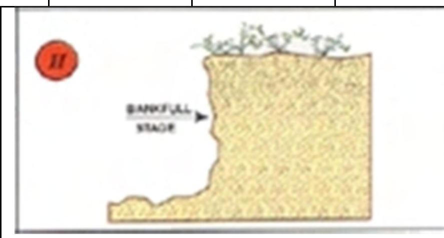
<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="4"> Bankfull indicators very common throughout the reach; their elevations are mostly at or near the top of the bank; stream has access to its floodplain during high water and bankfull flow events as shown by leaf lines or debris in the floodplain.</td><td colspan="3" rowspan="2"> Bankfull indicators somewhat common along portions of the reach; their elevations are usually below the top of the bank and more commonly at the middle or lower portions of the bank; channel may be somewhat incised.</td><td colspan="3" rowspan="2"> Bankfull indicators very infrequent throughout the reach; if observed, their elevations are in the middle and lower portions of the bank; channel is usually deeply incised.</td></tr>
<tr><td>LB</td><td>4</td><td>RB</td><td>4</td></tr>
</table>

Bankfull angles

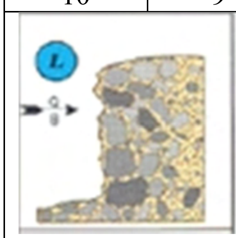
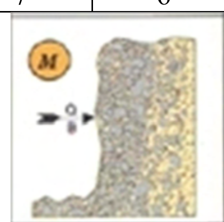
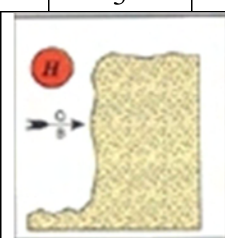
<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="4"> Banks have a slight to moderate angle throughout most of the reach; may have some areas of erosion (< 30%) but mostly the reach shows little sign of disturbance.</td><td colspan="3" rowspan="2"> Banks have a moderate to steep slope throughout much of the reach; some erosion is occurring (30-60%) within the reach. Note: some banks are often steep but very stable especially is covered by hard surfaces or vegetation (score higher if this is the case).</td><td colspan="3" rowspan="2"> Banks have a steep angle or are undercut throughout much of the reach (> 60%); there are obvious signs of erosions such as bare soils, exposed roots etc. along with many depositional features (point bars, islands, lateral bars etc.) in the channel.</td></tr>
<tr><td>LB</td><td>3</td><td>RB</td><td>2</td></tr>
</table>

Bank Erosion Potential Rating

Root density

<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="4">
More than 90% of the banks are covered by natural undisturbed vegetation (all layers are well represented); most roots systems probably extend to the lower portions of the bank.
LB 3 RB 1</td><td colspan="3">
60-90% of the banks are covered by natural vegetation (most layers represented but some may be absent); some disturbances such as mowed areas, pastures, trails etc. are evident; most root systems probably extend to the lower or middle sections of the bank.</td><td colspan="3">
< 60% of the banks covered by natural vegetation (only one or two layers represented but most are missing); areas of disturbance very obvious throughout most of the reach or non-native species dominate.</td></tr>
</table>

Composition

<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="4">
Banks consist primarily of large sized materials (cobble and boulder); smaller materials may be present but these can be seen only at the tops of the banks or on floodplain or terrace surfaces.
LB 3 RB 1</td><td colspan="3">
Banks consist of a mix of materials from large to smaller sizes (boulder to fine gravel); some sand may be intermixed but it usually makes up < 20%.</td><td colspan="3">
Banks are primarily made up of small materials (mostly fine gravel and sand); silts and clay may be present. Score higher if clay is observed in greater concentrations (e.g. > 50%).</td></tr>
</table>

Summary

Overall average		Left bank scores		Right bank scores	
Bank elevation	4	Bank elevation	4	Bank elevation	4
Bank angles	3	Bank angles	4	Bank angles	2
Root density	2	Root density	3	Root density	1
Bank composition	2	Bank composition	3	Bank composition	1
Total ÷ 4 =	2.75	Total ÷ 4 =	3.5	Total ÷ 4 =	2
Erosion rate	High	Erosion rate	High	Erosion rate	High

Compare your totals to the erosion rating scale below to determine your overall rating and the rating for both the left and right banks.

<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="3">Low</td><td colspan="4">Moderate</td><td colspan="3">High</td></tr>
</table>

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

G.S. Bevenger and R.M. King. 1995. A Pebble Count Procedure for Assessing Watershed Cumulative Effects. Res. Pap. RM-RP-319. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 17 p.

Harrelson, Cheryl C; Rawlins, C. L.; Potyondy, John P. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Leopold, L. B., M. Wolman, and J. Miller, 1964. Fluvial Processes in Geomorphology. W. H. Freeman, San Francisco, CA, 522 pp.

West Virginia's Nonpoint Source Program: Natural Stream Channel Design & Riparian Improvement Project Monitoring Coversheet

Project			
Grant		**Fiscal year**	

Location Information			
Watershed			
Stream			
County			
Latitude	**Longitude**	**Location description**	

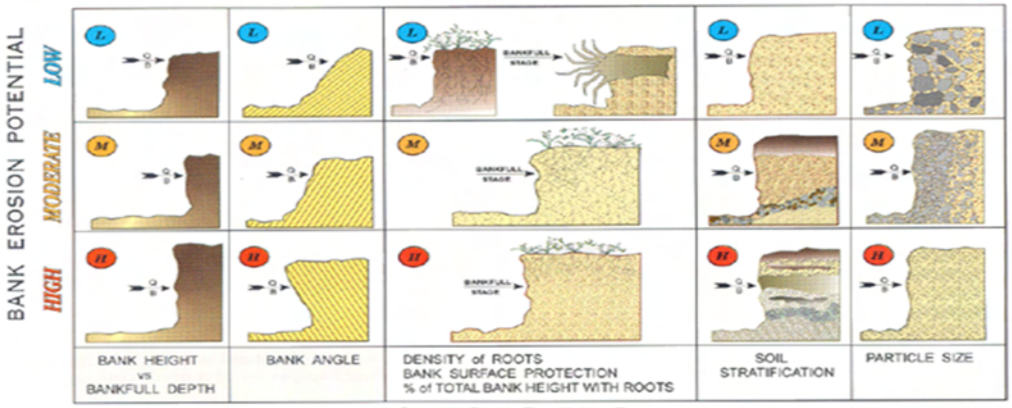
Monitors		
Landowner(s)	**Name(s)**	
	Address	
	Phone(s)	
	E-mail	

Important Dates			
Planning		**Other**	
Pre-Project			
Post-Project			

Sketch the project area showing approximate location of monitoring sites.

Bank Erosion Potential Rating

Elevations Angle Root density Composition



Stream Bank Erodibility Factors (Rosgen 1993d)

Evaluate each condition for both the right and left banks through-out your designated study area. Use the table at the bottom of the next page to record your scores. The study areas are defined as the length of your project site or if you are determining general conditions the length of your reach. The length of the reach is determined by the pattern and profile of the stream or the project length, at a minimum it should be 100 meters.

Stream name ____________________ Watershed ____________________

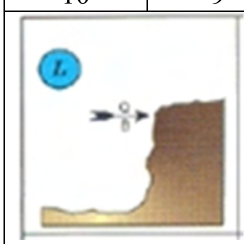
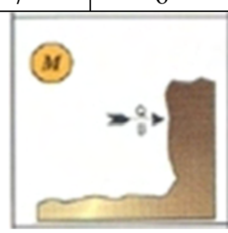
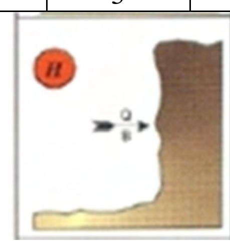
Site name ____________________ Sub-watershed ____________________

Surveyed by: ____________________ Date __________ __________ __________

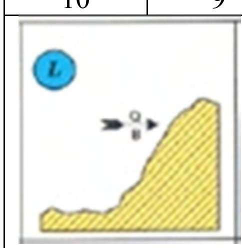
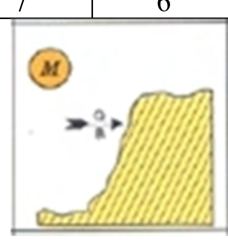
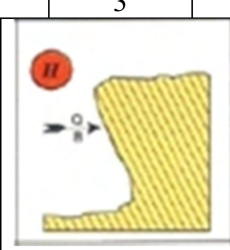
Site description ____________________ RR-miles __________ Latitude Longitude

Reach length __________

Bankfull elevations

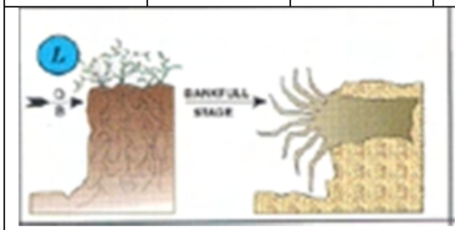
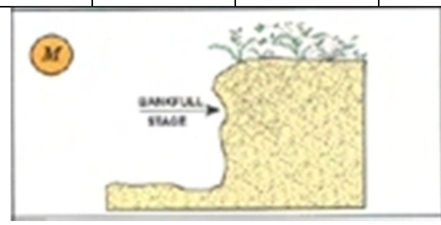
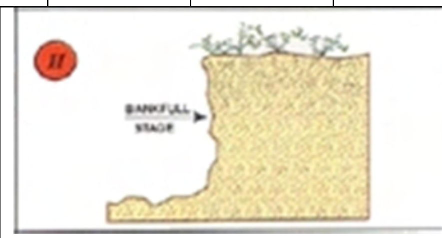
<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="3"> Bankfull indicators very common throughout the reach; their elevations are mostly at or near the top of the bank; stream has access to its floodplain during high water and bankfull flow events as shown by leaf lines or debris in the floodplain.
LB | | RB | </td><td colspan="4"> Bankfull indicators somewhat common along portions of the reach; their elevations are usually below the top of the bank and more commonly at the middle or lower portions of the bank; channel may be somewhat incised.</td><td colspan="3"> Bankfull indicators very infrequent throughout the reach; if observed, their elevations are in the middle and lower portions of the bank; channel is usually deeply incised.</td></tr>
</table>

Bankfull angles

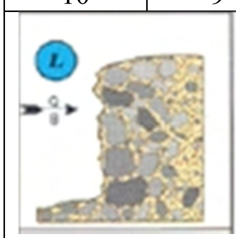
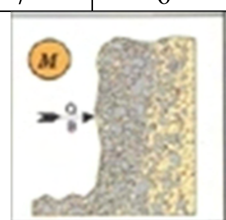
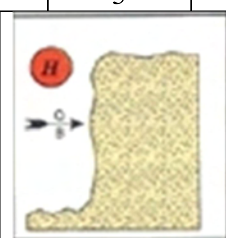
<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="3"> Banks have a slight to moderate angle throughout most of the reach; may have some areas of erosion (< 30%) but mostly the reach shows little sign of disturbance.
LB | | RB | </td><td colspan="4"> Banks have a moderate to steep slope throughout much of the reach; some erosion is occurring (30-60%) within the reach. Note: some banks are often steep but very stable especially is covered by hard surfaces or vegetation (score higher if this is the case).</td><td colspan="3"> Banks have a steep angle or are undercut throughout much of the reach (> 60%); there are obvious signs of erosions such as bare soils, exposed roots etc. along with many depositional features (point bars, islands, lateral bars etc.) in the channel.</td></tr>
</table>

Bank Erosion Potential Rating

Root density

<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="3">
More than 90% of the banks are covered by natural undisturbed vegetation (all layers are well represented); most roots systems probably extend to the lower portions of the bank.</td><td colspan="4" rowspan="2">
60-90% of the banks are covered by natural vegetation (most layers represented but some may be absent); some disturbances such as mowed areas, pastures, trails etc. are evident; most root systems probably extend to the lower or middle sections of the bank.</td><td colspan="3" rowspan="2">
< 60% of the banks covered by natural vegetation (only one or two layers represented but most are missing); areas of disturbance very obvious throughout most of the reach or non-native species dominate.</td></tr>
<tr><td colspan="3">LB | | RB |</td></tr>
</table>

Composition

<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="3">
Banks consist primarily of large sized materials (cobble and boulder); smaller materials may be present but these can be seen only at the tops of the banks or on floodplain or terrace surfaces.</td><td colspan="4" rowspan="2">
Banks consist of a mix of materials from large to smaller sizes (boulder to fine gravel); some sand may be intermixed but it usually makes up < 20%.</td><td colspan="3" rowspan="2">
Banks are primarily made up of small materials (mostly fine gravel and sand); silts and clay may be present. Score higher if clay is observed in greater concentrations (e.g. > 50%).</td></tr>
<tr><td colspan="3">LB | | RB |</td></tr>
</table>

Summary

<table>
<tr><td colspan="2">Overall average</td><td colspan="2">Left bank scores</td><td colspan="2">Right bank scores</td></tr>
<tr><td>Bank elevation</td><td></td><td>Bank elevation</td><td></td><td>Bank elevation</td><td></td></tr>
<tr><td>Bank angles</td><td></td><td>Bank angles</td><td></td><td>Bank angles</td><td></td></tr>
<tr><td>Root density</td><td></td><td>Root density</td><td></td><td>Root density</td><td></td></tr>
<tr><td>Bank composition</td><td></td><td>Bank composition</td><td></td><td>Bank composition</td><td></td></tr>
<tr><td>Total ÷ 4 =</td><td></td><td>Total ÷ 4 =</td><td></td><td>Total ÷ 4 =</td><td></td></tr>
<tr><td>Erosion rate</td><td></td><td>Erosion rate</td><td></td><td>Erosion rate</td><td></td></tr>
</table>

Compare your totals to the erosion rating scale below to determine your overall rating and the rating for both the left and right banks.

<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="3">Low</td><td colspan="4">Moderate</td><td colspan="3">High</td></tr>
</table>

Pebble Count Data Sheet

Materials	Size ranges (mm)	**Counts**			Station
		Riffles	Runs	Pools	
Silt/clay	< 0.06				
Very fine sand	0.06 – 0.125				
Fine sand	0.126 – 0.25				
Medium sand	0.26 – 0.5				
Coarse sand	0.5 – 1				
Very coarse sand	1 - 2				
Very fine gravel	2 - 4				
Fine gravel	5 - 8				
Medium gravel	9 - 16				
Coarse gravel	17 - 32				
Very coarse gravel	33 - 64				
Small cobble	65 - 90				
Medium cobble	91 - 128				
Large cobble	129 - 180				
Very large cobble	181 - 255				
Small boulder	256 - 512				
Medium boulder	513 - 1024				
Large boulder	1025 – 2048				
Very large boulder	> 2048				
Bedrock	Large solid unbroken surface				
Woody debris	Logs, sticks and leaf packs				
	Totals				

Based upon your count determine the % of each channel feature within your study reach.

Riffles	Runs	Pools

Indicate the location of your transects (**stations**) along your tape measure. Note: Use a sand gage to categorize the small materials (fine – very course sands)

Cross Sectional Measurements

Location description:	Latitude	Longitude
	Project/Reach length (ft)	

Left side pin	Date			Right side pin	Date		
Measurement	**Distance (ft)**	Pin #		**Measurement**	**Distance (ft)**	Pin #	
Pin to rod		Notes:		Pin to rod		Notes:	
TOB to rod				TOB to rod			
MB to rod				MB to rod			
BB to rod				BB to rod			
Rod to TW				Rod to TW			
TOB to SB				TOB to SB			

Left side pin	Date			Right side pin	Date		
Measurement	**Distance (ft)**	Pin #		**Measurement**	**Distance (ft)**	Pin #	
Pin to rod		Notes:		Pin to rod		Notes:	
TOB to rod				TOB to rod			
MB to rod				MB to rod			
BB to rod				BB to rod			
Rod to TW				Rod to TW			
TOB to SB				TOB to SB			

Left side pin	Date			Right side pin	Date		
Measurement	**Distance (ft)**	Pin #		**Measurement**	**Distance (ft)**	Pin #	
Pin to rod		Notes:		Pin to rod		Notes:	
TOB to rod				TOB to rod			
MB to rod				MB to rod			
BB to rod				BB to rod			
Rod to TW				Rod to TW			
TOB to SB				TOB to SB			

Left side pins	Date			Right side pin	Date		
Measurement	**Distance (ft)**	Pin #		**Measurement**	**Distance (ft)**	Pin #	
Pin to rod		Notes:		Pin to rod		Notes:	
TOB to rod				TOB to rod			
MB to rod				MB to rod			
BB to rod				BB to rod			
Rod to TW				Rod to TW			
TOB to SB				TOB to SB			

Bank Profile								
								Stretch a tape from bank to bank and anchor it at both ends. Move from left to right facing in an upstream direction; measure the distance from the stream bottom to the top of the tape at selected intervals (i.e. every foot). Record your measurements in the table at the left. The table provides spaces multiple measurements; if more are necessary you can create your own table on a separate piece of paper. Your tape measure will probably not start at zero so make sure to record the actual position of the tape as you measure across the channel.

Acronyms: LS - Left side facing downstream: RS – Right side facing downstream; U/S - upstream; TOB - top of bank; MB – mid Bank; BB – bottom of Bank; TW – thalweg; SB – streambed; TOB – SB (bank height)

Copy this data sheet as many times as needed to complete additional cross section measurements.

Total Reach Bank Erosion Calculations

Project							
Pin #		Date		Latitude		Longitude	

Measurement	Erosion Area (feet)	Bank Height (feet)	Section Length (feet)	Total Erosion (cubic feet)
Top of Bank				
Mid Bank				
Bottom of Bank				
Average width				
Divide Total Erosion by 27 cubic feet/cubic yards = Total Erosion in cubic yards				
Multiply Total Erosion by 1.3 = Total Erosion in tons				
Time Frame (years)		Divide Total Erosion by Time Frame = tons/year		

Project							
Pin #		Date		Latitude		Longitude	

Measurement	Erosion Area (feet)	Bank Height (feet)	Section Length (feet)	Total Erosion (cubic feet)
Top of Bank				
Mid Bank				
Bottom of Bank				
Average width				
Divide Total Erosion by 27 cubic feet/cubic yards = Total Erosion in cubic yards				
Multiply Total Erosion by 1.3 = Total Erosion in tons				
Time Frame (years)		Divide Total Erosion by Time Frame = tons/year		

Project							
Pin #		Date		Latitude		Longitude	

Measurement	Erosion Area (feet)	Bank Height (feet)	Section Length (feet)	Total Erosion (cubic feet)
Top of Bank				
Mid Bank				
Bottom of Bank				
Average width				
Divide Total Erosion by 27 cubic feet/cubic yards = Total Erosion in cubic yards				
Multiply Total Erosion by 1.3 = Total Erosion in tons				
Time Frame (years)		Divide Total Erosion by Time Frame = tons/year		

Additional comments/information	

PHOTOGRAPH LOG

Project/Landowner Information				
Stream name			Latitude	Longitude
Landowner name				
Landowner address				
Phone:		E-mail		
Survey completed by				
Notes				

Photo Information Location 1				Photo descriptions
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Photo Information Location 2				Photo descriptions
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Photo Information Location 3				Photo descriptions
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		
Date		Photo ID		