



US Army Corps
Of Engineers®
Nashville and Memphis Districts



Draft Prospectus Submittal Guidance for Stream Mitigation Banks or Stream In-Lieu Fee Projects within Tennessee May 26, 2016 (Draft)

A draft prospectus for a stream mitigation bank or stream in-lieu fee (ILF) project should contain the information outlined in this guidance document. To help facilitate project review, please provide the information outlined in this document along with an Interagency Review Team (IRT) meeting request. Prior to an IRT site visit, the sponsor will have up to an hour with the IRT to present the proposed project. Based on the initial information provided by the sponsor, the IRT will determine if the project has the potential to provide compensatory mitigation for activities authorized by Department of the Army permits. If the IRT determines the site has potential, a site visit will be scheduled to further evaluate the proposed project.

1. **Owner**. Identify the bank/ILF sponsor, landowners, and any agent for the sponsor.
2. **Agent**. Identify consultants or experts to be involved in design of the compensation site, and list their qualifications and experience in designing and implementing mitigation projects.
3. **Project Location**. Identify the project area in acres and location from the nearest intersection of roads. List the nearest town, county, state, HUC-8 watershed, HUC-12 watershed, ecoregion (Level III) and provide project coordinates in decimal degrees (NAD 83).
4. **Access to Property**. Provide written documentation of permission from the property owner to access the proposed mitigation site.
5. **Project Goals**. Describe the purpose and goals of the project. Provide a description of any physical, chemical, and/or biological degradation occurring within the proposed project area. The purpose and goals should address improving specific physical, chemical, and/or biological functions at the site.
6. **Project Objectives**. Describe how the goals or correction of the problem(s) will be achieved. The objectives will be more specific and should be quantitative.
7. **Site Constraints**. Describe constraints that would limit the restoration potential of the project. This should include a description of any watershed, physical, chemical, or biological constraints that would limit riparian buffer width, construction methodology, site protection, stream function, etc. Examples of constraints include, but are not limited to: adjacent landuse, roadways, utility lines, stormwater outfalls, liens, easements, or encumbrances on the property, inability to acquire property and/or long-term protection, presence of threaten or endangered species (state and federal), and historic properties. Identify any portion of the project that would occur on public lands and the public entity that owns the land.

8. **Catchment Assessment Form.** Provide a completed *Catchment Assessment Form* (Appendix A).
9. **Existing and Proposed Reach-Level Stream Function-Based Rapid Assessment Field Data Form.** Provide at least one complete *Rapid Assessment Field Data Form* for each unique stream reach within the project area (Appendix B). Provide a complete *Hydraulic and Geomorphic Assessment Data Form* (Appendix C) with each *Rapid Assessment Field Data Form*. To delineate each unique stream reach consider changes in gradient, Rosgen classification stream type, floodplain connectivity, lateral stability, riparian vegetation, and bedform diversity. More than one data form will often be necessary to adequately characterize the variable conditions among stream reaches. Complete additional forms as necessary. Refer to *A Function-Based Framework for Stream Assessments and Restoration Projects*¹ document for supporting information to complete the form.
10. **Biological Data.** Provide information on the biological scores for the waterbodies within the project boundaries. Contact TDEC² to obtain any pre-existing biological scores for the waterbody at or near the proposed project reach. If this information does not exist or is determined to no longer be valid, the state may elect to evaluate the site to establish existing biological conditions. In consultation with the TDEC, the applicant may provide biological scores following the standardized protocols found in TDEC's *Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys*³. Depending on site conditions and proposed treatments, biological scores may be requested for each unique stream reach within the project area.
11. **Visual Habitat Assessment.** Provide habitat assessment data sheets for each unique stream reach within the project area. These field sheets are modified from the *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (Barbour et. al., 1999). Choice of field data sheets (high gradient vs. low gradient) is dependent on the Level IV ecoregion and/or stream type at the sampling location. The assessor should use standardized protocols found in TDEC's *Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys*³ to enable comparison to ecoregional reference streams that have been assessed following the same standardized procedure. (Appendix D)
12. **Maps.**
 - a. Provide a plat or land ownership map and digital shapefile or KMZ file.

¹ Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012. A Function-Based Framework for Stream Assessment and Restoration Projects. US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC EPA 843-K-12-006. <https://streammechanics.egnyte.com/h-s/20120914/cde14b2bb9f2456d>

² TDEC's email contact information - water.permits@tn.gov

³TDEC's Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys - <https://www.tn.gov/assets/entities/environment/attachments/bugsop11.pdf>

- b. Provide a map showing the estimated boundaries of all existing aquatic resources on the project site (planning level of detail).
 - c. Provide a NRCS soil map with the boundary of the proposed stream mitigation site.
 - Include a table identifying the soil taxonomy for each soil type where proposed stream mitigation activities will occur.
 - d. Provide a National Wetlands Inventory (NWI) map with the site boundary clearly identified. See www.nwi.fws.gov for available maps.
 - e. Provide a USGS topographic map and a map with recent aerial imagery with the following information/layers included on each:
 - Boundaries of the proposed compensatory mitigation site;
 - Clearly identified stream reaches labeled by proposed mitigation approach (e.g. re-establishment, rehabilitation, enhancement, establishment, preservation, etc.);
 - Transportation Layer; and
 - Maintained easement locations (e.g. powerline ROW, sewerline easements, pipeline easements).
 - f. Provide historical aerial imagery overlain with proposed project boundaries, including at least one image per decade throughout the available period of record.
 - g. Provide a map of the proposed bank service area that shows the location of the bank site, county boundaries, and major municipalities. (*Mitigation Banks only*)
13. **Site Photos.** Provide photographs of the stream reaches within the proposed project area. Provide a photograph location map that clearly identifies the location and orientation of the photographs.
14. **Baseline Conditions.** Prepare a BRIEF narrative that describes:
- a. Proposed service area (mitigation bank), or identify the advanced credit service area associated with the proposed stream in-lieu fee project.
 - b. Provide a summary of the *Catchment Assessment Form* and *Rapid Assessment Data Forms*. List and describe all site selection criteria that were used to identify the proposed project. Site selection criteria could include watershed plans, State Wildlife Action Plans prepared for the watershed, plans under Section 319 Clean Water Act grants, and any other watershed scale assessments.
 - c. Adjacent land uses. Discuss reasonable expected development for the site (if bank or ILF activities were not implemented) and the surrounding area.

15. **Proposed Mitigation Approach.**

a. *Mitigation Approach.* Describe the proposed mitigation approach for each stream reach within the project site that will be considered in the mitigation plan (establishment, re-establishment, rehabilitation, enhancement, preservation – list separately). This description should be accompanied by a list presented in a table and organized by stream reach, length, proposed mitigation approach, and proposed mitigation ratio.

b. *Functional Lift.* Describe the conceptual mitigation approach for each stream reach. Describe how the proposed project will increase specific stream functions above the pre-project levels. Use the information collected in the *Rapid Assessment Data Form* to describe how the proposed project will improve stream functions within each reach. Identify stream reference reach(es) and provide a brief description of the reach(es).

16. **Site Protection.** Provide proposed legal arrangements and instrument, including site ownership that will be used to ensure the long-term protection of the compensatory mitigation project site. The site protection mechanism must provide long-term protection of the compensatory mitigation site and to the extent appropriate and practicable, prohibit incompatible uses that might otherwise jeopardize the objectives of the compensatory mitigation project. Prohibited uses may include but are not limited to:

- Clearing, cutting, and mowing of native vegetation;
- Earthmoving, grading, filling, topography change;
- Construction of permanent or temporary structures;
- Mining, drilling;
- Draining, diking;
- Diverting or affecting the flow of surface or subsurface waters;
- Applying herbicides or pesticides for reasons other than controlling invasive species;
- Grazing or use by domesticated animals;
- Use of off-road vehicles and motor vehicles; and
- Utility lines.

17. **Long-Term Management.** Proposed ownership arrangements and long-term management strategy for the mitigation bank or in-lieu fee project sites, including potential easement holders (e.g. land trusts, watershed groups, land conservation organizations, etc.)

18. **Historic Properties.** Provide a statement regarding the presence of cultural, archaeological, and/or historic resources. The information should include the name of the resources consulted, a website printout, and/or a survey report. Information regarding cultural resources and the National Historic Preservation Act can be reviewed at the National Park Service's website: <http://www.nps.gov/nr/>. It is not necessary to conduct a Phase I historic resources survey at this time.

19. **Threatened and Endangered Species.** Provide a discussion of any existing (state or federal) threatened or endangered species or their critical habitat known to exist on or near the site and cite the source of this information as well as last year the population was documented. It is not necessary to conduct a listed species survey at this time.

Rater(s):

Date:

Purpose: This form is used to determine the project's restoration potential.

Overall Watershed Condition

CATCHMENT ASSESSMENT					
Categories		Description of Catchment Condition			Rating (P/F/G)
		Poor	Fair	Good	
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments to reach restoration site and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	
2	Impervious cover (Hydrology)	Greater than 15%	Between 7% and 15%	Less than 7%	
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	
5	Watershed Hydrology (e.g., flow regime, basin characteristics) (Hydrology)	Flashy flow regime as a result of land use, rainfall patterns, geology, and soils.	Moderate flashy flow regime as a result of land use, rainfall patterns, geology, and soils.	Not Flashy flow regime as a result of land use, rainfall patterns, geology, and soils.	
6	Percent Forested (Watershed) (Hydrology)	<= 20%	>20% and <70%	>=70%	
7	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	
8	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	
9	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDLWS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDLWS Mgmt plan addressing deficiencies	Not on 303(d) list	
10	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	
11	NPDES Permits	Many NPDES permits within watershed or some within one mile of project reach	A few NPDES permits within watershed and none within one mile of project reach	No NPDES permits within watershed and none within one mile of project reach	
13	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact and fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	
14	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	
15	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is within the project reach.	40 to 60% of the total catchment area is within the project reach.	Greater than 60% of the total catchment area is within the project reach.	
16	Other				

EXISTING and PROPOSED REACH LEVEL STREAM FUNCTION-BASED RAPID ASSESSMENT FIELD DATA FORM

Watershed: _____	Rater(s): _____
Stream: _____	Date: _____
Reach Length: _____	Latitude: _____
Photo(s): _____	Longitude: _____

Reach ID:

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Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning

Stream Function Pyramid Level 1 Hydrology

Runoff	1. Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	Potential for concentrated flow/impairments to reach restoration site and no treatments are in place	
	Existing Condition				
	Proposed Condition				
	2. Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover less than 6%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover 7 - 15%	Flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover greater than 15%	
	Existing Condition				
	Proposed Condition				
	If existing runoff is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason				

Stream Function Pyramid Level 2 Hydraulics

Floodplain Connectivity (Vertical Stability)	3. Bank Height Ratio (BHR)	1.0-1.2	1.21 - 1.50	>1.50
	Existing Condition			
	Proposed Condition			
	4a. Entrenchment <small>(Meandering streams in alluvial valleys or Rosgen C, E, DA Streams)</small>	>2.2	2.2 - 2.0	<2.0
	Existing Condition			
	Proposed Condition			
	4b. Entrenchment <small>(Non meandering streams in colluvial valleys or Rosgen B Streams)</small>	= or >1.4	1.3 - 1.2	<1.2
	Existing Condition			
	Proposed Condition			
	5. Floodplain Drainage	no concentrated flow; runoff is primarily sheet flow; hillslopes < 10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented	runoff is equally sheet and concentrated flow (minor gully and rill erosion occurring); hillslopes 10 - 40%; hillslopes 50 - 200 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented	concentrated flows present (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or absent
	Existing Condition			
	Proposed Condition			
	6. Vertical Stability Extent	Stable: <5% of bottom affected by localized vertical channel down-cutting	Localized Instability: 5-50% of bottom affected by localized vertical stream channel down-cutting or scouring	Widespread Instability: 50% of bottom affected by widespread vertical down-cutting; head cuts present
	Existing Condition			
	Proposed Condition			
Provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason				

Appendix B. Existing and Proposed Reach-Level Stream Function-Based Rapid Assessment Field Data Form
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Reach ID: <input type="text"/>					
Function-based Rapid Reach Level Stream Assessment					
Assessment Parameter	Measurement Method	Category			
		Functioning	Functioning-at-Risk	Not Functioning	
Stream Function Pyramid Level 3 Geomorphology					
Riparian Vegetation	7. Buffer Width (ft) from top of bank	>50	30 - 49 ft	< 30 ft	
	Left Bank Existing				
	Left Bank Proposed				
	Right Bank Existing				
	Right Bank Proposed				
	8. Riparian Vegetation Zone (EPA, RBP Habitat Assessment)	Good vegetation community diversity and density; human activities do not impact zone(optimal score 9-10)	Human activities impacted zone minimally (sub-optimal, score 6-8); width of riparian zone 20-40 feet (6-12 meters); human activities have impacted zone a great deal (marginal, score 3-5)	Little or no riparian vegetation due to human activities (poor score 0-2)	
	Left Bank Existing				
	Left Bank Proposed				
	Right Bank Existing				
	Right Bank Proposed				
	9. Vegetative Protection	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. (optimal score 9-10)	70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. (sub-optimal score 6-8); 50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. (marginal, score 3-5)	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped. (poor score 0-2)	
	Left Bank Existing				
	Left Bank Proposed				
	Right Bank Existing				
	Right Bank Proposed				
10. Riparian Zone Invasive Species	Invasive species not present or sparse	Invasive species well represented and alter the community	Majority of vegetation is invasive		
Left Bank Existing					
Left Bank Proposed					
Right Bank Existing					
Right Bank Proposed					
Provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason					
Stream Function Pyramid Level 3 Geomorphology					
Lateral Stability	11. Dominant BEH/NBS Rating	L/VL, L/L, L/M, L/H, L/VH, M/VL	M/L, M/M, M/H, L/Ex, H/L, M/VH, M/Ex, H/L, H/M, VH/VL, Ex/VL	H/H, H/Ex, VH/H, Ex/M, Ex/H, Ex/VH, VH/VH, Ex/Ex	
	Existing Condition (Right bank)				
	Proposed Condition (Right Bank)				
	Existing Condition (Left bank)				
	Proposed Condition (Left Bank)				
	12. Dominant Bank Erosion	Dominate bank erosion rate is low 10%	Dominate bank erosion rate is moderate 10-25%	Dominate bank erosion rate is high >25%	
	Existing Condition				
	Proposed Condition				
	Provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason				

Function-based Rapid Reach Level Stream Assessment					
Assessment Parameter	Measurement Method	Category			
		Functioning	Functioning-at-Risk	Not Functioning	
Bedform Diversity	13. Shelter for Fish and Macroinvertebrates (EPA 1999)	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, rubble, gravel, cobble and large rocks, or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	20-70% mix of stable habitat; suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale)	Less than 20% mix of stable habitat; lack of habitat availability less than desirables obvious; substrate unstable or lacking	
	Existing Condition				
	Proposed Condition				
	14. Large Woody Debris Index (LWDI)	LWDI of project reach equals LWDI of reference reach	LWDI of project reach does not equal reference reach, but is trending towards reference	LWDI of project reach does not equal LWDI of reference reach and is not trending towards reference	
	Existing Condition				
	Proposed Condition				
	Streams in Alluvial Valleys (C, E)				
	15. Percent Riffle <3% slope	>60 - <70	70 - 80 or 40 - 60	> 80 or < 40	
	Existing Condition				
	Proposed Condition				
	16a. Pool-to-Pool Spacing Ratio (Watersheds < 10 m ²)	>4.0 - <5.0	3.0 - 4.0 or 5.0 - 7.0	< 3.0 or >7.0	
	Existing Condition				
	Proposed Condition				
	16b. Pool-to-Pool Spacing Ratio (Watersheds > 10 m ²)	>5.0 - <7.0	3.5 - 5.0 or 7.0 - 8.0	<3.5 or >8.0	
	Existing Condition				
	Proposed Condition				
	17a. Pool Max Depth Ratio/Depth Variability (Gravel Bed Streams)	>1.5	1.2 - 1.5	<1.2	
	Existing Condition				
	Proposed Condition				
	17b. Pool Max Depth Ratio/Depth Variability (Sand Bed Streams)	>1.2	1.1 - 1.2	<1.1	
	Existing Condition				
	Proposed Condition				
	Moderate Gradient Streams in Colluvial Valleys				
	18. Pool-to-Pool Spacing Ratio (3-5% Slope)	0.5- 4.0	4.0 - 6.0	>6.0	
Existing Condition					
Proposed Condition					
19. Pool Max Depth Ratio/Depth Variability	>1.5	1.2 - 1.5	<1.2		
Existing Condition					
Proposed Condition					
20a. Percent Riffle 3% - 10% slope	>50 - <60	50 - 40 or 60 - 70	> 70 or < 40		
Existing Condition					
Proposed Condition					
20b. Percent Riffle >10% slope	>75 - 80	70 - 75	< 70		
Existing Condition					
Proposed Condition					
	Provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason				

Reach ID:

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
Stream Function Pyramid Level 4 Physicochemical				
Water Quality and Nutrients (Do not complete if stream is ephemeral)	21. Water Appearance and Nutrient Enrichment (USDA 1999)	Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks. Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present	Frequent cloudiness especially after storm events; objects visible to depth 0.5 to 3.0 ft; may have slight green color; no oil sheen on water surface. Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrate	Very turbid or muddy appearance most of the time; objects visible at depth < 0.5 ft; slow moving water may be bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface; or strong odor of chemicals, oil, sewage, or other pollutants. Pea-green, gray, or brown water along entire reach; dense stands of macrophytes clogging stream; severe algal blooms creating thick algal mats in stream
	Existing Condition			
	Proposed Condition			
	22. Detritus (Petersen, 1992)	Mainly consisting of leaves and wood without sediment covering it	Leaves and wood scarce; fine organic debris without sediment	Fine organic sediment - black in color and foul odor (anaerobic) or detritus absent
	Existing Condition			
	Proposed Condition			
	Provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason			

Stream Function Pyramid Level 5 Biology				
Biology (Do not complete if stream is ephemeral)	23. Macroinvertebrate Index Semi Quantitative Single Habitat (SQSH) Macroinvertebrate Sample (as defined in 2011 TN State QSSOP for macroinvertebrate surveys)	SQSH Score: >34 (Ecoregion 73A; >24)	SQSH Score: 30-34 (Ecoregion 73A; 20-24)	SQSH Score: <30 (Ecoregion 73A; <20)
	Existing Condition			
	Proposed Condition			
	24. Macroinvertebrate Tolerance from NCBI Metric Score (as defined in the 2011 TN State QSSOP for macroinvertebrate surveys)	Abundant intolerant species 6	Limited intolerant species 4	Only tolerant species <4
	Existing Condition			
	Proposed Condition			
	25. Fish Presence	Abundant	Rare	Not present
	Existing Condition			
	Proposed Condition			
	Provide description of cause (s) and stability trend and if F can not be potentially achieved, provide reason			

Hydraulic and Geomorphic Assessment Data Form

Form created by Stream Mechanics and modified by Corps on 5/17/2016

I. Bankfull Verification

- | | | |
|--|-------|-----------|
| A. Regional Curve | _____ | |
| B. Drainage Area | _____ | sq. miles |
| C. Difference between bankfull stage and water surface | _____ | feet |
| D. Bankfull Width (Measured) | _____ | feet |
| E. Bankfull Area (Measured) | _____ | sq. feet |
| F. Bankfull Mean Depth (Area/Width) | _____ | feet |
| G. Bankfull Width (Regional Curve) | _____ | feet |
| H. Bankfull Area (Regional Curve) | _____ | sq. feet |
| I. Bankfull Mean Depth (Regional Curve) | _____ | feet |

<h3>Area Calculations</h3>
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II. Stream Classification

- | | | |
|---|-------|--------|
| A. Bankfull W/D, calculate as
$\frac{\text{Bankfull Width}}{\text{Bankfull Mean Depth}}$ | _____ | ft/ft. |
| B. Bankfull Max Riffle Depth (Dmax) | _____ | feet |
| C. Floodprone Area Width | _____ | feet |
| D. Entrenchment Ratio, calculate as
$\frac{\text{Floodprone Area Width}}{\text{Bankfull Width}}$ | _____ | ft/ft. |
| E. Slope Estimate | _____ | ft/ft. |
| F. Channel Material Estimate | _____ | |
| G. Rosgen Stream Type | _____ | |

III. Floodplain Connectivity

- A. Bank Height/Riffle Data

	R ₁	R ₂	R ₃	R ₄
Low Bank Height (LBH)				
Dmax				
Bank Height Ratio (LBH/Dmax)				
Riffle Length				

- B. Weighted Bank Height Ratio, calculate
 as $\frac{\Sigma(\text{Bank Height Ratio}_i \times \text{Riffle Length}_i)}{\Sigma \text{Riffle Length}}$ _____ ft/ft.
- C. Entrenchment Ratio from Riffle _____ ft/ft.

IV. Bedform Diversity

A. Pool Data

	P ₁	P ₂	P ₃	P ₄	P ₅
Station					
Pool to Pool Spacing					
Pool Spacing Ratio, $\frac{\text{Pool Spacing}}{\text{Bankfull Width}}$					
Pool Depth (max depth at bankfull)					
Pool Depth Ratio, $\frac{\text{Pool Depth}}{\text{Bankfull Mean Depth}}$					

- B. Average Pool Spacing Ratio _____ ft/ft.
- C. Average Pool Depth Ratio _____ ft/ft.

V. Large Woody Debris⁴

- A. Number of Pieces per 100m _____
- B. Large Woody Debris Index _____

⁴ Davis, Jeffrey C., G. Wayne Minshall, Christopher T. Robinson, Peter Landres. Monitoring Wilderness Stream Ecosystems. USDA Forest Service General Technical Report RMRS-GTR-70 (January 2001). http://www.fs.fed.us/rm/pubs/rmrs_gtr070.pdf

VI. Lateral Stability

A. Bank Data

BEHI/NBS ⁵ Score	Bank Length

- B. Total Eroding Bank Length _____ ft.
- C. Total Bank Length _____ ft.
- D. Dominant BEHI/NBS Score _____
- E. Percent of Bank Erosion, calculate as

$$\frac{\text{Total Eroding Bank Length}}{\text{Total Bank Length}} \quad \%$$

VI. Riparian Vegetation

A. Riparian Vegetation Data

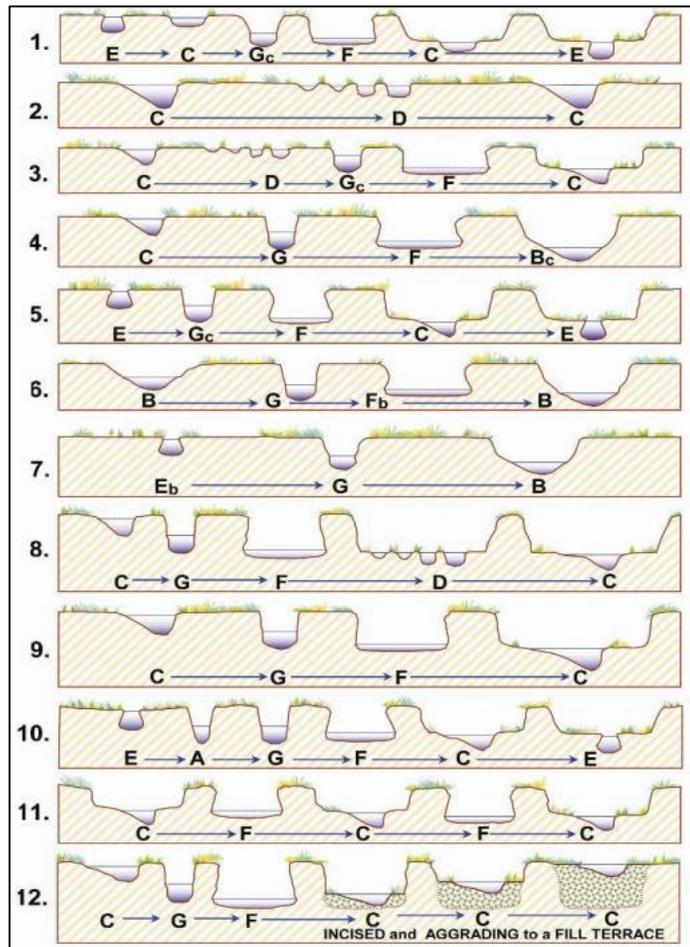
	Left	Right
Riparian/Buffer Width		
RBP Score		

VII. Channel Evolution

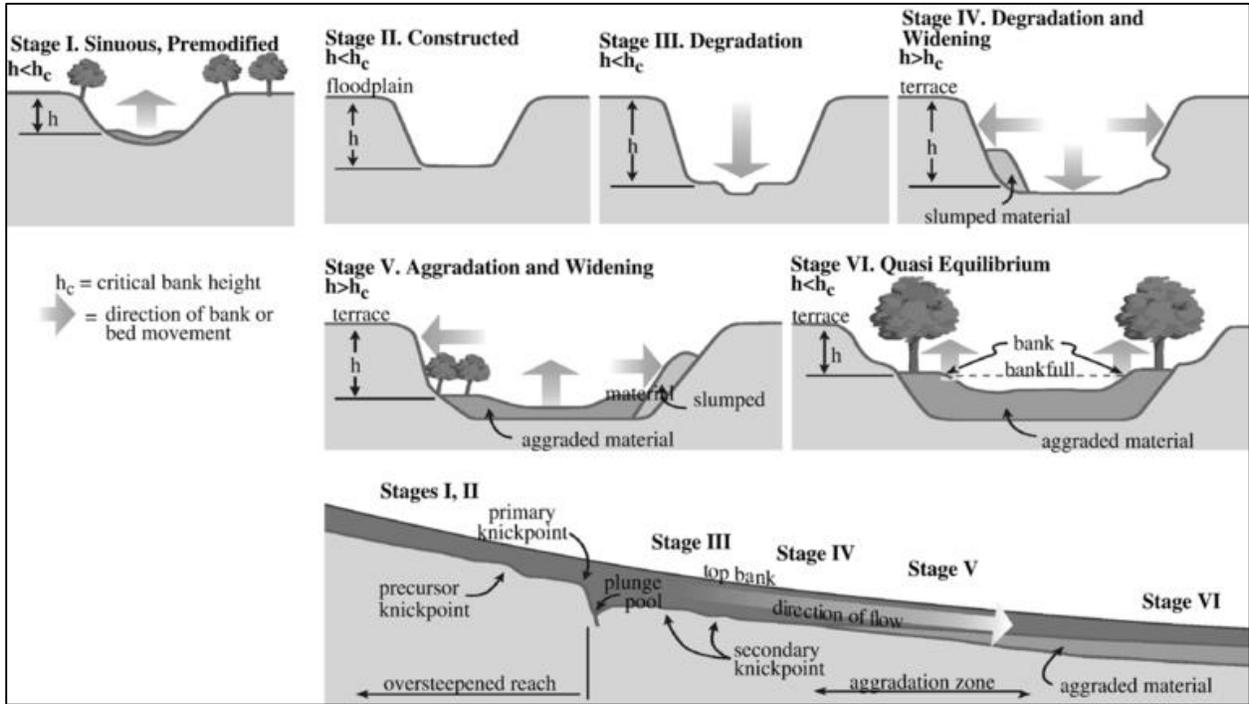
- A. Rosgen Channel Type Succession _____
- B. Simon Channel Evolution Model (Stage) _____
- C. Provide a brief narrative describing the channel evolution trend.

⁵ Rosgen, D. 2014. River Stability Field Guide (Second Edition). Wildland Hydrology, Fort Collins, CO.

Rosgen Channel Type Succession Scenarios



Simon Channel Evolution Model



Large Woody Debris Field Form

Name:

Stream Name:

Stream Type:

Reach ID:

Avg. Slope:

Reach Length:

Bed material:

Bankfull Width:

Reach Descriptions:

Score						
Pieces	1	2	3	4	5	Total
Length/Bankfull Width						
Diameter						
Location						
Type						
Structure						
Stability						
Orientation						
Total						
Debris Dams						
Length						
Height						
Structure						
Location						
Stability						
Total						

Notes:

LWD Key

	Score				
Pieces	1	2	3	4	5
Length/Bankfull Width	0.2 to 0.4	0.4 to 0.6	0.6 to 0.8	0.8 to 1.0	> 1.0
Diameter (Cm)	10 to 20	20 to 30	30 to 40	40 to 50	>50
Location	Zone 4		Zone 3	Zone 2	Zone 1
Type	Bridge		Ramp	Submersed	Buried
Structure	Plain		Intermediate		Sticky
Stability	Moveable		Intermediate		Secured
Orientation(degrees)	0 to 20	20 to 40	40 to 60	60 to 80	80 to 90
Debris Dams					
Length (% of bankfull width)	0 to 20	20 to 40	40 to 60	60 to 80	80 to 100
Height (% of bankfull depth)	0 to 20	20 to 40	40 to 60	60 to 80	80 to 100
Structure	Coarse		Intermediate		Fine
Location	Partially high flow	In high flow	Partially low flow	Mid low flow	In low flow
Stability	Moveable		Intermediate		Secured

Diameter Conversion

10 cm	0.33	feet
20 cm	0.66	feet
30 cm	0.98	feet
40 cm	1.3	feet
50 cm	1.6	feet

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)
 (See Protocol E for detailed descriptions and rank information)

STATION ID:					HABITAT ASSESSED BY:															
STREAM NAME:					DATE:					TIME:										
STATION LOCATION:					ECOREGION:					QC: Consensus Duplicate										
WBID/HUC:					GROUP:					ASSOCIATED LOG #:										
	Optimal				Suboptimal					Marginal					Poor					
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates. Four or more productive habitats are present.				Natural stable habitat covers 40-70% of stream reach. Three or more productive habitats present. (If near 70% and more than 3 go to optimal.)					Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present. (If near 40% and more than 2 go to suboptimal.)					Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
2. Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. If near 25% drop to suboptimal if riffle not layered cobble.				Gravel, cobble and boulders 25-50% surrounded by fine sediment. Niches in bottom layers of cobble compromised. If near 50% & riffles not layered cobble drop to marginal.					Gravel, cobble, and boulders are 50-75% surrounded by fine sediment. Niche space in middle layers of cobble is starting to fill with fine sediment.					Gravel, cobble, and boulders are more than 75% surrounded by fine sediment. Niche space is reduced to a single layer or is absent.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).				Only 3 of the 4 regimes present (if fast-shallow is missing score lower). If slow-deep missing score 15.					Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).					Dominated by 1 velocity/depth regime. Others regimes too small or infrequent to support aquatic populations.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.				Sediment deposition affects 5-30% of stream bottom. Slight deposition in pool or slow areas. Some new deposition on islands and point bars. Move to marginal if build-up approaches 30%.					Sediment deposition affects 30-50% of stream bottom. Sediment deposits at obstruction, constrictions and bends. Moderate pool deposition.					Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
5. Channel Flow Status.	Water reaches base of both lower banks and streambed is covered by water throughout reach. Minimal productive habitat is exposed.				Water covers > 75% of streambed or 25% of productive habitat is exposed.					Water covers 25-75% of streambed and/or productive habitat is mostly exposed.					Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

Station ID	Date										Initials													
6. Channel Alteration	Optimal	Channelization, dredging rock removal or 4-wheel activity (past or present) absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.					Suboptimal	Channelization, dredging or 4-wheel activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.					Marginal	Channelization, dredging or 4-wheel activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.					Poor	Over 80% of reach channelized, dredged or affected by 4-wheelers. Instream habitat greatly altered or removed. Artificial structures have greatly affected flow pattern.				
	SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			
	Comments																							
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category. Rank by quality.		Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by average stream width <7:1.						Occurrence of re-oxygenation zones infrequent; distance between areas divided by average stream width is 7 - 15.						Occasional re-oxygenation area. The distance between areas divided by average stream width is over 15 and up to 25.						Generally all flat water or flat bedrock; little opportunity for re-oxygenation. Distance between areas divided by average stream width >25.				
	SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1			
	Comments																							
8. Bank Stability (score each bank) Determine left or right side by facing downstream.		Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.						Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. If approaching 30% score marginal if banks steep.						Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score poor if banks steep.						Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.				
	SCORE (LB)	Left Bank	10	9	8	7	6	8	7	6	5	4	3	2	1	0								
	SCORE (RB)	Right Bank	10	9	8	7	6	8	7	6	5	4	3	2	1	0								
Comments																								
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream		More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.						70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (< 30%)						50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).						Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped. Non-native vegetation may dominate (> 50%)				
	SCORE (LB)	Left Bank	10	9	8	7	6	8	7	6	5	4	3	2	1	0								
	SCORE (RB)	Right Bank	10	9	8	7	6	8	7	6	5	4	3	2	1	0								
Comments																								
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.		Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.						Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.						Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.						Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.				
	SCORE (LB)	Left Bank	10	9	8	7	6	8	7	6	5	4	3	2	1	0								
	SCORE (RB)	Right Bank	10	9	8	7	6	8	7	6	5	4	3	2	1	0								
Comments																								

Total Score _____ Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW

If score is below guidelines , result of (circle): Natural Conditions or Human Disturbance

Describe

HABITAT ASSESSMENT FIELD SHEET- LOW GRADIENT STREAMS (FRONT)
 (See Protocol E for detailed descriptions and rank information)

STATION ID:					HABITAT ASSESSED BY:															
STREAM NAME:					DATE:					TIME:										
STATION LOCATION:					ECOREGION:					QC: Consensus Duplicate										
WBID/HUC:					GROUP:					ASSOCIATED LOG #:										
	Optimal				Suboptimal				Marginal				Poor							
1. Epifaunal Substrate/ Available Cover	Over 50% of reach has natural, stable habitat for colonization by macroinvertebrates and/or fish. Three or more productive habitats are present.				Natural stable habitat covers 30-50% of stream reach or less than three habitats are present.				Natural stable habitat 10-30% of stream reach. Availability less than desirable, substrate frequently disturbed or removed. Habitat diversity is reduced.				Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
2. Channel Substrate Characterization	Good mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.				Mixture of soft sand, mud or clay; or substrate is fissured bedrock, some root mats and submerged vegetation present.				All mud, clay, soft sand or fissured bedrock bottom, little or no root mat, no submerged vegetation present.				Hard-pan clay, conglomerate or predominantly flat bedrock; no root mat or submerged vegetation.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.				Majority of pools are large-deep very few shallow.				Shallow pools much more prevalent than deep pools.				Majority of pools small-shallow or pools absent.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
4. Sediment Deposition	Sediment deposition affects less than 20% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.				Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of bottom affected. Slight deposition in pools.				Moderate deposition of fine material on old and new bars, 50-80% of bottom affected; sediment deposits at obstructions, constrictions and bends; moderate deposition of pools.				Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				
5. Channel Flow Status. If water backed up by obstructions (beaver dam, log jams, bedrock during low flow) move assessment reach above or below affected area or consider postponing sampling until accurate assessment of stream can be achieved.	Water reaches base of both lower banks throughout reach. Streambed is covered. Minimal productive habitat is exposed.				Water covers > 75% of streambed and/or < 25% of productive habitat is exposed.				Water covers 25-75% of streambed and/or stable habitat is mostly exposed.				Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.							
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Comments																				

HABITAT ASSESSMENT FIELD SHEET- LOW GRADIENT STREAMS (BACK)

Station ID	Date										Initials										
6. Channel Alteration	Optimal	Channelization, dredging or 4-wheel activity absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.					Suboptimal	Channelization, dredging or 4-wheel activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.					Marginal	Channelization, dredging or 4-wheel activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.			Poor	Over 80% of reach channelized, dredged or affected by 4-wheelers. Instream habitat greatly altered or removed. Artificial structures may have greatly affected flow pattern.			
	SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Comments																				
7. Channel Sinuosity (Entire meander sequence not limited to sampling reach)	Optimal	The bends in the stream increase the stream length 3-4 times longer than if it was in a straight line.					Suboptimal	The bends in the stream increase the stream length 2-3 times longer than if it was in a straight line.					Marginal	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.			Poor	Channel straight; waterway has been channelized for a long distance.			
	SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Comments																				
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Optimal	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.					Suboptimal	Moderately stable; infrequent, small areas of erosion o 5-30% of bank eroded. If approaching 30% score marginal if banks steep.					Marginal	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score poor if banks steep.			Poor	Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.			
	SCORE (LB)	Left Bank	10	9			8	7	6			5	4	3			2	1	0		
	SCORE (RB)	Right Bank	10	9			8	7	6			5	4	3			2	1	0		
	Comments																				
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream	Optimal	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.					Suboptimal	70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (< 30%)					Marginal	50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).			Poor	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped. Non-native vegetation may dominate (> 50%)			
	SCORE (LB)	Left Bank	10	9			8	7	6			5	4	3			2	1	0		
	SCORE (RB)	Right Bank	10	9			8	7	6			5	4	3			2	1	0		
	Comments																				
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.	Optimal	Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.					Suboptimal	Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.					Marginal	Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.			Poor	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.			
	SCORE (LB)	Left Bank	10	9			8	7	6			5	4	3			2	1	0		
	SCORE (RB)	Right Bank	10	9			8	7	6			5	4	3			2	1	0		
	Comments																				

Total Score _____ Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW

If score below guidelines, result of (circle): Natural Conditions or Human Disturbance

Describe