DEPARTMENT OF ECOLOGY
State of Washington

Standard Operating Procedure EAP112, Version 1.1

Assessing Bank Erosion Vulnerability

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Purpose of this document

The Washington State Department of Ecology develops Standard Operating Procedures (SOPs) to document agency practices related to sampling, field and laboratory analysis, and other aspects of the agency's technical operations.

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SIGNATURES AVAILABLE UPON REQUEST

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which the Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
3/2/15	1.0	Draft Release	Throughout	Chris Hartman
1/26/17	1.1	Title, footers, general edits, references	All	Meghan Rosewood-Thurman
2/8/17	1.1	Updated glossary terms, edited and added references,	All	Meghan Rosewood-Thurman
2/22/17	1.1	"from portions of Platts, et al. (1987)." 2017a Added language for when no terrace is present. Removed period Removed repeat "Index Station" "See SOP EAP121 (Wolfe, 2017)" 2017b "… most-frequently longer than 500 m." 2017a 2017b Replace top 25% with full station EAP105 or EAP106 Cited Hartman Cited JNRC Re-arranged by SOP# (now a) Re-arranged by SOP# (now b) Spaces after initials Added Wolfe SOP EAP121	1.3 2.3 3.1 3.11 3.12 3.13 3.18 3.21 4.4 4.5 6.6 6.11 10.5 10.7 10.8 10.9 10.10 10.13	Glenn Merritt
2/24/17	1.1	Removed Draft Dates, added reviewers names	Signature Page	Meghan Rosewood-Thurman
5/17/17	1.1	Changed wording to reflect true methods	2.2.4	Meghan Rosewood-Thurman

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for assessing bank erosion vulnerability in rivers and streams for the Watershed Health Monitoring program (WHM). It was largely adapted from pages 70–78 of Archer et al. (2012) and from portions of Platts et al. (1987).

2.0 Applicability

2.1 This SOP contributes to both WHM protocols: Narrow and Wide.

2.2 This method is applied to right and left banks of the main channel at all 11 major transects.

2.2.1 *Bank angle* estimates are applied to a line on each bank per major transect.

2.2.2 *Bank location* estimates are applied to the same line as for angle.

2.2.3 *Bank cover* estimates are applied to a zone that extends across the top 25% of a bank station area:

2.2.4 *Bank failure* estimates are applied to the entire bank at the same length of the station.

2.3 This SOP requires that the procedures outlined in the WHM Site Verification and Layout SOP EAP106 (Merritt, 2017) have already been performed for the Data Collection Event (DCE).

3.0 Definitions

3.1 AOB-Top: Top angle observation boundary. This is the upper observation boundary at each bank of a major transect. Normally, this occurs at the first terrace at or above the bankfull stage. Exceptions are described within this SOP (Figures 2, 3, 4, and 5). Where no terrace is present, the AOB-Top is at 50 cm above the bankfull channel.

3.2 AOB-Bottom: Bottom angle observation boundary. This is the lower observation boundary at each bank of a major transect. Normally this occurs at the junction of the streambed and streambank. Exceptions are described within this SOP (Figures 2, 3, 4, and 5).

3.3 Bankfull margin: A term used to describe the limit of the stream channel. It is a line on the bank that coincides with the water's elevation during bankfull flow.

3.4 Bankfull stage: This stage is delineated by the elevation point of incipient flooding, indicated by deposits of sand or silt at the active scour mark, break in stream bank slope, perennial vegetation limit, rock discoloration, and root hair exposure (Endreny 2003).

3.5 Bank station: For this SOP, we are describing an area of the bank that is centered on each major transect at each bank. It extends vertically from the AOB-Top to the AOB-Bottom. For the Narrow Protocol, it extends horizontally 5 meters upstream and downstream of the transect. For the Wide Protocol, it extends 10 meters upstream and downstream from the transect (Figure 7 and 9).

3.6 Bedrock: For WHM, bedrock as any rock greater than 4 m diameter.

3.7 Cobble: Rocks of diameter size >64 mm – 250 mm.

3.8 Depositional banks: Banks with fresh fluvial deposits such as point bars. For this SOP, depositional banks are treated differently depending upon the size. When below the bankfull margin, the deposits are treated as part of the streambed. When deposits cover the terrace at or above bankfull margin, they are treated as part of the streambank (Figure 4).

3.9 DCE: The *Data Collection Event* is the sampling event for the given protocol. Data for a DCE are indexed using a code that includes the site ID followed by the year, month, day, and the time (military) for the start time of the sampling event. For example: WAM06600-000222-DCE-YYYY-MMDD-HH:MM. One DCE should be completed within one working day, lasting 4–6 hours, on average.

3.10 EAP: Environmental Assessment Program

3.11 Hardpan: A layer of earth that has become relatively hard and impermeable usually through mineral deposits. A chemically-hardened layer where soil particles are cemented together with organic matter of SiO_2, sesquioxides, or $CaCO_3$ (Armantrout, 1998).

3.12 Index station: The distinct point location mapped by the site coordinates obtained from the Washington Master Sample List. The index station is called “X” and is generally located at major transect F; however the point may occur at any elevation in the stream between transects A and K.

3.13 Large Woody Debris (LWD): Dead fallen wood of at least 10 cm diameter and at least 1 m long (eastern regions) or at least 2 m long (western regions). See SOP EAP121 (Wolfe, 2019). Some tree species may still remain partly alive, while the majority of the fallen trunk lies dead in or over the stream (e.g., crack willow, *Salix fragilis*). If the only living features of the fallen tree are small re-sprouted stems (<minimum LWD size class), these "live" nurse trees should still be considered LWD.

3.14 Left bank: For WHM, a person facing downstream will have the left bank on their left side.

3.15 Main channel: Channels in a stream are divided by islands (dry ground that rises above bankfull stage). Main channels contain the greatest proportion of flow.

3.16 Major transect: One of 11 equidistant transects across the length of a site. These transects run perpendicular to the thalweg and are labeled as follows: A (furthest downstream), B, C, D, E, F, G, H, I, J, and K (furthest upstream).

3.17 Narrow protocol: The set of Watershed Health Monitoring SOPs that describe data collection at wadeable sites with an average bankfull width of less than 25 m at the index station.

3.18 Pool: For WHM, this is a habitat unit that has a maximum depth at least 1.5 times its crest depth. Pools include dammed pools, plunge pools, and scour pools. For details, refer to SOP EAP120 (Merritt, 2018).

3.19 QAMP: Quality Assurance Monitoring Plan. The QAMP for WHM is Cusimano *et al* (2006). An updated version is in early stages of development.

3.20 Right bank: For WHM, a person facing downstream will have the right bank on their right side.

3.21 Site: A site is defined by the coordinates provided to a sampling crew and the boundaries established by the protocol's site layout method (Hartman, 2017 (SOP EAP105) for the Wide Protocol; Merritt, 2017 (SOP EAP106) for the Narrow Protocol). Typically, a site is centered on the index station and equal in length to 20 times the average of 5 bankfull width measurements. Sites cannot be longer than 2 km nor shorter than 150 m. Narrow protocol sites range from 150 m to 500 m long. Wide Protocol sites are up to 2 km long, and most frequently longer than 500 m. The most downstream end of a site coincides with major transect A; the most upstream end coincides with major transect K.

3.22 Streambed: Substrate plane, bounded by banks. Also called the stream bottom (Armantrout, 1998).

3.23 Streambank: Ground bordering a channel above the streambed and below the level of rooted vegetation that often has a steep gradient and exhibits a distinct brake in slope from the stream bottom. The portion of the channel that restricts lateral movement of water during normal streamflow (Armantrout, 1998).

3.24 STR: Status and Trends Regions (STRs) are based on Salmon Recovery Regions (SRRs) that were described by the Governor's Salmon Recovery Office (JNRC, 1999).

Membership is as follows:

3.25 Puget STR: Puget Sound, & Hood Canal/Puget Sound SRRs.

3.26 Coastal STR: Coastal SRR.

3.27 Lower Columbia STR: Lower Columbia SRR.

3.28 Mid Columbia STR: Mid Columbia SRR.

3.29 Upper Columbia STR: Upper Columbia SRR.

3.30 Snake STR: Snake SRR.

3.31 Northeast WA STR: Northeast Washington SRR.

3.32 Unlisted STR: No SRR identified.

3.33 Thalweg: Path of a stream that follows the deepest part of the channel (Armantrout, 1998). For WHM, we emphasize Armantrout's use of the word "path" because the thalweg longitudinal profile excludes (sometimes deeper) side pools that are not part of the dominant flow path.

3.34 Thalweg station or transect: One of one hundred (100) equidistant measurement locations in the thalweg, across the length of a site. For example, the thalweg stations at/above each major transect are named as follows:

- A0, A1, A2, A3, A4, A5, A6, A7, A8, A9,
- B0. B1, B2, B3, B4, B5, B6, B7, B8, B9,
- C0, C1, C2, C3, C4, C5, C6, C7, C8, C9,
- …
- J0, J1, J2, J3, J4, J5, J6, J7, J8, J9, and
- K0.

3.35 Undercut bank: Bank with a cavity below the [bankfull] waterline. It is maintained by scour from substrates and high water velocities (Armantrout, 1998).

3.36 WHM: Watershed Health Monitoring, a status and trends monitoring program within the Environmental Assessment Program at the Washington State Department of Ecology.

3.37 Wide protocol: The set of WHM SOPs that describes the sample and data collection at non-wadeable sites or sites wider than 25 m bankfull width. It is an abbreviated version of the Narrow Protocol and is typically accomplished by use of rafts.

3.38 Woody vegetation: Perennials, such as trees and shrubs, which have persistent woody stems and branches. We exclude vines and sub-shrubs as listed in USDA (2013).

4.0 Personnel Qualifications/Responsibilities

4.1 This SOP pertains to trained field staff in Ecology's Environmental Assessment Program.

4.2 All field staff must comply with the requirements of the EAP Safety Manual (Ecology, 2019).

4.3 All field staff must have completed the annual WHM field training session. This includes a briefing on project objectives, details of the project Quality Assurance Monitoring Plan (QAMP), and both field protocols.

4.4 Locating stations for estimating bank erosion vulnerability requires first performing Site Verification and Layout, SOPEAP106 (Merritt, 2017).

4.5 Estimating bank positions requires knowledge of Quantifying Habitat Units, SOP EAP120 (Merritt, 2018).

4.6 All field staff must be familiar with the electronic data recording tablet and web-based field forms that are required to record and submit data for the WHM program, SOP EAP125 (Janisch, 2017).

4.7 Field staff must be annually trained to minimize the spread of invasive species. See SOP EAP070 (Parsons, et al., 2018).

5.0 Equipment and Supplies

5.1 Field tablet (charged), loaded with the electronic field forms.

5.2 Binoculars (Wide Protocol), for observing the opposite banks.

5.3 Pre-cleaned gear for wading or boating. Prior to arrival, the gear will be disinfected to minimize the spread of invasive species from site to site. See SOP EAP070 (Parsons, et al., 2018).

6.0 Summary of Activity

6.1 Pre-observation

6.1.1 Establish the 11 major transects using SOP EAP106 (Merritt, 2017) or SOP EAP 105 (Hartman, 2017).

6.2 General Considerations

6.2.1 Make categorical estimates of four bank features: angle, location, cover, and failure. Make these estimates at both banks of all 11 major transects (22 stations total).

Electronically record the estimates on the tablet. Use the Transect page under the Channel tab of the WHM electronic field forms. Figure 1 highlights the location of the "Bank Angle", "Bank Location", "Bank Cover", and "Bank Failure" fields for both the right and left banks.

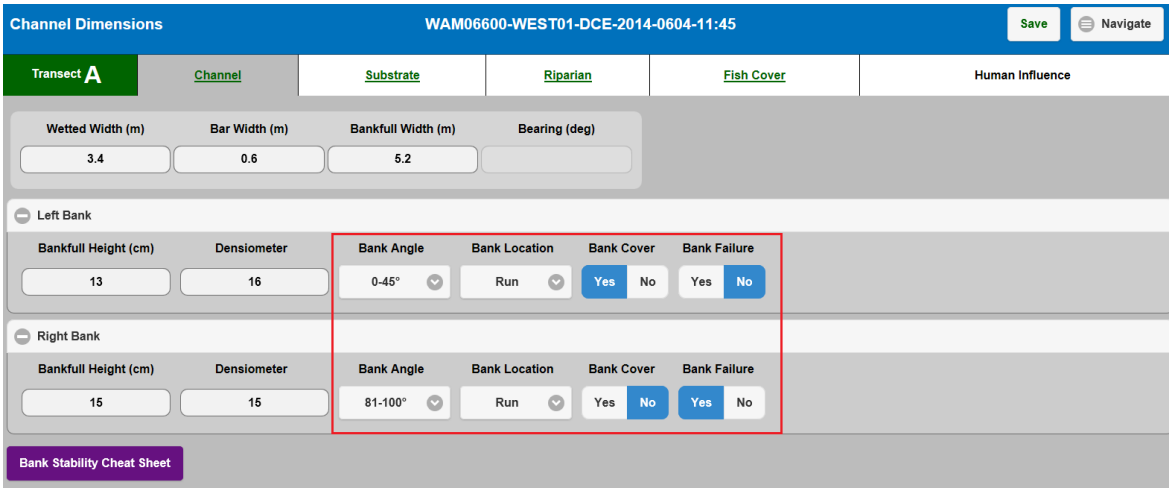

Figure 1. Location of the "Bank Angle," "Bank Location," "Bank Cover," and "Bank Failure" fields within the WHM electronic field forms.

6.3 Bank Angle

6.3.1 **Identify the AOB-Top** on each bank. This will vary with bank type (see Figures 2, 3, and 4).

6.3.1.1 Where terraces occur within 50 cm of the bankfull margin: set the AOB-Top at the first flat depositional feature at or above the bankfull margin.

6.3.1.2 Where no terrace is present, set the **AOB-Top** at 50 cm above the bankfull channel.

6.3.1.3 Where there is an undercut bank (overhung bank), position the **AOB-Top** at the most streamward edge of the bank.

6.3.1.4 On depositional banks (e.g., point bars) where unconsolidated sediment obscures the terrace or bankfull margin, set the **AOB-Top** at the estimated bankfull margin, on the sediment pile (Figure 4, right side).

6.3.1.5 For depositional banks without an obscured bankfull margin (Figure 4, left side), set the **AOB-Top** normally (as in 6.3.1.1 and 6.3.1.2)

6.3.2 **Identify the AOB-Bottom** on each bank (Figures 2, 3, and 4). It will always be below the bankfull margin.

6.3.3 For most banks, The **AOB-Bottom** will normally be where the streambed meets the streambank. Use available clues such as:

6.3.3.1 Change in slope from relatively flat (streambed) to relatively vertical (streambank)

6.3.3.2 Change in substrate from relatively coarse (streambed) to relatively fine (streambank).

6.3.4 On depositional banks, where deposited sediment obscures the streambed/streambank transition (Figure 4), either

6.3.4.1 Set the **AOB-Bottom** on top of the deposition pile (if the pile is fully below the bankfull margin), or

6.3.4.2 Set the **AOB-Bottom** on the streambed, adjacent to the pile (if pile extends above the bankfull margin or first terrace).

6.3.5 **Draw an imaginary line** from **AOB-Top** to **AOB-Bottom**, on each bank. Then imagine how each line intersects a horizontal plane.

6.3.6 **Estimate the angle** of this line relative to a horizontal plane. Record the bank angle (Figures 2, 3, and 5) according to the following categories:

6.3.6.1 Low (0–45°),

6.3.6.2 Moderate (46–80°),

6.3.6.3 Vertical (81–100°),

6.3.6.4 Overhung (>100°).

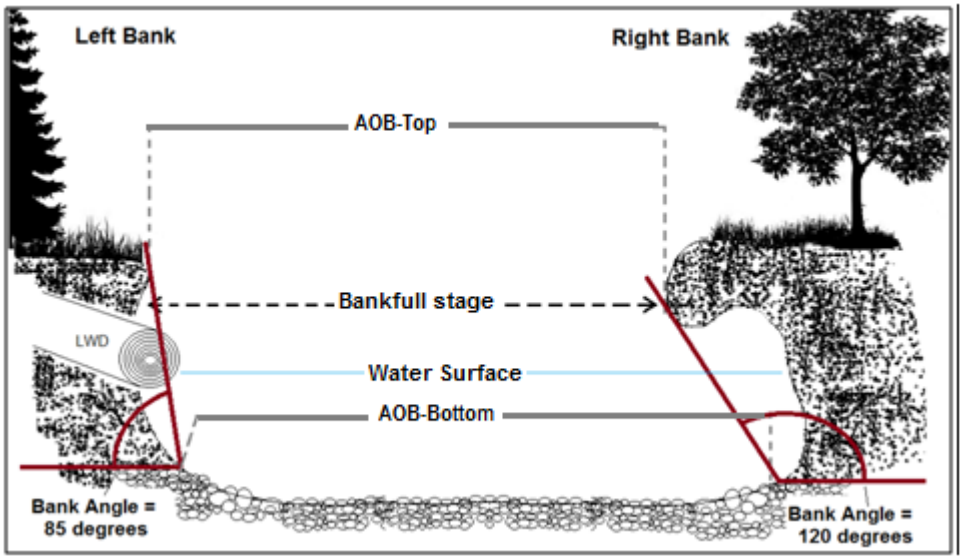

Figure 2. An example of a vertical bank angle (left) and of an overhung bank (right).

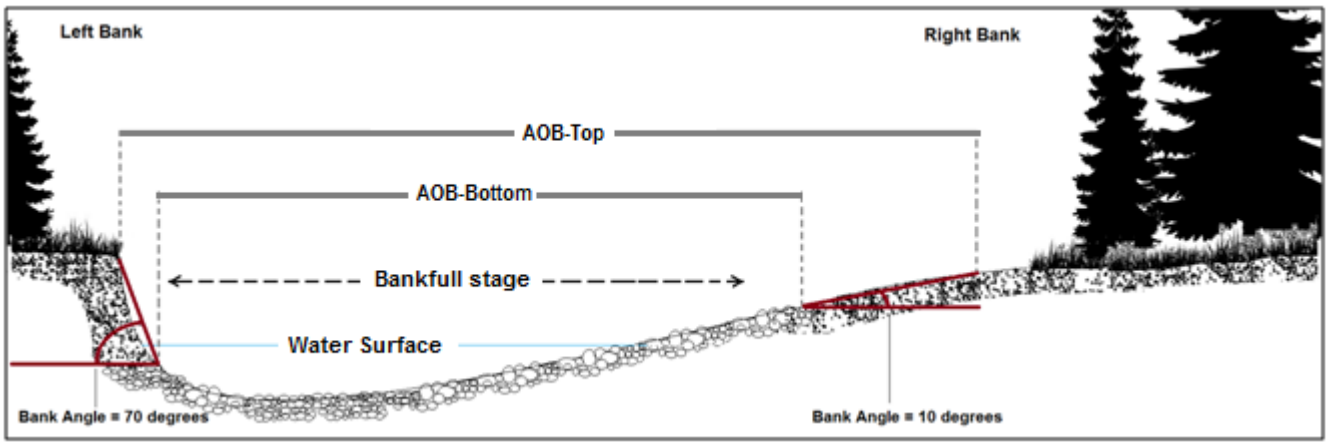

Figure 3. An example of a moderate bank (left) and a low bank (right).

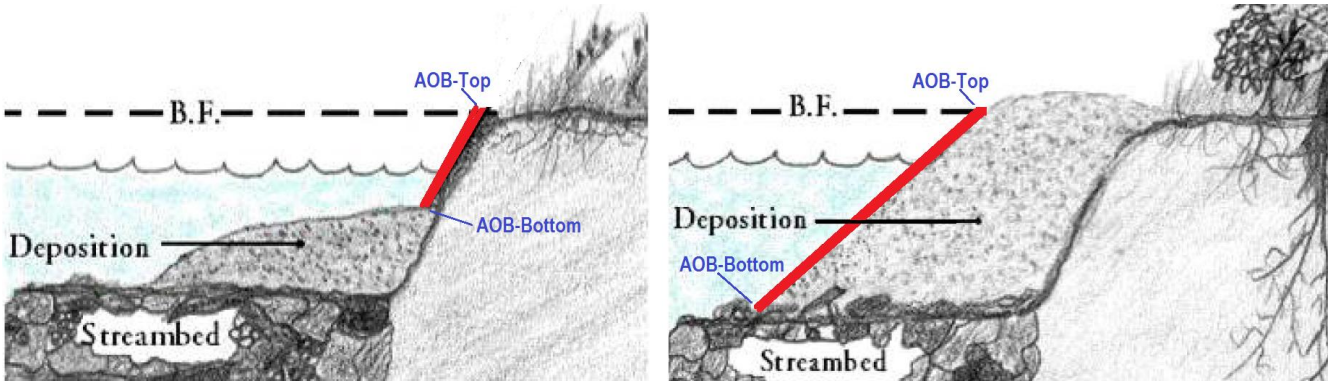

Figure 4. AOB-Top and AOB-Bottom for depositional banks.

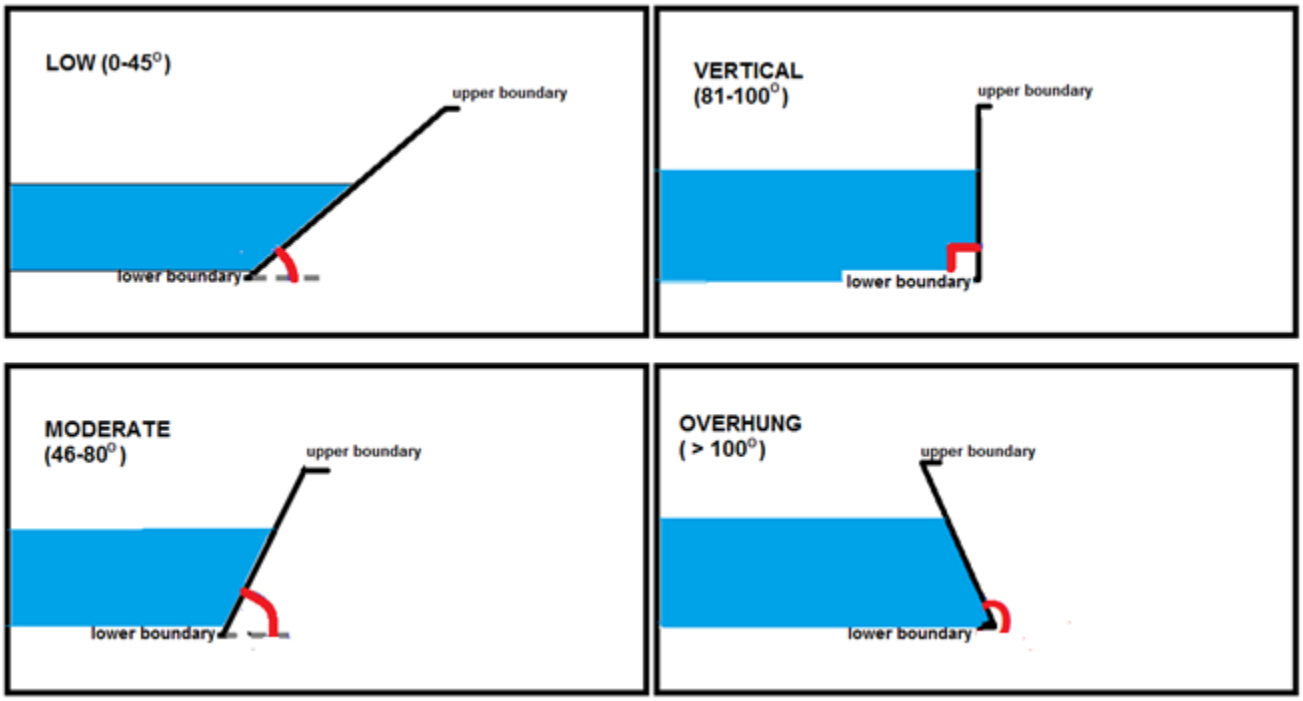

Figure 5. Bank angle categories.

6.4 Bank Location: **In**, **Out**, or **Run**

6.4.1 Determine whether or not each major transect crosses a pool of any type.

6.4.2 If the transect does not cross a pool, record **Run** for both banks

6.4.3 If the transect crosses a pool, then determine which bank is closer to the thalweg.

6.4.3.1 The bank that is closer to the thalweg should be marked as **Out**, meaning the outside (erosional) part of a river bend (Figure 6).

6.4.3.2 The bank that is further from the thalweg should be marked as **In**, meaning the inside (depositional) part of a river bend (Figure 6).

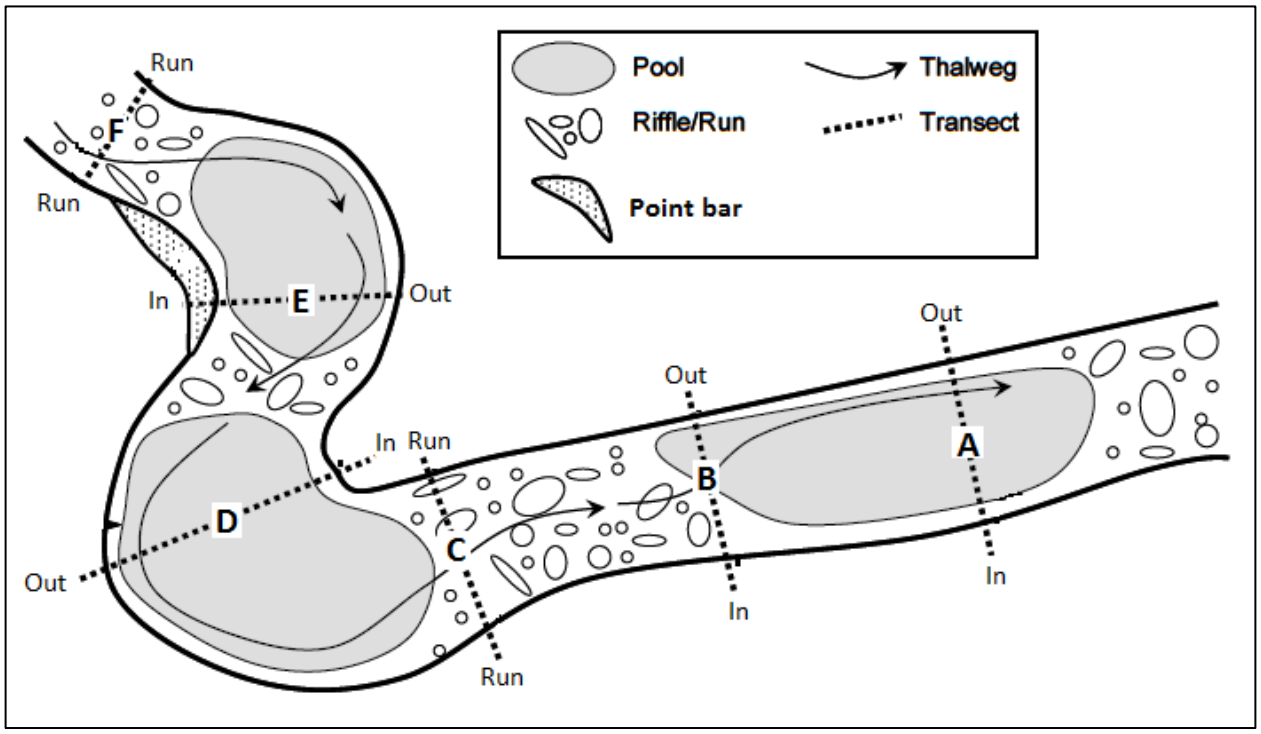

Figure 6. Hypothetical bank locations for six transects (A–F).

6.5 Bank Cover Assessment at top 25% of bank station.

6.5.1 At each bank, first establish the limits of the bank station (Figure 7). For the Narrow Protocol, it extends horizontally 5 meters upstream and downstream of the transect. For the Wide Protocol, it extends 10 meters upstream and downstream from the transect.

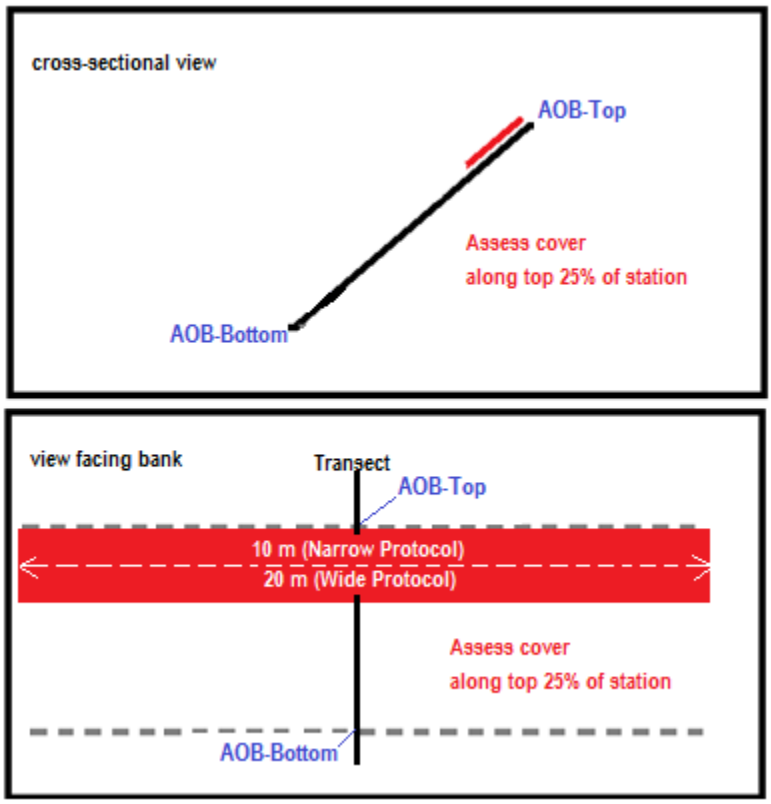

Figure 7. The bank station for assessing bank cover: cross-section view and view facing bank.

6.5.2 At each bank along the top 25% of the station, estimate the cumulative percent bank cover (Figure 8) provided by any of the following cover types:

6.5.2.1 **Large rocks:** Cobble or larger rocks. Include bedrock and hardpan.

6.5.2.2 **Large woody debris:** Pieces should be at least 10 cm diameter and 1 m long (in eastern STRs) or 2 m long (western STRs).

6.5.2.3 **Live roots** or rooted, woody vegetation

6.5.3 Record *YES* for bank cover if the cover estimate is greater than 50%.

6.5.4 Record *NO* otherwise.

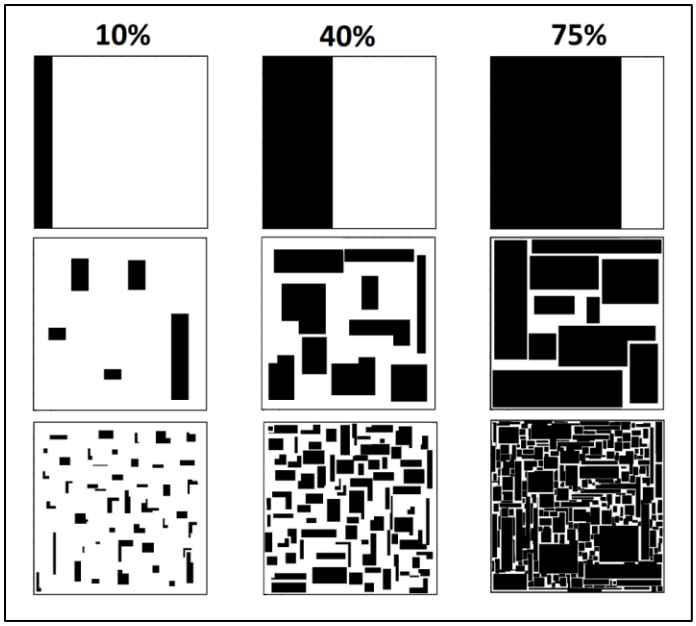

Figure 8. Comparison chart for 10%, 40%, and 75% cover.

6.6 Bank Failure Assessment at full bank station.

6.6.1 Refer to the same bank station used for assessing bank cover.

6.6.2 Assess the entire station (Figure 9) for signs of bank failure. If you observe that the bank is cracking, fracturing, or slumping record *YES*. Otherwise, record *NO*.

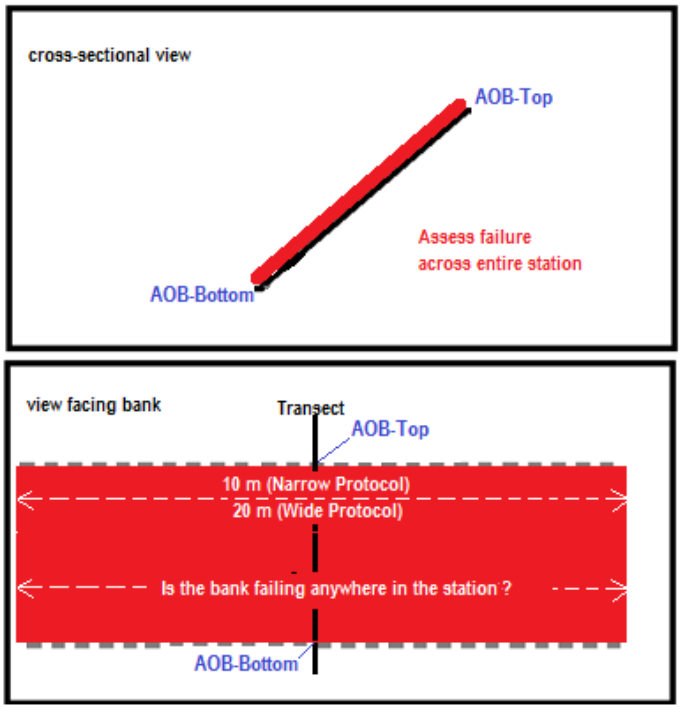

Figure 9. The bank station for assessing bank failure: cross-section view and view facing bank.

7.0 Records Management

7.1 Refer to the WHM SOP EAP125 (Janisch, 2017). This describes the process for validating, loading, and committing completed WHM electronic field forms to the WHM database.

8.0 Quality Control and Quality Assurance Section

8.1 QA/QC procedures are addressed in the QAMP for this project.

9.0 Safety

9.1 All field staff must comply with the requirements of the EAP Safety Manual (Ecology 2019).

10.0 References

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