Technical Memorandum

To: Walsh County Water Resource District

From: Zach Herrmann, PE
Houston Engineering, Inc.

Subject: Bylin Dam Environmental Assessment – Appendix D-8: Stream Classification and Riparian Area Assessment

Date: May 1, 2024

Project: HEI 7135-0037 NB FR Dam No. 1 (Bylin Dam) Rehab Plan

BACKGROUND

Bylin Dam is located on the North Branch Forest River in Sections 5 and 6 of Norton Township in Walsh County, North Dakota. A Watershed Plan – Environmental Assessment for the review of rehabilitation of Bylin Dam is currently underway. The purpose of the Watershed Plan is to bring Bylin Dam into compliance with current NRCS and North Dakota State Water Commission (SWC) dam performance, design, and safety standards while maintaining the current flood protection and recreational opportunities. As part of the Watershed Plan and rehabilitation effort, an assessment of the North Branch Forest River and riparian areas near the dam is required. The purpose of the analysis completed in this technical memorandum is to supplement the development of a conceptual design for an alternative where the dam is decommissioned, or for a no-action alternative where a breach of the dam is possible.

The Rosgen Stream Classification System was used to assess the condition of the North Branch Forest River both upstream and downstream of Bylin Dam. Through this effort, the stream was classified using a Level II assessment out of the *River Stability Field Guide* (Rosgen, 2014a). The Level II assessment involves field measurements to describe the morphology of the river, and to classify the stream being analyzed. The Rosgen Stream Classification System has been widely used in the Midwest to describe the geomorphic condition of rivers. Stream classification is dependent on various field measurements. Experience with fluvial geomorphology, engineering, and hydrology is required for the staff conducting the field measurements and observations.

Rapid Bioassessment Protocols (RBP) (Barbour, Gerritsen, Snyder, & Stribling, 1999) were used to assess the biological condition of riparian areas for the North Branch Forest River in a cost-effective manner. For the purposes of the Bylin Dam rehabilitation effort, the condition of riparian areas was evaluated by using the visual-based habitat assessment in Section 5.2 of *Rapid Bioassessment Protocols for Use in Stream and Wadeable Rivers* (Barbour, Gerritsen, Snyder, & Stribling, 1999). The visual-based habitat assessment provides a qualitative rating for aquatic habitat. The different elements of aquatic habitat to be evaluated include channel substrate, channel morphology, bank structure, and vegetation.

In addition to the stream classification and visual-based habitat assessment, a Level III river stability assessment that involves the collection and analysis of specific channel stability variables was completed to predict river stability. More information on the Level III assessment is available in the *River Stability Field Guide* (Rosgen, 2014a).

DATA ACQUISITION

Prior to any field work, an offsite review was conducted to determine appropriate locations to collect data. The offsite review included a review of current and historical aerial imagery, a review of the topography in the region based on LiDAR data collected in 2008 and 2009, and a review of observations made during prior field visits. Ultimately the observation locations for the Rosgen Stream Classification analyses are determined in the field and are based on good bankfull channel indicators and riffle sections that are representative of the overall reach. Observations for the RBP assessment were made at the same locations that the Rosgen Stream Classification data was collected.

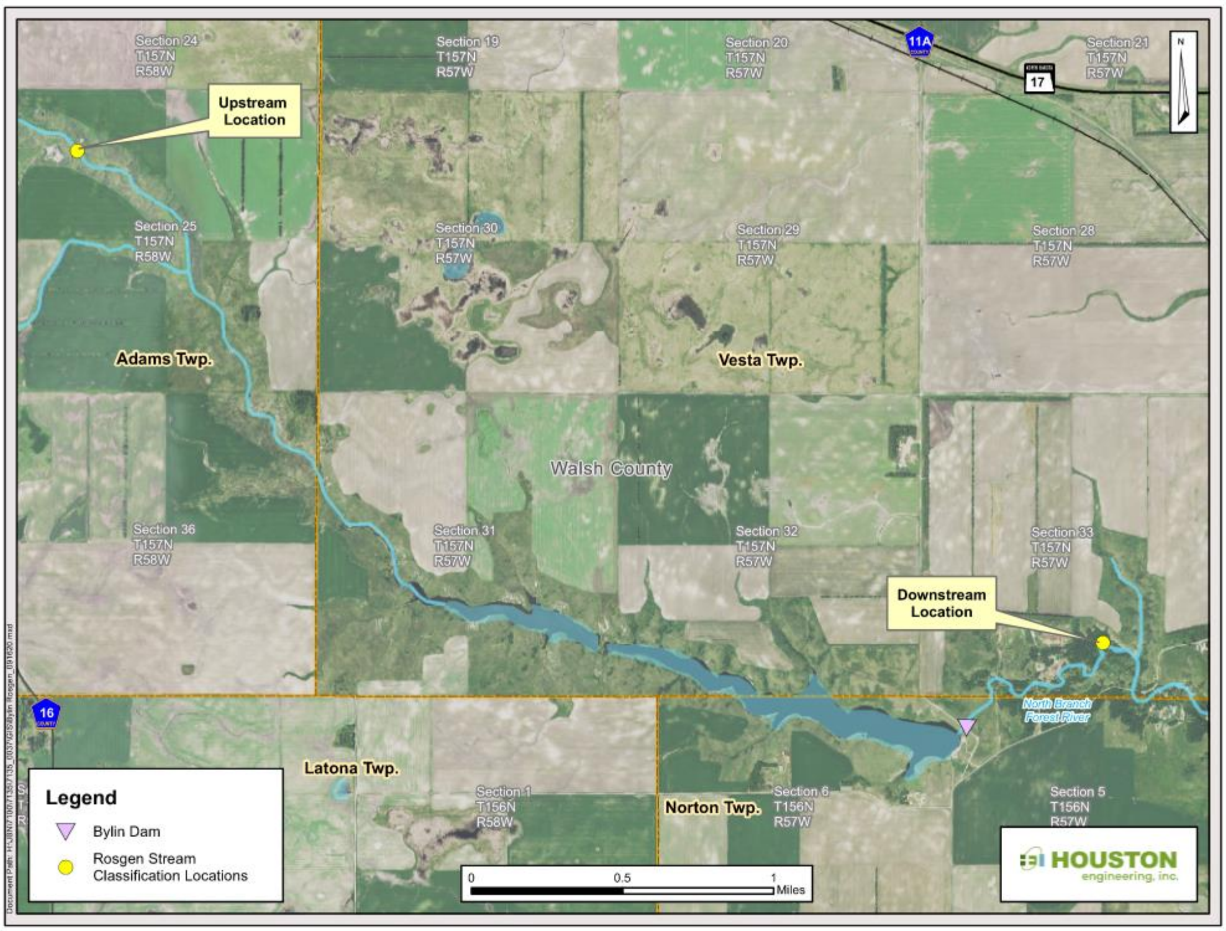


Figure D-8-1: Location Map of Data Collection Sites for Rosgen Stream Classification

The Rosgen Stream Classification location upstream of Bylin Dam was selected where the existing reservoir, bridges, or culverts would not influence the data. The observation location downstream of the dam was selected because it would not be impacted by the immediate release of the principal and/or auxiliary spillway of the dam, bridges, or culverts. Both locations were selected because they have good bankfull channel indicators and representative riffle cross sections. The locations where data was collected for the analysis are shown in Figure D-8-1: Location Map of Data Collection Sites for Rosgen Stream ClassificationFigure D-8-1.

The fieldwork for the Rosgen Stream Classification and RBP analysis took place in the summer of 2020. Staff experienced with environmental science, hydrology, engineering, and fluvial geomorphology conducted the fieldwork. Fieldwork for the Rosgen Stream Classification consisted of marking good channel bankfull indicators, marking appropriate riffle cross section locations to be surveyed at a later date, collecting data on riverbed material, and recording various other observations necessary for a Level II stream classification and Level III river stability assessment. Topographic survey data was collected for the bankfull elevations and riffle cross sections in the summer of 2020 shortly after those locations were marked by the field staff. Surveyed cross section data includes the channel thalweg, low bank elevations, and any other elevation breaks that occurred within the cross section. Survey data was collected using RTK GPS equipment, and LiDAR was used to supplement topography data outside of the survey extents.

Fieldwork for the RBP assessment involved filling out the Habitat Assessment Field Data Sheets included in Appendix A-1 of *Rapid Bioassessment Protocols for Use in Stream and Wadeable Rivers* (Barbour, Gerritsen, Snyder, & Stribling, 1999). The 10 categories included on the data sheets are described in Section 5.2 of *Rapid Bioassessment Protocols for Use in Stream and Wadeable Rivers*. Those 10 categories were used to qualitatively assess the habitat of the river and adjacent riparian areas in the field. The categories evaluated are listed below.

1. Epifaunal Substrate/Available Cover
2. Pool Substrate Characterization
3. Pool Variability
4. Sediment Deposition
5. Channel Flow Status
6. Channel Alteration
7. Channel Sinuosity
8. Bank Stability
9. Bank Vegetative Protection
10. Riparian Vegetative Zone Width

The rating system utilized for RBP involves applying numerical values to each of the categories from 0 to 20 with higher numbers indicating a more optimal aquatic habitat condition for the region. Table D-8-1 shows the different conditional categories used when a total rating number is computed at each RBP location.

Table D-8-1: RBP Conditional Categories Rating System

Condition Category	Total Rating
Poor	0 - 59
Marginal	60 - 109
Sub-Optimal	110 - 159
Optimal	160 - 200

DATA ANALYSIS

After all necessary data was acquired from either the offsite review or from field reconnaissance, the data analysis was conducted for the stream classification (Level II assessment), the RBP assessment, and the river stability prediction (Level III assessment).

STREAM CLASSIFICATION – LEVEL II ANALYSIS

Field data is used to determine parameters necessary to complete the Rosgen Stream Classification. After stream classification, the data is compared to regional curves developed based on stream classification work completed in northeastern North Dakota.

Stream Classification

The parameters determined upstream and downstream of Bylin Dam are shown in Table D-8-2. For definitions or further clarification on each of the parameters listed in Table D-8-2, refer to the *River Stability Field Guide* (Rosgen, 2014a). To classify the North Branch Forest River, the results shown in Table D-8-2 are used along with the Rosgen Stream Classification key shown in Figure D-8-2 (Figure D-8-2 is from the *River Stability Field Guide* (Rosgen, 2014a)).

First, the parameters upstream of Bylin Dam were analyzed to determine the stream classification where Bylin Dam would presumably have little to no effect on the stream. Starting at the top of Figure D-8-2, the North Branch Forest River is a single thread channel with an entrenchment ratio of about 8.35. Therefore, the channel is slightly entrenched. The width-to-depth ratio is 9.4, which falls in the category of a very low width-to-depth ratio. The sinuosity of the channel is 1.13, which is considered a low value. Even though the sinuosity of the channel is lower than expected based on the flow chart in Figure D-8-2, the data indicates that the North Branch Forest River upstream of Bylin Dam is an E type stream because of the entrenchment ratio and width-to-depth ratio.

Table D-8-2: Rosgen Classification Parameters

Parameter	Location	
	Upstream of Bylin Dam	Downstream of Bylin Dam
Bankfull Width (W_{bkf})	13.57 ft	12.00 ft
Bankfull Mean Depth (d_{bkf})	1.44 ft	1.58 ft
Bankfull Cross-Sectional Area (A_{bkf})	19.6 ft^2	18.98 ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf})	9.39 ft/ft	7.59 ft/ft
Bankfull Maximum Depth (d_{max})	2.88 ft	2.77 ft
Flood-Prone Area Width (W_{fpa})	113.35 ft	37.55 ft
Entrenchment Ratio (ER)	8.35 ft/ft	3.13 ft/ft
Channel Materials (Particle Size Index D_{50})	5 mm	5 mm

Average Water Surface Slope (S)	0.0029 ft/ft	0.0026 ft/ft
Channel Sinuosity (k)	1.13 ft/ft	1.80 ft/ft

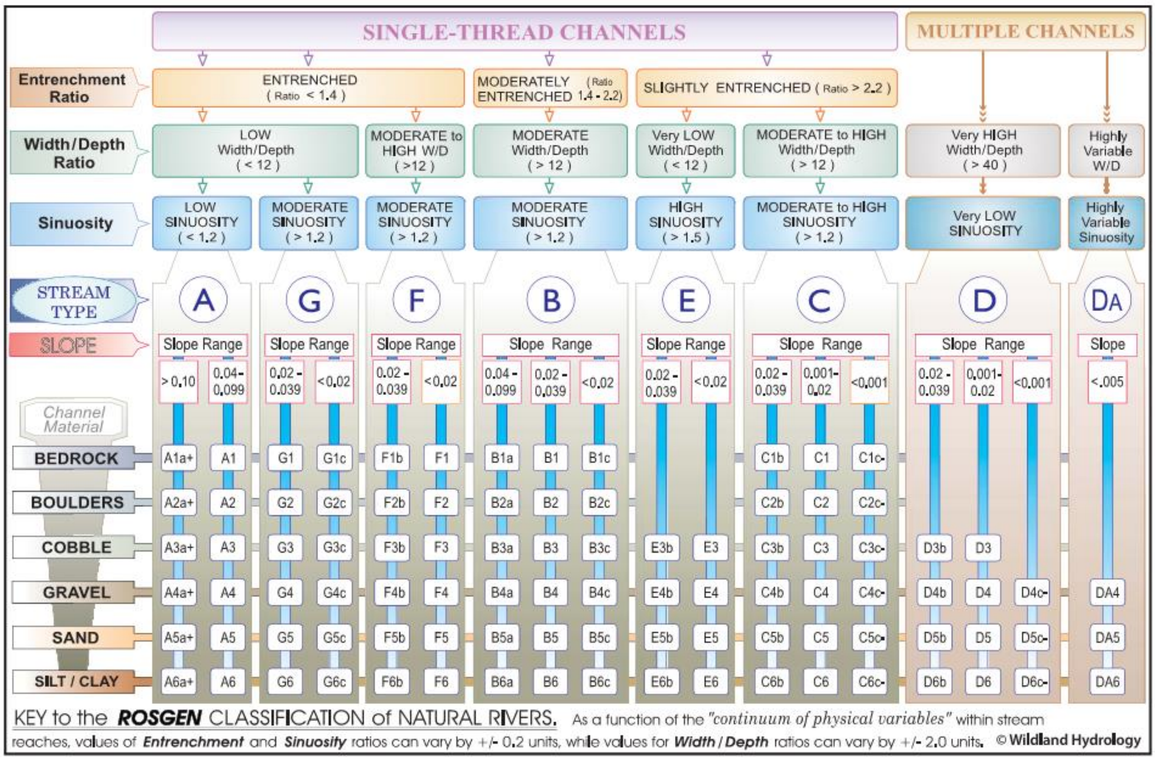


Figure D-8-2: Rosgen Stream Classification Key for Natural Rivers (Rosgen, 2014a)

Median particle size is also necessary to obtain a more specific classification. The median particle size of the channel upstream and downstream of Bylin Dam is determined via a pebble count conducted in the field. The particle distribution for the North Branch Forest River upstream and downstream of Bylin Dam is shown in Figure D-8-3. Based on the pebble count data provided in Figure D-8-3, the median particle size of the channel upstream of Bylin Dam is approximately 5 millimeters. Given this information, and the average water surface slope of the channel upstream of Bylin Dam, the North Branch Forest River upstream of Bylin Dam can be classified as an E4 type stream.

Downstream of Bylin Dam, the entrenchment ratio is 3.13 indicating that the stream is slightly entrenched. The width-to-depth ratio is 7.6, which is very low. The sinuosity of the channel is 1.8, which is considered high. Based on this data, the North Branch Forest River downstream of Bylin Dam is an E type stream. This matches the stream type for the North Branch Forest River upstream of Bylin Dam.

The median particle size in the downstream channel is also determined via a pebble count. The pebble count data for the North Branch Forest River downstream of Bylin Dam is shown in Figure D-8-3. The median particle size of the downstream channel is approximately 5 millimeters. Based on this information and the average water surface slope of the channel, the North Branch Forest River downstream of Bylin Dam can be classified as an E4 type stream. Therefore, the North Branch Forest River both upstream and downstream of Bylin Dam is an E4 type stream.

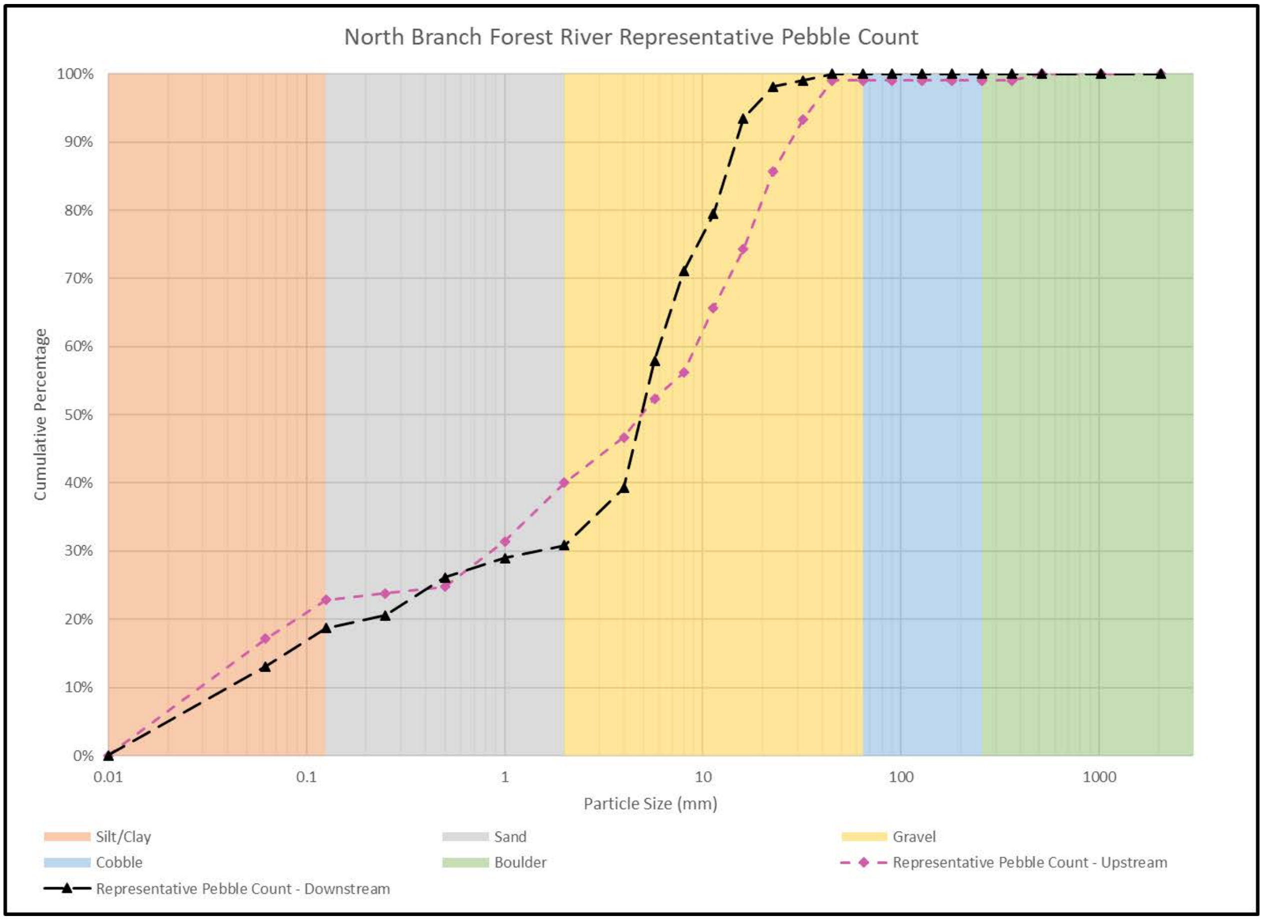


Figure D-8-3: Forest River Pebble Count Data for the North Branch Forest River

Regional Data Analysis

Regional data for northeastern North Dakota was obtained from the NRCS and previous studies done for other dam rehabilitations in the area by Houston Engineering Inc. Data collected for a geomorphic analysis through a Regional Cooperation Partnership Program on the Tongue River (also located in the northeastern North Dakota) was also obtained to be able to compare the data obtained for the North Branch Forest River. Figure D-8-4a, Figure D-8-4b, Figure D-8-4c, and Figure D-8-4d show the regional data and the North Branch Forest River data plotted on logarithmic axes with drainage area on the x-axis. The y-axis represents key parameters used with the Rosgen Stream Classification. The blue dots show the regional data and the blue dotted line shows the general trend of the data. The orange dots represent the data for the North Branch Forest River.

In general, the data from the North Branch Forest River is slightly above the trendlines plotted for the regional data. This is an indication that the bankfull cross sectional area, mean depth, and discharge are slightly higher than expected when compared to other streams in northeastern North Dakota. However, the data are not significantly distant from the plotted trendline and are considered acceptable for this analysis.

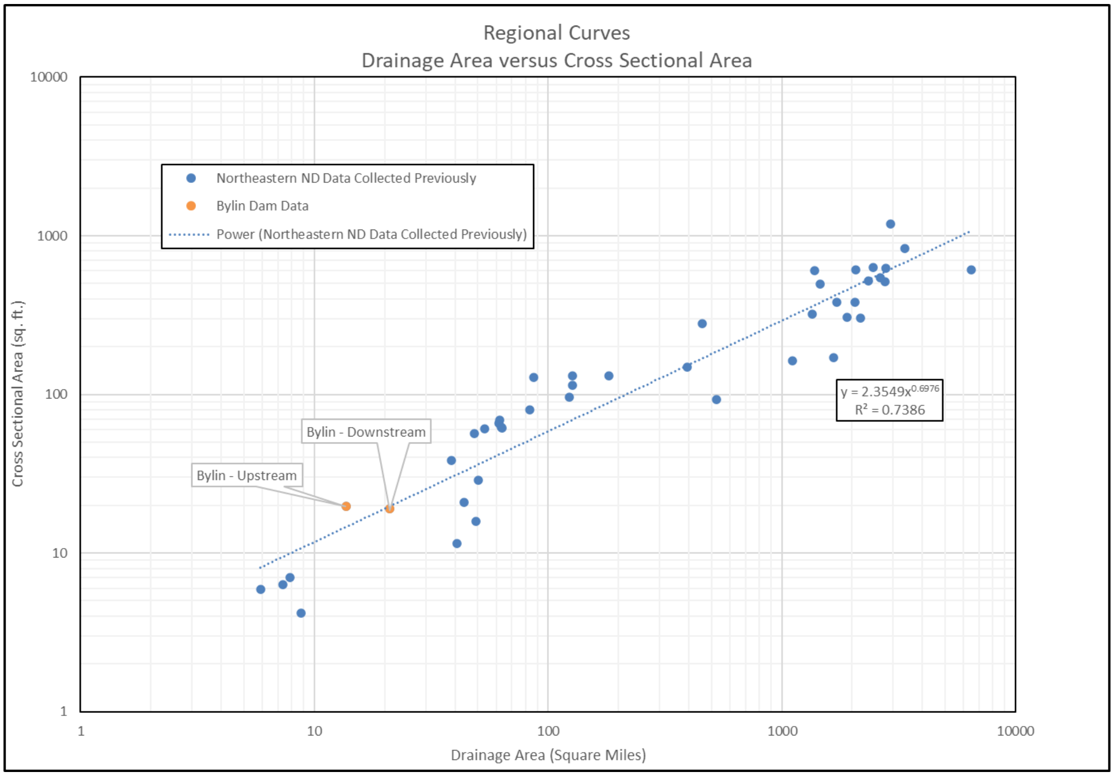


Figure D-8-4a: Regional Curves – Drainage Area vs Bankfull Flow Area

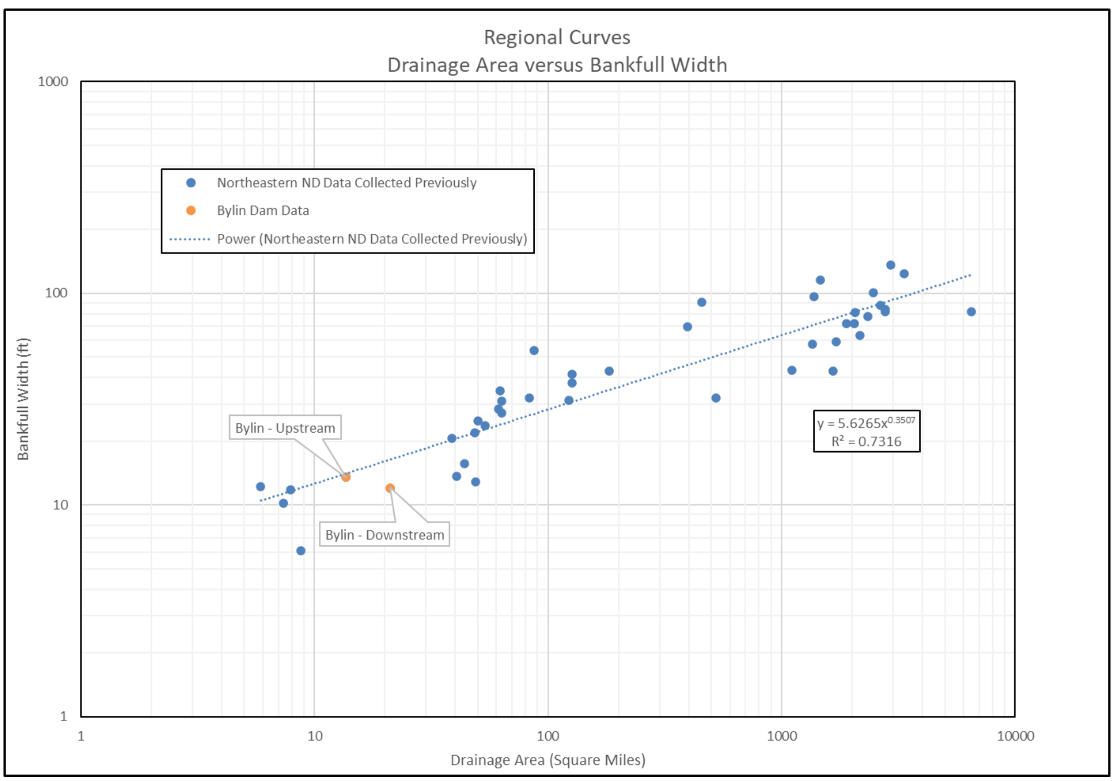


Figure D-8-4b: Regional Curves – Drainage Area vs Bankfull Width

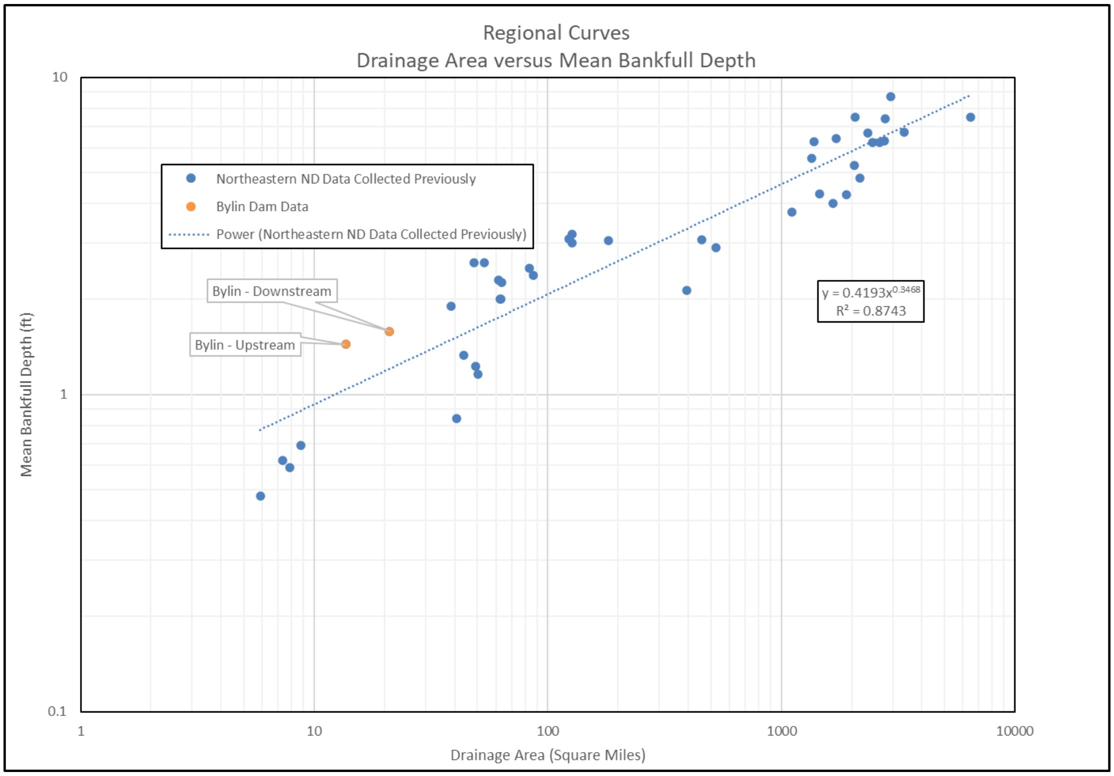


Figure D-8-4c: Regional Curves – Drainage Area vs Bankfull Mean Depth

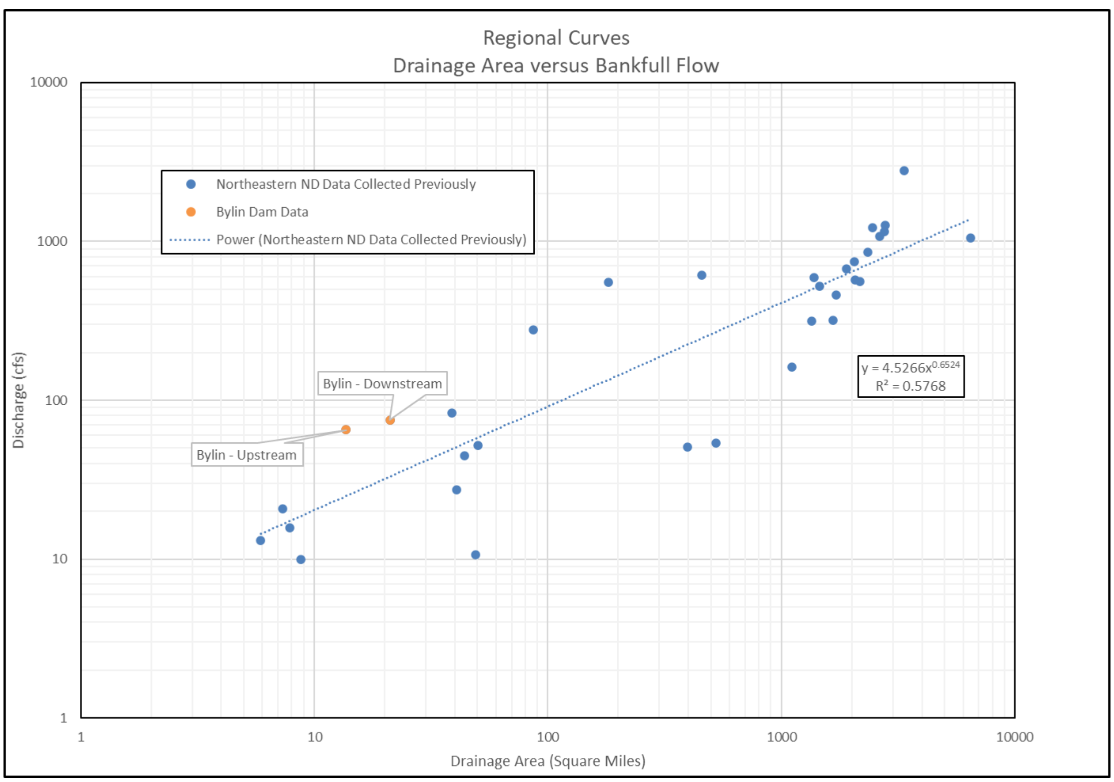


Figure D-8-4d: Regional Curves – Drainage Area vs Bankfull Flow

RAPID BIOASSESSMENT PROTOCOLS

Observations were made in the field for the 10 categories involved in the riparian area assessment using RBP. After the 10 categories were rated for the observation locations upstream and downstream of the dam the data was compiled and is shown in Table D-8-3. The habitat assessment for the North Branch Forest River resulted in an optimal rating for both locations evaluated. The downstream assessment location resulted in a higher rating with the upstream location near the cutoff between sub-optimal and optimal. A higher amount of tree cover in the area downstream helps to improve available cover in the stream and is one reason for the higher RBP rating there. The downstream location also has higher channel sinuosity, and better variability in pool sizes than the upstream observation location. Photos taken during the RBP assessment are provided in Attachment D-8-1 at the end of this document.

Table D-8-3: North Branch Forest River Rapid Bioassessment Protocol Totals

Location	Category (Rating Number)										TOTAL	Conditional Rating
	1	2	3	4	5	6	7	8	9	10		
Upstream of Dam	9	16	13	18	19	20	6	20	20	20	**161**	**Optimal**
Downstream of Dam	18	17	18	19	20	20	10	16	20	20	**178**	**Optimal**

RIVER STABILITY PREDICTION – LEVEL III ANALYSIS

For this effort, a Level III analysis was completed by using the field data described previously along with some additional information on vegetation and channel substrate recorded in the field. The North Branch Forest River upstream of the dam was used as the reference reach because it is not affected by Bylin Dam.

Stream Stability Indices

Stream stability indices – such as depositional patterns within the stream, and channel blockages – were evaluated both upstream and downstream of Bylin Dam. The results of the stream stability indices are shown on Worksheets 3-2 through 3-10 shown in Attachment D-8-2. The worksheets in Attachment D-8-2 were extracted from *River Stability – Forms and Worksheets* (Rosgen, 2014b).

The channel flow regime is considered perennial for both the upstream and downstream locations. Runoff is generated by snowmelt, rainfall, and rain on snow scenarios. The flow regime of the downstream location is impacted by Bylin Dam. The observation location downstream of the dam has irregular meanders with evidence of historic oxbows that are cutoff from the stream, while the upstream observation location has more regular meanders. The upstream observation location appeared to have a few additional mid-channel bars compared to the downstream location. A higher amount of channel blockages was noted at the downstream observation location when compared to the upstream location. This is due to the lack of trees in the upstream location. Trees are more prevalent adjacent to the North Branch Forest River downstream of Bylin Dam, which results in more fallen trees in the channel.

The degree of channel incision is significantly higher for the location downstream of Bylin Dam. The width-to-depth ratio state is considered stable for both observation locations. Due to the increased sinuosity downstream of the dam, the degree of confinement for the downstream location indicates little or no departure. To summarize the stream stability indices, the Pfankuch channel stability rating (1975) was used. Both observation locations produced a good stability rating for an E4 stream type. The downstream location produced a slightly higher value due to some bank erosion and cutting that was evident downstream of the dam.

Channel Stability

Worksheets 3-11 through 3-21 from *River Stability – Forms and Worksheets* (Rosgen, 2014b) are used to assess the stability of the channel. The stability of the channels is dependent on channel substrate and vegetation adjacent to the streams. Observations and data collection for channel substrate and vegetation were collected in the field for both observation locations. The completed worksheets are shown in Attachment D-8-2.

The results from the data upstream of Bylin Dam show that the channel is moderately stable. Point bar sediment was not able to be obtained for this analysis upstream of Bylin Dam because there were not any evident point bars near the observation location. The lack of point bar sediment along with the stream stability indices upstream of the dam indicate that deposition and incision are not expected to occur. The results show that a slight increase for channel enlargement is expected. The results from the data downstream of Bylin Dam show that the channel is stable laterally with a slightly higher chance of vertical incision when compared to the upstream location. The increase in potential for channel incision is caused by the apparent degree of channel incision at the downstream location (see worksheet 3-7 for the observation location downstream of Bylin Dam). Similar to the upstream observation location, the downstream observation location shows that there is some potential for channel enlargement.

CONCLUSION

Field data was collected upstream and downstream of Bylin Dam. The field data was used for a Level II stream classification, which results in a Rosgen Stream Classification of type E4 upstream of the dam and a stream type E4 downstream of the dam. Particle distributions upstream and downstream of the dam are used as the representative data for the North Branch Forest River.

A qualitative assessment of the North Branch Forest River was completed using a visual-based habitat assessment with Rapid Bioassessment Protocols (Barbour, Gerritsen, Snyder, & Stribling, 1999). The results of the assessment show that the habitat for the North Branch Forest River near Bylin Dam is optimal. Bylin Dam appears to have minimal impact on the habitat downstream of the dam. The RBP rating downstream of the dam is higher than the upstream location due to a higher frequency of epifaunal substrate and available cover, higher sinuosity, and more variability in pool sizes. The higher RBP rating downstream of the dam is not necessarily a result of the dam being in-place. There may be several reasons that the upstream rating is lower, including increased grazing and a higher percentage of tilled acres in the upstream area.

A Level III river stability analysis was also completed for both observation locations. This analysis indicates that the downstream channel is incised when compared to the upstream channel. This is likely due to the lack of sediment available for deposition because it is being withheld by Bylin Dam. Other than the increased channel incision, the downstream channel seems to be stable when compared to the upstream observation location. Based on the results, minimal lateral movement or vertical aggradation is expected if Bylin Dam were decommissioned.

REFERENCES

Barbour, M. T., Gerritsen, J., Snyder, B. D., & Stribling, J. B. (1999). *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers.* Washington, D.C.: US Environmental Protection Agency.

Pfankuch, D. J. (1975). *Stream Reach Inventory and Channel Stability Evaluation.* U.S. Department of Agriculture, Forest Service No. R1-75-002, GPO No. 696-260/200. Washington, D.C.: U.S. Government Printing Office.

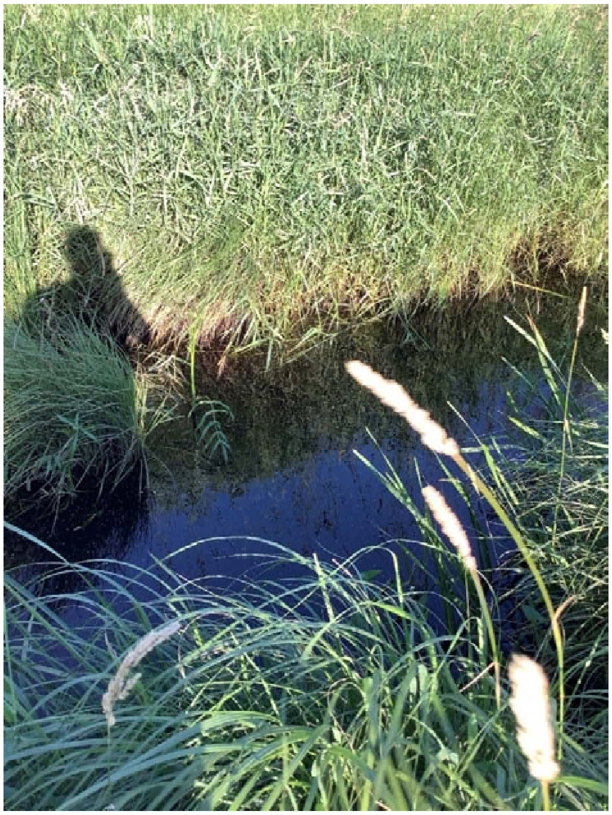
Rosgen, D. (1996). *Applied River Morphology.* Pagosa Springs, Colorado, United States of America: Wildland Hydrology.

Rosgen, D. (2014a). *River Stability Field Guide* (2nd ed.). (D. Geenen, Ed.) Fort Collins, Colorado: Wildland Hydrology.

Rosgen, D. (2014b). *River Stability Forms & Worksheets* (2nd ed.). (D. Geenen, Ed.) Fort Collins, Colorado: Wildland Hydrology.

ATTACHMENT D-8-1

PHOTOS FOR RBP ASSESSMENT



Photos for RBP evaluation upstream of Bylin Dam.

Photos for RBP evaluation upstream of Bylin Dam.

ATTACHMENT D-8-2

RIVER STABILITY PREDICTION WORKSHEETS

Worksheet 3-2. Flow regime variables that influence channel characteristics, sediment regime, and biological interpretations.

Flow Regime

Stream:	**Forest River**	Stream Type:	**E4**
Location:	**Upstream Bylin - 1**	Valley Type:	**U-GL-TP**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

List ALL COMBINATIONS that APPLY.............. ☞	**P1**	**P2**	**P9**					

General Category

E	***Ephemeral stream channel:*** Flows only in response to precipitation.
S	***Subterranean stream channel:*** Flows parallel to and near the surface for various seasons – a sub-surface flow that follows the stream bed.
I	***Intermittent stream channel:*** Surface water flows discontinuously along its length. Often associated with sporadic or seasonal flows and also with Karst (limestone) geology where losing/gaining reaches create flows that disappear then reappear farther downstream.
P	***Perennial stream channels:*** Surface water persists yearlong.

Specific Category

1	Seasonal variation in streamflow dominated primarily by snowmelt runoff.
2	Seasonal variation in streamflow dominated primarily by stormflow runoff.
3	Uniform stage and associated streamflow due to spring-fed condition, backwater, etc.
4	Streamflow regulated by glacial melt.
5	Ice flows/ice torrents from ice dam breaches.
6	Alternating flow/backwater due to tidal influence.
7	Regulated streamflow due to diversions, dam release, dewatering, etc.
8	Altered due to development, such as urban streams, cut-over watersheds, or vegetation conversions (forested to grassland) that change flow response to precipitation events.
9	Rain-on-snow generated runoff.

Worksheet 3-3. Stream order and stream size categories for stratification by stream type.

Stream Size and Order			
Stream:	**Forest River**		
Location:	**Upstream Bylin - 1**		
Observers:	**Paul LeClaire**	Stream Type:	**E4**
Valley Type:	**U-GL-TP**	Date:	**6/9/2020**
Stream Size Category and Order ☞			**S-3(3)**

Category	STREAM SIZE: Bankfull Width		Check (✓) Appropriate Category
	meters	feet	
S-1	0.305	<1	☐
S-2	0.3 – 1.5	1 – 5	☐
S-3	1.5 – 4.6	5 – 15	☑
S-4	4.6 – 9.0	15 – 30	☐
S-5	9.0 – 15.0	30 – 50	☐
S-6	15.0 – 22.8	50 – 75	☐
S-7	22.8 – 30.5	75 – 100	☐
S-8	30.5 – 46.0	100 – 150	☐
S-9	46 – 76	150 – 250	☐
S-10	76 – 107	250 – 350	☐
S-11	107 – 150	350 – 500	☐
S-12	150 – 305	500 – 1000	☐
S-13	>305	>1000	☐

Stream Order

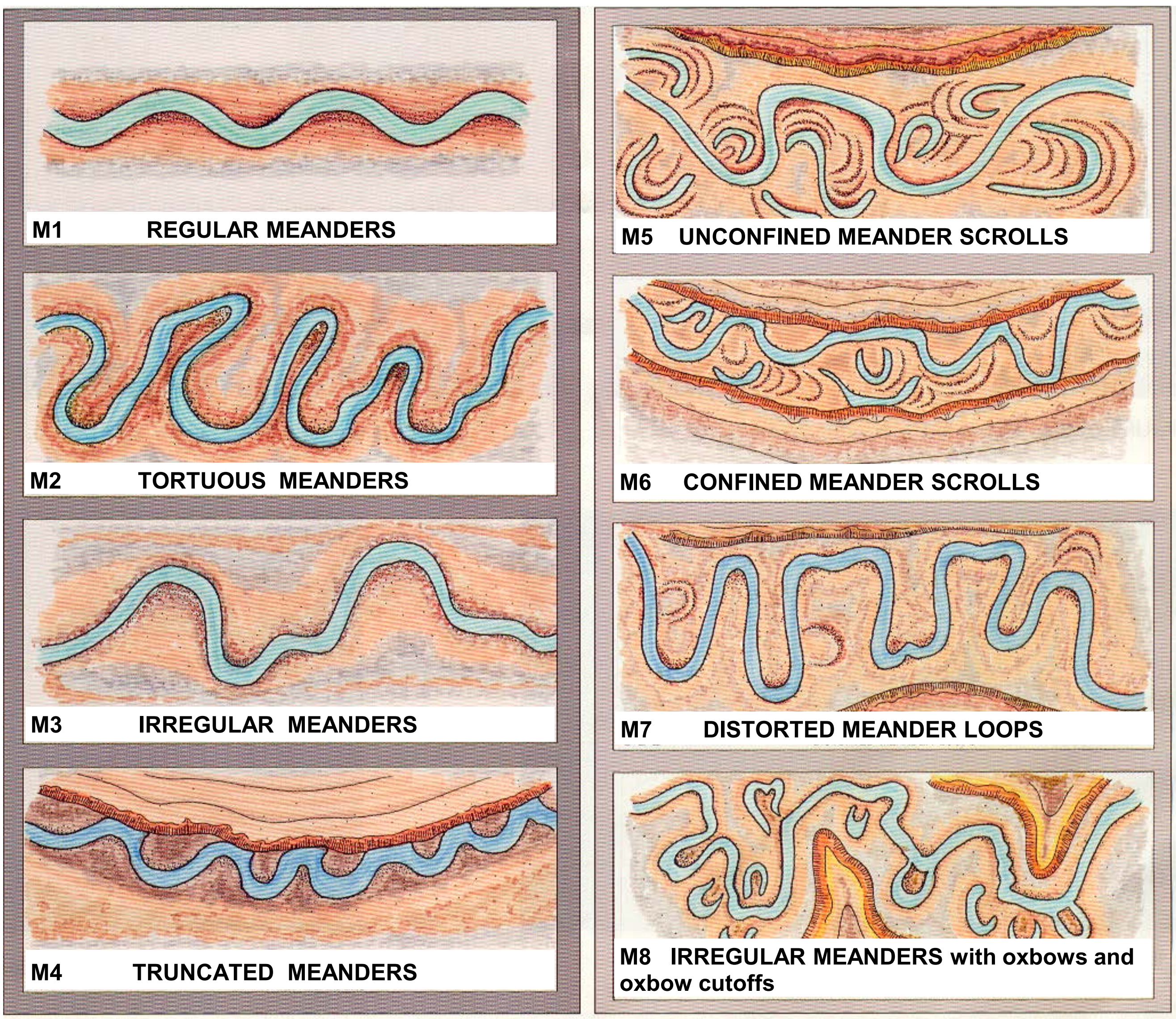
Add categories in parenthesis for specific stream order of reach. For example, a third-order stream with a bankfull width of 6.1 meters (20 feet) would be indexed as: S-4(3).

Worksheet 3-4. Meander pattern relations used for interpretations for river stability.

Meander Patterns			
Stream:	**Forest River**	Stream Type:	**E4**
Location:	**Upstream Bylin - 1**	Valley Type:	**U-GL-TP**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

List ALL CATEGORIES that APPLY ☞	**M1**				

Various Meander Pattern Variables modified from Galay et al. (1973)



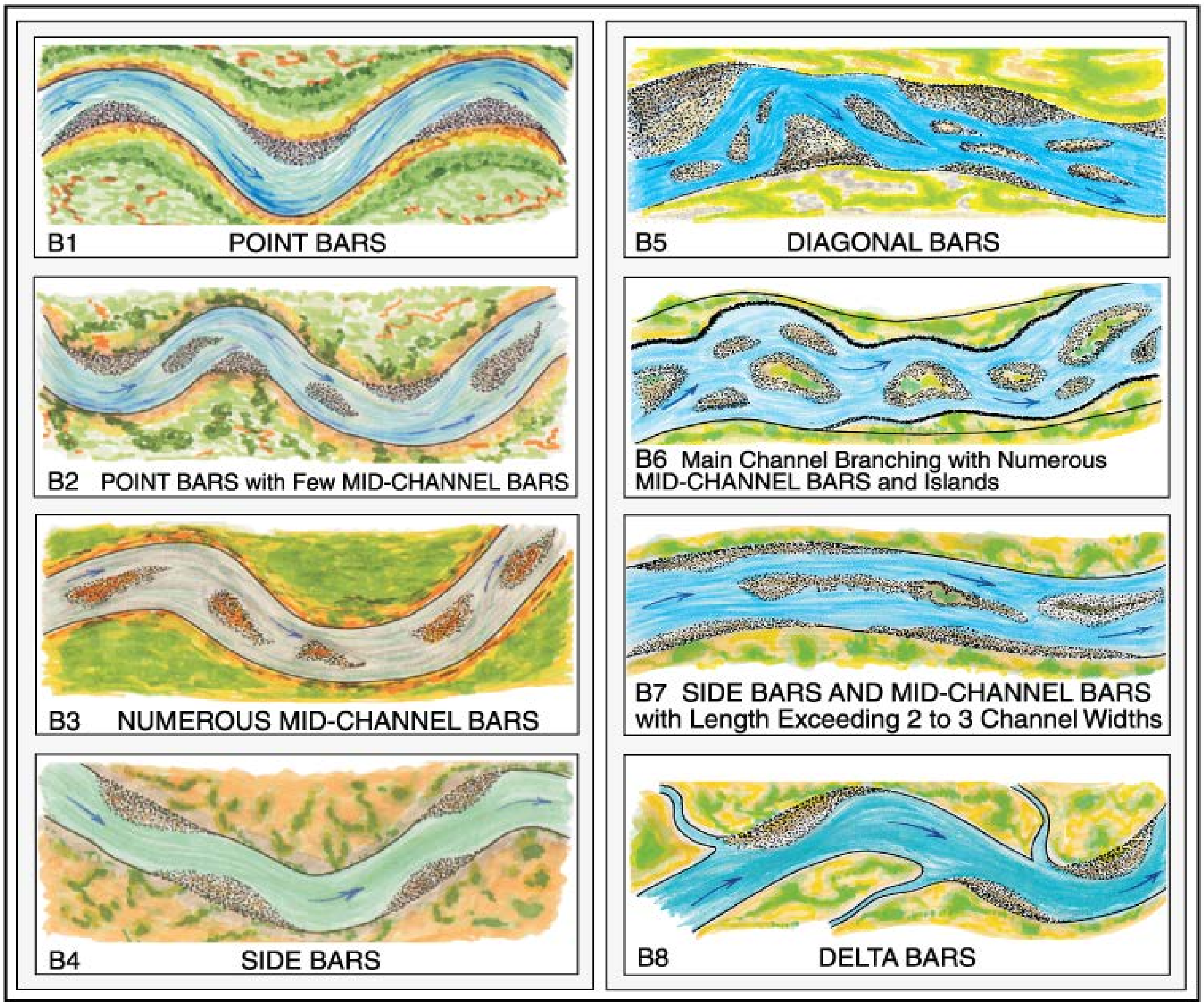
Worksheet 3-5. Depositional patterns used for stabiilty assessments.

Depositional Patterns

Stream:	**Forest River**	Stream Type:	**E4**
Location:	**Upstream Bylin - 1**	Valley Type:	**U-GL-TP**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

List ALL CATEGORIES that APPLY ☞	**B2**				

Various Depositional Features modified from Galay et al. (1973)



Worksheet 3-6. Various categories of in-channel debris, dams, and channel blockages used to evaluate channel stability.

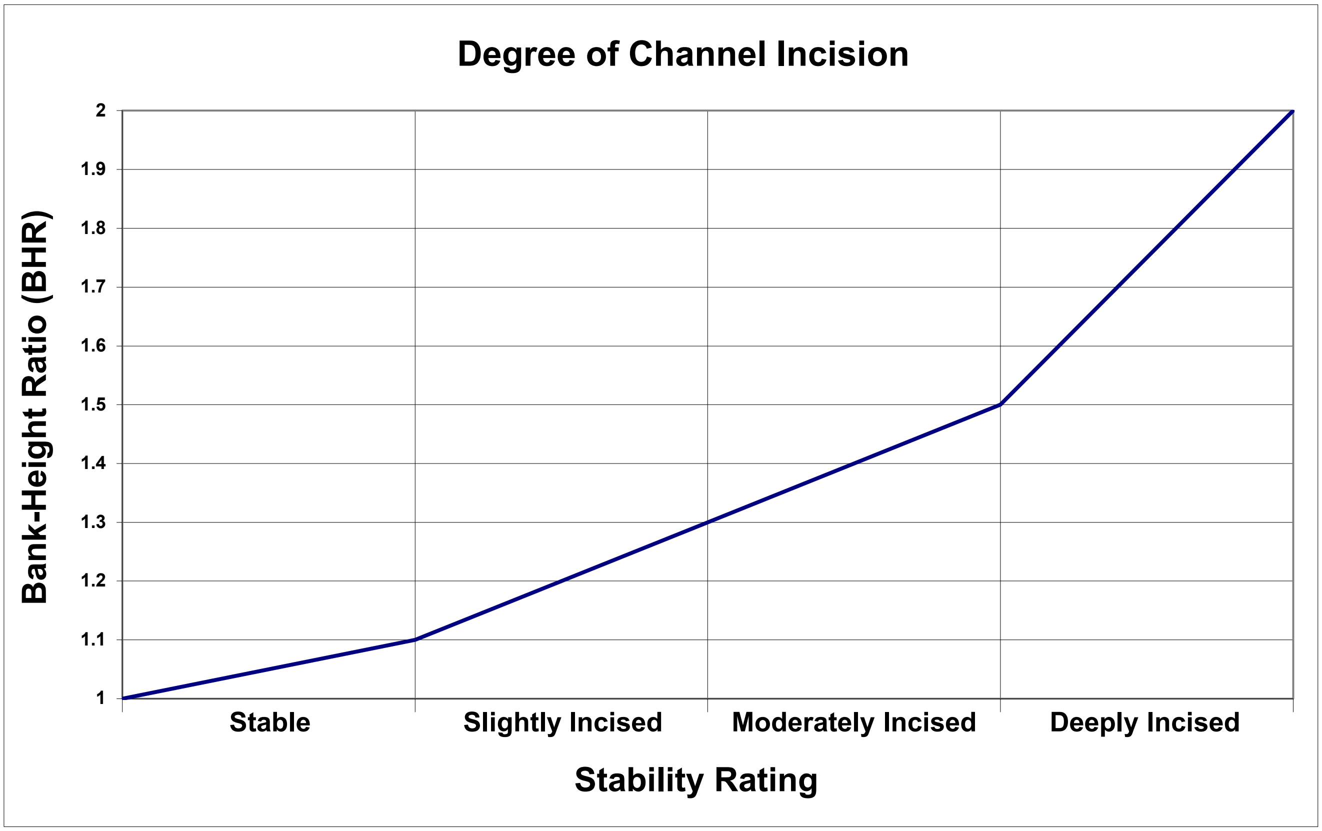
Channel Blockages			
Stream: **Forest River**		Stream Type: **E4**	
Location: **Upstream Bylin - 1**		Valley Type: **U-GL-TP**	
Observers: **Paul LeClaire**		Date: **6/9/2020**	
Description/Extent		**Materials that upon placement into the active channel or flood-prone area may cause adjustments in channel dimensions or conditions due to influences on the existing flow regime.**	**Check (✓) all that apply**
D1	None	Minor amounts of small, floatable material.	☐
D2	Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs, and twigs.	☑
D3	Moderate	Increasing frequency of small- to medium-sized material, such as large limbs, branches, and small logs, that when accumulated affect 10% or less of the active channel cross-sectional area.	☐
D4	Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs, or portions of trees, occupying 10–30% of the active channel cross-sectional area.	☐
D5	Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs, and trees, occupying 30–50% of the active channel cross-sectional area, often extending across the width of the active channel.	☐
D6	Dominating	Large, somewhat continuous, debris "dams," extensive in nature and occupying over 50% of the active channel cross-sectional area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	☐
D7	Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	☐
D8	Beaver Dams: Frequent	Frequency of dams is such that backwater conditions exist for channel reaches between structures where streamflow velocities are reduced and channel dimensions or conditions are influenced.	☐
D9	Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment or breached, initiating a series of channel adjustments, such as streambank erosion, lateral migration, avulsion, aggradation, or degradation.	☐
D10	Human Influences	Structures, facilities, or materials related to land uses or development located within the flood-prone area, such as diversions or low-head dams, controlled by-pass channels, velocity control structures, and various transportation encroachments that have an influence on the existing flow regime, such that significant channel adjustments occur.	☐

Worksheet 3-7. Relationship of Bank-Height Ratio (BHR) ranges to corresponding stream stability ratings.

Degree of Channel Incision			
Stream:	**Forest River**	Stream Type:	**E4**
Location:	**Upstream Bylin - 1**	Valley Type:	**U-GL-TP**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

Low Bank Height:	**2.91**	Bank-Height Ratio (BHR):	**1.01**
Bankfull Max Depth:	**2.88**		

Degree of Channel Incision Stability Rating ☞	**Stable**



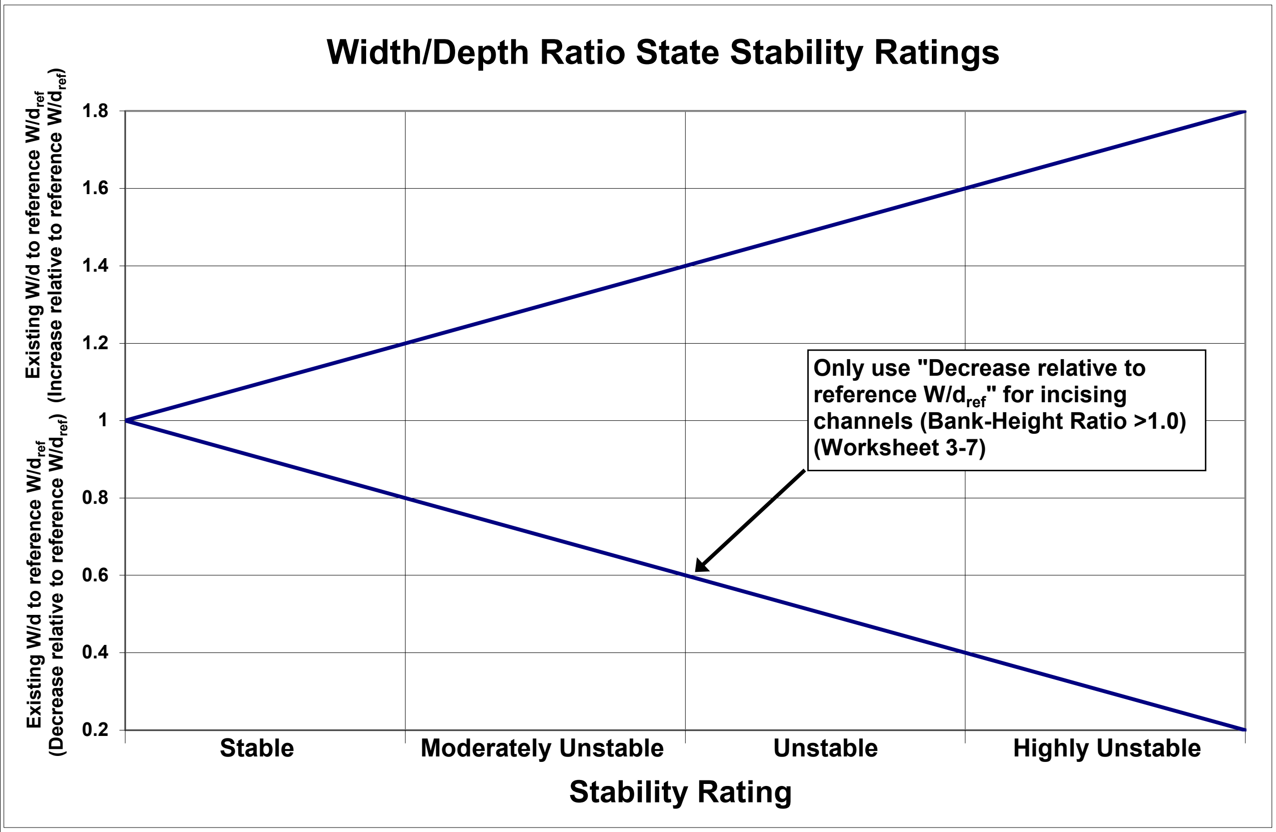
Worksheet 3-8. Stability ratings based on departure of width/depth ratio from reference condition.

Width/Depth Ratio State

Stream:	**Forest River**	Stream Type:	**E4**
Location:	**Upstream Bylin - 1**	Valley Type:	**U-GL-TP**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

Existing Width/Depth Ratio (W/d):	**9.393**
Reference Width/Depth Ratio (W/d_{ref}):	**9.39**
Existing W/d to Reference W/d_{ref}:	**1.00**

Width/Depth Ratio State Stability Rating ☞ **Stable**



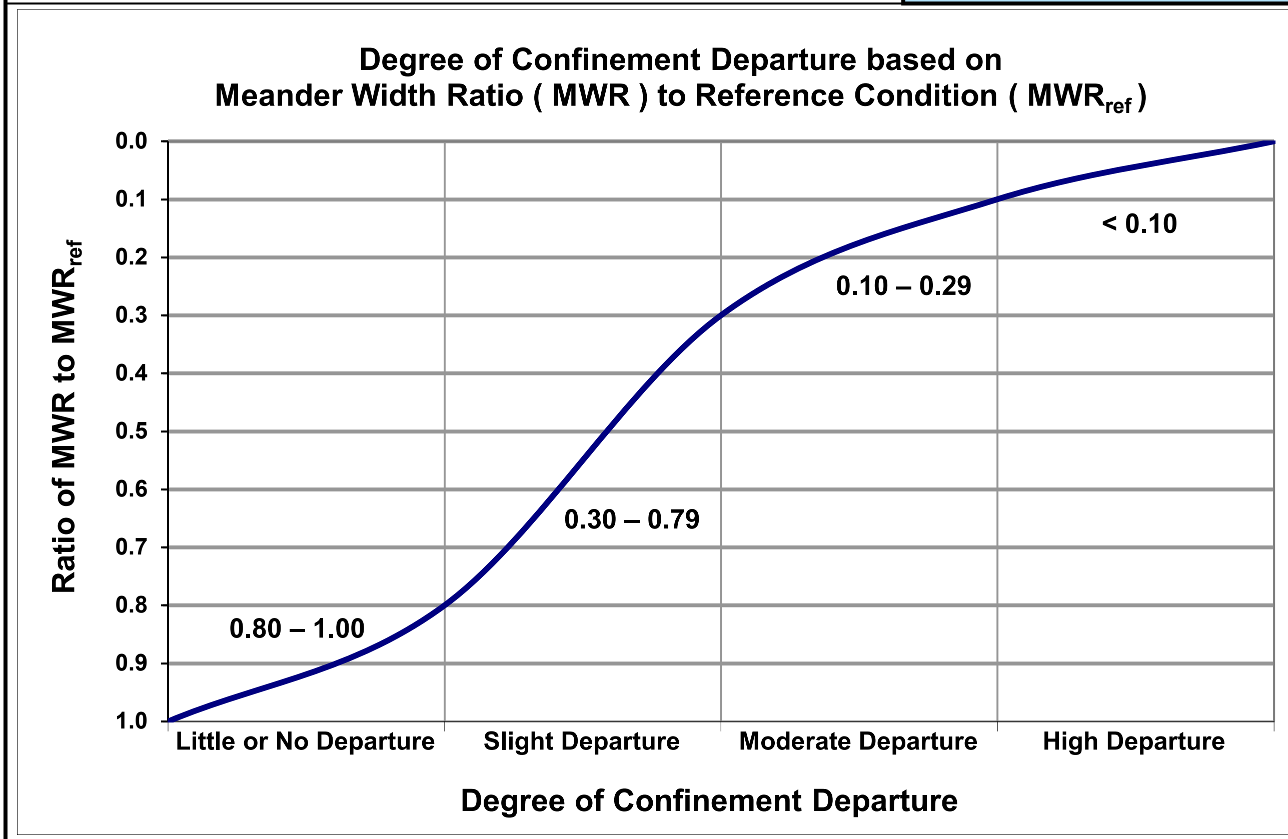
Worksheet 3-9. Degree of confinement departure based on Meander Width Ratio (MWR) divided by reference condition Meander Width Ratio (MWR_{ref}).

Degree of Confinement

Stream:	**Forest River**	Stream Type:	**E4**
Location:	**Upstream Bylin - 1**	Valley Type:	**U-GL-TP**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

Existing Meander Width Ratio (MWR):	**1.28**	Ratio of MWR to MWR_{ref}:	**1.00**
Reference Meander Width Ratio (MWR_{ref}):	**1.28**		

Degree of Confinement Stability Rating ☞ **Little or No Departure**



Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2006b).

Stream: Forest River **Location:** Upstream Bylin - 1 **Valley Type:** U-GL-TP **Observers:** Paul LeClaire **Date:** 6/9/2020

Location	Key	Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating
Upper banks	1	Landform slope	Bank slope gradient <30%.	**2**	Bank slope gradient 30–40%.	4	Bank slope gradient 40–60%.	6	Bank slope gradient > 60%.	8
	2	Mass erosion	No evidence of past or future mass erosion.	**3**	Infrequent. Mostly healed over. Low future potential.	6	Frequent or large, causing sediment nearly yearlong.	9	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
	3	Debris jam potential	Essentially absent from immediate channel area.	**2**	Present, but mostly small twigs and limbs.	4	Moderate to heavy amounts, mostly larger sizes.	6	Moderate to heavy amounts, predominantly larger sizes.	8
	4	Vegetative bank protection	> 90% plant density. Vigor and variety suggest a deep, dense, soil-binding root mass.	**3**	70–90% density. Fewer species or less vigor suggest less dense or deep root mass.	6	50–70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous, and shallow root mass.	12
Lower banks	5	Channel capacity	Bank heights sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0. Bank-Height Ratio (BHR) = 1.0.	**1**	Bankfull stage is contained within banks. Width/depth ratio departure from reference width/depth ratio = 1.0–1.2. Bank-Height Ratio (BHR) = 1.0–1.1.	2	Bankfull stage is not contained. Width/depth ratio departure from reference width/depth ratio = 1.2–1.4. Bank-Height Ratio (BHR) = 1.1–1.3.	3	Bankfull stage is not contained; over-bank flows are common with flows less than bankfull. Width/depth ratio departure from reference width/depth ratio > 1.4. Bank-Height Ratio (BHR) > 1.3.	4
	6	Bank rock content	> 65% with large angular boulders. 12"+ common.	2	40–65%. Mostly boulders and small cobbles 6–12".	4	20–40%. Most in the 3–6" diameter class.	6	<20% rock fragments of gravel sizes, 1–3" or less.	**8**
	7	Obstructions to flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	2	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	**4**	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	8
	8	Cutting	Little or none. Infrequent raw banks <6".	**4**	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	6	Significant. Cuts 12–24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
	9	Deposition	Little or no enlargement of channel or point bars.	**4**	Some new bar increase, mostly from coarse gravel.	8	Moderate depostion of new gravel and coarse sand on old and some new bars.	12	Extensive deposit of predominantly fine particles. Accelerated bar development.	16
Bottom	10	Rock angularity	Sharp edges and corners. Plane surfaces rough.	1	Rounded corners and edges. Surfaces smooth and flat.	**2**	Corners and edges well-rounded in two dimensions.	3	Well-rounded in all dimensions, surfaces smooth.	4
	11	Brightness	Surfaces dull, dark, or stained. Generally not bright.	1	Mostly dull, but may have <35% bright surfaces.	**2**	Mixture dull and bright, i.e., 35–65% mixture range.	3	Predominantly bright, > 65%, exposed or scoured surfaces.	4
	12	Consolidation of particles	Assorted sizes tightly packed or overlapping.	2	Moderately packed with some overlapping.	**4**	Mostly loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	8
	13	Bottom size distribution	No size change evident. Stable material 80–100%.	4	Distribution shift light. Stable material 50–80%.	**8**	Moderate change in sizes. Stable materials 20–50%.	12	Marked distribution change. Stable materials 0–20%.	16
	14	Scouring and deposition	<5% of bottom affected by scour or deposition.	**6**	5–30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12	30–50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.	18	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
	15	Aquatic vegetation	Abundant growth moss-like, dark green perennial. In swift water too.	1	Common. Algae forms in low velocity and pool areas. Moss here too.	**2**	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	3	Perennial types scarce or absent. Yellow-green, short-term bloom may be present.	4
			Excellent Total =	**25**	**Good Total =**	**22**	**Fair Total =**	**0**	**Poor Total =**	**8**

Stream type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6
Good (Stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107	85-107	85-107	67-98
Fair (Mod. unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132	108-132	108-132	99-125
Poor (Unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+	133+	133+	126+

Stream type	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2	G3	G4	G5	G6
Good (Stable)	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60	85-107	85-107	90-112	85-107
Fair (Mod. unstable)	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78	108-120	108-120	113-125	108-120
Poor (Unstable)	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	121+

Grand Total =	**55**
Existing Stream Type =	**E4**
***Potential Stream Type =**	**E4**
Modified channel stability rating =	**Good**

***Rating is adjusted to *potential* stream type, not existing stream type**

Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

Bank Erosion Hazard Index (BEHI)

Stream: **Forest River** Location: **Upstream Bylin - 1**

Station: Observers: **Paul LeClaire**

Date: **6/9/2020** Stream Type: **E4** Valley Type: **U-GL-TP**

BEHI Score (Fig. 3-7)

Study Bank Height to Bankfull Height (C)

Study Bank Height (ft) =	**2.91** (A)	**Bankfull Height** (ft) =	**2.88** (B)	(A) / (B) =	**1.01** (C)	**1.0**

Root Depth to Study Bank Height (E)

Root Depth (ft) =	**0.67** (D)	**Study Bank Height** (ft) =	**2.91** (A)	(D) / (A) =	**0.23** (E)	**6.5**

Weighted Root Density (G)

Root Density as % =	**30.00** (F)	(F) × (E) =	**6.87285** (G)	**8.5**

Bank Angle (H)

Bank Angle as *Degrees* =	**9.838** (H)	**1.5**

Surface Protection (I)

Surface Protection as % =	**95%** (I)	**1.0**

Bank Material Adjustment:

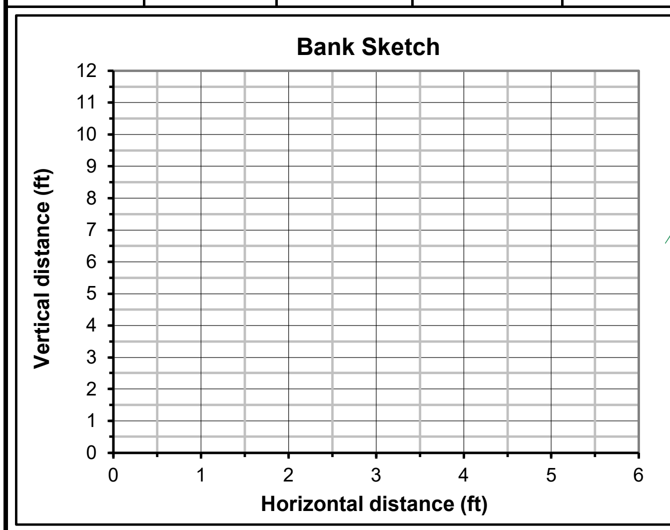
Bedrock (Overall *Very Low* BEHI)
Boulders (Overall *Low* BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment unless primarily clay, then subtract 20 points)

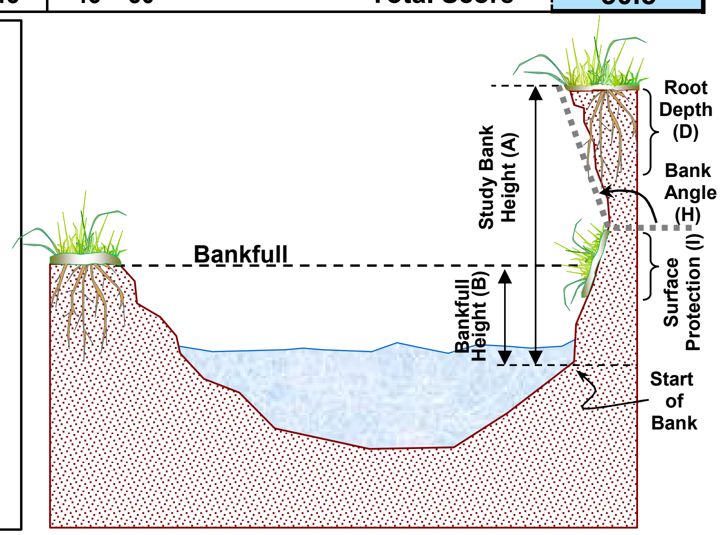
Bank Material Adjustment: **7**

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage: **5**

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score**: **High** / **30.5**





Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate an erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Forest River**	Location: **Upstream Bylin - 1**	
Station:	Stream Type: **E4**	Valley Type: **U-GL-TP**
Observers: **Paul LeClaire**		Date: **6/9/2020**

Methods for Estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar, or central bar creating NBS	Level I	Reconaissance
(2)	Radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General Prediction
(3)	Pool slope to average water surface slope (S_p / S)	Level II	General Prediction
(4)	Pool slope to riffle slope (S_p / S_{rif})	Level II	General Prediction
(5)	Near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed Prediction
(6)	Near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed Prediction
(7)	Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)
- Transverse or central bars - short or discontinuous……..…………..…………..…..**NBS = *High / Very High***
- Extensive deposition (continuous, cross-channel)……………..……………..………………..**NBS = *Extreme***
- Chute cutoffs, down-valley meander migration, converging flow………………..………….**NBS = *Extreme***

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	**Near-Bank Stress (NBS)**
89.95	**13.57**	**6.6285925**	**Very Low**

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	**Near-Bank Stress (NBS)**

Dominant Near-Bank Stress

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	**Near-Bank Stress (NBS)**

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	**Near-Bank Stress (NBS)**

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	*Ratio* τ_{nb} / τ_{bkf}	**Near-Bank Stress (NBS)**

Level IV

(7)

Velocity Gradient (ft / sec / ft)	**Near-Bank Stress (NBS)**

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) Ratings	Method Number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) Rating	**Very Low**

Worksheet 3-13. Annual streambank erosion estimates for various study reaches.

Streambank Erosion Prediction

Stream: **Forest River** Location: **Upstream Bylin - 1**

Graph Used: Total Stream Length (ft): Date: **6/9/2020**

Observers: **Paul LeClaire** Valley Type: **U-GL-TP** Stream Type: **E4**

(1) Station (ft)	(2) BEHI Rating (Worksheet 3-11) (adjective)	(3) NBS Rating (Worksheet 3-12) (adjective)	(4) Bank Erosion Rate (Figure 3-9 or 3-10) (ft/yr)	(5) Length of Bank (ft)	(6) Study Bank Height (ft)	(7) Erosion Subtotal [(4)×(5)×(6)] (ft^3/yr)	(8) Unit Erosion Rate (tons/yr/ft) {[(7)/27] × 1.3 / (5)}
1.	High	Very Low	0.165	1.00	2.91	0.48	0.02315
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
Sum erosion subtotals in Column (7) for each BEHI/NBS combination					Total Erosion (ft^3/yr)	0.48	
Convert erosion in ft^3/yr to yds^3/yr {divide *Total Erosion (ft^3/yr)* by 27}					Total Erosion (yds^3/yr)	0.02	
Convert erosion in yds^3/yr to tons/yr {multiply *Total Erosion (yds^3/yr)* by 1.3}					Total Erosion (tons/yr)	0.02	
Calculate erosion per unit length of channel {divide *Total Erosion (tons/yr)* by *Total Stream Length (ft)* surveyed}					Unit Erosion Rate (tons/yr/ft)		

Worksheet 3-14. Sediment competence calculation form to assess bed stability.

Sediment Competence using Dimensional and Dimensionless Shear Stress Methods

Stream:	**Forest River**	Stream Type:	**E4**
Location:	**Upstream Bylin - 1**	Valley Type:	**U-GL-TP**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

Enter Required Information for Existing Condition

9.1	D_{50}	Median particle size of riffle bed material (mm)			
	$\hat{D}_{50}$	Median particle size of bar or sub-pavement sample (mm)			
	D_{max}	Largest particle from bar sample (ft)	**0**	**(mm)**	304.8 mm/ft
0.0029	S	Existing average water surface slope (ft/ft)			
1.44	d	Existing bankfull mean depth (ft)			
1.65	$\gamma_s - \gamma / \gamma$	Immersed specific gravity of sediment			

Select the Appropriate Equation and Calculate Critical Dimensionless Shear Stress

	$D_{50}/\hat{D}_{50}$	Range: 3 – 7	Use EQUATION 1: $\tau^* = 0.0834\,(D_{50}/\hat{D}_{50})^{-0.872}$	
0.00	D_{max}/D_{50}	Range: 1.3 – 3.0	Use EQUATION 2: $\tau^* = 0.0384\,(D_{max}/D_{50})^{-0.887}$	
	τ^*	Bankfull Dimensionless Shear Stress	EQUATION USED:	

Calculate Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample

	d	Required bankfull mean depth (ft) $d = \dfrac{\tau^*(\gamma_s - 1)D_{max}}{S}$	(use D_{max} in ft)

Calculate Average Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample

	S	Required average water surface slope (ft/ft) $S = \dfrac{\tau^*(\gamma_s - 1)D_{max}}{d}$	(use D_{max} in ft)

Check: ☐ Stable ☑ Aggrading ☐ Degrading

Sediment Competence Using Dimensional Shear Stress

0.261		Bankfull shear stress $\tau = \gamma dS$ (lbs/ft^2) (substitute hydraulic radius, R, with mean depth, d) γ = 62.4, d = existing depth, S = existing slope
Shields **19**	CO **57**	Predicted largest moveable particle size (mm) at bankfull shear stress τ **(Figure 3-11)**
Shields **0.000**	CO **0.000**	Predicted shear stress required to initiate movement of measured D_{max} (mm) **(Figure 3-11)**
Shields **0.00**	CO **0.00**	Predicted mean depth required to initiate movement of measured D_{max} (mm) τ = predicted shear stress, γ = 62.4, S = existing slope $\quad d = \dfrac{\tau}{\gamma S}$
Shields **0.0000**	CO **0.0000**	Predicted slope required to initiate movement of measured D_{max} (mm) τ = predicted shear stress, γ = 62.4, d = existing depth $\quad S = \dfrac{\tau}{\gamma d}$

Check: ☐ Stable ☐ Aggrading ☐ Degrading

Worksheet 3-15. Stability ratings for stream type stage shifts.

Stream Succession Stage Shifts	
Stream: **Forest River**	Stream Type: **E4**
Location: **Upstream Bylin - 1**	Valley Type: **U-GL-TP**
Observers: **Paul LeClaire**	Date: **6/9/2020**
Stream Type Stage Shifts (Figure 3-14)	**Stability Rating (Check ✓ Appropriate Rating)**
Stream Type at Potential, (C→E), (F_b→B), (F→B_c), (F→C), (G→B), (D→C)	☐ Stable
(E→C), (B→High W/d B), (C→High W/d C)	☑ Moderately Unstable
(G_c→F), (G→F_b), (F→D), (C→F)	☐ Unstable
(C→D), (A→G), (B→G), (D→G), (C→G), (E→G), (E→A)	☐ Highly Unstable

Worksheet 3-16. Lateral stability prediction summary.

Lateral Stability Prediction					
Stream: **Forest River**			Stream Type: **E4**		
Location: **Upstream Bylin - 1**			Valley Type: **U-GL-TP**		
Observers: **Paul LeClaire**			Date: **6/9/2020**		
Lateral stability criteria (choose one stability category for each criterion 1–5)	**Lateral Stability Categories**				**Selected Points (from each row)**
	Stable	***Moderately Unstable***	***Unstable***	***Highly Unstable***	
1 W/d Ratio State (Worksheet 3-8)	< 1.2 **(2)**	1.2 – 1.4 **(4)**	1.4 – 1.6 **(6)**	> 1.6 **(8)**	**2**
2 Depositional Patterns (Worksheet 3-5)	B1, B2 **(1)**	B4, B8 **(2)**	B3 **(3)**	B5, B6, B7 **(4)**	**2**
3 Meander Patterns (Worksheet 3-4)	M1, M3, M4 **(1)**		M2, M5, M6, M7, M8 **(3)**		**1**
4 Streambank Erosion: Unit Rate (Worksheet 3-13)	< 0.006 **(2)**	0.006 – 0.04 **(4)**	0.041 – 0.07 **(6)**	> 0.07 **(8)**	**4**
5 Degree of Confinement (MWR / MWR_{ref}) (Worksheet 3-9)	> 0.8 **(1)**	0.3 – 0.79 **(2)**	0.1 – 0.29 **(3)**	< 0.1 **(4)**	**1**
				Total Points	**10**
	Lateral Stability Category Point Range				chosen
Overall Lateral Stability Category (use total points and check ✓ stability rating)	***Stable* < 10** ☐	***Moderately Unstable* 10 – 12** ☑	***Unstable* 13 – 21** ☐	***Highly Unstable* > 21** ☐	Moderately Unstable

Worksheet 3-17. Vertical stability prediction for excess deposition and aggradation.

Vertical Stability Prediction for Excess Deposition and Aggradation					
Stream: **Forest River**			Stream Type: **E4**		
Location: **Upstream Bylin - 1**			Valley Type: **U-GL-TP**		
Observers: **Paul LeClaire**			Date: **6/9/2020**		
Vertical Stability Criteria (choose one stability category for each criterion 1–6)	**Vertical Stability Categories for Excess Deposition / Aggradation**				**Selected Points (from each row)**
	No Deposition	***Moderate Deposition***	***Excess Deposition***	***Aggradation***	
1 **Sediment Competence (Worksheet 3-14)**	Sufficient depth and slope to transport largest size available **(2)**	Trend toward insufficient depth or slope- slightly incompetent **(4)**	Cannot move D_{35} of bed material and/or D_{100} of bar material **(6)**	Cannot move D_{16} of bed material and/or D_{100} of bar or sub-pavement size **(8)**	**2**
2 **Sediment Capacity (POWERSED)**	Sufficient capacity to transport annual load **(2)**	Trend toward insufficient sediment capacity **(4)**	Reduction up to 25% of annual sediment yield of bedload or suspended sand **(6)**	Reduction over 25% of annual sediment yield for bedload or suspended sand **(8)**	**2**
3 **W/d Ratio State (Worksheet 3-8)**	< 1.2 **(2)**	1.2 – 1.4 **(4)**	1.4 – 1.6 **(6)**	> 1.6 **(8)**	**2**
4 **Stream Succession Stage Shifts (Worksheet 3-15)**	Current stream type at potential or does not indicate deposition/ aggradation **(2)**	(E→C) **(4)**	(B→High W/d B), (C→High W/d C), (C→F), (G_c→F), (G→F_b) **(6)**	(C→D), (F→D) **(8)**	**4**
5 **Depositional Patterns (Worksheet 3-5)**	B1 **(1)**	B2, B4 **(2)**	B3, B5 **(3)**	B6, B7, B8 **(4)**	**2**
6 **Debris / Blockages (Worksheet 3-6)**	D1, D2, D3 **(1)**	D4, D7 **(2)**	D5, D8 **(3)**	D6, D9, D10 **(4)**	**1**
				Total Points	**13**
	Vertical Stability Category Point Range for Excess Deposition and Aggradation				**chosen**
Vertical Stability for Excess Deposition / Aggradation (use total points and check ✓ stability rating)	***No Deposition*** **< 15** ☐	***Moderate Deposition*** **15 – 20** ☑	***Excess Deposition*** **21 – 30** ☐	***Aggradation*** **> 30** ☐	No Deposition

Worksheet 3-18. Vertical stability prediction for channel incision and degradation.

Vertical Stability Prediction for Channel Incision and Degradation						
Stream: **Forest River**				Stream Type: **E4**		
Location: **Upstream Bylin - 1**				Valley Type: **U-GL-TP**		
Observers: **Paul LeClaire**				Date: **6/9/2020**		
Vertical Stability Criteria (choose one stability category for each criterion 1–5)	**Vertical Stability Categories for Channel Incision / Degradation**				**Selected Points (from each row)**	
	Not Incised	***Slightly Incised***	***Moderately Incised***	***Degradation***		
1 **Sediment Competence (Worksheet 3-14)**	Does not indicate excess competence **(2)**	Trend to move larger sizes than D_{100} of bar or D_{84} of bed **(4)**	D_{100} of bed moved **(6)**	Particles much larger than D_{100} of bed moved **(8)**	**2**	
2 **Sediment Capacity (POWERSED)**	Does not indicate excess capacity **(2)**	Slight excess energy: up to 10% increase above reference **(4)**	Excess energy sufficient to increase load up to 50% of annual load **(6)**	Excess energy transporting more than 50% of annual load **(8)**	**2**	
3 **Degree of Channel Incision (BHR) (Worksheet 3-7)**	1.00 – 1.10 **(2)**	1.11 – 1.30 **(4)**	1.31 – 1.50 **(6)**	> 1.50 **(8)**	**2**	
4 **Stream Succession States (Worksheets 3-15 and 3-7)**	Does not indicate incision or degradation **(2)**	If BHR > 1.1 and stream type has W/d between 5–10 **(4)**	If BHR > 1.1 and stream type has W/d less than 5 **(6)**	(B→G), (C→G), (E→G), (D→G), (A→G), (E→A) **(8)**	**2**	
5 **Confinement (MWR / MWR_{ref}) (Worksheet 3-9)**	0.80 – 1.00 **(1)**	0.30 – 0.79 **(2)**	0.10 – 0.29 **(3)**	< 0.10 **(4)**	**1**	
				Total Points	**9**	
	Vertical Stability Category Point Range for Channel Incision and Degradation				**chosen**	
Vertical Stability for Channel Incision/ Degradation (use total points and check ✓ stability rating)	***Not Incised*** **< 12** ☑	***Slightly Incised*** **12 – 18** ☐	***Moderately Incised*** **19 – 27** ☐	***Degradation*** **> 27** ☐	Not Incised	

Worksheet 3-19. Channel enlargement prediction summary.

<table>
<tr><th colspan="6">Channel Enlargement Prediction</th></tr>
<tr><td colspan="3">Stream: **Forest River**</td><td colspan="3">Stream Type: **E4**</td></tr>
<tr><td colspan="3">Location: **Upstream Bylin - 1**</td><td colspan="3">Valley Type: **U-GL-TP**</td></tr>
<tr><td colspan="3">Observers: **Paul LeClaire**</td><td colspan="3">Date: **6/9/2020**</td></tr>
<tr><td rowspan="2">**Channel Enlargement Prediction Criteria** **(choose one stability category for each criterion 1–4)**</td><td colspan="4">**Channel Enlargement Prediction Categories**</td><td rowspan="2">**Selected Points (from each row)**</td></tr>
<tr><td>***No Increase***</td><td>***Slight Increase***</td><td>***Moderate Increase***</td><td>***Extensive***</td></tr>
<tr><td>1 **Stream Succession Stage Shifts (Worksheet 3-15)**</td><td>Stream Type at Potential, (C→E), (F_b→B), (G→B), (F→B_c), (F→C), (D→C)
(2)</td><td>(B→High W/d B), (C→High W/d C), (E→C)
(4)</td><td>(G→F), (F→D)
(6)</td><td>(C→D), (A→G), (B→G), (D→G), (C→G), (E→G), (E→A), (C→F)
(8)</td><td>**4**</td></tr>
<tr><td>2 **Lateral Stability (Worksheet 3-16)**</td><td>*Stable*
(2)</td><td>*Moderately Unstable*
(4)</td><td>*Unstable*
(6)</td><td>*Highly Unstable*
(8)</td><td>**4**</td></tr>
<tr><td>3 **Vertical Stability Excess Deposition and Aggradation (Worksheet 3-17)**</td><td>*No Deposition*
(2)</td><td>*Moderate Deposition*
(4)</td><td>*Excess Deposition*
(6)</td><td>*Aggradation*
(8)</td><td>**2**</td></tr>
<tr><td>4 **Vertical Stability Channel Incision and Degradation (Worksheet 3-18)**</td><td>*Not Incised*
(2)</td><td>*Slightly Incised*
(4)</td><td>*Moderately Incised*
(6)</td><td>*Degradation*
(8)</td><td>**2**</td></tr>
<tr><td colspan="5">**Total Points**</td><td>**12**</td></tr>
<tr><td></td><td colspan="4">**Category Point Range**</td><td>**chosen**</td></tr>
<tr><td>**Channel Enlargement Prediction (use total points and check ✓ stability rating)**</td><td>***No Increase*** **< 11** ☐</td><td>***Slight Increase*** **11 – 16** ☑</td><td>***Moderate Increase*** **17 – 24** ☐</td><td>***Extensive*** **> 24** ☐</td><td>Slight Increase</td></tr>
</table>

Worksheet 3-20. Overall sediment supply rating determined from individual stability rating categories.

Overall Sediment Supply Prediction				
Stream: **Forest River**			Stream Type: **E4**	
Location: **Upstream Bylin - 1**			Valley Type: **U-GL-TP**	
Observers: **Paul LeClaire**			Date: **6/9/2020**	
Overall Sediment Supply Prediction Criteria (choose corresponding points for each criterion 1–5)		**Stability Rating**	**Points**	**Selected Points**
1	**Lateral Stability (Worksheet 3-16)**	***Stable***	**1**	**2**
		Mod. Unstable	**2**	
		Unstable	**3**	
		Highly Unstable	**4**	
2	**Vertical Stability Excess Deposition or Aggradation (Worksheet 3-17)**	***No Deposition***	**1**	**1**
		Mod. Deposition	**2**	
		Excess Deposition	**3**	
		Aggradation	**4**	
3	**Vertical Stability Channel Incision or Degradation (Worksheet 3-18)**	***Not Incised***	**1**	**1**
		Slightly Incised	**2**	
		Mod. Incised	**3**	
		Degradation	**4**	
4	**Channel Enlargement Prediction (Worksheet 3-19)**	***No Increase***	**1**	**2**
		Slight Increase	**2**	
		Mod. Increase	**3**	
		Extensive	**4**	
5	**Pfankuch Channel Stability (Worksheet 3-10)**	***Good: Stable***	**1**	**1**
		Fair: Mod. Unstable	**2**	
		Poor: Unstable	**4**	
			Total Points	**7**

Overall Sediment Supply Rating (use total points and check ✓ stability rating)	**Category Point Range**			
	Low < 6 ☐	***Moderate*** 6 – 10 ☑	***High*** 11 – 15 ☐	***Very High*** > 15 ☐

Worksheet 3-21. Summary of stability condition categories.

Summary of Stability Conditions					
Stream:	**Forest River**		Location: **Upstream Bylin - 1**		
Observers:	**Paul LeClaire**	Date: **6/9/2020**	Stream Type: **E4**	Valley Type: **U-GL-TP**	
Channel Dimension	Bankfull Mean Depth (ft): **1.44**	Bankfull Width (ft): **13.57**	Cross-Sectional Area (ft^2): **19.6**	Width/Depth Ratio: **9.393231**	Entrenchment Ratio: **8.35**
Channel Pattern	Mean: / Range: λ/W_{bkf}: **121**	L_m/W_{bkf}: **124**	R_c/W_{bkf}: **62**	MWR: **1.28**	Sinuosity: **1.13**
Streamflow	Bankfull Mean Velocity ($\bar{u}_{bkf}$) (ft/sec): **3.33**	Bankfull Discharge (Q_{bkf}): **65.33**	Estimation Method: **1**		Drainage Area (mi^2): **13.6445**
River Profile & Bed Features	Check: ☑ Riffle/Pool ☐ Step/Pool ☐ Plane Bed ☐ Convergence/Divergence ☐ Dunes/Antidunes/Smooth Bed				
	Bankfull Max Depth (ft): Riffle **2.88**; Pool	Depth Ratio (max to mean): Riffle **1.99**; Pool	Pool-to-Pool Spacing: Ratio	Slope: Valley:	Water Surface: **0.0029**
Level III Stream Stability Indices	Riparian Vegetation	Current Composition/Density:	Potential Composition/Density:	Remarks: Condition, Vigor & Usage of Existing Reach:	
	Flow Regime: **P1**	Stream Size & Order: **S-3(3)**	Meander Patterns: **M1**	Depositional Patterns: **B2**	Debris/Channel Blockages: **D2**
	Degree of Incision (Bank-Height Ratio): **1.01**	Degree of Incision Stability Rating: **Stable**	Modified Pfankuch Stability Rating (Numeric & Adjective Rating): **55 Good**		
	W/d Ratio State (W/d) / (W/d_{ref}): **1.00**	W/d Ratio State Stability Rating: **Stable**	Degree of Confinement (MWR / MWR_{ref}): **1.00**	MWR / MWR_{ref} Stability Rating: **Little or No Departure**	
Bank Erosion Summary	Length of Reach Studied (ft): **1**	Annual Streambank Erosion Rate: **0.02** (tons/yr) **0.023** (tons/yr/ft)	Curve Used: **LOW BEHI**	Remarks:	
Sediment Capacity (POWERSED)	☐ *Sufficient Capacity* ☐ *Insufficient Capacity* ☐ *Excess Capacity*			Remarks:	
Entrainment/ Competence	Largest Particle from Bar Sample (mm):	$\tau =$ **0.261**	$\tau^* =$ **0.0000**	Existing Depth: **1.44** Required Depth: **0.0**	Existing Slope: **0.0029** Required Slope: **0**
Stream Succession	→ → → → →		Existing Stream State (Type): **E4**	Potential Stream State (Type):	
Lateral Stability	☐ *Stable* ☑ *Mod. Unstable* ☐ *Unstable* ☐ *Highly Unstable*			Remarks:	
Vertical Stability (Aggradation)	☑ *No Deposition* ☐ *Mod. Deposition* ☐ *Ex. Deposition* ☐ *Aggradation*			Remarks:	
Vertical Stability (Degradation)	☑ *Not Incised* ☐ *Slightly Incised* ☐ *Mod. Incised* ☐ *Degradation*			Remarks:	
Channel Enlargement	☐ *No Increase* ☑ *Slight Increase* ☐ *Mod. Increase* ☐ *Extensive*			Remarks:	
Sediment Supply (Channel Source)	☐ *Low* ☑ *Moderate* ☐ *High* ☐ *Very High*			Remarks:	

Worksheet 3-2. Flow regime variables that influence channel characteristics, sediment regime, and biological interpretations.

Flow Regime

Stream:	**Forest River North Branch**	Stream Type:	**E4**
Location:	**Downstream Bylin - 1**	Valley Type:	**C-AL-AD**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

List ALL COMBINATIONS that APPLY...............☞	**P1**	**P2**	**P7**	**P9**				

General Category

E	***Ephemeral stream channel:*** Flows only in response to precipitation.
S	***Subterranean stream channel:*** Flows parallel to and near the surface for various seasons – a sub-surface flow that follows the stream bed.
I	***Intermittent stream channel:*** Surface water flows discontinuously along its length. Often associated with sporadic or seasonal flows and also with Karst (limestone) geology where losing/gaining reaches create flows that disappear then reappear farther downstream.
P	***Perennial stream channels:*** Surface water persists yearlong.

Specific Category

1	Seasonal variation in streamflow dominated primarily by snowmelt runoff.
2	Seasonal variation in streamflow dominated primarily by stormflow runoff.
3	Uniform stage and associated streamflow due to spring-fed condition, backwater, etc.
4	Streamflow regulated by glacial melt.
5	Ice flows/ice torrents from ice dam breaches.
6	Alternating flow/backwater due to tidal influence.
7	Regulated streamflow due to diversions, dam release, dewatering, etc.
8	Altered due to development, such as urban streams, cut-over watersheds, or vegetation conversions (forested to grassland) that change flow response to precipitation events.
9	Rain-on-snow generated runoff.

Worksheet 3-3. Stream order and stream size categories for stratification by stream type.

Stream Size and Order			
Stream:	**Forest River North Branch**		
Location:	**Downstream Bylin - 1**		
Observers:	**Paul LeClaire**	Stream Type:	**E4**
Valley Type:	**C-AL-AD**	Date:	**6/9/2020**
Stream Size Category and Order ☞			**S-3(3)**

Category	STREAM SIZE: Bankfull Width		Check (✓) Appropriate Category
	meters	feet	
S-1	0.305	<1	☐
S-2	0.3 – 1.5	1 – 5	☐
S-3	1.5 – 4.6	5 – 15	☑
S-4	4.6 – 9.0	15 – 30	☐
S-5	9.0 – 15.0	30 – 50	☐
S-6	15.0 – 22.8	50 – 75	☐
S-7	22.8 – 30.5	75 – 100	☐
S-8	30.5 – 46.0	100 – 150	☐
S-9	46 – 76	150 – 250	☐
S-10	76 – 107	250 – 350	☐
S-11	107 – 150	350 – 500	☐
S-12	150 – 305	500 – 1000	☐
S-13	>305	>1000	☐

Stream Order

Add categories in parenthesis for specific stream order of reach. For example, a third-order stream with a bankfull width of 6.1 meters (20 feet) would be indexed as: S-4(3).

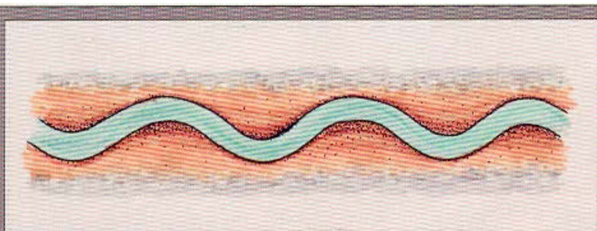
Worksheet 3-4. Meander pattern relations used for interpretations for river stability.

Meander Patterns

Stream:	**Forest River North Branch**	Stream Type:	**E4**
Location:	**Downstream Bylin - 1**	Valley Type:	**C-AL-AD**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

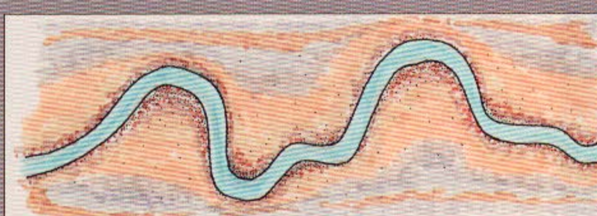
List ALL CATEGORIES that APPLY ☞	**M3**	**M8**			

Various Meander Pattern Variables modified from Galay et al. (1973)

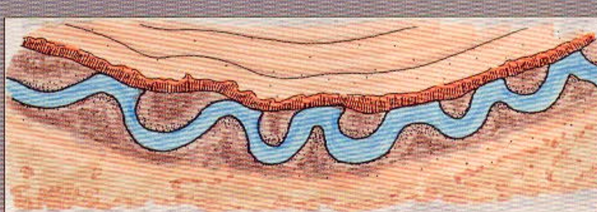


M1 REGULAR MEANDERS

M2 TORTUOUS MEANDERS



M3 IRREGULAR MEANDERS



M4 TRUNCATED MEANDERS

M5 UNCONFINED MEANDER SCROLLS

M6 CONFINED MEANDER SCROLLS

M7 DISTORTED MEANDER LOOPS

M8 IRREGULAR MEANDERS with oxbows and oxbow cutoffs

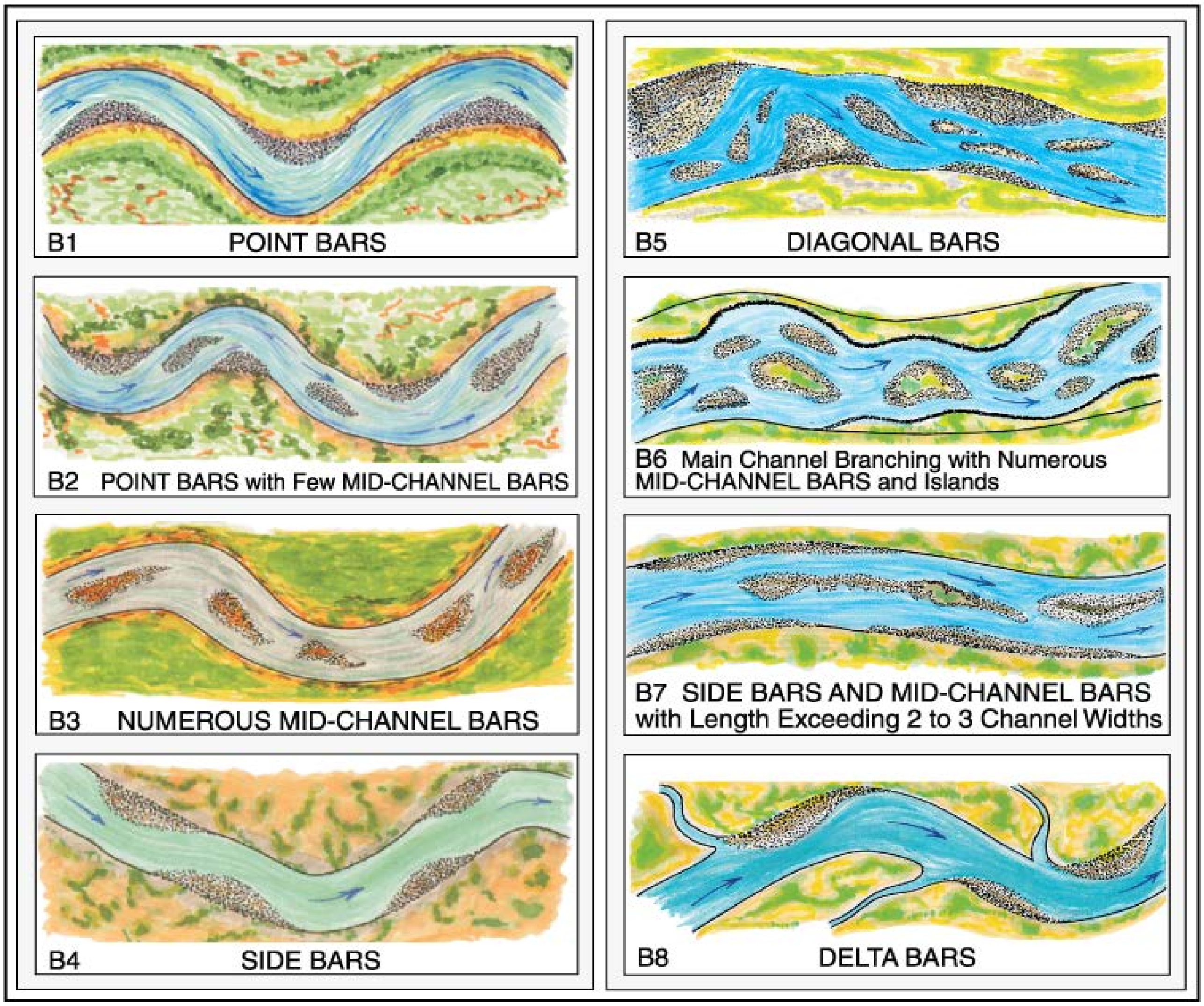
Worksheet 3-5. Depositional patterns used for stabiilty assessments.

Depositional Patterns

Stream:	**Forest River North Branch**	Stream Type:	**E4**
Location:	**Downstream Bylin - 1**	Valley Type:	**C-AL-AD**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

List ALL CATEGORIES that APPLY ☞	**B1**				

Various Depositional Features modified from Galay et al. (1973)



Worksheet 3-6. Various categories of in-channel debris, dams, and channel blockages used to evaluate channel stability.

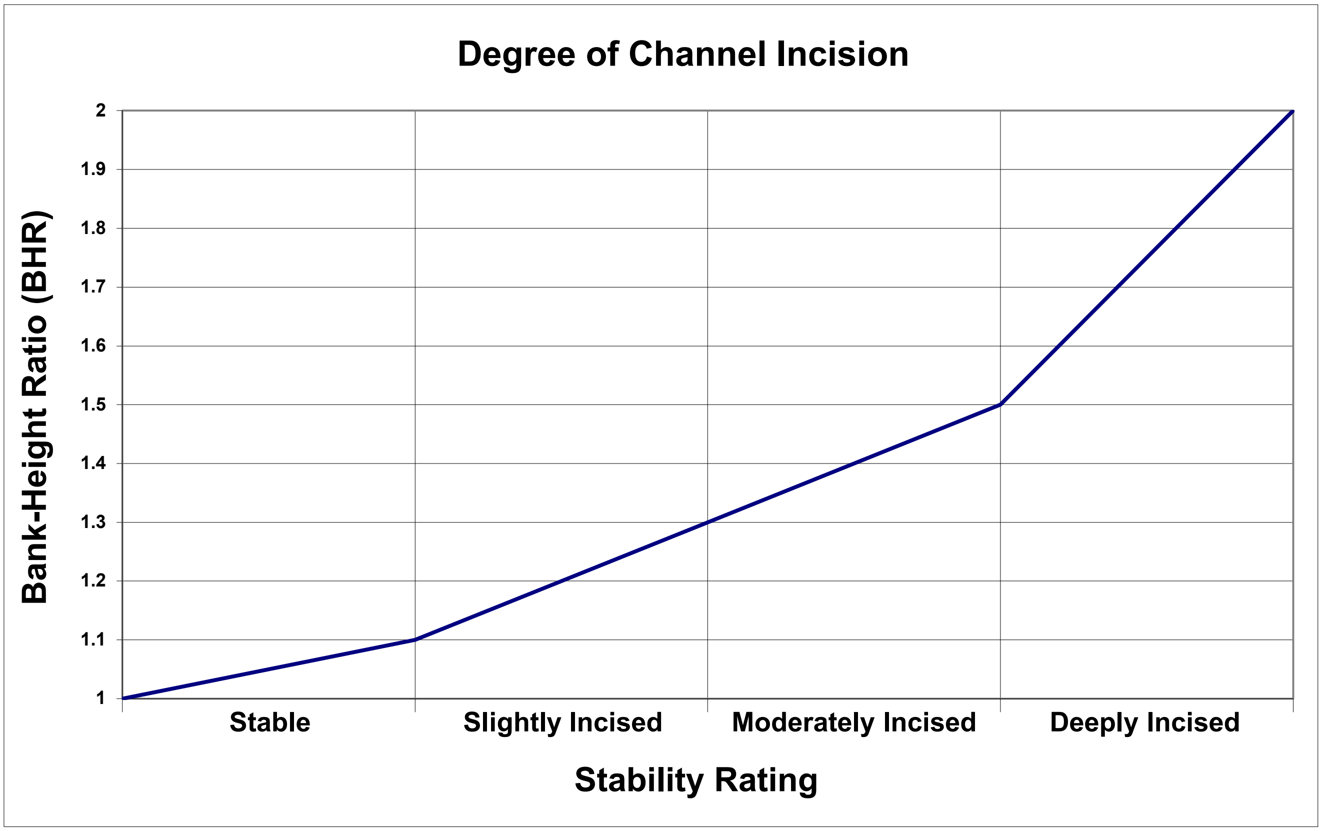
Channel Blockages			
Stream: **Forest River North Branch**		Stream Type: **E4**	
Location: **Downstream Bylin - 1**		Valley Type: **C-AL-AD**	
Observers: **Paul LeClaire**		Date: **6/9/2020**	
Description/Extent		**Materials that upon placement into the active channel or flood-prone area may cause adjustments in channel dimensions or conditions due to influences on the existing flow regime.**	**Check (✓) all that apply**
D1	None	Minor amounts of small, floatable material.	☐
D2	Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs, and twigs.	☐
D3	Moderate	Increasing frequency of small- to medium-sized material, such as large limbs, branches, and small logs, that when accumulated affect 10% or less of the active channel cross-sectional area.	☑
D4	Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs, or portions of trees, occupying 10–30% of the active channel cross-sectional area.	☐
D5	Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs, and trees, occupying 30–50% of the active channel cross-sectional area, often extending across the width of the active channel.	☐
D6	Dominating	Large, somewhat continuous, debris "dams," extensive in nature and occupying over 50% of the active channel cross-sectional area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	☐
D7	Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	☐
D8	Beaver Dams: Frequent	Frequency of dams is such that backwater conditions exist for channel reaches between structures where streamflow velocities are reduced and channel dimensions or conditions are influenced.	☐
D9	Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment or breached, initiating a series of channel adjustments, such as streambank erosion, lateral migration, avulsion, aggradation, or degradation.	☐
D10	Human Influences	Structures, facilities, or materials related to land uses or development located within the flood-prone area, such as diversions or low-head dams, controlled by-pass channels, velocity control structures, and various transportation encroachments that have an influence on the existing flow regime, such that significant channel adjustments occur.	☐

Worksheet 3-7. Relationship of Bank-Height Ratio (BHR) ranges to corresponding stream stability ratings.

Degree of Channel Incision			
Stream:	**Forest River North Branch**	Stream Type:	**E4**
Location:	**Downstream Bylin - 1**	Valley Type:	**C-AL-AD**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

Low Bank Height:	**4.51**
Bankfull Max Depth:	**2.77**
Bank-Height Ratio (BHR):	**1.63**

Degree of Channel Incision Stability Rating ☞ **Deeply Incised**



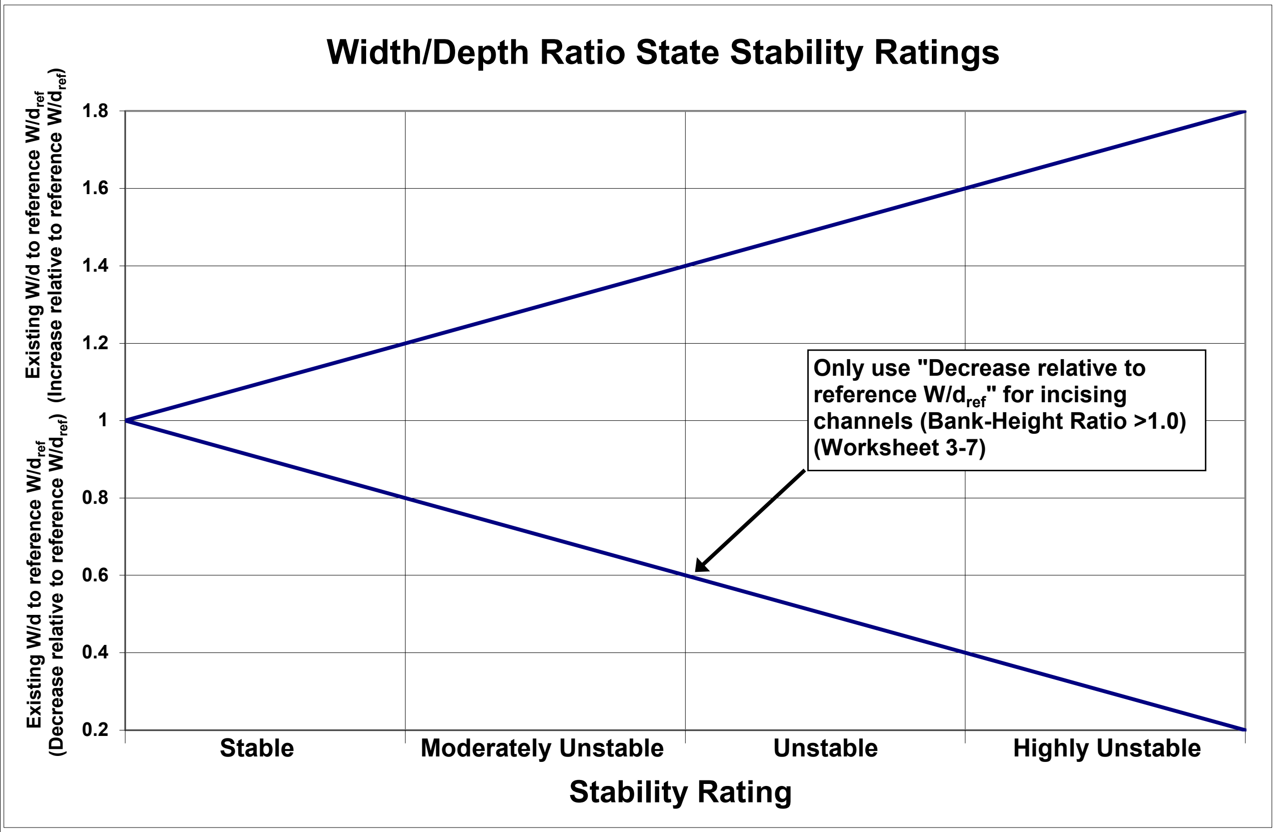
Worksheet 3-8. Stability ratings based on departure of width/depth ratio from reference condition.

Width/Depth Ratio State

Stream:	**Forest River North Branch**	Stream Type:	**E4**
Location:	**Downstream Bylin - 1**	Valley Type:	**C-AL-AD**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

Existing Width/Depth Ratio (W/d):	**7.587**	Existing W/d to Reference W/d $_{ref}$:	**0.81**
Reference Width/Depth Ratio (W/d $_{ref}$):	**9.4**		

Width/Depth Ratio State Stability Rating ☞	**Stable**



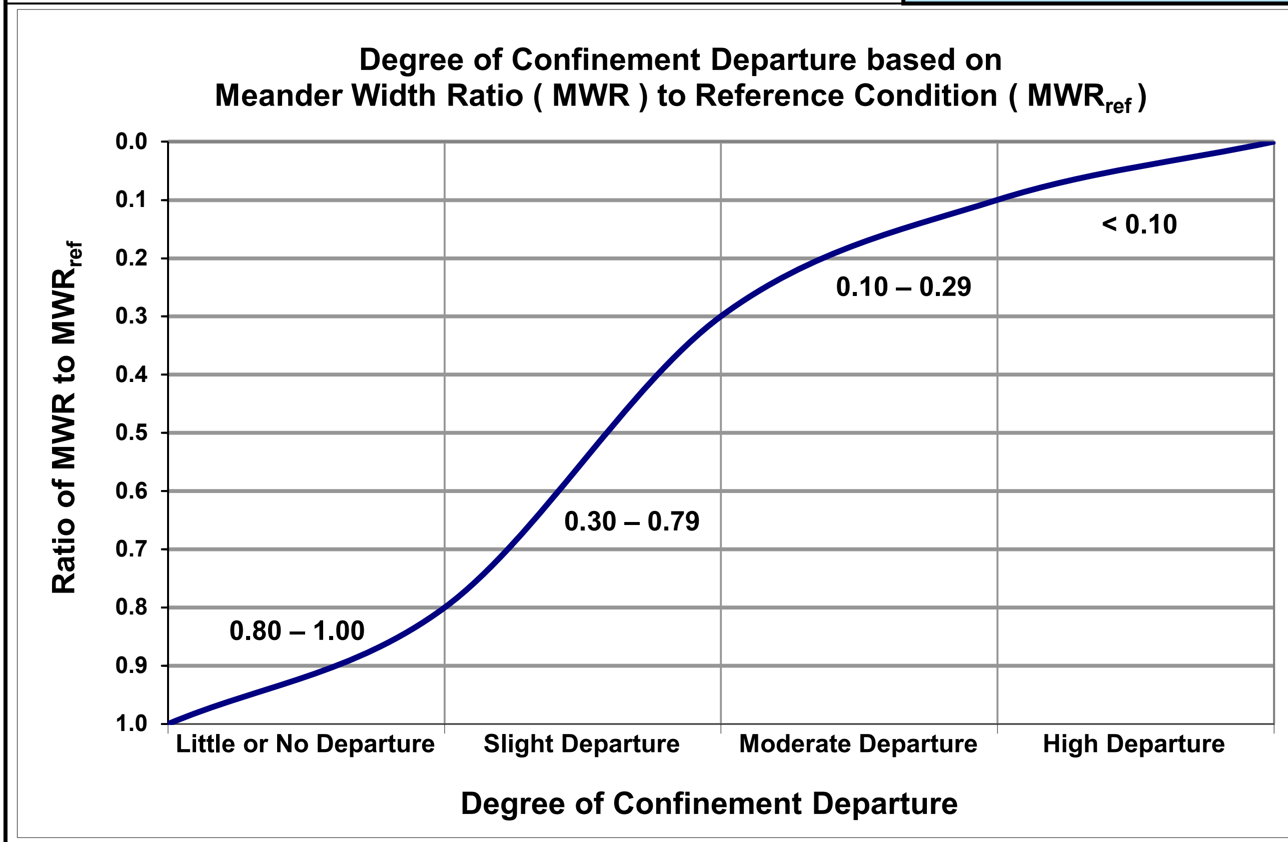
Worksheet 3-9. Degree of confinement departure based on Meander Width Ratio (MWR) divided by reference condition Meander Width Ratio (MWR_{ref}).

Degree of Confinement

Stream:	**Forest River North Branch**	Stream Type:	**E4**
Location:	**Downstream Bylin - 1**	Valley Type:	**C-AL-AD**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

Existing Meander Width Ratio (MWR):	**14.28**	Ratio of MWR to MWR_{ref}:	**11.16**
Reference Meander Width Ratio (MWR_{ref}):	**1.28**		

Degree of Confinement Stability Rating ☞ **Little or No Departure**



Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2006b).

Stream: Forest River North Branch **Location:** Downstream Bylin - 1 **Valley Type:** C-AL-AD **Observers:** Paul LeClaire **Date:** 6/9/2020

Loca-tion	Key	Category	Excellent		Good		Fair		Poor	
			Description	Rating	Description	Rating	Description	Rating	Description	Rating
Upper banks	1	Landform slope	Bank slope gradient <30%.	2	Bank slope gradient 30–40%.	4	Bank slope gradient 40–60%.	6	Bank slope gradient > 60%.	8
Upper banks	2	Mass erosion	No evidence of past or future mass erosion.	3	Infrequent. Mostly healed over. Low future potential.	6	Frequent or large, causing sediment nearly yearlong.	9	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Upper banks	3	Debris jam potential	Essentially absent from immediate channel area.	2	Present, but mostly small twigs and limbs.	4	Moderate to heavy amounts, mostly larger sizes.	6	Moderate to heavy amounts, predominantly larger sizes.	8
Upper banks	4	Vegetative bank protection	> 90% plant density. Vigor and variety suggest a deep, dense, soil-binding root mass.	3	70–90% density. Fewer species or less vigor suggest less dense or deep root mass.	6	50–70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous, and shallow root mass.	12
Lower banks	5	Channel capacity	Bank heights sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0. Bank-Height Ratio (BHR) = 1.0.	1	Bankfull stage is contained within banks. Width/depth ratio departure from reference width/depth ratio = 1.0–1.2. Bank-Height Ratio (BHR) = 1.0–1.1.	2	Bankfull stage is not contained. Width/depth ratio departure from reference width/depth ratio = 1.2–1.4. Bank-Height Ratio (BHR) = 1.1–1.3.	3	Bankfull stage is not contained; over-bank flows are common with flows less than bankfull. Width/depth ratio departure from reference width/depth ratio > 1.4. Bank-Height Ratio (BHR) > 1.3.	4
Lower banks	6	Bank rock content	> 65% with large angular boulders. 12"+ common.	2	40–65%. Mostly boulders and small cobbles 6–12".	4	20–40%. Most in the 3–6" diameter class.	6	<20% rock fragments of gravel sizes, 1–3" or less.	8
Lower banks	7	Obstructions to flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	2	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	8
Lower banks	8	Cutting	Little or none. Infrequent raw banks <6".	4	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	6	Significant. Cuts 12–24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Lower banks	9	Deposition	Little or no enlargement of channel or point bars.	4	Some new bar increase, mostly from coarse gravel.	8	Moderate depostion of new gravel and coarse sand on old and some new bars.	12	Extensive deposit of predominantly fine particles. Accelerated bar development.	16
Bottom	10	Rock angularity	Sharp edges and corners. Plane surfaces rough.	1	Rounded corners and edges. Surfaces smooth and flat.	2	Corners and edges well-rounded in two dimensions.	3	Well-rounded in all dimensions, surfaces smooth.	4
Bottom	11	Brightness	Surfaces dull, dark, or stained. Generally not bright.	1	Mostly dull, but may have <35% bright surfaces.	2	Mixture dull and bright, i.e., 35–65% mixture range.	3	Predominantly bright, > 65%, exposed or scoured surfaces.	4
Bottom	12	Consolidation of particles	Assorted sizes tightly packed or overlapping.	2	Moderately packed with some overlapping.	4	Mostly loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	8
Bottom	13	Bottom size distribution	No size change evident. Stable material 80–100%.	4	Distribution shift light. Stable material 50–80%.	8	Moderate change in sizes. Stable materials 20–50%.	12	Marked distribution change. Stable materials 0–20%.	16
Bottom	14	Scouring and deposition	<5% of bottom affected by scour or deposition.	6	5–30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12	30–50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.	18	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Bottom	15	Aquatic vegetation	Abundant growth moss-like, dark green perennial. In swift water too.	1	Common. Algae forms in low velocity and pool areas. Moss here too.	2	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	3	Perennial types scarce or absent. Yellow-green, short-term bloom may be present.	4
			Excellent Total =	**15**	**Good Total =**	**38**	**Fair Total =**	**3**	**Poor Total =**	**8**

Stream type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6
Good (Stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107	85-107	85-107	67-98
Fair (Mod. unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132	108-132	108-132	99-125
Poor (Unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+	133+	133+	126+

Stream type	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2	G3	G4	G5	G6
Good (Stable)	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60	85-107	85-107	90-112	85-107
Fair (Mod. unstable)	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78	108-120	108-120	113-125	108-120
Poor (Unstable)	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	121+

Grand Total =	**64**
Existing Stream Type =	**E4**
***Potential Stream Type =**	**E4**
Modified channel stability rating =	**Good**

***Rating is adjusted to *potential* stream type, not existing stream type**

Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

Bank Erosion Hazard Index (BEHI)

Stream: **Forest River North Branch** Location: **Downstream Bylin - 1**

Station: Observers: **Paul LeClaire**

Date: **6/9/2020** Stream Type: **E4** Valley Type: **C-AL-AD**

Parameter	Input 1	Input 2	Calculation	Result	BEHI Score (Fig. 3-7)
Study Bank Height to Bankfull Height (C)	Study Bank Height (ft) = 4.51 (A)	Bankfull Height (ft) = 2.77 (B)	(A) / (B) =	1.63 (C)	6.5
Root Depth to Study Bank Height (E)	Root Depth (ft) = 0.58 (D)	Study Bank Height (ft) = 4.51 (A)	(D) / (A) =	0.13 (E)	8.0
Weighted Root Density (G)	Root Density as % = 30.00 (F)		(F) × (E) =	3.87805 (G)	9.0
Bank Angle (H)			Bank Angle as *Degrees* =	35.2 (H)	3.0
Surface Protection (I)			Surface Protection as % =	90% (I)	1.0

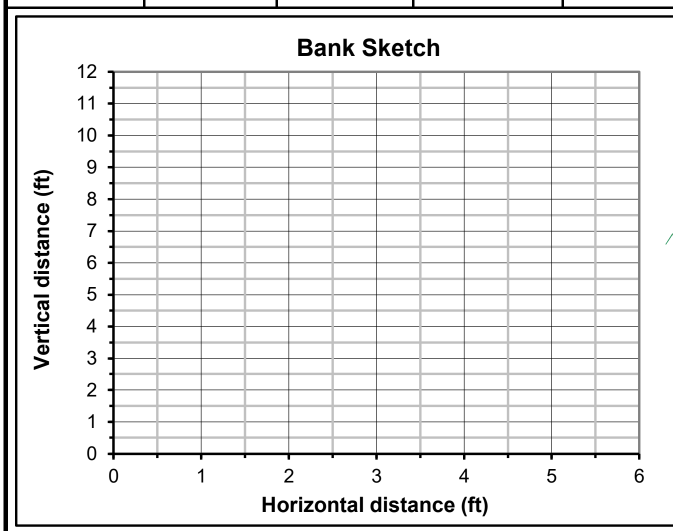
Bank Material Adjustment:
- **Bedrock** (Overall *Very Low* BEHI)
- **Boulders** (Overall *Low* BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment unless primarily clay, then subtract 20 points)

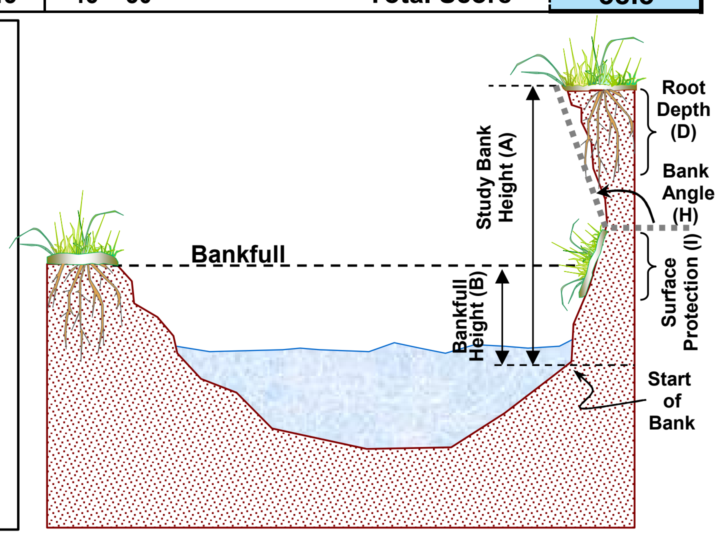
Bank Material Adjustment: 6

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage: 5

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score**: **High** / **38.5**





Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate an erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Forest River North Branch**	Location: **Downstream Bylin - 1**	
Station:	Stream Type: **E4**	Valley Type: **C-AL-AD**
Observers: **Paul LeClaire**		Date: **6/9/2020**

Methods for Estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar, or central bar creating NBS	Level I	Reconaissance
(2)	Radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General Prediction
(3)	Pool slope to average water surface slope (S_p / S)	Level II	General Prediction
(4)	Pool slope to riffle slope (S_p / S_{rif})	Level II	General Prediction
(5)	Near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed Prediction
(6)	Near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed Prediction
(7)	Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)	Transverse or central bars - short or discontinuous……………………………………**NBS = *High / Very High***
	Extensive deposition (continuous, cross-channel)……………………………………**NBS = *Extreme***
	Chute cutoffs, down-valley meander migration, converging flow……………………**NBS = *Extreme***

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	**Near-Bank Stress (NBS)**
(2)	**88.05**	**12**	**7.3375**	**Very Low**

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	**Near-Bank Stress (NBS)**
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	**Near-Bank Stress (NBS)**
(4)				

Dominant Near-Bank Stress

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	**Near-Bank Stress (NBS)**
(5)				

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	*Ratio* τ_{nb} / τ_{bkf}	**Near-Bank Stress (NBS)**
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	**Near-Bank Stress (NBS)**
(7)		

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) Ratings	Method Number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) Rating	**Very Low**

Worksheet 3-13. Annual streambank erosion estimates for various study reaches.

Streambank Erosion Prediction

Stream: **Forest River North Branch** Location: **Downstream Bylin - 1**

Graph Used: Total Stream Length (ft): Date: **6/9/2020**

Observers: **Paul LeClaire** Valley Type: **C-AL-AD** Stream Type: **E4**

(1) Station (ft)	(2) BEHI Rating (Worksheet 3-11) (adjective)	(3) NBS Rating (Worksheet 3-12) (adjective)	(4) Bank Erosion Rate (Figure 3-9 or 3-10) (ft/yr)	(5) Length of Bank (ft)	(6) Study Bank Height (ft)	(7) Erosion Subtotal [(4)×(5)×(6)] (ft^3/yr)	(8) Unit Erosion Rate (tons/yr/ft) {[(7)/27] × 1.3 / (5)}
1.	High	Very Low	0.165	1.00	4.51	0.75	0.03588
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
Sum erosion subtotals in Column (7) for each BEHI/NBS combination					Total Erosion (ft^3/yr)	0.75	
Convert erosion in ft^3/yr to yds^3/yr {divide *Total Erosion (ft^3/yr)* by 27}					Total Erosion (yds^3/yr)	0.03	
Convert erosion in yds^3/yr to tons/yr {multiply *Total Erosion (yds^3/yr)* by 1.3}					Total Erosion (tons/yr)	0.04	
Calculate erosion per unit length of channel {divide *Total Erosion (tons/yr)* by *Total Stream Length (ft)* surveyed}					Unit Erosion Rate (tons/yr/ft)		

Worksheet 3-14. Sediment competence calculation form to assess bed stability.

Sediment Competence using Dimensional and Dimensionless Shear Stress Methods

Stream:	**Forest River North Branch**	Stream Type:	**E4**
Location:	**Downstream Bylin - 1**	Valley Type:	**C-AL-AD**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

Enter Required Information for Existing Condition

7.0	D_{50}	Median particle size of riffle bed material (mm)			
	$\hat{D}_{50}$	Median particle size of bar or sub-pavement sample (mm)			
	D_{max}	Largest particle from bar sample (ft)	**0**	**(mm)**	304.8 mm/ft
0.0026	S	Existing average water surface slope (ft/ft)			
1.58	d	Existing bankfull mean depth (ft)			
1.65	$\gamma_s - \gamma / \gamma$	Immersed specific gravity of sediment			

Select the Appropriate Equation and Calculate Critical Dimensionless Shear Stress

	$D_{50}/\hat{D}_{50}$	Range: 3 – 7	Use EQUATION 1:	$\tau^* = 0.0834\,(D_{50}/\hat{D}_{50})^{-0.872}$
0.00	D_{max}/D_{50}	Range: 1.3 – 3.0	Use EQUATION 2:	$\tau^* = 0.0384\,(D_{max}/D_{50})^{-0.887}$
	τ^*	Bankfull Dimensionless Shear Stress	EQUATION USED:	

Calculate Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample

	d	Required bankfull mean depth (ft)	$d = \dfrac{\tau^*(\gamma_s - 1)D_{max}}{S}$	(use D_{max} in ft)

Calculate Average Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample

	S	Required average water surface slope (ft/ft)	$S = \dfrac{\tau^*(\gamma_s - 1)D_{max}}{d}$	(use D_{max} in ft)

Check: ☐ Stable ☑ Aggrading ☐ Degrading

Sediment Competence Using Dimensional Shear Stress

0.257		Bankfull shear stress $\tau = \gamma dS$ (lbs/ft^2) (substitute hydraulic radius, R, with mean depth, d) γ = 62.4, d = existing depth, S = existing slope
Shields **19**	CO **56**	Predicted largest moveable particle size (mm) at bankfull shear stress τ **(Figure 3-11)**
Shields **0.000**	CO **0.000**	Predicted shear stress required to initiate movement of measured D_{max} (mm) **(Figure 3-11)**
Shields **0.00**	CO **0.00**	Predicted mean depth required to initiate movement of measured D_{max} (mm) τ = predicted shear stress, γ = 62.4, S = existing slope $\quad d = \dfrac{\tau}{\gamma S}$
Shields **0.0000**	CO **0.0000**	Predicted slope required to initiate movement of measured D_{max} (mm) τ = predicted shear stress, γ = 62.4, d = existing depth $\quad S = \dfrac{\tau}{\gamma d}$

Check: ☐ Stable ☐ Aggrading ☐ Degrading

Worksheet 3-15. Stability ratings for stream type stage shifts.

Stream Succession Stage Shifts	
Stream: **Forest River North Branch**	Stream Type: **E4**
Location: **Downstream Bylin - 1**	Valley Type: **C-AL-AD**
Observers: **Paul LeClaire**	Date: **6/9/2020**
Stream Type Stage Shifts (Figure 3-14)	**Stability Rating (Check ✓ Appropriate Rating)**
Stream Type at Potential, (C→E), (F_b→B), (F→B_c), (F→C), (G→B), (D→C)	☐ Stable
(E→C), (B→High W/d B), (C→High W/d C)	☑ Moderately Unstable
(G_c→F), (G→F_b), (F→D), (C→F)	☐ Unstable
(C→D), (A→G), (B→G), (D→G), (C→G), (E→G), (E→A)	☐ Highly Unstable

Worksheet 3-16. Lateral stability prediction summary.

Lateral Stability Prediction					
Stream: **Forest River North Branch**				Stream Type: **E4**	
Location: **Downstream Bylin - 1**				Valley Type: **C-AL-AD**	
Observers: **Paul LeClaire**				Date: **6/9/2020**	
Lateral stability criteria (choose one stability category for each criterion 1–5)	**Lateral Stability Categories**				**Selected Points (from each row)**
	Stable	***Moderately Unstable***	***Unstable***	***Highly Unstable***	
1 W/d Ratio State (Worksheet 3-8)	< 1.2 **(2)**	1.2 – 1.4 **(4)**	1.4 – 1.6 **(6)**	> 1.6 **(8)**	**2**
2 Depositional Patterns (Worksheet 3-5)	B1, B2 **(1)**	B4, B8 **(2)**	B3 **(3)**	B5, B6, B7 **(4)**	**1**
3 Meander Patterns (Worksheet 3-4)	M1, M3, M4 **(1)**		M2, M5, M6, M7, M8 **(3)**		**1**
4 Streambank Erosion: Unit Rate (Worksheet 3-13)	< 0.006 **(2)**	0.006 – 0.04 **(4)**	0.041 – 0.07 **(6)**	> 0.07 **(8)**	**4**
5 Degree of Confinement (MWR / MWR_{ref}) (Worksheet 3-9)	> 0.8 **(1)**	0.3 – 0.79 **(2)**	0.1 – 0.29 **(3)**	< 0.1 **(4)**	**1**
				Total Points	**9**
	Lateral Stability Category Point Range				chosen
Overall Lateral Stability Category (use total points and check ✓ stability rating)	***Stable*** **< 10** ☐	***Moderately Unstable*** **10 – 12** ☑	***Unstable*** **13 – 21** ☐	***Highly Unstable*** **> 21** ☐	Stable

Worksheet 3-17. Vertical stability prediction for excess deposition and aggradation.

Vertical Stability Prediction for Excess Deposition and Aggradation					
Stream: **Forest River North Branch**			Stream Type: **E4**		
Location: **Downstream Bylin - 1**			Valley Type: **C-AL-AD**		
Observers: **Paul LeClaire**			Date: **6/9/2020**		
Vertical Stability Criteria (choose one stability category for each criterion 1–6)	**Vertical Stability Categories for Excess Deposition / Aggradation**				**Selected Points (from each row)**
	No Deposition	***Moderate Deposition***	***Excess Deposition***	***Aggradation***	
1 **Sediment Competence (Worksheet 3-14)**	Sufficient depth and slope to transport largest size available **(2)**	Trend toward insufficient depth or slope- slightly incompetent **(4)**	Cannot move D_{35} of bed material and/or D_{100} of bar material **(6)**	Cannot move D_{16} of bed material and/or D_{100} of bar or sub-pavement size **(8)**	**2**
2 **Sediment Capacity (POWERSED)**	Sufficient capacity to transport annual load **(2)**	Trend toward insufficient sediment capacity **(4)**	Reduction up to 25% of annual sediment yield of bedload or suspended sand **(6)**	Reduction over 25% of annual sediment yield for bedload or suspended sand **(8)**	**2**
3 **W/d Ratio State (Worksheet 3-8)**	< 1.2 **(2)**	1.2 – 1.4 **(4)**	1.4 – 1.6 **(6)**	> 1.6 **(8)**	**2**
4 **Stream Succession Stage Shifts (Worksheet 3-15)**	Current stream type at potential or does not indicate deposition/ aggradation **(2)**	(E→C) **(4)**	(B→High W/d B), (C→High W/d C), (C→F), (G_c→F), (G→F_b) **(6)**	(C→D), (F→D) **(8)**	**4**
5 **Depositional Patterns (Worksheet 3-5)**	B1 **(1)**	B2, B4 **(2)**	B3, B5 **(3)**	B6, B7, B8 **(4)**	**1**
6 **Debris / Blockages (Worksheet 3-6)**	D1, D2, D3 **(1)**	D4, D7 **(2)**	D5, D8 **(3)**	D6, D9, D10 **(4)**	**2**
				Total Points	**13**
	Vertical Stability Category Point Range for Excess Deposition and Aggradation				**chosen**
Vertical Stability for Excess Deposition / Aggradation (use total points and check ✓ stability rating)	***No Deposition*** **< 15** ☑	***Moderate Deposition*** **15 – 20** ☐	***Excess Deposition*** **21 – 30** ☐	***Aggradation*** **> 30** ☐	No Deposition

Worksheet 3-18. Vertical stability prediction for channel incision and degradation.

Vertical Stability Prediction for Channel Incision and Degradation						
Stream: **Forest River North Branch**				Stream Type: **E4**		
Location: **Downstream Bylin - 1**				Valley Type: **C-AL-AD**		
Observers: **Paul LeClaire**				Date: **6/9/2020**		
Vertical Stability Criteria (choose one stability category for each criterion 1–5)		**Vertical Stability Categories for Channel Incision / Degradation**				**Selected Points (from each row)**
		Not Incised	***Slightly Incised***	***Moderately Incised***	***Degradation***	
1	**Sediment Competence (Worksheet 3-14)**	Does not indicate excess competence **(2)**	Trend to move larger sizes than D_{100} of bar or D_{84} of bed **(4)**	D_{100} of bed moved **(6)**	Particles much larger than D_{100} of bed moved **(8)**	**2**
2	**Sediment Capacity (POWERSED)**	Does not indicate excess capacity **(2)**	Slight excess energy: up to 10% increase above reference **(4)**	Excess energy sufficient to increase load up to 50% of annual load **(6)**	Excess energy transporting more than 50% of annual load **(8)**	**2**
3	**Degree of Channel Incision (BHR) (Worksheet 3-7)**	1.00 – 1.10 **(2)**	1.11 – 1.30 **(4)**	1.31 – 1.50 **(6)**	> 1.50 **(8)**	**8**
4	**Stream Succession States (Worksheets 3-15 and 3-7)**	Does not indicate incision or degradation **(2)**	If BHR > 1.1 and stream type has W/d between 5–10 **(4)**	If BHR > 1.1 and stream type has W/d less than 5 **(6)**	(B→G), (C→G), (E→G), (D→G), (A→G), (E→A) **(8)**	**4**
5	**Confinement (MWR / MWR_{ref}) (Worksheet 3-9)**	0.80 – 1.00 **(1)**	0.30 – 0.79 **(2)**	0.10 – 0.29 **(3)**	< 0.10 **(4)**	**1**
					Total Points	**17**
		Vertical Stability Category Point Range for Channel Incision and Degradation				**chosen**
Vertical Stability for Channel Incision/ Degradation (use total points and check ✓ stability rating)		***Not Incised*** **< 12** ☐	***Slightly Incised*** **12 – 18** ☑	***Moderately Incised*** **19 – 27** ☐	***Degradation*** **> 27** ☐	Slightly Incised

Worksheet 3-19. Channel enlargement prediction summary.

Channel Enlargement Prediction					
Stream: **Forest River North Branch**			Stream Type: **E4**		
Location: **Downstream Bylin - 1**			Valley Type: **C-AL-AD**		
Observers: **Paul LeClaire**			Date: **6/9/2020**		
Channel Enlargement Prediction Criteria (choose one stability category for each criterion 1–4)	**Channel Enlargement Prediction Categories**				**Selected Points (from each row)**
	No Increase	***Slight Increase***	***Moderate Increase***	***Extensive***	
1 **Stream Succession Stage Shifts (Worksheet 3-15)**	Stream Type at Potential, (C→E), (F_b→B), (G→B), (F→B_c), (F→C), (D→C) **(2)**	(B→High W/d B), (C→High W/d C), (E→C) **(4)**	(G→F), (F→D) **(6)**	(C→D), (A→G), (B→G), (D→G), (C→G), (E→G), (E→A), (C→F) **(8)**	**4**
2 **Lateral Stability (Worksheet 3-16)**	*Stable* **(2)**	*Moderately Unstable* **(4)**	*Unstable* **(6)**	*Highly Unstable* **(8)**	**2**
3 **Vertical Stability Excess Deposition and Aggradation (Worksheet 3-17)**	*No Deposition* **(2)**	*Moderate Deposition* **(4)**	*Excess Deposition* **(6)**	*Aggradation* **(8)**	**2**
4 **Vertical Stability Channel Incision and Degradation (Worksheet 3-18)**	*Not Incised* **(2)**	*Slightly Incised* **(4)**	*Moderately Incised* **(6)**	*Degradation* **(8)**	**4**
				Total Points	**12**
	Category Point Range				**chosen**
Channel Enlargement Prediction (use total points and check ✓ stability rating)	***No Increase*** **< 11** ☐	***Slight Increase*** **11 – 16** ☑	***Moderate Increase*** **17 – 24** ☐	***Extensive*** **> 24** ☐	Slight Increase

Worksheet 3-20. Overall sediment supply rating determined from individual stability rating categories.

Overall Sediment Supply Prediction

Stream:	**Forest River North Branch**	Stream Type:	**E4**
Location:	**Downstream Bylin - 1**	Valley Type:	**C-AL-AD**
Observers:	**Paul LeClaire**	Date:	**6/9/2020**

Overall Sediment Supply Prediction Criteria (choose corresponding points for each criterion 1–5)	Stability Rating	Points	Selected Points
1 Lateral Stability (Worksheet 3-16)	*Stable*	1	1
	Mod. Unstable	2	
	Unstable	3	
	Highly Unstable	4	
2 Vertical Stability Excess Deposition or Aggradation (Worksheet 3-17)	*No Deposition*	1	1
	Mod. Deposition	2	
	Excess Deposition	3	
	Aggradation	4	
3 Vertical Stability Channel Incision or Degradation (Worksheet 3-18)	*Not Incised*	1	2
	Slightly Incised	2	
	Mod. Incised	3	
	Degradation	4	
4 Channel Enlargement Prediction (Worksheet 3-19)	*No Increase*	1	2
	Slight Increase	2	
	Mod. Increase	3	
	Extensive	4	
5 Pfankuch Channel Stability (Worksheet 3-10)	*Good: Stable*	1	1
	Fair: Mod. Unstable	2	
	Poor: Unstable	4	
		Total Points	7

Overall Sediment Supply Rating (use total points and check ✓ stability rating)	Category Point Range			
	Low < 6 ☐	*Moderate* 6 – 10 ☑	*High* 11 – 15 ☐	*Very High* > 15 ☐

Worksheet 3-21. Summary of stability condition categories.

Summary of Stability Conditions

Stream:	**Forest River North Branch**				Location:	**Downstream Bylin - 1**			
Observers:	**Paul LeClaire**		Date:	**6/9/2020**	Stream Type:	**E4**	Valley Type:	**C-AL-AD**	
Channel Dimension	Bankfull Mean Depth (ft): **1.58**	Bankfull Width (ft): **12**	Cross-Sectional Area (ft^2): **18.98**	Width/Depth Ratio: **7.586934**	Entrenchment Ratio: **3.13**				
Channel Pattern	Mean: / Range:	λ/W_{bkf}: **226**	L_m/W_{bkf}: **360**	R_c/W_{bkf}: **56**	MWR: **14.28**	Sinuosity: **1.80**			
Streamflow	Bankfull Mean Velocity ($\bar{u}_{bkf}$) (ft/sec): **3.94**	Bankfull Discharge (Q_{bkf}): **74.80**	Estimation Method: **1**	Drainage Area (mi^2): **21.0545**					
River Profile & Bed Features	Check: ☑ Riffle/Pool ☐ Step/Pool ☐ Plane Bed ☐ Convergence/Divergence ☐ Dunes/Antidunes/Smooth Bed								
	Bankfull Max Depth (ft): Riffle **2.77**, Pool	Depth Ratio (max to mean): Riffle **1.75**, Pool	Pool-to-Pool Spacing: Ratio	Slope: Valley: **0.2**	Water Surface: **0.0026**				
Level III Stream Stability Indices	Riparian Vegetation	Current Composition/Density:	Potential Composition/Density:	Remarks: Condition, Vigor & Usage of Existing Reach:					
	Flow Regime: **P1**	Stream Size & Order: **S-3(3)**	Meander Patterns: **M3**	Depositional Patterns: **B1**	Debris/Channel Blockages: **D3**				
	Degree of Incision (Bank-Height Ratio): **1.63**	Degree of Incision Stability Rating: **Deeply Incised**	Modified Pfankuch Stability Rating (Numeric & Adjective Rating): **64 Good**						
	W/d Ratio State (W/d) / (W/d_{ref}): **0.81**	W/d Ratio State Stability Rating: **Stable**	Degree of Confinement (MWR / MWR_{ref}): **11.16**	MWR / MWR_{ref} Stability Rating: **Little or No Departure**					
Bank Erosion Summary	Length of Reach Studied (ft): **1**	Annual Streambank Erosion Rate: **0.04** (tons/yr) **0.036** (tons/yr/ft)	Curve Used: **Moderate BEHI**	Remarks:					
Sediment Capacity (POWERSED)	☐ *Sufficient Capacity* ☐ *Insufficient Capacity* ☐ *Excess Capacity*	Remarks:							
Entrainment/ Competence	Largest Particle from Bar Sample (mm):	$\tau =$ **0.257**	$\tau^* =$ **0.0000**	Existing Depth: **1.58**	Required Depth: **0.0**	Existing Slope: **0.0026**	Required Slope: **0**		
Stream Succession	→ → → → →	Existing Stream State (Type): **E4**	Potential Stream State (Type):						
Lateral Stability	☑ *Stable* ☐ *Mod. Unstable* ☐ *Unstable* ☐ *Highly Unstable*	Remarks:							
Vertical Stability (Aggradation)	☑ *No Deposition* ☐ *Mod. Deposition* ☐ *Ex. Deposition* ☐ *Aggradation*	Remarks:							
Vertical Stability (Degradation)	☐ *Not Incised* ☑ *Slightly Incised* ☐ *Mod. Incised* ☐ *Degradation*	Remarks:							
Channel Enlargement	☐ *No Increase* ☑ *Slight Increase* ☐ *Mod. Increase* ☐ *Extensive*	Remarks:							
Sediment Supply (Channel Source)	☐ *Low* ☑ *Moderate* ☐ *High* ☐ *Very High*	Remarks:							