

# **APPENDIX A**



## **FIELD INVESTIGATION NOTES**

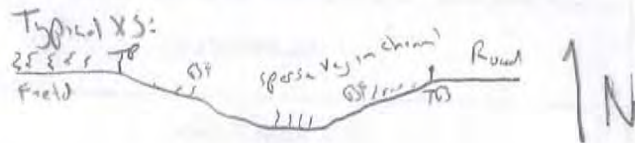
# Geomorphic Analysis Check List

Site Name: Lower Rush River - 1

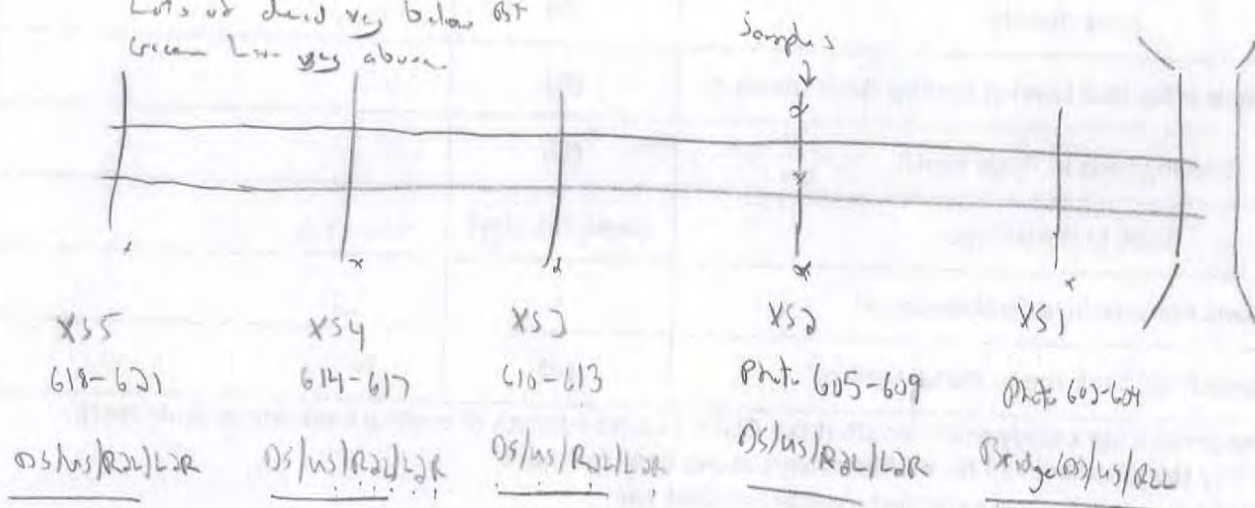
Date: 9/29/11

**SKETCH**

BF Note: Based on Veg  
TB influenced by rd + Field due  
to man-made ditch



Org during visit  
Lots of dead veg below BT  
Green Lm-veg above



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	2003	Bank Full (BF)	✓	2002	Water Surface (WS)	N/A	
	Right	Top of Bank (TB)	✓	2000	Bank Full (BF)	✓	2001			
Section 2	Left	Top of Bank (TB)	✓	2009	Bank Full (BF)	✓	2008	Water Surface (WS)	N/A	
	Right	Top of Bank (TB)	✓	2006	Bank Full (BF)	✓	2007			
Section 3	Left	Top of Bank (TB)	✓	2014	Bank Full (BF)	✓	2013	Water Surface (WS)	N/A	
	Right	Top of Bank (TB)	✓	2010	Bank Full (BF)	✓	2011			
Section 4	Left	Top of Bank (TB)	✓	2019	Bank Full (BF)	✓	2018	Water Surface (WS)	N/A	
	Right	Top of Bank (TB)	✓	2016	Bank Full (BF)	✓	2017			
Section 5	Left	Top of Bank (TB)	✓	2024	Bank Full (BF)	✓	2023	Water Surface (WS)	N/A	
	Right	Top of Bank (TB)	✓	2021	Bank Full (BF)	✓	2022			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.06	0.06
Root Depth	(ft)	unknown		
Root Density	(%)	unknown		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	10%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	5%		
Bank Material Type	(sand, silt, clay)	see lab.		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	N/A		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	Dry	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	LR1-LB	2225
Right Bank (RB)	✓	LR1-RB	2226
Bed Surface (BED)			
Bed Core (BED-C)			
Bar (BAR)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

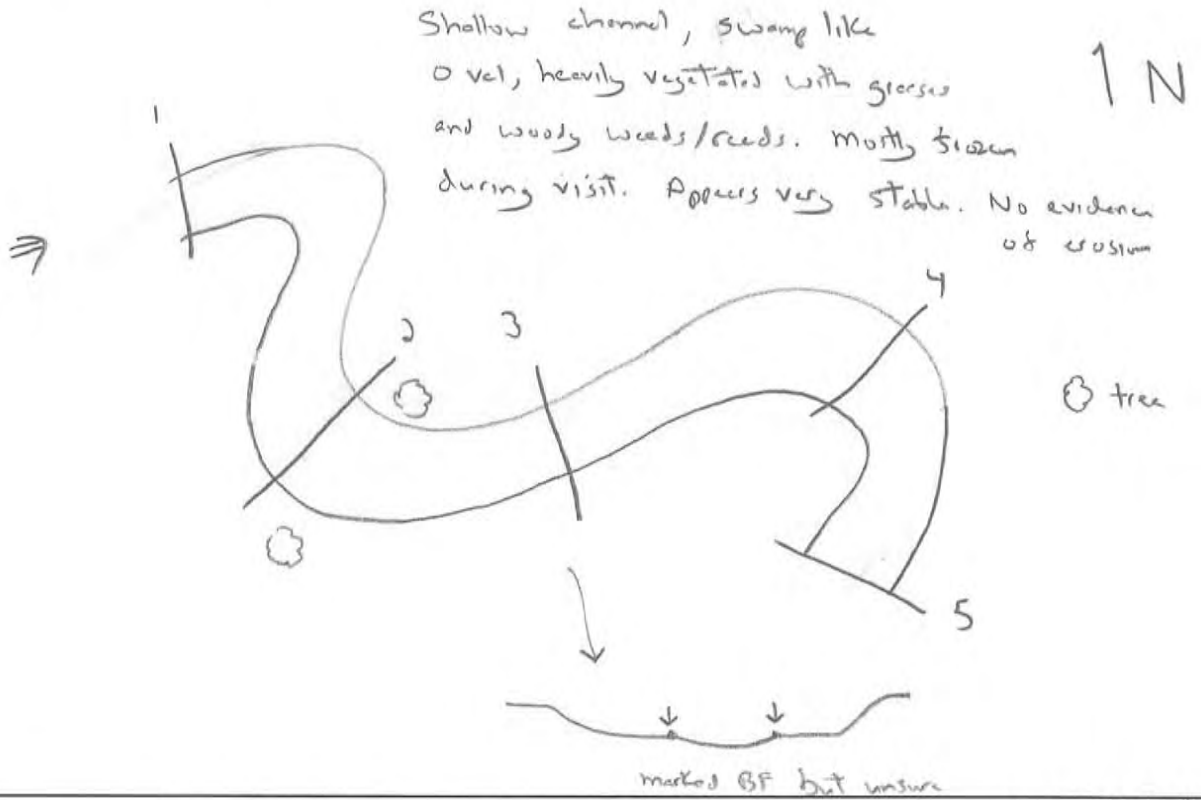
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

Geomorphic Analysis Check List

Site Name: Lower Rush 11/18/10

FID 9 (RMG.50-6.03)

SKETCH



Survey crew did not  
 find. Did not resurvey  
 in 2011 as G = 0

Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	3005	Bank Full (BF)	same	3005	Water Surface (WS)	✓	3003
	Right	Top of Bank (TB)	✓	3001	Bank Full (BF)	✓	3002			
Section 2	Left	Top of Bank (TB)	✓	3006	Bank Full (BF)	same	3006	Water Surface (WS)	✓	3008
	Right	Top of Bank (TB)	✓	3009	Bank Full (BF)	same	3009			
Section 3	Left	Top of Bank (TB)	✓	3010	Bank Full (BF)	✓	3011	Water Surface (WS)	✓	3014
	Right	Top of Bank (TB)	✓	3016	Bank Full (BF)	✓	3015			
Section 4	Left	Top of Bank (TB)	✓	3024	Bank Full (BF)	same	3024	Water Surface (WS)	✓	3017
	Right	Top of Bank (TB)	✓	3018	Bank Full (BF)	same	3018			
Section 5	Left	Top of Bank (TB)	✓	3022	Bank Full (BF)	same	3022	Water Surface (WS)	✓	3020
	Right	Top of Bank (TB)	✓	3021	Bank Full (BF)	same	3021			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.06
Root Depth	(ft)	est 0.5-1
Root Density	(%)	25
Eroding Bank Surface Cover	(%)	0
Eroding Bank Length	(ft)	0
Bank Material Type	(sand, <u>silt</u> , clay)	See lab sample
Bank Material Stratification Score <sup>1</sup>	-	0
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	~ 1.5'

estimated, not easily visible  
maybe 1" high

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	No
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

- Frozen, also veg would be too thick in channel for measurements

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	LR-1	3025
Right Bank (RB)	✓	LR-3	3026
Bed (BED)	✓	LR-2	3027
Bar - Armor (B-A)			
Bar - Sub Armor (B-SA)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

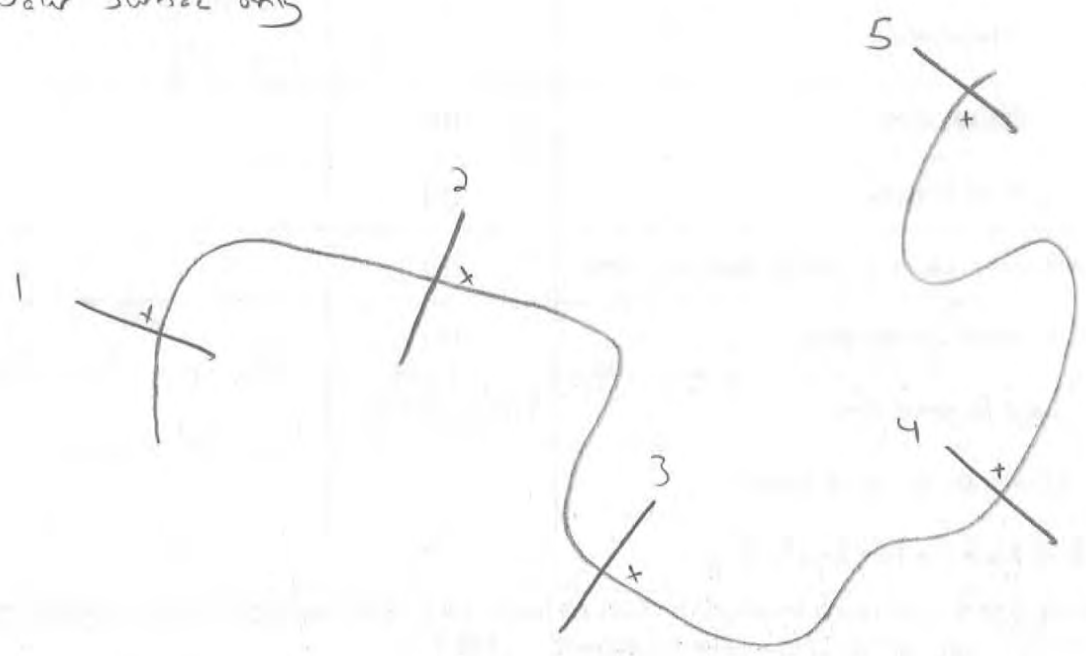
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Maple 1

Date: 10/1/11

SKETCH Water Surface only



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt																
Section 1	Left	Top of Bank (TB)	X	X	Bank Full (BF)	X	X	Water Surface (WS)	✓	2404																
	Right	Top of Bank (TB)			Bank Full (BF)																					
Section 2	Left	Top of Bank (TB)			X			X	Bank Full (BF)	X	X	Water Surface (WS)	✓	2403												
	Right	Top of Bank (TB)							Bank Full (BF)																	
Section 3	Left	Top of Bank (TB)							X			X	Bank Full (BF)	X	X	Water Surface (WS)	✓	2402								
	Right	Top of Bank (TB)											Bank Full (BF)													
Section 4	Left	Top of Bank (TB)											X			X	Bank Full (BF)	X	X	Water Surface (WS)	✓	2401				
	Right	Top of Bank (TB)															Bank Full (BF)									
Section 5	Left	Top of Bank (TB)															X			X	Bank Full (BF)	X	X	Water Surface (WS)	✓	2400
	Right	Top of Bank (TB)																			Bank Full (BF)					

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.0335	0.045	0.045
Root Depth	(ft)			
Root Density	(%)			
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)			
Eroding Bank in Study Reach <sup>1</sup>	(%)			
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-			
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)			

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	OS Gage	Riparian Vegetation Worksheet	
Depositional Features Worksheet		Pfankuch Method	
Channel Blockages Worksheet			

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)			
Right Bank (RB)			
Bed Surface (BED)			
Bed Core (BED-C)	Did not collect (clay)		
Bar (BAR)			

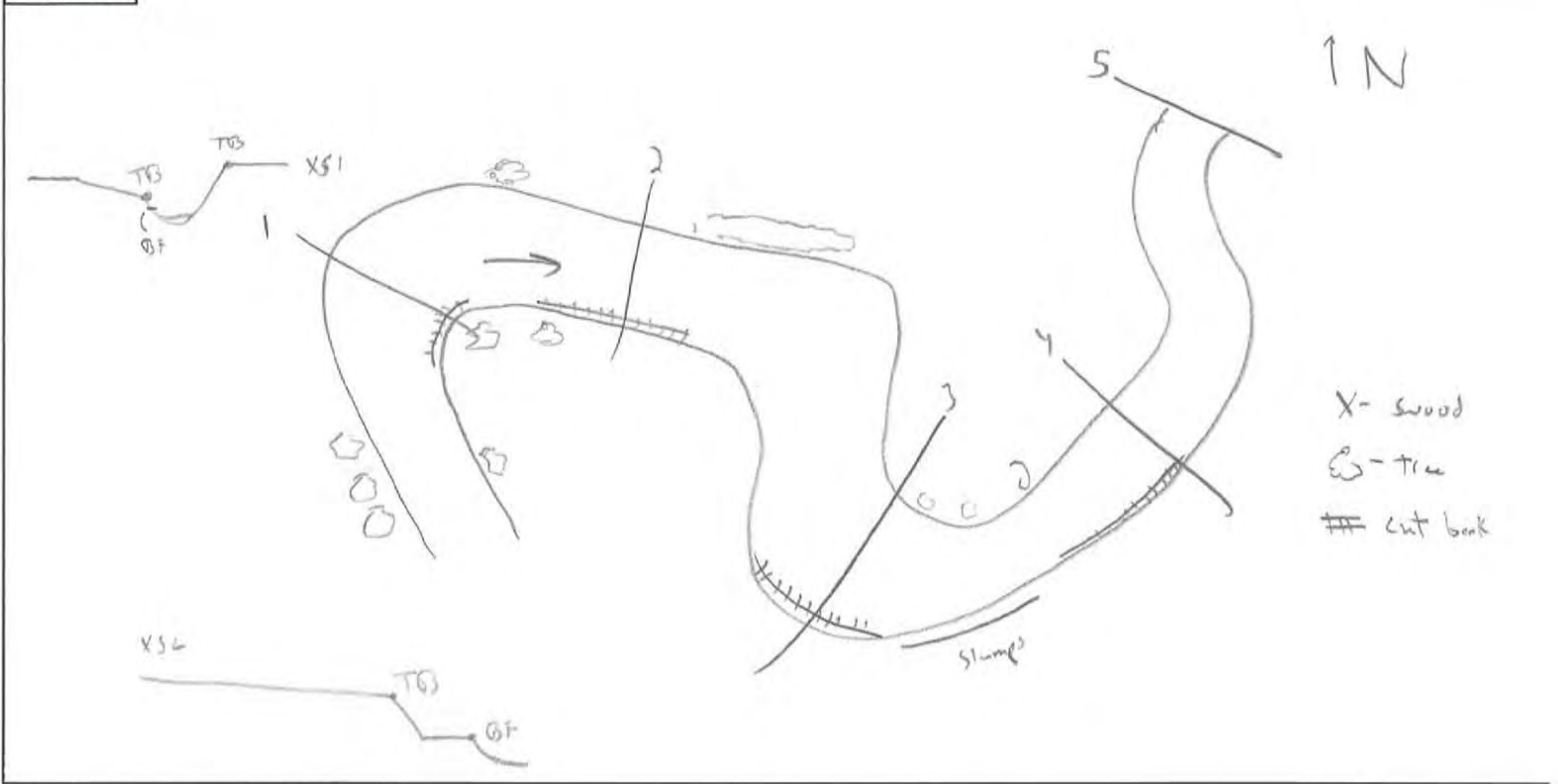
River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

Maple River - 1-0.80 11/16/10  
 Geomorphic Analysis Check List

Site Name: Maple 11/16/10 FID 18 (RM 1.31-0.77)

SKETCH



Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	1000	Bank Full (BF)	✓	1003	Water Surface (WS)	✓	1004
	Right	Top of Bank (TB)	✓	1021	Bank Full (BF)	Same	1021			
Section 2	Left	Top of Bank (TB)	✓	1006	Bank Full (BF)	✓	1007	Water Surface (WS)	✓	1008
	Right	Top of Bank (TB)	✓	1022	Bank Full (BF)	Same	1022			
Section 3	Left	Top of Bank (TB)	✓		Bank Full (BF)			Water Surface (WS)	✓	
	Right	Top of Bank (TB)	✓	1018	Bank Full (BF)	✓	1017			
Section 4	Left	Top of Bank (TB)	✓	1032	Bank Full (BF)	✓	1033	Water Surface (WS)	✓	1036
	Right	Top of Bank (TB)	✓	1024	Bank Full (BF)	N/A	steep			
Section 5	Left	Top of Bank (TB)	✓	1034	Bank Full (BF)	N/A	steep	Water Surface (WS)	✓	1037
	Right	Top of Bank (TB)	✓	1025	Bank Full (BF)	✓	1026			



## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.03-0.035
Root Depth	(ft)	0.5-1.5
Root Density	(%)	25%
Eroding Bank Surface Cover	(%)	10%
Eroding Bank Length	(ft)	1300 ft
Bank Material Type	(sand, silt, clay)	See lab
Bank Material Stratification Score <sup>1</sup>	-	0
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	? see survey

maybe avg?

maybe high

50% of total dist

How below

Full

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	gaged
Depositional Features Noted on Worksheet	none noted
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	m-01	1010
Right Bank (RB)	✓	m-02	1031
Bed (BED)	✓	m-03	1031 Shore
Bar - Armor (B-A)			likely bank material
Bar - Sub Armor (B-SA)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

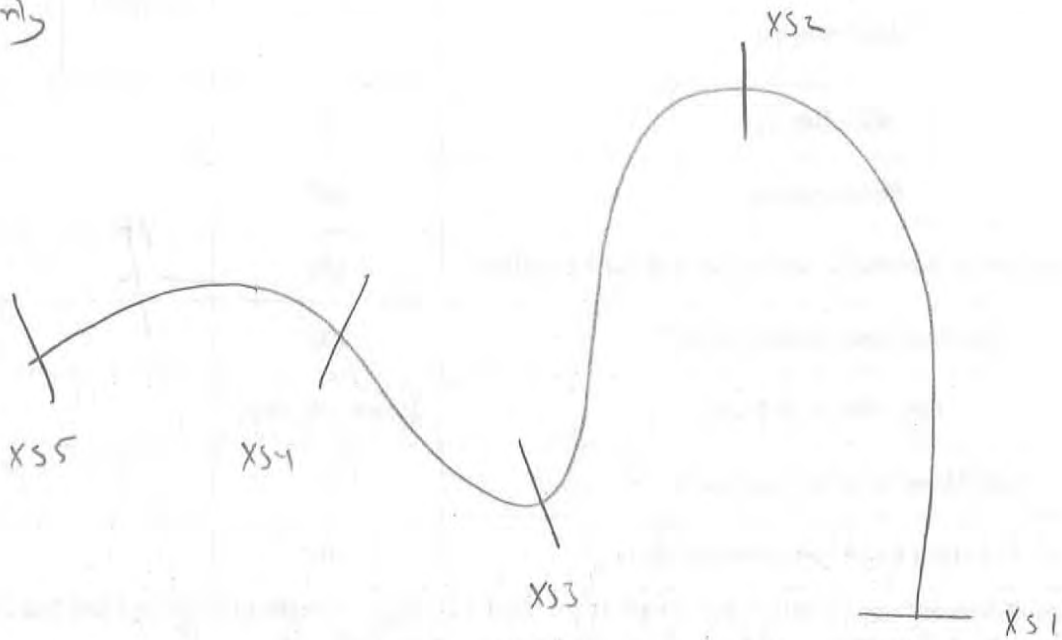
# Geomorphic Analysis Check List

Site Name: Maple 2

Date: 10/3/11

SKETCH

WS only



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	3000
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 2	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	3001
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 3	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	3002
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 4	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	3003
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 5	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	3004
	Right	Top of Bank (TB)			Bank Full (BF)					

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-			
Root Depth	(ft)			
Root Density	(%)			
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)			
Eroding Bank in Study Reach <sup>1</sup>	(%)			
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-			
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)			

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements		Riparian Vegetation Worksheet	
Depositional Features Worksheet		Pfankuch Method	
Channel Blockages Worksheet			

### Sampling Checklist

Location	Collected	Label	GPS Pt #	
Left Bank (LB)				
Right Bank (RB)				
Bed Surface (BED)				
Bed Core (BED-C)		✓	MR2-CH	3005
Bar (BAR)				

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

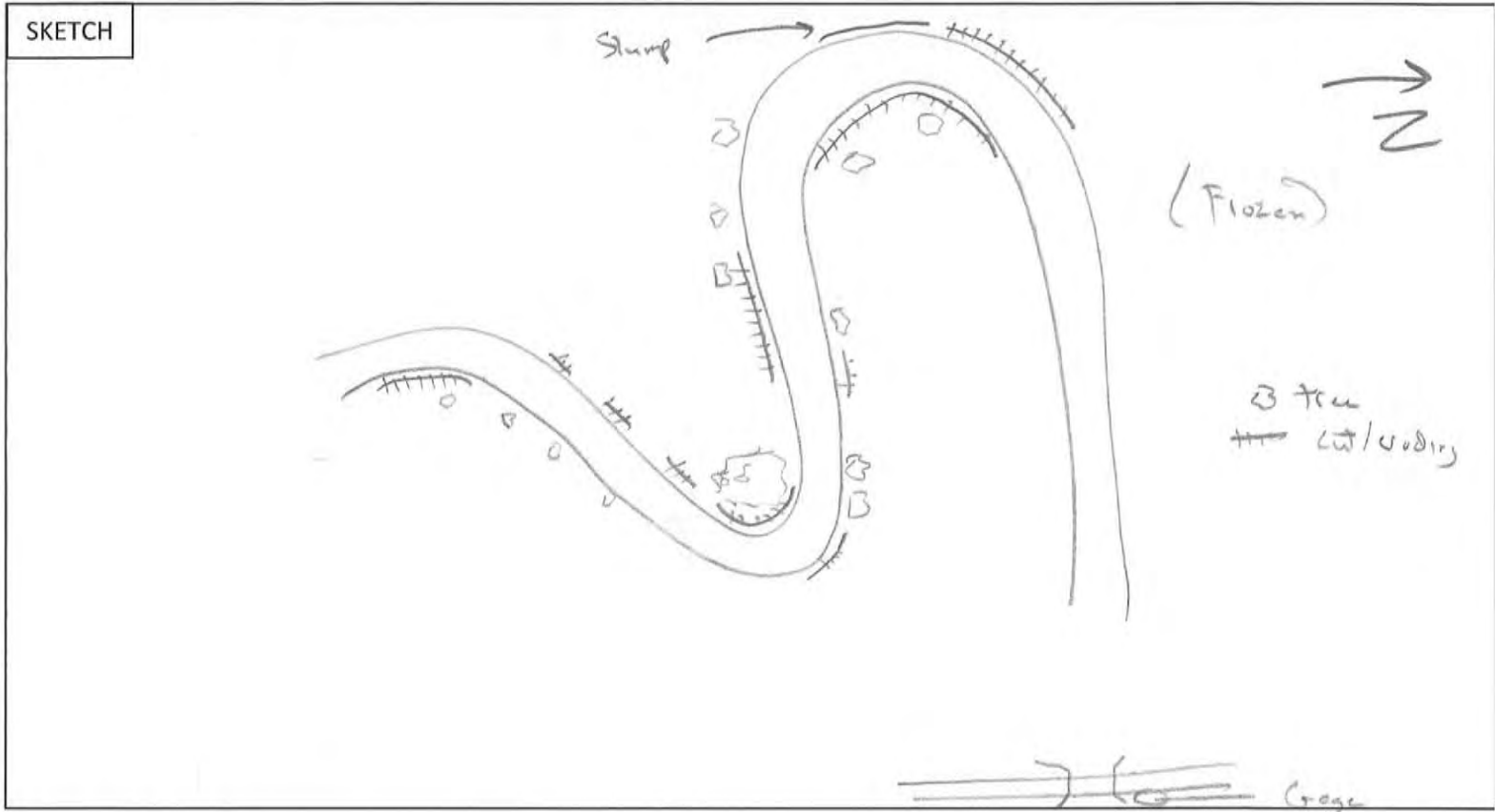
↓  
 taken via wading ~ 6' from edge water

Geomorphic Analysis Check List

Site Name: Maple

11/20/10

(RM 12.28-11.40)



Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	6017	Bank Full (BF)	✓	6016	Water Surface (WS)	✓	6015
	Right	Top of Bank (TB)	✓	6000	Bank Full (BF)	same	6000			
Section 2	Left	Top of Bank (TB)	✓	6019	Bank Full (BF)	✓	6021	Water Surface (WS)	✓	6020
	Right	Top of Bank (TB)	✓	6001	Bank Full (BF)	same	6001			
Section 3	Left	Top of Bank (TB)	✓	6024	Bank Full (BF)	same	6024	Water Surface (WS)	✓	6003
	Right	Top of Bank (TB)	✓	6005	Bank Full (BF)	✓	6004			
Section 4	Left	Top of Bank (TB)	✓	6025	Bank Full (BF)	✓	6026	Water Surface (WS)	✓	6007
	Right	Top of Bank (TB)	✓	6009	Bank Full (BF)	✓	6008			
Section 5	Left	Top of Bank (TB)	✓	6028	Bank Full (BF)	✓	6023	Water Surface (WS)	✓	6011
	Right	Top of Bank (TB)	✓	6013	Bank Full (BF)	✓	6032			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.03- 0.035
Root Depth	(ft)	1-1.5
Root Density	(%)	10-20
Eroding Bank Surface Cover	(%)	10
Eroding Bank Length	(ft)	1500
Bank Material Type	(sand, silt, clay)	See lab
Bank Material Stratification Score <sup>1</sup>	-	5
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	? frozen

major high

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	gaged
Depositional Features Noted on Worksheet	none
Channel Blockages Noted on Worksheet	none
Pfankuch Method Completed	✓

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)			
Right Bank (RB)	✓	m-B-1	
Bed (BED)	✓	m-B-2	
Bar - Armor (B-A)		↑ taken close to shore	
Bar - Sub Armor (B-SA)			

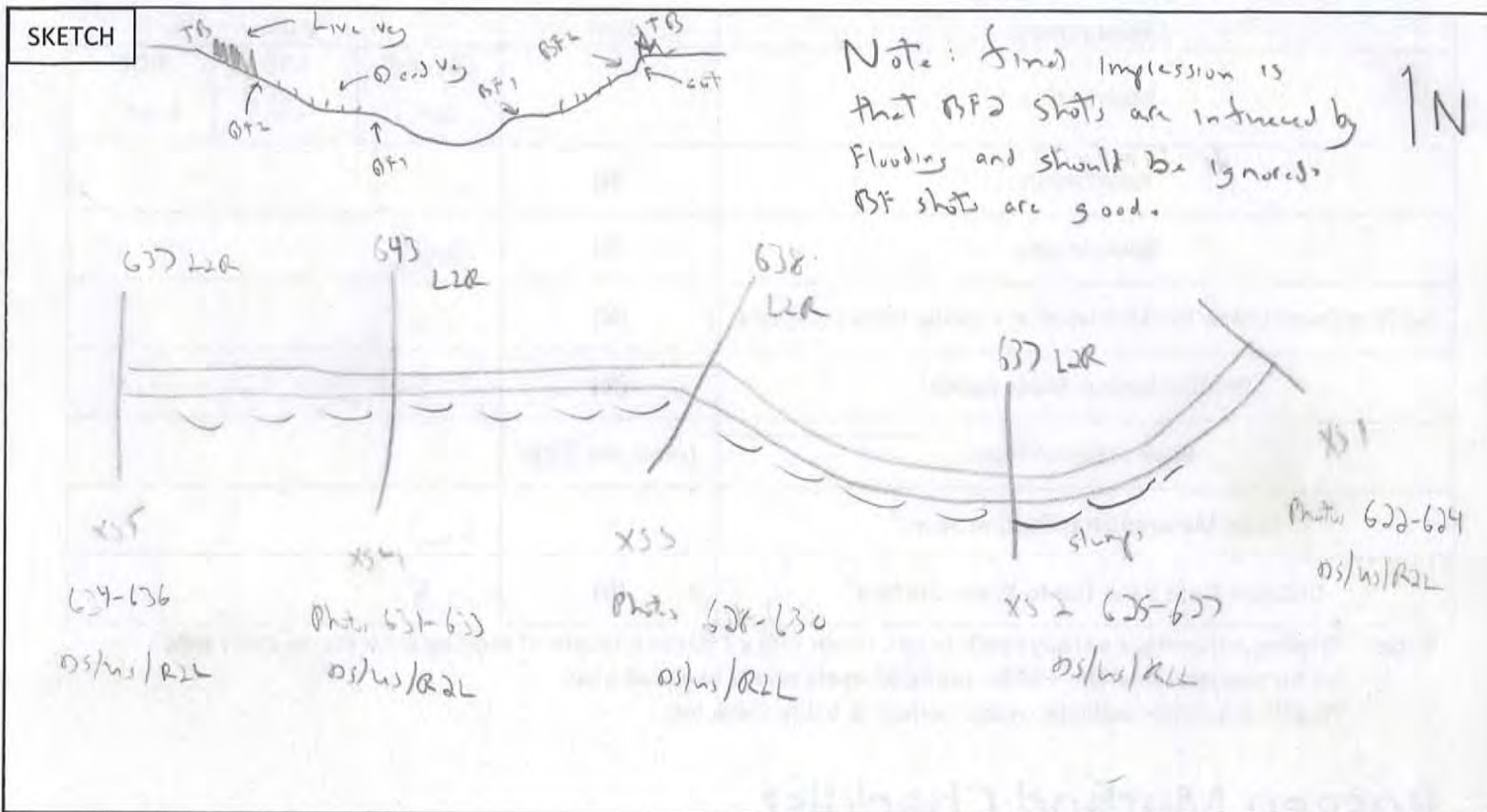
River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: R. Rush I

Date: 9/29/11



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	2258	Bank Full (BF)	✓	2257.2	Water Surface (WS)	✓	2029
	Right	Top of Bank (TB)	✓	2227	Bank Full (BF)	✓	2255 BF 2027			
Section 2	Left	Top of Bank (TB)	✓	2261	Bank Full (BF)	✓	2260.2 2259	Water Surface (WS)	✓	2233
	Right	Top of Bank (TB)	✓	2234	Bank Full (BF)	✓	2251 BF 2233			
Section 3	Left	Top of Bank (TB)	✓	2263	Bank Full (BF)	✓	2264.2 2262	Water Surface (WS)	✓	2237
	Right	Top of Bank (TB)	✓	2278	Bank Full (BF)	✓	2253 BF 2236			
Section 4	Left	Top of Bank (TB)	✓	2267	Bank Full (BF)	✓	2266.2 2267	Water Surface (WS)	✓	2239
	Right	Top of Bank (TB)	✓	2243	Bank Full (BF)	✓	2242 BF 2241			
Section 5	Left	Top of Bank (TB)	✓	2249	Bank Full (BF)	✓	2250 (2) 2251	Water Surface (WS)	✓	2244
	Right	Top of Bank (TB)	✓	2247	Bank Full (BF)	✓	2245 BF 2246			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.03	0.05	0.05
Root Depth	(ft)	0.5-1'		
Root Density	(%)	25%		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	20%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	? 20% → 90%		
Bank Material Type	(sand, silt, <u>clay</u> )			
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	<0.5		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements		Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)		Rush1-LB	
Right Bank (RB)		?	
Bed Surface (BED)		↓	
Bed Core (BED-C)		Rush2-LB	
Bar (BAR)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Rush River - 1

Date: \_\_\_\_\_

SKETCH	
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## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 2	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 3	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 4	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 5	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					



## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-			
Root Depth	(ft)		X	
Root Density	(%)		X	
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)			
Eroding Bank in Study Reach <sup>1</sup>	(%)			
Bank Material Type	(sand, silt, clay)		X	
Bank Material Stratification Score <sup>2</sup>	-		X	
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)		X	

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements		Riparian Vegetation Worksheet	X
Depositional Features Worksheet	X	Pfankuch Method	X
Channel Blockages Worksheet	X		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	X		
Right Bank (RB)	X		
Bed Surface (BED)	X		
Bed Core (BED-C)			
Bar (BAR)	X		

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

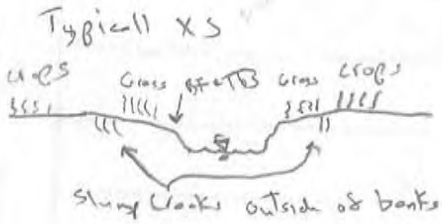
# Geomorphic Analysis Check List

Site Name: Rush River - 2

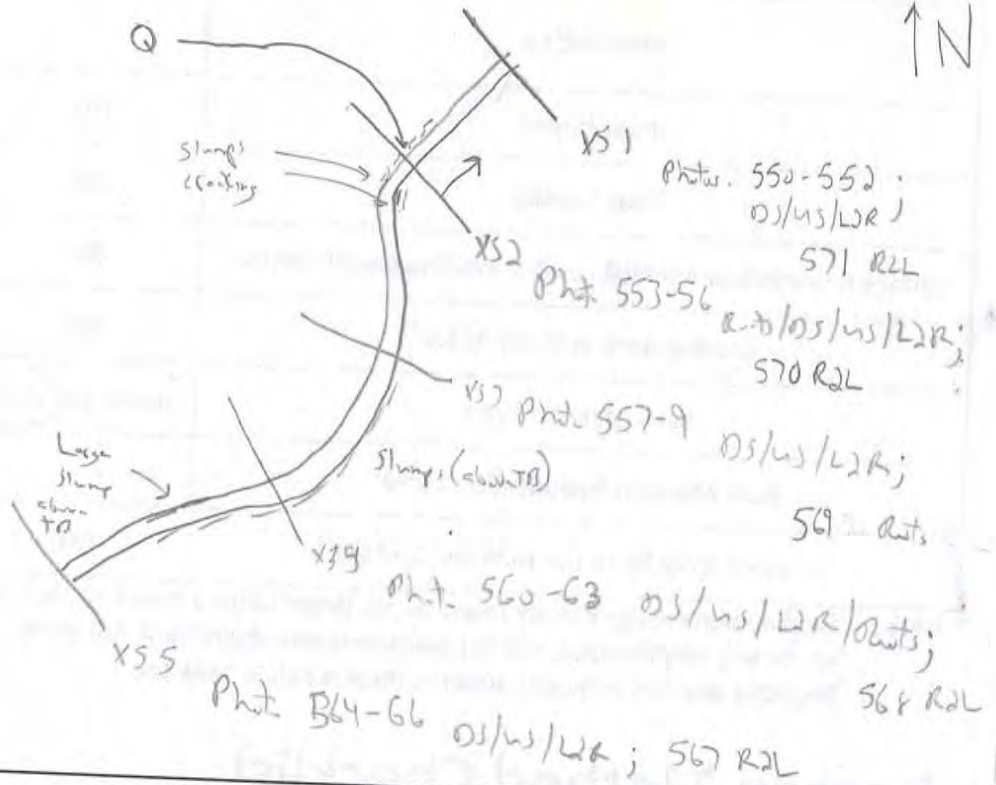
Date: 9/27/11

**SKETCH**

Note: Q measurement:  
measurement 18 @ dist 14 ft  
read 0.0 but should be 0.02



Depth on border Sur plying



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	101	Bank Full (BF)	✓	101	Water Surface (WS)	✓	102
	Right	Top of Bank (TB)	✓	125	Bank Full (BF)	✓	125			
Section 2	Left	Top of Bank (TB)	✓	104	Bank Full (BF)	✓	104	Water Surface (WS)	✓	103
	Right	Top of Bank (TB)	✓	124	Bank Full (BF)	✓	123			
Section 3	Left	Top of Bank (TB)	✓	106	Bank Full (BF)	✓	107	Water Surface (WS)	✓	108
	Right	Top of Bank (TB)	✓	120	Bank Full (BF)	✓	120			
Section 4	Left	Top of Bank (TB)	✓	112	Bank Full (BF)	✓	112	Water Surface (WS)	✓	111
	Right	Top of Bank (TB)	✓	119	Bank Full (BF)	✓	119			
Section 5	Left	Top of Bank (TB)	✓	115	Bank Full (BF)	✓	115	Water Surface (WS)	✓	114
	Right	Top of Bank (TB)	✓	116	Bank Full (BF)	✓	116			

# Geomorphic Analysis Check List

## Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.55-0.6	0.55-0.6
Root Depth	(ft)	0.5		
Root Density	(%)	50%? (25?) Thick grass		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5-10%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	80%		
Bank Material Type	(sand, silt, clay)	-		
Bank Material Stratification Score <sup>2</sup>	-	5		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	1.5'		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

## Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

## Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	Rush2-LB	128
Right Bank (RB)	✓	Rush2-RB	129
Bed Surface (BED)			
Bed Core (BED-C)	✓	Rush2-CH	Photo 572 127
Bar (BAR)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

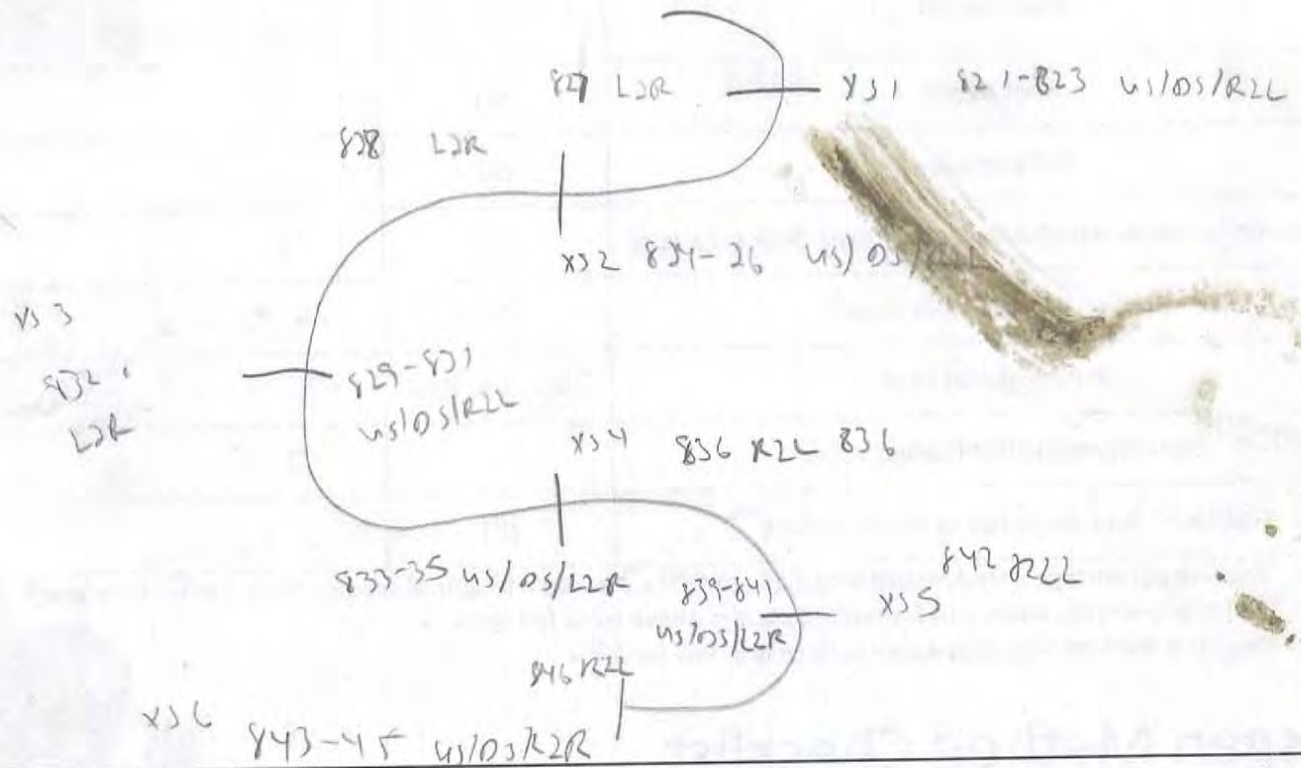
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Sheyenne River - 1

Date: 10/6/11

SKETCH



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	3509	Bank Full (BF)	✓	3508	Water Surface (WS)	✓	3503
	Right	Top of Bank (TB)	✓	3501	Bank Full (BF)	✓	3502			
Section 2	Left	Top of Bank (TB)	✓	3512	Bank Full (BF)	✓	3511	Water Surface (WS)	✓	3604
	Right	Top of Bank (TB)	✓	3506	Bank Full (BF)	✓	3605			
Section 3	Left	Top of Bank (TB)	✓	3578	Bank Full (BF)	✓	3519	Water Surface (WS)	✓	3517
	Right	Top of Bank (TB)	✓	3515	Bank Full (BF)	✓	3516			
Section 4	Left	Top of Bank (TB)	✓	3522	Bank Full (BF)	✓	3523	Water Surface (WS)	✓	3524
	Right	Top of Bank (TB)	✓	3527	Bank Full (BF)	✓	3528			
Section 5	Left	Top of Bank (TB)	✓	3531	Bank Full (BF)	✓	3532	Water Surface (WS)	✓	3533
	Right	Top of Bank (TB)	✓	3534	Bank Full (BF)	✓	3535			
Sect. 6	L		✓	3538		✓	3539		✓	3540
	R		✓	3541		✓	3543			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.055	0.055
Root Depth	(ft)	1-3'		
Root Density	(%)	20%		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	75%		
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	see survey		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	SR1/3525/LOB	3525
Right Bank (RB)	✓	SR1/3527/ROB	3529
Bed Surface (BED)		SR1/3530/LCH	3530
Bed Core (BED-C)	✓	↓	↓
Bar (BAR)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

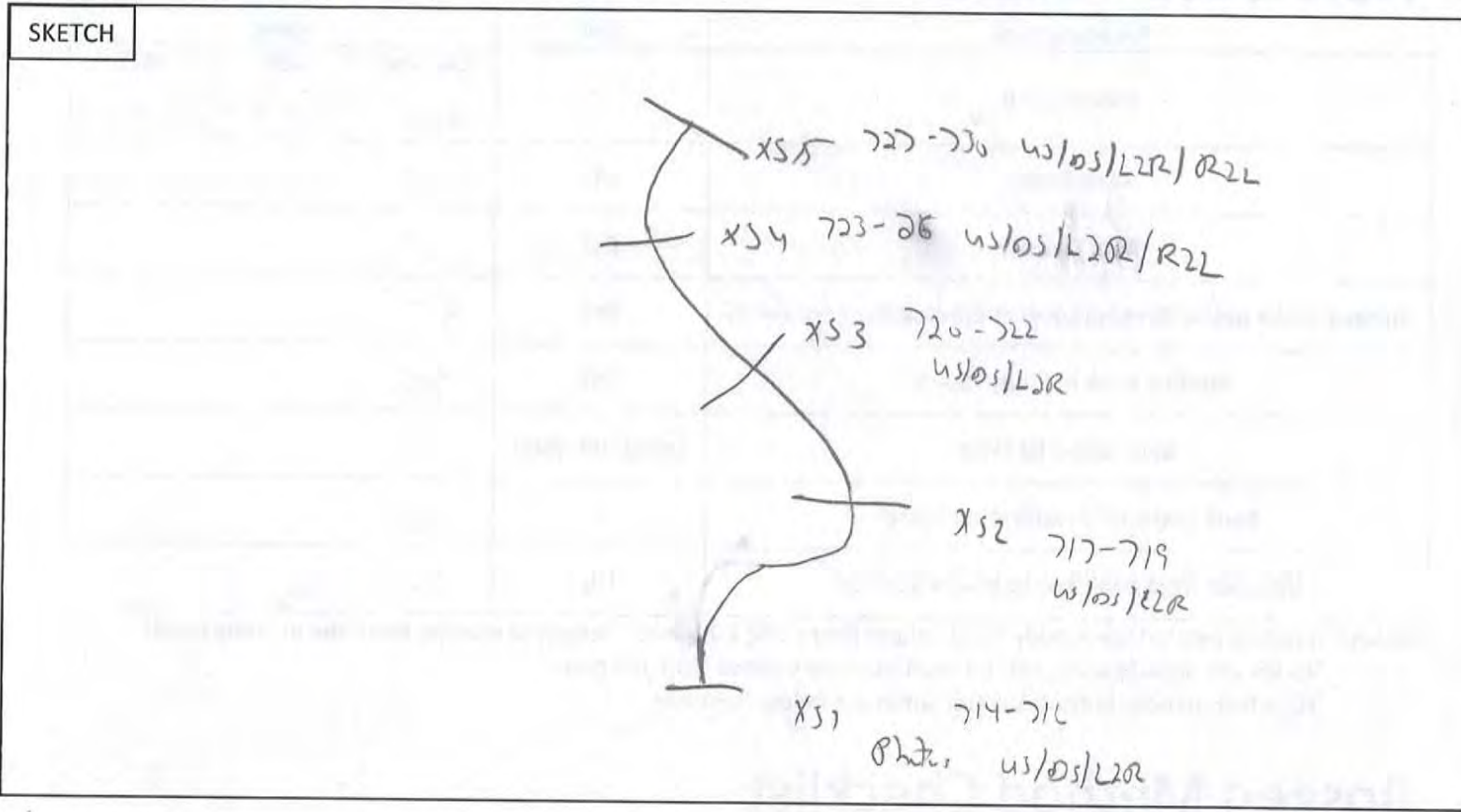
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

↓ 1-2 cm sand layer on top, then ph. mud. cla

# Geomorphic Analysis Check List

Site Name: Sheyenne River - 2

Date: 10/3/11



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	2900	Bank Full (BF)	✓	2901	Water Surface (WS)	✓	2902
	Right	Top of Bank (TB)	—	—	Bank Full (BF)	—	—			
Section 2	Left	Top of Bank (TB)	✓	2905	Bank Full (BF)	✓	2906	Water Surface (WS)	✓	2907
	Right	Top of Bank (TB)	—	—	Bank Full (BF)	—	—			
Section 3	Left	Top of Bank (TB)	✓	2908	Bank Full (BF)	✓	2909	Water Surface (WS)	✓	2911
	Right	Top of Bank (TB)	—	—	Bank Full (BF)	—	—			
Section 4	Left	Top of Bank (TB)	✓	2917	Bank Full (BF)	✓	2917	Water Surface (WS)	✓	2912
	Right	Top of Bank (TB)	✓	2913	Bank Full (BF)	✓	2914			
Section 5	Left	Top of Bank (TB)	✓	2920	Bank Full (BF)	✓	2919	Water Surface (WS)	✓	2915
	Right	Top of Bank (TB)	✓	2923	Bank Full (BF)	✓	2922			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.03	0.055-0.6	0.055-0.6
Root Depth	(ft)	1-1.5'		
Root Density	(%)	20%		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	75		
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	See survey		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)			
Right Bank (RB)	✓	SR3/2924/RB	2924
Bed Surface (BED)			
Bed Core (BED-C)	✓	SR3/2925/CH	2925
Bar (BAR)			

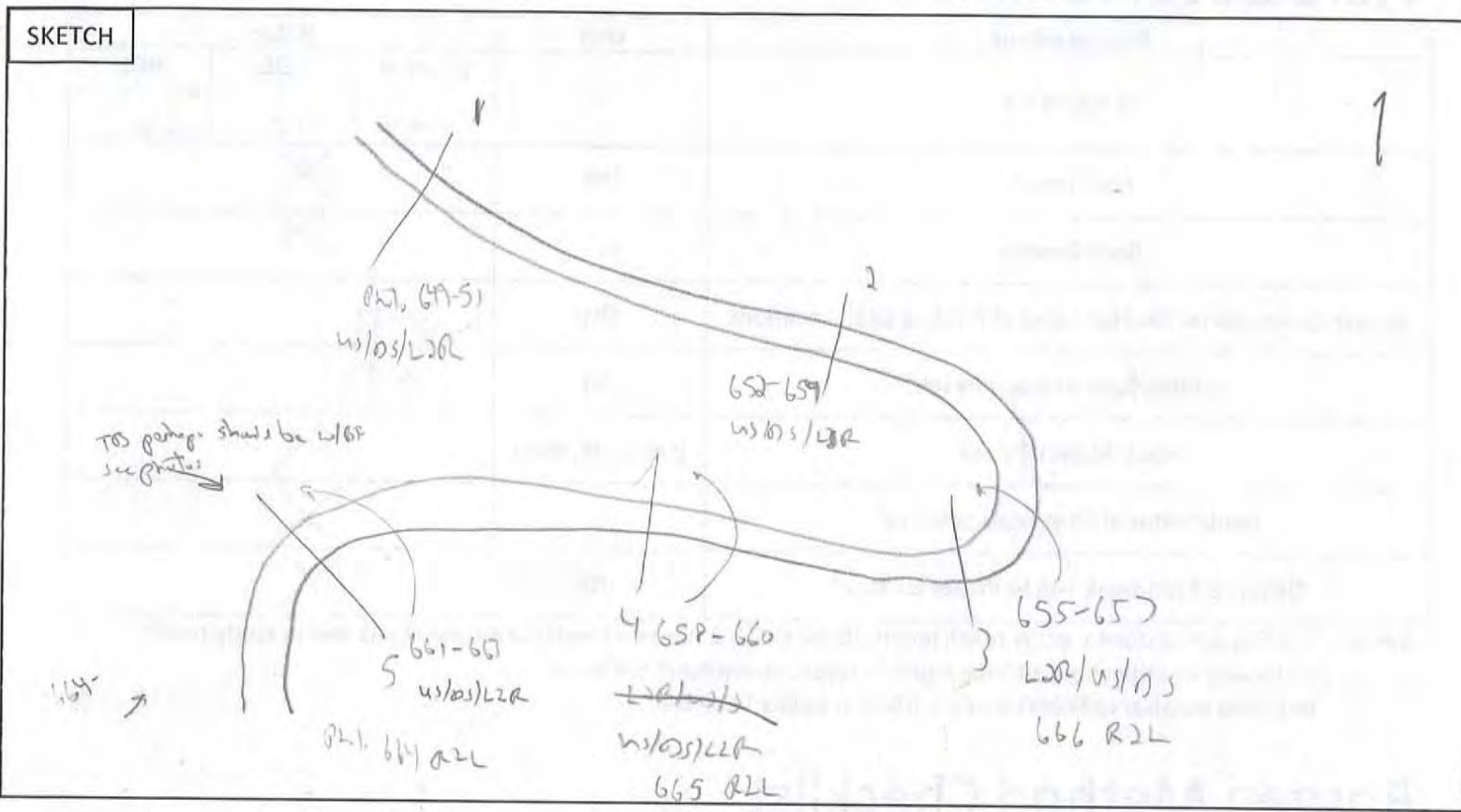
River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Sheyenne River - 3

Date: 9/30/11



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	2300	Bank Full (BF)	✓	2301	Water Surface (WS)	✓	2302
	Right	Top of Bank (TB)	✓		Bank Full (BF)	✓				
Section 2	Left	Top of Bank (TB)	✓	2306	Bank Full (BF)	✓	2306	Water Surface (WS)	✓	2307
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 3	Left	Top of Bank (TB)	✓	2309	Bank Full (BF)	✓	2308	Water Surface (WS)	✓	2307
	Right	Top of Bank (TB)	✓	2325	Bank Full (BF)	✓	2324			
Section 4	Left	Top of Bank (TB)	✓	2312	Bank Full (BF)	✓	2313	Water Surface (WS)	✓	2314
	Right	Top of Bank (TB)	✓	2322	Bank Full (BF)	✓	2321			
Section 5	Left	Top of Bank (TB)	✓	2315	Bank Full (BF)	✓	2316	Water Surface (WS)	✓	2317
	Right	Top of Bank (TB)	✓	2321	Bank Full (BF)	✓	2320			



## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB <small>Large Wood Frequency</small>
Manning's n	-	0.028-0.03	0.05	0.05
Root Depth	(ft)		X	
Root Density	(%)		X	
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	0-5%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	75%		
Bank Material Type	(sand, silt, clay)		X	
Bank Material Stratification Score <sup>2</sup>	-		X	
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)		X	

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements		Riparian Vegetation Worksheet	X
Depositional Features Worksheet	X	Pfankuch Method	X
Channel Blockages Worksheet	X		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	X		
Right Bank (RB)	X		
Bed Surface (BED)	X		
Bed Core (BED-C)			
Bar (BAR)	X		

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

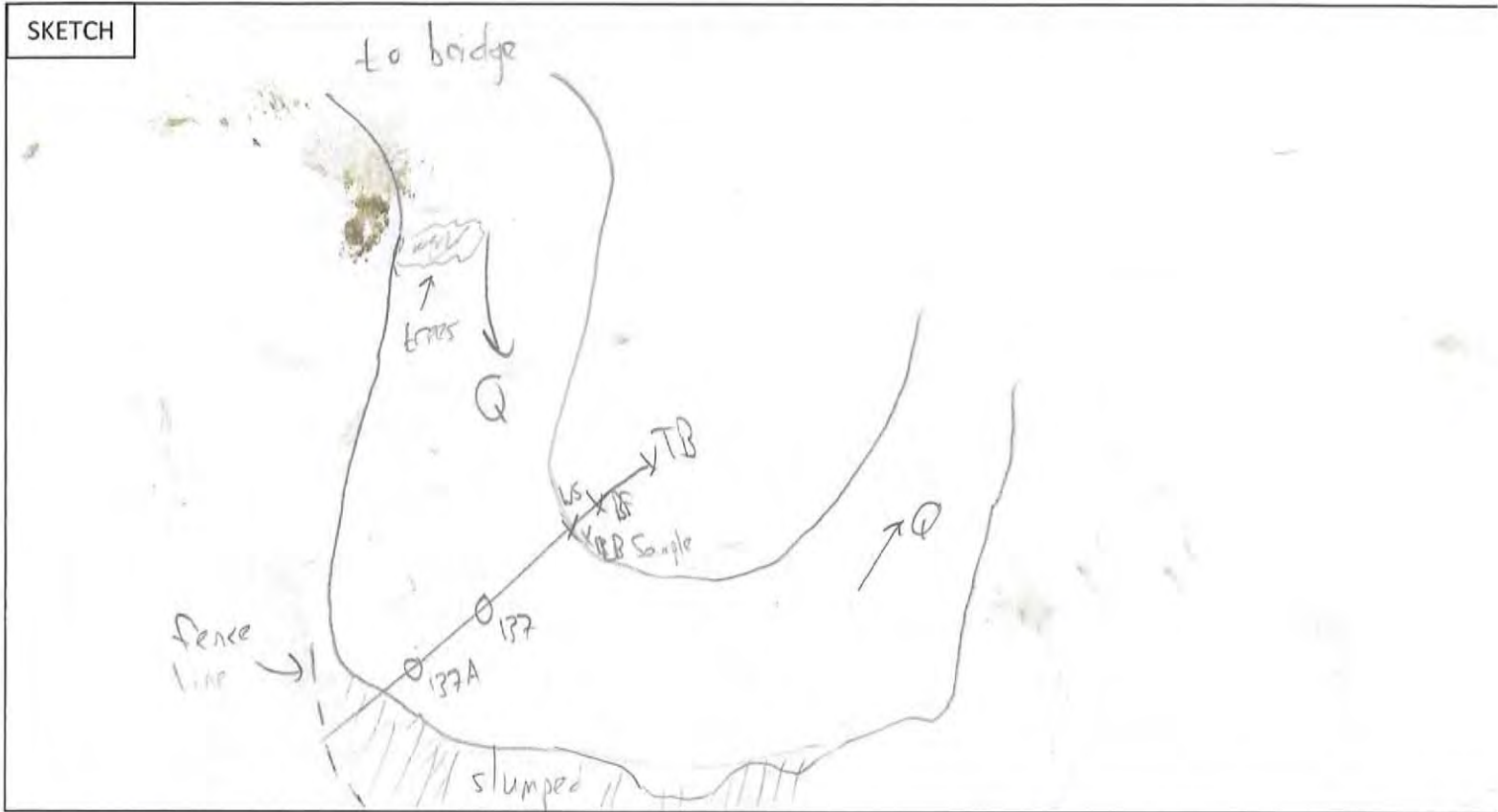
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

↘ no gps pt. either digital sample (clay)  
or if lab has a missed pt

Shoeyenne River - S - 18.17 / 11/17/10

### Geomorphic Analysis Check List

Site Name: Shoeyenne River @ 40<sup>th</sup> Ave Bridge (R/18.68 - 18.05)



Resided in 2011

### Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	148	Bank Full (BF)	✓	149	Water Surface (WS)	✓	150
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			
Section 2	Left	Top of Bank (TB)	✓	143	Bank Full (BF)	✓	144	Water Surface (WS)	✓	145
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			
Section 3	Left	Top of Bank (TB)	✓	138	Bank Full (BF)	✓	139	Water Surface (WS)	✓	141
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			
Section 4	Left	Top of Bank (TB)	✓	138	Bank Full (BF)	✓	134	Water Surface (WS)	✓	135
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			
Section 5	Left	Top of Bank (TB)	✓	129	Bank Full (BF)	✓	130	Water Surface (WS)	✓	B1
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.03
Root Depth	(ft)	2'
Root Density	(%)	25
Eroding Bank Surface Cover	(%)	3
Eroding Bank Length	(ft)	250'
Bank Material Type	(sand, silt, clay)	clay
Bank Material Stratification Score <sup>1</sup>	-	-
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	2.3'

See also 2011  
 Study reach length = 3280 ft  
 estimated eroding %

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	✓
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	S/140/LB	140
Right Bank (RB)	-	-	-
Bed (BED)	✓	S/137/BED	137
Bar - Armor (B-A)	-	-	-
Bar - Sub Armor (B-SA)	-	-	-

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

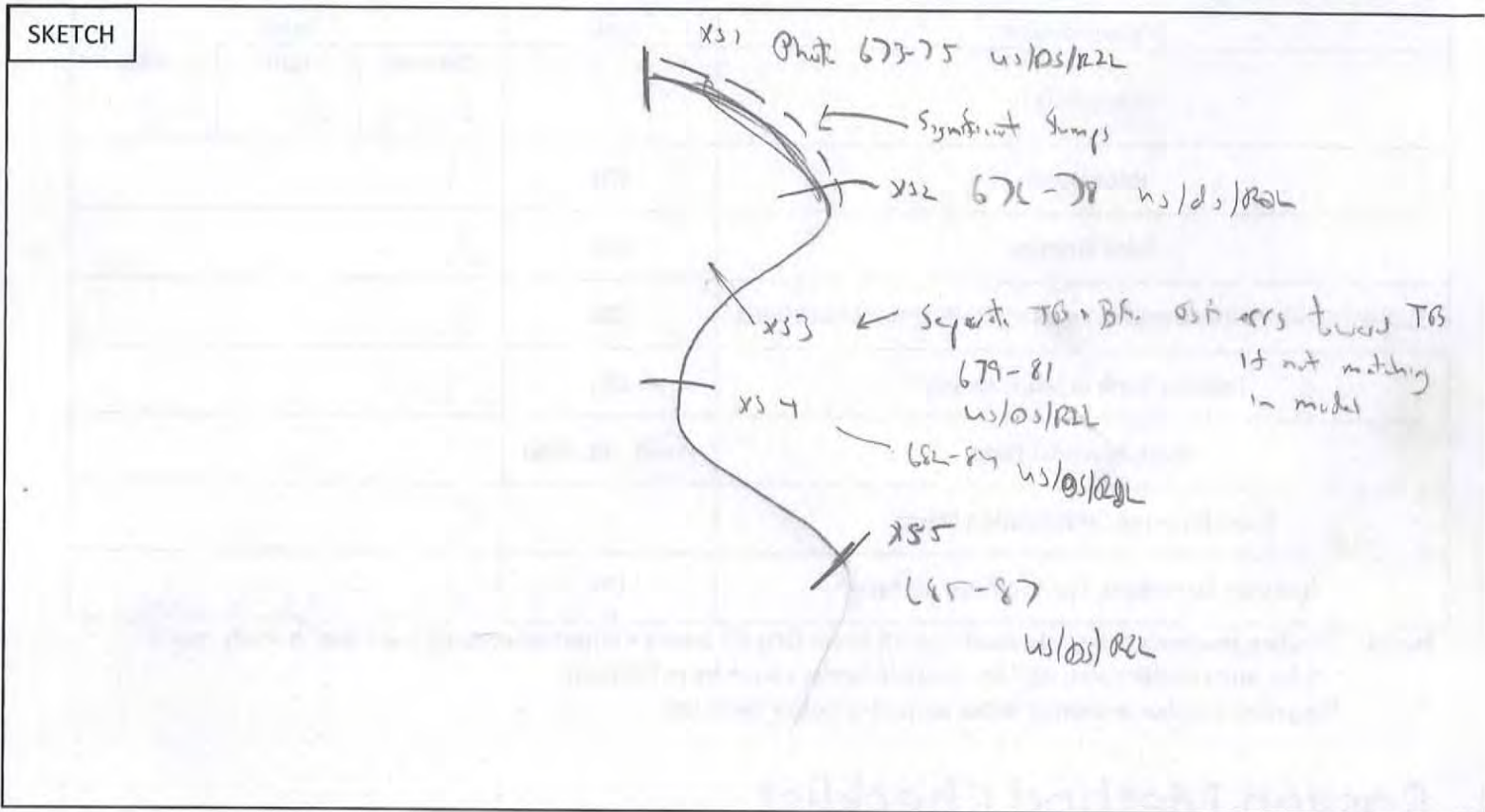
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

See also 2011

# Geomorphic Analysis Check List

Site Name: Sheyenne River - 4

Date: 10/1/11



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	_____	_____	Bank Full (BF)	_____	_____	Water Surface (WS)		
	Right	Top of Bank (TB)	✓	2600	Bank Full (BF)	✓	2600		✓	2601
Section 2	Left	Top of Bank (TB)	_____	_____	Bank Full (BF)	_____	_____	Water Surface (WS)		
	Right	Top of Bank (TB)	✓	2604	Bank Full (BF)	✓	2604		✓	2605
Section 3	Left	Top of Bank (TB)	_____	_____	Bank Full (BF)	_____	_____	Water Surface (WS)		
	Right	Top of Bank (TB)	✓	2609	Bank Full (BF)	✓	2609		✓	2608
Section 4	Left	Top of Bank (TB)	_____	_____	Bank Full (BF)	_____	_____	Water Surface (WS)		
	Right	Top of Bank (TB)	✓	2611	Bank Full (BF)	✓	2611		✓	2612
Section 5	Left	Top of Bank (TB)	_____	_____	Bank Full (BF)	_____	_____	Water Surface (WS)		
	Right	Top of Bank (TB)	✓	2613	Bank Full (BF)	✓	2613		✓	2614

# Geomorphic Analysis Check List

## Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.03-35	0.05	0.05
Root Depth	(ft)	1'		
Root Density	(%)	20%		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	20%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	85%		
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	unknown - see X3 survey		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

## Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements		Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

## Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)			
Right Bank (RB)	✓	SR4-RB	2616
Bed Surface (BED)			
Bed Core (BED-C)	✓	SR4-CH	2617
Bar (BAR)			

*All sand likely due to proximity to bank and significant sampling of sandy banks.*

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Sheyenne River - S Date: 10/5/17

SKETCH

At BSF during survey is visible below  
BSF difficult to determine. Perhaps some  
grasses but minimal/more  
shrubs/tree.  
Many riparian tree  
density.

X55 814-17 us/os/L2R/R2L

X54 809-813 us/os/L2R/R2L

X53 806-08 → 1/L2R/R2L/L2R/L2L  
+ 818-19 → us/os  
at bank broke steep facing. no stairs

X52 802-05 us/os/L2R/R2L

X51 Phot. 799-801 us/os/L2R/

## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	3403	Bank Full (BF)	✓	3402	Water Surface (WS)	✓	3401
	Right	Top of Bank (TB)	—		Bank Full (BF)	—				
Section 2	Left	Top of Bank (TB)	✓	3404	Bank Full (BF)	✓	3405	Water Surface (WS)	✓	3406
	Right	Top of Bank (TB)	✓	3409	Bank Full (BF)	✓	3408			
Section 3	Left	Top of Bank (TB)	✓	3410	Bank Full (BF)	✓	3412	Water Surface (WS)	✓	3411
	Right	Top of Bank (TB)	—		Bank Full (BF)	—				
Section 4	Left	Top of Bank (TB)	✓	3417	Bank Full (BF)	✓	3416	Water Surface (WS)	✓	3415
	Right	Top of Bank (TB)	✓	3418	Bank Full (BF)	✓	3419			
Section 5	Left	Top of Bank (TB)	✓	3420	Bank Full (BF)	✓	3421	Water Surface (WS)	✓	3423
	Right	Top of Bank (TB)	✓	3225	Bank Full (BF)	✓	3424			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.354	0.07	0.07
Root Depth	(ft)	widely variable 1-3'		
Root Density	(%)	30%		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	? under water (K2) minimal		
Eroding Bank in Study Reach <sup>1</sup>	(%)	30%		
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	See survey		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)			
Right Bank (RB)	✓	SRS/3426/RB	3426
Bed Surface (BED)			
Bed Core (BED-C)	✓	SRS/3427/LB	3427
Bar (BAR)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

(1) with minor sand → sand layer a top, then well mixed sand + clay.

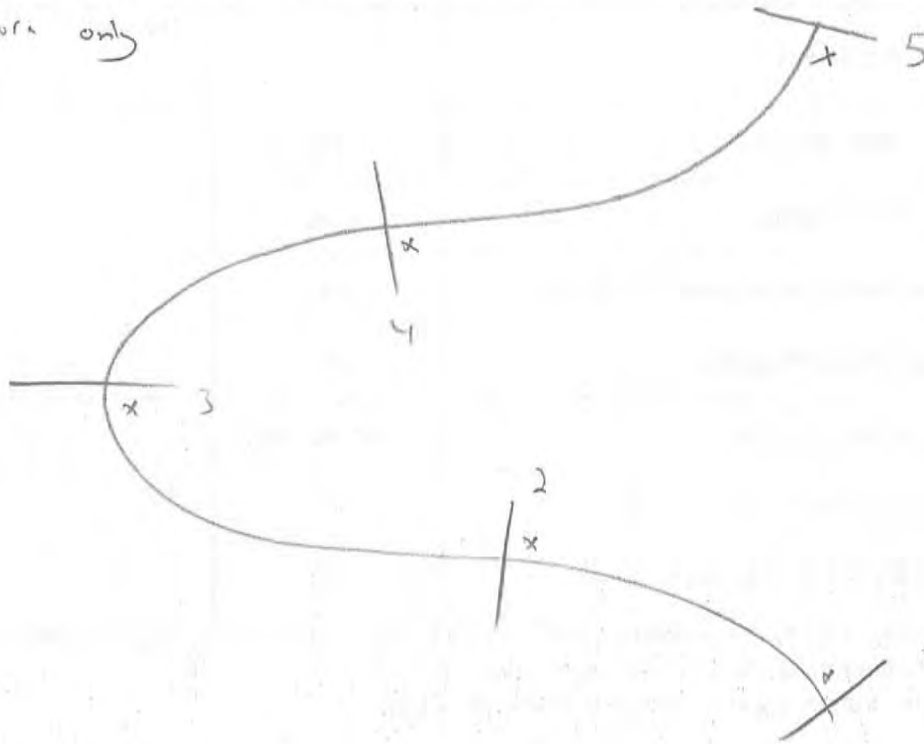
# Geomorphic Analysis Check List

Site Name: Sheyem 6

Date: 10/2/11

SKETCH

WS + Core only



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	2700
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 2	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	2701
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 3	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	2702
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 4	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	2703
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 5	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)	✓	2704
	Right	Top of Bank (TB)			Bank Full (BF)					



## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-			
Root Depth	(ft)			
Root Density	(%)			
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)			
Eroding Bank in Study Reach <sup>1</sup>	(%)			
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-			
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)			

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements		Riparian Vegetation Worksheet	
Depositional Features Worksheet		Pfankuch Method	
Channel Blockages Worksheet			

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)			
Right Bank (RB)			
Bed Surface (BED)			
Bed Core (BED-C)		SRB-LH	2705
Bar (BAR)			

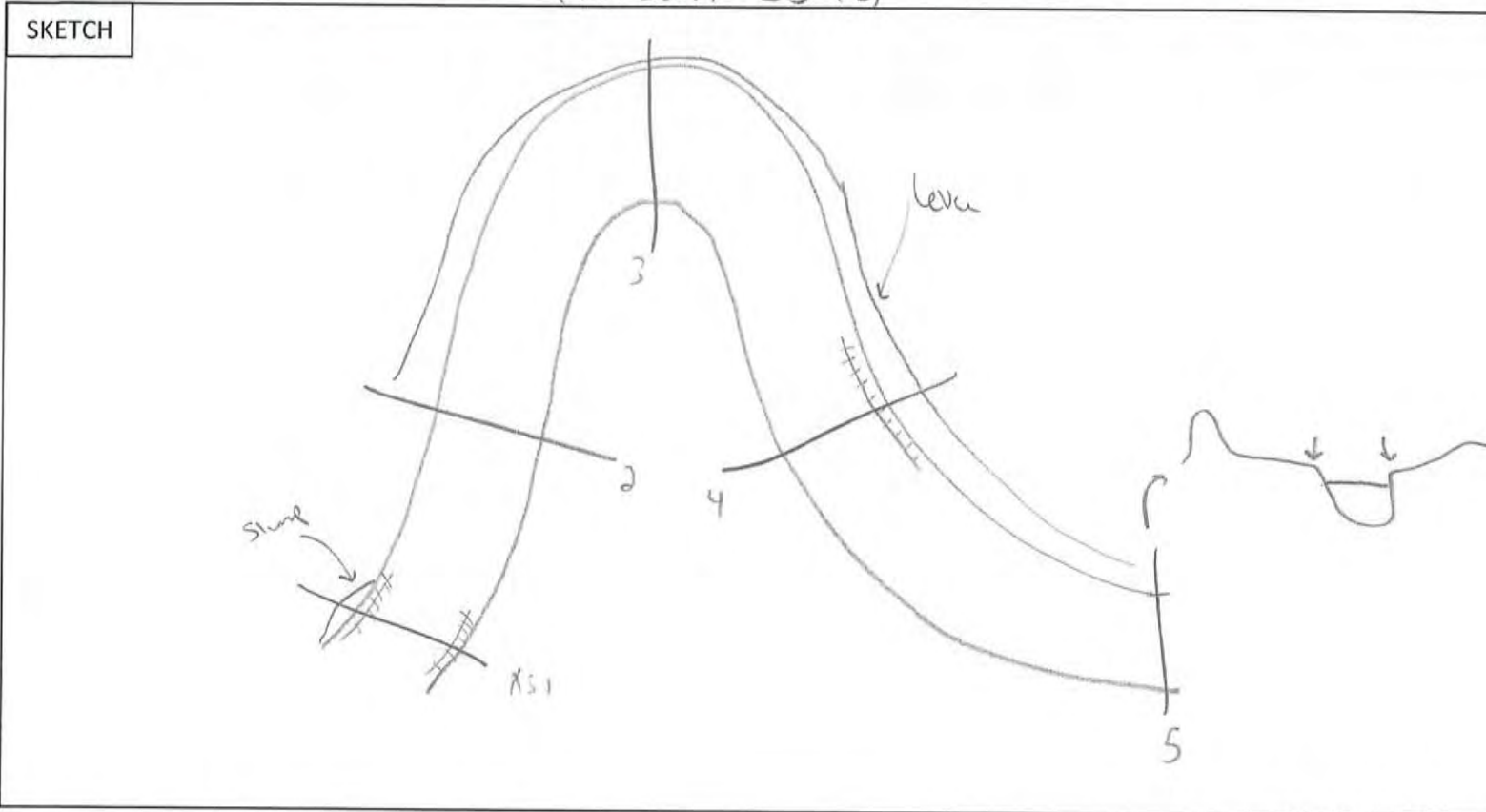
River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

→ taken in snag approx 8' from shore. Thelwell to.

Geomorphic Analysis Check List

Site Name: Shyenne @ 170<sup>th</sup> & 64<sup>th</sup> (FID 29) 11/21/10  
 (RM 36.17 - 35.72)



Staking

did not find  
- restaked 2018

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	7001	Bank Full (BF)	✓	Same	Water Surface (WS)	✓	7014
	Right	Top of Bank (TB)	✓	7013	Bank Full (BF)	✓	Same			
Section 2	Left	Top of Bank (TB)	✓	7004	Bank Full (BF)	✓	7002	Water Surface (WS)	Too steep	
	Right	Top of Bank (TB)	✓	7016	Bank Full (BF)	✓	7015			
Section 3	Left	Top of Bank (TB)	✓	7007	Bank Full (BF)	✓	7006	Water Surface (WS)	✓	7005
	Right	Top of Bank (TB)	✓	7019	Bank Full (BF)	✓	Same			
Section 4	Left	Top of Bank (TB)	✓	7009	Bank Full (BF)	✓	Same	Water Surface (WS)	too steep	
	Right	Top of Bank (TB)	✓	7019	Bank Full (BF)	✓	Same			
Section 5	Left	Top of Bank (TB)	✓	7011	Bank Full (BF)	✓	Same	Water Surface (WS)	too steep	
	Right	Top of Bank (TB)	✓	7021	Bank Full (BF)	✓	Same			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.035-04
Root Depth	(ft)	5-1.5 ft
Root Density	(%)	20%
Eroding Bank Surface Cover	(%)	10%
Eroding Bank Length	(ft)	500
Bank Material Type	(sand, silt, clay)	
Bank Material Stratification Score <sup>1</sup>	-	? Snow
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	? Frozen

maybe high

(25%)

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	gaga
Depositional Features Noted on Worksheet	none
Channel Blockages Noted on Worksheet	none
Pfankuch Method Completed	✓

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	S-R-1	7023
Right Bank (RB)		Similar material	
<del>Bed (BED)</del>		Frozen	
<del>Bar - Armor (B-A)</del>			
<del>Bar - Sub Armor (B-SA)</del>			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

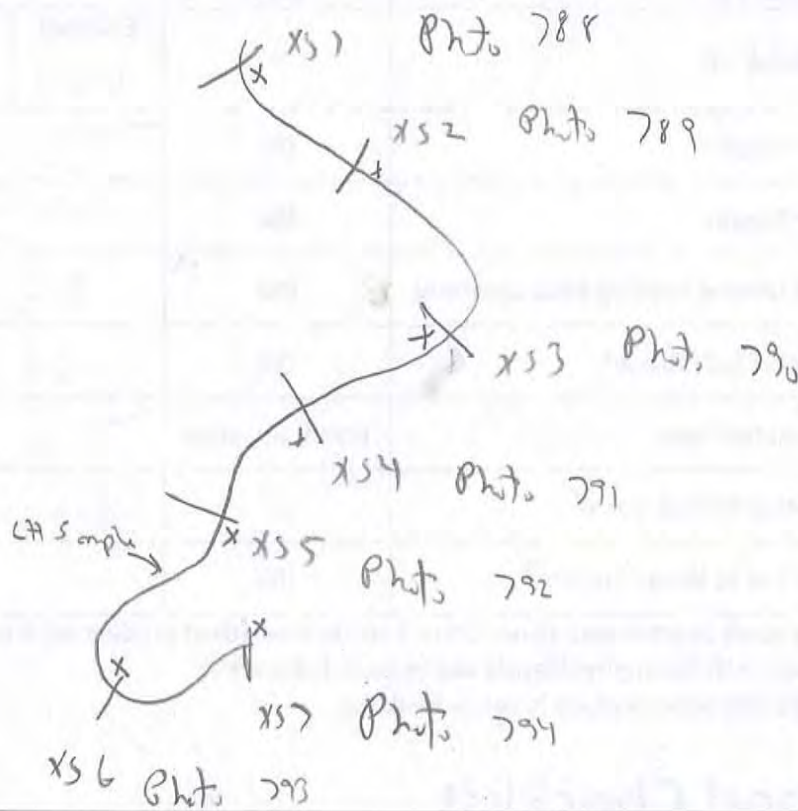
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: SR7

Date: 16/5/11

SKETCH



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt																
Section 1	Left	Top of Bank (TB)	X	X	Bank Full (BF)	X	X	Water Surface (WS)	✓	3300																
	Right	Top of Bank (TB)			Bank Full (BF)																					
Section 2	Left	Top of Bank (TB)			X			X	Bank Full (BF)	X	X	Water Surface (WS)	✓	3301												
	Right	Top of Bank (TB)							Bank Full (BF)																	
Section 3	Left	Top of Bank (TB)							X			X	Bank Full (BF)	X	X	Water Surface (WS)	✓	3302								
	Right	Top of Bank (TB)											Bank Full (BF)													
Section 4	Left	Top of Bank (TB)											X			X	Bank Full (BF)	X	X	Water Surface (WS)	✓	3303				
	Right	Top of Bank (TB)															Bank Full (BF)									
Section 5	Left	Top of Bank (TB)															X			X	Bank Full (BF)	X	X	Water Surface (WS)	✓	3304
	Right	Top of Bank (TB)																			Bank Full (BF)					

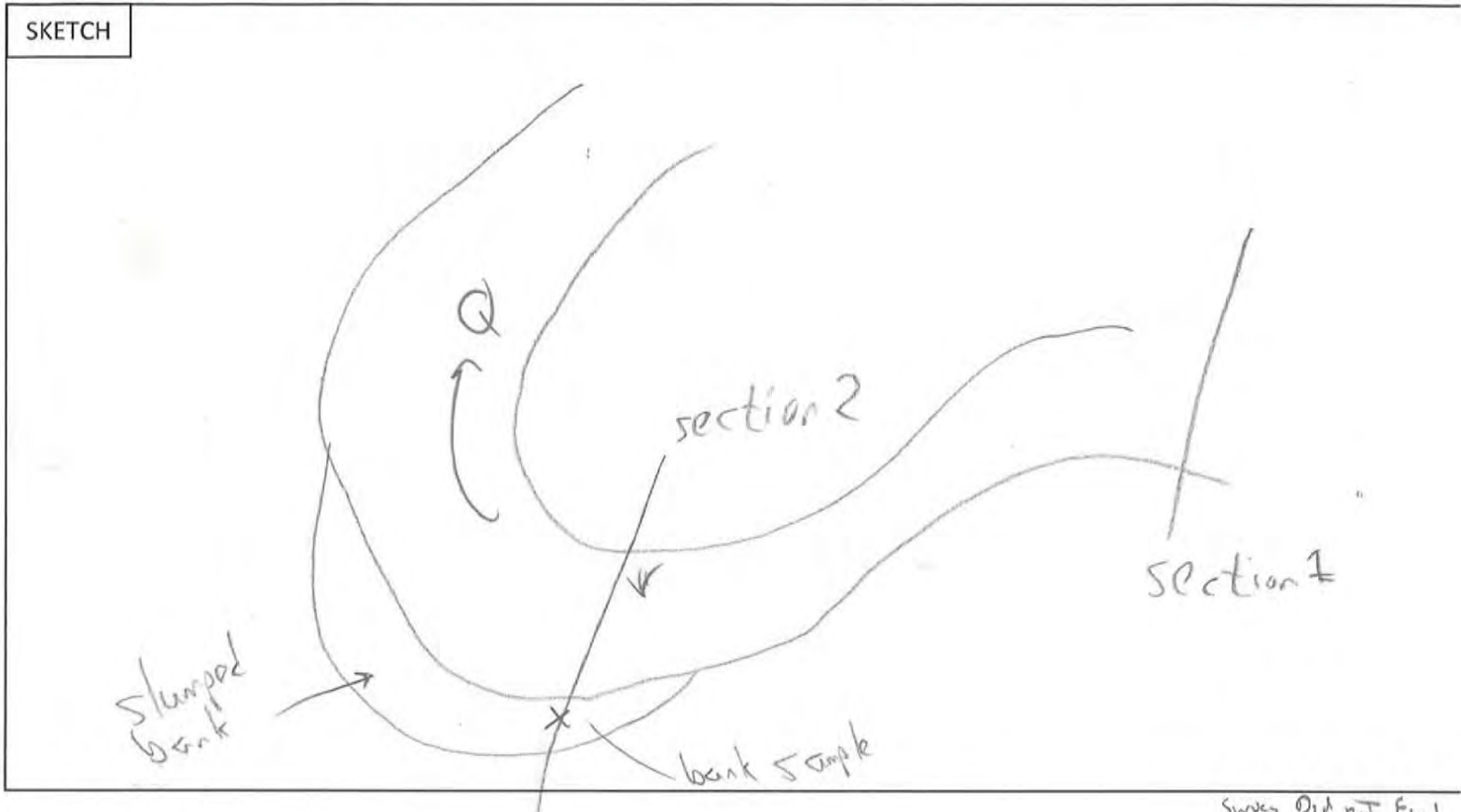
XS 6 WS ✓ 3305

XS 7 WS ✓ 3301



Sheyenne River - 7-43.29 11/20/10  
 Geomorphic Analysis Check List

Site Name: Sheyenne River west of I-29, Exit 54 (RM 43.85-43.15)



Survey Did not Find  
 Restaked 2011

Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	261	Bank Full (BF)	✓	262	Water Surface (WS)	✓	260
	Right	Top of Bank (TB)	✓	258	Bank Full (BF)	✓	259			
Section 2	Left	Top of Bank (TB)	✓	243	Bank Full (BF)	✓	245	Water Surface (WS)	✓	246
	Right	Top of Bank (TB)	✓	247	Bank Full (BF)	✓	248			
Section 3	Left	Top of Bank (TB)	✓	252	Bank Full (BF)	✓	253	Water Surface (WS)	✓	254
	Right	Top of Bank (TB)	✓	255	Bank Full (BF)	✓	256			
Section 4	Left	Top of Bank (TB)	✓	229	Bank Full (BF)	✓	228	Water Surface (WS)	✓	227
	Right	Top of Bank (TB)	✓	225	Bank Full (BF)	✓	226			
Section 5	Left	Top of Bank (TB)	✓	219	Bank Full (BF)	✓	220	Water Surface (WS)	✓	221
	Right	Top of Bank (TB)	✓	222	Bank Full (BF)	✓	223			
6			✓	237		✓	238		✓	239
			✓	240		✓	241		✓	242
			✓	234		✓	235		✓	236

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.03
Root Depth	(ft)	1'
Root Density	(%)	20
Eroding Bank Surface Cover	(%)	1
Eroding Bank Length	(ft)	325'
Bank Material Type	(sand, silt, clay)	silty clay/ clay
Bank Material Stratification Score <sup>1</sup>	-	-
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	2.3'

study reach length = 3,670 ft  
estimated eroding % =

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	-
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

← too cold for ADCP

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	S/244/LB	244
Right Bank (RB)			
Bed (BED)			
Bar - Armor (B-A)	-	-	-
Bar - Sub Armor (B-SA)	-	-	-

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

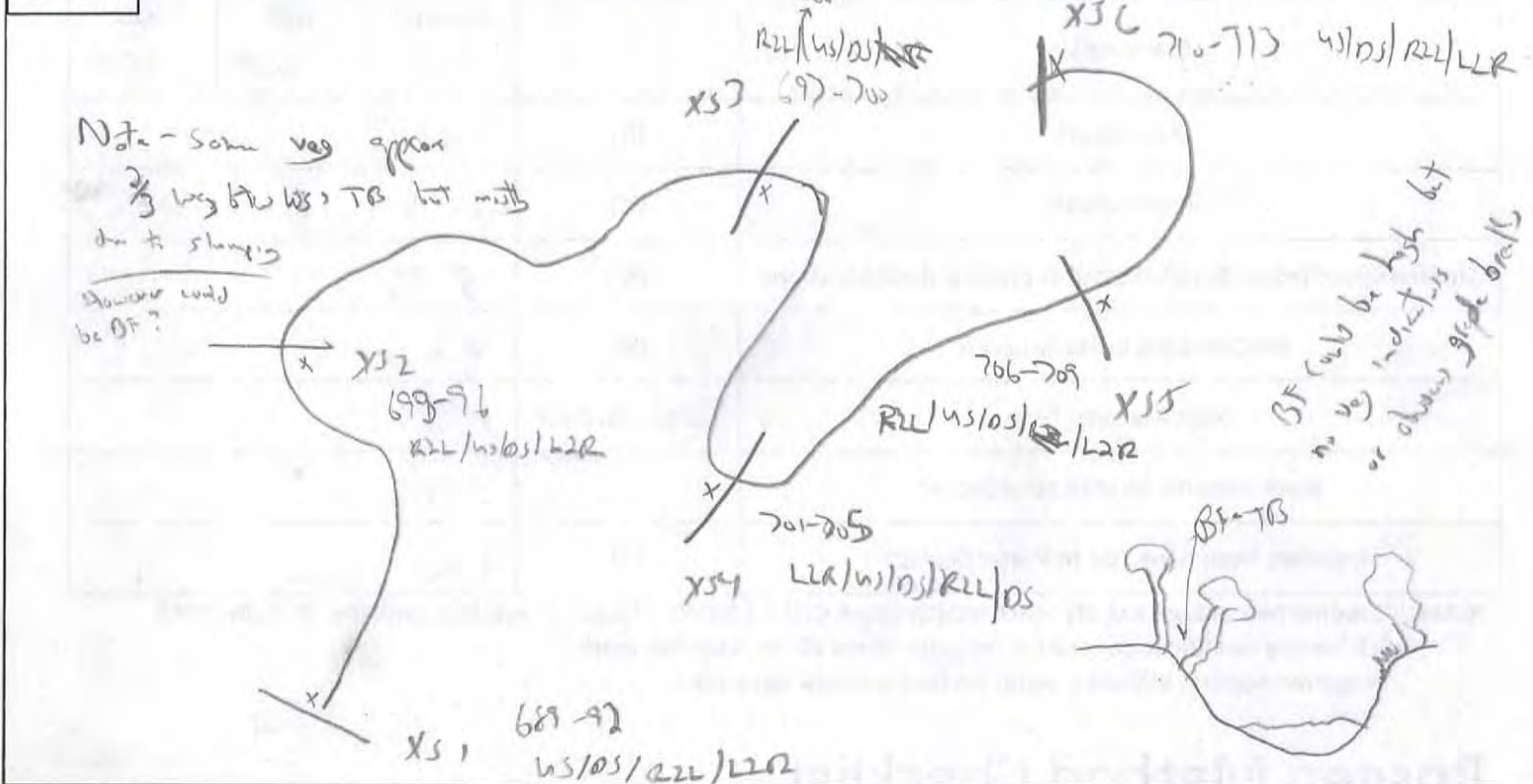
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Sheyenne River - 8

Date: 10/2/11

SKETCH



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	2802	Bank Full (BF)	✓	2802	Water Surface (WS)	✓	2803
	Right	Top of Bank (TB)	✓	2800	Bank Full (BF)	✓	2800			
Section 2	Left	Top of Bank (TB)	✓	2805	Bank Full (BF)	✓	2805	Water Surface (WS)	✓	2804
	Right	Top of Bank (TB)	✓	2806	Bank Full (BF)	✓	2806			
Section 3	Left	Top of Bank (TB)	✓	2808	Bank Full (BF)	✓	2808	Water Surface (WS)	✓	2809
	Right	Top of Bank (TB)	✓	2809	Bank Full (BF)	✓	2809			
Section 4	Left	Top of Bank (TB)	✓	2812	Bank Full (BF)	✓	2812	Water Surface (WS)	✓	2814
	Right	Top of Bank (TB)	✓	2815	Bank Full (BF)	✓	2815			
Section 5	Left	Top of Bank (TB)	✓	2819	Bank Full (BF)	✓	2819	Water Surface (WS)	✓	2816
	Right	Top of Bank (TB)	✓	2817	Bank Full (BF)	✓	2817			
			✓	2823		✓	2823		✓	2820



## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.03	0.055	0.055
Root Depth	(ft)	1.5'		
Root Density	(%)	10%		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	80%		
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	See Survey		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	SR8-203	2824
Right Bank (RB)			
Bed Surface (BED)			
Bed Core (BED-C)	✓	SR8-CA	2825
Bar (BAR)			

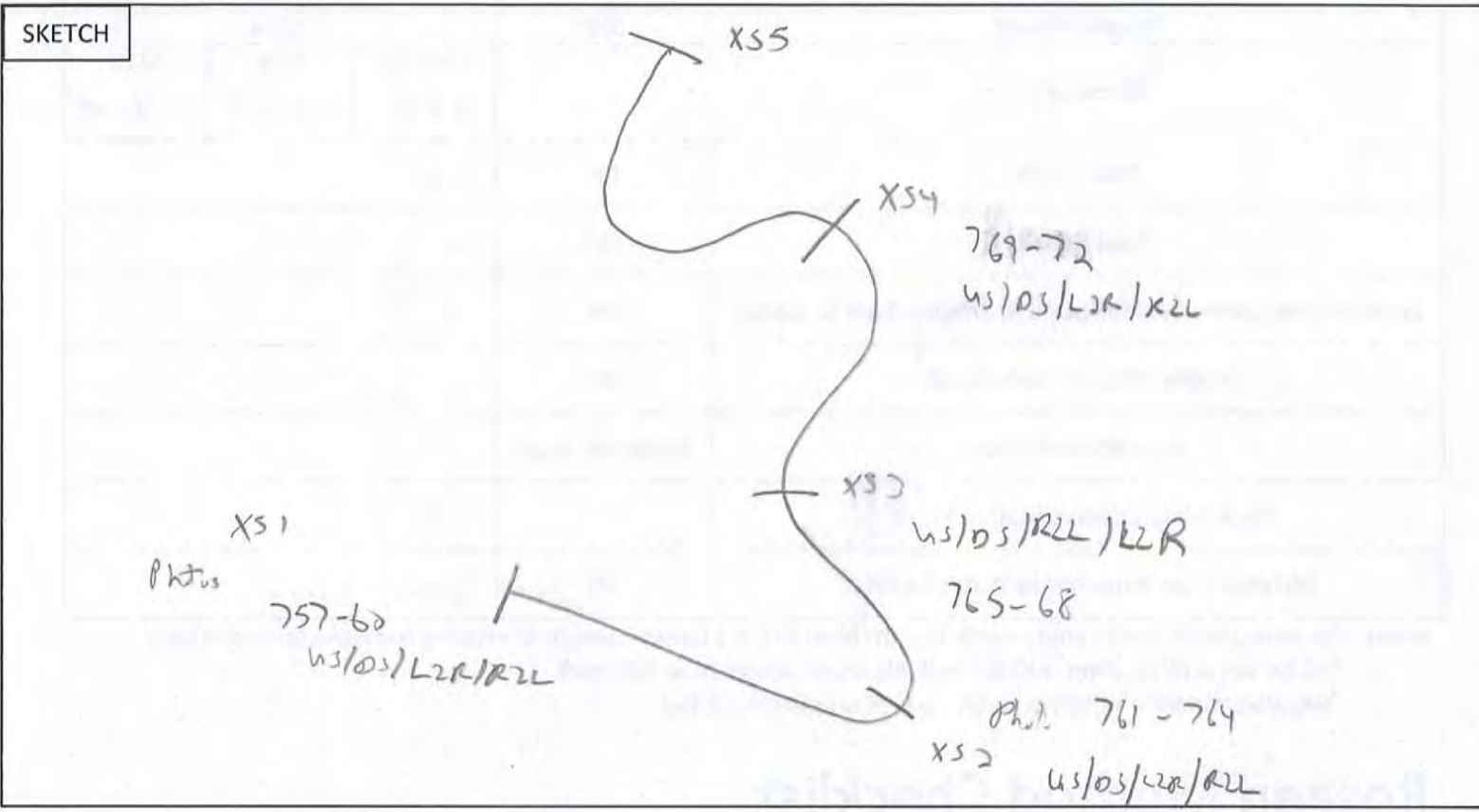
River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Wild Rice River - 1

Date: 10/4/11



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	3200	Bank Full (BF)	✓	3200	Water Surface (WS)	✓	3201
	Right	Top of Bank (TB)	✓	3203	Bank Full (BF)	✓	3204			
Section 2	Left	Top of Bank (TB)	✓	3205	Bank Full (BF)	✓	3205	Water Surface (WS)	✓	3206
	Right	Top of Bank (TB)	✓	3209	Bank Full (BF)	✓	3208			
Section 3	Left	Top of Bank (TB)	✓	3214	Bank Full (BF)	✓	3213	Water Surface (WS)	✓	3221
	Right	Top of Bank (TB)	✓	3210	Bank Full (BF)	✓	3211			
Section 4	Left	Top of Bank (TB)	✓	3216	Bank Full (BF)	✓	3215	Water Surface (WS)	✓	3220
	Right	Top of Bank (TB)	✓	3218	Bank Full (BF)	✓	3219			
Section 5	Left	Top of Bank (TB)	✓	3222	Bank Full (BF)	✓	3222	Water Surface (WS)	✓	3224
	Right	Top of Bank (TB)	✓	3225	Bank Full (BF)	✓	3226			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.055	0.055	0.055
Root Depth	(ft)	12'		
Root Density	(%)	15%		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	30%		
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	See survey		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	Clay - no sample	
Right Bank (RB)	✓	Clay - no sample	
Bed Surface (BED)	✓		3227
Bed Core (BED-C)	✓	WR1/3227/LH	3227
Bar (BAR)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

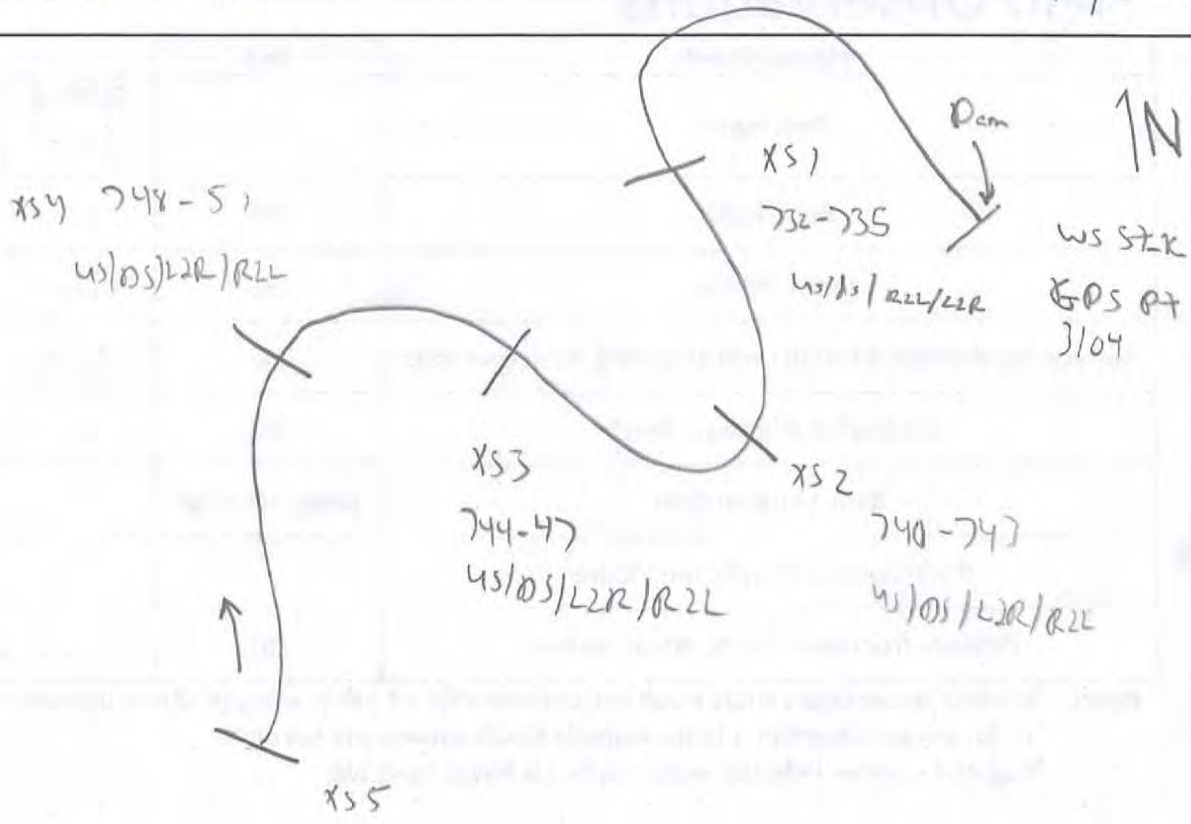
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Wild Rice River-2

Date: 10/4/11

SKETCH



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	3101	Bank Full (BF)	✓	3100	Water Surface (WS)	✓	3102
	Right	Top of Bank (TB)	✓	3103	Bank Full (BF)	✓	3103			
Section 2	Left	Top of Bank (TB)	✓	3106	Bank Full (BF)	✓	3106	Water Surface (WS)	✓	3109
	Right	Top of Bank (TB)	✓	3108	Bank Full (BF)	✓	3108			
Section 3	Left	Top of Bank (TB)	✓	3110	Bank Full (BF)	✓	3110	Water Surface (WS)	✓	3111
	Right	Top of Bank (TB)	✓	3113	Bank Full (BF)	✓	3114			
Section 4	Left	Top of Bank (TB)	✓	3115	Bank Full (BF)	✓	3116	Water Surface (WS)	✓	3117
	Right	Top of Bank (TB)	✓	3118	Bank Full (BF)	✓	3118			
Section 5	Left	Top of Bank (TB)	✓	3119	Bank Full (BF)	✓	3120	Water Surface (WS)	✓	3121
	Right	Top of Bank (TB)	✓	3123	Bank Full (BF)	✓	3124			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.05	0.05
Root Depth	(ft)	1-1.5'		
Root Density	(%)	10-20%		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	40%		
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	See AS Survey		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓		
Right Bank (RB)	✓	WR 2/3125/RB	3125
Bed Surface (BED)			
Bed Core (BED-C)	✓	WR 2/3126/LA	3126
Bar (BAR)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

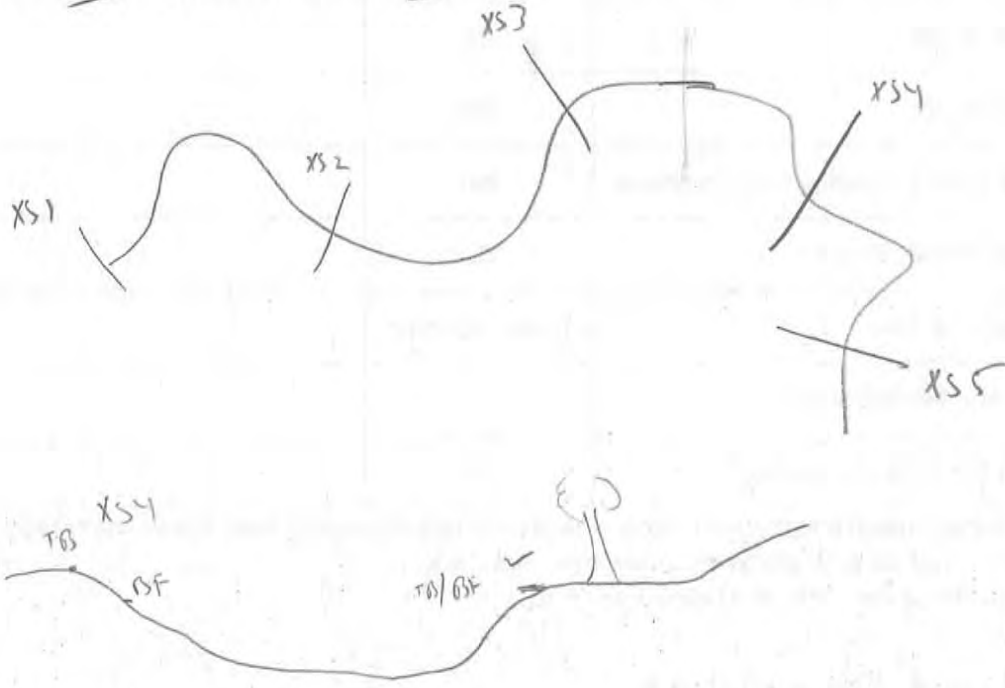
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Wolverton Creek 1

Date: 9/28/11

**SKETCH** Was scheduled for WS stakes but Q < 1 c/s. Staked 2 BF to clarify 2010 BF staking.



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)			Bank Full (BF)	✓	2100	Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 2	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 3	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 4	Left	Top of Bank (TB)			Bank Full (BF)	✓	2101	Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 5	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-			
Root Depth	(ft)			
Root Density	(%)			
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)			
Eroding Bank in Study Reach <sup>1</sup>	(%)			
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-			
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)			

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements		Riparian Vegetation Worksheet	
Depositional Features Worksheet		Pfankuch Method	
Channel Blockages Worksheet			

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)			
Right Bank (RB)			
Bed Surface (BED)			
Bed Core (BED-C)			
Bar (BAR)			

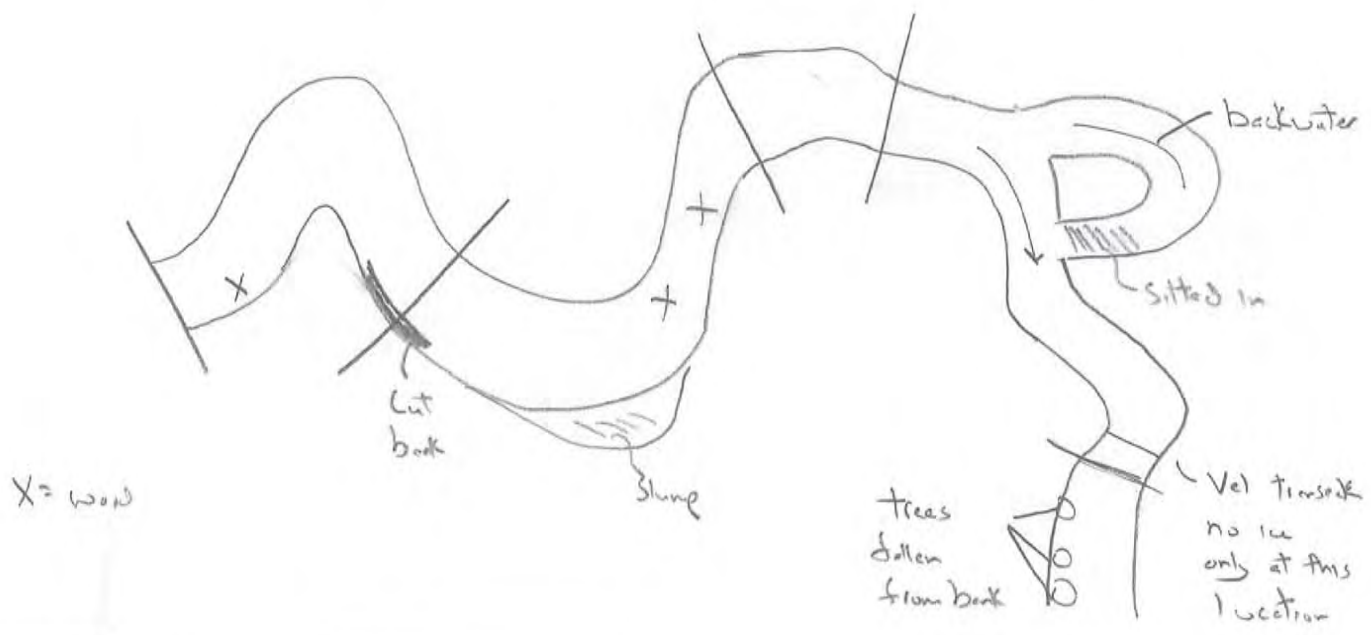
<i>River</i>	<i>Abbreviation</i>
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

Geomorphic Analysis Check List

Site Name: Wolverton Crk 11/19/10 FID 21 (RMS.41-5.15)

SKETCH



Staking

Did not find.  
Did not mistake in 20 as Q=0

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	4001	Bank Full (BF)	Same	4001	Water Surface (WS)	✓	4018
	Right	Top of Bank (TB)	✓	4019	Bank Full (BF)	Same	4019			
Section 2	Left	Top of Bank (TB)	✓	4004	Bank Full (BF)	✓	4003	Water Surface (WS)	✓	4002
	Right	Top of Bank (TB)	✓	4022	Bank Full (BF)	✓	4021			
Section 3	Left	Top of Bank (TB)	✓	4008	Bank Full (BF)	Same	4008	Water Surface (WS)	✓	4025
	Right	Top of Bank (TB)	✓	4023	Bank Full (BF)	✓	4024			
Section 4	Left	Top of Bank (TB)	✓	4013	Bank Full (BF)	✓	4012	Water Surface (WS)	✓	4027
	Right	Top of Bank (TB)	✓	4028	Bank Full (BF)	✓	4026			
Section 5	Left	Top of Bank (TB)	✓	4017	Bank Full (BF)	Same	4017	Water Surface (WS)	✓	4016
	Right	Top of Bank (TB)	✓	4029	Bank Full (BF)	✓	4020			



## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.04
Root Depth	(ft)	1-3 ft
Root Density	(%)	25%
Eroding Bank Surface Cover	(%)	5%
Eroding Bank Length	(ft)	700
Bank Material Type	(sand, silt, clay)	See Lab
Bank Material Stratification Score <sup>1</sup>	-	0
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	> Frozen

maybe high

75%  
at tot. distance

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	✓
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)			
Right Bank (RB)	✓	WC-1	4032
Bed (BED)	✓	WC-2	4033
Bar - Armor (B-A)	✓	WC-3	4034
Bar - Sub Armor (B-SA)			

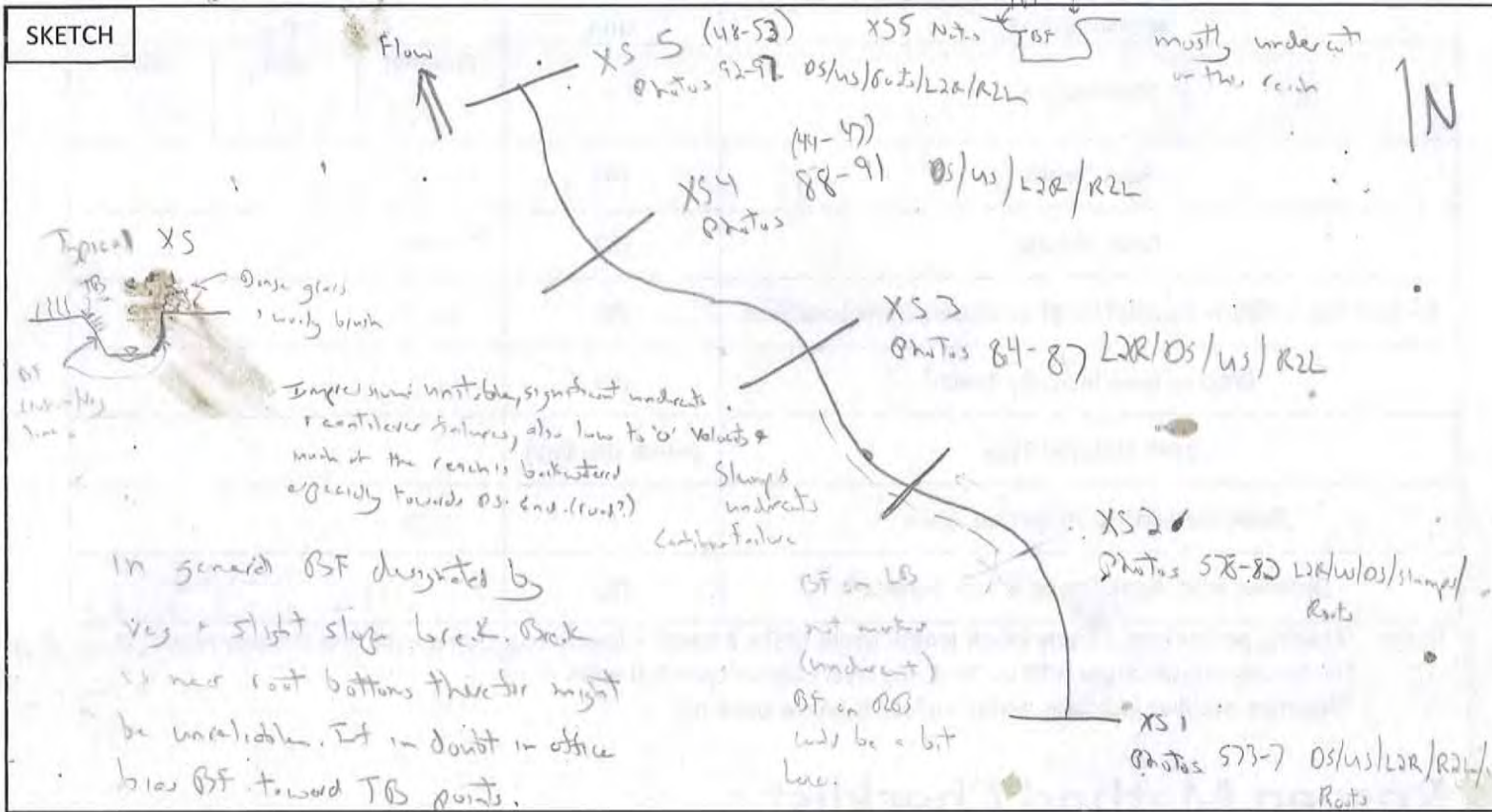
River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Wolverton Creek - 2

Date: 7/28/11



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	2003	Bank Full (BF)	✓	2004	Water Surface (WS)	✓	2005
	Right	Top of Bank (TB)	✓	2001	Bank Full (BF)	✓	2002			
Section 2	Left	Top of Bank (TB)	✓	2006	Bank Full (BF)			Water Surface (WS)	✓	2010
	Right	Top of Bank (TB)	✓	2008	Bank Full (BF)	✓	2009			
Section 3	Left	Top of Bank (TB)	✓	2014	Bank Full (BF)	✓	2015	Water Surface (WS)	✓	2013
	Right	Top of Bank (TB)	✓	2011	Bank Full (BF)	✓	2012			
Section 4	Left	Top of Bank (TB)	✓	2019	Bank Full (BF)	✓	2018	Water Surface (WS)	✓	2017
	Right	Top of Bank (TB)	✓	2016	Bank Full (BF)	✓	2016			
Section 5	Left	Top of Bank (TB)	✓	2025	Bank Full (BF)	✓	2024	Water Surface (WS)	✓	2023
	Right	Top of Bank (TB)	✓	2020	Bank Full (BF)					

# Geomorphic Analysis Check List

## Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.07	0.07
Root Depth	(ft)	1-1.5		
Root Density	(%)	Dense Grass	25%	
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	20%		
Eroding Bank in Study Reach <sup>1</sup>	(%)	90%		
Bank Material Type	(sand, silt, clay)			
Bank Material Stratification Score <sup>2</sup>	-	5		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	0-1.5' seems heavily Banknote dependent		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

*Lots of Bending in this reach*

## Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓ Estimated nr 0	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

## Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	W22-LB	2028
Right Bank (RB)			
Bed Surface (BED)			
Bed Core (BED-C)	✓	W22-LA	2027
Bar (BAR)			

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Buffalo River - 1

Date: 9/27/11

SKETCH

See GIS printout

Clayey sample with a small sheen of sand on top.

## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 105 Section 1 1192 U/S 74 LB 93 D/S 95 RB	Left	Top of Bank (TB)	✓	103	Bank Full (BF)	✓	104	Water Surface (WS)	✓	102
	Right	Top of Bank (TB)	✓	100	Bank Full (BF)	✓	101			
Pic 111 Section 2 1176 U/S 1193 U/S 1198 RB 97 LB	Left	Top of Bank (TB)	✓	107	Bank Full (BF)	✓	106	Water Surface (WS)	✓	108
	Right	Top of Bank (TB)	✓	110	Bank Full (BF)	✓	109			
Pic 122 Section 3 1200 Det 1201 U/S 1202 U/S	Left	Top of Bank (TB)	✓	120	Bank Full (BF)	✓	121	Water Surface (WS)	✓	115
	Right	Top of Bank (TB)	✓	117	Bank Full (BF)	✓	116			
Pic 128 Section 4 1206 U/S 1207 U/S	Left	Top of Bank (TB)	✓	125	Bank Full (BF)	✓	124	Water Surface (WS)	✓	123
	Right	Top of Bank (TB)	✓	126	Bank Full (BF)	✓	127			
Pic 134 Section 5 1210 U/S 1211 D/S	Left	Top of Bank (TB)	✓	133	Bank Full (BF)	✓	132	Water Surface (WS)	✓	129
	Right	Top of Bank (TB)	✓	131	Bank Full (BF)	✓	130			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.025	0.035	0.035
Root Depth	(ft)	2		
Root Density	(%)	3		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	0		
Eroding Bank in Study Reach <sup>1</sup>	(%)	98		
Bank Material Type	(sand, silt, clay)	clay		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	3		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	BR/119/LB	119
Right Bank (RB)	✓	BR/118/RB	118
Bed Surface (BED)	-	-	-
Bed Core (BED-C)	✓	BR/114/BED-C	114
Bar (BAR)	-	-	-

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation				
Stream: Buffalo River		Location: BR-1		
Observers: KDD	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: 9/27/11	
Existing species composition: large trees, sparse underbrush		Potential species composition:		
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	15	large trees	100%
				100%
2. Understory	Shrub layer	2	shrubs, nettle/bushes	40%
				100%
3. Ground level	Herbaceous	3	grass	100%
	Leaf or needle litter	0	Remarks: Condition, vigor and/or usage of existing reach:	100%
	Bare ground	85		
		<b>Column total</b>	<b>100%</b>	

\*Based on crown closure.  
\*\*Based on basal area to surface area.

**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations.

**Depositional Patterns**

Stream: Buffalo River

Reach: BR-1

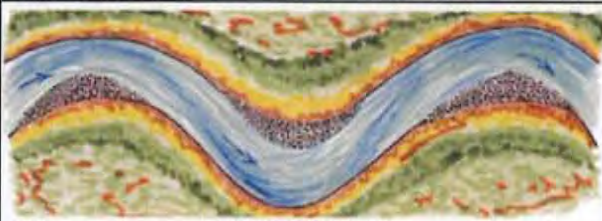
Observers: KPD

Date: 9/27/11

List ALL CATEGORIES that APPLY

NONE

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



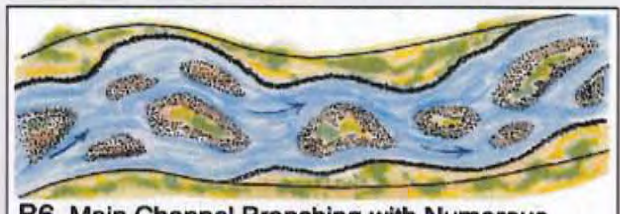
**B1 POINT BARS**



**B5 DIAGONAL BARS**



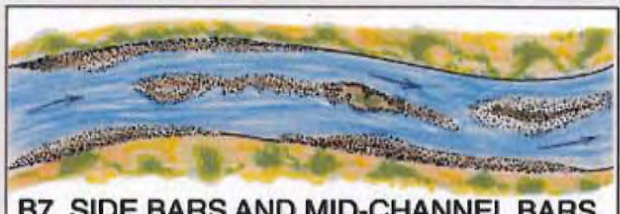
**B2 POINT BARS with Few MID-CHANNEL BARS**



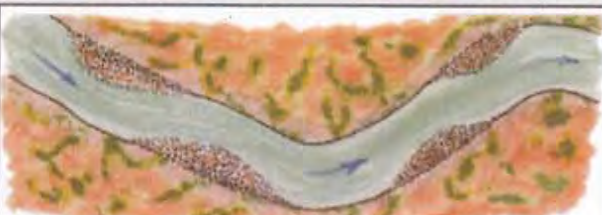
**B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands**



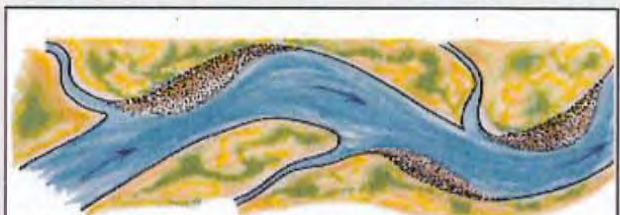
**B3 NUMEROUS MID-CHANNEL BARS**



**B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths**



**B4 SIDE BARS**



**B8 DELTA BARS**

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

Channel Blockages		
Stream: <i>Buffalo River</i>		Location: <i>BR-1</i>
Observers: <i>KDD</i>		Date: <i>9/27/11</i>
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.	<input checked="" type="checkbox"/>
D2 Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
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-section area.	<input checked="" type="checkbox"/>
D4 Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input checked="" type="checkbox"/>
D5 Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input checked="" type="checkbox"/>
D6 Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
D7 Beaver dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
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.	<input type="checkbox"/>
D9 Beaver dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
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.	<input type="checkbox"/>



Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

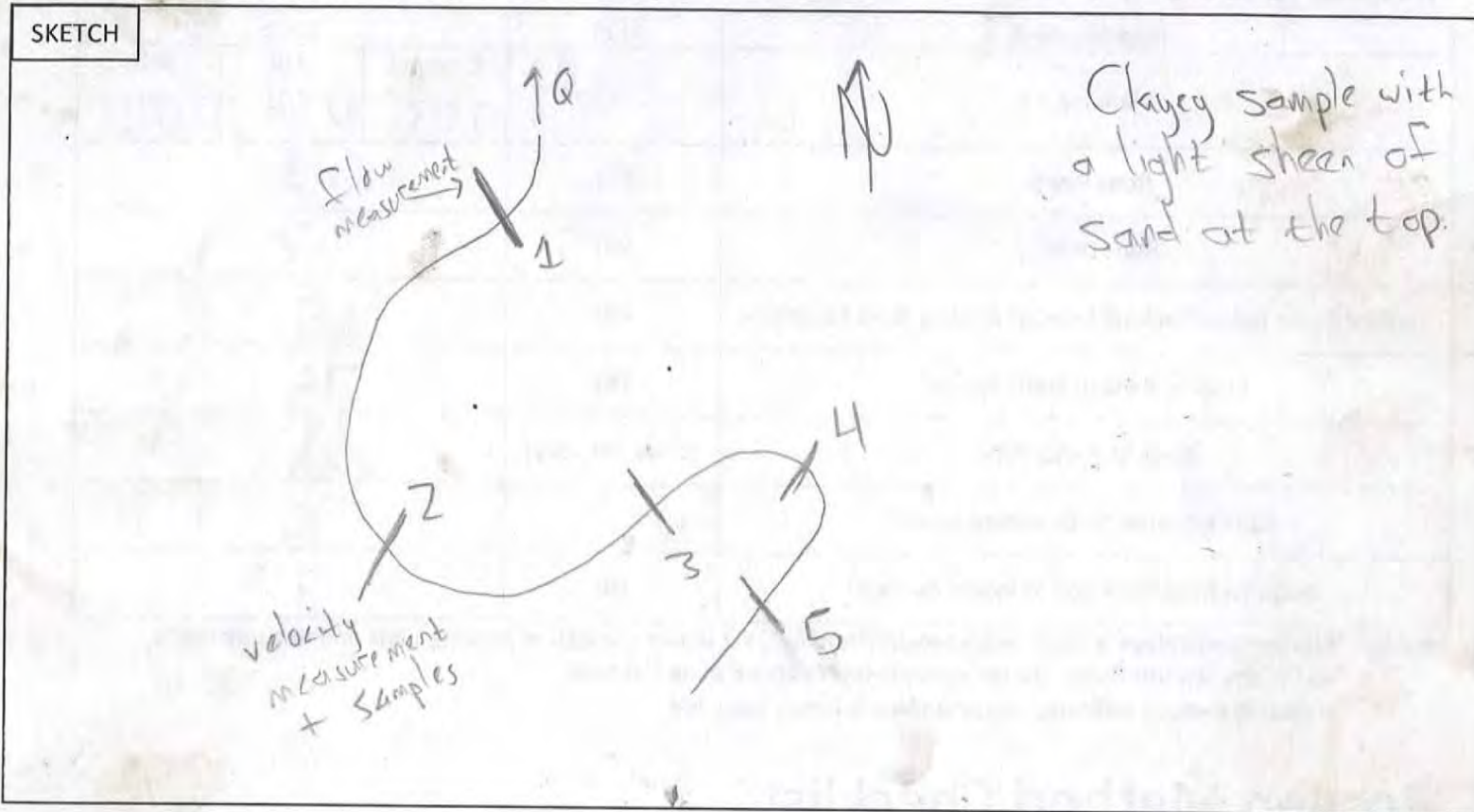
Stream: <u>Kaffale River</u>		Location: <u>RR-1</u>		Valley Type: <u>KDD</u>		Observers: <u>KDD</u>		Date: <u>9/27/11</u>																					
Loca-tion	Key	Excellent			Good			Fair			Poor																		
		Description	Rating	Description	Rating	Description	Rating	Description	Rating	Description	Rating																		
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																			
	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-High 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-High 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-High Ratio (BHR) > 1.4.	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-High 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	4	Some, intermittently at outcrops 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 deposition of new gravel and coarse sand on old and some new bars.	12	Extensive deposit of predominantly fine particles. Accelerated bar development.	16																			
	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 2 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 scored 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																			
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																			
	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																			
<b>Excellent total = 15</b>				<b>Good total = 20</b>				<b>Fair total = 6</b>				<b>Poor total = 44</b>																	
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	60-85	85-107	85-107	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	86-105	108-132	108-132	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+	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	50-75	50-75	40-63	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	76-96	76-96	64-86	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	108-120	108-120	113-125	108-120	113-125									
Poor (Unstable)	87+	87+	87+	87+	87+	97+	87+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	121+									
<b>Grand total = 85</b>																						<b>Existing stream type =</b>		<b>*Potential stream type =</b>		<b>Modified channel stability rating =</b>			

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

# Geomorphic Analysis Check List

Site Name: Red River - 1

Date: 9/28/11



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 140 Section 1 1214 U/S 1215 D/S	Left 1216 LB	Top of Bank (TB)	✓	137	Bank Full (BF)	✓	136	Water Surface (WS)	✓	135
	Right 1217 RB	Top of Bank (TB)	✓	138	Bank Full (BF)	✓	139			
Pic 149 Section 2 1219 U/S 1220 D/S	Left 1221 LB	Top of Bank (TB)	✓	147	Bank Full (BF)	✓	146	Water Surface (WS)	✓	140
	Right 1222 RB	Top of Bank (TB)	✓	143	Bank Full (BF)	✓	142			
Pic 155 Section 3 1223 U/S 1224 D/S	Left 1225 LB	Top of Bank (TB)	✓	154	Bank Full (BF)	✓	153	Water Surface (WS)	✓	150
	Right 1226 RB	Top of Bank (TB)	✓	152	Bank Full (BF)	✓	151			
Pic 161 Section 4 1227 U/S 1228 D/S	Left 1229 LB	Top of Bank (TB)	✓	159	Bank Full (BF)	✓	157	Water Surface (WS)	✓	156
	Right 1230 RB	Top of Bank (TB)	✓	160	Bank Full (BF)	✓	159			
Pic 167 Section 5 1231 U/S 1232 D/S	Left 1233 LB	Top of Bank (TB)	✓	164	Bank Full (BF)	✓	163	Water Surface (WS)	✓	162
	Right 1234 RB	Top of Bank (TB)	✓	165	Bank Full (BF)	✓	166			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.03	0.04	0.045
Root Depth	(ft)	1		
Root Density	(%)	2		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	15		
Eroding Bank in Study Reach <sup>1</sup>	(%)	75		
Bank Material Type	(sand, silt, clay)	clay		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	3		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		





### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	RR/148/LB	148
Right Bank (RB)	✓	RR/144/RB	144
Bed Surface (BED)	—	—	—
Bed Core (BED-C)	✓	RR/145/BED-C	145
Bar (BAR)	—	—	—

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation				
Stream: Red River		Location: RR-1		
Observers: KDD	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: 9/28/11	
Existing species composition: trees, brush		Potential species composition:		
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	15	5	trees
				100
				100%
2. Understory	Shrub layer		20	small shrubs
				100
				100%
3. Ground level	Herbaceous		10	grass/weeds
	Leaf or needle litter		0	Remarks: Condition, vigor and/or usage of existing reach:
	Bare ground		65	
*Based on crown closure. **Based on basal area to surface area.		Column total		100%

**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations.

**Depositional Patterns**

Stream: *Red River*

Reach: *RR-1*

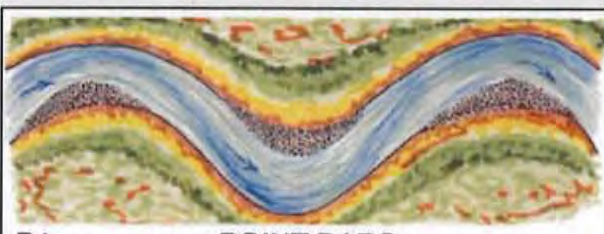






Observers: *KDD*

Date: *9/28/11*

List ALL CATEGORIES that APPLY

<i>NONE</i>				
-------------	--	--	--	--

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

 <p><b>B1</b> POINT BARS</p>	 <p><b>B5</b> DIAGONAL BARS</p>
 <p><b>B2</b> POINT BARS with Few MID-CHANNEL BARS</p>	 <p><b>B6</b> Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</p>
 <p><b>B3</b> NUMEROUS MID-CHANNEL BARS</p>	 <p><b>B7</b> SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</p>
 <p><b>B4</b> SIDE BARS</p>	 <p><b>B8</b> DELTA BARS</p>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Red River</i>		Location: <i>RR-1</i>
Observers: <i>KDD</i>		Date: <i>9/28/11</i>
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 <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input checked="" type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Worksheet 3-10. Pfrankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

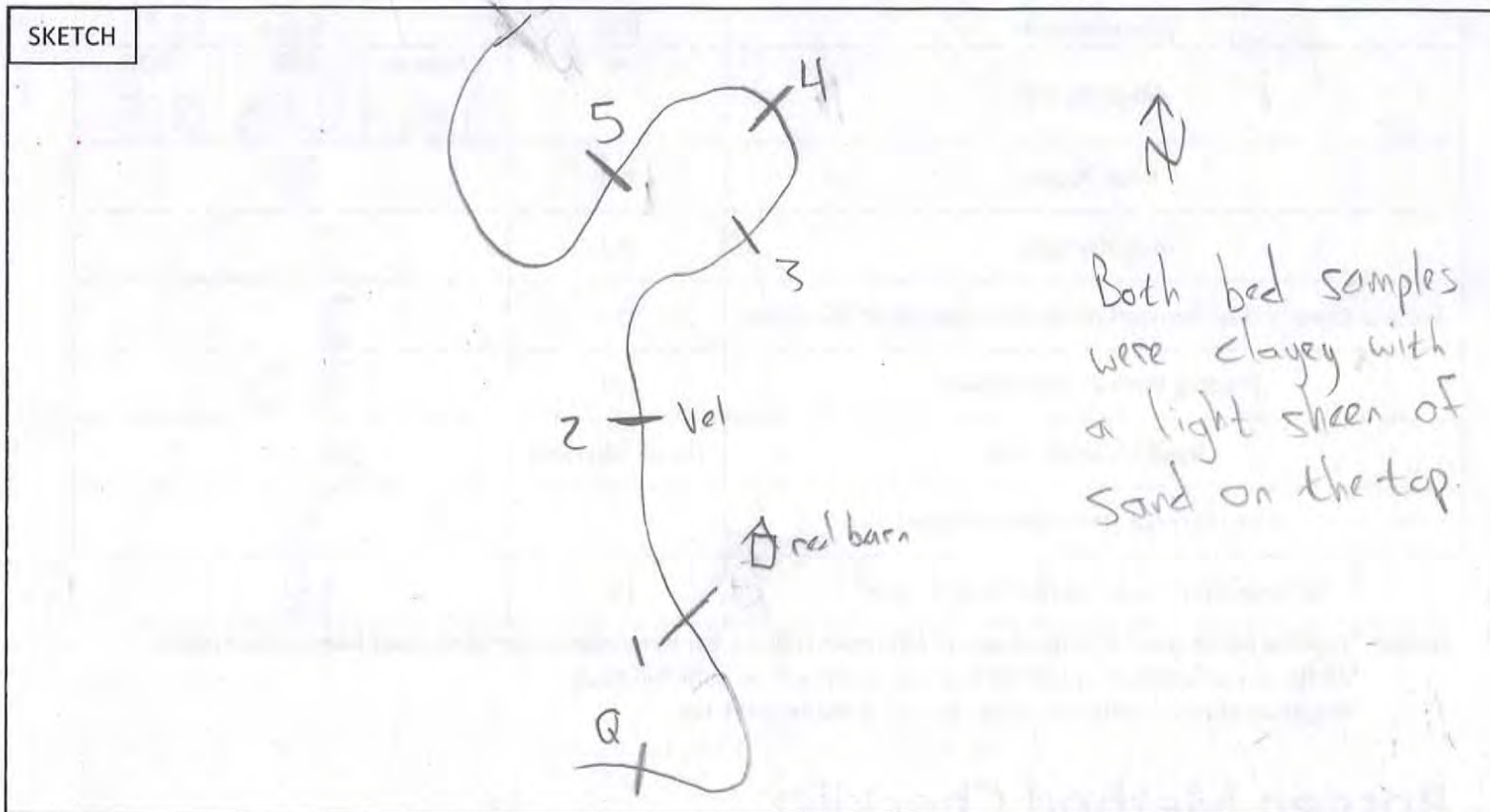
Stream: <u>Red River</u>		Location: <u>RR-1</u>		Valley Type: <u>KND</u>		Observers: <u>KND</u>		Date: <u>9/78/11</u>																
Loca- tion	Key Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating															
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8															
	2	Mass erosion	3	No evidence of past or future mass erosion.	6	Infrequent. Mostly healed over. Low future potential.	9	Frequent or large, causing sediment yearling OR imminent danger of same.	12															
	3	Debris jam potential	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, predominantly larger sizes.	8															
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	12															
Lower Banks	5	Channel capacity	1	Bank heights sufficient to contain the bankfull stage. Width/depth ratio from reference width/depth ratio = 1.0. Bank-Height Ratio (BHR) = 1.0.	2	Bankfull stage is contained within banks. 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. Overbank 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	2	> 65% with large angular boulders. 12"+ common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	<20% rock fragments of gravel sizes, 1-3" or less.	8															
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross obstructions and minor pool filling. Obstructions fewer and less firm.	6	Frequent obstructions and deflectors cause bank erosion yearling. Sediment traps full, channel migration occurring.	8															
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcrops and constrictions. Raw banks may be up to 12".	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16															
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Extensive deposit of predominantly fine particles. Accelerated bar development.	16															
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Well rounded in all dimensions, surfaces smooth.	4															
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Predominantly bright, > 65%, exposed or scoured surfaces.	4															
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8															
	13	Bottom size distribution	4	No size change evident. Stable material 80-100%.	8	Distribution shift light. Stable material 50-80%.	12	Moderate change in sizes. Stable materials 20-50%.	16															
	14	Scouring and deposition	6	<5% of bottom affected by scour or deposition.	12	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	18	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	24															
	15	Aquatic vegetation	1	Abundant growth moss-like, dark green perennial. In swift water too.	2	Common. Algae forms in low velocity and pool areas. Moss here too.	3	Perennial types scarce or absent. Yellow-green, short-term bloom may be present.	4															
		Excellent Total = <u>21</u>		Good Total = <u>12</u>		Fair Total = <u>0</u>		Poor Total = <u>44</u>																
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	38-43	38-45	38-45	38-45	38-45	38-45	38-45	38-45	38-45	38-50	38-50	38-50	38-50	38-50	38-50	38-50	38-50	38-50	38-50	38-50	38-50	38-50
Fair (Mod. Unstable)	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47
Poor (Unstable)	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+
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	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63
Fair (Mod. Unstable)	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86
Poor (Unstable)	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+
		Grand Total = <u>77</u>																						
		Existing Stream Type =																						
		*Potential Stream Type =																						
		Modified Channel Stability Rating =																						

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

# Geomorphic Analysis Check List

Site Name: Red River - 2

Date: 9/29/11



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 174 Section 1 1235 U/S 1236 D/S	Left 1237 LB	Top of Bank (TB)	✓	173	Bank Full (BF)	✓	172	Water Surface (WS)	✓	169
	Right 1238 RB	Top of Bank (TB)	✓	171	Bank Full (BF)	✓	170			
Pic 182 Section 2 1234 U/S 1246 D/S	Left 1241 LB	Top of Bank (TB)	✓	179	Bank Full (BF)	✓	181	Water Surface (WS)	✓	178
	Right 1242 RB	Top of Bank (TB)	✓	175	Bank Full (BF)	✓	177			
Pic 190 Section 3 1246 U/S 1247 D/S	Left 1248 LB	Top of Bank (TB)	✓	189	Bank Full (BF)	✓	188	Water Surface (WS)	✓	187
	Right 1249 RB	Top of Bank (TB)	✓	186	Bank Full (BF)	✓	185			
Pic 196 Section 4 1250 U/S 1251 D/S	Left 1252 LB	Top of Bank (TB)	✓	195	Bank Full (BF)	✓	194	Water Surface (WS)	✓	191
	Right 1253 RB	Top of Bank (TB)	✓	193	Bank Full (BF)	✓	192			
Pic 202 Section 5 1254 U/S 1255 D/S	Left 1256 LB	Top of Bank (TB)	✓	197	Bank Full (BF)	✓	198	Water Surface (WS)	✓	199
	Right 1257 RB	Top of Bank (TB)	✓	200	Bank Full (BF)	✓	201			



## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.03	0.05	0.05
Root Depth	(ft)	3		
Root Density	(%)	5		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	2		
Eroding Bank in Study Reach <sup>1</sup>	(%)	70%		
Bank Material Type	(sand, silt, clay)	clay		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	1.8		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		




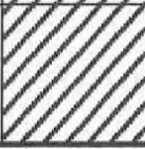
### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	RR/180/LB	180
Right Bank (RB)	✓	RR/176/RB	176
Bed Surface (BED)	—	—	—
Bed Core (BED-C)	✓✓	RR/183/BED-C-R RR/184/BED-C	183 (Pt 1245) 184 (Pt 1245)
Bar (BAR)	—	—	—

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation					
Stream: Red River		Location: RR-2			
Observers: KDD	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: 9/29/10		
Existing species composition: trees, shrubs		Potential species composition:			
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition	
1. Overstory	Canopy layer	40	10	trees	100
				-----	-----
				100%	
2. Understory	Shrub layer		15	nettle	10
				small shrubs	90
				100%	
3. Ground level	Herbaceous		40	grass, weeds	100
	Leaf or needle litter		0	Remarks: Condition, vigor and/or usage of existing reach:	100%
	Bare ground		65		
*Based on crown closure. **Based on basal area to surface area.		Column total 100%			

**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations.

**Depositional Patterns**

Stream: Red River

Reach: RR-2

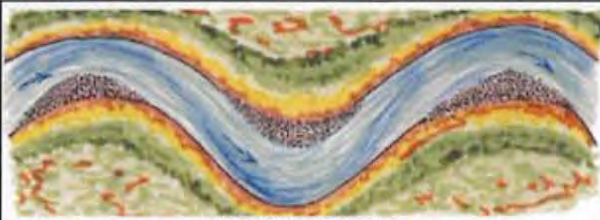
Observers: KDD

Date: 9/29/11

List ALL CATEGORIES that APPLY ↗

NONE

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



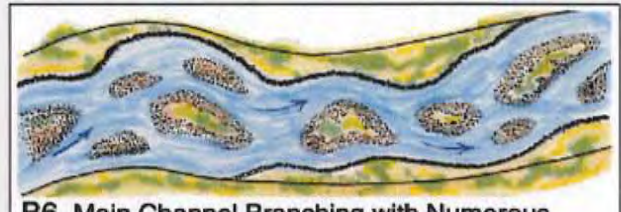
**B1 POINT BARS**



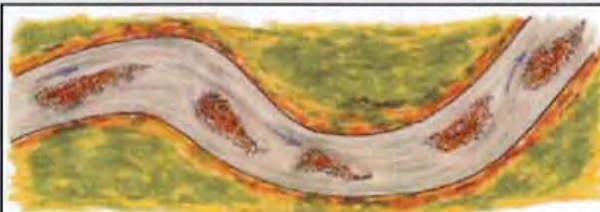
**B5 DIAGONAL BARS**



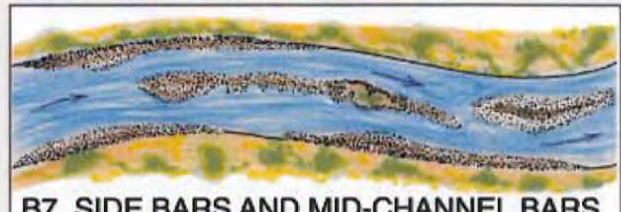
**B2 POINT BARS with Few MID-CHANNEL BARS**



**B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands**



**B3 NUMEROUS MID-CHANNEL BARS**



**B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths**



**B4 SIDE BARS**



**B8 DELTA BARS**

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Red River</i>		Location: <i>RR-2</i>
Observers: <i>KDD</i>		Date: <i>9/29/11</i>
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 <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input checked="" type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input checked="" type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

**Worksheet 3-10. Pfrankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2005b).**

Stream: <u>Red River</u> Location: <u>RR-7</u> Valley Type: <u>KDD</u> Observers: <u>KDD</u> Date: <u>5/25/11</u>			Excellent		Good		Fair		Poor															
Loca- tion	Key Category	Description	Rating	Description	Rating	Description	Rating	Description	Rating	Description														
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8															
	2	Mass erosion	3	No evidence of past or future mass erosion.	6	Frequent. Mostly healed over. Low future potential.	9	Frequent or large, causing sediment nearby yearlong OR imminent danger of same.	12															
	3	Debris jam potential	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, mostly larger sizes.	8															
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	50-70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	12	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.														
Lower Banks	5	Channel capacity	1	Bank heights sufficient to contain the bankfull stage. Width/depth ratio from reference width/depth ratio = 1.0. Bank-Height Ratio (BHR) = 1.0.	2	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.	3	Bankfull stage is not contained. Width/depth ratio departure from reference width/depth ratio = 1.2-1.4. Bank-Height Ratio (BHR) > 1.3.	4	Bankfull stage is not contained, overbank 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.														
	6	Bank rock content	2	> 65% with large angular boulders. 12"+ common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	20-40%. Most in the 3-6" diameter class.	8	<20% rock fragments of gravel sizes, 1-3" or less.														
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	8	Frequent obstructions and defectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.														
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcoves and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.														
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16	Extensive deposit of predominantly fine particles. Accelerated bar development.														
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4	Well rounded in all dimensions, surfaces smooth.														
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4	Predominantly bright, > 65%, exposed or scoured surfaces.														
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8	No packing evident. Loose assortment, easily moved.														
	13	Bottom size distribution	4	No size change evident. Stable material 80-100%.	8	Distribution shift light. Stable material 50-80%.	12	Moderate change in sizes. Stable materials 20-50%.	16	Marked distribution change. Stable materials 0-20%.														
14	Scouring and deposition	6	<5% of bottom affected by scour or deposition.	12	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	18	30-50% affected. Deposits and scour at obstructions, constrictions and bands. Some filling of pools.	24	More than 50% of the bottom in a state of flux or change nearly yearlong.															
15	Aquatic vegetation	1	Abundant growth moss-like, dark green perennial. In swift water too.	2	Common. Algae forms in low velocity and pool areas. Moss here too.	3	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	4	Perennial types scarce or absent. Yellow-green, short-term bloom may be present.															
			Excellent Total = <b>21</b>	Good Total = <b>4</b>	Fair Total = <b>12</b>	Poor Total = <b>14</b>																		
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	40-63	60-85	80-95	50-80	38-45	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	60-85	60-85	85-107	85-107	85-107	85-107	67-98
Fair (Mod. Unstable)		44-47	44-47	81-129	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	86-105	86-105	108-132	108-132	108-132	108-132	99-125
Poor (Unstable)		48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	108+	111+	111+	106+	133+	133+	133+	128+	
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	50-75	50-75	40-63	40-63	60-85	60-85	60-85	85-110	85-110	80-95	40-60	40-60	85-107	85-107	85-107	85-107			
Fair (Mod. Unstable)		64-86	64-86	64-86	64-86	76-96	76-96	64-86	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+	97+	97+	87+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	126+			
			Excellent Total = <b>21</b>	Good Total = <b>4</b>	Fair Total = <b>12</b>	Poor Total = <b>14</b>					Grand Total = <b>18</b>			Existing Stream Type =			*Potential Stream Type =			Modified Channel Stability Rating =				

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

# Geomorphic Analysis Check List

Site Name: Red River-7

Date: 9/30/11

**SKETCH**

Note: 2 bed core samples taken - one near right bank, one at thalweg. RB core was primarily sand. Had a little clay near bottom of sample. Center core was mix of clay and sand. Ran into clay layer at a shallower depth here than in RB core. Seems to be a fine sheet of sand overlain a compact clay layer.

## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 206 Section 1 1258 U/S 1259 D/S	Left 1260 LB	Top of Bank (TB)	-	-	Bank Full (BF)	-	-	Water Surface (WS)	✓	205
	Right 1261 RB	Top of Bank (TB)	✓	203	Bank Full (BF)	✓	204			
Pic 214 Section 2 1262 U/S 1263 D/S	Left 1264 LB	Top of Bank (TB)	-	-	Bank Full (BF)	-	-	Water Surface (WS)	✓	211
	Right 1265 RB	Top of Bank (TB)	✓	208	Bank Full (BF)	✓	210			
Pic 220 Section 3 1266 U/S 1267 D/S	Left 1268 LB	Top of Bank (TB)	✓	219	Bank Full (BF)	✓	218	Water Surface (WS)	✓	217
	Right 1269 RB	Top of Bank (TB)	✓	216	Bank Full (BF)	✓	215			
Pic 226 Section 4 1270 U/S 1271 D/S	Left 1272 LB	Top of Bank (TB)	✓	225	Bank Full (BF)	✓	224	Water Surface (WS)	✓	223
	Right 1273 RB	Top of Bank (TB)	✓	222	Bank Full (BF)	✓	221			
Pic 232 Section 5 1274 U/S 1275 D/S	Left 1276 LB	Top of Bank (TB)	✓	230	Bank Full (BF)	✓	231	Water Surface (WS)	✓	229
	Right 1277 RB	Top of Bank (TB)	✓	227	Bank Full (BF)	✓	228			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.05	0.05
Root Depth	(ft)	3		
Root Density	(%)	10		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5		
Eroding Bank in Study Reach <sup>1</sup>	(%)	70		
Bank Material Type	(sand, silt, clay)	clay		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	4.9'		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	—	—	—
Right Bank (RB)	✓	RR/209/RB	209
Bed Surface (BED)	—	—	—
Bed Core (BED-C)	✓	RR/212/RB-C-RP 213/BED-C-C	212 213
Bar (BAR)	—	—	—

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

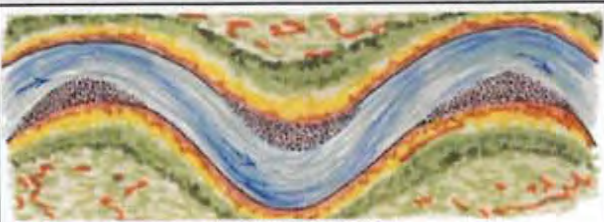







**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation					
Stream: <i>Red River</i>		Location: <i>RR-7</i>			
Observers: <i>KDD</i>	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: <i>9/30/11</i>		
Existing species composition: <i>trees,</i>		Potential species composition:			
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition	
1. Overstory	Canopy layer	<i>80</i>	<i>15</i>	<i>trees</i>	<i>100</i>
					<b>100%</b>
2. Understory	Shrub layer		<i>40</i>	<i>weeds, shrubs</i>	<i>100</i>
					<b>100%</b>
3. Ground level	Herbaceous		<i>20</i>	<i>grass, weeds</i>	<i>100</i>
	Leaf or needle litter		<i>5</i>	<b>Remarks:</b> Condition, vigor and/or usage of existing reach:	<b>100%</b>
	Bare ground		<i>20</i>		
		<b>Column total</b>		<b>100%</b>	

\*Based on crown closure.  
 \*\*Based on basal area to surface area.



**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations.

<b>Depositional Patterns</b>	
Stream: <u>Red River</u>	Reach: <u>RR-7</u>
Observers: <u>KDD</u>	Date: <u>9/30/11</u>
List ALL CATEGORIES that APPLY <span style="border: 1px solid black; padding: 2px 10px; font-family: monospace;">NONE</span>	
<i>Various Depositional Features modified from Galay et al. (1973)</i>	
 <b>B1 POINT BARS</b>	 <b>B5 DIAGONAL BARS</b>
 <b>B2 POINT BARS with Few MID-CHANNEL BARS</b>	 <b>B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b>
 <b>B3 NUMEROUS MID-CHANNEL BARS</b>	 <b>B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b>
 <b>B4 SIDE BARS</b>	 <b>B8 DELTA BARS</b>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Red River</i>		Location: <i>RR-7</i>
Observers: <i>KDA</i>		Date: <i>9/30/11</i>
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 <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input checked="" type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input checked="" type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input checked="" type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

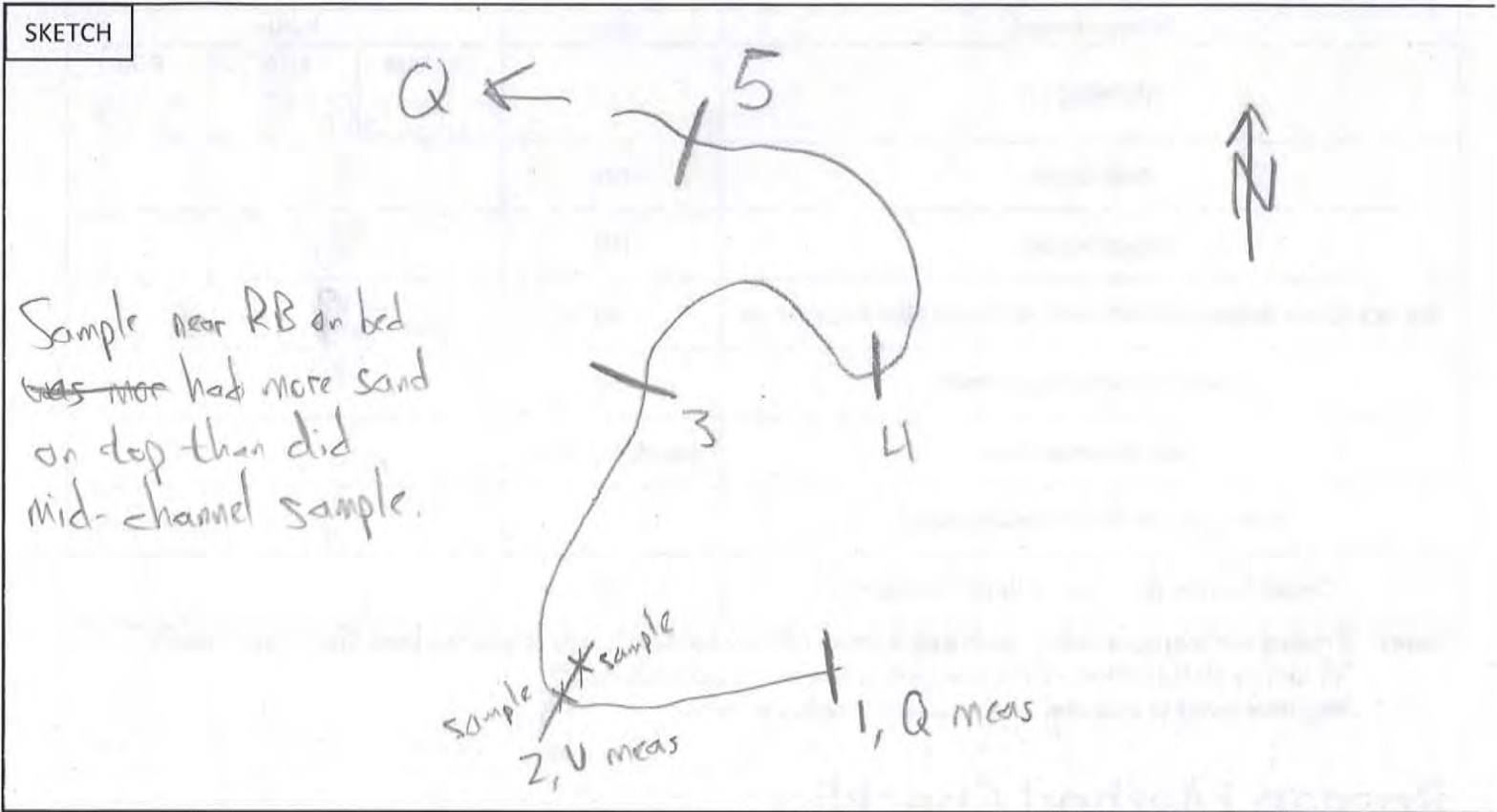
Stream: <u>Ked River</u>		Location: <u>Rk-7</u>		Valley Type: <u>VD</u>		Observers: <u>KD</u>		Date: <u>7/20/11</u>																		
Loca-tion	Key Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating																	
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8																	
	2	Mass erosion	3	No evidence of past or future mass erosion.	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	2	Essentially absent from immediate channel area.	4	Moderate to heavy amounts, mostly larger sizes.	6	Moderate to heavy amounts, predominantly larger sizes.	8																	
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense soil-binding root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	12																	
Lower Banks	5	Channel capacity	1	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.	2	Bankfull stage is contained within banks. 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; overbank 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	2	> 65% with large angular boulders. 12" + common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	<20% rock fragments of gravel sizes, 1-3" or less.	8																	
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	8																	
	8	Cutting banks	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcrops and constrictions. Raw banks may be up to 12".	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16																	
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16																	
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Well rounded in all dimensions, surfaces smooth.	4																	
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4																	
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8																	
	13	Bottom size distribution	4	No size change evident. Stable material 80-100%.	8	Distribution shift light. Stable material 50-80%.	12	Moderate change in sizes. Stable materials 20-50%.	16																	
	14	Scouring and deposition	6	<5% of bottom affected by scour or deposition.	12	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	18	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	24																	
	15	Aquatic vegetation	1	Abundant growth moss-like, dark green perennial. In swift water too.	2	Common. Algae forms in low velocity and pool areas. Moss here too.	3	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	4																	
		Excellent Total = 9	Good Total = 28	Fair Total = 12	Poor Total = 14																					
Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6	Grand Total = 93			
Good (Stable)	38-43	38-43	54-60	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	60-85	85-107	85-107	85-107	85-107	85-107	85-107	67-98	Existing Stream Type =	
Fair (Mod. Unstable)	44-47	44-47	91-129	96-132	95-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	86-105	108-132	108-132	108-132	108-132	108-132	108-132	99-125	*Potential Stream Type =	
Poor (Unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	106+	133+	133+	133+	133+	133+	133+	126+	Modified Channel Stability Rating =	
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	50-75	50-75	40-63	40-63	60-85	60-85	85-110	85-110	80-95	80-95	40-60	40-60	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107		
Fair (Mod. Unstable)	64-86	64-86	64-86	64-86	76-96	76-96	64-86	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	113-125	108-120	108-120	108-120		
Poor (Unstable)	87+	87+	87+	87+	97+	97+	87+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	126+	126+	126+	126+	126+		

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

# Geomorphic Analysis Check List

Site Name: Wild Rice River - 6

Date: 10/1/11



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 238 Section 1 1279 U/S 1280 D/S	Left 1281 LB	Top of Bank (TB)	✓	233	Bank Full (BF)	✓	234	Water Surface (WS)	✓	235
	Right 1282 RB	Top of Bank (TB)	✓	236	Bank Full (BF)	✓	237			
Pic 247 Section 2 1284 U/S 1285 D/S	Left 1286 LB	Top of Bank (TB)	✓	245	Bank Full (BF)	✓	244	Water Surface (WS)	✓	242
	Right 1287 RB	Top of Bank (TB)	✓	240	Bank Full (BF)	✓	241			
Pic 254 Section 3 1288 U/S 1289 D/S	Left 1290 LB	Top of Bank (TB)	✓	252	Bank Full (BF)	✓	253	Water Surface (WS)	✓	251
	Right 1291 RB	Top of Bank (TB)	✓	249	Bank Full (BF)	✓	250			
Pic 260 Section 4 1292 U/S 1293 D/S	Left 1294 LB	Top of Bank (TB)	✓	258	Bank Full (BF)	✓	259	Water Surface (WS)	✓	255
	Right 1295 RB	Top of Bank (TB)	✓	257	Bank Full (BF)	✓	256			
Pic 266 Section 5 1296 U/S 1297 D/S	Left 1298 LB	Top of Bank (TB)	✓	262	Bank Full (BF)	✓	261	Water Surface (WS)	✓	263
	Right 1299 RB	Top of Bank (TB)	✓	264	Bank Full (BF)	✓	265			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.05	0.05
Root Depth	(ft)	3		
Root Density	(%)	10		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5		
Eroding Bank in Study Reach <sup>1</sup>	(%)	70		
Bank Material Type	(sand, silt, clay)	clay		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	2.5		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	WR/243/LB	243
Right Bank (RB)	✓	WR/239/RB	239
Bed Surface (BED)	-	-	-
Bed Core (BED-C)	✓	WR/246/BED-C-C WR/248/BED-C-RB	246 248
Bar (BAR)	-	-	-







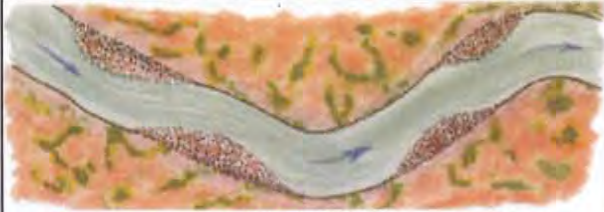

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation					
Stream: <i>Wild Rice River</i>		Location: <i>WRP-6</i>			
Observers: <i>KDD</i>	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: <i>10/1/11</i>		
Existing species composition:		Potential species composition:			
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition	
1. Overstory	Canopy layer	<i>85</i>	<i>20</i>	<i>trees</i>	<i>100</i>
					<b>100%</b>
2. Understory	Shrub layer		<i>20</i>	<i>shrubs</i>	<i>100</i>
					<b>100%</b>
3. Ground level	Herbaceous		<i>5</i>	<i>grass, weeds</i>	<i>100</i>
	Leaf or needle litter		<i>5</i>	<b>Remarks:</b> Condition, vigor and/or usage of existing reach:	<b>100%</b>
	Bare ground		<i>50</i>		
*Based on crown closure. **Based on basal area to surface area.		<b>Column total</b> <b>100%</b>			

**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations.

<b>Depositional Patterns</b>	
Stream: <u>Wild Rico River</u>	Reach: <u>WRR-C</u>
Observers: <u>KDD</u>	Date: <u>10/1/11</u>
List ALL CATEGORIES that APPLY <span style="border: 1px solid black; padding: 2px 10px; font-family: monospace;">NONE</span>	
<i>Various Depositional Features modified from Galay et al. (1973)</i>	
 <b>B1 POINT BARS</b>	 <b>B5 DIAGONAL BARS</b>
 <b>B2 POINT BARS with Few MID-CHANNEL BARS</b>	 <b>B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b>
 <b>B3 NUMEROUS MID-CHANNEL BARS</b>	 <b>B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b>
 <b>B4 SIDE BARS</b>	 <b>B8 DELTA BARS</b>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Wild Rice River</i>		Location: <i>VRR-6</i>
Observers: <i>KDD</i>		Date: <i>10/1/11</i>
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 <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input checked="" type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input checked="" type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>



Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

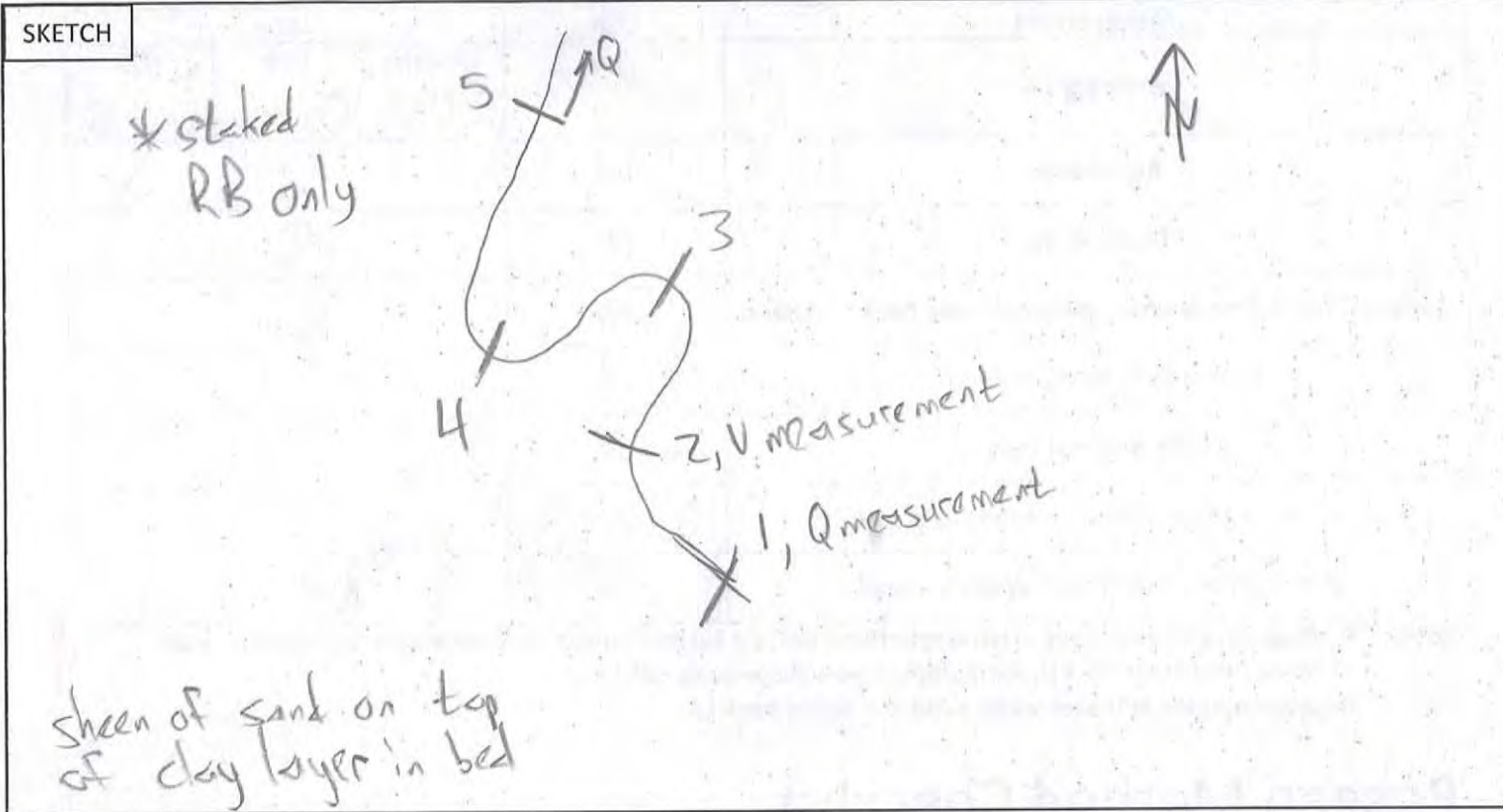
Stream: <u>Wild Rice River</u> Location: <u>URR-1</u> Valley Type: <u>KO1</u> Observers: <u>KO1</u> Date: <u>10/1/10</u>		Excellent		Good		Fair		Poor																						
Loca- tion	Key Category	Description	Rating	Description	Rating	Description	Rating	Description	Rating																					
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8																					
	2	Mass erosion	3	No evidence of past or future mass erosion.	6	Infrequent. Mostly healed over. Low future potential.	9	Frequent or large, causing sediment nearby yearlong.	12																					
	3	Debris jam potential	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, mostly larger sizes.	8																					
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	50-70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	12																					
Lower Banks	5	Channel capacity	1	Bank heights sufficient to contain the bankfull stage. Width/depth ratio from reference width/depth ratio = 1.0. Bank-Height Ratio (BHR) = 1.0.	2	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.	3	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.	4																					
	6	Bank rock content	2	> 65% with large angular boulders. 12" + common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	20-40%. Most in the 3-6" diameter class.	8																					
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	8																					
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcaves and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16																					
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16																					
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4																					
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4																					
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8																					
Stream Type	A1	38-43	A2	38-43	A3	38-45	A4	38-45	A5	38-45	A6	38-45	A7	38-45	A8	38-45	A9	38-45	A10	38-45	A11	38-45	A12	38-45	A13	38-45	A14	38-45	A15	38-45
	DA3	44-47	DA4	44-47	DA5	44-47	DA6	44-47	DA7	44-47	DA8	44-47	DA9	44-47	DA10	44-47	DA11	44-47	DA12	44-47	DA13	44-47	DA14	44-47	DA15	44-47	DA16	44-47	DA17	44-47
	GA3	48+	GA4	48+	GA5	48+	GA6	48+	GA7	48+	GA8	48+	GA9	48+	GA10	48+	GA11	48+	GA12	48+	GA13	48+	GA14	48+	GA15	48+	GA16	48+	GA17	48+
Stream Type	GA3	40-63	GA4	40-63	GA5	40-63	GA6	40-63	GA7	40-63	GA8	40-63	GA9	40-63	GA10	40-63	GA11	40-63	GA12	40-63	GA13	40-63	GA14	40-63	GA15	40-63	GA16	40-63	GA17	40-63
Stream Type	PA3	64-86	PA4	64-86	PA5	64-86	PA6	64-86	PA7	64-86	PA8	64-86	PA9	64-86	PA10	64-86	PA11	64-86	PA12	64-86	PA13	64-86	PA14	64-86	PA15	64-86	PA16	64-86	PA17	64-86
Stream Type	PU3	87+	PU4	87+	PU5	87+	PU6	87+	PU7	87+	PU8	87+	PU9	87+	PU10	87+	PU11	87+	PU12	87+	PU13	87+	PU14	87+	PU15	87+	PU16	87+	PU17	87+
Excellent Total =		21		Good Total =		0		Fair Total =		18		Poor Total =		14		Grand Total =		33		Existing Stream Type =		*Potential Stream Type =		Modified Channel Stability Rating =						

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

# Geomorphic Analysis Check List

Site Name: Wild Rice River - S

Date: 10/2/11



## Staking

Section #	Bank		Staked	GPS Pt	Bank Full	Staked	GPS Pt		Staked	GPS Pt
Pic 270 Section 1 1301 U/S 1302 D/S	Left 1303 LB	Top of Bank (TB)	—	—	Bank Full (BF)	—	—	Water Surface (WS)	✓	269
	Right 1304 RB	Top of Bank (TB)	✓	267	Bank Full (BF)	✓	268			
Pic 277 Section 2 1305 U/S 1306 D/S	Left 1307 LB	Top of Bank (TB)	—	—	Bank Full (BF)	—	—	Water Surface (WS)	✓	273
	Right 1308 RB	Top of Bank (TB)	✓	271	Bank Full (BF)	✓	272			
Pic 281 Section 3 1309 U/S 1310 D/S	Left 1311 LB	Top of Bank (TB)	—	—	Bank Full (BF)	—	—	Water Surface (WS)	✓	278
	Right 1312 RB	Top of Bank (TB)	✓	279	Bank Full (BF)	✓	280			
Pic 285 Section 4 1313 U/S 1314 D/S	Left 1315 LB	Top of Bank (TB)	—	—	Bank Full (BF)	—	—	Water Surface (WS)	✓	282
	Right 1316 RB	Top of Bank (TB)	✓	284	Bank Full (BF)	✓	283			
Pic 289 Section 5 1317 U/S 1318 D/S	Left 1319 LB	Top of Bank (TB)	—	—	Bank Full (BF)	—	—	Water Surface (WS)	✓	286
	Right 1320 RB	Top of Bank (TB)	✓	288	Bank Full (BF)	✓	287			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.045	0.045
Root Depth	(ft)	2		
Root Density	(%)	15		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5		
Eroding Bank in Study Reach <sup>1</sup>	(%)	50		
Bank Material Type	(sand, silt, clay)	clay		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	2.3		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	—	—	—
Right Bank (RB)	✓	WR/274/RB	274
Bed Surface (BED)	—	—	—
Bed Core (BED-C)	✓	WR/275/BED-C-C	275
	✓	WR/276/BED-C-RB	276
Bar (BAR)	—	—	—

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

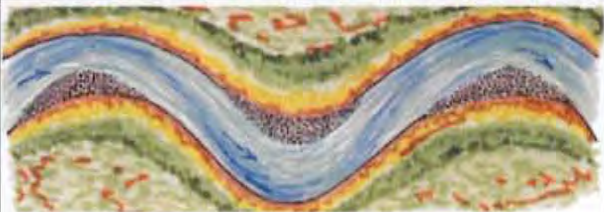







Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation					
Stream: <i>Wild Rice River</i>		Location: <i>WRR-5</i>			
Observers: <i>KDD</i>	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: <i>10/2/11</i>		
Existing species composition:		Potential species composition:			
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition	
1. Overstory	Canopy layer	<i>70</i>	<i>15</i>	<i>trees</i>	<i>100</i>
					<b>100%</b>
2. Understory	Shrub layer		<i>10</i>	<i>shrubs</i>	<i>100</i>
					<b>100%</b>
3. Ground level	Herbaceous		<i>5</i>	<i>grass, weeds</i>	<i>100</i>
	Leaf or needle litter		<i>10</i>	<b>Remarks:</b> Condition, vigor and/or usage of existing reach:	
	Bare ground		<i>60</i>		
		<b>Column total</b>		<b>100%</b>	

\*Based on crown closure.  
 \*\*Based on basal area to surface area.

**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations.

Depositional Patterns	
Stream: <u>Wild Rice River</u>	Reach: <u>WRR-5</u>
Observers: <u>KDD</u>	Date: <u>10/2/11</u>
List ALL CATEGORIES that APPLY <input type="checkbox"/>	<u>NONE</u>
<i>Various Depositional Features modified from Galay et al. (1973)</i>	
 <p><b>B1 POINT BARS</b></p>	 <p><b>B5 DIAGONAL BARS</b></p>
 <p><b>B2 POINT BARS with Few MID-CHANNEL BARS</b></p>	 <p><b>B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b></p>
 <p><b>B3 NUMEROUS MID-CHANNEL BARS</b></p>	 <p><b>B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b></p>
 <p><b>B4 SIDE BARS</b></p>	 <p><b>B8 DELTA BARS</b></p>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Wild Rice River</i>		Location: <i>WRR-5</i>
Observers: <i>KDD</i>		Date: <i>10/2/11</i>
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
<b>D1</b> None	Minor amounts of small, floatable material.	<input checked="" type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input checked="" type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input checked="" type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

Stream: <u>Wild Rice River</u>		Location: <u>WRS</u>		Valley Type: <u>KDD</u>		Observers: <u>KDD</u>		Date: <u>10/7/11</u>																			
Local- tion	Key Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating																		
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8																		
	2	Mass erosion	3	No evidence of past or future mass erosion.	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	2	Essentially absent from immediate channel area.	4	Moderate to heavy amounts, mostly larger sizes.	6	Moderate to heavy amounts, predominantly larger sizes.	8																		
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding 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	1	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.	2	Bankfull stage is contained within banks. 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; overbank 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	2	> 65% with large angular boulders. 12"+ common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	20-40%. Most in the 3-6" diameter class.	8																		
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	8																		
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcrops and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16																		
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16																		
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4																		
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4																		
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8																		
	13	Bottom size distribution	4	No size change evident. Stable material 80-100%.	8	Distribution shift light. Stable material 50-80%.	12	Moderate change in sizes. Stable materials 20-50%.	16																		
	14	Scouring and deposition	6	<5% of bottom affected by scour or deposition.	12	5-30% affected. Scour at constrictions and where grades steeper. Some deposition in pools.	18	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	24																		
	15	Aquatic vegetation	1	Abundant growth moss-like, dark green perennial. In swift water too.	2	Common. Algae forms in low velocity and pool areas. Moss here too.	3	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	4																		
		Excellent Total =	23	Good Total =	0	Fair Total =	33	Poor Total =	16																		
Stream Type		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6	Grand Total = 72			
Good (Stable)		38-43	40-43	40-63	40-63	40-63	40-63	40-63	40-63	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	60-85	60-85	85-107	85-107	85-107	85-107	67-98	Existing Stream Type =	
Fair (Mod. Unstable)		44-47	44-47	91-129	95-132	95-142	81-110	46-58	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	86-105	86-105	108-132	108-132	108-132	108-132	99-125	*Potential Stream Type =	
Poor (Unstable)		48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	79+	79+	82+	82+	106+	111+	111+	106+	106+	133+	133+	133+	133+	126+	Modified Channel Stability Rating =	
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	40-63	40-63	40-63	40-63	60-85	60-85	60-85	60-85	60-85	60-85	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107		
Fair (Mod. Unstable)		64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	86-105	86-105	86-105	86-105	86-105	86-105	108-120	108-120	108-120	108-120	108-120	108-120	108-120	108-120	108-120		
Poor (Unstable)		87+	87+	87+	87+	87+	87+	87+	87+	87+	106+	106+	106+	106+	106+	111+	111+	121+	121+	121+	121+	121+	121+	121+	121+		

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

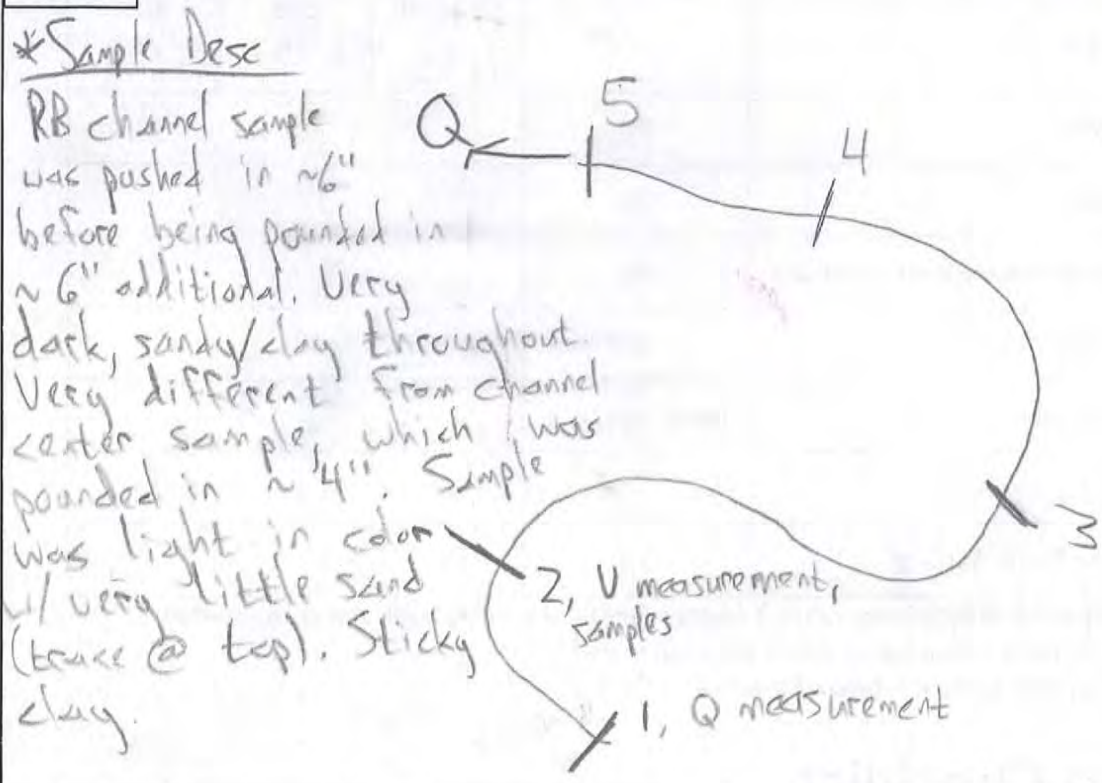
# Geomorphic Analysis Check List

Access @ 54th St  
Crossing (NE corner)

Site Name: Wild Rice River - 4

Date: 10/3/17

**SKETCH**



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 295 Section 1 1321 U/S 1322 D/S	Left 1323 LB	Top of Bank (TB)	✓	292	Bank Full (BF)	✓	291	Water Surface (WS)	✓	290
	Right 1324 RB	Top of Bank (TB)	✓	294	Bank Full (BF)	✓	293			
Pic 305 Section 2 1325 U/S 1326 D/S	Left 1327 LB	Top of Bank (TB)	✓	302	Bank Full (BF)	✓	300	Water Surface (WS)	✓	296
	Right 1328 RB	Top of Bank (TB)	✓	299	Bank Full (BF)	✓	297			
Pic 310 Section 3 1329 U/S 1330 D/S	Left 1331 LB	Top of Bank (TB)	✓	310	Bank Full (BF)	✓	309	Water Surface (WS)	✓	308
	Right 1332 RB	Top of Bank (TB)	✓	306	Bank Full (BF)	✓	307			
Pic 317 Section 4 1333 U/S 1334 D/S	Left 1335 LB	Top of Bank (TB)	✓	314	Bank Full (BF)	✓	313	Water Surface (WS)	✓	312
	Right 1336 RB	Top of Bank (TB)	✓	316	Bank Full (BF)	✓	315			
Pic 323 Section 5 1337 U/S 1338 D/S	Left 1339 LB	Top of Bank (TB)	✓	320	Bank Full (BF)	✓	319	Water Surface (WS)	✓	318
	Right 1340 RB	Top of Bank (TB)	✓	322	Bank Full (BF)	✓	321			



## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.045	0.045
Root Depth	(ft)	2		
Root Density	(%)	2		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	10		
Eroding Bank in Study Reach <sup>1</sup>	(%)	65		
Bank Material Type	(sand, silt, clay)	clay		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	2.3		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	WR/301/LB	301
Right Bank (RB)	✓	WR/298/RB	298
Bed Surface (BED)	—	—	—
Bed Core (BED-C)	✓ ✓	WR/303/BED-L-RD WR/304/BED-C-C	303 304
Bar (BAR)	—	—	—

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

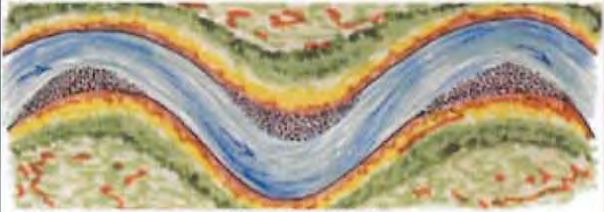




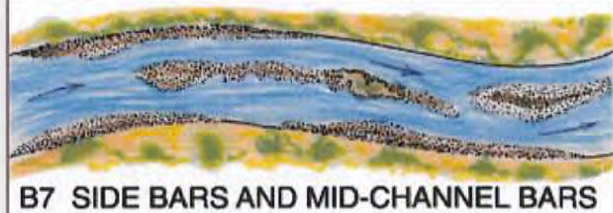


**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation				
Stream: <i>Wild Rice River</i>		Location: <i>WRR-4</i>		
Observers: <i>KDD</i>	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: <i>10/3/11</i>	
Existing species composition:		Potential species composition:		
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	<i>75</i>	<i>trees</i>	<i>100</i>
				<b>100%</b>
2. Understory	Shrub layer	<i>5</i>	<i>shrubs</i>	<i>100</i>
				<b>100%</b>
3. Ground level	Herbaceous	<i>15</i>	<i>weeds, grass</i>	<i>100</i>
	Leaf or needle litter	<i>5</i>	Remarks: Condition, vigor and/or usage of existing reach:	<b>100%</b>
	Bare ground	<i>60</i>		
*Based on crown closure. **Based on basal area to surface area.		<b>Column total 100%</b>		

**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations.

Depositional Patterns	
Stream: <u>Wild Rice River</u>	Reach: <u>WRR-4</u>
Observers: <u>KDD</u>	Date: <u>10/3/11</u>
List ALL CATEGORIES that APPLY	<u>NONE</u>

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

 <p><b>B1 POINT BARS</b></p>	 <p><b>B5 DIAGONAL BARS</b></p>
 <p><b>B2 POINT BARS with Few MID-CHANNEL BARS</b></p>	 <p><b>B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b></p>
 <p><b>B3 NUMEROUS MID-CHANNEL BARS</b></p>	 <p><b>B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b></p>
 <p><b>B4 SIDE BARS</b></p>	 <p><b>B8 DELTA BARS</b></p>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <u>Wild Rice River</u>		Location: <u>WRR-4</u>
Observers: <u>KDD</u>		Date: <u>10/3/11</u>
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 <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input checked="" type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input checked="" type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

Stream: <u>Wild Rice River</u>		Location: <u>ARR-4</u>		Valley Type: <u>ARR-4</u>		Observers: <u>KAD</u>		Date: <u>1/3/11</u>							
Loca-tion	Key Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating						
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8						
	2	Mass erosion	3	No evidence of past or future mass erosion.	6	Frequent or large, causing sediment nearly yearlong potential.	9	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12						
	3	Debris jam potential	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, predominantly larger sizes.	8						
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	12						
Lower Banks	5	Channel capacity	1	Bank heights sufficient to contain the bankfull stage. Width/depth ratio from reference width/depth ratio = 1.0. Bank-Height Ratio (BHR) = 1.0.	2	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.	3	Bankfull stage is not contained. Width/depth ratio departure from reference width/depth ratio > 1.4. Bank-Height Ratio (BHR) > 1.3.	4						
	6	Bank rock content	2	> 65% with large angular boulders. 12" + common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	<20% rock fragments of gravel sizes, 1-3" or less.	8						
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Moderately frequent, unstable protrusions move with high flows causing bank cutting and pool filling.	8						
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcaves and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16						
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16						
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4						
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4						
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8						
Stream Type	DA3	48+	48+	133+	133+	106+	106+	133+	126+						
	DA4	44-47	44-47	96-129	96-129	81-110	81-110	111+	111+						
	DA5	40-43	40-43	64-86	64-86	40-63	40-63	61-78	61-78						
Stream Type	A1	38-43	38-43	54-90	54-90	38-45	38-45	60-85	60-85						
	A2	44-47	44-47	96-132	96-132	81-129	81-129	106-132	106-132						
	A3	40-43	40-43	64-86	64-86	40-63	40-63	61-78	61-78						
Stream Type	B1	50-80	50-80	111+	111+	59+	59+	133+	126+						
	B2	48-58	48-58	96-142	96-142	81-110	81-110	106-132	106-132						
	B3	44-58	44-58	81-129	81-129	61-78	61-78	79+	79+						
Stream Type	C1	60-85	60-85	111+	111+	85-107	85-107	106-132	106-132						
	C2	54-90	54-90	96-132	96-132	81-129	81-129	106-132	106-132						
	C3	40-63	40-63	64-86	64-86	40-63	40-63	61-78	61-78						
Stream Type	D1	87+	87+	133+	133+	106+	106+	133+	126+						
	D2	87+	87+	133+	133+	106+	106+	133+	126+						
	D3	87+	87+	133+	133+	106+	106+	133+	126+						
Excellent Total =		23		Good Total =		8		Fair Total =		0		Poor Total =		44	
Grand Total =		75		Existing Stream Type =		*Potential Stream Type =		Modified Channel Stability Rating =							

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

Access = A12

Access = A21 (NE corner of bridge)

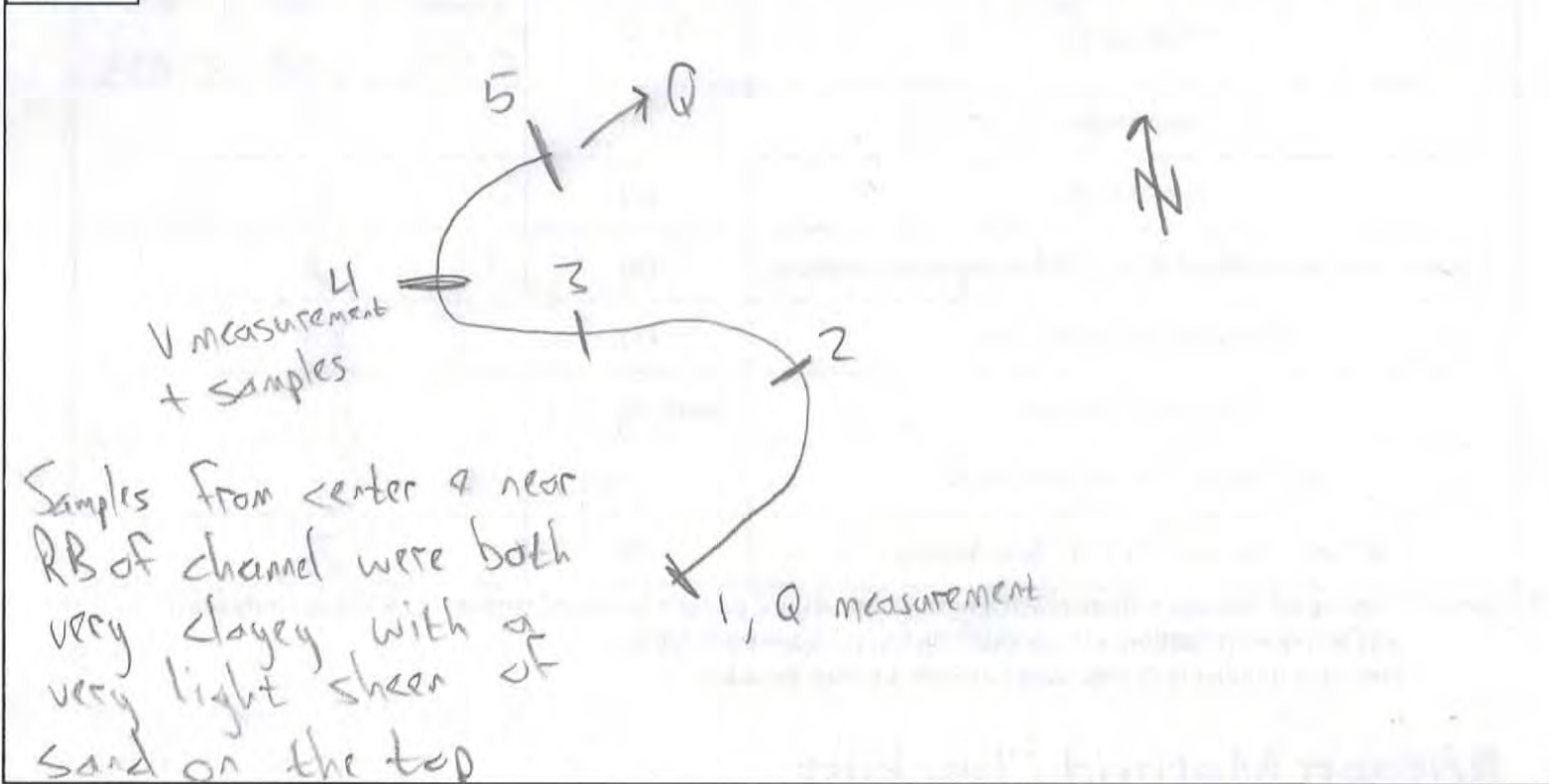
# Geomorphic Analysis Check List

- back trailer behind guards

Site Name: Wild Rice River - 3

- follow recently mowed path to edge of water  
Date: 10/4/11

SKETCH



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 329 Section 1 1345 U/S 1346 D/S	Left 1347 LB	Top of Bank (TB)	✓	326	Bank Full (BF)	✓	325	Water Surface (WS)	✓	324
	Right 1348 RB	Top of Bank (TB)	✓	328	Bank Full (BF)	✓	327			
Pic 335 Section 2 1349 U/S 1350 D/S	Left 1351 LB	Top of Bank (TB)	✓	332	Bank Full (BF)	✓	331	Water Surface (WS)	✓	330
	Right 1352 RB	Top of Bank (TB)	✓	334	Bank Full (BF)	✓	333			
Pic 341 Section 3 1353 U/S 1354 D/S	Left 1355 LB	Top of Bank (TB)	✓	340	Bank Full (BF)	✓	339	Water Surface (WS)	✓	338
	Right 1356 RB	Top of Bank (TB)	✓	336	Bank Full (BF)	✓	337			
Pic 351 Section 4 1357 U/S 1358 D/S	Left 1359 LB	Top of Bank (TB)	✓	348	Bank Full (BF)	✓	346	Water Surface (WS)	✓	342
	Right 1360 RB	Top of Bank (TB)	✓	345	Bank Full (BF)	✓	343			
Pic 357 Section 5 1361 U/S 1362 D/S	Left 1363 LB	Top of Bank (TB)	✓	356	Bank Full (BF)	✓	355	Water Surface (WS)	✓	352
	Right 1364 RB	Top of Bank (TB)	✓	354	Bank Full (BF)	✓	353			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.045	0.045
Root Depth	(ft)	2		
Root Density	(%)	1		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	2		
Eroding Bank in Study Reach <sup>1</sup>	(%)	80		
Bank Material Type	(sand, silt, clay)	clay		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	2.0		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	WR/347/LB	347
Right Bank (RB)	✓	WR/344/RB	344
Bed Surface (BED)	—	—	—
Bed Core (BED-C)	✓	WR/349/BED-C-C	349
	✓	WR/350/BED-C-RB	350
Bar (BAR)	—	—	—

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation					
Stream: <i>Wild Rice River</i>		Location: <i>WRR-3</i>			
Observers: <i>KDD</i>	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: <i>10/4/11</i>		
Existing species composition:		Potential species composition:			
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition	
1. Overstory	Canopy layer	<i>60</i>	<i>10</i>	<i>trees</i>	<i>100</i>
					<b>100%</b>
2. Understory	Shrub layer		<i>25</i>	<i>shrubs</i>	<i>100</i>
					<b>100%</b>
3. Ground level	Herbaceous		<i>5</i>	<i>grass, weeds</i>	<i>100</i>
	Leaf or needle litter		<i>5</i>	<b>Remarks:</b> Condition, vigor and/or usage of existing reach:	<b>100%</b>
	Bare ground		<i>55</i>		
*Based on crown closure. **Based on basal area to surface area.		<b>Column total 100%</b>			



**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations.

**Depositional Patterns**

Stream: *Wild Rice River*

Reach: *WRR-3*

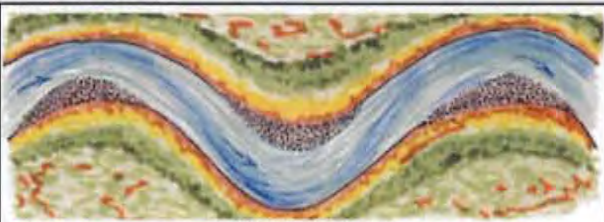







Observers: *KDD*

Date: *10/4/11*

List ALL CATEGORIES that APPLY ↗

<i>NONE</i>			
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*Various Depositional Features modified from Galay et al. (1973)*

 <p><b>B1 POINT BARS</b></p>	 <p><b>B5 DIAGONAL BARS</b></p>
 <p><b>B2 POINT BARS with Few MID-CHANNEL BARS</b></p>	 <p><b>B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b></p>
 <p><b>B3 NUMEROUS MID-CHANNEL BARS</b></p>	 <p><b>B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b></p>
 <p><b>B4 SIDE BARS</b></p>	 <p><b>B8 DELTA BARS</b></p>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Wild Rice River</i>		Location: <i>WRR-3</i>
Observers: <i>KDD</i>		Date: <i>10/4/11</i>
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 <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input checked="" type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input checked="" type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input checked="" type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

Stream: <u>Wild Rice River</u>		Location: <u>RR-4</u>		Valley Type: <u>KVD</u>		Observers: <u>KVD</u>		Date: <u>10/4/11</u>																		
Key	Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating																	
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8																	
	2	Mass erosion	3	No evidence of past or future mass erosion.	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	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, predominantly larger sizes.	8																	
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	12																	
Lower Banks	5	Channel capacity	1	Bank heights sufficient to contain the bankfull stage. Width/depth ratio from reference width/depth ratio = 1.0. Bank-Height Ratio (BHR) = 1.0.	2	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.	3	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.	4																	
	6	Bank rock content	2	> 65% with large angular boulders. 12" + common.	4	40-65%. Mostly boulders and small cobbles 5-12".	6	20-40%. Most in the 3-6" diameter class.	8																	
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	8																	
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcaves and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16																	
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16																	
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4																	
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4																	
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8																	
Stream Type	A1	38-43	A2	38-43	B2	38-45	B3	40-60	C2	38-50	C3	60-85	C4	70-90	C5	60-85	C6	85-107	D3	85-107	D4	85-107	D5	85-107	D6	85-107
	DA3	44-47	DA4	44-47	DA5	46-58	DA6	46-58	E5	58-59	E6	58-59	F1	61-78	F2	61-78	F3	61-78	F4	61-78	F5	61-78	F6	61-78	G6	61-78
	DA3	48+	DA4	48+	DA5	59+	DA6	59+	E5	59+	E6	59+	F1	79+	F2	79+	F3	79+	F4	79+	F5	79+	F6	79+	G6	79+
Good (Stable)	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63
Fair (Mod. Unstable)	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86
Poor (Unstable)	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+
Excellent Total =		23		Good Total =		0		Fair Total =		17		Poor Total =		14		Grand Total =		74		Existing Stream Type =		*Potential Stream Type =		Modified Channel Stability Rating =		

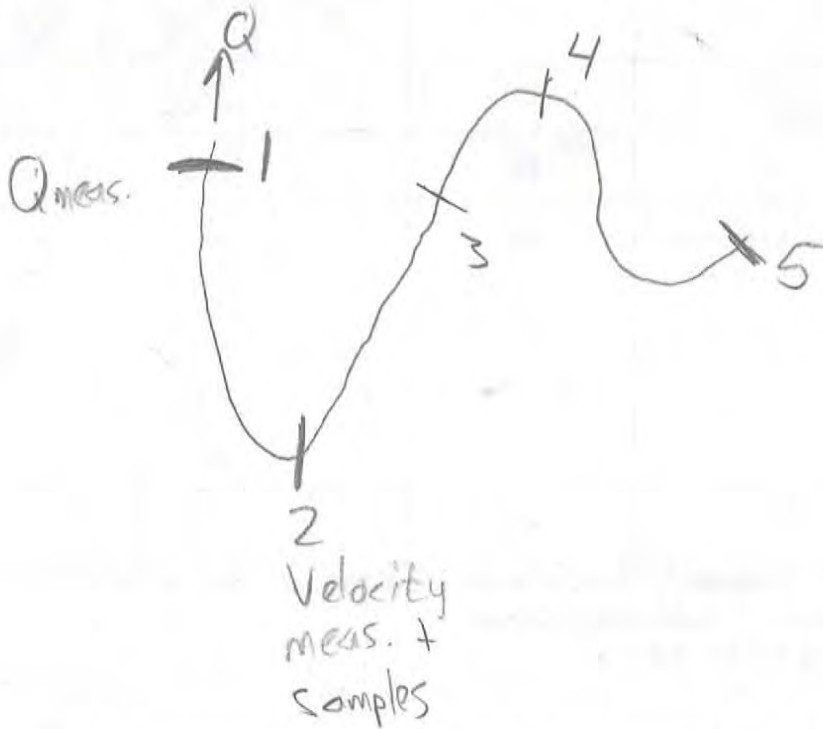
\*Rating is adjusted to potential stream type, not existing.

# Geomorphic Analysis Check List

Site Name: Red River - 3

Date: 10/4/11

**SKETCH**



Sample from channel center was hard-packed clay as was bed near RB. RB sample was darker in color than central channel bed sed. sample. Light layer of sand on both samples.

## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 363 Section 1 1365 U/S 1366 D/S	Left 1367 LB	Top of Bank (TB)	✓	360	Bank Full (BF)	✓	359	Water Surface (WS)	✓	358
	Right 1368 RB	Top of Bank (TB)	✓	362	Bank Full (BF)	✓	361			
Pic 369 Section 2 1369 U/S 1370 D/S	Left 1371 LB	Top of Bank (TB)	✓	365	Bank Full (BF)	✓	364	Water Surface (WS)	✓	366
	Right 1372 RB	Top of Bank (TB)	✓	367	Bank Full (BF)	✓	368			
Pic 377 Section 3 1374 U/S 1375 D/S	Left 1376 LB	Top of Bank (TB)	✓	376	Bank Full (BF)	✓	375	Water Surface (WS)	✓	374
	Right 1377 RB	Top of Bank (TB)	✓	373	Bank Full (BF)	✓	372			
Pic 383 Section 4 1378 U/S 1379 D/S	Left 1380 LB	Top of Bank (TB)	✓	378	Bank Full (BF)	✓	379	Water Surface (WS)	✓	380
	Right 1381 RB	Top of Bank (TB)	✓	382	Bank Full (BF)	✓	381			
Pic 389 Section 5 1382 U/S 1383 D/S	Left 1384 LB	Top of Bank (TB)	✓	384	Bank Full (BF)	✓	385	Water Surface (WS)	✓	386
	Right 1385 RB	Top of Bank (TB)	✓	388	Bank Full (BF)	✓	387			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	X	X	X
Root Depth	(ft)		X	
Root Density	(%)		X	
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)		3	
Eroding Bank in Study Reach <sup>1</sup>	(%)		05	
Bank Material Type	(sand, silt, clay)		X	
Bank Material Stratification Score <sup>2</sup>	-		X	
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)		X	

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach  
<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	J	Riparian Vegetation Worksheet	X
Depositional Features Worksheet	X	Pfankuch Method	X
Channel Blockages Worksheet	X		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	X	X	X
Right Bank (RB)	X	X	X
Bed Surface (BED)	X	X	X
Bed Core (BED-C)	✓	RR/370/BED-L	370
	✓	RR/371/BED-L-RB	371
Bar (BAR)	X	X	X

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

Shey + Access = A14  
 Shey S Access = A16

Access = A0

## Geomorphic Analysis Check List

Site Name: Red River - 8

Date: 10/5/11

**SKETCH**

Bed sample from channel center had thin layer of gravelly sand at the top. Was underlain by clay (dark in color). Bed sample from near RB, however, was all sand, mirroring the material found in the RB. The sampler was pushed in ~18" before removal.

## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 395 Section 1 1392 U/S 1393 D/S	Left 1394 LB	Top of Bank (TB)	✓	390	Bank Full (BF)	✓	391	Water Surface (WS)	✓	392
	Right 1395 RB	Top of Bank (TB)	✓	394	Bank Full (BF)	✓	393			
Pic 403 Section 2 1396 U/S 1397 D/S	Left 1398 LB	Top of Bank (TB)	✓	398	Bank Full (BF)	✓	397	Water Surface (WS)	✓	396
	Right 1399 RB	Top of Bank (TB)	✓	402	Bank Full (BF)	✓	401			
Pic 409 Section 3 1402 U/S 1403 D/S	Left 1404 LB	Top of Bank (TB)	-	-	Bank Full (BF)	-	-	Water Surface (WS)	✓	406
	Right 1405 RB	Top of Bank (TB)	✓	408	Bank Full (BF)	✓	407			
Pic 415 Section 4 1406 U/S 1407 D/S	Left 1408 LB	Top of Bank (TB)	✓	412	Bank Full (BF)	✓	411	Water Surface (WS)	✓	410
	Right 1409 RB	Top of Bank (TB)	✓	414	Bank Full (BF)	✓	413			
Pic 419 Section 5 1410 U/S 1411 D/S	Left 1412 LB	Top of Bank (TB)	-	-	Bank Full (BF)	-	-	Water Surface (WS)	✓	418
	Right 1413 RB	Top of Bank (TB)	✓	417	Bank Full (BF)	✓	416			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.05	0.05
Root Depth	(ft)	2		
Root Density	(%)	3		
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)	5		
Eroding Bank in Study Reach <sup>1</sup>	(%)	80		
Bank Material Type	(sand, silt, clay)	clay		
Bank Material Stratification Score <sup>2</sup>	-	0		
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)	5.5		

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	✓
Depositional Features Worksheet	✓	Pfankuch Method	✓
Channel Blockages Worksheet	✓		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	RR/399/LB	399
Right Bank (RB)	✓	RR/400/RB	400
Bed Surface (BED)	—	—	—
Bed Core (BED-C)	✓	RR/404/BED-C-C	404
	✓	RR/405/BED-C-RB	405
Bar (BAR)	—	—	—

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

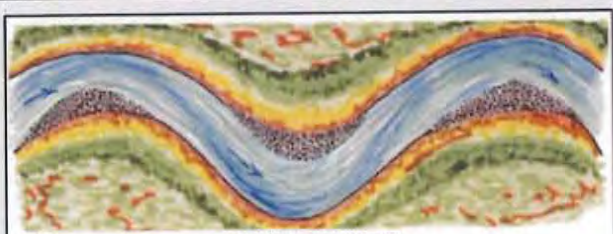




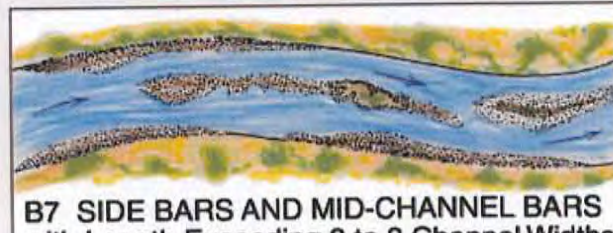

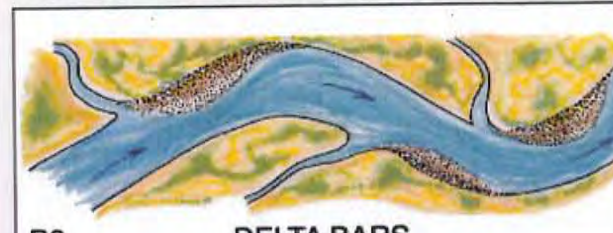
Riparian Vegetation				
Stream: Red River		Location: RR-8		
Observers: KDD	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: 10/5/11	
Existing species composition:		Potential species composition:		
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	60	trees	100
				100%
2. Understory	Shrub layer	35	shrubs	100
				100%
3. Ground level	Herbaceous	15	grass, weeds	100
	Leaf or needle litter	5	Remarks: Condition, vigor and/or usage of existing reach:	100%
	Bare ground	35		
*Based on crown closure. **Based on basal area to surface area.		Column total	100%	



**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations.

Depositional Patterns	
Stream: <u>Red River</u>	Reach: <u>RR-8</u>
Observers: <u>KDJ</u>	Date: <u>10/5/11</u>
List ALL CATEGORIES that APPLY	<div style="border: 1px solid black; display: inline-block; padding: 2px 10px; margin-right: 5px;">NONE</div> <div style="border: 1px solid black; width: 30px; height: 20px; display: inline-block; margin-right: 5px;"></div> <div style="border: 1px solid black; width: 30px; height: 20px; display: inline-block; margin-right: 5px;"></div> <div style="border: 1px solid black; width: 30px; height: 20px; display: inline-block; margin-right: 5px;"></div> <div style="border: 1px solid black; width: 30px; height: 20px; display: inline-block; margin-right: 5px;"></div>

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

 <p><b>B1</b>      <b>POINT BARS</b></p>	 <p><b>B5</b>      <b>DIAGONAL BARS</b></p>
 <p><b>B2</b>    <b>POINT BARS with Few MID-CHANNEL BARS</b></p>	 <p><b>B6</b>    <b>Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b></p>
 <p><b>B3</b>    <b>NUMEROUS MID-CHANNEL BARS</b></p>	 <p><b>B7</b>    <b>SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b></p>
 <p><b>B4</b>      <b>SIDE BARS</b></p>	 <p><b>B8</b>      <b>DELTA BARS</b></p>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Red River</i>		Location: <i>RR-8</i>
Observers: <i>KDD</i>		Date: <i>10/5/11</i>
<b>Description/ Extent</b>	<b>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</b>	<b>Check <input checked="" type="checkbox"/> all that apply</b>
<b>D1</b> None	Minor amounts of small, floatable material.	<input checked="" type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input checked="" type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

Stream: <u>Dad River</u>		Location: <u>R-R-8</u>		Valley Type: <u>KND</u>		Observers: <u>KND</u>		Date: <u>10/5/11</u>																
Loca- tion	Key Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating															
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8															
	2	Mass erosion	3	No evidence of past or future mass erosion.	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	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, predominantly larger sizes.	8															
	4	Vegetative bank protection	3	>90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	12															
Lower Banks	5	Channel capacity	1	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.	2	Bankfull stage is contained within banks. 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; overbank 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	2	> 65% with large angular boulders. 12'+ common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	20-40%. Most in the 3-6" diameter class.	8															
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	8															
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcrops and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16															
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16															
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough. <u>clay</u>	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4															
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright. <u>clay</u>	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4															
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8															
	13	Bottom size distribution	4	No size change evident. Stable material 80-100%.	8	Distribution shift light. Stable material 50-80%.	12	Moderate change in sizes. Stable materials 20-50%.	16															
	14	Scouring and deposition	6	<5% of bottom affected by scour or deposition.	12	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	18	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	24															
	15	Aquatic vegetation	1	Abundant growth moss-like, dark green perennial. In swift water too.	2	Common. Algae forms in low velocity and pool areas. Moss here too.	3	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	4															
Excellent Total =		23		Good Total =		12		Fair Total =		12		Poor Total =		44										
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	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47
Fair (Mod. Unstable)	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47	44-47
Poor (Unstable)	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+	48+
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	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63	40-63
Fair (Mod. Unstable)	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86	64-86
Poor (Unstable)	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+
Grand Total =		79		Existing Stream Type =		*Potential Stream Type =		Modified Channel Stability Rating =																

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

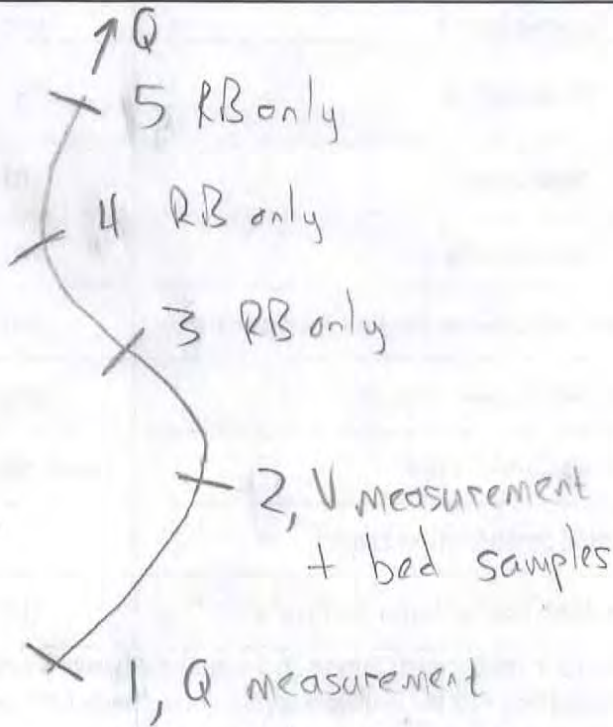
## Geomorphic Analysis Check List

Site Name: Red River-S

Date: 10/6/11

**SKETCH**

Sample from channel thalweg was medium colored clay w/ very little sand on top.  
 Sample from near LB on the 'shelf' was primarily sand. Top portion was a lighter colored sand and bottom portion was a darker sand/clay mix.



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 445 Section 1 1439 U/S 1440 D/S	Left 1441 LB	Top of Bank (TB)	✓	442	Bank Full (BF)	✓	441	Water Surface (WS)	✓	440
	Right 1442 RB	Top of Bank (TB)	✓	444	Bank Full (BF)	✓	443			
Pic 439 Section 2 1435 U/S 1436 D/S	Left 1437 LB	Top of Bank (TB)	✓	436	Bank Full (BF)	✓	435	Water Surface (WS)	✓	434
	Right 1438 RB	Top of Bank (TB)	✓	438	Bank Full (BF)	✓	437			
Pic 449 Section 3 1443 U/S 1444 D/S	Left 1445 LB	Top of Bank (TB)	-	-	Bank Full (BF)	-	-	Water Surface (WS)	✓	446
	Right 1446 RB	Top of Bank (TB)	✓	448	Bank Full (BF)	✓	447			
Pic 453 Section 4 1447 U/S 1448 D/S	Left 1449 LB	Top of Bank (TB)	-	-	Bank Full (BF)	-	-	Water Surface (WS)	✓	450
	Right 1450 RB	Top of Bank (TB)	✓	452	Bank Full (BF)	✓	451			
Pic 457 Section 5 1451 U/S 1452 D/S	Left 1453 LB	Top of Bank (TB)	-	-	Bank Full (BF)	-	-	Water Surface (WS)	✓	451
	Right 1454 RB	Top of Bank (TB)	✓	456	Bank Full (BF)	✓	455			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-	0.035	0.05	0.05
Root Depth	(ft)		X	
Root Density	(%)		X	
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)		3	
Eroding Bank in Study Reach <sup>1</sup>	(%)		75	
Bank Material Type	(sand, silt, clay)		X	
Bank Material Stratification Score <sup>2</sup>	-		X	
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)		X	

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	✓	Riparian Vegetation Worksheet	X
Depositional Features Worksheet	X	Pfankuch Method	X
Channel Blockages Worksheet	X		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	X	X	X
Right Bank (RB)	X	X	X
Bed Surface (BED)	X	X	X
Bed Core (BED-C)	✓	RR/432/BED-C-C	432
	✓	RR/433/BED-C-L	433
Bar (BAR)	X	X	X

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

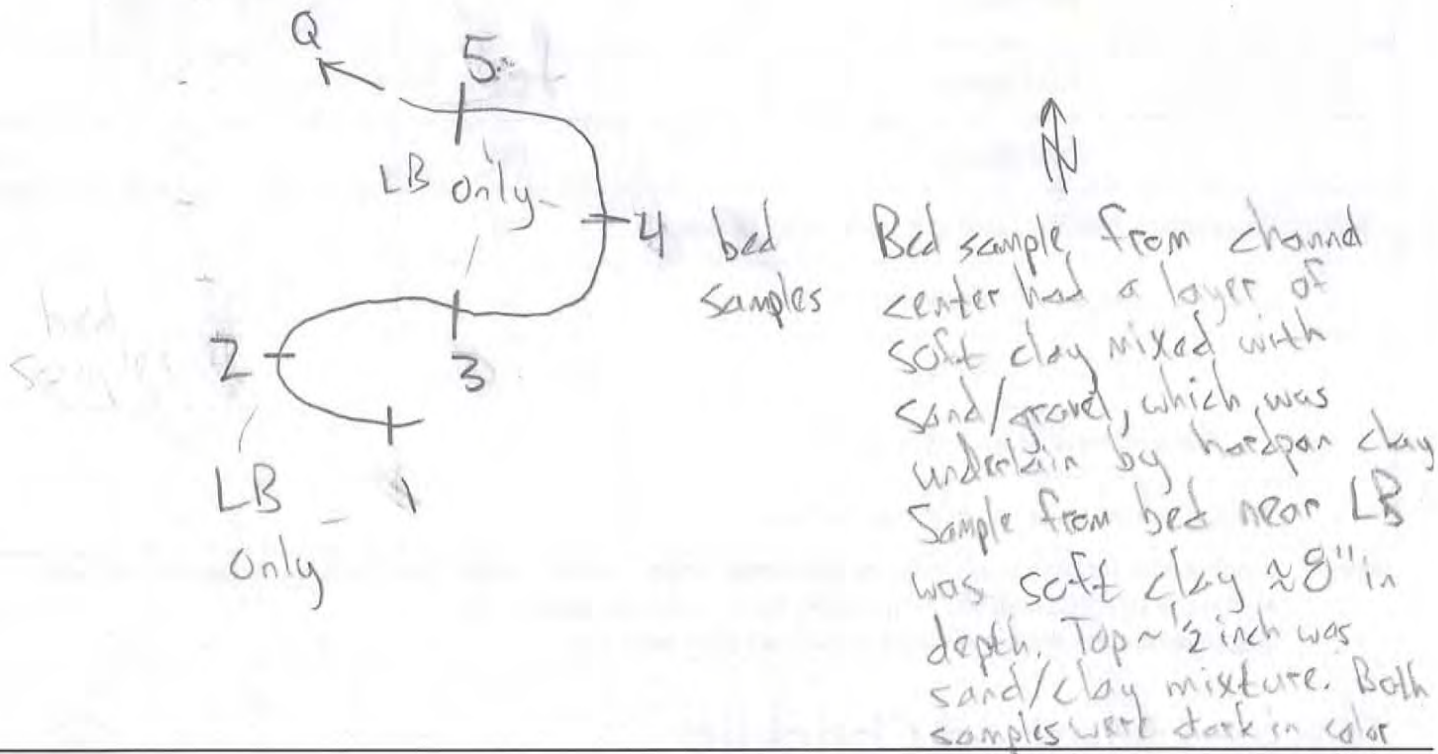
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

# Geomorphic Analysis Check List

Site Name: Red River - 6

Date: 10/6/11

SKETCH



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Pic 421 Section 1 1414 U/S 1415 D/S	Left 1412 LB	Top of Bank (TB)	X	X	Bank Full (BF)	✓	420	Water Surface (WS)	X	X
	Right 1417 RB	Top of Bank (TB)			Bank Full (BF)	—	—			
Pic 423 Section 2 1418 U/S 1419 D/S	Left 1420 LB	Top of Bank (TB)			Bank Full (BF)	✓	422	Water Surface (WS)		
	Right 1421 RB	Top of Bank (TB)			Bank Full (BF)	—	—			
Pic 425 Section 3 1422 U/S 1423 D/S	Left 1424 LB	Top of Bank (TB)			Bank Full (BF)	✓	424	Water Surface (WS)		
	Right 1425 RB	Top of Bank (TB)			Bank Full (BF)	—	—			
Pic 428 Section 4 1427 U/S 1428 D/S	Left 1429 LB	Top of Bank (TB)			Bank Full (BF)	✓	426	Water Surface (WS)		
	Right 1430 RB	Top of Bank (TB)			Bank Full (BF)	—	—			
Pic 431 Section 5 1431 U/S 1432 D/S	Left 1431 LB	Top of Bank (TB)			Bank Full (BF)	✓	430	Water Surface (WS)		
	Right 1432 RB	Top of Bank (TB)			Bank Full (BF)	—	—			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value		
		Channel	LOB	ROB
Manning's n	-			
Root Depth	(ft)		X	
Root Density	(%)		X	
Surface Cover below Bankfull Level at Eroding Bank Locations	(%)		2	
Eroding Bank in Study Reach <sup>1</sup>	(%)		80	2
Bank Material Type	(sand, silt, clay)		X	
Bank Material Stratification Score <sup>2</sup>	-		X	
Distance from Bank Toe to Water Surface <sup>3</sup>	(ft)		X	

Notes: <sup>1</sup>Eroding percentage x study reach length (from GIS) x 2 banks = length of eroding bank line in study reach

<sup>2</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>3</sup>Negative number indicates water surface is below bank toe

### Rosgen Method Checklist

Item	Completed	Item	Completed
Velocity Measurements	X	Riparian Vegetation Worksheet	X
Depositional Features Worksheet	X	Pfankuch Method	X
Channel Blockages Worksheet	X		

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	X	X	X
Right Bank (RB)	X	X	X
Bed Surface (BED)	X	X	X
Bed Core (BED-C)	✓	RR/427/BED-C-C	427
	✓	RR/429/BED-C-LB	429
Bar (BAR)	X	X	X

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

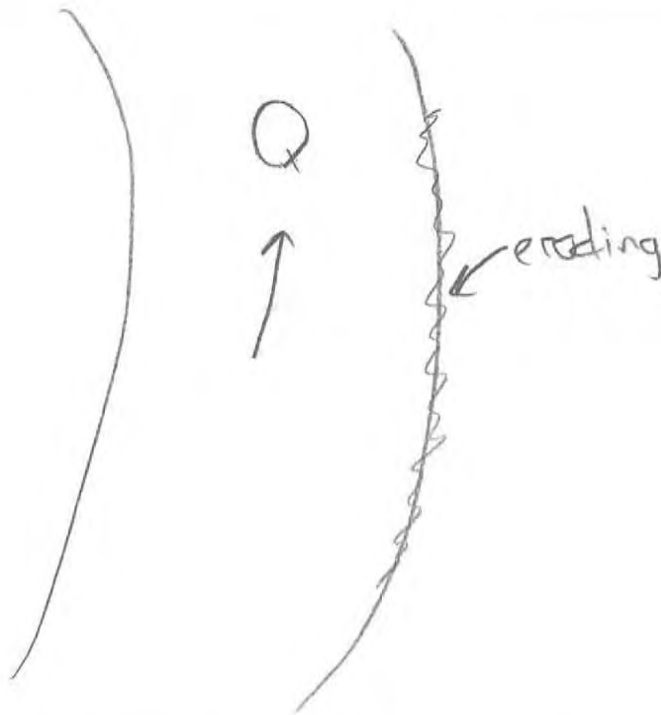
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

Pic 1426

# Geomorphic Analysis Check List

Site Name: Red River near Linderwood Dr.

SKETCH



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	128	Bank Full (BF)	✓	127	Water Surface (WS)	✓	126
	Right	Top of Bank (TB)	✓	124	Bank Full (BF)	✓	125			
Section 2	Left	Top of Bank (TB)	✓	119	Bank Full (BF)	✓	120	Water Surface (WS)	✓	121
	Right	Top of Bank (TB)	✓	123	Bank Full (BF)	✓	122			
Section 3	Left	Top of Bank (TB)	✓	114	Bank Full (BF)	✓	115	Water Surface (WS)	✓	113
	Right	Top of Bank (TB)	✓	111	Bank Full (BF)	✓	112			
Section 4	Left	Top of Bank (TB)	✓	107	Bank Full (BF)	✓	106	Water Surface (WS)	✓	108
	Right	Top of Bank (TB)	✓	110	Bank Full (BF)	✓	109			
Section 5	Left	Top of Bank (TB)	✓	105	Bank Full (BF)	✓	104	Water Surface (WS)	✓	103
	Right	Top of Bank (TB)	✓	101	Bank Full (BF)	✓	102			



## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.03
Root Depth	(ft)	1'
Root Density	(%)	15
Eroding Bank Surface Cover	(%)	10
Eroding Bank Length	(ft)	260
Bank Material Type	(sand, silt, clay)	clay
Bank Material Stratification Score <sup>1</sup>	-	0
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	0.98

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	✓
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	RR/117/LB	117
Right Bank (RB)	✓	RR/116/RB	116
Bed (BED)	✓	RR/118/BED	118
Bar – Armor (B-A)	-	-	-
Bar - Sub Armor (B-SA)	-	-	-

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC


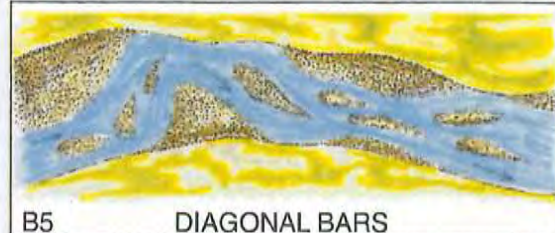

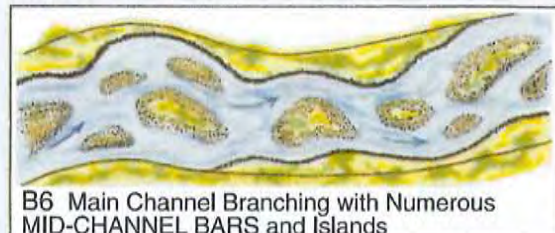

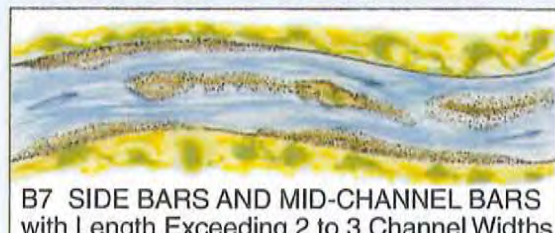

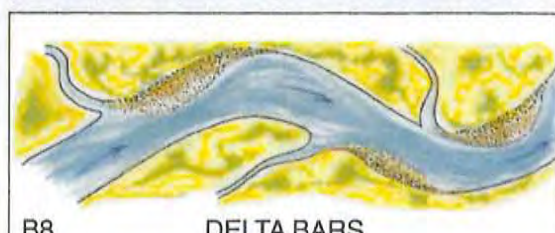
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation				
Stream: Red River		Location: @ Fargo		
Observers: KDD	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: 11/16/10	
Existing species composition:		Potential species composition:		
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	20% w/o leaves 80% w/ leaves	trees	100
				100%
2. Understory	Shrub layer	75	berries	80
				100%
3. Ground level	Herbaceous	10	grass	100
	Leaf or needle litter	10	Remarks: Condition, vigor and/or usage of existing reach:	100%
	Bare ground	80		
		Column total	100%	

\*Based on crown closure.  
\*\*Based on basal area to surface area.

Worksheet 3-5. Depositional patterns used for stability assessment interpretations (modified from Galay et al., 1973; Rosgen, 1996, 2006b).

<b>Depositional Patterns</b>	
Stream: <u>Red River</u>	Reach: <u>@ Fargo</u>
Observers: <u>KDD</u>	Date: <u>11/16/10</u>
List ALL CATEGORIES that APPLY <input type="checkbox"/>	<u>NONE</u>
<b>Various Depositional Features Modified from Galay et al. (1973)</b>	
 <b>B1 POINT BARS</b>	 <b>B5 DIAGONAL BARS</b>
 <b>B2 POINT BARS with Few MID-CHANNEL BARS</b>	 <b>B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b>
 <b>B3 NUMEROUS MID-CHANNEL BARS</b>	 <b>B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b>
 <b>B4 SIDE BARS</b>	 <b>B8 DELTA BARS</b>

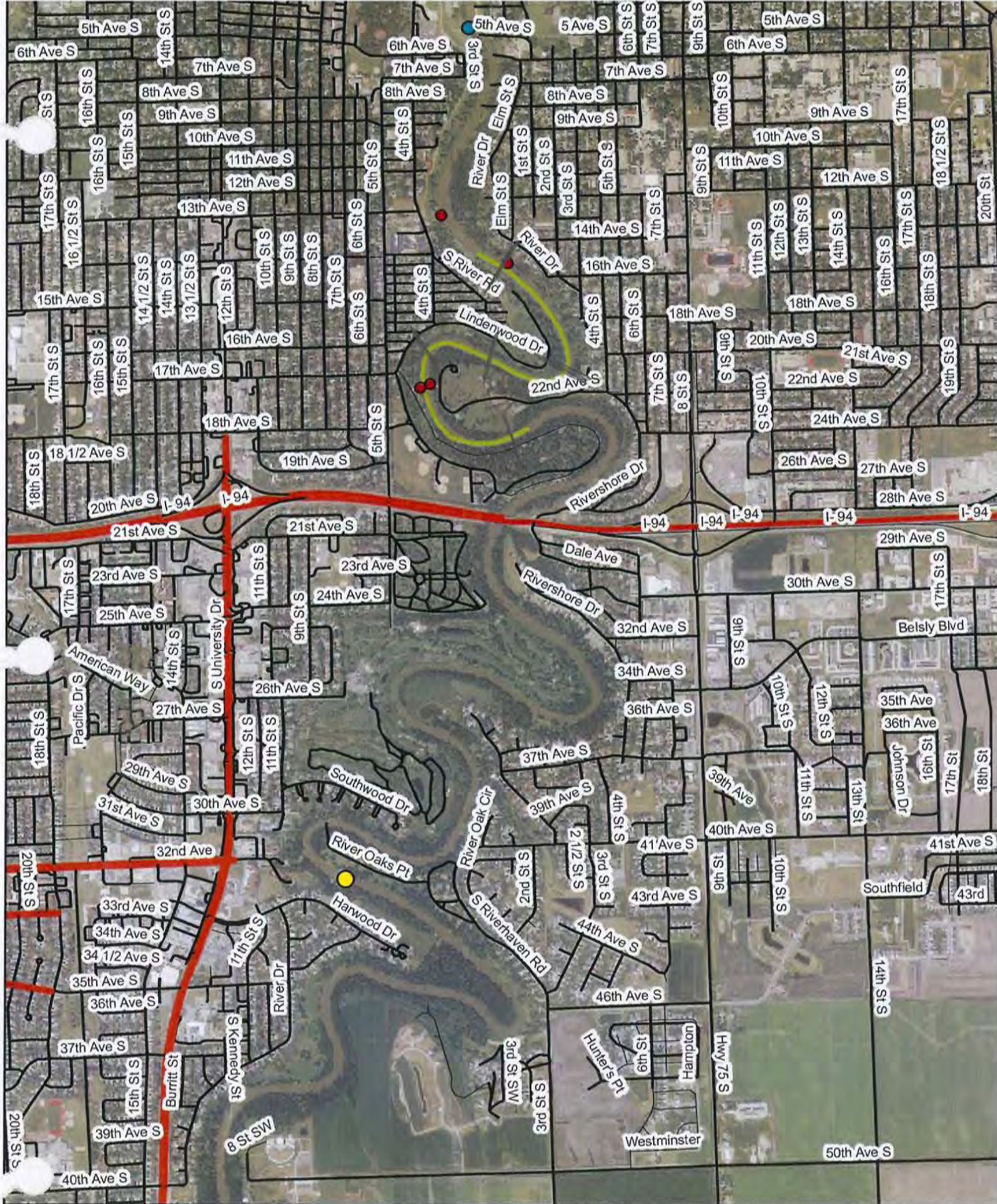
**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Red River</i>		Location: <i>@ Fargo</i>
Observers: <i>KDD</i>		Date: <i>11/16/10</i>
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 <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

Stream:		Location:			Valley Type:			Observers:			Date:		
Loca-tion	Key Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating				
Upper Banks	1	Landform slope	2	Bank slope gradient <30%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8				
	2	Mass erosion	3	No evidence of past or future mass erosion.	6	Infrequent. Mostly healed over. Low future potential.	9	Frequent or large, causing sediment nearly yearlong.	12				
	3	Debris jam potential	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, mostly larger sizes.	8				
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	12				
Lower Banks	5	Channel capacity	1	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.	2	Bankfull stage is contained within banks. 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; overbank 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	2	> 65% with large angular boulders. 12" + common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	20-40%. Most in the 3-6" diameter class.	8				
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	8				
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcoves and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16				
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16				
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4				
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4				
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8				
Stream Type	13	Bottom size distribution	4	No size change evident. Stable material 80-100%.	8	Distribution shift light. Stable material 50-80%.	12	Moderate change in sizes. Stable materials 20-50%.	16				
	14	Scouring and deposition	6	<5% of bottom affected by scour or deposition.	12	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	18	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	24				
	15	Aquatic vegetation	1	Abundant growth moss-like, dark green perennial. In swift water too.	2	Common. Algae forms in low velocity and pool areas. Moss here too.	3	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	4				
			Excellent Total = 10			Good Total = 20			Fair Total = 36			Poor Total = 24	
		Grand Total = 90			Existing Stream Type =			*Potential Stream Type =			Modified Channel Stability Rating =		

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

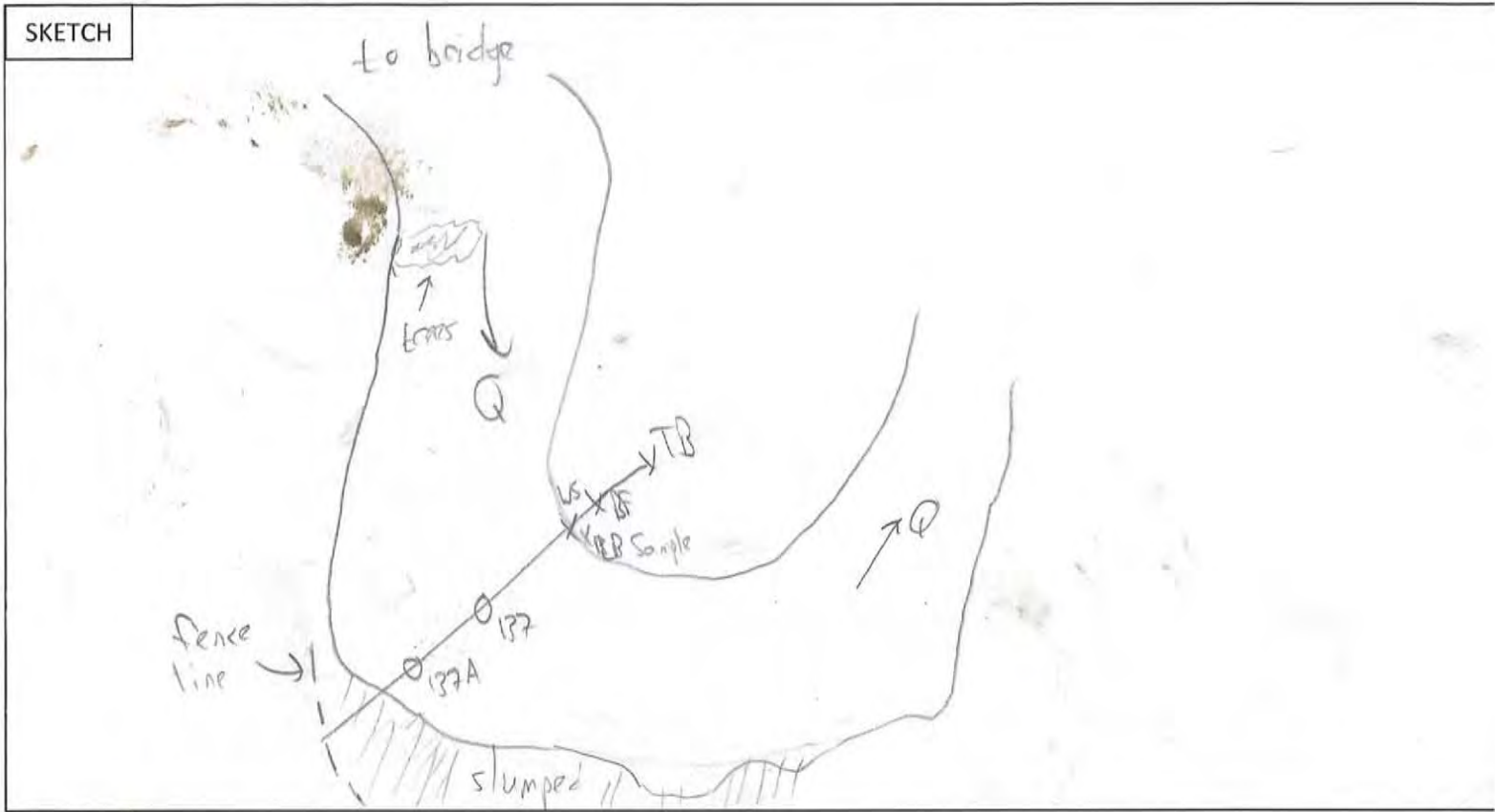


0 1,000 2,000 4,000 Feet

Red River of the North  
Detailed Study Reach No. 4

# Geomorphic Analysis Check List

Site Name: Shoeyonne River @ 40<sup>th</sup> Ave Bridge



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	148	Bank Full (BF)	✓	149	Water Surface (WS)	✓	150
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			
Section 2	Left	Top of Bank (TB)	✓	143	Bank Full (BF)	✓	144	Water Surface (WS)	✓	145
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			
Section 3	Left	Top of Bank (TB)	✓	138	Bank Full (BF)	✓	139	Water Surface (WS)	✓	141
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			
Section 4	Left	Top of Bank (TB)	✓	138	Bank Full (BF)	✓	134	Water Surface (WS)	✓	135
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			
Section 5	Left	Top of Bank (TB)	✓	129	Bank Full (BF)	✓	130	Water Surface (WS)	✓	B1
	Right	Top of Bank (TB)	-	-	Bank Full (BF)	-	-			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.03
Root Depth	(ft)	2'
Root Density	(%)	5
Eroding Bank Surface Cover	(%)	0 below BF 90 above BF
Eroding Bank Length	(ft)	250'
Bank Material Type	(sand, silt, clay)	clay
Bank Material Stratification Score <sup>1</sup>	-	-
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	2.3'

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	✓
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	S/140/LB	140
Right Bank (RB)	-	-	-
Bed (BED)	✓	S/137/BED	137
Bar - Armor (B-A)	-	-	-
Bar - Sub Armor (B-SA)	-	-	-

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC




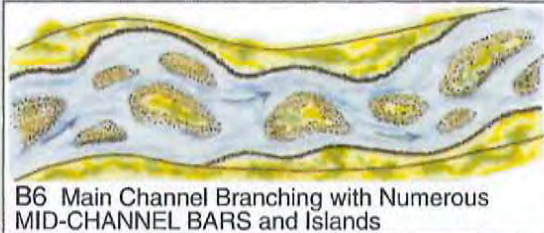



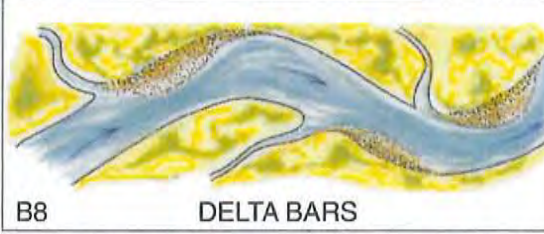
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation



**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation				
Stream: <i>Shoeyenne</i>		Location: <i>40<sup>th</sup> Ave Bridge</i>		
Observers: <i>KDD</i>	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: <i>11/17/10</i>	
Existing species composition:		Potential species composition:		
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	<i>15 w/o leaves</i>	<i>tree (oak)</i>	<i>100</i>
		<i>65 w/ leaves</i>		
				<b>100%</b>
2. Understory	Shrub layer	<i>none</i>		
				<b>100%</b>
3. Ground level	Herbaceous	<i>90</i>	<i>fall grass</i>	<i>100</i>
	Leaf or needle litter		<b>Remarks:</b> Condition, vigor and/or usage of existing reach:	
	Bare ground	<i>10</i>		
*Based on crown closure. **Based on basal area to surface area.		<b>Column total</b>	<b>100%</b>	

Worksheet 3-5. Depositional patterns used for stability assessment interpretations (modified from Galay et al., 1973; Rosgen, 1996, 2006b).

<b>Depositional Patterns</b>	
Stream: <u>Shayenne River</u>	Reach: <u>40th Ave Bridge</u>
Observers: <u>KDJ</u>	Date: _____
List ALL CATEGORIES that APPLY <input checked="" type="checkbox"/> <u>B1</u> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
<i>Various Depositional Features Modified from Galay et al. (1973)</i>	
 <p><b>B1</b> POINT BARS</p>	 <p><b>B5</b> DIAGONAL BARS</p>
 <p><b>B2</b> POINT BARS with Few MID-CHANNEL BARS</p>	 <p><b>B6</b> Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</p>
 <p><b>B3</b> NUMEROUS MID-CHANNEL BARS</p>	 <p><b>B7</b> SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</p>
 <p><b>B4</b> SIDE BARS</p>	 <p><b>B8</b> DELTA BARS</p>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Shoeyzane</i>		Location: <i>@ 40<sup>th</sup> Ave Bridge</i>
Observers: <i>KDD</i>		Date: <i>11/17/10</i>
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 <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input type="checkbox"/>
<b>D3</b> 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-section area.	<input checked="" type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Shyenne River @ 40th Ave Bridge

Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

Stream:		Location:			Valley Type:			Observers:			Date:			
Loca-tion	Key Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating					
Upper Banks	1	Landform slope	2	Bank slope gradient <30%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8					
	2	Mass erosion	3	No evidence of past or future mass erosion.	6	Infrequent. Mostly healed over. Low future potential.	9	Frequent or large, causing sediment nearly yearlong.	12					
	3	Debris jam potential	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, mostly predominantly larger sizes.	8					
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	12					
Lower Banks	5	Channel capacity	1	Bank heights sufficient to contain the bankfull stage. 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 contained within banks. 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. Width/depth ratio departure from reference width/depth ratio >1.4. Bank-Height Ratio (BHR) >1.3.	4					
	6	Bank rock content	2	> 65% with large angular boulders. 12" + common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	20-40%. Most in the 3-6" diameter class.	8					
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	8					
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcaves and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16					
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16					
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4					
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4					
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8					
Grand Total =	13	Bottom size distribution	4	No size change evident. Stable material 80-100%.	8	Distribution shift light. Stable material 50-80%.	12	Moderate change in sizes. Stable materials 20-50%.	16					
	14	Scouring and deposition	6	<5% of bottom affected by scour or deposition.	12	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	18	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	24					
	15	Aquatic vegetation	1	Abundant growth moss-like, dark green perennial. In swift water too.	2	Common. Algae forms in low velocity and pool areas. Moss here too.	3	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	4					
	Excellent Total = 72									Fair Total = 6			Poor Total = 19	
Grand Total = 97														
Existing Stream Type =														
*Potential Stream Type =														
Modified Channel Stability Rating =														

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

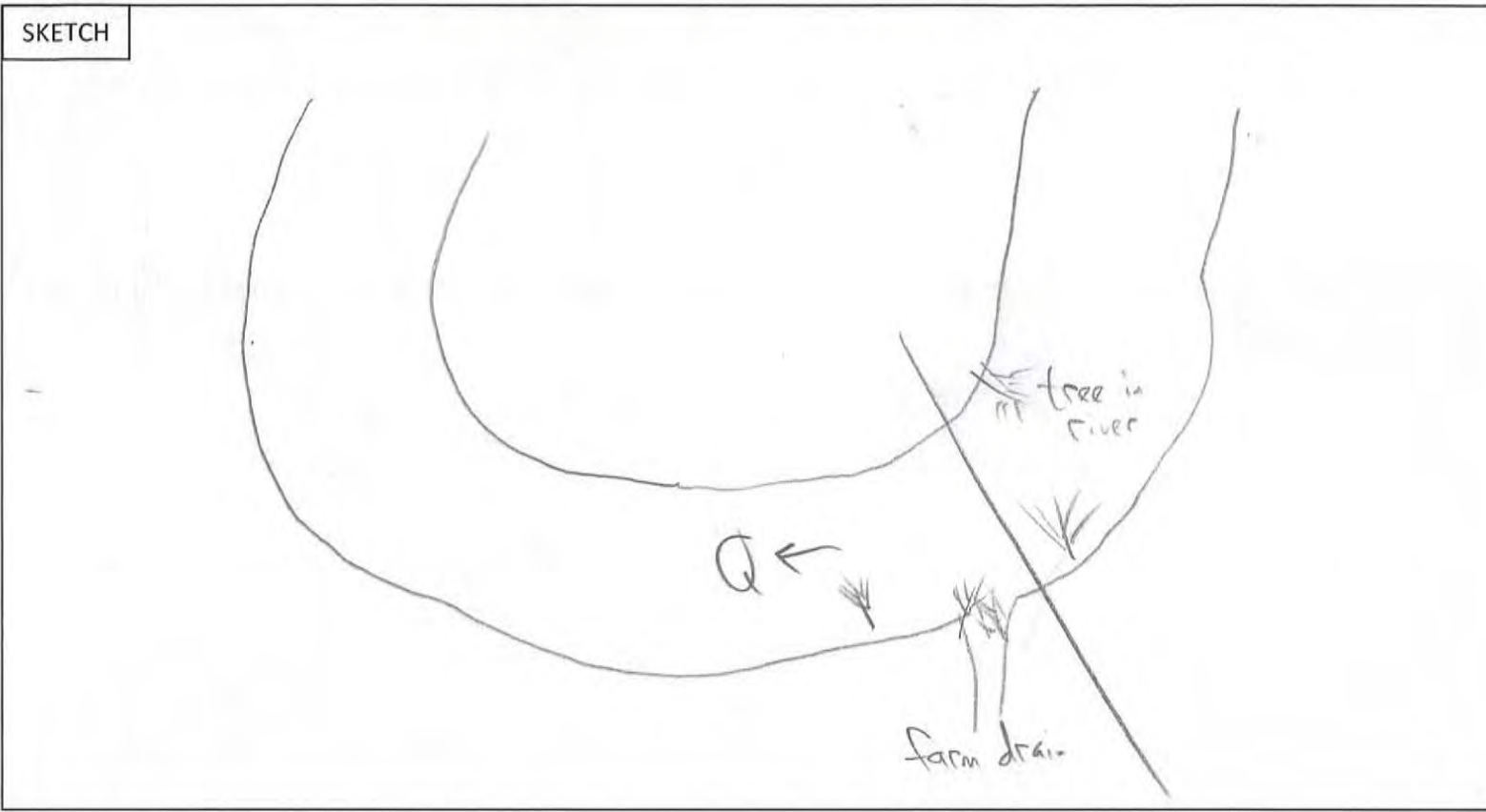


0 1,000 2,000 4,000 Feet

Sheyenne River

# Geomorphic Analysis Check List

Site Name: Red River Upstream of Wild Rice



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 2	Left	Top of Bank (TB)	✓	170	Bank Full (BF)	✓	171	Water Surface (WS)	✓	172
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 3	Left	Top of Bank (TB)	✓	167	Bank Full (BF)	✓	168	Water Surface (WS)	✓	166
	Right	Top of Bank (TB)	✓	164	Bank Full (BF)	✓	165			
Section 4	Left	Top of Bank (TB)	✓	162	Bank Full (BF)	✓	161	Water Surface (WS)	✓	160
	Right	Top of Bank (TB)	✓	158	Bank Full (BF)	✓	159			
Section 5	Left	Top of Bank (TB)	✓	156	Bank Full (BF)	✓	155	Water Surface (WS)	✓	154
	Right	Top of Bank (TB)	✓	152	Bank Full (BF)	✓	153			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.03
Root Depth	(ft)	2'
Root Density	(%)	5
Eroding Bank Surface Cover	(%)	5
Eroding Bank Length	(ft)	450
Bank Material Type	(sand, silt, clay)	silt/clay
Bank Material Stratification Score <sup>1</sup>	-	-
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	✓
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	RR/173/LB	173
Right Bank (RB)	✓	RR/174/RB	174
Bed (BED)	✓	RR/174/BED	174
Bar - Armor (B-A)	-	-	-
Bar - Sub Armor (B-SA)	-	-	-

River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC



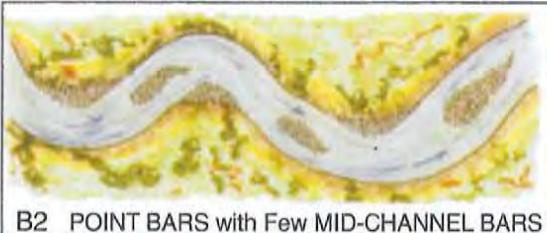
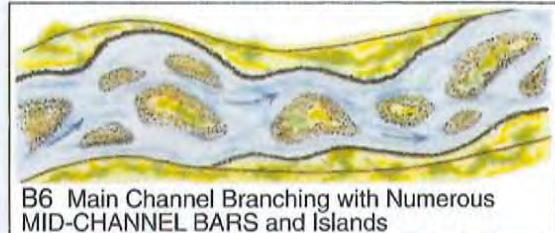

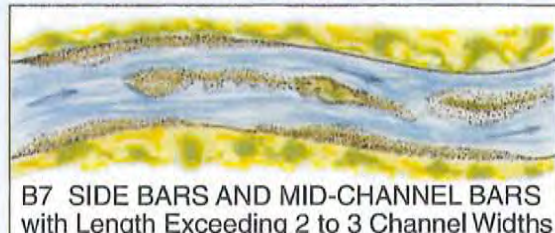

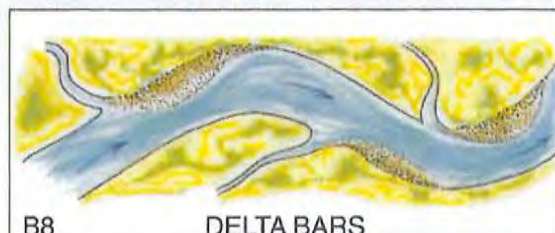
Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation				
Stream: Red River		Location: W/S of Wild Rice		
Observers: KDD	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: 11/18/10	
Existing species composition: trees, small prickly pear bushes		Potential species composition: -		
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	20% w/o leaves	trees	100
		85% w/ leaves		
				100%
2. Understory	Shrub layer	60%	cockleburs	100
				100%
3. Ground level	Herbaceous	-		-
	Leaf or needle litter	-		
	Bare ground	100		
*Based on crown closure.		Column total 100%		
**Based on basal area to surface area.		Remarks: Condition, vigor and/or usage of existing reach:		



**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations (modified from Galay et al., 1973; Rosgen, 1996, 2006b).

<b>Depositional Patterns</b>	
Stream: <u>Red River</u>	Reach: <u>U/S of Wild Rice</u>
Observers: <u>KDD</u>	Date: <u>11/18/16</u>
List ALL CATEGORIES that APPLY <input checked="" type="checkbox"/> <u>B1</u> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
<b>Various Depositional Features Modified from Galay et al. (1973)</b>	
 <p><b>B1 POINT BARS</b></p>	 <p><b>B5 DIAGONAL BARS</b></p>
 <p><b>B2 POINT BARS with Few MID-CHANNEL BARS</b></p>	 <p><b>B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b></p>
 <p><b>B3 NUMEROUS MID-CHANNEL BARS</b></p>	 <p><b>B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b></p>
 <p><b>B4 SIDE BARS</b></p>	 <p><b>B8 DELTA BARS</b></p>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

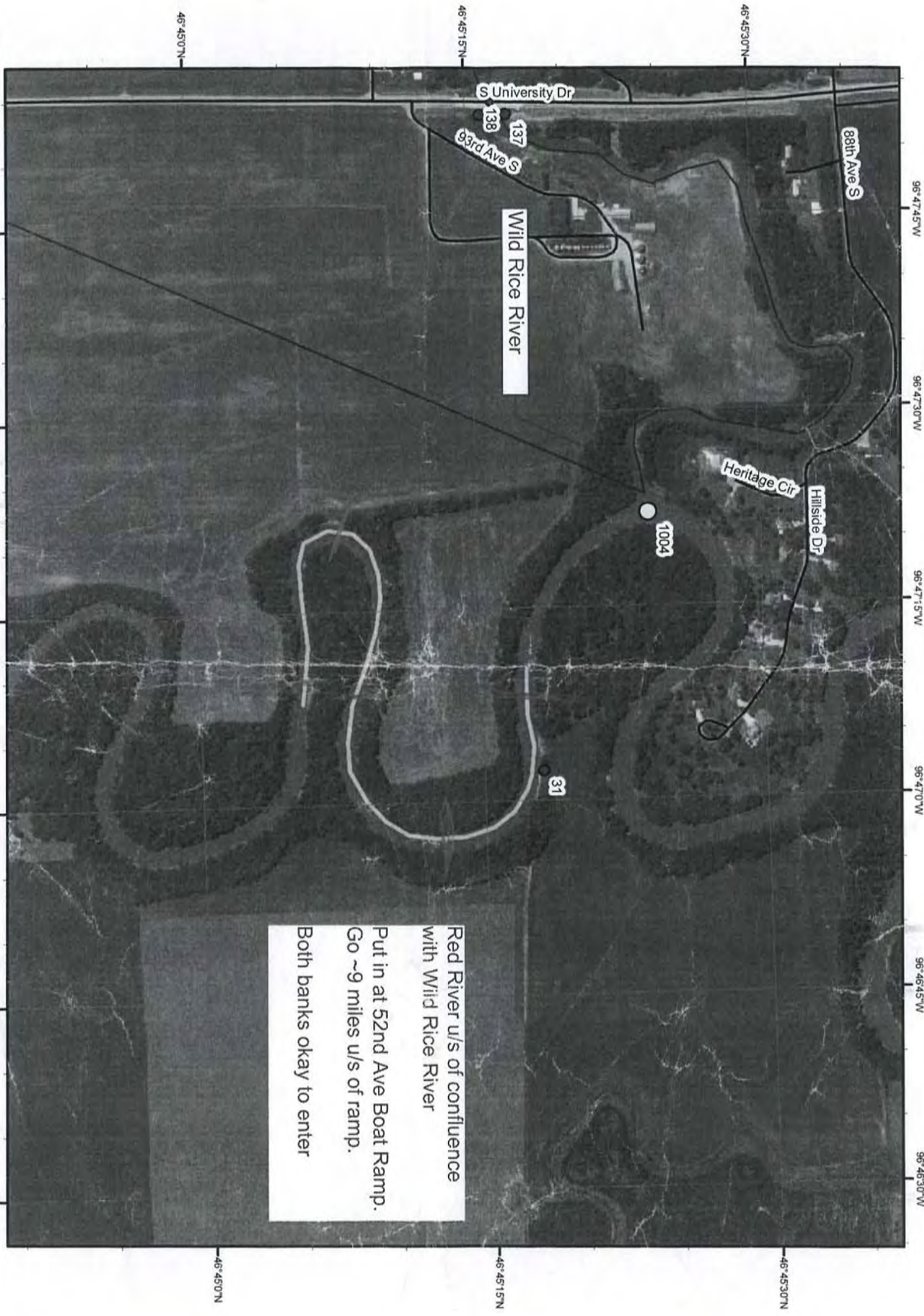
<b>Channel Blockages</b>		
Stream: <i>Red River</i>		Location: <i>U/S of Wild Rice</i>
Observers: <i>KDA</i>		Date: <i>11/18/10</i>
Description/ Extent	Materials that upon placement into the active channel or flood-prone area may cause adjustments in channel dimensions or conditions due to influences on the existing flow regime	Check <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input type="checkbox"/>
<b>D3</b> 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-section area.	<input type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input checked="" type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

RR U/S of Wild R. K. KAD  
11/18/10

**Worksheet 3-10. Pfrankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).**

Stream:		Location:			Valley Type:			Observers:			Date:																
Loca- tion	Key Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating																		
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8																		
	2	Mass erosion	3	No evidence of past or future mass erosion.	6	Infrequent. Mostly healed over. Low future potential.	9	Frequent or large, causing sediment nearly yearlong.	12																		
	3	Debris jam potential	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, mostly larger sizes.	8																		
	4	Vegetative bank protection	3	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	12																		
Lower Banks	5	Channel capacity	1	Bankfull stage sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0.	2	Bank Height Ratio (BHR) = 1.0-1.2.	3	Bankfull stage is not contained, overbank 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	2	> 65% with large angular boulders. 12"+ common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	<20% rock fragments of gravel sizes, 1-3" or less.	8																		
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	8																		
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcaves and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16																		
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16																		
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4																		
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4																		
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8																		
	13	Bottom size distribution	4	No size change evident. Stable material 80-100%.	8	Distribution shift light. Stable material 50-80%.	12	Moderate change in sizes. Stable materials 20-50%.	16																		
	14	Scouring and deposition	6	<5% of bottom affected by scour or deposition.	12	5-30% affected. Scour at constrictions and where grades steeper. Some deposition in pools.	18	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	24																		
	15	Aquatic vegetation	1	Abundant growth moss-like, dark green perennial. In swift water too.	2	Common. Algae forms in low velocity and pool areas. Moss here too.	3	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	4																		
		Excellent Total = 9			Good Total = 12			Fair Total = 15			Poor Total = 26																
Stream Type		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6	Grand Total = 76			
Good (Stable)		38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	46-58	46-58	61-78	65-84	69-88	61-78	51-61	60-85	70-90	70-90	60-85	85-107	85-107	85-107	85-107	67-98	Existing Stream Type =	
Fair (Mod. Unstable)		44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	46-58	61-78	65-84	69-88	61-78	51-61	60-85	70-90	70-90	60-85	85-107	85-107	85-107	85-107	85-107	99-125	*Potential Stream Type =	
Poor (Unstable)		48+	48+	130+	133+	143+	111+	59+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+	133+	133+	126+	Modified Channel Stability Rating =		
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	50-75	50-75	50-75	40-63	40-63	60-85	60-85	65-110	65-110	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	76-96	76-96	76-96	64-86	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	108-120	108-120	113-125	108-120						
Poor (Unstable)		87+	87+	87+	87+	97+	97+	97+	87+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	121+					

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



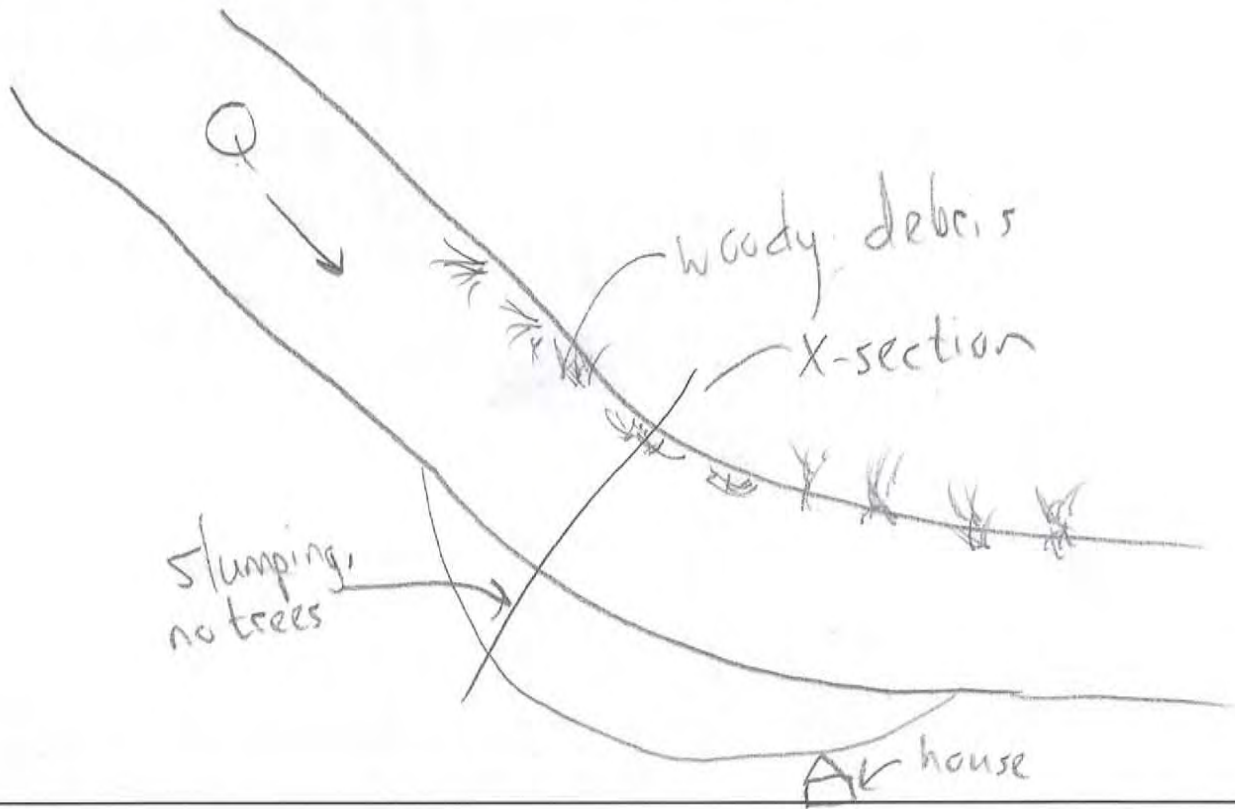
Red River u/s of confluence  
with Wild Rice River  
Put in at 52nd Ave Boat Ramp.  
Go ~9 miles u/s of ramp.  
Both banks okay to enter

Red River u/s of confluence with Wild Rice River

# Geomorphic Analysis Check List

Site Name: Red River ~2mi W/S of 52<sup>nd</sup> Ave Boat Launch

SKETCH



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 2	Left	Top of Bank (TB)	✓		Bank Full (BF)	✓		Water Surface (WS)	✓	207
	Right	Top of Bank (TB)	✓	204	Bank Full (BF)	✓	206			
Section 3	Left	Top of Bank (TB)	✓	199	Bank Full (BF)	✓	200	Water Surface (WS)	✓	198
	Right	Top of Bank (TB)	✓	202	Bank Full (BF)	✓	201			
Section 4	Left	Top of Bank (TB)	✓	192	Bank Full (BF)	✓	193	Water Surface (WS)	✓	194
	Right	Top of Bank (TB)	✓	195	Bank Full (BF)	✓	196			
Section 5	Left	Top of Bank (TB)	✓	186	Bank Full (BF)	✓	187	Water Surface (WS)	✓	188
	Right	Top of Bank (TB)	✓	189	Bank Full (BF)	✓	190			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.035
Root Depth	(ft)	1'
Root Density	(%)	5%
Eroding Bank Surface Cover	(%)	90%
Eroding Bank Length	(ft)	~350'
Bank Material Type	(sand, silt, clay)	silt silt/clay
Bank Material Stratification Score <sup>1</sup>	-	-
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	3.2'

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	NO ←
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

← too cold for ADCP

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	RR/208/LB	208
Right Bank (RB)	✓	RR/205/RB	205
Bed (BED)	✓	RR/212/BED	212
Bar – Armor (B-A)	-	-	-
Bar - Sub Armor (B-SA)	-	-	-




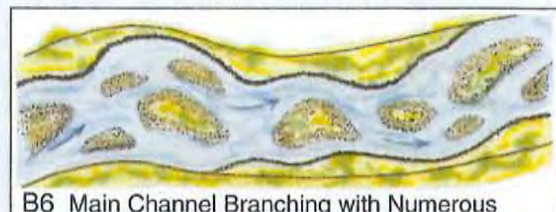

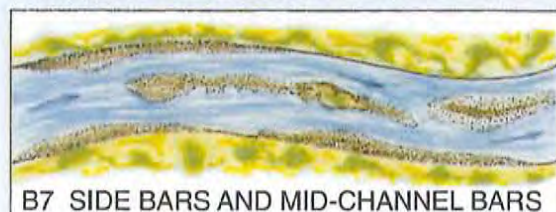

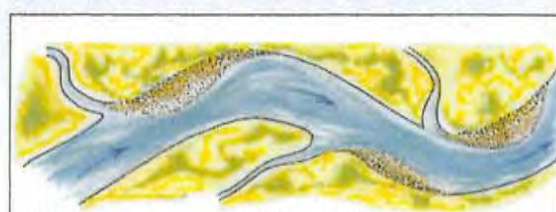
River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation				
Stream: Red River		Location: ~2 mi U/S of 52 <sup>nd</sup> Ave Boat Ramp		
Observers: KDD	Reference reach	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: 11/19/10	
Existing species composition: cockleburs, tall grass		Potential species composition: -		
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	1%	1 tree	100
			-----	
				100%
2. Understory	Shrub layer	98	cocklebur	30
			tall grass	70
				100%
3. Ground level	Herbaceous	-	-----	
	Leaf or needle litter	-	-----	
	Bare ground	01	-----	
*Based on crown closure.		Remarks: Condition, vigor and/or usage of existing reach:		
**Based on basal area to surface area.		Column total 100%		

Worksheet 3-5. Depositional patterns used for stability assessment interpretations (modified from Galay et al., 1973; Rosgen, 1996, 2006b).

<b>Depositional Patterns</b>	
Stream: <u>Red River</u>	Reach: <u>~2 mi U/S of 52<sup>nd</sup> Ave Ramp</u>
Observers: <u>KDD</u>	Date: <u>11/19/10</u>
List ALL CATEGORIES that APPLY <input type="checkbox"/>	<u>NONE</u>
<b>Various Depositional Features Modified from Galay et al. (1973)</b>	
 <p><b>B1 POINT BARS</b></p>	 <p><b>B5 DIAGONAL BARS</b></p>
 <p><b>B2 POINT BARS with Few MID-CHANNEL BARS</b></p>	 <p><b>B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b></p>
 <p><b>B3 NUMEROUS MID-CHANNEL BARS</b></p>	 <p><b>B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b></p>
 <p><b>B4 SIDE BARS</b></p>	 <p><b>B8 DELTA BARS</b></p>



**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

<b>Channel Blockages</b>		
Stream: <i>Red River</i>		Location: <i>~2 mi U/S of 52<sup>nd</sup> Ave Ramp</i>
Observers: <i>KDD</i>		Date: <i>11/19/10</i>
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 <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

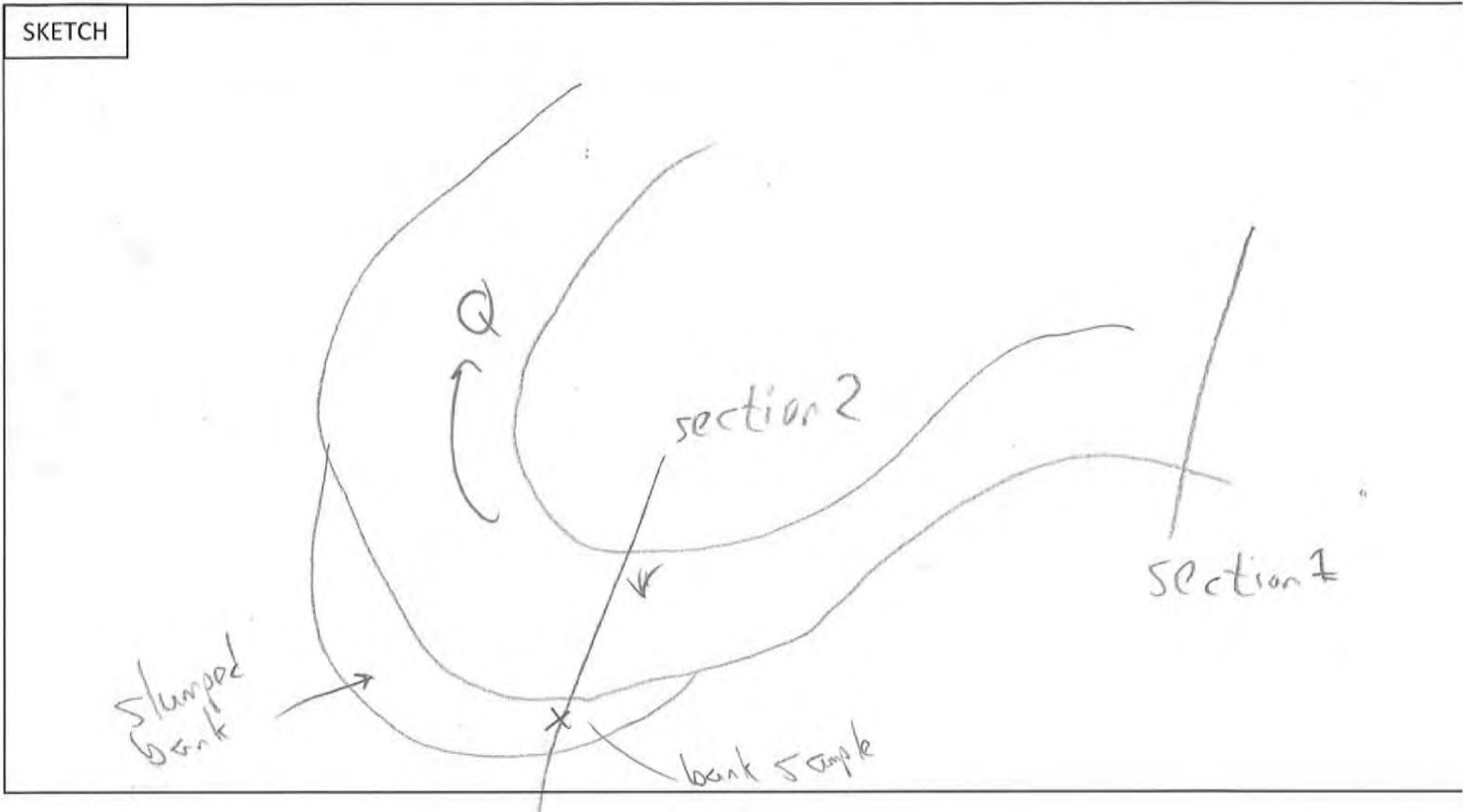
Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

Stream:		Location:			Valley Type:			Observers:			Date:																																																																																														
Loca-tion	Key Category	Excellent Description	Rating	Good Description	Rating	Fair Description	Rating	Poor Description	Rating																																																																																																
Upper Banks	1	Landform slope	2	Bank slope gradient 30-40%.	4	Bank slope gradient 40-60%.	6	Bank slope gradient > 60%.	8																																																																																																
	2	Mass erosion	3	No evidence of past or future mass erosion.	6	Infrequent. Mostly healed over. Low future potential.	9	Frequent or large, causing sediment nearly yearlong.	12																																																																																																
	3	Debris jam potential	2	Essentially absent from immediate channel area.	4	Present, but mostly small twigs and limbs.	6	Moderate to heavy amounts, mostly larger sizes.	8																																																																																																
	4	Vegetative bank protection	3	>90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	6	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	12																																																																																																
Lower Banks	5	Channel capacity	1	Bank heights sufficient to contain the bankfull stage. 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 contained within banks. 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. Width/depth ratio departure from reference width/depth ratio >1.4. Bank-Height Ratio (BHR) >1.3.	4																																																																																																
	6	Bank rock content	2	> 65% with large angular boulders. 12"+ common.	4	40-65%. Mostly boulders and small cobbles 6-12".	6	20-40%. Most in the 3-6" diameter class.	8																																																																																																
	7	Obstructions to flow	2	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	4	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	6	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	8																																																																																																
	8	Cutting	4	Little or none. Infrequent raw banks <6".	6	Some, intermittently at outcurves and constrictions. Raw banks may be up to 12".	12	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	16																																																																																																
Bottom	9	Deposition	4	Little or no enlargement of channel or point bars.	8	Some new bar increase, mostly from coarse gravel.	12	Moderate deposition of new gravel and coarse sand on old and some new bars.	16																																																																																																
	10	Rock angularity	1	Sharp edges and corners. Plane surfaces rough.	2	Rounded corners and edges. Surfaces smooth and flat.	3	Corners and edges well rounded in 2 dimensions.	4																																																																																																
	11	Brightness	1	Surfaces dull, dark or stained. Generally not bright.	2	Mostly dull, but may have <35% bright surfaces.	3	Mixture dull and bright, i.e., 35-65% mixture range.	4																																																																																																
	12	Consolidation of particles	2	Assorted sizes tightly packed or overlapping.	4	Moderately packed with some overlapping.	6	Mostly loose assortment with no apparent overlap.	8																																																																																																
Stream Type	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2	G3	G4	G5	G6	D1	D2	D3	D4	D5	D6	Grand Total = 88																																																																														
	48+	48+	48+	48+	130+	133+	143+	111+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	59+	Existing Stream Type =																																																																												
	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	87+	*Potential Stream Type =																																																																													
Excellent Total = 8																										Good Total = 30																										Fair Total = 15																										Poor Total = 40																										Modified Channel Stability Rating =	

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

# Geomorphic Analysis Check List

Site Name: Sheyenne River west of I-29, Exit 54



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 2	Left	Top of Bank (TB)	✓	243	Bank Full (BF)	✓	245	Water Surface (WS)	✓	246
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 3	Left	Top of Bank (TB)			Bank Full (BF)			Water Surface (WS)		
	Right	Top of Bank (TB)			Bank Full (BF)					
Section 4	Left	Top of Bank (TB)	✓	229	Bank Full (BF)	✓	228	Water Surface (WS)	✓	227
	Right	Top of Bank (TB)	✓	225	Bank Full (BF)	✓	226			
Section 5	Left	Top of Bank (TB)	✓	219	Bank Full (BF)	✓	220	Water Surface (WS)	✓	221
	Right	Top of Bank (TB)	✓	222	Bank Full (BF)	✓	223			
6			✓	237		✓	238		✓	239
			✓	240		✓	241		✓	
7			✓	234		✓	235		✓	233
			✓	231		✓	232		✓	

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.03
Root Depth	(ft)	1'
Root Density	(%)	5%
Eroding Bank Surface Cover	(%)	15%
Eroding Bank Length	(ft)	325'
Bank Material Type	(sand, silt, clay)	silty clay / clay
Bank Material Stratification Score <sup>1</sup>	-	-
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	2.3'

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark  
<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	-
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

← too cold for ADCP

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	S/244/LB	244
Right Bank (RB)			
Bed (BED)			
Bar - Armor (B-A)	-	-	-
Bar - Sub Armor (B-SA)	-	-	-




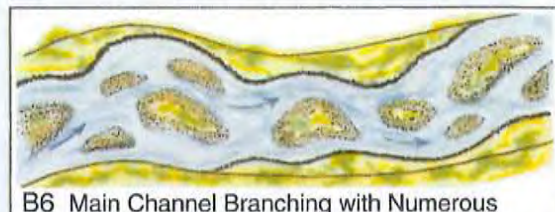

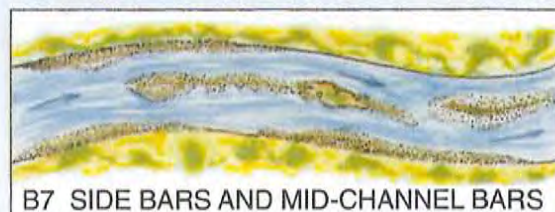

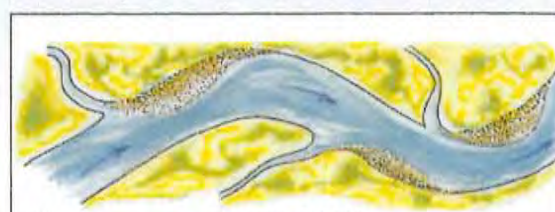
River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation				
Stream: <i>Sheyenne River</i>		Location: <i>24 mi. West of I-29 exit 54</i>		
Observers: <i>KDD</i>	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: <i>11/20/10</i>	
Existing species composition: <i>small shrubs</i>		Potential species composition: <i>-</i>		
Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	<i>2</i>	<i>Trees</i>	<i>100</i>
				<b>100%</b>
2. Understory	Shrub layer	<i>70</i>	<i>small shrubs cockleburs</i>	<i>95</i>
				<b>100%</b>
3. Ground level	Herbaceous	<i>-</i>		
	Leaf or needle litter	<i>4</i>	<b>Remarks:</b> Condition, vigor and/or usage of existing reach:	<b>100%</b>
	Bare ground	<i>24</i>		
*Based on crown closure. **Based on basal area to surface area.		<b>Column total</b>		<b>100%</b>

Worksheet 3-5. Depositional patterns used for stability assessment interpretations (modified from Galay et al., 1973; Rosgen, 1996, 2006b).

<b>Depositional Patterns</b>	
Stream: <u>Sheyene</u>	Reach: <u>~4 mi west of I-29 exit 854</u>
Observers: <u>KDD</u>	Date: <u>11/20/10</u>
List ALL CATEGORIES that APPLY <span style="font-size: 1.5em; margin-left: 20px;">NONE</span>	
<b>Various Depositional Features Modified from Galay et al. (1973)</b>	
 <b>B1 POINT BARS</b>	 <b>B5 DIAGONAL BARS</b>
 <b>B2 POINT BARS with Few MID-CHANNEL BARS</b>	 <b>B6 Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b>
 <b>B3 NUMEROUS MID-CHANNEL BARS</b>	 <b>B7 SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b>
 <b>B4 SIDE BARS</b>	 <b>B8 DELTA BARS</b>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

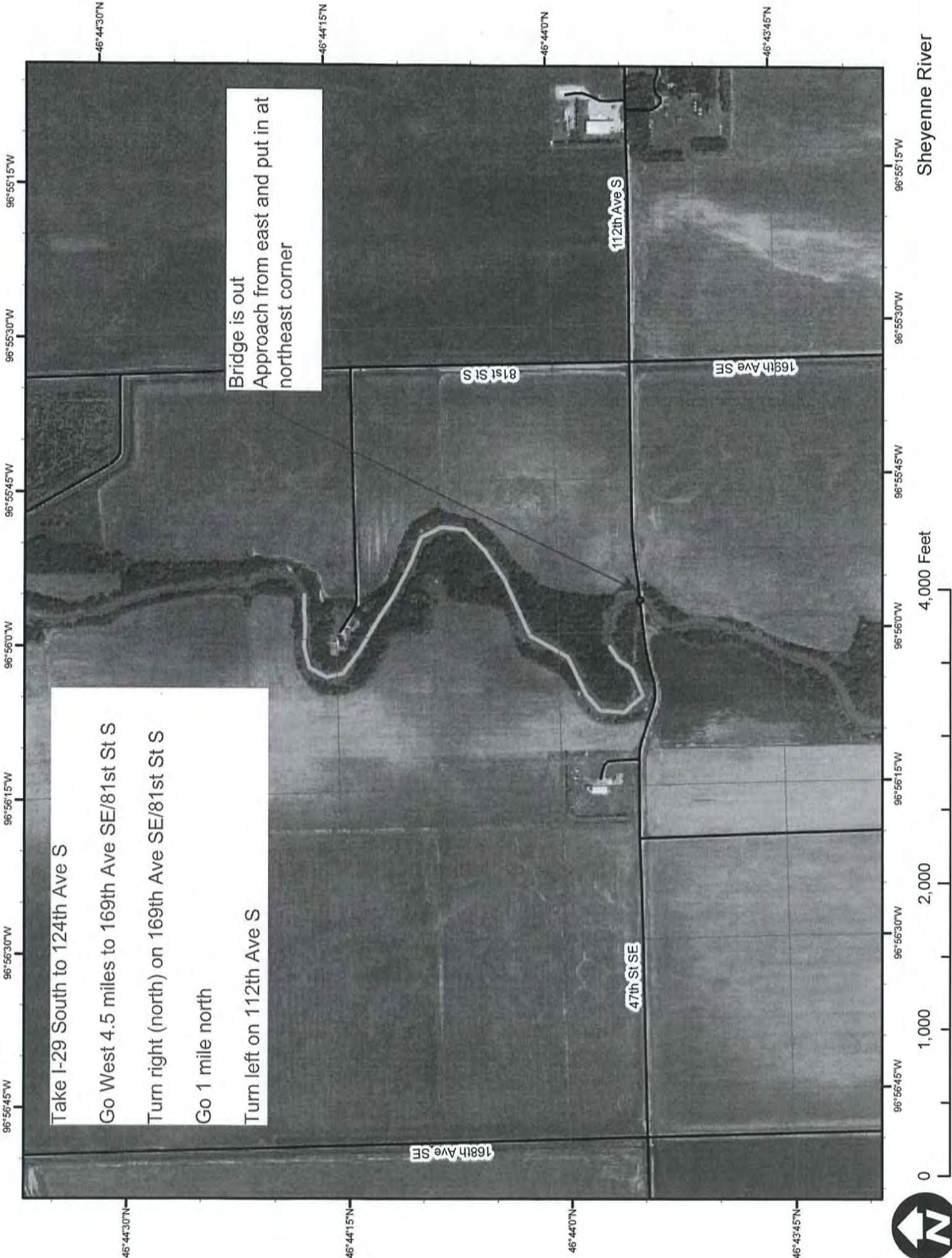
<b>Channel Blockages</b>		
Stream: <i>Shoeyenc</i>		Location: <i>4 mi west of 2-29 rd 84</i>
Observers: <i>KDD</i>		Date: <i>11/20/10</i>
Description/ Extent	Materials that upon placement into the active channel or flood-prone area may cause adjustments in channel dimensions or conditions due to influences on the existing flow regime	Check <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Stream: **Upper Banks** **Lower Banks** **Bottom**

Location:		Valley Type:			Observers:			Date:																
Key	Category	Excellent Description	Good Description	Fair Description	Poor Description	Rating	Rating	Rating	Rating															
1	Landform slope	Bank slope gradient <30%.	Bank slope gradient 30-40%.	Bank slope gradient 40-60%.	Bank slope gradient > 60%.	2	4	6	8															
2	Mass erosion	No evidence of past or future mass erosion.	Infrequent. Mostly healed over. Low future potential.	Frequent or large, causing sediment nearly yearlong.	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	3	6	9	12															
3	Debris jam potential	Essentially absent from immediate channel area.	Present, but mostly small twigs and limbs.	Moderate to heavy amounts, mostly larger sizes.	Moderate to heavy amounts, predominantly larger sizes.	2	4	6	8															
4	Vegetative bank protection	> 90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass.	70-90% density. Fewer species or less vigor suggest less dense or deep root mass.	50-70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	<50% density plus fewer species and less vigor indicating poor, discontinuous and shallow root mass.	3	6	9	12															
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.	Bank heights contained within banks. Width/depth ratio departure from reference width/depth ratio = 1.0-1.2. Bank-Height Ratio (BHR) = 1.0-1.1.	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.	Bankfull stage is not contained; overbank 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.	1	2	3	4															
6	Bank rock content	> 65% with large angular boulders. 12"+ common.	40-65%. Mostly boulders and small cobbles 6-12".	20-40%. Most in the 3-6" diameter class.	<20% rock fragments of gravel sizes, 1-3" or less.	2	4	6	8															
7	Obstructions to flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	2	4	6	8															
8	Cutting	Little or none. Infrequent raw banks <6".	Some, intermittently at outcrops and constrictions. Raw banks may be up to 12".	Significant. Cuts 12-24" high. Root mat overhangs and sloughing evident.	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	4	6	12	16															
9	Deposition	Little or no enlargement of channel or point bars.	Some new bar increase, mostly from coarse gravel.	Moderate deposition of new gravel and coarse sand on old and some new bars.	Extensive deposit of predominantly fine particles. Accelerated bar development.	4	8	12	16															
10	Rock angularity	Sharp edges and corners. Plane surfaces rough.	Rounded corners and edges. Surfaces smooth and flat.	Rounded corners and edges. Surfaces smooth and flat.	Well rounded in all dimensions, surfaces smooth.	1	2	3	4															
11	Brightness	Surfaces dull, dark or stained. Generally not bright.	Mostly dull, but may have <35% bright surfaces.	Mixture dull and bright, i.e., 35-65% mixture range.	Predominantly bright, > 65%, exposed or scoured surfaces.	1	2	3	4															
12	Consolidation of particles	Assorted sizes tightly packed or overlapping.	Moderately packed with some overlapping.	Moderately packed with some overlapping.	No packing evident. Loose assortment, easily moved.	2	4	6	8															
13	Bottom size distribution	No size change evident. Stable material 80-100%.	Distribution shift light. Stable material 50-80%.	Moderate change in sizes. Stable materials 20-50%.	Marked distribution change. Stable materials 0-20%.	4	8	12	16															
14	Scouring and deposition	<5% of bottom affected by scour or deposition.	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	More than 50% of the bottom in a state of flux or change nearly yearlong.	6	12	18	24															
15	Aquatic vegetation	Abundant growth moss-like, dark green perennial. In swift water too.	Common. Algae forms in low velocity and pool areas. Moss here too.	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	Perennial types scarce or absent. Yellow-green, short-term bloom may be present.	1	2	3	4															
<b>Excellent Total = 6</b>						<b>Good Total = 38</b>	<b>Fair Total = 27</b>	<b>Poor Total = 16</b>																
<b>Stream Type</b>	<b>A1</b>	<b>A2</b>	<b>A3</b>	<b>A4</b>	<b>A5</b>	<b>A6</b>	<b>B1</b>	<b>B2</b>	<b>B3</b>	<b>B4</b>	<b>B5</b>	<b>B6</b>	<b>C1</b>	<b>C2</b>	<b>C3</b>	<b>C4</b>	<b>C5</b>	<b>C6</b>	<b>D3</b>	<b>D4</b>	<b>D5</b>	<b>D6</b>		
Good (Stable)	38-43	38-43	54-90	60-95	60-95	50-90	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	80-85	70-90	70-90	60-85	85-107	85-107	85-107	85-107	67-98	
Far (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	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+	133+	126+	
<b>Stream Type</b>	<b>DA3</b>	<b>DA4</b>	<b>DA5</b>	<b>DA6</b>	<b>E3</b>	<b>E4</b>	<b>E5</b>	<b>E6</b>	<b>F1</b>	<b>F2</b>	<b>F3</b>	<b>F4</b>	<b>F5</b>	<b>F6</b>	<b>G1</b>	<b>G2</b>	<b>G3</b>	<b>G4</b>	<b>G5</b>	<b>G6</b>				
Good (Stable)	40-63	40-63	40-63	40-63	50-75	50-75	40-63	40-63	80-85	80-85	85-110	85-110	90-115	80-95	40-60	40-60	40-60	85-107	85-107	90-112	86-107			
Far (Mod. Unstable)	64-86	64-86	64-86	64-86	76-96	76-96	64-86	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	108-120			
Poor (Unstable)	87+	87+	87+	87+	97+	97+	87+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	126+	121+			
<b>Grand Total = 27</b>						<b>Existing Stream Type =</b>	<b>*Potential Stream Type =</b>	<b>Modified Channel Stability Rating =</b>																

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





Take I-29 South to 124th Ave S  
Go West 4.5 miles to 169th Ave SE/81st St S  
Turn right (north) on 169th Ave SE/81st St S  
Go 1 mile north  
Turn left on 112th Ave S

Bridge is out  
Approach from east and put in at  
northeast corner



4,000 Feet

2,000

1,000

0

96°55'15"W

96°55'30"W

96°55'45"W

96°56'00"W

96°56'15"W

96°56'30"W

96°56'45"W

96°55'15"W

46°44'30"N

46°44'15"N

46°44'00"N

46°43'45"N

46°44'30"N

46°44'15"N

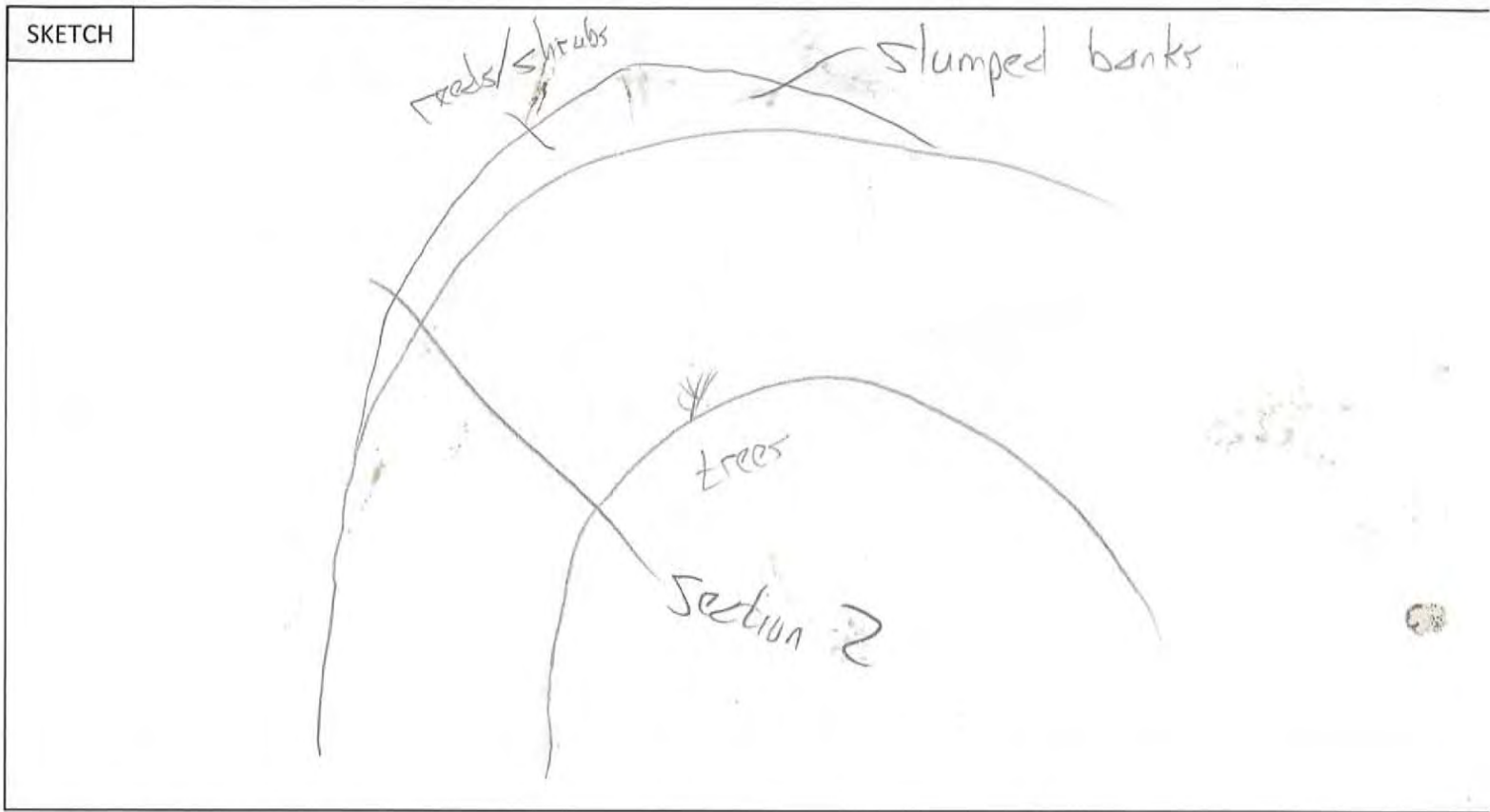
46°44'00"N

46°43'45"N

Sheyenne River

# Geomorphic Analysis Check List

Site Name: Red River U/S of 4th Ave Bridge



## Staking

Section #	Bank		Staked	GPS Pt		Staked	GPS Pt		Staked	GPS Pt
Section 1	Left	Top of Bank (TB)	✓	264	Bank Full (BF)	✓	265	Water Surface (WS)	✓	266
	Right	Top of Bank (TB)	—	—	Bank Full (BF)	—	—			
Section 2	Left	Top of Bank (TB)	✓	268	Bank Full (BF)	✓	269	Water Surface (WS)	✓	270
	Right	Top of Bank (TB)	—	—	Bank Full (BF)	—	—			
Section 3	Left	Top of Bank (TB)	✓	272	Bank Full (BF)	✓	273	Water Surface (WS)	✓	274
	Right	Top of Bank (TB)	—	—	Bank Full (BF)	—	—			
Section 4	Left	Top of Bank (TB)	✓	278	Bank Full (BF)	✓	277	Water Surface (WS)	✓	276
	Right	Top of Bank (TB)	—	—	Bank Full (BF)	—	—			
Section 5	Left	Top of Bank (TB)	✓	✓	Bank Full (BF)	✓		Water Surface (WS)	✓	
	Right	Top of Bank (TB)	—	—	Bank Full (BF)	—	—			

## Geomorphic Analysis Check List

### Field Observations

Measurement	Unit	Value
Manning's n at Bank Full Condition	-	0.03
Root Depth	(ft)	1ft
Root Density	(%)	30
Eroding Bank Surface Cover	(%)	90
Eroding Bank Length	(ft)	~625 ft
Bank Material Type	(sand, silt, clay)	silt/clay
Bank Material Stratification Score <sup>1</sup>	-	-
Distance from Bank Toe to Water Surface <sup>2</sup>	(ft)	

Notes: <sup>1</sup>+5 for any stratification, +10 for multiple layers above bank full mark

<sup>2</sup>Negative number indicates water surface is below bank toe.

### Rosgen Method Checklist

Item	Completed?
Velocity Measurements Taken	—
Depositional Features Noted on Worksheet	✓
Channel Blockages Noted on Worksheet	✓
Pfankuch Method Completed	✓

### Sampling Checklist

Location	Collected	Label	GPS Pt #
Left Bank (LB)	✓	RR/278/LB	278
Right Bank (RB)	—	—	—
Bed (BED)			
Bar – Armor (B-A)	—	—	—
Bar - Sub Armor (B-SA)	—	—	—




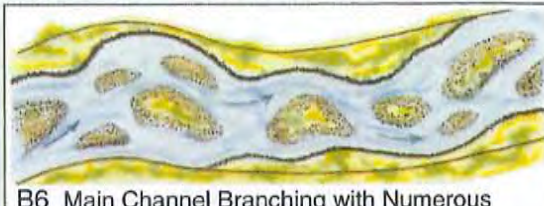

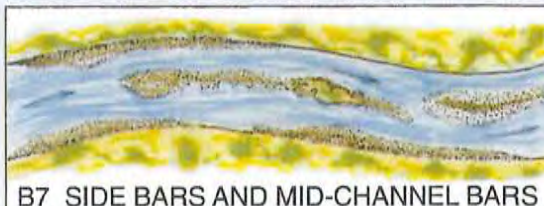

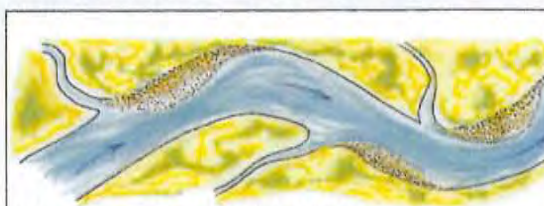
River	Abbreviation
Red River of the North	RR
Sheyenne River	S
Lower Rush	LR
Rush	RUSH
Maple	M
Buffalo	B
Sheyenne Diversion	SD
Wild Rice	WR
Wolverton Creek	WC

Sample Labeling: River Abbreviation / GPS Point # / Sampling Location Abbreviation

**Worksheet 3-1.** Riparian vegetation composition/density used for channel stability assessment (Rosgen, 2006b).

Riparian Vegetation				
Stream: <i>Red River</i>		Location: <i>W/S of 4th Ave Bridge</i>		
Observers: <i>KDD</i>	Reference reach <input type="checkbox"/>	Disturbed (impacted reach) <input checked="" type="checkbox"/>	Date: <i>11/21/10</i>	
Existing species composition: <i>shrubs</i>		Potential species composition: <i>-</i>		
	Riparian cover categories	Percent aerial cover*	Percent of site coverage**	Species composition
1. Overstory	Canopy layer	<i>0</i>	<i>0</i>	<i>-</i>
	<b>100%</b>			
2. Understory	Shrub layer	<i>90</i>	<i>90</i>	<i>shrubs</i>
	<b>100%</b>			
3. Ground level	Herbaceous	<i>0</i>	<i>0</i>	<i>-</i>
	Leaf or needle litter	<i>0</i>	<i>0</i>	<b>Remarks:</b> Condition, vigor and/or usage of existing reach:
	Bare ground	<i>0</i>	<i>0</i>	
			<b>Column total</b> <b>100%</b>	

**Worksheet 3-5.** Depositional patterns used for stability assessment interpretations (modified from Galay *et al.*, 1973; Rosgen, 1996, 2006b).

<b>Depositional Patterns</b>	
Stream: <u>Red River</u>	Reach: <u>u/s of 4th Ave Bridge</u>
Observers: <u>KDD</u>	Date: <u>11/21/10</u>
List ALL CATEGORIES that APPLY <span style="border: 1px solid black; padding: 2px 10px; font-family: cursive;">NONE</span>	
<b>Various Depositional Features Modified from Galay <i>et al.</i> (1973)</b>	
 <b>B1</b> <b>POINT BARS</b>	 <b>B5</b> <b>DIAGONAL BARS</b>
 <b>B2</b> <b>POINT BARS with Few MID-CHANNEL BARS</b>	 <b>B6</b> <b>Main Channel Branching with Numerous MID-CHANNEL BARS and Islands</b>
 <b>B3</b> <b>NUMEROUS MID-CHANNEL BARS</b>	 <b>B7</b> <b>SIDE BARS AND MID-CHANNEL BARS with Length Exceeding 2 to 3 Channel Widths</b>
 <b>B4</b> <b>SIDE BARS</b>	 <b>B8</b> <b>DELTA BARS</b>

**Worksheet 3-6.** Various categories of in-channel debris, dams and channel blockages used to evaluate channel stability (adapted from Rosgen, 1996, 2006b).

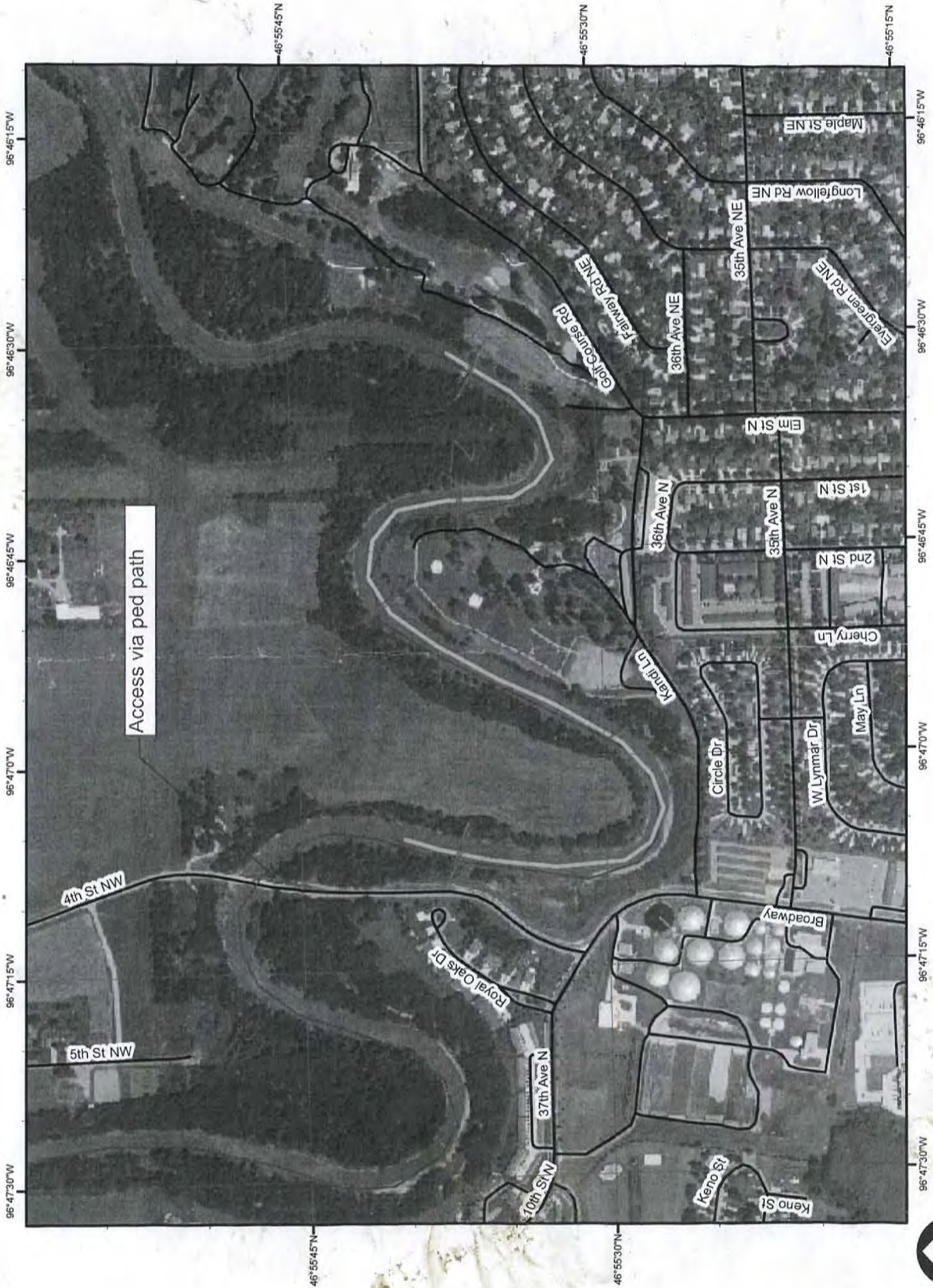
<b>Channel Blockages</b>		
Stream: <i>Red River</i>		Location: <i>U/S of 4<sup>th</sup> Ave Bridge</i>
Observers: <i>KDD</i>		Date: <i>11/21/10</i>
Description/ Extent	Materials that upon placement into the active channel or flood-prone area may cause adjustments in channel dimensions or conditions due to influences on the existing flow regime	Check <input checked="" type="checkbox"/> all that apply
<b>D1</b> None	Minor amounts of small, floatable material.	<input type="checkbox"/>
<b>D2</b> Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	<input checked="" type="checkbox"/>
<b>D3</b> 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-section area.	<input type="checkbox"/>
<b>D4</b> Numerous	Significant build-up of medium- to large-sized materials, e.g., large limbs, branches, small logs or portions of trees that may occupy 10–30% of the active channel cross-section area.	<input type="checkbox"/>
<b>D5</b> Extensive	Debris "dams" of predominantly larger materials, e.g., branches, logs and trees, occupying 30–50% of the active channel cross-section area, often extending across the width of the active channel.	<input type="checkbox"/>
<b>D6</b> Dominating	Large, somewhat continuous debris "dams," extensive in nature and occupying over 50% of the active channel cross-section area. Such accumulations may divert water into the flood-prone areas and form fish migration barriers, even when flows are at less than bankfull.	<input type="checkbox"/>
<b>D7</b> Beaver Dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	<input type="checkbox"/>
<b>D8</b> 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.	<input type="checkbox"/>
<b>D9</b> Beaver Dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	<input type="checkbox"/>
<b>D10</b> 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.	<input type="checkbox"/>

Red River U/S of 4-Ave Bridge

Worksheet 3-10. Pfankuch (1975) channel stability rating procedure, as modified by Rosgen (1996, 2001c, 2006b).

Stream:		Location:			Valley Type:			Observers:			Date:																							
Loca-tion	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; overbank 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 outcrops 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																								
Bottom	9	Deposition	Little or no enlargement of channel or point bars.	4	Some new bar increase, mostly from coarse gravel.	8	Moderate deposition of new gravel and coarse sand on old and some new bars.	12	Extensive deposit of predominantly fine particles. Accelerated bar development.	16																								
	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 2 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 steeper. 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 = 89					Good Total = 78					Fair Total = 9					Poor Total = 32															
Stream Type		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6	Grand Total = 87		Existing Stream Type =		*Potential Stream Type =		Modified Channel Stability Rating =				
Good (Stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	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	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107		
Far (Mod. Unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	85-105	91-110	91-110	85-105	108-132	108-132	108-132	108-132	108-132	108-132	108-132	108-132	108-132	108-132	108-132	108-132	108-132		
Poor (Unstable)	48+	48+	130+	133+	143+	111+	59+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+	133+	133+	133+	133+	133+	133+	133+	133+	133+	133+	133+	133+	133+	
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	50-75	50-75	50-75	40-63	40-63	60-85	60-85	85-110	85-110	80-95	80-95	40-60	40-60	40-60	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	85-107	
Far (Mod. Unstable)	64-86	64-86	64-86	64-86	76-96	76-96	76-96	64-86	64-86	86-105	86-105	111-125	111-125	116-130	116-130	61-78	61-78	61-78	108-120	108-120	113-125	113-125	113-125	113-125	113-125	113-125	113-125	113-125	113-125	113-125	113-125	113-125	113-125	113-125
Poor (Unstable)	87+	87+	87+	87+	97+	97+	97+	87+	87+	106+	106+	126+	126+	131+	131+	79+	79+	79+	121+	121+	126+	126+	126+	126+	126+	126+	126+	126+	126+	126+	126+	126+	126+	126+

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



Access via ped path

Red River

Left Bank Only

2,000 Feet

1,000

500

0

