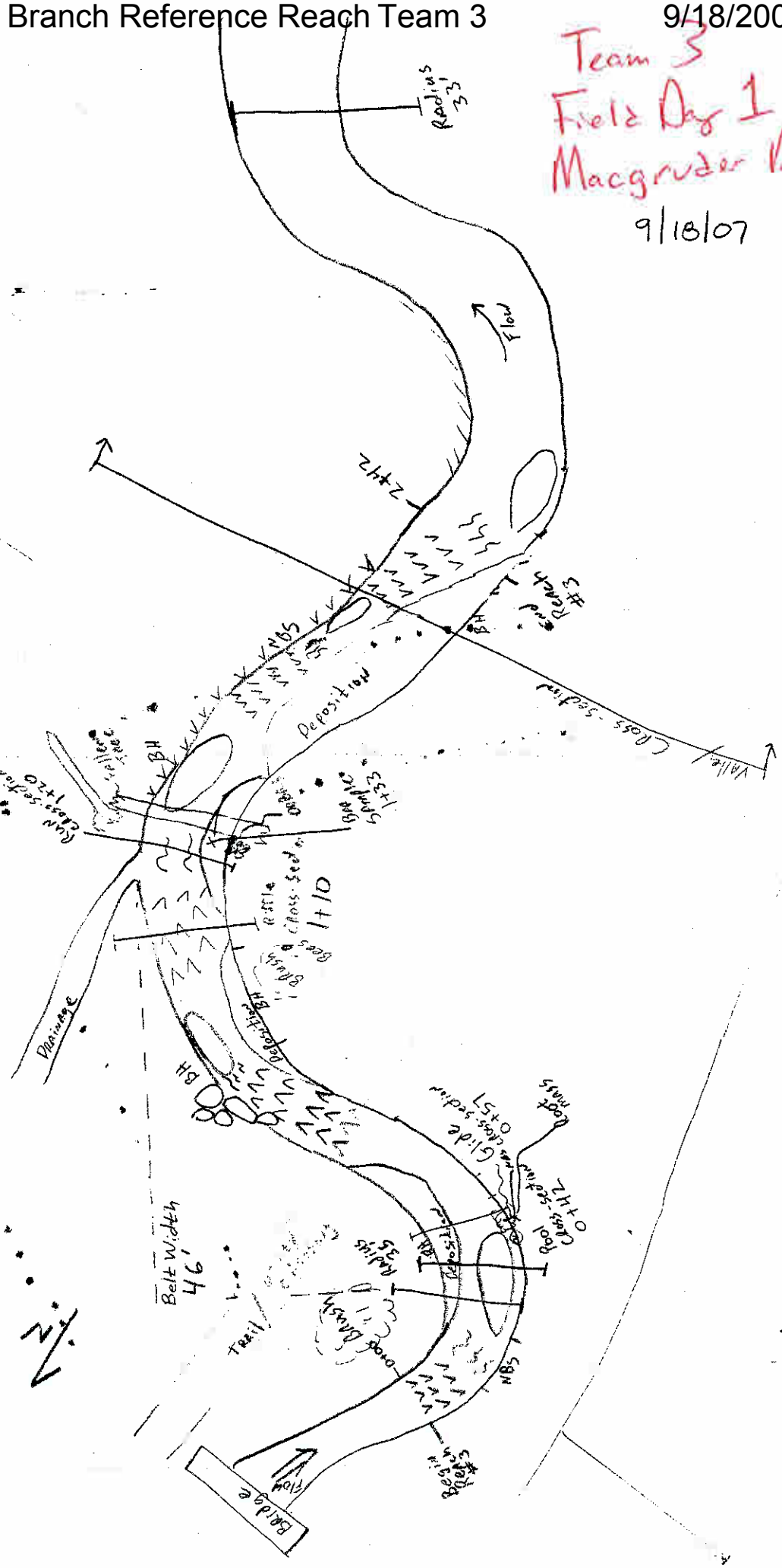
River Assessment and Monitoring
NCTC - Shepherdstown, WV
9/17 – 9/27/2007

Team 3
Day 1
Magruders Branch
Reference Reach

Team 3
Field Day 1
Macgruder Branch
9/18/07

Sinuosity = Stream Length / Valley Length = 2412 / 192 = 1.26



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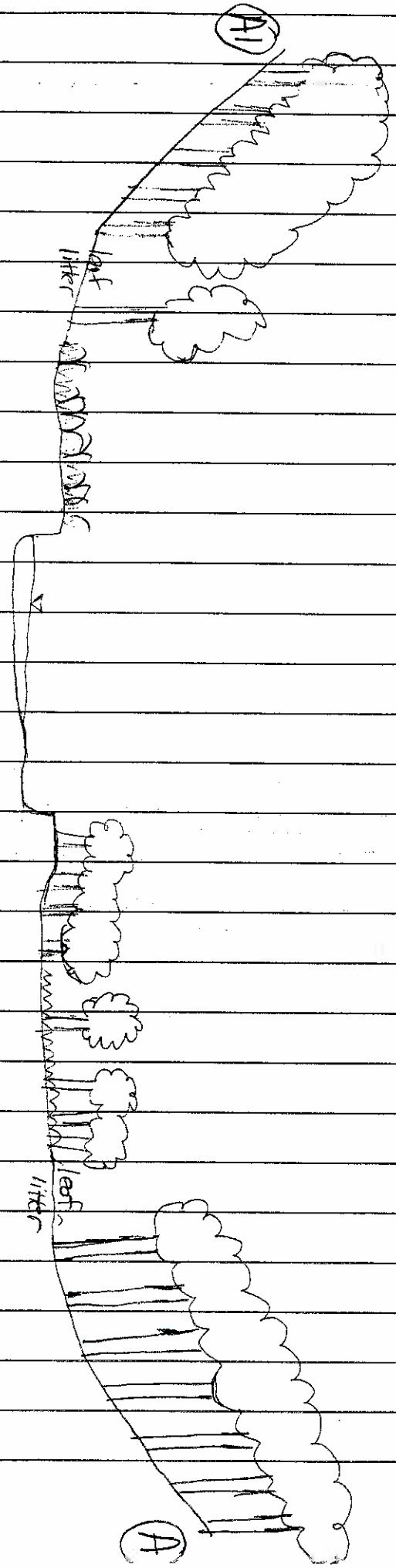
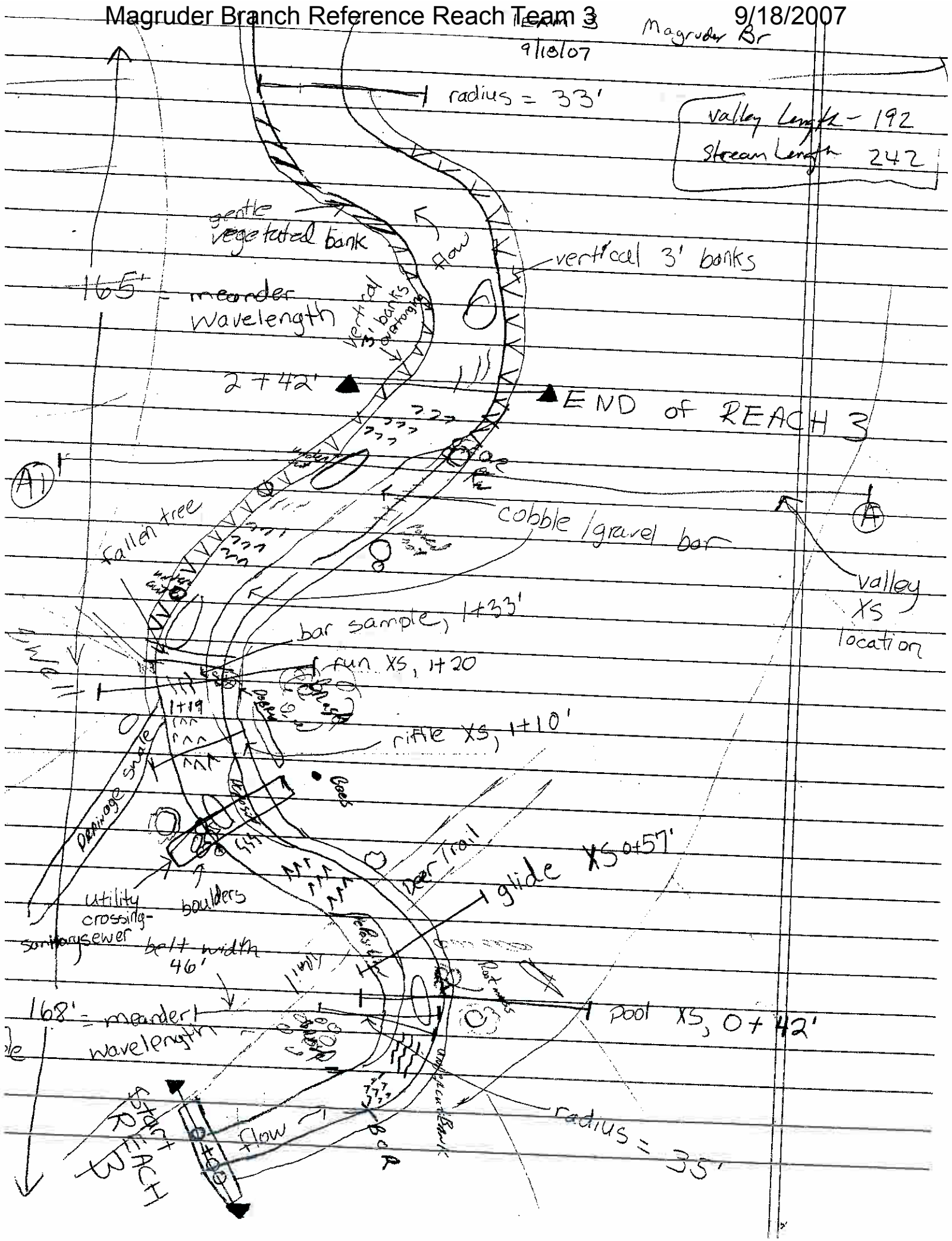
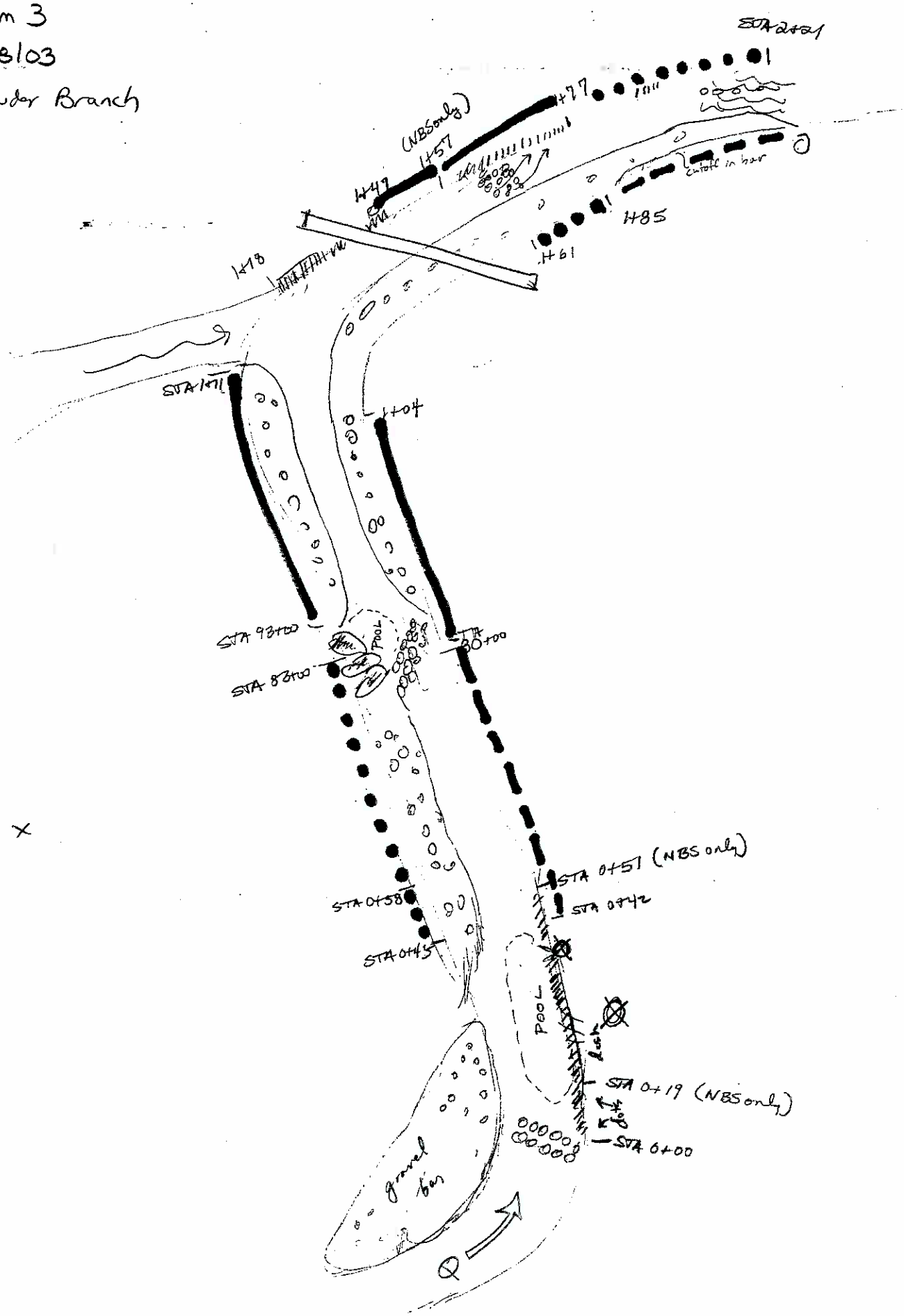



TEAM 3
9/18/07
Magruder Br
radius = 33'
valley Length - 192
Stream Length 242
gentle vegetated bank
flow
vertical 3' banks
165' = meander wavelength
vertical 3' banks overhanging
2+42'
END of REACH 3
A1
A
fallen tree
cobble/gravel bar
valley XS location
bar sample, 1+33'
run XS, 1+20
1+19
riffle XS, 1+10'
drainage swale
Beds
deer trail
glide XS 0+57'
utility crossing-sanitary sewer
boulders
belt width 46'
168' = meander wavelength
pool XS, 0+42'
flow
radius = 35'
Bar
Undercut Bank
Upstream WEIR

TEAM 3
9/18/03
Magruder Branch



depth
ave depth = x

depth
10 in = mean

Magruder Branch Reference Reach Team 3 9/18/2007

1	LOW,	LOW	Grey
2	LOW,	MOD	orange
3	MOD	V. LOW	Brown
4	MOD	LOW	red
5	MOD	MOD	dark green
	MOD	HIGH	yellow
6	MOD	V. HIGH	Green
7	MOD	EXTREME	dark blue
8	HIGH	LOW	pink
9	HIGH	MOD	Blue
10	HIGH	HIGH	purple

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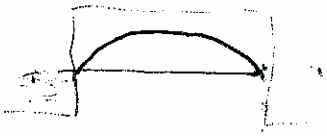

9/18/07

River Name: Macgruder Branch
Reach Name: Reach 3
Profile Name: Final Longpro
Survey Date: 09/18/2007

Survey Data

DIST	CH	WS	BKF	P1	P2	P3	P4
0	7.5	6.75		4.31	6.75		
4.5	7.08	6.82			6.82		
8	7.54	7.14		4.4			
11.1	7.91	7.23					
19	8.81	7.28		4.36			
24	8.27	7.31					
27	8.12	7.24					
35	9.18	7.26					
39	9.22	7.25					
43	8.89	7.2	5.81				
46	8.47	7.22	5.65	4.8			
57			5.26				
68							
73	7.49	7.27					
81	7.98	7.89					
84	8.91	7.88					
87	9.22	7.88					
89	8.89	7.87					
104	8.82	7.96		5.19			
110	8.16	7.97	5.99				
117	8.31	8.05					
120			5.97				
121	8.67	8.04		5.97			
139	9.59	8.03					
143			6.19				
147	9	8.07					
160	8.35	8.07					
165	8.27	8.07	6.09				
168	8.66	8.5		5.88			
173	9.15	8.53					
178	9.53	8.53					
185	9.16	8.52					
195	8.98	8.54		6.14			
196			7.21				
203	8.78	8.56		6.41			
218	8.8	8.69			8.69		
245	9.54	9.33	7.45	6.77			

Cross Section / Bank Profile Locations

Name	Type	Profile Station
Riffle	Riffle XS	0
Glide	Glide XS	0
Run	Run XS	0
Pool	Pool XS	0

TEAM 3

Bankfull Slope: 0.0091 9/18/07

Variable	Min	Avg	Max
S riffle	0.01056	0.08072	0.14497
S pool	0.0003	0.00153	0.00419
S run	0.0012	0.01024	0.03048
S glide	0.00088	0.0016	0.00219
P - P	38.64	46.2	51.81
Pool length	20.13	29.01	38.95
Riffle length	3.03	33.48	89.82
Dmax riffle	1.88	2.07	2.24
Dmax pool	2.86	3.32	3.83
Dmax run	2.29	2.46	2.62
Dmax glide	1.82	2.25	2.46
Low bank ht	2.48	2.72	2.95

Length and depth measurements in feet, slopes in ft/ft.

RIVERMORPH PROFILE SUMMARY

Notes

River Name: Macgruder Branch
Reach Name: Reach 3
Profile Name: Final Longpro
Survey Date: 09/18/2007

DIST	Note

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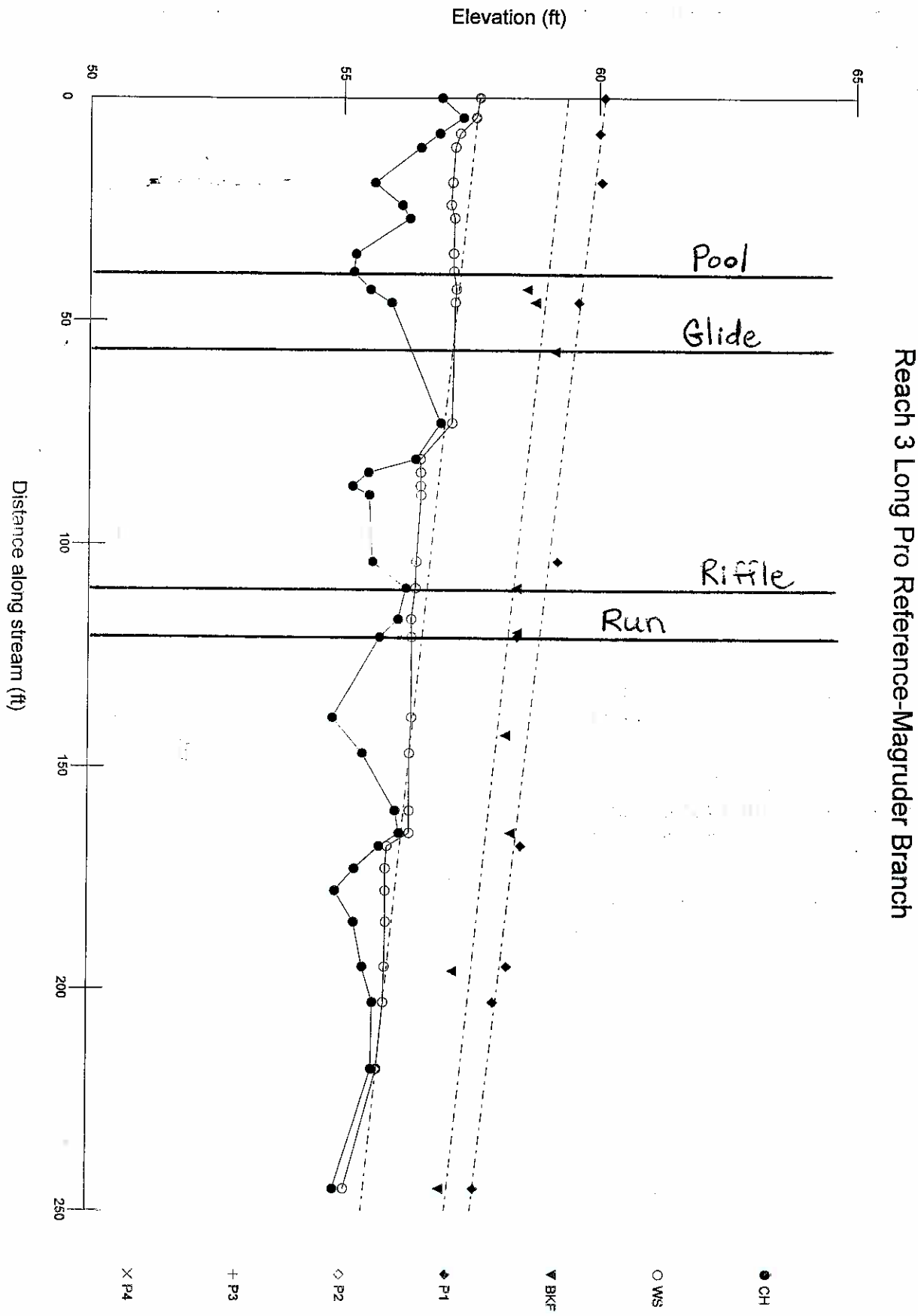

Reach 3 Long Pro Reference-Magruder Branch
Elevation (ft)
65
60
55
50
Distance along stream (ft)
0
50
100
150
200
250
Pool
Glide
Riffle
Run
CH
WS
BKF
P1
P2
P3
P4

River Name: Macgruder Branch
Reach Name: Reach 3
Cross Section Name: Riffle
Survey Date: 09/18/2007

TEAM 3
9/18/07

Cross Section Data Entry

BM Elevation: 59.29 ft
Backsight Rod Reading: 5.22 ft

TAPE	FS	ELEV	NOTE
1	3.48	61.03	
8.9	4.66	59.85	
14.9	5.15	59.36	
17.9	5.27	59.24	
22.9	6.95	57.56	
24.9	7.48	57.03	
26.9	7.32	57.19	
33.9	5.86	58.65	
35.9	5.76	58.75	
36.4	5.87	58.64	BKF
37.9	7.37	57.14	
41.4	7.85	56.66	REW
44.9	8.26	56.25	
49.9	7.83	56.68	LEW
54.4	7.34	57.17	
56.4	5.87	58.64	BKF
59.3	4.9	59.61	
170.3	3.48	61.03	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	61.03	61.03	61.03
Bankfull Elevation (ft)	58.64	58.64	58.64
Floodprone Width (ft)	169.3	-----	-----
Bankfull Width (ft)	20	0.37	19.63
Entrenchment Ratio	8.47	-----	-----
Mean Depth (ft)	1.75	0.19	1.78
Maximum Depth (ft)	2.39	0.37	2.39
Width/Depth Ratio	11.43	1.95	11.03
Bankfull Area (sq ft)	34.93	0.07	34.86
Wetted Perimeter (ft)	21.21	0.89	21.05
Hydraulic Radius (ft)	1.65	0.08	1.66
Begin BKF Station	36.4	36.4	36.77
End BKF Station	56.4	36.77	56.4

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0

River Name: Macgruder Branch
Reach Name: Reach 3
Cross Section Name: Run
Survey Date: 09/18/2007

TEAM 3
9/18/07

Cross Section Data Entry

BM Elevation: 59.29 ft
Backsight Rod Reading: 5.22 ft

TAPE	FS	ELEV	NOTE
1	5.62	58.89	
3	5.89	58.62	
3.3	6.07	58.44	BKF
3.5	7.87	56.64	
3.6	7.97	56.54	REW
6	8.21	56.3	
7	8.36	56.15	
11.5	7.97	56.54	LEW
15.5	7.89	56.62	
17	7.68	56.83	
19	7.54	56.97	
20	7.4	57.11	
21	7.37	57.14	
22.3	7.05	57.46	
22.5	7.46	57.05	
23	6.07	58.44	BKF
23.8	5.94	58.57	
24.5	5.46	59.05	
25.5	5.22	59.29	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	60.73	60.73	60.73
Bankfull Elevation (ft)	58.44	58.44	58.44
Floodprone Width (ft)	24.5	-----	-----
Bankfull Width (ft)	19.7	9.85	9.85
Entrenchment Ratio	1.24	-----	-----
Mean Depth (ft)	1.76	2.03	1.5
Maximum Depth (ft)	2.29	2.29	1.87
Width/Depth Ratio	11.19	4.85	6.57
Bankfull Area (sq ft)	34.73	19.96	14.77
Wetted Perimeter (ft)	22.7	13.41	13.02
Hydraulic Radius (ft)	1.53	1.49	1.13
Begin BKF Station	3.3	3.3	13.15
End BKF Station	23	13.15	23

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side

River Name: Macgruder Branch
Reach Name: Reach 3
Cross Section Name: Pool
Survey Date: 09/18/2007

TEAM 3
9/18/07

Cross Section Data Entry

BM Elevation: 59.29 ft
Backsight Rod Reading: 5.12 ft

TAPE	FS	ELEV	NOTE
0	4.64	59.77	
1.2	5.18	59.23	
1.7	5.61	58.8	
1.68	5.73	58.68	
1.54	6.53	57.88	
1.48	6.93	57.48	
1.44	7.33	57.08	REW
0.36	7.53	56.88	
-0.44	7.93	56.48	
-0.44	8.53	55.88	
1.9	9.33	55.08	
3	9.02	55.39	
4	8.61	55.8	
5	8.56	55.85	
6	8.33	56.08	
7	8.14	56.27	
8	7.93	56.48	
9	7.55	56.86	
9.9	7.31	57.1	LEW
11	6.94	57.47	
12	6.74	57.67	
13	6.43	57.98	
14	6.17	58.24	
15	5.84	58.57	
16	5.75	58.66	BKF
17	5.2	59.21	
18	4.85	59.56	
19	4.66	59.75	
21	4.61	59.8	
23	4.38	60.03	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	62.24	62.24	62.24
Bankfull Elevation (ft)	58.66	58.66	58.66
Floodprone Width (ft)	23.44	-----	-----
Bankfull Width (ft)	14.32	7.16	7.16
Entrenchment Ratio	1.64	-----	-----
Mean Depth (ft)	2.01	2.74	0.85
Maximum Depth (ft)	3.58	3.58	1.86
Width/Depth Ratio	7.12	2.61	8.42
Bankfull Area (sq ft)	28.8	19.62	6.09
Wetted Perimeter (ft)	21.27	12.79	9.28

Begin BKF Station	1.68	1.68	8.84
End BKF Station	16	8.84	16

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

TEAM 3

9/18/07

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Macgruder Branch
Reach Name: Reach 3
Cross Section Name: Glide
Survey Date: 09/18/2007

TEAM 3
9/18/07

Cross Section Data Entry

BM Elevation: 59.29 ft
Backsight Rod Reading: 5.22 ft

TAPE	FS	ELEV	NOTE
0.5	4.46	60.05	
1.5	4.87	59.64	
2.3	5.48	59.03	BKF
2.8	6.08	58.43	
3.3	6.31	58.2	
3.8	7.07	57.44	
5.8	6.84	57.67	
10.5	6.9	57.61	
13.8	7.16	57.35	REW
18	7.61	56.9	
19.5	7.49	57.02	
20.8	7.19	57.32	LEW
22	6.27	58.24	
22.5	5.92	58.59	
23	5.36	59.15	BKF
24.8	5.77	58.74	
28	4.49	60.02	

Cross Sectional Geometry

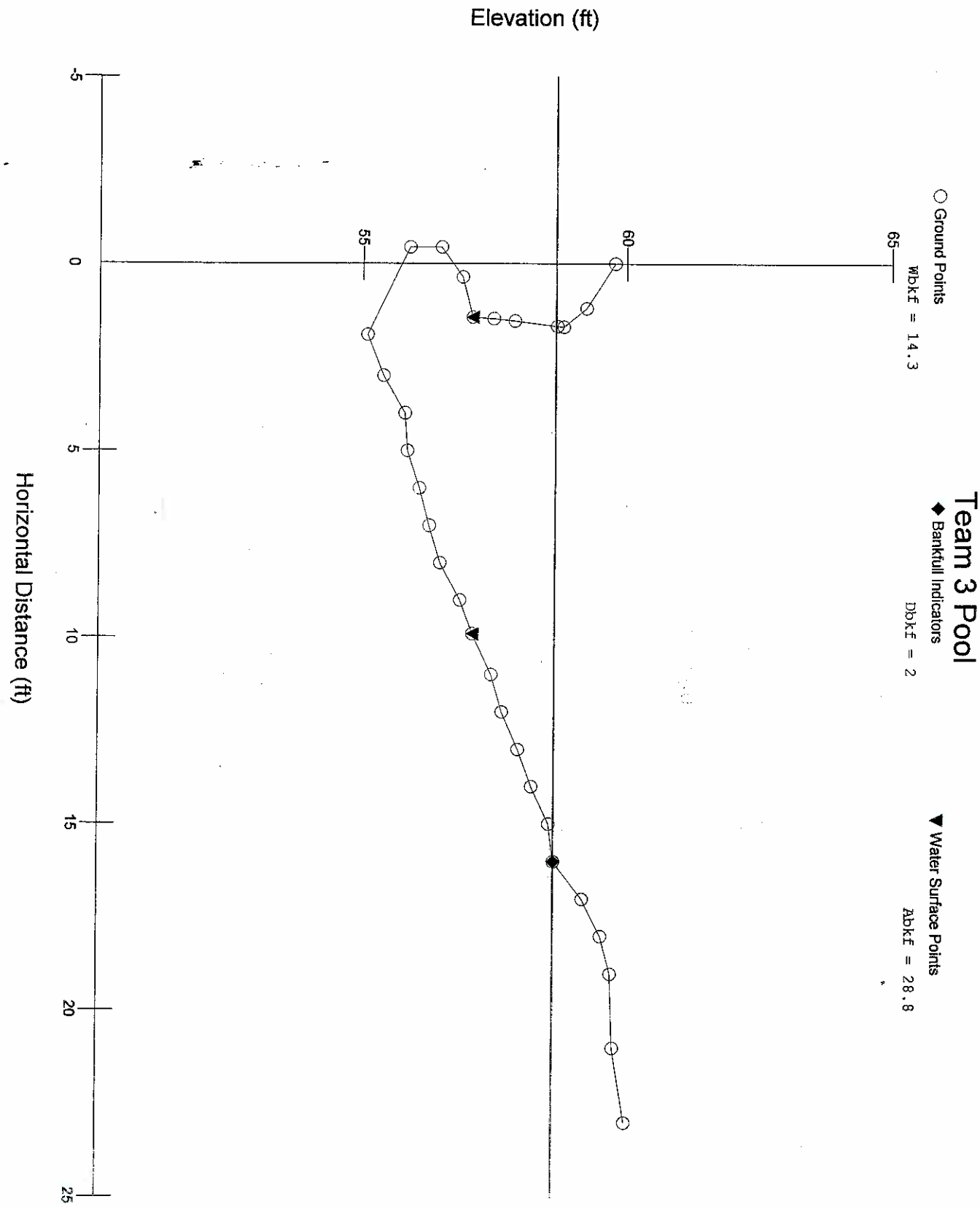
	Channel	Left	Right
Floodprone Elevation (ft)	61.28	61.28	61.28
Bankfull Elevation (ft)	59.09	59.09	59.09
Floodprone Width (ft)	27.5	-----	-----
Bankfull Width (ft)	23.14	11.57	11.89
Entrenchment Ratio	1.19	-----	-----
Mean Depth (ft)	1.42	1.42	1.42
Maximum Depth (ft)	2.19	1.74	2.19
Width/Depth Ratio	16.3	8.15	8.37
Bankfull Area (sq ft)	32.79	16.39	16.4
Wetted Perimeter (ft)	24.74	14.09	14.12
Hydraulic Radius (ft)	1.33	1.16	1.16
Begin BKF Station	2.22	2.22	13.79
End BKF Station	25.68	13.79	25.68

Entrainment Calculations

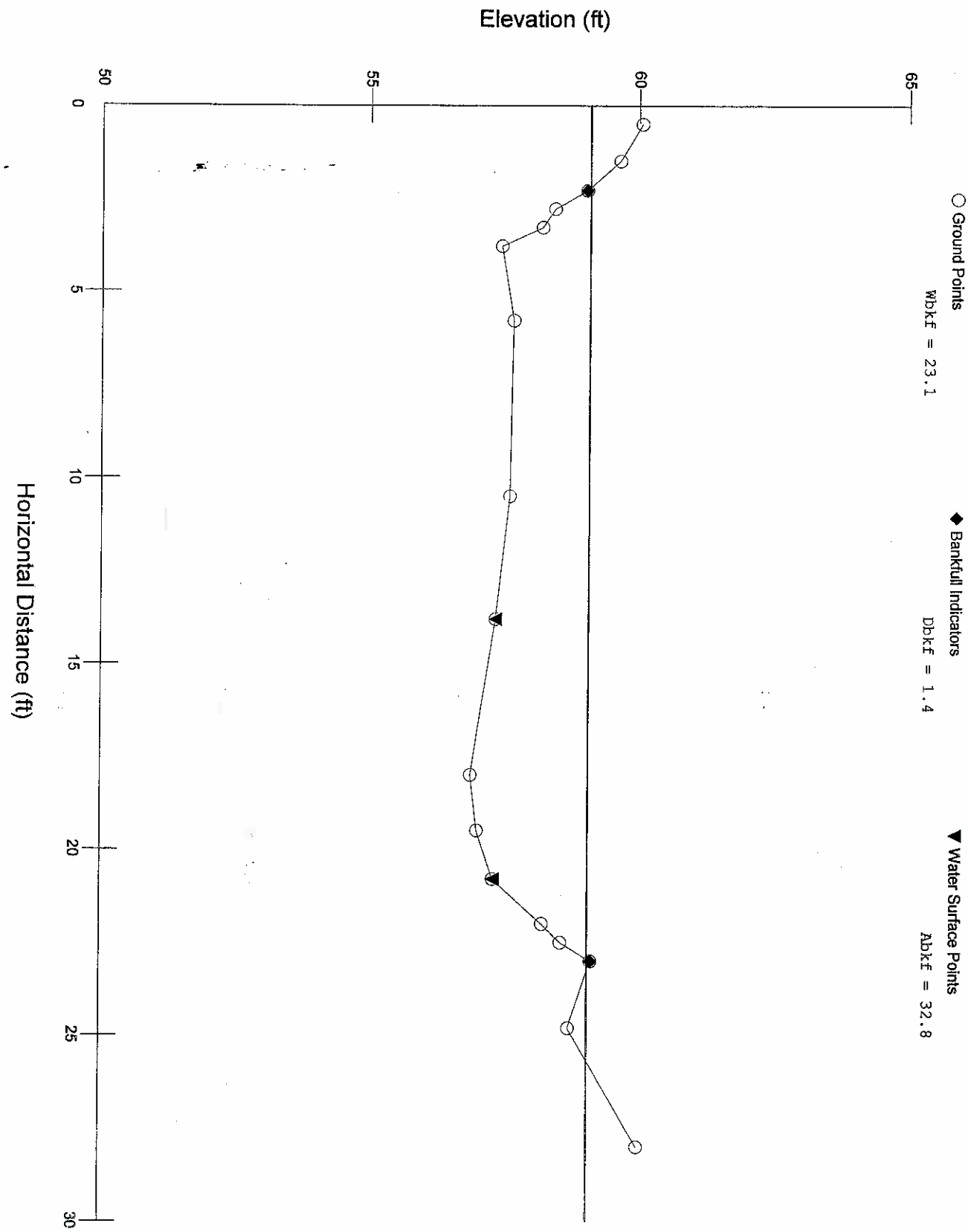
Entrainment Formula: Rosgen Modified Shields Curve

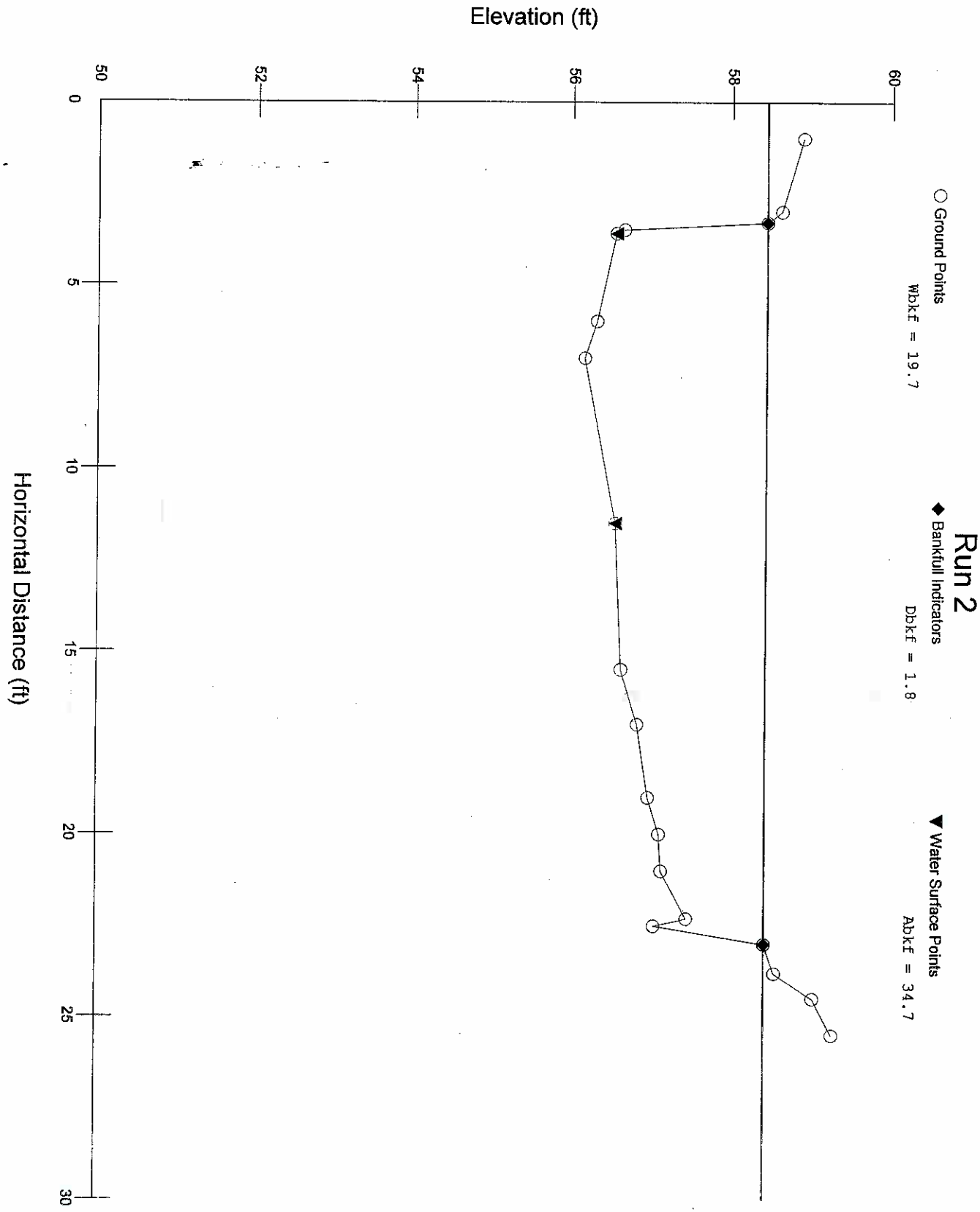
	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			

TEAM 3
9/18/07

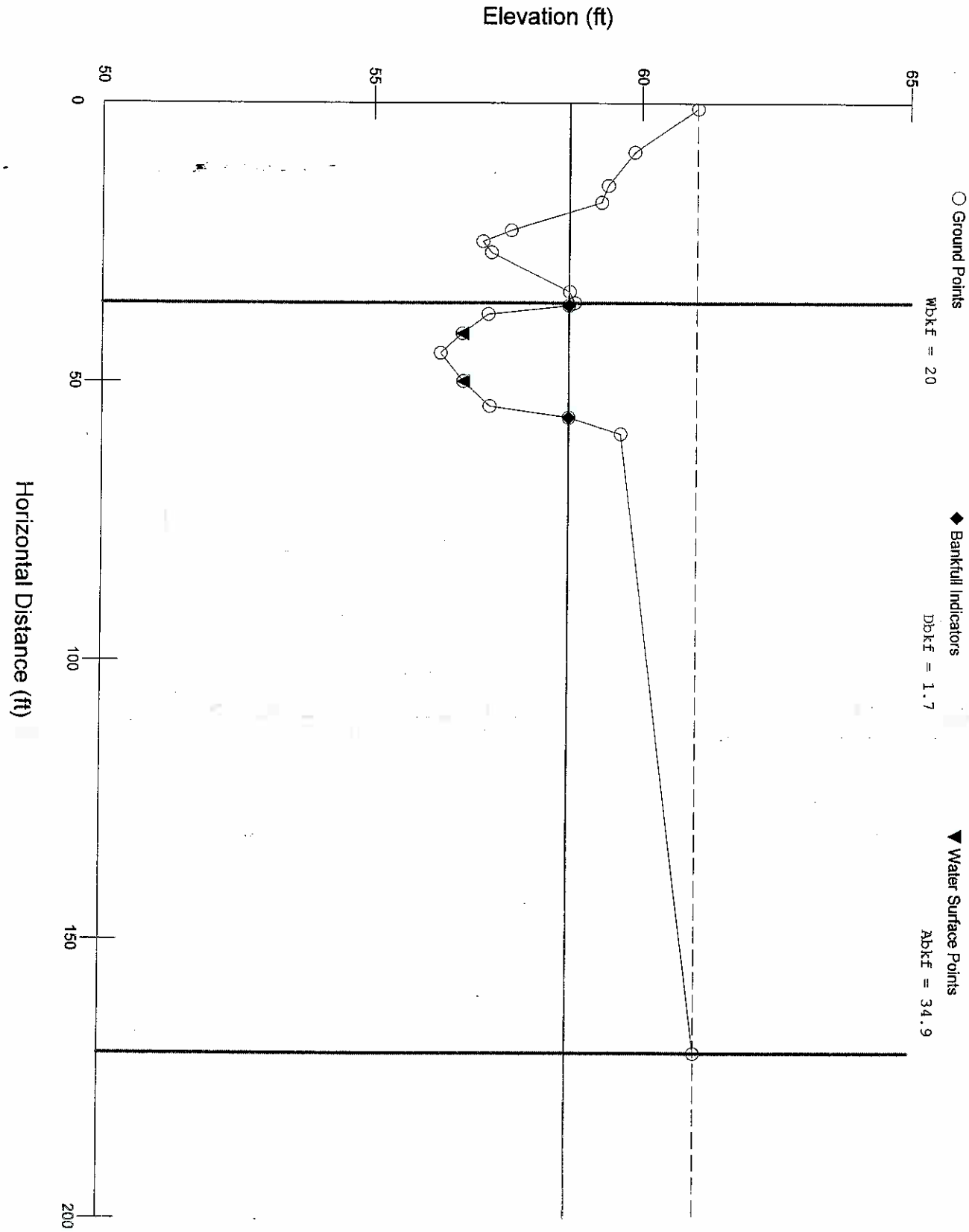

Team 3 Pool
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 14.3
Dbkf = 2
Abkf = 28.8
Elevation (ft)
65
60
55
Horizontal Distance (ft)
-5
0
5
10
15
20
25

TEAM 3
9/18/07


Glide 2
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 23.1
Dbkf = 1.4
Abkf = 32.8
Elevation (ft)
65
60
55
50
Horizontal Distance (ft)
0
5
10
15
20
25
30


TEAM 3
9/18/07
Run 2
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 19.7
Dbkf = 1.8
Abkf = 34.7
Elevation (ft)
60
58
56
54
52
50
0
5
10
15
20
25
30
Horizontal Distance (ft)

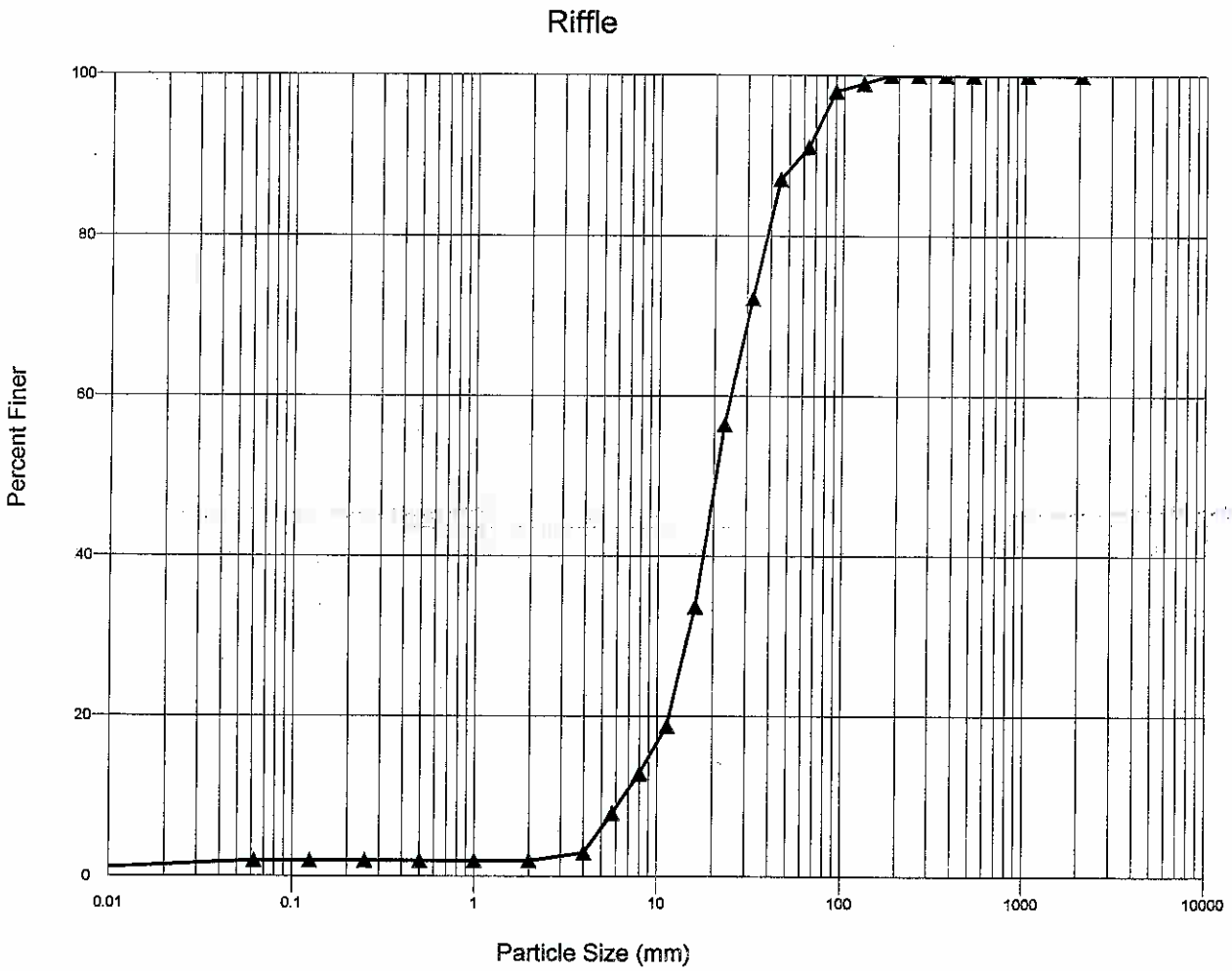
TEAM 3
9/18/07


Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 20
Dbkf = 1.7
Abkf = 34.9
Elevation (ft)
65
60
55
50
0
50
100
150
200
Horizontal Distance (ft)

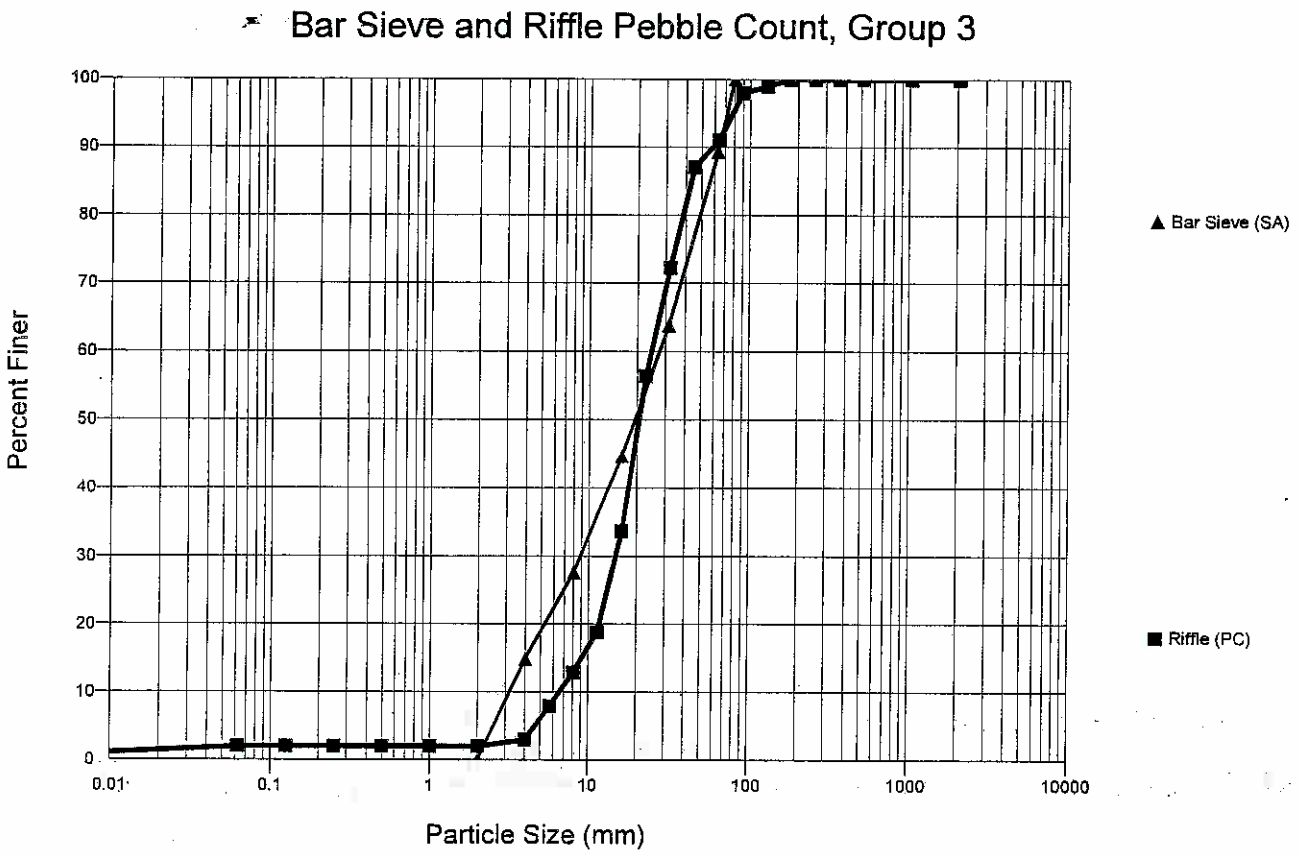
Magruder Branch Reference Reach Team 3 9/18/2007

TEAM 3

9/18/07



TEAM 3
9/18/07


Bar Sieve and Riffle Pebble Count, Group 3
Percent Finer
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
Bar Sieve (SA)
Riffle (PC)

River Name: Macgruder Branch
Reach Name: Reach 3
Sample Name: Bar Sieve
Survey Date: 09/18/2007

TEAM 3
9/18/07

SIEVE (mm)	NET WT
63	2
31.5	12
16	9
8	8
4	6
2	7
PAN	0

D16 (mm)	4.35
D35 (mm)	11.45
D50 (mm)	20.31
D84 (mm)	56.38
D95 (mm)	72.01
D100 (mm)	80
Silt/Clay (%)	0
Sand (%)	0
Gravel (%)	90.06
Cobble (%)	9.94
Boulder (%)	0
Bedrock (%)	0

Total Weight = 47.0000.

Largest Surface Particles:

	Size(mm)	Weight
Particle 1:	80	2
Particle 2:	60	1

Magruder Branch Reference Reach Team 3 9/18/2007

TEAM 3
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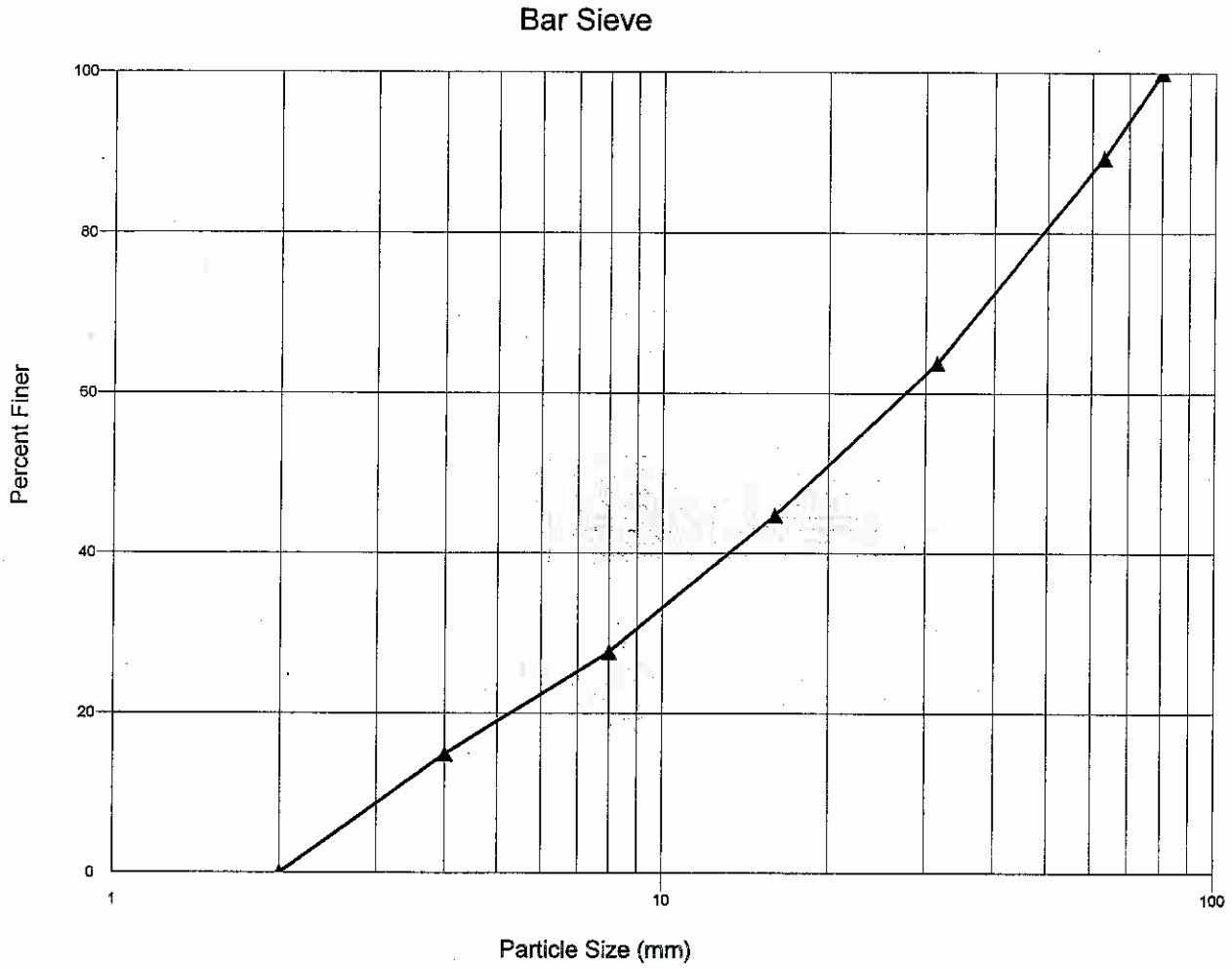
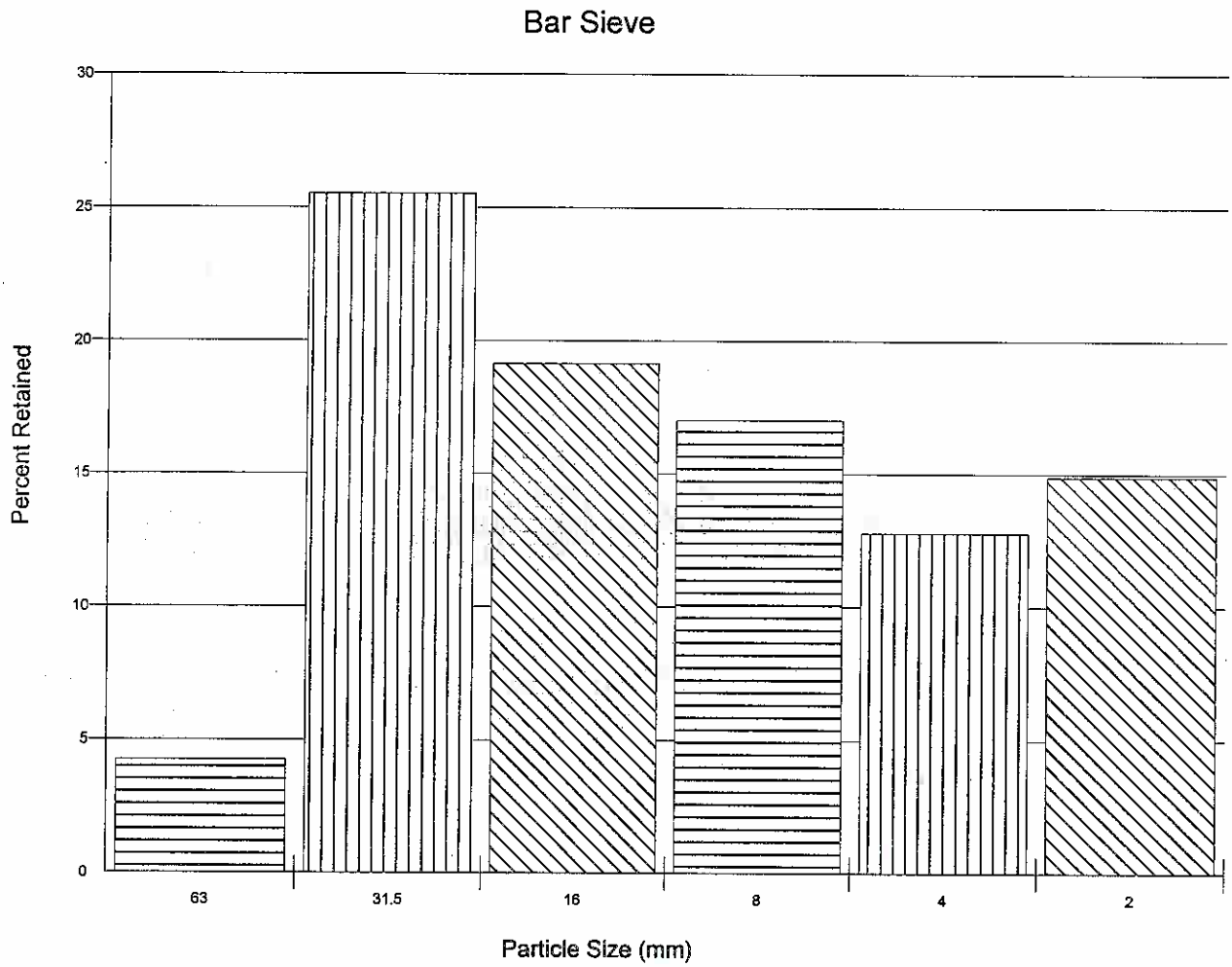


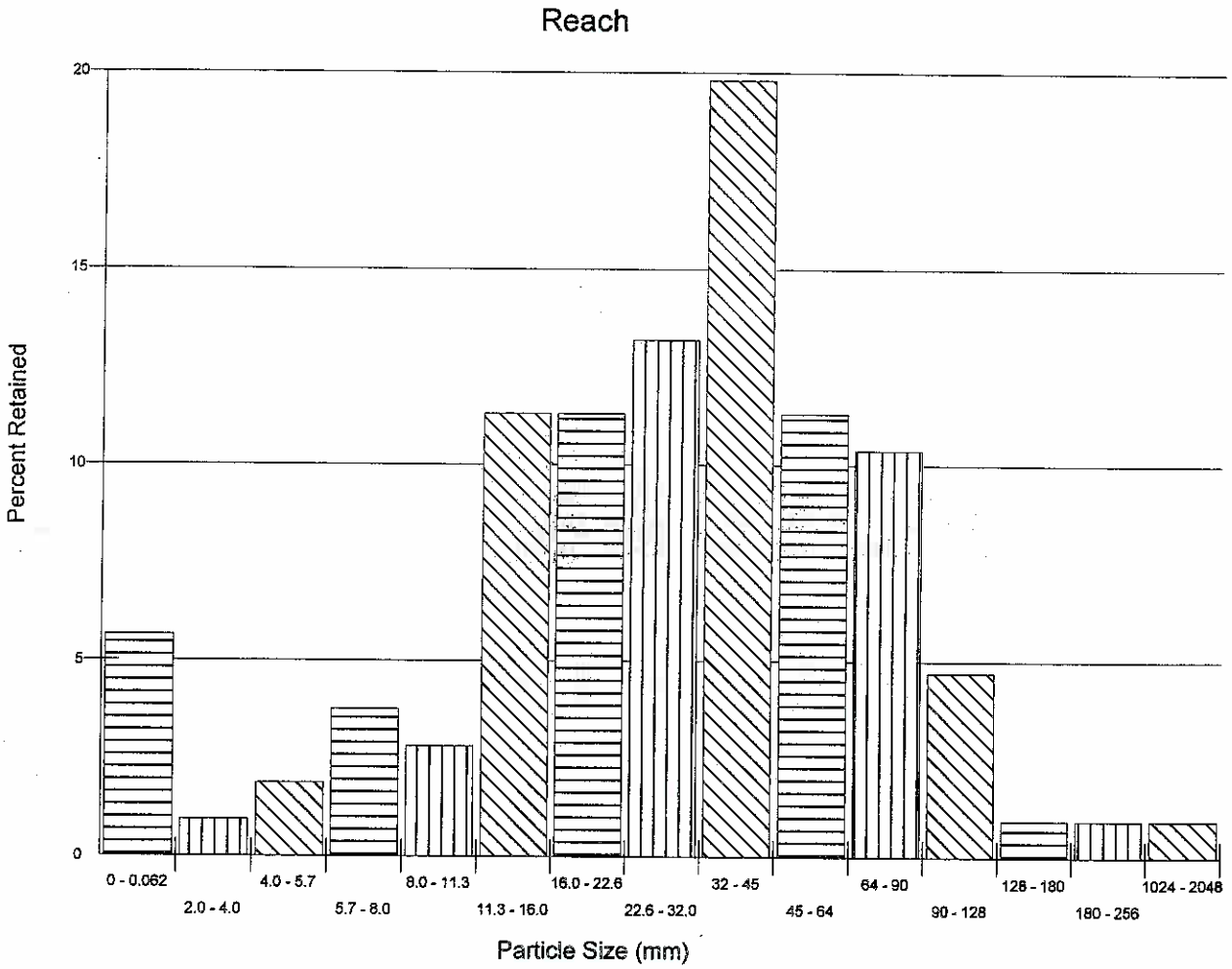
Magruder Branch Reference Reach Team 3 9/18/2007

TEAM 3
9/18/07



Magruder Branch Reference Reach Team 3 9/18/2007

TEAM 3
9/18/07



River Name: Macgruder Branch
Reach Name: Reach 3
Sample Name: Reach
Survey Date: 09/19/2007

TEAM 3
9/18/07

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	6	5.66	5.66
0.062 - 0.125	0	0.00	5.66
0.125 - 0.25	0	0.00	5.66
0.25 - 0.50	0	0.00	5.66
0.50 - 1.0	0	0.00	5.66
1.0 - 2.0	0	0.00	5.66
2.0 - 4.0	1	0.94	6.60
4.0 - 5.7	2	1.89	8.49
5.7 - 8.0	4	3.77	12.26
8.0 - 11.3	3	2.83	15.09
11.3 - 16.0	12	11.32	26.42
16.0 - 22.6	12	11.32	37.74
22.6 - 32.0	14	13.21	50.94
32 - 45	21	19.81	70.75
45 - 64	12	11.32	82.08
64 - 90	11	10.38	92.45
90 - 128	5	4.72	97.17
128 - 180	1	0.94	98.11
180 - 256	1	0.94	99.06
256 - 362	0	0.00	99.06
362 - 512	0	0.00	99.06
512 - 1024	0	0.00	99.06
1024 - 2048	1	0.94	100.00
Bedrock	0	0.00	100.00

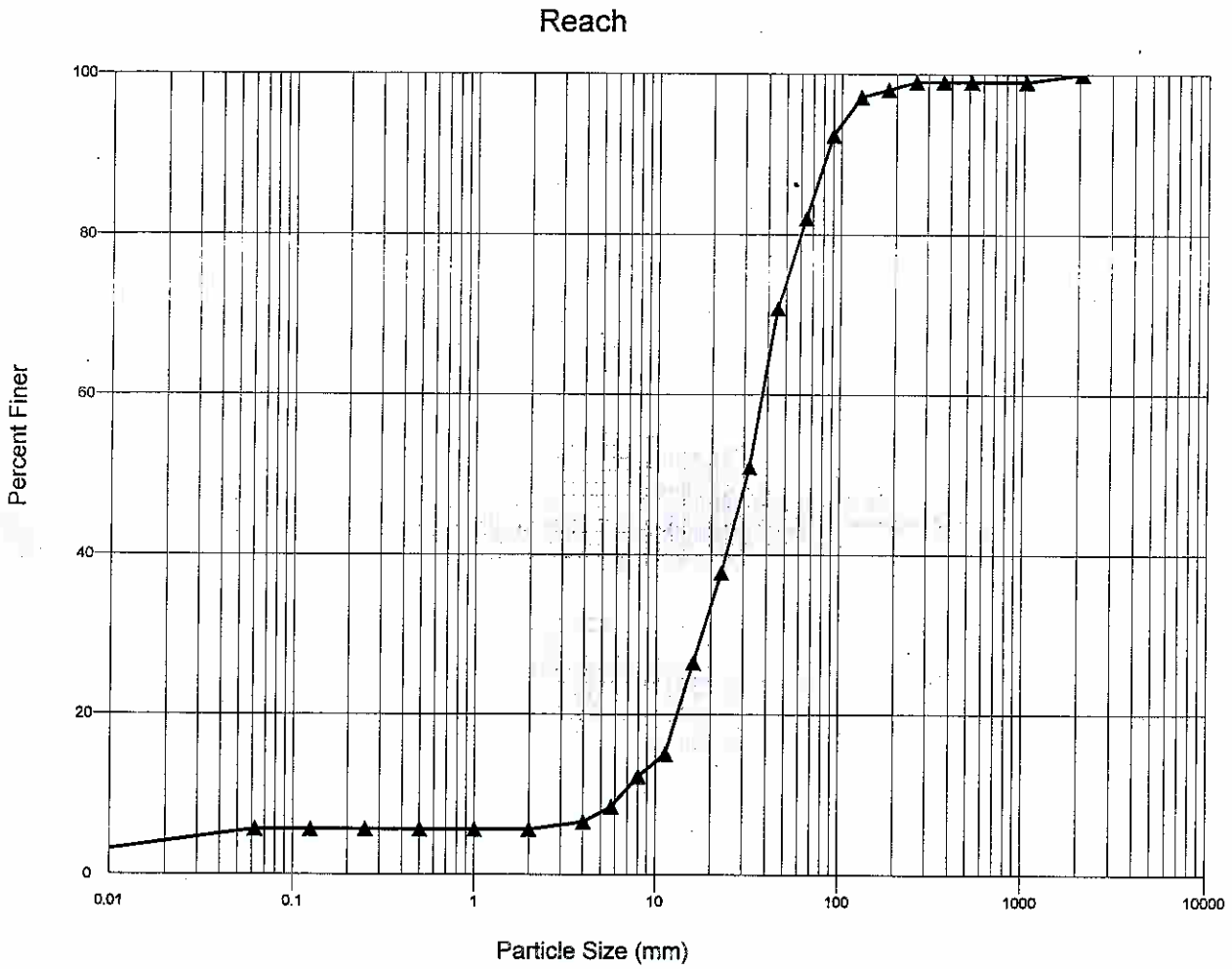
D16 (mm)	11.68
D35 (mm)	21
D50 (mm)	31.33
D84 (mm)	68.81
D95 (mm)	110.53
D100 (mm)	2047.89
Silt/Clay (%)	5.66
Sand (%)	0
Gravel (%)	76.42
Cobble (%)	16.98
Boulder (%)	0.94
Bedrock (%)	0

Total Particles = 106.

Magruder Branch Reference Reach Team 3 9/18/2007

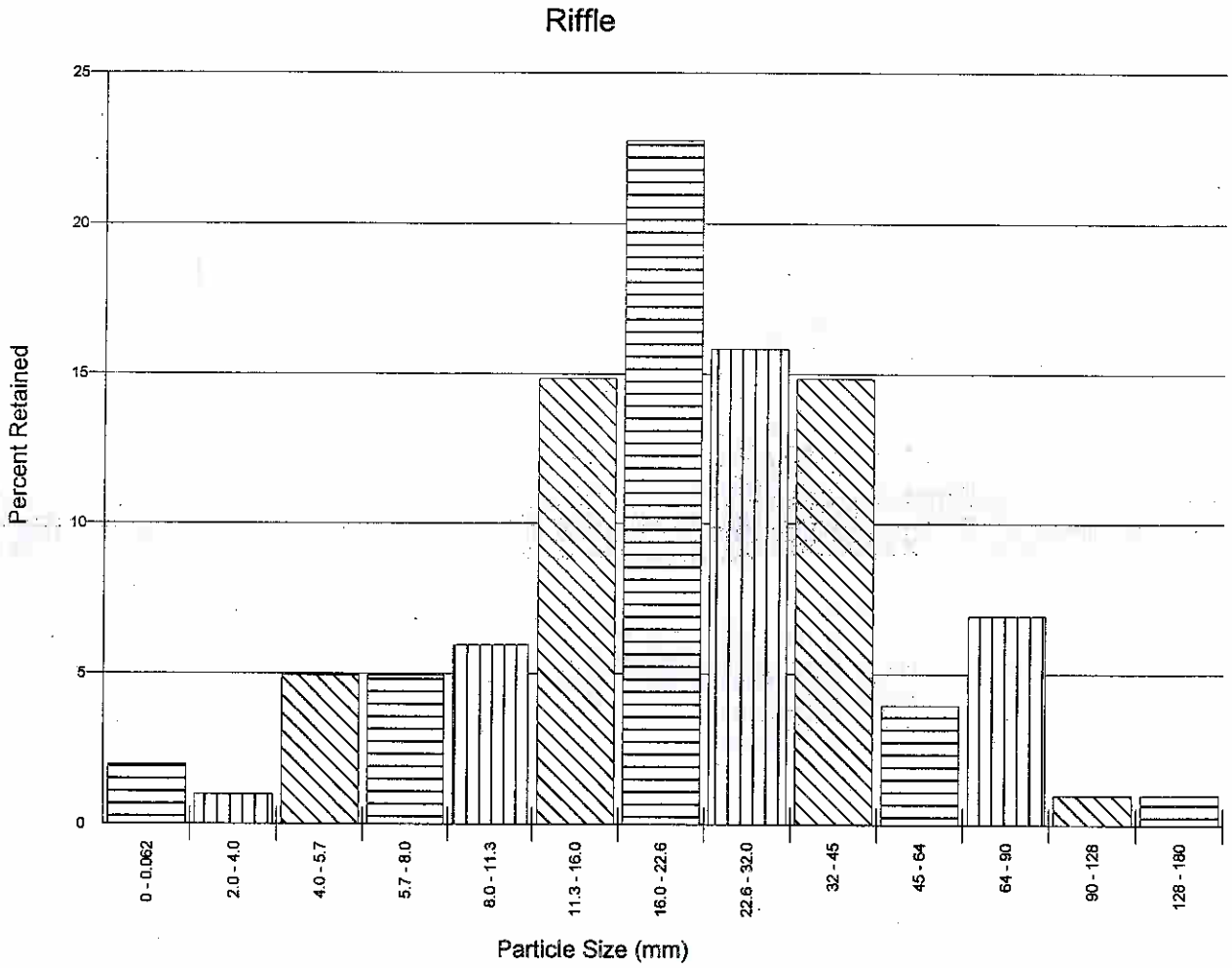
TEAM 3

9/18/07



Magruder Branch Reference Reach Team 3 9/18/2007

TEAM 3
9/18/07



River Name: Macgruder Branch
Reach Name: Reach 3
Sample Name: Riffle
Survey Date: 09/19/2007

TEAM 3
9/18/07

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	2	1.98	1.98
0.062 - 0.125	0	0.00	1.98
0.125 - 0.25	0	0.00	1.98
0.25 - 0.50	0	0.00	1.98
0.50 - 1.0	0	0.00	1.98
1.0 - 2.0	0	0.00	1.98
2.0 - 4.0	1	0.99	2.97
4.0 - 5.7	5	4.95	7.92
5.7 - 8.0	5	4.95	12.87
8.0 - 11.3	6	5.94	18.81
11.3 - 16.0	15	14.85	33.66
16.0 - 22.6	23	22.77	56.44
22.6 - 32.0	16	15.84	72.28
32 - 45	15	14.85	87.13
45 - 64	4	3.96	91.09
64 - 90	7	6.93	98.02
90 - 128	1	0.99	99.01
128 - 180	1	0.99	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	9.74
D35 (mm)	16.39
D50 (mm)	20.73
D84 (mm)	42.26
D95 (mm)	78.67
D100 (mm)	179.99
Silt/Clay (%)	1.98
Sand (%)	0
Gravel (%)	89.11
Cobble (%)	8.91
Boulder (%)	0
Bedrock (%)	0

Total Particles = 101.

Worksheet 5-6. Riparian vegetation composition/density used for channel stability assessment.

Stream: **MacGruder Branch**		Location: **Reach #3**	
Observers: **Team #3**	Reference reach [X]	Disturbed (impacted reach) [ ]	Date: **09/18/2007**
Existing species composition: **Maturing Forest**		Potential species composition: **Maturing Forest**	

Riparian cover categories		Percent aerial cover*	Percent of site coverage**	Species composition	Percent of total species composition
1. Overstory	Canopy layer	65%	20%	Sycamore	5%
				Tuluip Poplar	60%
				Red Maple	30%
				White Oak	5%
					100%
2. Understory	Shrub layer		15%	Spice Bush	75%
				Iron Wood	10%
				Mountain Laurel	5%
				Greenbrier	5%
				Lowbush Blueberry	5%
					100%
3. Ground level	Herbaceous		30%	Flase Nettle	25%
				Micro Stegium	40%
				Moss	15%
				VA Creeper	10%
				White Smartweed	10%
					100%
	Leaf or needle litter		25%	**Remarks:** Condition, vigor and/or usage of existing reach:	
	Bare ground		10%		
			Column total = 100%		

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

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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**080-104 R**	Observers:	**Team 3**
Date: **09/18/07**	Stream Type: **C4**	Valley Type:	**VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	1.7 (A)	Bankfull Height (ft) =	1.7 (B)	(A) / (B) =	1 (C)	1
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.1 (D)	Study Bank Height (ft) =	1.7 (A)	(D) / (A) =	0.64706 (E)	3.17
Weighted Root Density (G)						
Root Density as % =	70 (F)			(F) × (E) =	45.2941 (G)	4.69
Bank Angle (H)						
Bank Angle as *Degrees* =	5 (H)					1.23
Surface Protection (I)						
Surface Protection as % =	20 (I)					7.22

Bank Material Adjustment:

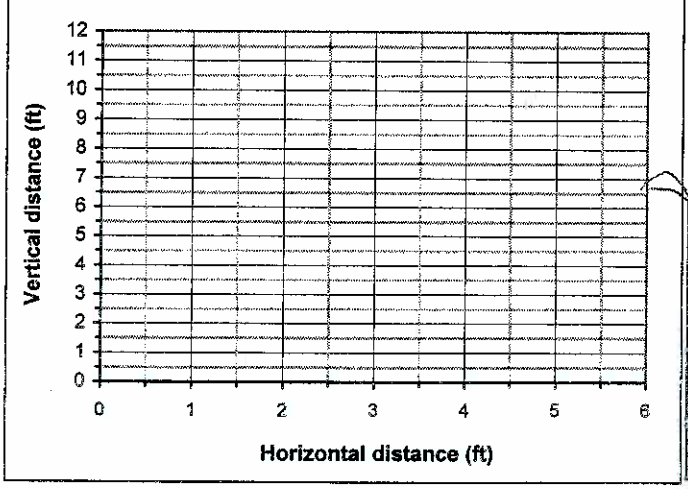
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no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

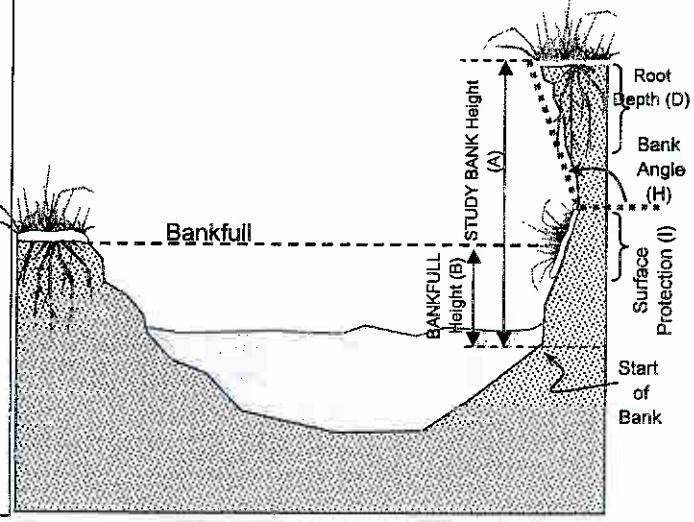
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme		
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	**Adjective Rating** and **Total Score**	**Low** 17.3

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**051-080 R**	Observers:	**Team 3**
Date:	**09/18/07**	Stream Type: **C4**	Valley Type: **VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	2.3 (A)	Bankfull Height (ft) =	1.4 (B)	(A) / (B) =	1.64286 (C)	6.19
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.5 (D)	Study Bank Height (ft) =	2.3 (A)	(D) / (A) =	0.65217 (E)	3.17
Weighted Root Density (G)						
		Root Density as % =	15 (F)	(F) x (E) =	9.78261 (G)	8.47
Bank Angle (H)						
				Bank Angle as *Degrees* =	48 (H)	3.32
Surface Protection (I)						
				Surface Protection as % =	10 (I)	9

Bank Material Adjustment:

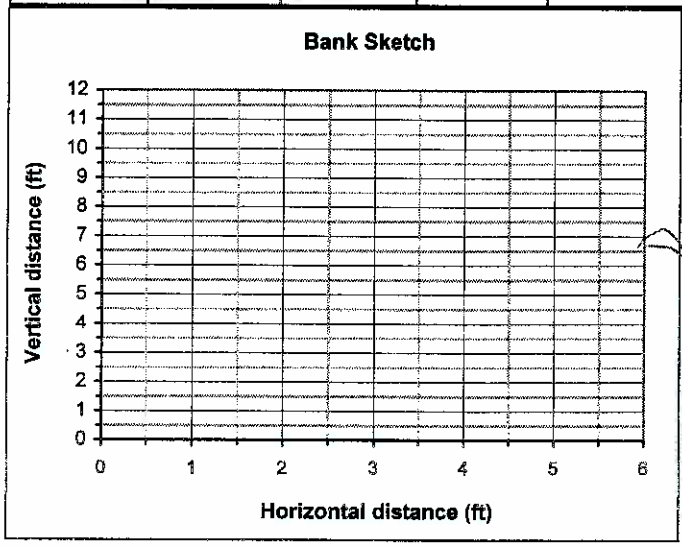
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

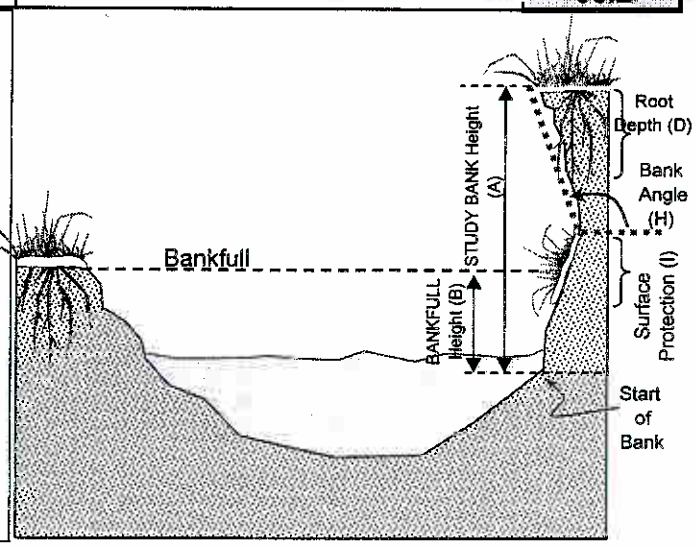
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	High
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		30.2

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**019-042 R**	Observers:	**Team 3**
Date: **09/18/07**	Stream Type: **C4**	Valley Type:	**VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	3.9 (A)	Bankfull Height (ft) =	3.8 (B)	(A) / (B) =	1.02632 (C)	1.27
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	3.2 (D)	Study Bank Height (ft) =	3.9 (A)	(D) / (A) =	0.82051 (E)	2.34
Weighted Root Density (G)						
Root Density as % =	70 (F)			(F) × (E) =	57.4359 (G)	3.71
Bank Angle (H)						
Bank Angle as *Degrees* =	140 (H)					10
Surface Protection (I)						
Surface Protection as % =	50 (I)					4.32

Bank Material Adjustment:

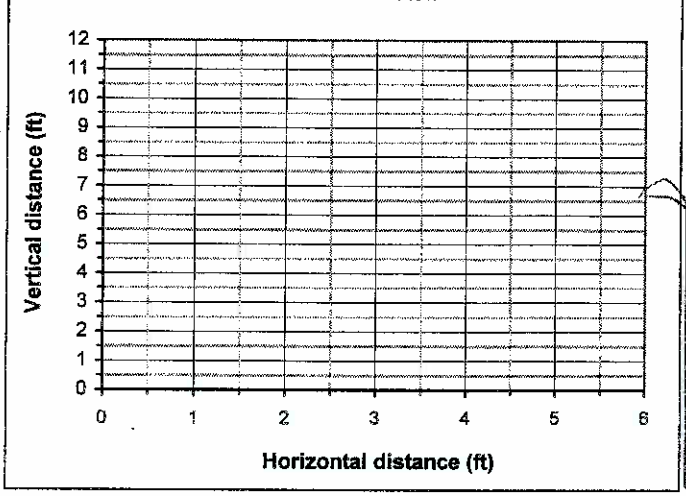
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no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

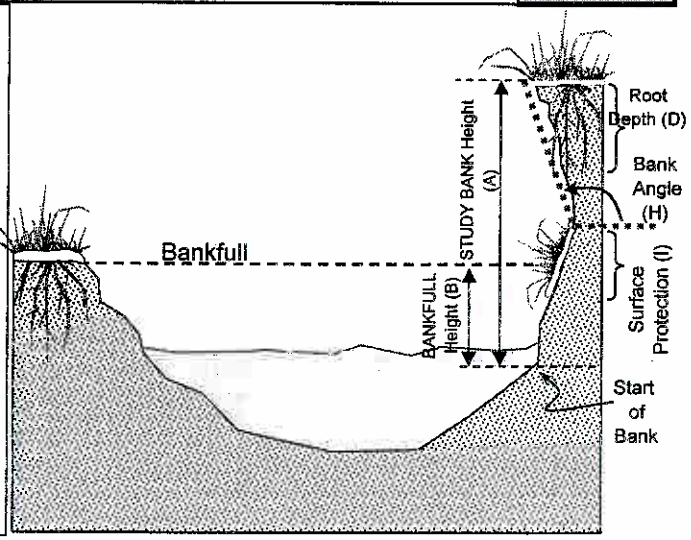
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Moderate
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		21.6

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**045-058 L**	Observers:	**Team 3**
Date: **09/18/07**	Stream Type: **C4**	Valley Type:	**VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	2.2 (A)	Bankfull Height (ft) =	1.7 (B)	(A) / (B) =	1.29412 (C)	4.57
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	0.9 (D)	Study Bank Height (ft) =	2.2 (A)	(D) / (A) =	0.40909 (E)	4.8
Weighted Root Density (G)						
Root Density as % =	15 (F)			(F) × (E) =	6.13636 (G)	8.87
Bank Angle (H)						
Bank Angle as *Degrees* =	48 (H)					3.32
Surface Protection (I)						
Surface Protection as % =	5 (I)					10

Bank Material Adjustment:

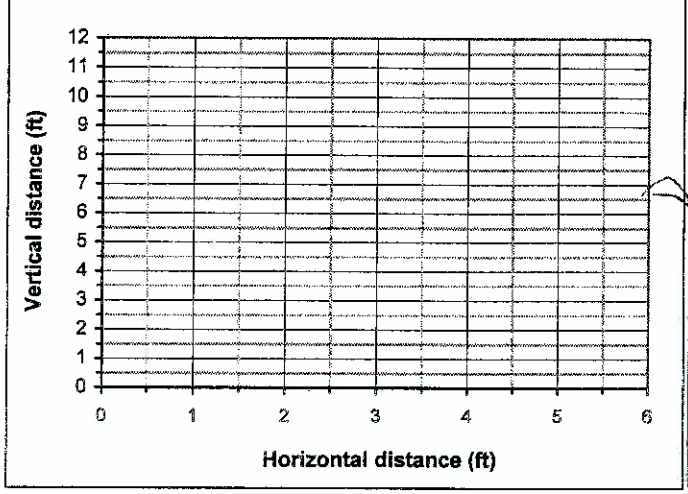
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

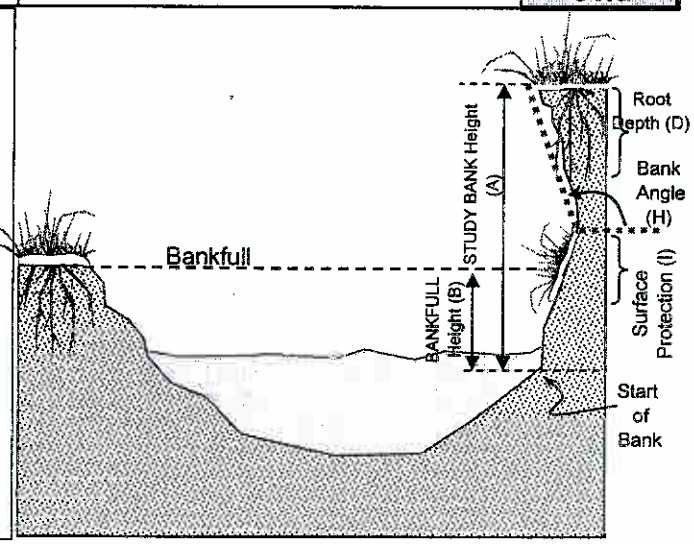
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	High
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		31.6

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream: **Macgruder Branch, Reach - Reach 3**		Location: **Reach 3**	
Station: **093-111 L**		Observers: **Team 3**	
Date: **09/18/07**	Stream Type: **C4**	Valley Type: **VIII**	

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	1.9 (A)	Bankfull Height (ft) =	1.7 (B)	(A) / (B) =	1.11765 (C)	2.24
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.9 (D)	Study Bank Height (ft) =	1.9 (A)	(D) / (A) =	1 (E)	1
Weighted Root Density (G)						
Root Density as % =	30 (F)			(F) x (E) =	30 (G)	5.9
Bank Angle (H)						
Bank Angle as *Degrees* =	66 (H)					4.5
Surface Protection (I)						
Surface Protection as % =	10 (I)					9

Bank Material Adjustment:

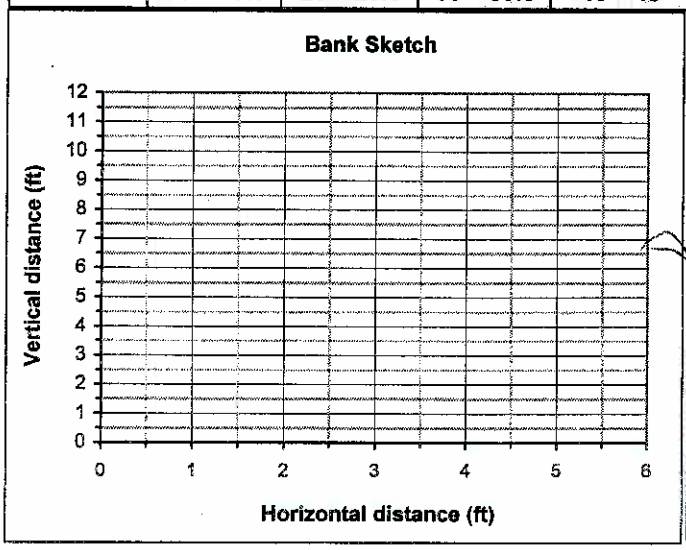
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no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

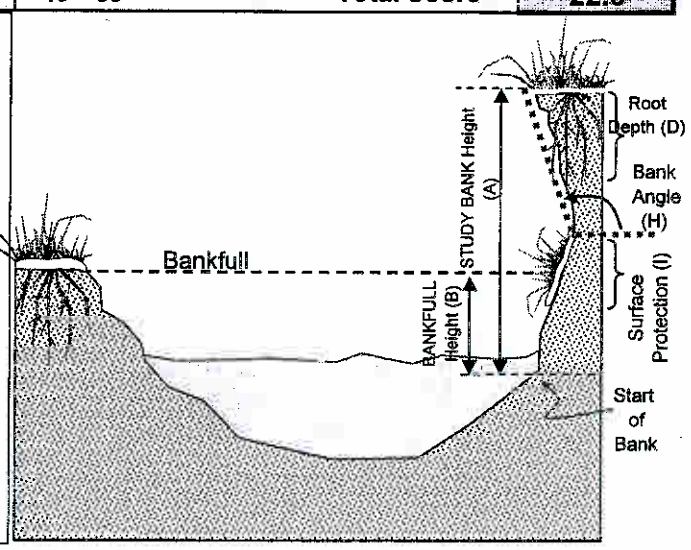
Bank Material Adjustment 0

Stratification Adjustment Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Moderate
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		22.6

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**118-147 L**	Observers:	**Team 3**
Date: **09/18/07**	Stream Type: **C4**	Valley Type:	**VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	2.7 (A)	Bankfull Height (ft) =	2 (B)	(A) / (B) =	1.35 (C)	4.95
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	2.3 (D)	Study Bank Height (ft) =	2.7 (A)	(D) / (A) =	0.85185 (E)	2.19
Weighted Root Density (G)						
Root Density as % =	75 (F)			(F) × (E) =	63.8889 (G)	3.2
Bank Angle (H)						
Bank Angle as *Degrees* =	110 (H)					8.68
Surface Protection (I)						
Surface Protection as % =	65 (I)					3.11

Bank Material Adjustment:

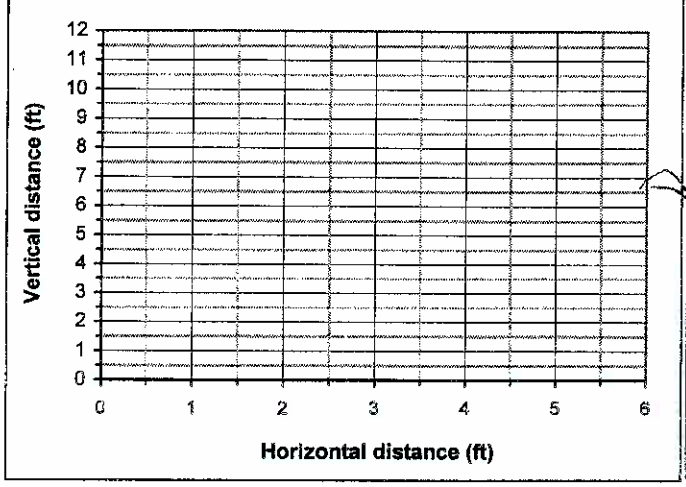
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

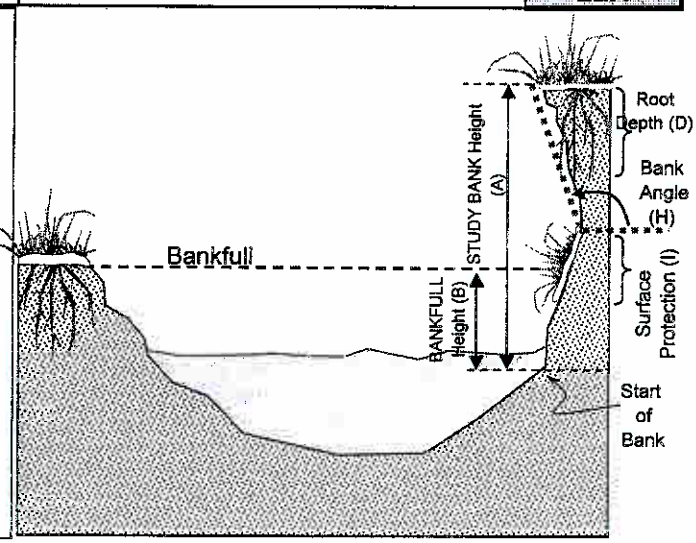
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Moderate
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		22.1

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**147-157 L**	Observers:	**Team 3**
Date: **09/18/07**	Stream Type: **C4**	Valley Type:	**VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	3 (A)	Bankfull Height (ft) =	1.6 (B)	(A) / (B) =	1.875 (C)	7.33
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.4 (D)	Study Bank Height (ft) =	3 (A)	(D) / (A) =	0.46667 (E)	4.2
Weighted Root Density (G)						
Root Density as % =	65 (F)			(F) x (E) =	30.3333 (G)	5.87
Bank Angle (H)						
Bank Angle as *Degrees* =	100 (H)					8.32
Surface Protection (I)						
Surface Protection as % =	40 (I)					5.11

Bank Material Adjustment:

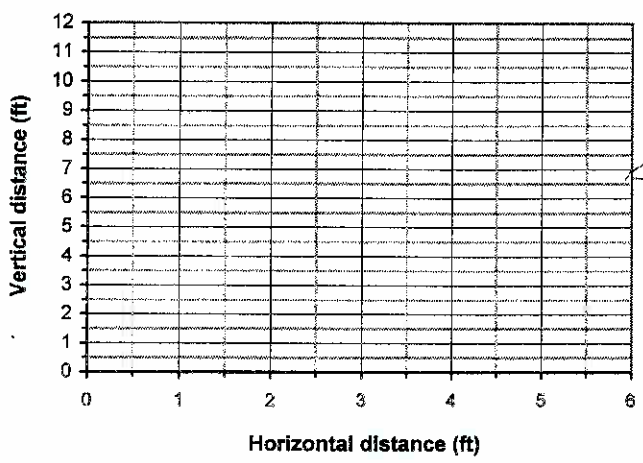
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

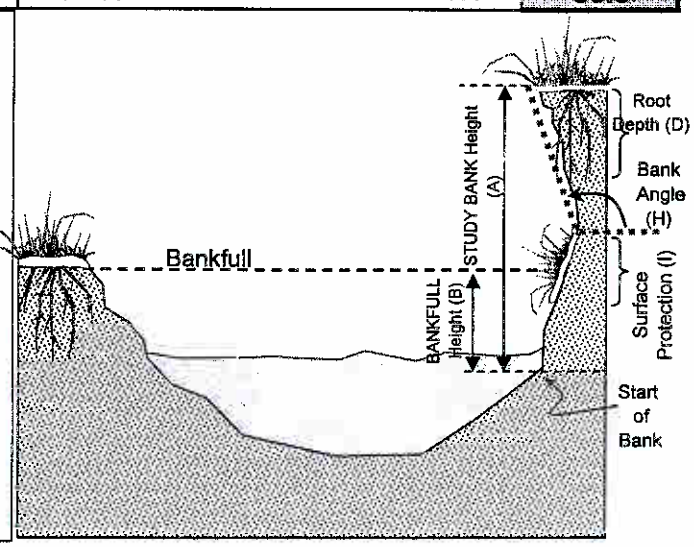
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	High
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		30.8

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**042-051 R**	Observers:	**Team 3**
Date:	**09/18/07**	Stream Type: **C4**	Valley Type: **VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	2.3 (A)	Bankfull Height (ft) =	1.4 (B)	(A) / (B) =	1.64286 (C)	6.19
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.5 (D)	Study Bank Height (ft) =	2.3 (A)	(D) / (A) =	0.65217 (E)	3.17
Weighted Root Density (G)						
		Root Density as % =	15 (F)	(F) × (E) =	9.78261 (G)	8.47
Bank Angle (H)						
				Bank Angle as *Degrees* =	38 (H)	2.83
Surface Protection (I)						
				Surface Protection as % =	10 (I)	9

Bank Material Adjustment:

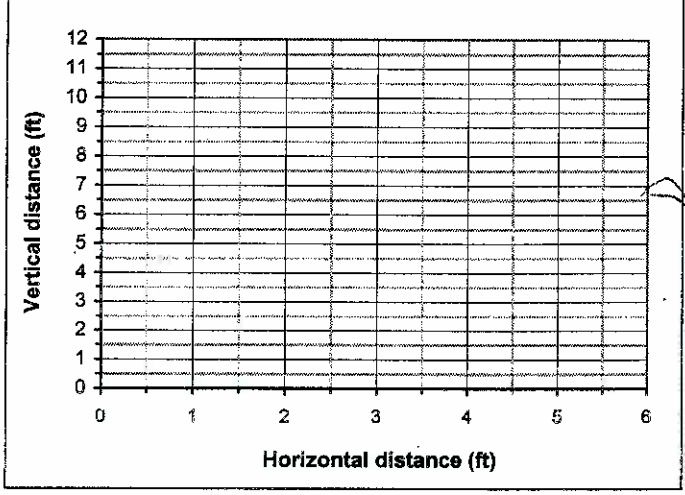
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no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

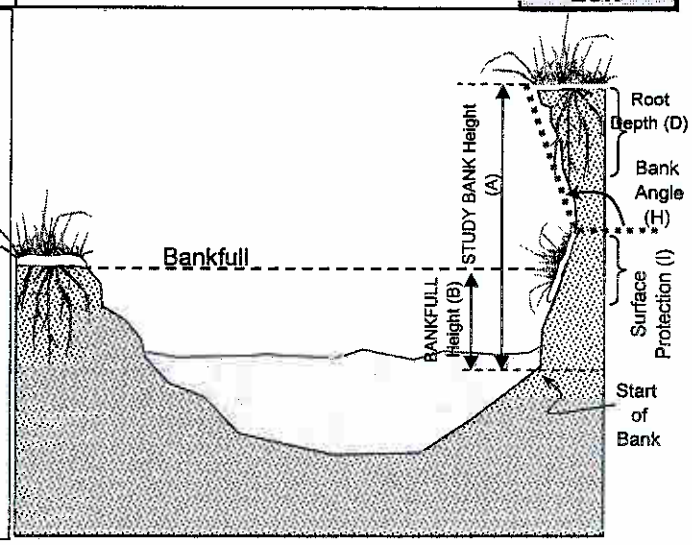
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Moderate
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		29.7

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**157-177 L**	Observers:	**Team 3**
Date: **09/18/07**	Stream Type: **C4**	Valley Type:	**VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	3 (A)	Bankfull Height (ft) =	2 (B)	(A) / (B) =	1.5 (C)	5.9
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.4 (D)	Study Bank Height (ft) =	3 (A)	(D) / (A) =	0.46667 (E)	4.2
Weighted Root Density (G)						
Root Density as % =	65 (F)			(F) × (E) =	30.3333 (G)	5.87
Bank Angle (H)						
Bank Angle as *Degrees* =	100 (H)					8.32
Surface Protection (I)						
Surface Protection as % =	40 (I)					5.11

Bank Material Adjustment:

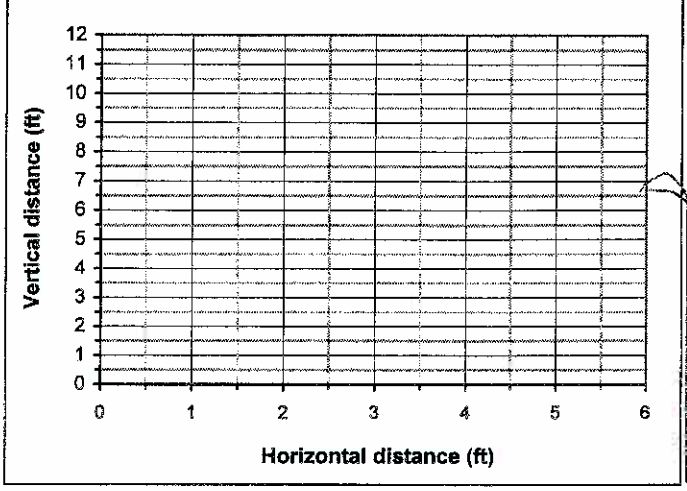
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no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

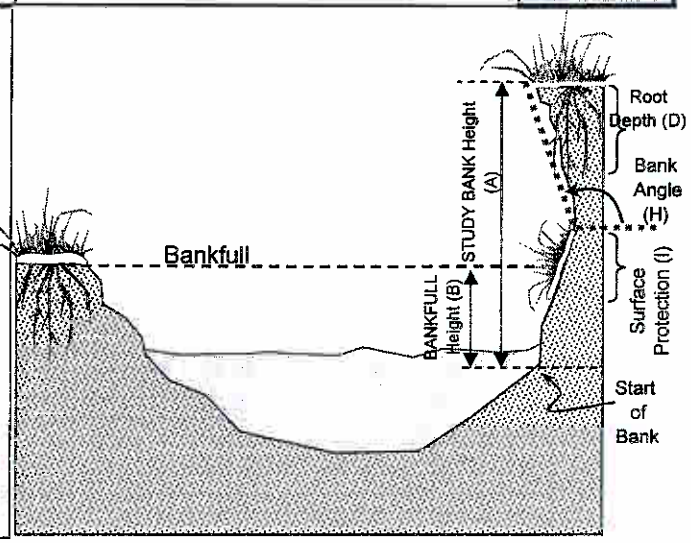
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Moderate
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		29.4

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**177-221 L**	Observers:	**Team 3**
Date: **09/18/07**	Stream Type: **C4**	Valley Type:	**VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	3 (A)	Bankfull Height (ft) =	1.8 (B)	(A) / (B) =	1.66667 (C)	6.33
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.4 (D)	Study Bank Height (ft) =	3 (A)	(D) / (A) =	0.46667 (E)	4.2
Weighted Root Density (G)						
Root Density as % =	65 (F)			(F) × (E) =	30.3333 (G)	5.87
Bank Angle (H)						
Bank Angle as *Degrees* =	100 (H)					8.32
Surface Protection (I)						
Surface Protection as % =	40 (I)					5.11

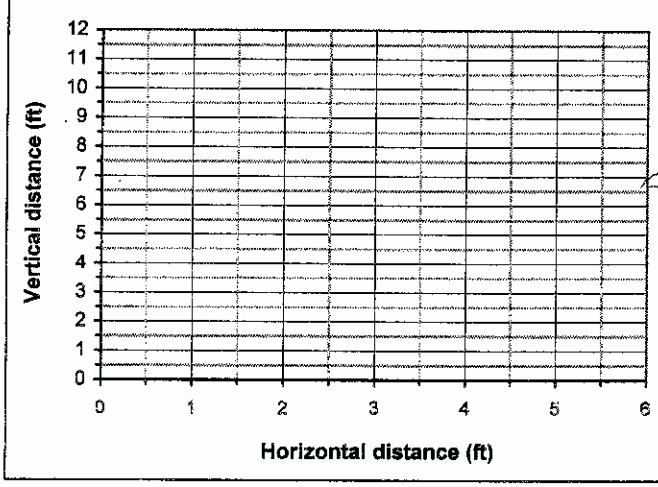
Bank Material Adjustment:

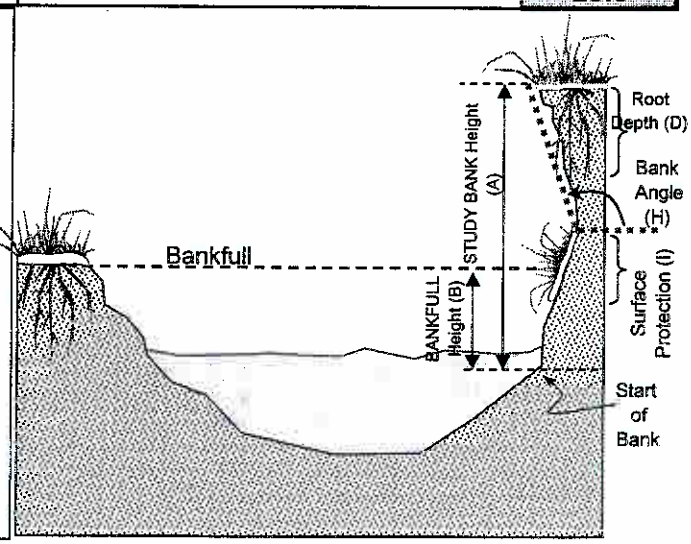
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment	0
Stratification Adjustment Add 5–10 points, depending on position of unstable layers in relation to bankfull stage	0

Very Low	Low	Moderate	High	Very High	Extreme		
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	**Adjective Rating** and **Total Score**	**Moderate** 29.8

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**185-221 R**	Observers:	**Team 3**
Date:	**09/18/07**	Stream Type: **C4**	Valley Type: **VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	2.5 (A)	Bankfull Height (ft) =	1.5 (B)	(A) / (B) =	1.66667 (C)	6.33
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	2.5 (D)	Study Bank Height (ft) =	2.5 (A)	(D) / (A) =	1 (E)	1
Weighted Root Density (G)						
Root Density as % =	60 (F)			(F) × (E) =	60 (G)	3.5
Bank Angle (H)						
Bank Angle as *Degrees* =	35 (H)					2.68
Surface Protection (I)						
Surface Protection as % =	60 (I)					3.5

Bank Material Adjustment:

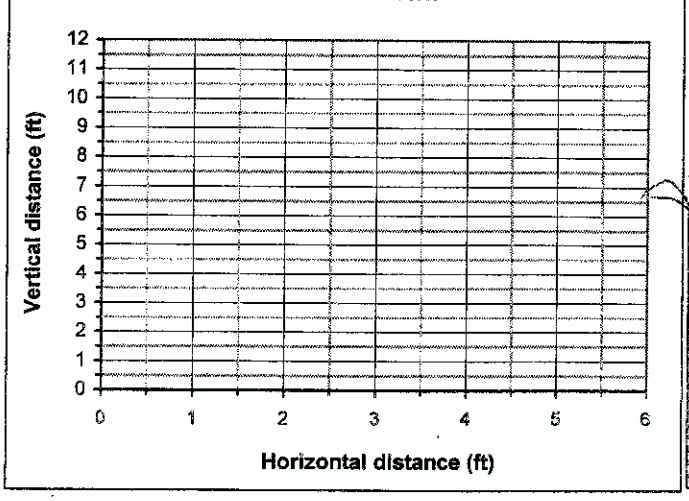
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no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

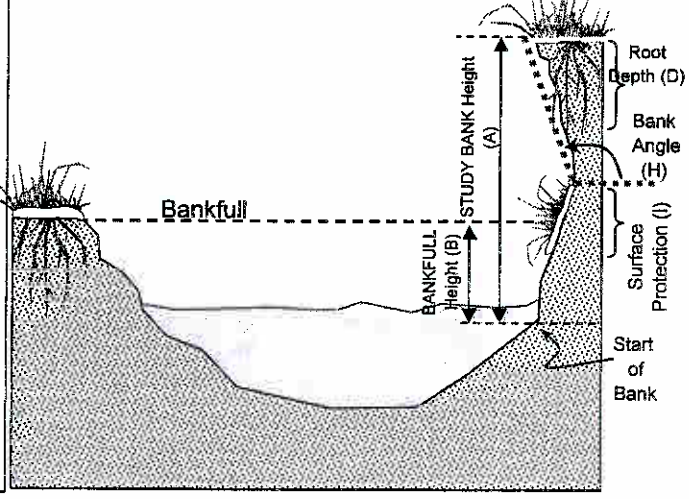
Bank Material Adjustment 0

Stratification Adjustment
Add 5–10 points, depending on position of unstable layers in relation to bankfull stage 0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Low
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		17.0

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**000-019 R**	Observers:	**Team 3**
Date:	**09/18/07**	Stream Type: **C4**	Valley Type: **VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	3.9 (A)	Bankfull Height (ft) =	2.86 (B)	(A) / (B) =	1.36364 (C)	5.01
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	3.2 (D)	Study Bank Height (ft) =	3.9 (A)	(D) / (A) =	0.82051 (E)	2.34
Weighted Root Density (G)						
Root Density as % =	70 (F)			(F) × (E) =	57.4359 (G)	3.71
Bank Angle (H)						
Bank Angle as *Degrees* =	140 (H)					10
Surface Protection (I)						
Surface Protection as % =	50 (I)					4.32

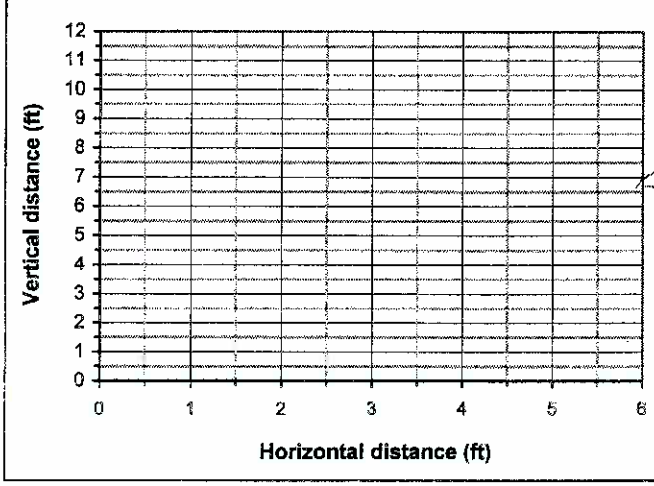
Bank Material Adjustment:

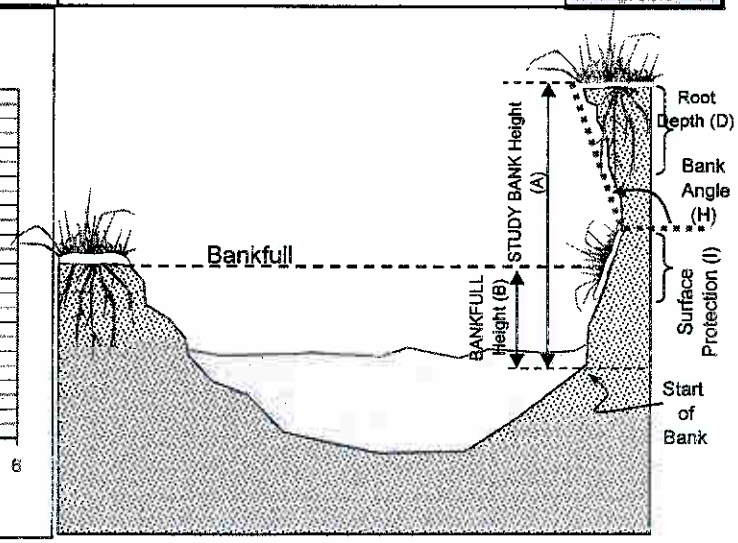
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment	0
Stratification Adjustment Add 5–10 points, depending on position of unstable layers in relation to bankfull stage	0

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	Moderate
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		25.4

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**058-083 L**	Observers:	**Team 3**
Date:	**09/18/07**	Stream Type: **C4**	Valley Type: **VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	2.5 (A)	Bankfull Height (ft) =	1.6 (B)	(A) / (B) =	1.5625 (C)	5.81
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.3 (D)	Study Bank Height (ft) =	2.5 (A)	(D) / (A) =	0.52 (E)	3.8
Weighted Root Density (G)						
		Root Density as % =	10 (F)	(F) × (E) =	5.2 (G)	8.98
Bank Angle (H)						
				Bank Angle as *Degrees* =	52 (H)	3.51
Surface Protection (I)						
				Surface Protection as % =	5 (I)	10

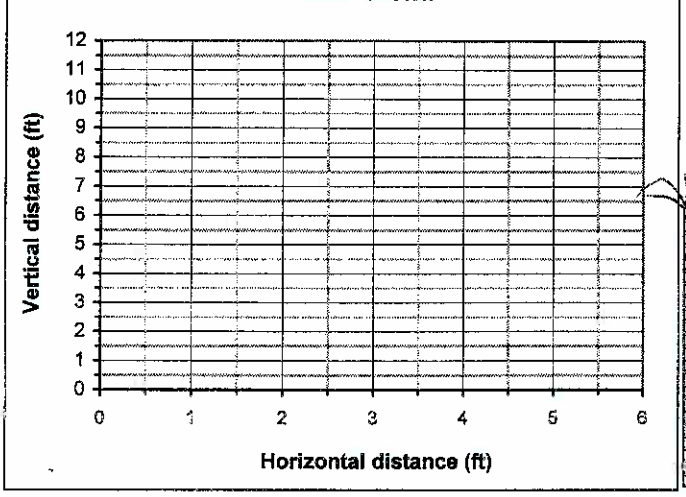
Bank Material Adjustment:

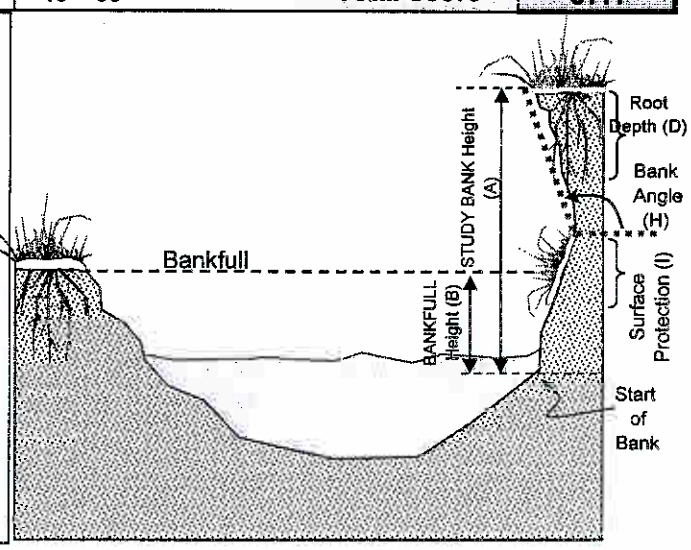
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no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

Bank Material Adjustment	0
Stratification Adjustment Add 5–10 points, depending on position of unstable layers in relation to bankfull stage	5

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score	High
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50		37.1

Bank Sketch





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Worksheet 5-8. Form to calculate Bank Erosion Hazard Index (BEHI) variables and an overall BEHI rating (Rosgen, 1996, 2001a). Use **Figure 5-19** with BEHI variables to determine BEHI score.

Stream:	**Macgruder Branch, Reach - Reach 3**	Location:	**Reach 3**
Station:	**161-185 R**	Observers:	**Team 3**
Date:	**09/18/07**	Stream Type: **C4**	Valley Type: **VIII**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	2.5 (A)	Bankfull Height (ft) =	1.2 (B)	(A) / (B) =	2.08333 (C)	7.97
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.3 (D)	Study Bank Height (ft) =	2.5 (A)	(D) / (A) =	0.52 (E)	3.8
Weighted Root Density (G)						
		Root Density as % =	40 (F)	(F) × (E) =	20.8 (G)	7.11
Bank Angle (H)						
				Bank Angle as *Degrees* =	40 (H)	2.93
Surface Protection (I)						
				Surface Protection as % =	10 (I)	9

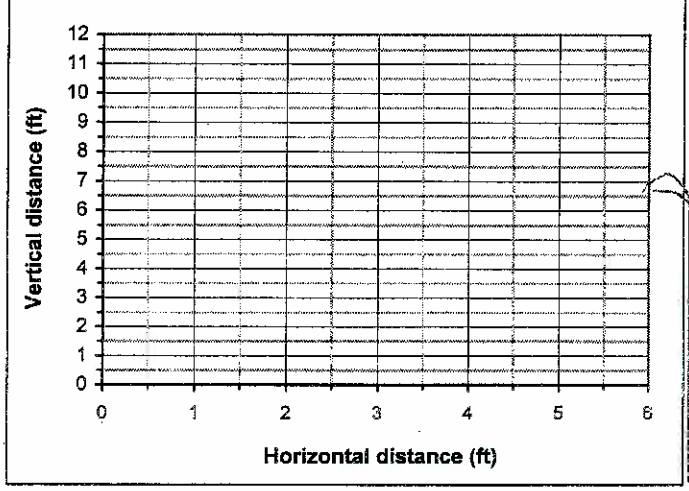
Bank Material Adjustment:

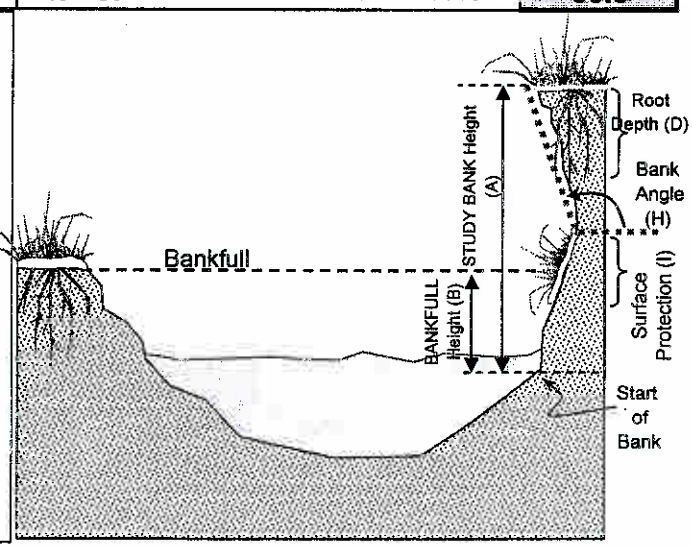
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment	0
Stratification Adjustment Add 5–10 points, depending on position of unstable layers in relation to bankfull stage	0

Very Low	Low	Moderate	High	Very High	Extreme		
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50	**Adjective Rating** and **Total Score**	**High** 30.8

Bank Sketch





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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **161-185 R** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	1.3	0.95	1.37	Low

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

Level IV

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

Dominant Near-Bank Stress: **Low**

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating: **Low**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **080-104 R** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress: **Moderate**

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
	1.9	**1.12**	**1.7**	**Moderate**

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

Level IV

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

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating **Moderate**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **051-080 R** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**2.1**	**1.32**	**1.59**	**Moderate**

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

Level IV

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

Dominant Near-Bank Stress

Moderate

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating **Moderate**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **019-042 R** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**3.3**	**1.27**	**2.6**	**Very High**

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

Level IV

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

Dominant Near-Bank Stress

Very High

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating **Very High**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **045-058 L** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress: **Low**

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
	1.8	**1.69**	**1.07**	**Low**

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

Level IV

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

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating **Low**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **093-111 L** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**1.8**	**1.12**	**1.61**	**Moderate**

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

Level IV

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

Dominant Near-Bank Stress: **Moderate**

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating **Moderate**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **118-147 L** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**3.3**	**1.08**	**3.06**	**Extreme**

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

Level IV

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

Dominant Near-Bank Stress
Extreme

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating **Extreme**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **147-157 L** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**3.3**	**1.44**	**2.29**	**High**

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

Level IV

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

Dominant Near-Bank Stress

High

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating **High**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **157-177 L** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Level III

(5) Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
2	1.2	1.67	Moderate

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

Level IV

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

Dominant Near-Bank Stress
Moderate

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating **Moderate**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **177-221 L** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Level III

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

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

Level IV

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

Dominant Near-Bank Stress

Very Low

Converting values to a Near-Bank Stress (NBS) rating

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

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

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **058-083 L** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**1.8**	**1.2**	**1.5**	**Low**

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

Level IV

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

Dominant Near-Bank Stress
Low

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating **Low**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **185-221 R** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Dominant Near-Bank Stress: **Low**

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**1.85**	**1.26**	**1.47**	**Low**

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

Level IV

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

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating: **Low**

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Worksheet 5-9. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: **Macgruder Branch, Reach - Reach 3** Location: **Reach 3**

Station: **000-019 R** Stream Type: **C4** Valley Type: **VIII**

Observers: **Team 3** Date: **09/18/07**

Methods for estimating Near-Bank Stress (NBS)

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

Level I

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

Level II

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

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

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

Dominant Near-Bank Stress: High

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	2.2	1.1	2	High

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

Level IV

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

Converting values to a Near-Bank Stress (NBS) rating

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

Overall Near-Bank Stress (NBS) rating = **High**

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Team 3
9/18/07

River Assessment and Monitoring: Reference Reach

1st Field Day

Worksheet A-17. Bar sample data collection and sieve analysis form. Stn 135

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis

Observers:

Stream: Mac Gruder

Location: R-3

Date: 9/18/07

Subsamples	0	2	4	8	16	32	64	128	256	512
	Catch Pan or BUCKET	Sieve SIZE 2 mm	Sieve SIZE 4 mm	Sieve SIZE 8 mm	Sieve SIZE 16 mm	Sieve SIZE 32 mm	Sieve SIZE 64 mm	Sieve SIZE 128 mm	Sieve SIZE 256 mm	
Tare weight	1lb 14oz	1lb 10oz	1lb 14oz	1lb 12oz	2lb	2lbs 4oz	n/A			
Sample weights Total	5lb 6oz	4lb 14oz	4lb 14oz	5lb 14oz	7lb 5oz	10lb 12oz	3oz			
Sample weights Net		4lb 4oz	8lb 8oz	8lb 14oz	3lb 8oz	3lb 4oz				
Net wt. total	5	7	6	8	9	12	2			
% Grand total										
Accum. % =<										

SURFACE MATERIALS DATA (Two largest particles)		
No.	Dia.	WT.
1.	80	28oz
2.	60	12oz

Bucket + materials weight	49
Bucket tare weight	2
Materials weight	47
Materials less than:	2 mm

Be sure to add separate material weights to grand total

GRAND TOTAL SAMPLE WEIGHT

Sample location notes

Sample location sketch

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Magruder Branch Reference Reach Team 3 9/18/2007

TEAM 3
9/18/07

Worksheet A-18. Sediment competence calculation form to assess bed stability.

Stream: Magruder Branch			Stream Type: C4		
Location: Reach 3			Valley Type: 8		
Observers: Team 3			Date: 9-19-07		
Enter required information					
20.73	D_{50}	Riffle bed material D_{50} (mm)			
20.31	$\hat{D}_{50}$	Bar sample D_{50} (mm)			
0.197	D_{max}	Largest particle from bar sample (ft)	60	(mm)	304.8 mm/ft
0.011	S	Existing bankfull water surface slope (ft/ft)			
1.75	d	Existing bankfull mean depth (ft)			
1.65	γ_s	Submerged specific weight of sediment			
Select the appropriate equation and calculate critical dimensionless shear stress					
	$D_{50}/\hat{D}_{50}$	Range: 3 – 7	Use EQUATION 1: $\tau^* = 0.0834\,(D_{50}/\hat{D}_{50})^{-0.872}$		
2.89	D_{max}/D_{50}	Range: 1.3 – 3.0	Use EQUATION 2: $\tau^* = 0.0384\,(D_{max}/D_{50})^{-0.887}$		
0.015	τ^*	Bankfull Dimensionless Shear Stress	EQUATION USED:		2
Calculate bankfull mean depth required for entrainment of largest particle in bar sample					
0.53	d	Required bankfull mean depth (ft)	$d = \frac{\tau^* \gamma_s D_{max}}{S}$		
Check: ☐ Stable ☐ Aggrading ☑ Degrading					
Calculate bankfull water surface slope required for entrainment of largest particle in bar sample					
.0028	S	Required bankfull water surface slope (ft/ft)	$S = \frac{\tau^* \gamma_s D_{max}}{d}$		
Check: ☑ Stable ☐ Aggrading ☑ Degrading					
Sediment competence using dimensional shear stress					
~~.306~~ .9	Bankfull shear stress $\tau = \gamma dS$ (lbs/ft^2) (substitute hydraulic radius, R, with mean depth, d)				
~~85.7~~ 155	Moveable particle size (mm) at bankfull shear stress **(Figure A-28)**				
.29	Predicted shear stress required to initiate movement of D_{max} (mm) **(Figure A-28)**				
0.49	Predicted mean depth required to initiate movement of D_{max} (mm) $d = \frac{\tau}{\gamma S}$		$\frac{.306}{.624}$		
.003	Predicted slope required to initiate movement of D_{max} (mm) $S = \frac{\tau}{\gamma d}$		$\frac{.306}{109.2}$		

Andrews Equation

62.4

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Worksheet A-19. Stability ratings for corresponding successional stage shifts of stream types. Check (✓) the appropriate stability rating.

TEAM 3
9/18/07

Stream: MAGRUDER	Stream Type: C4
Location: REACH 3	Valley Type: 8
Observers: TEAM 3	Date: 9/16/07

Stream type changes due to successional stage shifts (Figure A-29)	Stability rating (check appropriate rating)
Stream type at potential, (C→E), (F_b→B), (G→B), (F→B_c), (F→C), (D→C)	☐ Stable
(E→C)	☐ Moderately unstable
(G→F), (F→D), (C→F)	☐ Unstable
(C→D), (B→G), (D→G), (C→G) (EARLY STAGE), (E→G)	☒ Highly unstable SCENARIO 9

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Worksheet 5-10. Summary form of annual streambank erosion estimates for various study reaches. A-16

Stream: **Macgruder Branch, Reach - Reach 3**		Location: **Reach 3**	
Graph Used:	Total Bank Length (ft): **242**		Date: **9/18/2007**
Observers: **Team 3**	Valley Type: **VIII**		Stream Type: **C4**

(1) Station (ft)	(2) BEHI rating (Worksheet 5-8) (adjective)	(3) NBS rating (Worksheet 5-9) (adjective)	(4) Bank erosion rate (Figure 5-38 or 5-39) (ft/yr)	(5) Length of bank (ft)	(6) Study bank height (ft)	(7) Erosion subtotal [(4)×(5)×(6)] (ft^3/yr)	(8) Erosion Rate (tons/yr/ft) {[(7)/27] × 1.3 / (5)}
1. 000-019 R	Moderate	High	0.8016194	19	3.9	59.4	0.15
2. 019-042 R	Moderate	Very High	1.9986622	23	3.9	179.28	0.38
3. 042-051 R	Moderate	Low	0.1173913	9	2.3	2.43	0.01
4. 045-058 L	High	Low	0.3965035	13	2.2	11.34	0.04
5. 051-080 R	High	Moderate	0.501949	29	2.3	33.48	0.06
6. 058-083 L	High	Low	0.29808	25	2.5	18.63	0.04
7. 080-104 R	Low	Moderate	0.0794118	24	1.7	3.24	0.01
8. 093-111 L	Moderate	Moderate	0.3	18	1.9	10.26	0.03
9. 118-147 L	Moderate	Extreme	6	29	2.7	469.8	0.78
10. 147-157 L	High	High	0.999	10	3	29.97	0.14
11. 157-177 L	Moderate	Moderate	0.3015	20	3	18.09	0.04
12. 161-185 R	High	Low	0.4005	24	2.5	24.03	0.05
13. 177-221 L	Moderate	Very Low	0.0409091	44	3	5.4	0.01
14. 185-221 R	Low	Low	0.021	36	2.5	1.89	0.00
15.							

Sum erosion subtotals in Column (7) for each BEHI/NBS combination	Total erosion (ft^3/yr)	867.24
Convert erosion in ft^3/yr to yds^3/yr {divide Total erosion (ft^3/yr) by 27}	Total erosion (yds^3/yr)	32.12
Convert erosion in yds^3/yr to tons/yr {multiply Total erosion (yds^3/yr) by 1.3}	Total erosion (tons/yr)	41.76
Calculate erosion per unit length of channel {divide Total erosion (tons/yr) by total length of stream (ft) surveyed}	Total erosion (tons/yr/ft)	0.1725

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Worksheet B-1. Level II stream classification form.

Stream: Mac Gruder Branch	
Basin:	Drainage Area: acres 1.8 mi^2
Location: R-3	
Twp.&Rge:	Sec.&Qtr.:
Cross-Section Monuments (Lat./Long.):	Date: 9/18/07
Observers: Team 3	Valley Type: 8

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	20	ft
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A / W_{bkf}$).	1.75	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	34.93	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	11.43	ft/ft
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	2.39	ft
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or ($2 \times d_{mbkf}$) = the stage/elevation at which flood-prone area WIDTH is determined in a riffle section.	169.3	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	8.47	ft/ft
Channel Materials (Particle Size Index) D_{50} The D_{50} particle size index represents the mean diameter of channel materials, as sampled from the channel surface, between the bankfull stage and Thalweg elevations.	31.33	mm
Water Surface SLOPE (S) Channel slope = "rise over run" for a reach approximately 20–30 bankfull channel widths in length, with the "riffle-to-riffle" water surface slope representing the gradient at bankfull stage.	0.0091	ft/ft
Channel SINUOSITY (k) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL / VL); or estimated from a ratio of valley slope divided by channel slope (VS / S).	1.26	

Stream Type C4

Reference: *WARSSS*, **Figure 2-14**, page 2-23

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Magruder Branch Reference Reach Team 3 9/18/2007

River Name: Macgruder Branch
Reach Name: Reach 3 <-- ~~This is not a Reference Reach~~ TEAM 3
Drainage Area: 1.8 sq mi 9/18/07
State: Maryland
County: Montgomery
Latitude: 0
Longitude: 0
Survey Date: 09/18/2007

Classification Data

Valley Type:	Type VIII	
Valley Slope:	0.0115	ft/ft
Number of Channels:	Single	
Width:	20	ft
Mean Depth:	1.75	ft
Flood-Prone Width:	169.3	ft
Channel Materials D50:	31.33	mm
Water Surface Slope:	0.0091	ft/ft
Sinuosity:	1.26	
Discharge:	225 ~~8~~	cfs
Velocity:	6.5 ~~8~~	fps
Cross Sectional Area:	34.93	sq ft
Entrenchment Ratio:	8.47	
Width to Depth Ratio:	11.43	
Rosgen Stream Classification:	C4	

TEAM 3
9/18/07

Worksheet A-2. River reach summary data.

Stream: MAGRUDER Location: REACH 3
Observers: TEAM 3 Date: 9/18/07 Valley Type: VIII Stream Type: C4

River Reach Summary Data

Channel Dimension								
Mean Riffle Depth (d_{bkf})	1.75	ft	Riffle Width (W_{bkf})	20	ft	Riffle Area (A_{bkf})	34.93	ft²
Mean Pool Depth (d_{bkfp})	2.01	ft	Pool Width (W_{bkfp})	14.32	ft	Pool Area (A_{bkfp})	28.8	ft²
Mean Pool Depth/Mean Riffle Depth	1.15	d_{bkfp}/d_{bkf}	Pool Width/Riffle Width	0.72	W_{bkfp}/W_{bkf}	Pool Area / Riffle Area	0.82	A_{bkfp}/A_{bkf}
Max Riffle Depth (d_{mbkf})	2.07	ft	Max Pool Depth (d_{mbkfp})	3.32	ft	Max Riffle Depth/Mean Riffle Depth	1.18	1.4
Max Pool Depth/Mean Riffle Depth	1.90					Point Bar Slope	0.114	
Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	6.5	ft/s	Estimation Method	#1 (FRICTION FACTOR/RELATIVE ROUGHNESS)				
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	225	cfs	Drainage Area	1.8	mi²			

Channel Pattern									
Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Meander Wavelength (Lm)	165	166.5	168	ft	Meander Length Ratio (Lm/W_{bkf})	8.25	8.32	8.4
Radius of Curvature (Rc)	33	34	35	ft	Radius of Curvature/Riffle Width (Rc/W_{bkf})	1.65	1.7	1.75
Belt Width (W_{blt})		46		ft	Meander Width Ratio (W_{blt}/W_{bkf})		2.3	
Individual Pool Length	20.13	29.01	38.93	ft	Pool Length/Riffle Width	1.01	1.45	1.95
Pool to Pool Spacing	46.2	38.6	51.8	ft	Pool to Pool Spacing/Riffle Width	2.31	1.93	2.59
Riffle Length	33.5	3.09	89.8	ft	Riffle Length/Riffle Width	1.67	0.15	4.49

Channel Profile									
Valley Slope (VS)	0.0115	ft/ft	Average Water Surface Slope (S)	0.0091	ft/ft	Sinuosity (VS/S)	1.26		
Stream Length (SL)	242	ft	Valley Length (VL)	192	ft	Sinuosity (SL/VL)	1.26		
Low Bank Height (LBH)	start 2.48 ft, end 2.75 ft		Max Riffle Depth	start 2.19 ft, end 1.96 ft		Bank-Height Ratio (BHR) (LBH/Max Riffle Depth)	start 1.13, end 1.51		
Facet Slopes	Mean	Min	Max		Dimensionless Slope Ratios	Mean	Min	Max
Riffle Slope (S_{rif})	0.091	0.011	0.145	ft/ft	Riffle Slope/Average Water Surface Slope (S_{rif} / S)	8.87	1.16	15.9
Run Slope (S_{run})	0.016	0.001	0.030	ft/ft	Run Slope/Average Water Surface Slope (S_{run} / S)	1.175	0.132	3.35
Pool Slope (S_p)	0.002	0.001	0.004	ft/ft	Pool Slope/Average Water Surface Slope (S_p / S)	0.165	0.038	0.46
Glide Slope (S_g)	0.002	0.001	0.002	ft/ft	Glide Slope/Average Water Surface Slope (S_g / S)	0.178	0.077	2.41
Feature Midpoint	Mean	Min	Max		Dimensionless Depth Ratios	Mean	Min	Max
Riffle Depth (d_{rif})	2.07	1.38	2.74	ft	Riffle Depth/Mean Riffle Depth (d_{rif} / d_{bkf})	1.18	1.07	1.28
Run Depth (d_{run})	2.46	2.29	2.62	ft	Run Depth/Mean Riffle Depth (d_{run} / d_{bkf})	1.41	1.31	1.50
Pool Depth (d_p)	3.32	2.86	3.93	ft	Pool Depth/Mean Riffle Depth (d_p / d_{bkf})	1.90	1.63	2.19
Glide Depth (d_g)	2.25	1.82	2.46	ft	Glide Depth/Mean Riffle Depth (d_g / d_{bkf})	1.29	1.04	1.41

Channel Materials	Reach	Riffle	Bar		Reach	Riffle	Bar	Pool	Roughness Height
% Silt/Clay	5.66	2.0	0.0	D_{16}	11.68	9.74	4.35		mm
% Sand	0	0	0	D_{35}	21	16.39	11.45		mm
% Gravel	76.42	4	90.06	D_{50}	31.53	20.73	20.31		mm
% Cobble	16.98	0	9.94	D_{84}	68.81	42.26	56.38		mm
% Boulder	0.94	0	0	D_{95}	110.55	78.67	72.91		mm
% Bedrock	0	94	0	D_{100}	2047.89	179.97	80		mm

a Min, max, mean depths are the average mid-point values except pools, which are taken at deepest part of pool.
b Composite sample of riffles and pools within the designated reach.
c Active bed of a riffle.
d Height of roughness feature above bed.

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Magruder Branch Reference Reach Team 3

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River Name: Macgruder Branch
Reach Name: Reach 3

Stream Type	Valley Type	D50(mm)	Val Slope	BKF Q(cfs)	DA(sq mi)
C4	VIII	31.33	0.0115	~~0~~ 225	1.8

Dimension Summary

Database based on the following Cross Sections:

Variable	Min	Avg	Max
Floodprone Width (ft)	169.3	169.3	169.4
Riffle Area (Sq ft)	34.93	34.93	34.93
Max Riffle Depth (ft)	1.88	2.07	2.24
Mean Riffle Depth (ft)	1.75	1.75	1.75
Riffle Width (ft)	20	20	20
Pool Area (Sq ft)	28.8	28.8	28.8
Max Pool Depth (ft)	2.86	3.32	3.83
Mean Pool Depth (ft)	2.01	2.01	2.01
Pool Width (ft)	14.32	14.32	14.32
Run Area (Sq ft)	34.73	34.73	34.73
Max Run Depth (ft)	2.29	2.46	2.62
Mean Run Depth (ft)	1.76	1.76	1.76
Run Width (ft)	19.7	19.7	19.7
Glide Area (Sq ft)	32.79	32.79	32.79
Max Glide Depth (ft)	1.82	2.25	2.46
Mean Glide Depth (ft)	1.42	1.42	1.42
Glide Width (ft)	23.14	23.14	23.14

Pattern Summary

Variable	Min	Avg	Max
Sinuosity		1.26	
Meander Wavelength (ft)	165	~~0~~ 166.5	168
Radius of Curvature (ft)	33	~~0~~ 34	35
Belt Width (ft)	0	46	0

Profile Summary

Data Based on the following:

Variable	Min	Avg	Max
S riffle (ft/ft)	0.01056	0.08072	0.14497
S pool (ft/ft)	0.0003	0.00153	0.00419
S run (ft/ft)	0.0012	0.01024	0.03048
S glide (ft/ft)	0.00088	0.0016	0.00219
P - P (ft)	38.64	46.2	51.81
Pool length (ft)	20.13	29.01	38.95
Riffle length (ft)	3.03	33.48	89.82
Dmax riffle (ft)	1.88	2.07	2.24
Dmax pool (ft)	2.86	3.32	3.83
Dmax run (ft)	2.29	2.46	2.62
Dmax glide (ft)	1.82	2.25	2.46
Low bank ht (ft)	2.48	2.72	2.95
Bankfull slope (ft/ft)		0.0091	

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Variable	Min	Avg	Max
Discharge (cfs)	225	0	
Velocity (fps)	6.5	0	
Hyd Radius (ft)	1.65	1.65	1.65

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Worksheet A-3. Bankfull velocity and discharge estimates.

Bankfull VELOCITY / DISCHARGE Estimates

Site	MacGruder	Location	R-3
Date	9/18/07	Stream Type	C4
Valley Type	8		
Observers	Team 3	HUC	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Cross-section AREA	34.9	A_{bkf} (SqFt)	Bankfull Mean DEPTH	1.75	D_{bkf} (Ft)
Bankfull WIDTH	20.0	W_{bkf} (Ft)	Wetted PERIMETER ~ $2 * d_{bkf} + W_{bkf}$	23.5	W_{Pbkf} (Ft)
D84 @ Riffle	42.26	Dia. (mm)	D84 mm / 304.8 =	0.139	D84 (Ft)
Bankfull SLOPE	0.0091	S (Ft / Ft)	Hydraulic RADIUS A_{bkf} / W_{Pbkf}	1.745	R (Ft)
Gravitational Acceleration	32.2	g (Ft / Sec^2)	Relative Roughness R (ft) / D84 (ft)	12.55	
Drainage AREA	1.8	DA (SqMi)	Shear Velocity $u^* = \sqrt{gRS}$	0.715	u* (Ft / Sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66 Log\{ R / D84 \}]u*$	6.47	Ft / Sec	225.80	CFS
2. Roughness Coefficient: a) Manning's 'n' from friction factor / relative roughness. $u = 1.4895*R^{2/3}*S^{1/2}/n$ n = 0.037	5.57	Ft / Sec	194.39	CFS
2. Roughness Coefficient: $u = 1.4895* R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n = 0.39S^{.38}R^{-.16}$ n = 0.06 Note: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder-dominated stream systems; i.e., for stream types A1, A2, A3, B1, B2, B3, C2 and E3.	3.43	Ft / Sec	119.79	CFS
2. Roughness Coefficient: $u = 1.4895* R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type n = 0.031	6.64	Ft / Sec	231.74	CFS
3. Other Methods, ie. Hydraulic Geometry (Hey, Darcy-Weisback, Chezy C, etc.) DARCY-WEISBACH	6.55	Ft / Sec	228.7	CFS
3. Other Methods, ie. Hydraulic Geometry (Hey, Darcy-Weisback, Chezy C, etc.) HEY	6.75	Ft / Sec	235.6	CFS
4. Continuity Equations: a) Regional Curves u = Q / A Return Period for Bankfull Discharge Q = 3.78 MD Piedmont	3.78	Ft / Sec	132	CFS
4. Continuity Equations: b) USGS Gage Data u = Q / A		Ft / Sec		CFS

Options for using the D84 term in the **relative roughness relation** (R/D84), when using estimation method 1:

Option 1: For sand-bed channels: measure the **"protrusion height"** (h_{sd}) of sand dunes above channel bed elevations. Substitute an average sand dune protrusion height (h_{sd} in feet) for the D84 term in estimation method 1.

Option 2: For **boulder-dominated** channels: measure several **"protrusion heights"** (h_{bo}) of boulders above channel bed elevations. Substitute an average boulder protrusion height (h_{bo} in feet) for the D84 term in estimation method 1.

For **bedrock-dominated** channels: measure several **"protrusion heights"** (h_{br}) of rock separations above channel bed elevations. Substitute an average bedrock protrusion height (h_{br} in feet) for the D84 term in estimation method 1.

NE Piedmont Q = 361 cfs, u = 10.34 ft/s

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Main Piedmont Q = 113 cfs u = 3.24 ft/s

Piedmont Urban Q = 314 cfs u = 8.997 ft/s

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b. Flow Regime

Worksheet A-5. Flow Regime variables that influence channel characteristics, sediment regime and biological interpretations.

FLOW REGIME

Stream: MacGruder			Location: R-3					
Observers: RW, MR							Date: 9/18/07	
List ALL COMBINATIONS that APPLY.....	P	2	8					

General Category

E	Ephemeral stream channels: flows only in response to precipitation. Often used in conjunction with intermittent.
S	Subterranean stream channel: flows parallel to and near the surface for various seasons - a sub-surface flow that follows the stream bed.
I	Intermittent stream channel: one that flows only seasonally or sporadically. Surface sources involve springs, snowmelt, artificial controls, etc. Often this term is associated with flows that reappear along various locations of a reach then run subterranean.
P	Perennial stream channels: surface water persists yearlong.

Specific Category

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

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c. Stream Size and Order

Worksheet A-6. Stream size/order categories for stratification by stream type.

Stream Size and Order			
Stream: MaGruder			
Location: R-3			
Observers: RW, MR			
Date: 9/18/07			
Stream Size Category and Order ☞			
Category	**STREAM SIZE: Bankfull width**		**Check (✓) appropriate category**
	meters	**feet**	
S-1	0.305	<1	☐
S-2	0.3 – 1.5	1 – 5	☐
S-3	1.5 – 4.6	5 – 15	☐
S-4	4.6 – 9	15 – 30	☑
S-5	9 – 15	30 – 50	☐
S-6	15 – 22.8	50 – 75	☐
S-7	22.8 – 30.5	75 – 100	☐
S-8	30.5 – 46	100 – 150	☐
S-9	46 – 76	150 – 250	☐
S-10	76 – 107	250 – 350	☐
S-11	107 – 150	350 – 500	☐
S-12	150 – 305	500 – 1000	☐
S-13	>305	>1000	☐
Stream Order			
Add categories in parenthesis for specific stream order of reach. For example a third order stream with a bankfull width of 6.1 meters (20 feet) would be indexed as: S-4(3).			

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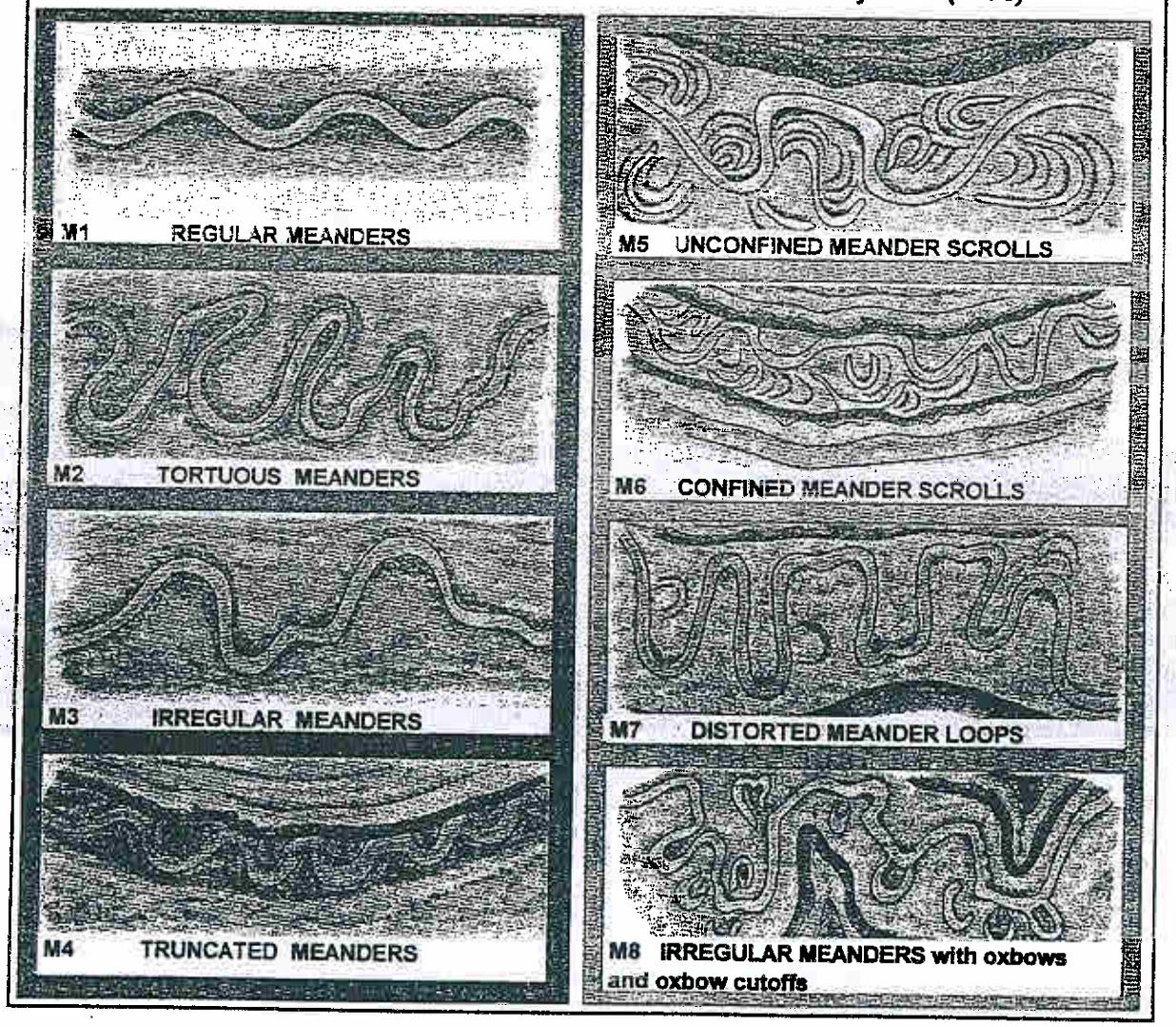
d. Meander Patterns

Worksheet A-7. Meander pattern relations used for interpretations for river stability.

Meander Patterns					
Stream: Maggruder Branch		Reach: R-3			
Observers: Team 3		Date: 9/18/2007			
List ALL CATEGORIES that APPLY ☞	M3				

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



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e. Depositional Patterns

Worksheet A-8. Depositional patterns used for stability assessment interpretations.

Depositional Patterns					
Stream:		Reach: R-3			
Observers:		Date:			
List ALL CATEGORIES that APPLY	B1	B4			

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

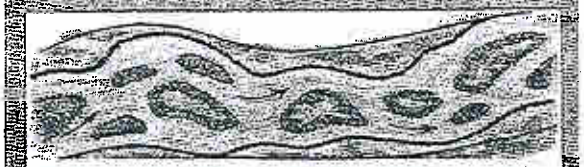
B1 POINT BARS

B2 POINT BARS with Few MID-CHANNEL BARS

B3 NUMEROUS MID-CHANNEL BARS

B4 SIDE BARS

B5 DIAGONAL BARS



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

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

B8 DELTA BARS

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f. Channel Blockages

Worksheet A-9. Various categories of in-channel debris, dams and/or channel blockages used to evaluate channel stability.

Channel Blockages		
Stream:	Location: R-3	
Observers:	Date:	
Description/extent	**Materials, which upon placement into the active channel or flood-prone area, may cause adjustments in channel dimensions or conditions due to influences on the existing flow regime.**	**Check (✓) all that apply**
D1 None	Minor amounts of small, floatable material.	☐
D2 Infrequent	Debris consists of small, easily moved, floatable material, e.g., leaves, needles, small limbs and twigs.	☑
D3 Moderate	Increasing frequency of small- to medium-sized material, such as large limbs, branches and small logs, that when accumulated, affect 10% or less of the active channel cross-section area.	☐
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.	☐
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.	☐
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.	☐
D7 Beaver dams: Few	An infrequent number of dams spaced such that normal streamflow and expected channel conditions exist in the reaches between dams.	☐
D8 Beaver dams: Frequent	Frequency of dams is such that backwater conditions exist for channel reaches between structures where streamflow velocities are reduced and channel dimensions or conditions are influenced.	☐
D9 Beaver dams: Abandoned	Numerous abandoned dams, many of which have filled with sediment and/or breached, initiating a series of channel adjustments, such as bank erosion, lateral migration, avulsion, aggradation and degradation.	☐
D10 Human influences	Structures, facilities or materials related to land uses or development located within the flood-prone area, such as diversions or low-head dams, controlled by-pass channels, velocity control structures and various transportation encroachments that have an influence on the existing flow regime, such that significant channel adjustments occur.	☐

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g. Degree of Channel Incision (Bank-Height Ratio) (*continued*)

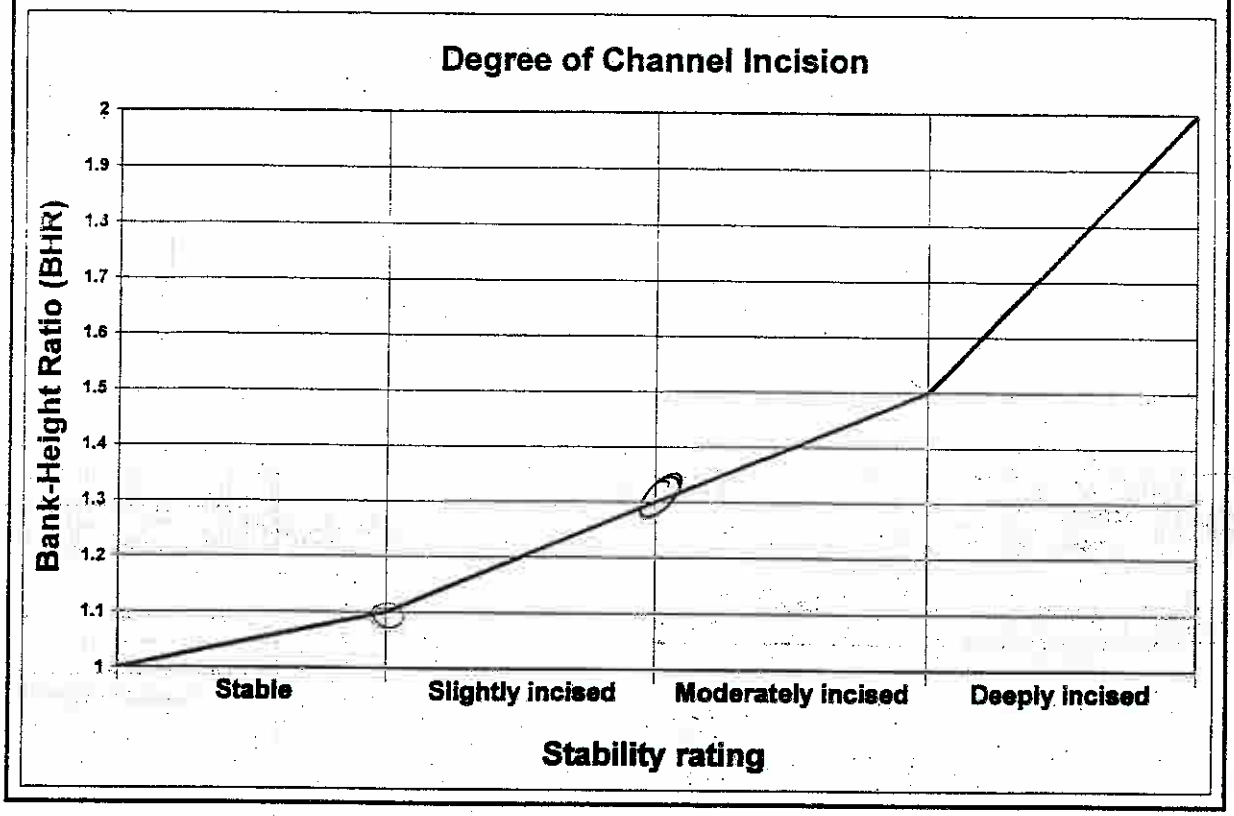
Worksheet A-10. Relationship of Bank-Height Ratio (BHR) ranges to corresponding stream stability ratings to determine degree of channel incision.

Degree of Channel Incision

Low Bank Height:	3.64
Max Bankfull Depth:	2.73

Bank-Height Ratio:	1.33

Degree of Channel Incision Stability Rating ☞ SLIGHTLY / MODERATELY INCISED



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River Name: Macgruder Branch
Reach Name: Reach 3
Survey Date: 09/19/2007

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Upper Bank

Landform Slope:	2
Mass Wasting:	3
Debris Jam Potential:	6
Vegetative Protection:	5

Lower Bank

Channel Capacity:	2
Bank Rock Content:	4
Obstructions to Flow:	2
Cutting:	8
Deposition:	6

Channel Bottom

Rock Angularity:	1
Brightness:	1
Consolidation of Particles:	3
Bottom Size Distribution:	5
Scouring and Deposition:	8
Aquatic Vegetation:	4

Channel Stability Evaluation

Sediment Supply: Moderate
Stream Bed Stability: Degrading
W/D Condition: Normal
Stream Type: ~~C4~~ C4
Rating - 60
Condition - Good

i. Width/Depth Ratio State (*Continued*)

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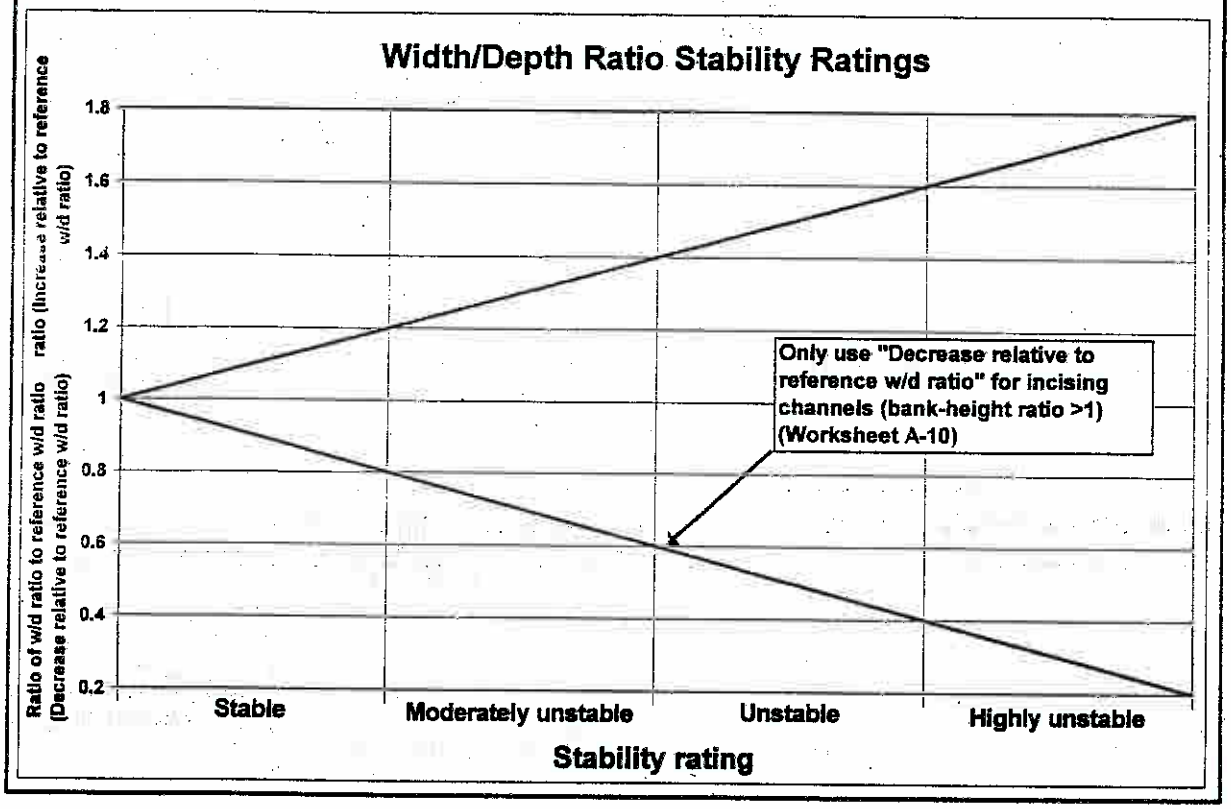
Worksheet A-12. Width/depth ratio state stability rating.

Width/Depth Ratio State			
Existing Width/Depth Ratio:	11.43	Ratio of existing w/d to reference w/d:	1
Reference Width/Depth Ratio:	11.43		
Width/Depth Ratio State Stability Rating	STABLE		



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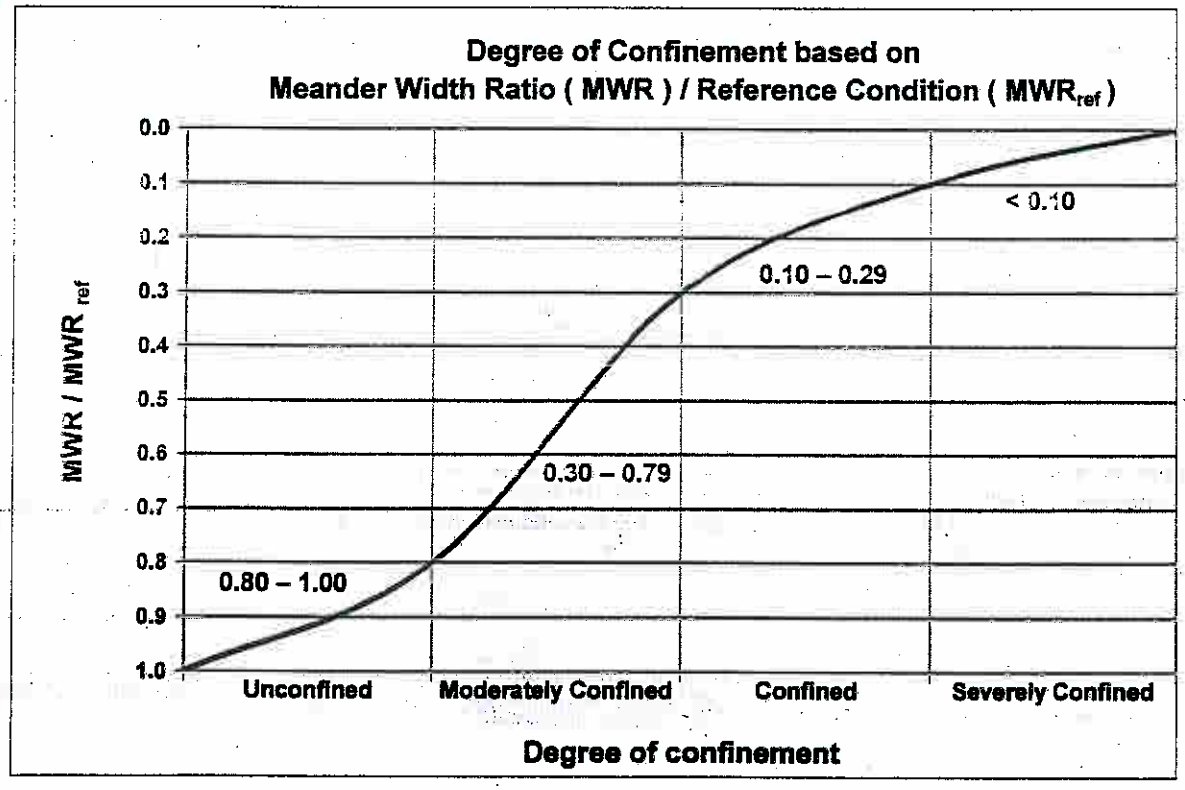
j. Degree of Channel Confinement (Meander Width Ratio (MWR)) (*Continued*)

Worksheet A-13. Degree of confinement stability ratings based on meander width ratio divided by reference meander width ratio.

Degree of Confinement			
Existing Meander Width Ratio (MWR):	2.3	Ratio of MWR to MWRref:	1
Reference Meander Width Ratio (MWR_{ref}):	2.3		
Degree of Confinement Stability Rating	UNCONFINED		



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Worksheet A-20. Lateral stability prediction summary.

Stream: Magruder Branch		Stream Type: C4	
Location: Reach 3		Valley Type: 8	
Observers: Team 3		Date: 9/18/2007	

Lateral stability criteria (choose one stability category for each criterion 1–5)	Lateral stability categories: Stable	Moderately unstable	Unstable	Highly unstable	Selected points (from each row)
1 W/d ratio state (Worksheet A-12)	< 1.2 (2)	1.2 – 1.4 (4)	1.4 – 1.6 (6)	> 1.6 (8)	2
2 Depositional pattern (Worksheet A-8)	B1, B2 (1)	B4, B8 (2)	B3 (3)	B5, B6, B7 (4)	~~2~~ 3
3 Meander pattern (Worksheet A-7)	M1, M3, M4 (1)		M2, M5, M6, M7, M8 (3)		1
4 Dominant BEHI / NBS (Worksheet A-16)	L/VL, L/L, L/M, L/H, L/VH, M/VL (2)	M/L, M/M, M/H, L/Ex, H/L (4)	M/VH, M/Ex, H/L, H/M, H/H, VH/VL, Ex/VL (6)	H/H, H/Ex, Ex/M, Ex/H, Ex/VH, VH/VH, Ex/Ex (8)	3
5 Degree of confinement (MWR / MWR_{ref}) (Worksheet A-13)	0.8 – 1.0 (1)	0.3 – 0.79 (2)	0.1 – 0.29 (3)	< 0.1 (4)	1
				Total points	10

Overall lateral stability category (use total points and check stability rating)	Lateral stability category point range: Stable 7 – 9	Moderately unstable 10 – 12	Unstable 13 – 21	Highly unstable > 21	
	☑	☐	☐	☐	STABLE

ok

mod unstable

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Worksheet A-21. Vertical stability prediction for excess deposition/aggradation.

Stream: Magruder Branch		Stream Type: C4	
Location: Reach 3		Valley Type: 8	
Observers: Group 3		Date: 9-18-2007	

Vertical stability criteria (choose one stability category for each criterion 1–6)	Vertical stability categories for excess deposition / aggradation				Selected points (from each row)
	No deposition	Moderate deposition	Excess deposition	Aggradation	
1 Sediment competence (Worksheet A-18)	Sufficient depth and/or slope to transport largest size available (2)	Trend toward insufficient depth and/or slope-slightly incompetent (4)	Cannot move D_{35} of bed material and/or D_{100} of bar material (6)	Cannot move D_{15} of bed material and/or D_{100} of bar or sub-pavement size (8)	2
2 Sediment capacity (POWERSED)	Sufficient capacity to transport annual load (2)	Trend toward insufficient sediment capacity (4)	Reduction up to 25% of annual sediment yield of bedload and/or suspended (6)	Reduction over 25% of annual sediment yield for bedload and/or suspended (8)	2
3 N/d ratio state (Worksheet A-12)	1.0 – 1.2 (2)	1.2 – 1.4 (4)	1.4 – 1.6 (6)	>1.6 (8)	2
4 Stream succession states (Worksheet A-19)	Current stream type at potential or does not indicate deposition/ aggradation C-G (2)	(E→C) (4)	(C→High w/d C), (B→High w/d B), (C→F) (6)	(C→D), (F→D) (8)	2
5 Depositional patterns (Worksheet A-8)	B1 (1)	B2, B4 (2)	B3, B5 (3)	B6, B7, B8 (4)	1.5
6 Debris / blockages (Worksheet A-9)	D1, D2, D3 (1)	D4, D7 (2)	D5, D8 (3)	D6, D9, D10 (4)	1
				Total points	

Vertical stability for excess deposition / aggradation (use total points and check stability rating)	Vertical stability category point range for excess deposition / aggradation				
	No deposition 10 – 14 ☐	Moderate deposition 15 – 20 ☑	Excess deposition 21 – 30 ☐	Aggradation > 30 ☐	10.5 ~~15.5~~

ok

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Worksheet A-22. Vertical stability prediction for channel incision/degradation.

Stream: Magruder Branch			Stream Type: C4		
Location: Reach 3			Valley Type: VIII		
Observers: Team 3			Date: 9-18-2007		
Vertical stability criteria (choose one stability category for each criterion 1–5)	**Vertical stability categories for channel incision / degradation**				**Selected points (from each row)**
	Not incised	**Slightly incised**	**Moderately incised**	**Degradation**	
1 **Sediment competence (Worksheet A-18)**	Does not indicate excess competence (2)	Trend to move larger sizes than D_{100} of bar or > D_{84} of bed (4)	D_{100} of bed moved (6)	Particles much larger than D_{100} of bed moved (8)	4
2 **Sediment capacity (POWERSED)**	Does not indicate excess capacity (2)	Slight excess energy: up to 10% increase above reference (4)	Excess energy sufficient to increase load up to 50% of annual load (6)	Excess energy transporting more than 50% of annual load (8)	4
3 Degree of channel incision (BHR) (Worksheet A-10)	1.00 – 1.10 (2)	1.11 – 1.30 (4)	1.31 – 1.50 (6)	> 1.50 (8)	6
4 **Stream succession states (Worksheets A-19 and A-10)**	Does not indicate incision or degradation (2)	If BHR > 1.1 and stream type has w/d between 5–10 (4)	If BHR > 1.1 and stream type has w/d less than 5 (6)	(B→G), (C→G), (E→G), (D→G) (8)	8
5 **Confinement (MWR / MWR_{ref}) (Worksheet A-13)**	0.80 – 1.00 (1)	0.30 – 0.79 (2)	0.10 – 0.29 (3)	< 0.10 (4)	1
				Total points	
	Vertical stability category point range for channel incision / degradation				
Vertical stability for channel incision/ degradation (use total points and check stability rating)	**Not incised 9 – 11** ☐	**Slightly incised 12 – 18** ☐	**Moderately incised 19 – 27** ☑	**Degradation > 27** ☐	23

ok

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Worksheet A-23. Channel enlargement prediction summary.

Stream: MAGRUDER BRANCH			Stream Type: C4		
Location: REACH 3			Valley Type: VIII		
Observers: TEAM 3			Date: 9-18-2007		
Channel enlargement prediction criteria (choose one stability category for each criterion 1–4)	**Channel enlargement prediction categories**				**Selected points (from each row)**
	No increase	**Slight increase**	**Moderate increase**	**Extensive**	
1 **Successional stage shift (Worksheet A-19)**	Stream type at potential, (C→E), (F_b→B), (G→B), (F→B_c), (F→C), (D→C) (2)	(E→C) (4)	(G→F), (F→D) (6)	(C→D), (B→G), (D→G), (C→G), (E→G), (C→F) (8)	8
2 **Lateral stability (Worksheet A-20)**	Stable (2)	Moderately unstable (4)	Unstable (6)	Highly unstable (8)	4
3 **Vertical stability/ excess deposition/ aggradation (Worksheet A-21)**	No deposition (2)	Moderate deposition (4)	Excess deposition (6)	Aggradation (8)	2
4 **Vertical stability incision/ degradation (Worksheet A-22)**	Not incised (2)	Slightly incised (4)	Moderately incised (6)	Degradation (8)	6
				Total points	20
	Category point range				
Channel enlargement prediction (use total points and check stability rating)	**No increase 8 – 10** ☐	**Slight increase 11 – 16** ☐	**Moderate increase 17 – 24** ☑	**Extensive > 24** ☐	Mod increase

OK

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Worksheet A-24. Overall sediment supply rating determined from individual stability rating categories.

Stream: MAGRUDER BRANCH		Stream Type: C4	
Location: REACH 3		Valley Type: VIII	
Observers: TEAM 3		Date: 9/19/07	
Overall sediment supply prediction criteria (choose corresponding points for each criterion 1–5)	**Stability rating**	**Points**	**Selected points**
1 Lateral stability (Worksheet A-20)	Stable	1	2
	Mod. unstable	2	
	Unstable	3	
	Highly unstable	4	
2 Vertical stability excess deposition/ aggradation (Worksheet A-21)	No deposition	1	1
	Mod. deposition	2	
	Excess deposition	3	
	Aggradation	4	
3 Vertical stability channel incision/ degradation (Worksheet A-22)	Not incised	1	3
	Slightly incised	2	
	Mod. incised	3	
	Degradation	4	
4 Channel enlargement prediction (Worksheet A-23)	No increase	1	3
	Slight increase	2	
	Mod. increase	3	
	Extensive	4	
5 Pfankuch channel stability (Worksheet A-11)	Good: stable	1	1
	Fair: mod unstable	2	
	Poor: unstable	4	
		Total Points	10

OK

	Category point range			
Overall sediment supply rating (use total points and check stability rating)	**Low** 5 ☐	**Moderate** 6 – 10 ☑	**High** 11 – 15 ☐	**Very High** 16 – 20 ☐

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MEAN POOL DEPTH: 2.01

TEAM 3
9/18/07

River Assessment and Monitoring: Reference Reach

1st Field Day

Worksheet A-25. Summary of stability condition categories.

Stream: MAGRUDER BRANCH				Location: REACH 3		
Observers: TEAM 3		Date: 9/19/07		Stream Type: C4	Valley Type: VIII	
Channel Dimension	Mean bankfull depth (ft): 1.75	Mean bankfull width (ft): 20	Cross-section area (ft²): [illegible]	Width of flood-prone area (ft): 170	Entrenchment ratio: 8.5	
Channel Pattern	Mean (range)	MWR: 2.3	L_m/W_{bkf}: 8.3 (8.25 - [illegible])	R_c/W_{bkf}: 1.7 (1.65 - 1.75)	Sinuosity: 1.26	
River Profile and Bed Features	Circle: Riffle/pool Step/pool Plane bed Convergence/divergence Dunes/antidunes/smooth bed					
	Max bankfull depth (ft): Riffle 2.4	Pool 3.6	Depth ratio (max/mean): Riffle 1.4	Pool 1.3	Pool to pool spacing: 2.3	Ratio
	Slope: Valley: 0.0115	Average bankfull: 0.0091				
Level III Stream Stability Indices	Riparian vegetation	Current composition/density: Maturing Forest	Potential composition/density: Mature Forest	Remarks: Condition, vigor and/or usage of exiting reach: healthy, 65% Canopy Closure		
	Flow regime: P2	Stream size and order: S-4(2)	Meander pattern(s): M[illegible]	Depositional pattern(s): B1, B4	Debris/channel blockage(s): D2	
	Degree of incision (Bank-Height Ratio): 1.33	Degree of incision stability rating: slightly / moderately incised	Modified Pfankuch stability rating (numeric and adjective rating): 60			
	Width/depth ratio (W/D): 11.43	Reference W/D ratio (W/D_{ref}): 11.43	Width/depth ratio state (W/D) / (W/D_{ref}): 1	W/D ratio state stability rating: stable		
	Meander Width Ratio (MWR): 2.3	Reference MWR_{ref}: 2.3	Degree of confinement (MWR / MWR_{ref}): 1	MWR / MWR_{ref} stability rating: unconfined		
Bank Erosion Summary	Length of reach studied (ft): 242	Annual streambank erosion rate: 41.76 (tons/yr)	0.1725 (tons/yr/ft)	Curve used: DC Bank Erosion Curve	Remarks:	
Sediment Capacity (POWERSED)	Sufficent capacity NA	Insufficient capacity	Remarks:			
Entrainment/ Competence	Largest particle from bar sample (mm): 60	$\tau = 0.306$	$\tau^* = 0.015$	Existing $depth_{bkf}$: 1.75	Required $depth_{bkf}$: 0.53	Existing $slope_{bkf}$: 0.0091	Required $slope_{bkf}$: 0.0028
Successional Stage Shift	C → G → F → C →			Existing stream state (type): C	Potential stream state (type): C	
Lateral Stability	Circle: Stable	Moderately unstable	Unstable	Highly unstable	Remarks/causes:	
Vertical Stability (Aggradation)	Circle: No deposition	Moderate deposition	Excess deposition	Aggradation	Remarks/causes:	
Vertical Stability (Degradation)	Circle: Not incised	Slightly incised	Moderately incised	Degradation	Remarks/causes:	
Channel Enlargement	Circle: No increase	Slight increase	Moderate increase	Extensive	Remarks/causes:	
Sediment Supply (Channel Source)	Circle: Low	Moderate → High	Very high	Remarks/causes:		

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