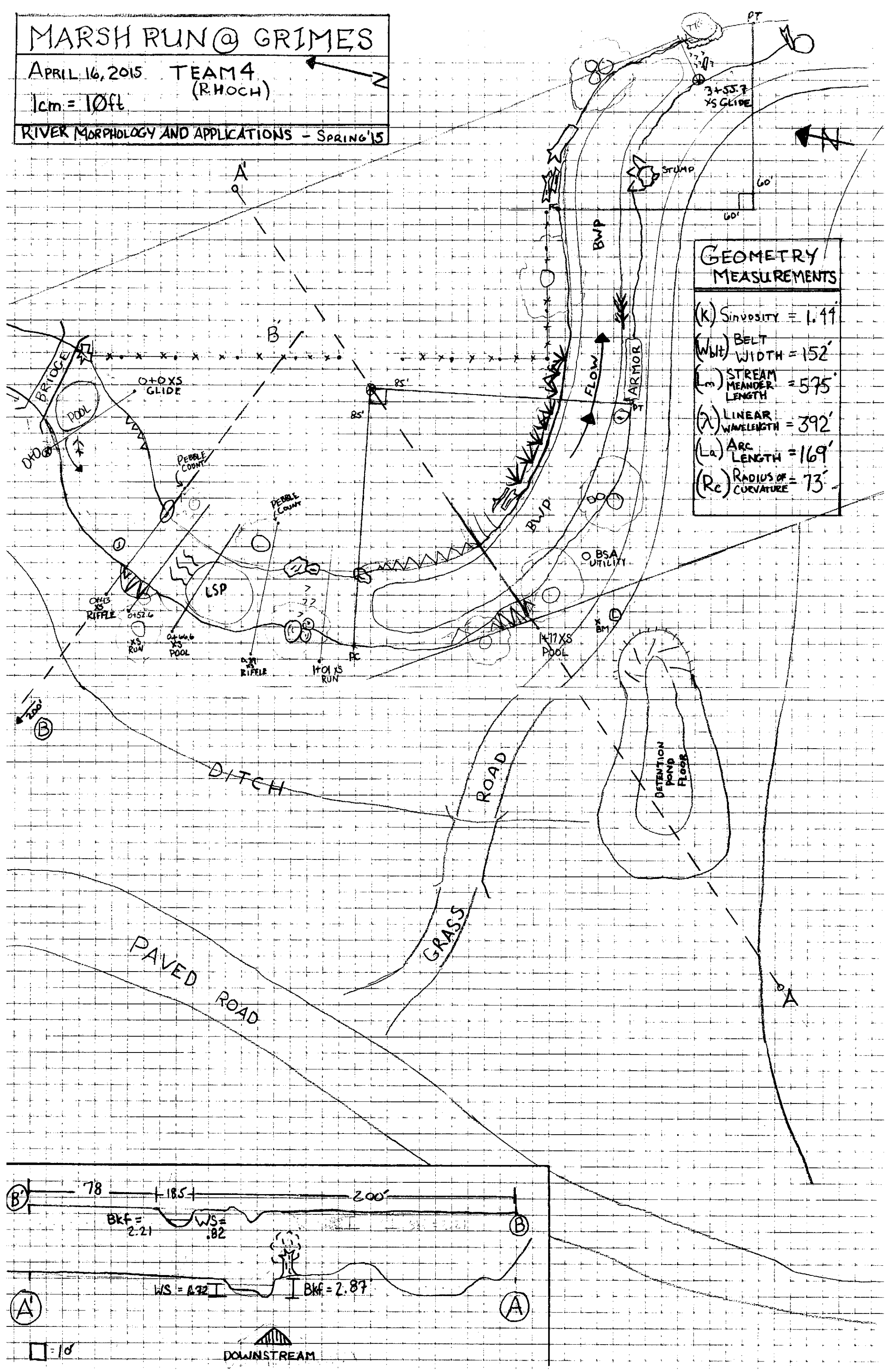
MARSH RUN @ GRIMES

APRIL 16, 2015 TEAM 4 (RHOCH)

1cm = 10ft

RIVER MORPHOLOGY AND APPLICATIONS - SPRING'15

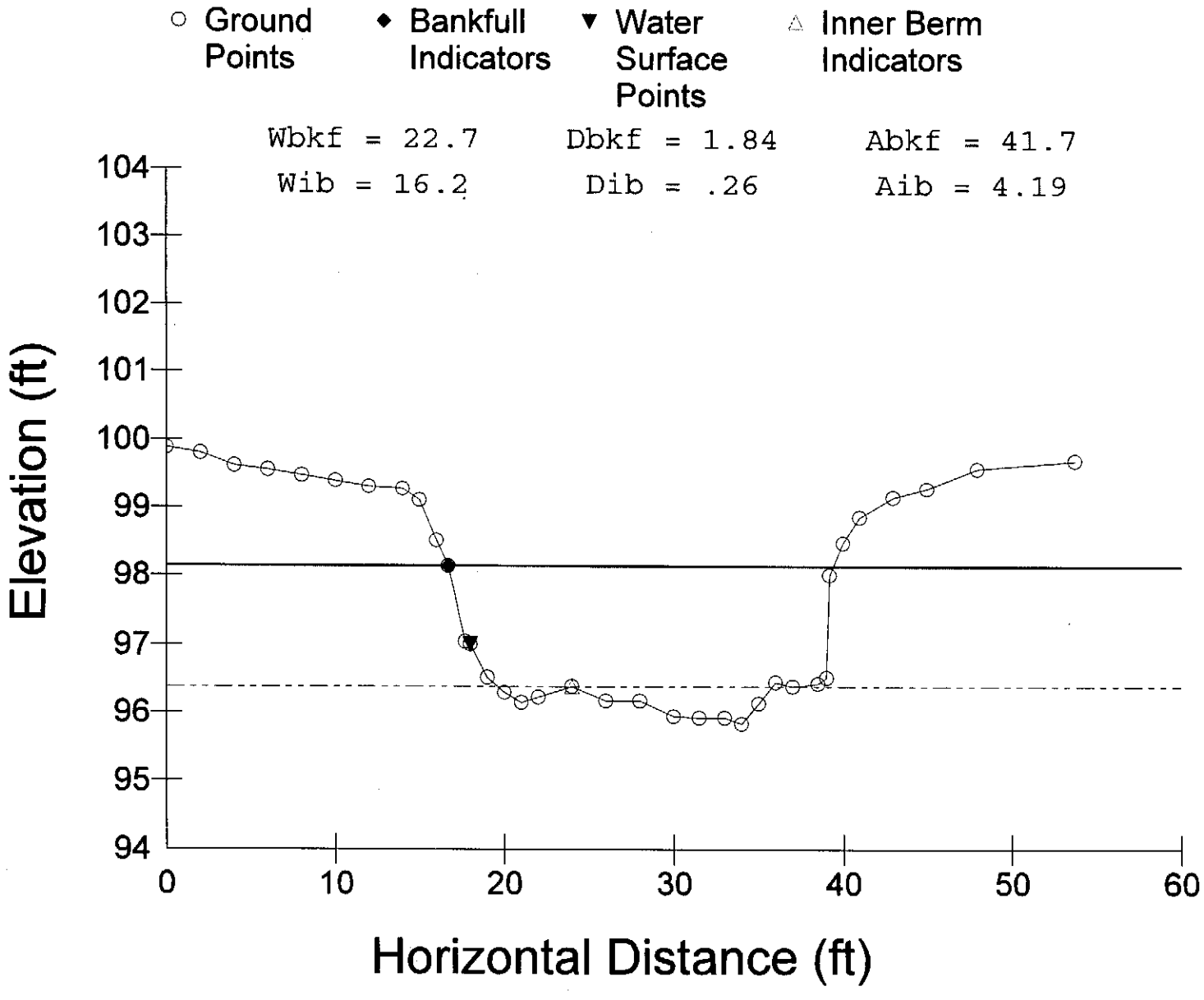


GEOMETRY MEASUREMENTS

(K)	SINUOSITY	= 1.44
(W_{blt})	BELT WIDTH	= 152'
(L_m)	STREAM MEANDER LENGTH	= 575'
(λ)	LINEAR WAVELENGTH	= 392'
(L_a)	ARC LENGTH	= 169'
(R_c)	RADIUS OF CURVATURE	= 73'

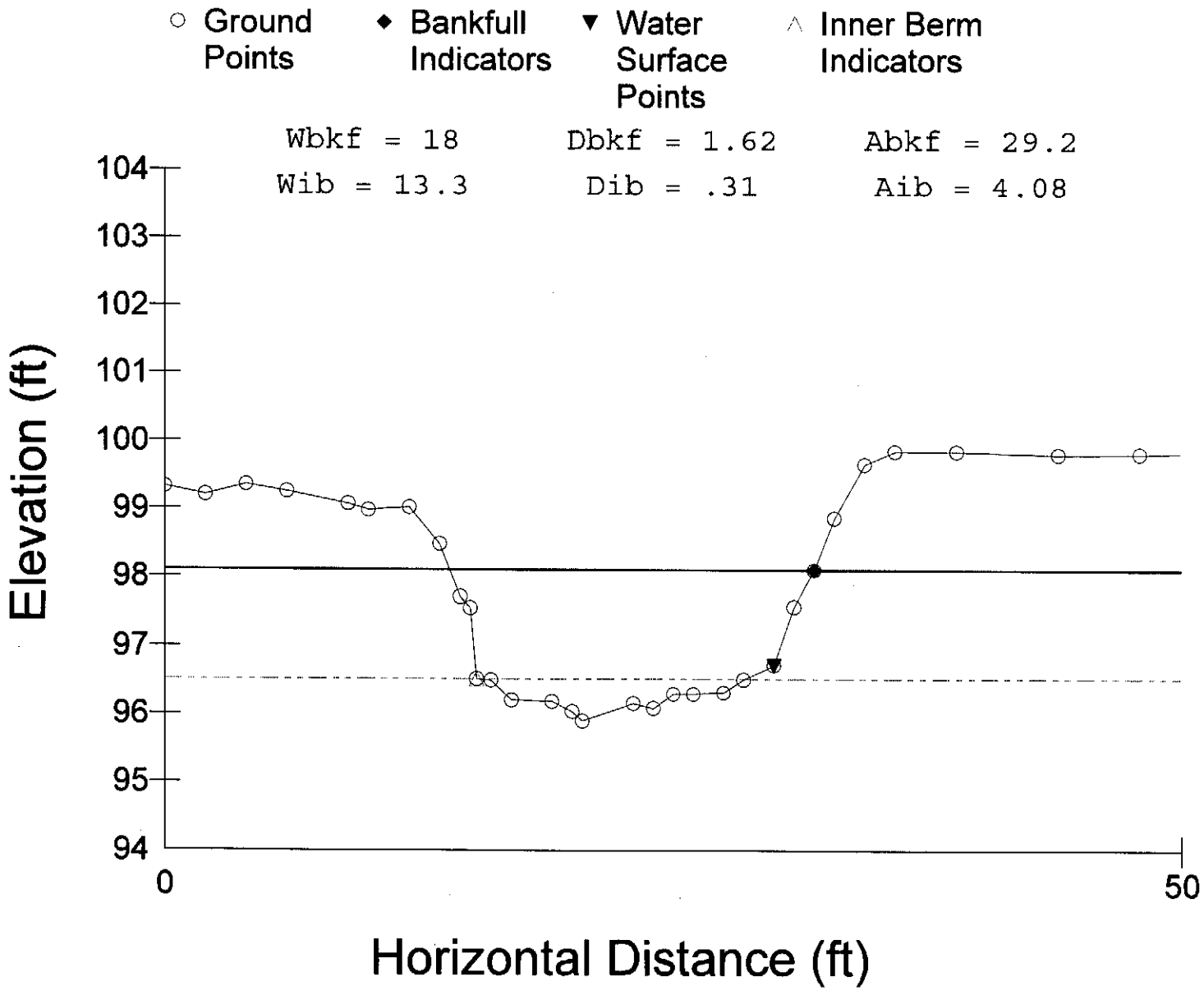
Marsh Run
Reach 4
4/16/15

Glide 0+00



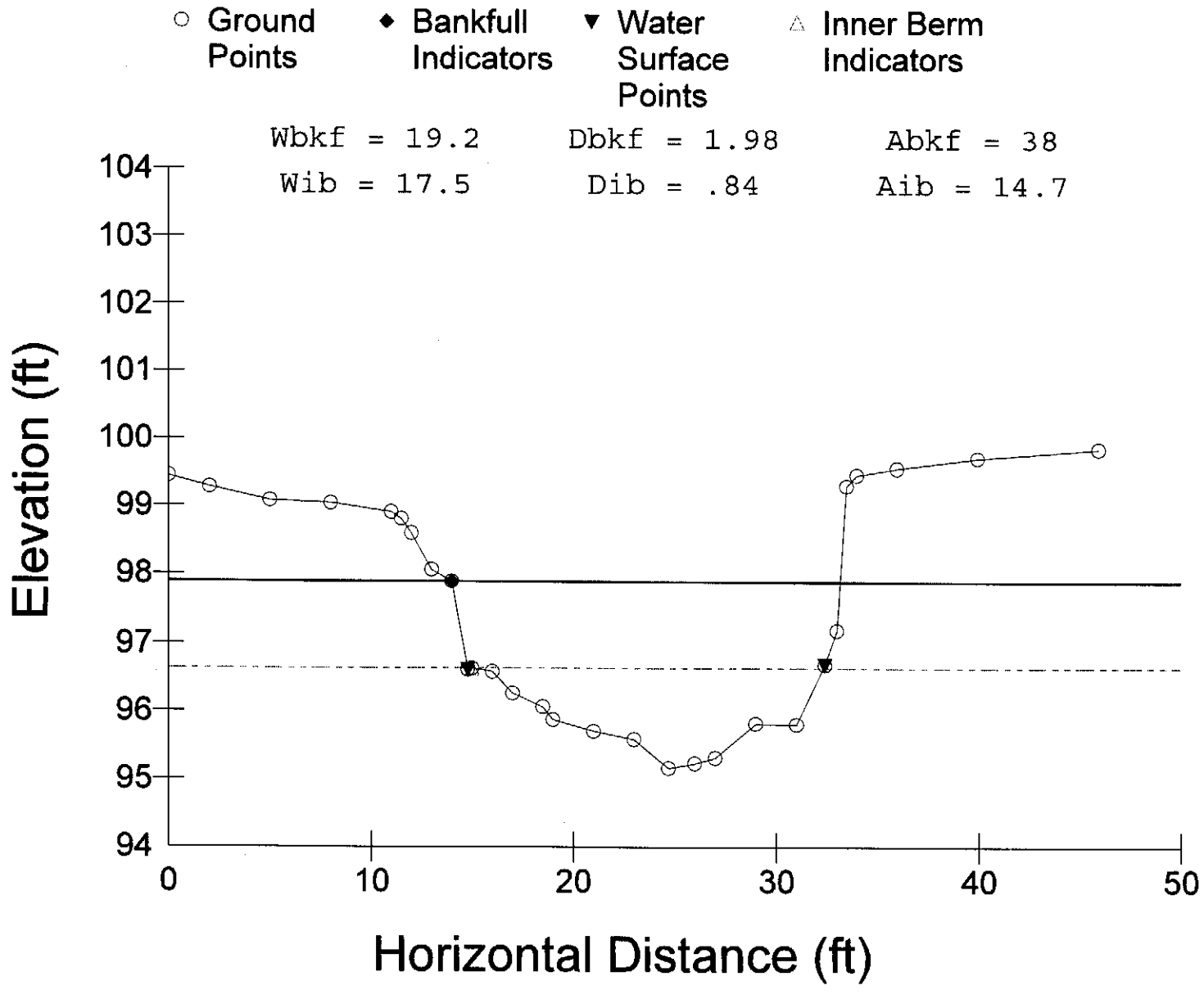
Marsh Run
Team 4
4/16/15

Riffle 0+43



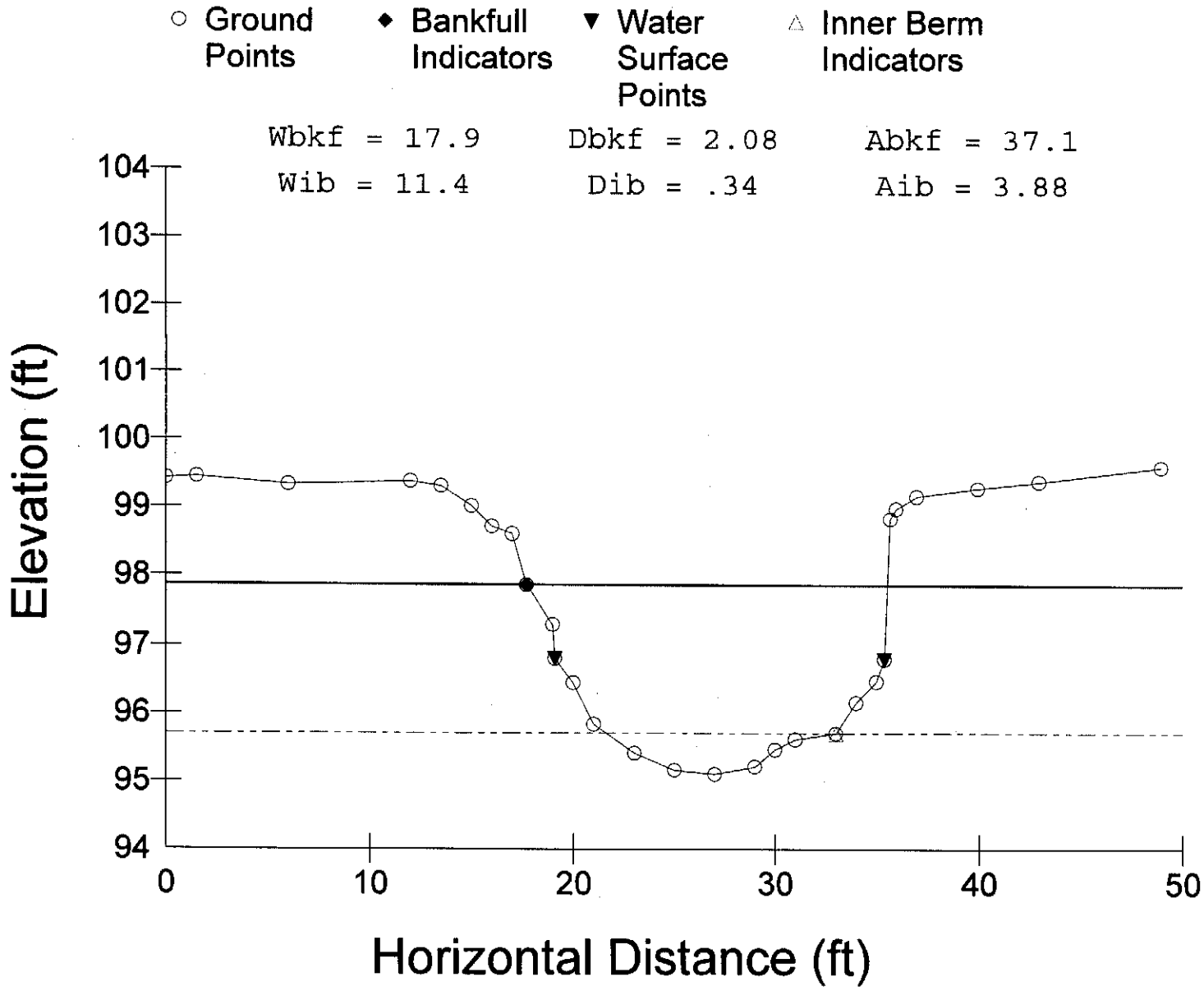
Marsh Run
Team 4
4/16/15

Run 0+52.6



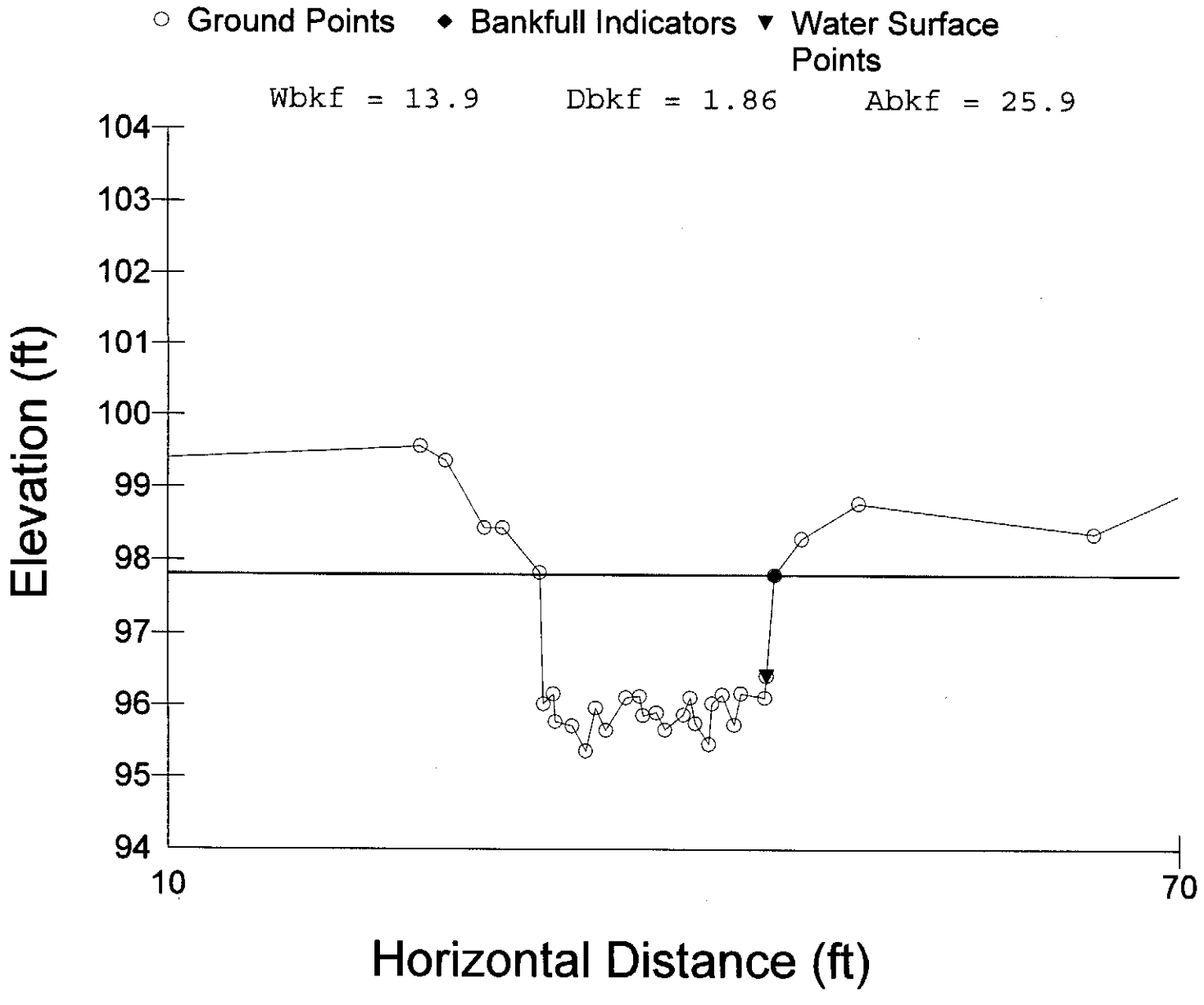
Marsh Run
Reach 4
4/16/15

Pool 0+66.6



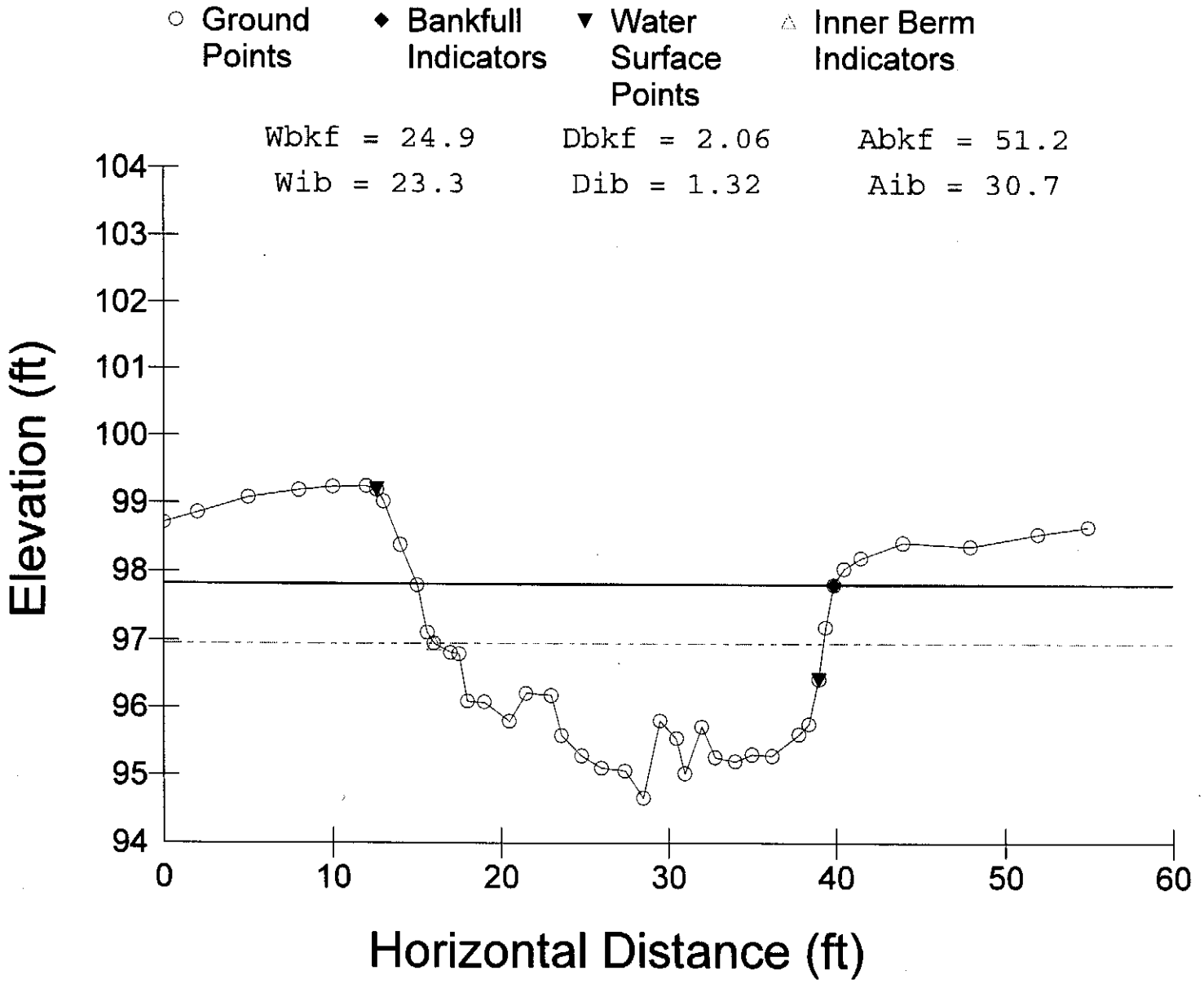
Marsh Run
Reach 4
4/16/15

Riffle 0+89



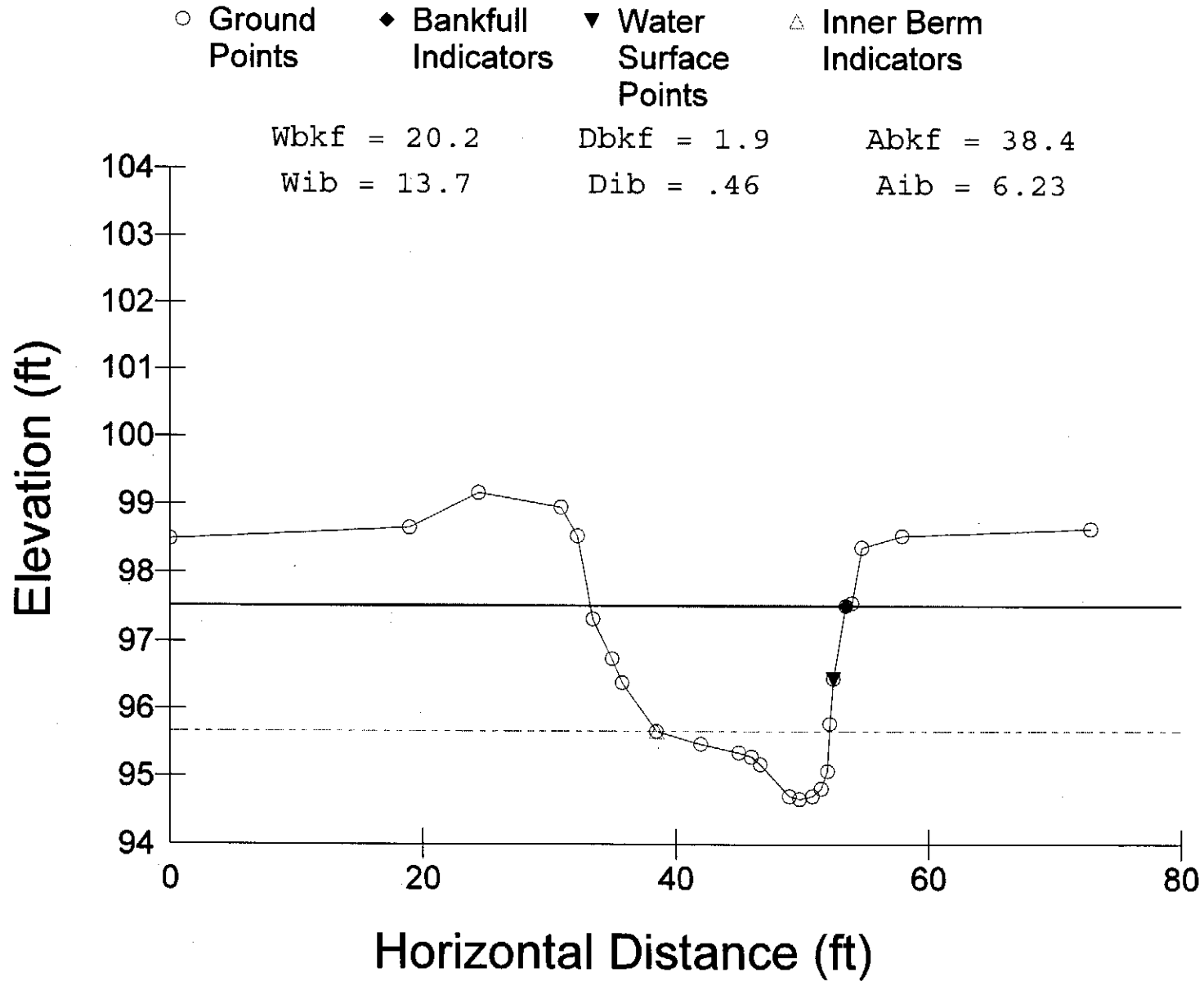
Marsh Run
Reach 4
4/16/15

Run 1+01

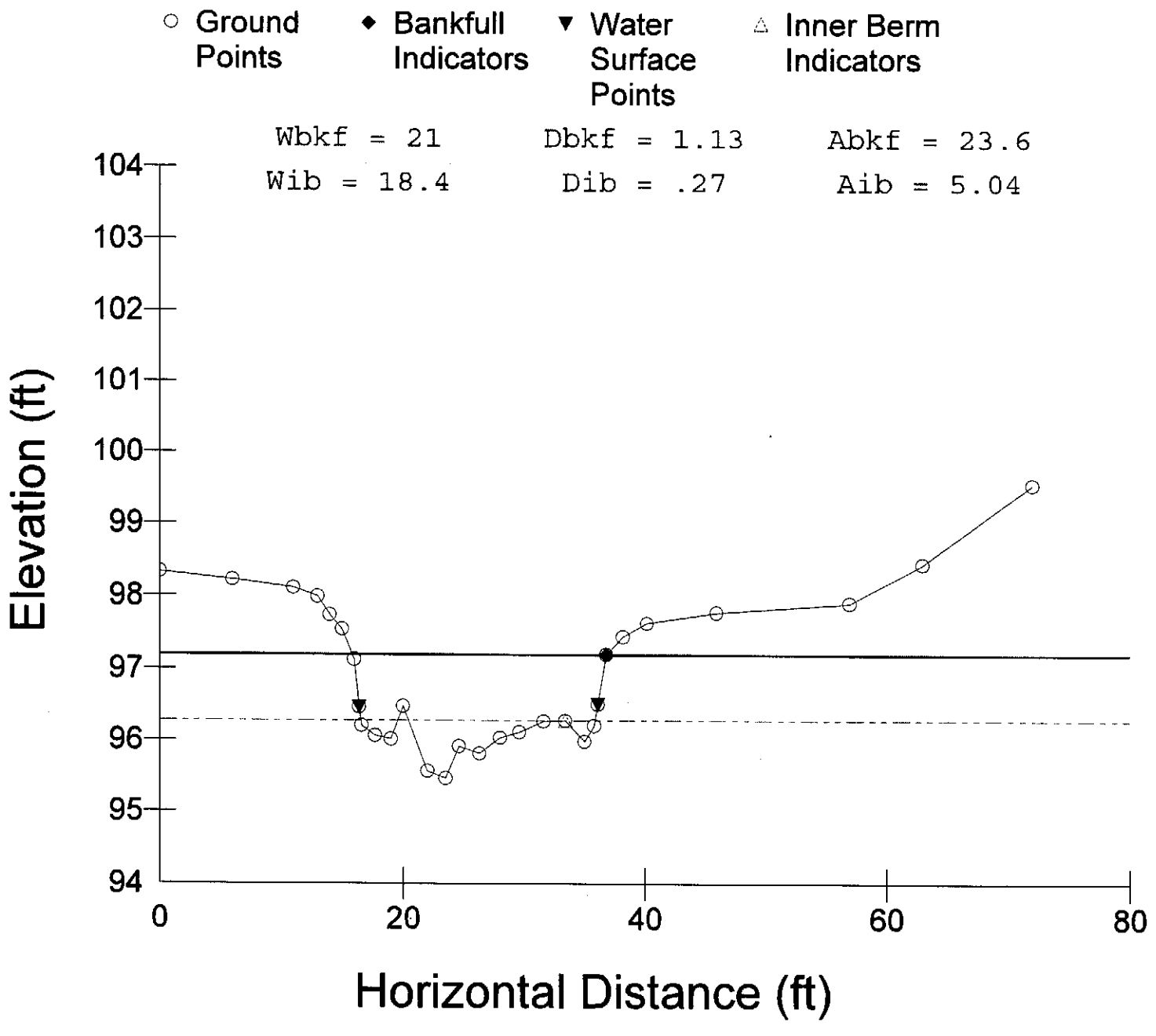


Marsh Run
Reach 4
4/16/15

Pool 1+77



Marsh Run
Reach 4
4/16/15



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SURVEY DATA ⟹ **CROSS - SECTION** 7

SITE: Team 4 Pool @ Station 77 **Date:** 4/16/15

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	TBM1	3.59	103.59		100.00	
30	0			5.10		
31	0+19			4.93		
32	0+24.5			4.42		
33	0+31			4.63		
34	0+32.3			5.05		Top of left bank
35	0+33.5			6.26		
36	0+35			6.85		
37	0+35.8			7.21		Left edge of water
38	0+38.5			7.93		
39	0+42			8.12		
40	0+45			8.25		end of depositional mud - hardens after this
41	0+46			8.31		
42	0+46.7			8.42		
43	0+49			8.89		
44	0+49.8			8.93		
45	0+50.8			8.89		
46	0+51.5			8.78		IB?
47	0+52			8.52		mud
48	0+52.2			7.82		Tree Roots
49	0+52.5			7.15		Right edge of water
50	0+53.5			6.06		Tree Roots - BF?
51	0+54			6.02		
52	0+54.8			5.21		Top of Right Bank
53	0+58			5.04		
54	0+73			4.93		
55						
56						
57						
58						
59						

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SURVEY DATA ⟹ **CROSS - SECTION** 1

SITE: Marsh Run Date: 4/16/15

Location: Station 01+00 – Run

Party / Notes: Team 4 HUC: _____

Item	Distance, Point, or STATION ft	Back-Sight BS ft	Height of Instrument HI ft	Fore-Sight FS ft	Elevation ft	NOTES (1) / COMMENTS / REMARKS (2)
1	0	6.90	105.61			LEP
2	2	6.75		STA	BS	
3	5	6.53		33.8	10.35	
4	8	6.42		34	10.41	
5	10	6.37		35	10.31	
6	12	6.36		36.2	10.33	
7	12.6	6.41		37.8	10.01	
8	13	6.58		38.4	9.86	
9	14	7.22		39.0	9.19 REW	
10	15	7.81		39.4	8.41	
11	15.6	8.49		39.9	7.80	
12	16	8.65		40.5	7.56	
13	17	8.79		41.5	7.40	
14	17.5	8.81		44	7.18	
15	18	9.52		48	7.23	
16	19	9.53		52	7.05	
17	20.5	9.82		55	6.94	
18	21.5	9.40				
19	23	9.43				
20	23.6	10.03				
21	24.8	10.33				
22	26	10.51				
23	27.4	10.55				
24	28.5	10.95				
25	29.5	9.81				
26	30.5	10.07				
27	31	10.59				
28	32	9.90				

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SURVEY DATA ⟹ **CROSS - SECTION** 1

SITE: Marsh Creek Date: 4/16/15

Location: Glide XS 0+00

Party / Notes: Team 4 HUC: _____

Item	Distance, Point, or STATION ft	Back-Sight BS ft	Height of Instrument HI ft	Fore-Sight FS ft	Elevation ft	REMARKS / COMMENTS / NOTES
						Looking DS
1	0	5.61	105.61	5.73		Bm = 100
2	2			5.81		
3	4			5.99		
4	6			6.05		
5	8			6.13		
6	10			6.21		
7	12			6.3		
8	14			6.33		
9	15			6.5		Top of Lt. Bank
10	16			7.1*		
11	16.7			7.47		Bankfull
12	17.5			8.57		Slope Break
13	18			8.61		Lt EOW
14	19			9.10		
15	20			9.32		
16	21			9.47		
17	22			9.39		
18	24			9.23		
19	26			9.44		
20	28			9.44		
21	30.5			9.67		
22	31.5			9.69		
23	33			9.69		
24	34			9.78		TWG
25	35			9.48		
26	36			9.17		
27	37			9.23		
28	38.5			9.19		

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SURVEY DATA ⟹ **CROSS - SECTION 2**

SITE: Glide XS 0+00 Marsh Creek Team 4 **Date:** 4/16/15

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	39		16.5.61	9.1		No EOW b/c Bank eroded
30	39.2			7.6		Slope Break
31	40			7.13		
32	41			6.74		
33	43			6.45		
34	45			6.32		
35	48			6.02		
36	53.8			5.9		
37						
38						
39						
40						
41						
42						
43						
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58						
59						

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SURVEY DATA ⟹ **CROSS-SECTION 3**

SITE: Riffle 0+43 / Team 4 Marsh Run **Date:** 4/16/15

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	0		105.61	6.29		Looking DS
30	2			6.41		
31	4			6.26		
32	6			6.36		
33	9			6.54		
34	10			6.63		
35	12			6.59		
36	13.5			7.13		Top of Lt Bank
37	14.5			7.9		
38	15			8.06		@Tree root (can't get EOW)
39	15.3			9.10		
40	16			9.12		Tree root (submerged)
41	17			9.41		
42	19			9.43		Rock (submerged)
43	20			9.58		
44	20.5			9.72		TWG
45	23			9.46		
46	24			9.53		
47	25			9.32		Rocks
48	26			9.32		
49	27.5			9.3		
50	28.5			9.11		
51	30			8.9		Rt EOW
52	31			8.04		
53	32		105.61 − 98.1	7.51		Bankfull?
54	33			6.74		
55	34.5			5.95		Top of Rt. Bank
56	36			5.76		
57	39			5.76		
58	44			5.8		
59	48			5.79		

0+20
9.68
TWG

2.21
5.30

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entered

SURVEY DATA ⟹ CROSS-SECTION 1

SITE: Marsh Creek Date: 4/16/15

Location: Run XS 0+52.6

Party / Notes: Team 4 HUC: _____

Item	Distance, Point, or STATION (ft)	Back-Sight BS (ft)	Height of Instrument HI (ft)	Fore-Sight FS (ft)	Elevation (ft)	REMARKS / COMMENTS / NOTES
						Looking DS
1	0		105.61	6.17		
2	2			6.33		
3	5			6.53		
4	8			6.57		
5	11			6.70		
6	11.5			6.80		Top of Lt. Bank
7	12			7.01		
8	13			7.55		
9	14			7.72		Bankfull * [illegible] ✓
10	14.8			9		EB EOW
11	15			8.98		
12	16			9.03		
13	17			9.35		
14	18.5			9.55		
15	19			9.74		
16	21			9.91		
17	23			10.03		
18	24.7			10.45		TWG
19	26			10.38		
20	27			10.3		
21	29			9.8		
22	31			9.81		
23	32.4			8.93		RT EOW
24	33			8.42		
25	33.5			6.3		
26	34			6.14		Top of Rt bank
27	36			6.04		
28	40			5.89		
	46			5.75		

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entered

SURVEY DATA → **CROSS - SECTION 2**

SITE: Pool XS 0+66.6 / Team 4 Marsh Run Date: 4/16/15

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	0		105.81	6.19		
30	1~~2~~			6.17		
31	6			6.28		
32	12			6.23		
33	13.5			6.30		
34	15			6.59		
35	16			6.89		
36	17			7.00		Top of Lt Bank
37	18			7.~~12~~5		Bankfull
38	19			8.31		
39	19.~~3~~1			8.81		Lt EOW
40	20			9.17		
41	21			9.78		
42	23			10.20		
43	25			10.45		
44	27			10.51		TWG
45	29			10.4		
46	30			10.15		
47	31			10		
48	33			9.91		
49	34			9.46		
50	35			9.15		
51	35.4			8.82		Rt. EOW
52	35.7			6.77		
53	36			6.62		Rt. Top of Bank
54	37			6.44		
55	40			6.32		
56	43			6.22		
57	49			6		
58						
59						

8.81 − 7.92 = 0.89

18 | 7.92

9.30 − 7.92 = 1.38

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Entered

SURVEY DATA ⟹ **CROSS - SECTION 6**

SITE: Riffle @ 00+89.6 Page: Marsh Run Date: 4/16/15

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	TBM 1	4.11	104.11		100.00	
30	0+00	4.8		4.82		
31	0+25			4.54		
32	0+26.5			4.74		
33	0+28.8			5.67		
34	0+29.2			6.17		
35	0+29.9			5.67		Rock
36	0+32.1			6.28		Big Rock
37	0+32.5			7.59		Left Edge of Water
38	0+32.3			8.09		Bed depth
39	0+32.9			7.95		
40	0+33.0			8.34		
41	0+34			8.40		
42	0+34.8			8.75	95.36	Thalweg
43	0+35.4			8.15		
44	0+36.0			8.46		
45	0+37.2			8.00		
46	0+38.0			7.98		
47	0+38.2			8.25		
48	0+39			8.21		
49	0+39.5			8.45		
50	0+40.6			8.24		
51	0+41			8.00		
52	0+41.3			8.36		
53	0+42.1			8.65		
54	0+42.3			8.08		
55	0+42.9			7.96		
56	0+43.6			8.38		
57	0+44			7.94		
58	0+45.4			8.00		
59	0+45.5			7.70		Right Edge of water

6.31 BF off to the Side
BF elev

Thalweg 8.75
6.31
2.44 max
thalweg elev 95.36
BF elev 97.8
2.44 max Depth

1.43 Rod reading

97.8
+ 2.44
100.24
104.11
100.24
3.87
B61 Rod Reading

Flood Prone BF { 2.44 / 2.48

Left bank 60ft + Right Bank 82.5ft + Tape Length 56ft = Flood prone area

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SURVEY DATA ⟹ **CROSS - SECTION** 5

SITE: Riffle @ 00+89.6 Page 2 **Date:**

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	0+46			6.41		BF?
30	0+47.6			5.81		Top of Right Bank
31	0+51			5.32		
32	0+65			5.74		
33	0+72			4.99		
34	0+76			4.81		
35						
36						
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SURVEY DATA ⟹ **CROSS-SECTION 8**

SITE: Downstream Glide - bottom of Reach. **Date:** 4/16/15

Item	STATION ft	BS ft	HI ft	FS ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	TBM 1	3.16	103.16		100	
30	0+00			4.83		
31	0+06			4.94		
32	0+11.0			5.05		
33	0+13.0			5.17		
34	0+14.0			5.42		
35	0+15.0			5.62		
36	0+16.0			6.03		TOLB
37	0+16.4			6.70		LEW
38	0+16.6			6.96		
39	0+17.7			7.10		
40	0+19.0			7.15		
41	0+20.0			6.69		Bedrock IB??
42	0+22.0			7.60		
43	0+23.5			7.70		Thal?
44	0+24.6			7.25		
45	0+26.3			7.35		
46	0+28			7.13		Rock outcrop
47	0+29.6			7.05		↓
48	0+31.6			6.90		
49	0+33.4			6.89		
50	0+35			7.18		↓
51	0+35.8			6.96		Silt deposition IB??
52	0+36.1			6.65		REW
53	0+36.8			5.96		TORB
54	0+38.2			5.72		BF ??
55	0+40.2			5.53		
56	0+46			5.38		
57	0+57			5.25		
58	0+63			4.71		
59	0+72			3.60		

3+55.7

Flood Prone Area

BF 5.75

5.61

TBM 1 3.21 close shot. WTF?!?!

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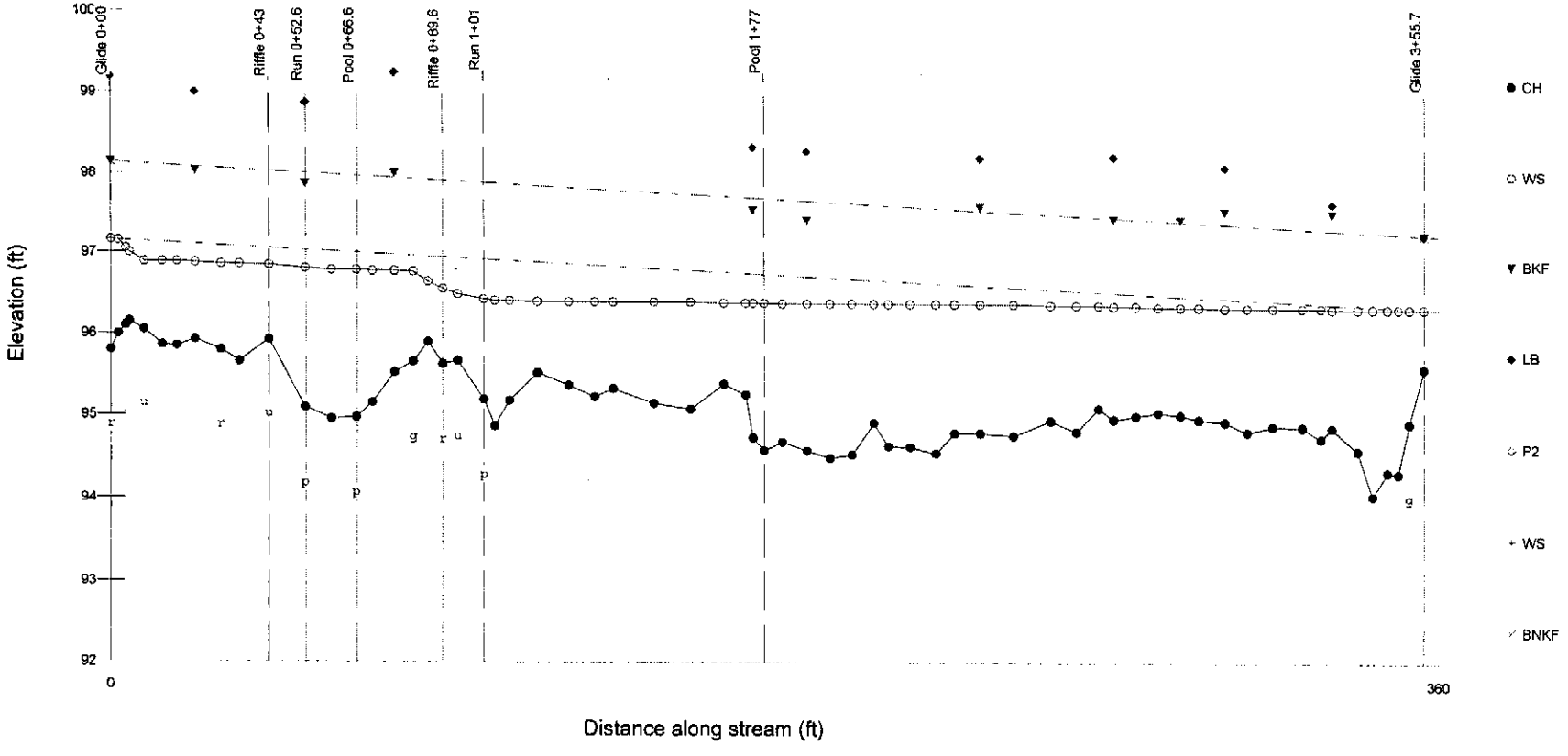
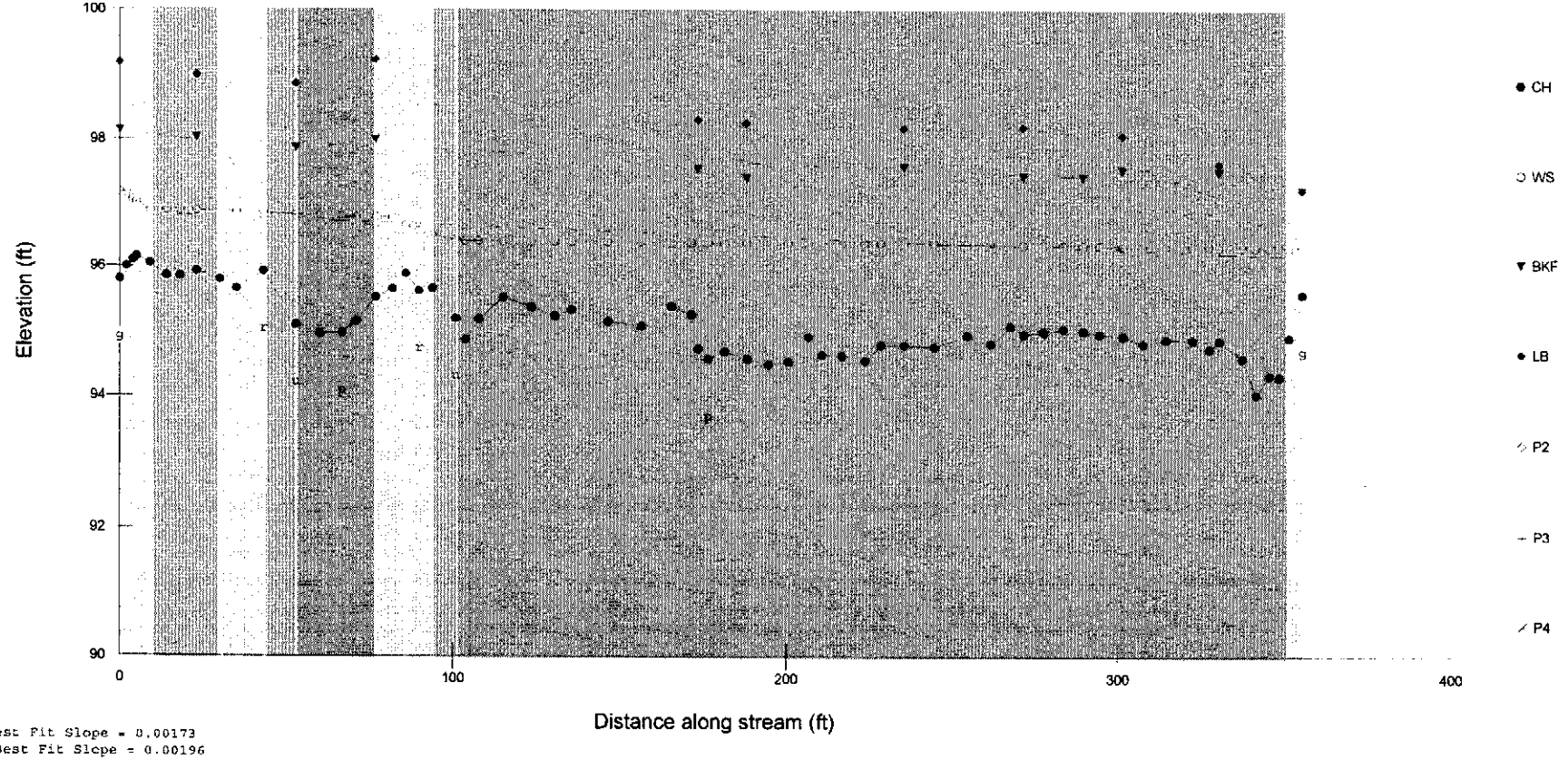
Marsh Run
4/16/15

Long Pro Reach 4



Marsh Run
4/16/15

Long Pro Reach 4



WS Best Fit Slope = 0.00173
BKF Best Fit Slope = 0.00196

SURVEY DATA ⟹ LONGITUDINAL PROFILE 1

SITE: MARSH RUN AT GRIMES, MD Date: 04/16/15

Location: REACH 4

Party / Notes: TODD M & MATT W HUC:

	Distance, Point, or	Back-Sight	Height of Instrument	Thalweg		Water Surface		Bankfull		Low Bank HI		NOTES
				Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	e.g. Riffle Run Pool Glide
	STATION	BS	HI	FS	Elev.	FS	Elev.	FS	Elev.	FS	Elev.	
	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	
1	BM1	5.61	105.61									
2	0			9.81		1.24 8.45		7.47		6.42		GLIDE XS
3	2			9.61		1.15 8.46						
4	4			9.51		0.95 8.56						
5	5			9.46		0.85 8.61						
6	9			9.56		8.72						
7	14			9.75		8.72						
8	18			9.76		8.72						
9	23			9.68		8.73		7.58		6.61		
10	30			9.81		8.75						
11	35			9.95		8.75						
12	43			9.68		8.76						RIFFLE XS
13	52.8			10.51		8.80		7.74		6.74		RUN XS
14	60			10.65		8.82						
15	66.7			10.63		8.82						POOL XS
16	71			10.45		8.83						
17	77			10.08		8.83		7.61		6.37		
18	82			9.95		8.84						
19	86			9.71		8.96						RI XS
20	90			9.98		9.05						
21	94			9.94		9.12						
22	101			10.41		9.18						
23	104			10.73		9.20						
24	108			10.42		9.20						
25	115.5			10.08		9.21						RUN XS G
26	124			10.23		9.21						
27	131			10.37		9.21						

0.023
0.025

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SURVEY DATA ⟹ **LONGITUDINAL PROFILE 2**

SITE: Marsh Run Team 4 Date: 4/16/15

Location:

Party / Notes: HUC:

	Distance, Point, or	Back-Sight	Height of Instru-ment	Thalweg		Water Surface		Bankfull		Low Bank HI		NOTES e.g. Riffle Run Pool Glide
				Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	
	STATION	BS	HI	FS	Elev.	FS	Elev.	FS	Elev.	FS	Elev.	
	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	
28	136			10.27		9.21						
29	147			10.45		9.21						
30	157			10.52		9.21						
31	166			10.21		9.22						
32	172			10.34		9.22						
33	174			10.86		9.22		8.06		7.28		POOR BANKFULL
34	177			11.02		9.22						POOL XS
35	182			10.91		9.23						
36	188.7			11.02		9.23		8.20		7.33		
37	195			11.11		9.23						
38	201			11.07		9.23						
39	207			10.68		9.23						
40	211			10.96		9.23						
41	217			10.97		9.23						
42	224			11.05		9.23						
43	229			10.80		9.23						
44	236			10.80		9.23		8.02		7.41		POOR BANKFULL
45	245			10.83		9.23						
46	255			10.65		9.24						
47	262			10.78		9.24						
48	268			10.50		9.24						
49	272			10.63		9.25		8.17		7.39		
50	278			10.59		9.25						
51	284			10.55		9.26						
52	290			10.58		9.26		8.18				
53	295			10.63		9.26						
54	302			10.66		9.27		8.07		7.52		

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SURVEY DATA ⟹ **LONGITUDINAL PROFILE 3**

SITE: Marsh Run Team 4 Date: 4/16/15

Location:

Party / Notes: HUC:

	Distance, Point, or	Back-Sight	Height of Instru-ment	Thalweg		Water Surface		Bankfull		Low Bank HI		NOTES
				Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	Fore-Sight	Elevation	e.g. Riffle Run Pool Glide
	STATION	BS	HI	FS	Elev.	FS	Elev.	FS	Elev.	FS	Elev.	
	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	
55	308			10.78		9.27						
56	315			10.71		9.27						
57	323			10.72		9.27						
58	328			10.86		9.27						
59	331			10.73		9.28		8.10		7.97		
60	338			11.01		9.28						
61	342			11.56		9.28						
62	346			11.27		9.28						
63	349			11.29		9.28						
64	352			10.68		9.28						
65	356			10.01		9.28		8.37		8.37		GLIDE XS
66												
67												
68												
69												
70												
71												
72												
73												
74												
75												
76												
77												
78												
79												
80												
81												

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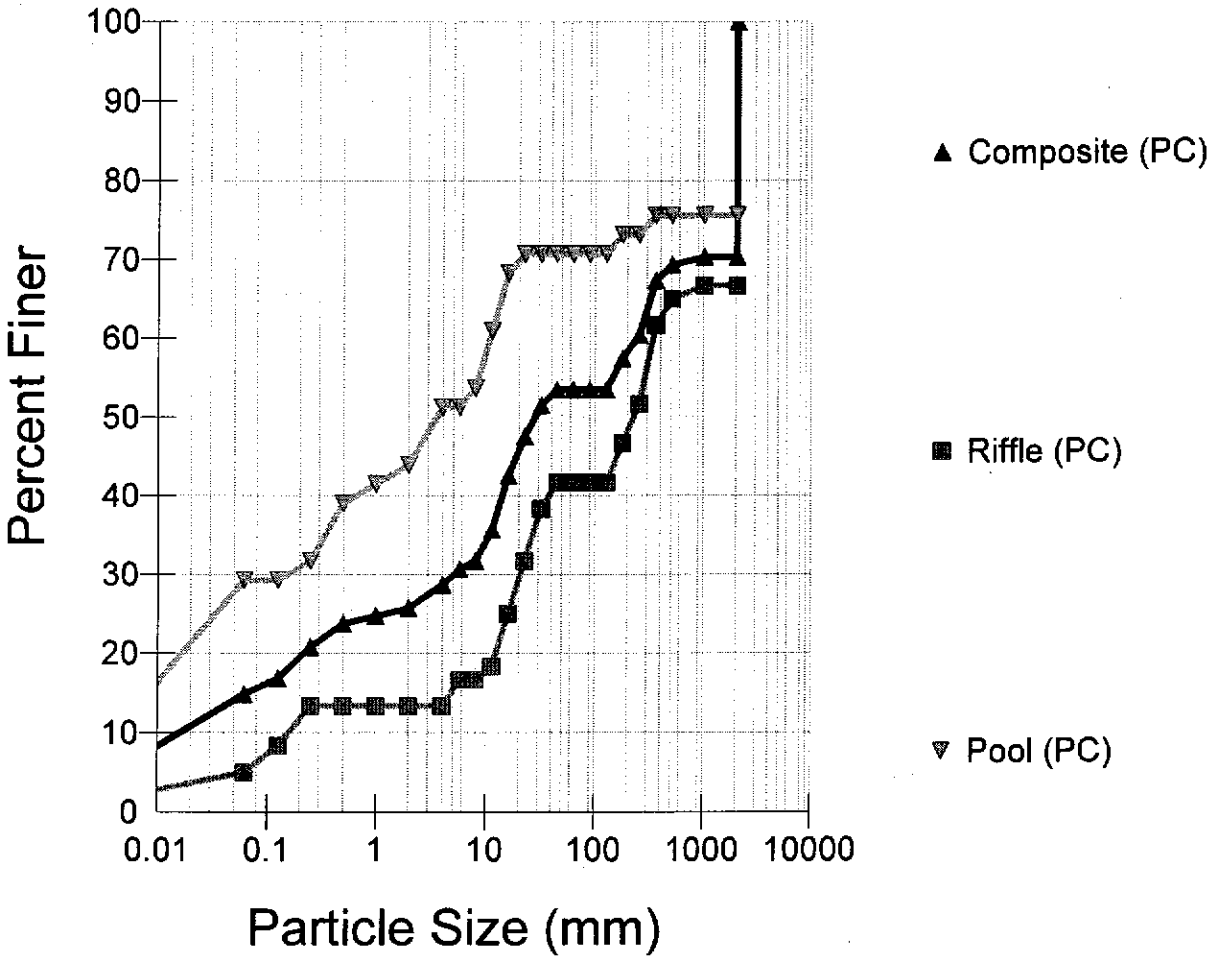
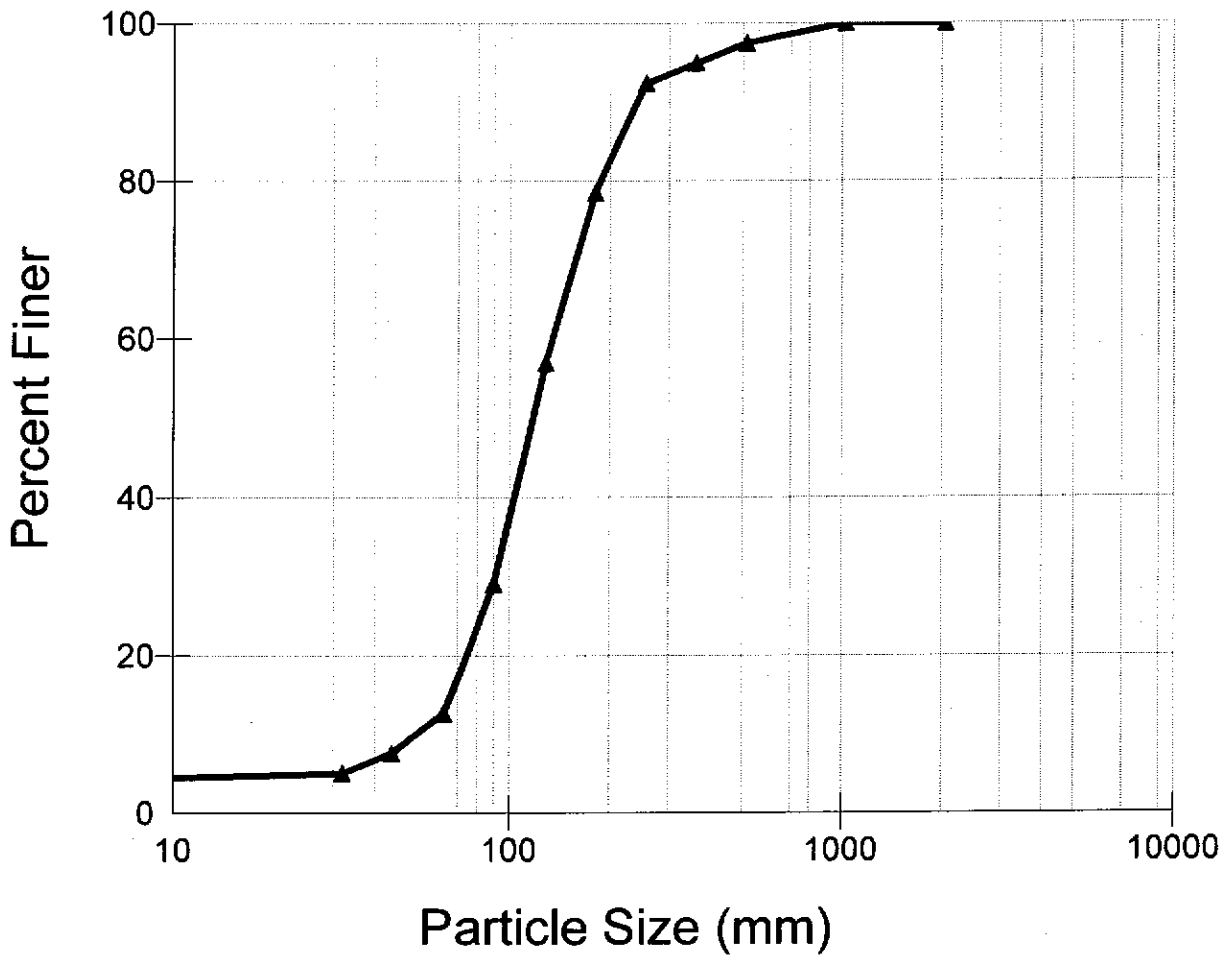
Marsh Run
Reach 4
4/16/15

Composite



Marsh Run Reach 4
Protrosion

Active Bed STAT 44'



Active Bed Station 88' Team 4

Protrusion Heights

Site: Team Farm – Marsh Run Date: 4/16/15

Location: HUC:

Party:

88' Dot Count for RIFFLE 1 POOL 2 44 COMP. 3

Inches	PARTICLE	Millimeters		RIFFLE (1) TOT #	RIFFLE (1) ITEM %	RIFFLE (1) % CUM	POOL (2) TOT #	POOL (2) ITEM %	POOL (2) % CUM	COMPOSITE (3) TOT #	COMPOSITE (3) ITEM %	COMPOSITE (3) % CUM
	Silt / Clay	< .062	S/C									
	Very Fine	.062 - .125	SAND									
	Fine	.125 - .25										
	Medium	.25 - .50										
	Coarse	.50 - 1.0										
.04 - .08	Very Coarse	1.0 - 2										
.08 - .16	Very Fine	2 - 4	GRAVEL									
.16 - .22	Fine	4 - 5.7										
.22 - .31	Fine	5.7 - 8		•	1							
.31 - .44	Medium	8 - 11.3		•	1							
.44 - .63	Medium	11.3 - 16		••	3							
.63 - .89	Coarse	16 - 22.6										
.89 - 1.3	Coarse	22.6 - 32		•	1		::	4				
1.3 - 1.8	Very Coarse	32 - 45		:•	5		••	2				
1.8 - 2.5	Very Coarse	45 - 64		:•	6		•:	4				
2.5 - 3.5	Small	64 - 90	COBBLE	⊠ ⊏	17		⊠ :·	13				
3.5 - 5.0	Small	90 - 128		⊠ •	11		⊠ ⊠ :·	22				
5.0 - 7.1	Large	128 - 180		⊠ ⊠ •	21		⊠ ⊏	17				
7.1 - 10.1	Large	180 - 256		⊠ ⊏	17		⊠ •	11				
10.1 - 14.3	Small	256 - 362	BOULDER	⊠ •	11		•:	2				
14.3 - 20	Small	362 - 512		:•	5		••	2				
20 - 40	Medium	512 - 1024		•	1		:	2				
40 - 80	Large-Vry Large	1024 - 2048										
	Bedrock		BDRK									
Stream Type:			**Valley Type:**	TOTAL →	100			77				

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Run 2 Glide 1

BF 1H

60% 40%

Non Pool

B104

Site: Team 4 Marsh Run Date: 4/16/15

Location: Reach Avg HUC:

Party:

Inches	PARTICLE	Millimeters		Dot Count for RIFFLE 1	POOL 2	COMP. 3	RIFFLE (1) Reach: Date: TOT #	ITEM %	% CUM	POOL (2) Reach: Date: TOT #	ITEM %	% CUM	COMPOSITE (3) Reach: Date: TOT #	ITEM %	% CUM
	Silt / Clay	< .062	S/C				3			12					
	Very Fine	.062 - .125	SAND				2								
	Fine	.125 - .25	SAND				3			1					
	Medium	.25 - .50	SAND							3					
	Coarse	.50 - 1.0	SAND							1					
.04 - .08	Very Coarse	1.0 - 2	SAND							1					
.08 - .16	Very Fine	2 - 4	GRAVEL							3					
.16 - .22	Fine	4 - 5.7	GRAVEL				2								
.22 - .31	Fine	5.7 - 8	GRAVEL							1					
.31 - .44	Medium	8 - 11.3	GRAVEL				1			3					
.44 - .63	Medium	11.3 - 16	GRAVEL				4			3					
.63 - .89	Coarse	16 - 22.6	GRAVEL				4			1					
.89 - 1.3	Coarse	22.6 - 32	GRAVEL				4								
1.3 - 1.8	Very Coarse	32 - 45	GRAVEL				2								
1.8 - 2.5	Very Coarse	45 - 64	GRAVEL												
2.5 - 3.5	Small	64 - 90	COBBLE												
3.5 - 5.0	Small	90 - 128	COBBLE												
5.0 - 7.1	Large	128 - 180	COBBLE				3			1					
7.1 - 10.1	Large	180 - 256	COBBLE				3								
10.1 - 14.3	Small	256 - 362	BOULDER				6			1					
14.3 - 20	Small	362 - 512	BOULDER				2								
20 - 40	Medium	512 - 1024	BOULDER				1								
40 - 80	Large-Vry Large	1024 - 2048	BOULDER												
	Bedrock		BDRK				20			10					
						TOTAL→	60			40					

Stream Type: **Valley Type:**

2 Riffle 2 Glide

2 Run

40 Pool

3P

16

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Worksheet 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007).

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	**Marsh Run**			Location:	**Reach - Reach 4**
Date:	**4/16/2015**	Stream Type:	**E4/1**	Valley Type:	**VIIIb**
Observers:	**Team 4**			HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	**29.19**	**A_{bkf}** (ft^2)	Bankfull Riffle Mean DEPTH	**1.62**	**d_{bkf}** (ft)
Bankfull Riffle WIDTH	**18.01**	**W_{bkf}** (ft)	Wetted PERMIMETER ~ $(2 * d_{bkf}) + W_{bkf}$	**19.54**	**W_p** (ft)
D_{84} at Riffle	**210.12**	**Dia.** (mm)	D_{84} (mm) / 304.8	**0.69**	**D_{84}** (ft)
Bankfull SLOPE	**0.0168**	**S_{bkf}** (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	**1.49**	**R** (ft)
Gravitational Acceleration	**32.2**	**g** (ft / sec^2)	Relative Roughness R(ft) / D_{84} (ft)	**2.16**	**R / D_{84}**
Drainage Area	**18.9**	**DA** (mi^2)	Shear Velocity $u^* = (gRS)^{½}$	**0.898**	**u^*** (ft/sec)

ESTIMATION METHODS		Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness	$u = [\ 2.83 + 5.66 * Log\ \{ R / D_{84} \}\ ]\ u^*$	**4.25**	ft / sec	**124.14**	cfs
2. Roughness Coefficient: a) Manning's *n* from Friction Factor / Relative Roughness (Figs. 2-18, 2-19)	$u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ **0.0528**	**4.77**	ft / sec	**139.21**	cfs
2. Roughness Coefficient: b) Manning's *n* from Stream Type (Fig. 2-20)	$u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ **0.0385**	**6.54**	ft / sec	**190.90**	cfs
2. Roughness Coefficient: c) Manning's *n* from Jarrett (USGS): Note: This equation is applicable to **steep, step/pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for Stream Types A1, A2, A3, B1, B2, B3, C2 & E3	$u = 1.49 * R^{2/3} * S^{1/2} / n$ $n = 0.39 * S^{0.38} * R^{-0.16}$ $n =$ **0.077**	**3.25**	ft / sec	**94.96**	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach (Leopold, Wolman and Miller)		**4.64**	ft / sec	**135.53**	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Chezy C		**0.00**	ft / sec	**0.00**	cfs
4. Continuity Equations: a) Regional Curves **Return Period for Bankfull Discharge**	$u = Q / A$ Q = **2.0** **year**	**3.43**	ft / sec	**100.00**	cfs
4. Continuity Equations: b) USGS Gage Data	$u = Q / A$	**3.82**	ft / sec	**111.50**	cfs

Protrusion Height Options for the D_{84} Term in the Relative Roughness Relation (R/D_{84}) – Estimation Method 1

Option 1.	For **sand-bed** channels: Measure 100 **"protrusion heights"** of sand dunes from the downstream side of feature to the top of feature. Substitute the D_{84} sand dune protrusion height in ft for the D_{84} term in method 1.
Option 2.	For **boulder-dominated** channels: Measure 100 **"protrusion heights"** of boulders on the sides from the bed elevation to the top of the rock on that side. Substitute the D_{84} boulder protrusion height in ft for the D_{84} term in method 1.
Option 3.	For **bedrock-dominated** channels: Measure 100 **"protrusion heights"** of rock separations, steps, joints or uplifted surfaces above channel bed elevation. Substitute the D_{84} bedrock protrusion height in ft for the D_{84} term in method 1.
Option 4.	For **log-influenced** channels: Measure **"protrusion heights"** proportionate to channel width of log diameters or the height of the log on upstream side if embedded. Substitute the D_{84} protrusion height in ft for the D_{84} term in method 1.

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Worksheet 5-3. Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream:	**Marsh Run, Reach - Reach 4**			
Basin:		Drainage Area: **12096** acres	**18.9**	mi^2
Location:	**Marsh Run at Grimes, MD**			
Twp.&Rge: ;		Sec.&Qtr.: ;		
Cross-Section Monuments (Lat./Long.):	**0 Lat / 0 Long**		Date: **04/16/15**	
Observers: **Team 4**			Valley Type: VIIIb	

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	**18.01**	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}).	**1.62**	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	**29.19**	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	**11.12**	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.	**2.21**	ft
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined in a riffle section.	**237.5**	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	**13.19**	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.	**28.47**	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.	**0.00247**	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).	**1.44**	

Stream Type **E 4/1** (See **Figure 2-14**)

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Worksheet 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2007; Rosgen, 2008).

Stream: **Marsh Run** Location: **Reach - Reach 4**

Observers: **Team 4** Date: **04/16/15** Valley Type: **VIIIb** Stream Type: **E 4/1**

River Reach Dimension Summary Data.....1

Riffle Dimensions*, **, *

Riffle Dimensions*, **, ***	Mean	Min	Max		Riffle Dimensions & Dimensionless Ratios****	Mean	Min	Max
Riffle Width (W_{bkf})	18	13.9	18	ft	Riffle Cross-Sectional Area (A_{bkf}) (ft^2)	29.19	25.88	29.19
Mean Riffle Depth (d_{bkf})	1.62	1.62	1.86	ft	Riffle Width/Depth Ratio (W_{bkf} / d_{bkf})	9.30	7.47	11.12
Maximum Riffle Depth (d_{max})	2.33	2.21	2.44	ft	Max Riffle Depth to Mean Riffle Depth (d_{max} / d_{bkf})	1.338	1.312	1.364
Width of Flood-Prone Area (W_{fpa})	215	192	238	ft	Entrenchment Ratio (W_{fpa} / W_{bkf})	13.500	13.187	13.813
Riffle Inner Berm Width (W_{ib})	13.3	13.3	13.3	ft	Riffle Inner Berm Width to Riffle Width (W_{ib} / W_{bkf})	0.737	0.737	0.737
Riffle Inner Berm Depth (d_{ib})	0.31	0.31	0.31	ft	Riffle Inner Berm Depth to Mean Depth (d_{ib} / d_{bkf})	0.190	0.190	0.190
Riffle Inner Berm Area (A_{ib})	4.08	4.08	4.08	ft^2	Riffle Inner Berm Area to Riffle Area (A_{ib} / A_{bkf})	0.140	0.140	0.140
Riffle Inner Berm W/D Ratio (W_{ib} / d_{ib})	43.2	43.2	43.2					

Pool Dimensions*, **, *

Pool Dimensions*, **, ***	Mean	Min	Max		Pool Dimensions & Dimensionless Ratios****	Mean	Min	Max
Pool Width (W_{bkfp})	19	17.9	20.2	ft	Pool Width to Riffle Width (W_{bkfp} / W_{bkf})	1.057	0.992	1.122
Mean Pool Depth (d_{bkfp})	1.99	1.9	2.08	ft	Mean Pool Depth to Mean Riffle Depth (d_{bkfp} / d_{bkf})	1.228	1.173	1.284
Pool Cross-Sectional Area (A_{bkfp})	37.8	37.1	38.4	ft	Pool Area to Riffle Area (A_{bkfp} / A_{bkf})	1.294	1.271	1.317
Maximum Pool Depth (d_{maxp})	2.82	2.76	2.87	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	1.741	1.704	1.772
Pool Inner Berm Width (W_{ibp})	6.83	0	13.7	ft	Pool Inner Berm Width to Pool Width (W_{ibp} / W_{bkfp})	0.339	0.000	0.677
Pool Inner Berm Depth (d_{ibp})	0.23	0	0.46	ft	Pool Inner Berm Depth to Pool Depth (d_{ibp} / d_{bkfp})	0.120	0.000	0.240
Pool Inner Berm Area (A_{ibp})	3.11	0	6.23	ft^2	Pool Inner Berm Area to Pool Area (A_{ibp} / A_{bkfp})	0.081	0.000	0.162
Point Bar Slope (S_{pb})	0.000	0.000	0.000	ft/ft	Pool Inner Berm Width/Depth Ratio (W_{ibp} / d_{ibp})	15.001	0.000	30.001

Run Dimensions*

Run Dimensions*	Mean	Min	Max		Run Dimensionless Ratios****	Mean	Min	Max
Run Width (W_{bkfr})	22.1	19.2	24.9	ft	Run Width to Riffle Width (W_{bkfr} / W_{bkf})	1.224	1.064	1.384
Mean Run Depth (d_{bkfr})	2.02	1.98	2.06	ft	Mean Run Depth to Mean Riffle Depth (d_{bkfr} / d_{bkf})	1.247	1.222	1.272
Run Cross-Sectional Area (A_{bkfr})	44.6	38	51.3	ft	Run Area to Riffle Area (A_{bkfr} / A_{bkf})	1.528	1.301	1.756
Maximum Run Depth (d_{maxr})	2.94	2.73	3.15	ft	Max Run Depth to Mean Riffle Depth (d_{maxr} / d_{bkf})	1.815	1.685	1.944
Run Width/Depth Ratio (W_{bkfr} / d_{bkfr})	10.9	9.68	12.1	ft				

Glide Dimensions*

Glide Dimensions*	Mean	Min	Max		Glide Dimensions & Dimensionless Ratios****	Mean	Min	Max
Glide Width (W_{bkfg})	21.9	21	22.7	ft	Glide Width to Riffle Width (W_{bkfg} / W_{bkf})	1.213	1.164	1.262
Mean Glide Depth (d_{bkfg})	1.49	1.13	1.84	ft	Mean Glide Depth to Mean Riffle Depth (d_{bkfg} / d_{bkf})	0.920	0.698	1.136
Glide Cross-Sectional Area (A_{bkfg})	32.7	23.7	41.7	ft	Glide Area to Riffle Area (A_{bkfg} / A_{bkf})	1.120	0.810	1.429
Maximum Glide Depth (d_{maxg})	2.03	1.74	2.31	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.253	1.074	1.426
Glide Width/Depth Ratio (W_{bkfg} / d_{bkfg})	15.5	12.4	18.6	ft/ft	Glide Inner Berm Width/Depth Ratio (W_{ibg} / d_{ibg})	65.094	62.681	67.506
Glide Inner Berm Width (W_{ibg})	17.3	16.2	18.5	ft	Glide Inner Berm Width to Glide Width (W_{ibg}/W_{bkfg})	0.797	0.714	0.880
Glide Inner Berm Depth (d_{ibg})	0.27	0.26	0.27	ft	Glide Inner Berm Depth to Glide Depth (d_{ibg} / d_{bkfg})	0.192	0.141	0.242
Glide Inner Berm Area (A_{ibg})	4.62	4.19	5.04	ft^2	Glide Inner Berm Area to Glide Area (A_{ibg} / A_{bkfg})	0.157	0.101	0.213

Step**

Step Dimensions**	Mean	Min	Max		Step Dimensionless Ratios****	Mean	Min	Max
Step Width (W_{bkfs})	0	0	0	ft	Step Width to Riffle Width (W_{bkfs} / W_{bkf})	0.000	0.000	0.000
Mean Step Depth (d_{bkfs})	0	0	0	ft	Mean Step Depth to Riffle Depth (d_{bkfs} / d_{bkf})	0.000	0.000	0.000
Step Cross-Sectional Area (A_{bkfs})	0	0	0	ft	Step Area to Riffle Area (A_{bkfs} / A_{bkf})	0.000	0.000	0.000
Maximum Step Depth (d_{maxs})	0	0	0	ft	Max Step Depth to Mean Riffle Depth (d_{maxs} / d_{bkf})	0.000	0.000	0.000
Step Width/Depth Ratio (W_{bkfs} / d_{bkfs})	0	0	0					

*Riffle–Pool system (i.e., C, E, F stream types) bed features include riffles, runs, pools and glides.

**Step–Pool system (i.e., A, B, G stream types) bed features include riffles, rapids, chutes, pools and steps (note: include rapids and chutes in riffle category).

***Convergence-Divergence system (i.e., D stream types) bed features include riffles and pools; cross-sections taken at riffles for classification purposes.

****Mean values are used as the normalization parameter for all dimensionless ratios; e.g., minimum pool width to riffle width ratio uses the *mean* riffle width value.

Worksheet 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2007; Rosgen, 2008).

Stream: **Marsh Run** Location: **Reach - Reach 4**

Observers: **Team 4** Date: **04/16/15** Valley Type: **VIIIb** Stream Type: **E 4/1**

River Reach Summary Data.....2

Hydraulics

Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	4.25	ft/sec	Estimation Method	Relative Roughness	
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	124	cfs	Drainage Area	18.9	mi^2

Channel Pattern

Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Linear Wavelength (λ)	392	392	392	ft	Linear Wavelength to Riffle Width (λ / W_{bkf})	21.77	21.77	21.77
Stream Meander Length (L_m)	575	575	575	ft	Stream Meander Length Ratio (L_m / W_{bkf})	31.93	31.93	31.93
Radius of Curvature (R_c)	72.5	60	85	ft	Radius of Curvature to Riffle Width (R_c / W_{bkf})	4.03	3.33	4.72
Belt Width (W_{blt})	152	152	152	ft	Meander Width Ratio (W_{blt} / W_{bkf})	8.44	8.44	8.44
Arc Length (L_a)	168	168	168	ft	Arc Length to Riffle Width (L_a / W_{bkf})	9.33	9.33	9.33
Riffle Length (L_r)	10	8	13	ft	Riffle Length to Riffle Width (L_r / W_{bkf})	0.56	0.44	0.72
Individual Pool Length (L_p)	138	24.2	251	ft	Individual Pool Length to Riffle Width (L_p / W_{bkf})	7.64	1.34	13.94
Pool to Pool Spacing (P_s)	170	170	170	ft	Pool to Pool Spacing to Riffle Width (P_s / W_{bkf})	9.44	9.44	9.44

Channel Profile

Valley Slope (S_{val})	0.0033	ft/ft	Average Water Surface Slope (S)	0.00247	ft/ft	Sinuosity (S_{val} / S) 1.44
Stream Length (SL)	356	ft	Valley Length (VL)	512	ft	Sinuosity (SL / VL) 0.70

Low Bank Height (LBH)	start	3.37	ft	Max Depth (d_{max})	start	2.38	ft	Bank-Height Ratio (BHR) (LBH / d_{max})	start 1.42
	end	1.63	ft		end	1.63	ft		end 1

Facet Slopes	Mean	Min	Max		Dimensionless Facet Slope Ratios	Mean	Min	Max
Riffle Slope (S_{rif})	0.017	0.001	0.030	ft/ft	Riffle Slope to Average Water Surface Slope (S_{rif} / S)	6.81	0.31	12.03
Run Slope (S_{run})	0.005	0.001	0.009	ft/ft	Run Slope to Average Water Surface Slope (S_{run} / S)	1.90	0.58	3.47
Pool Slope (S_p)	0.001	0.000	0.001	ft/ft	Pool Slope to Average Water Surface Slope (S_p / S)	0.33	0.16	0.50
Glide Slope (S_g)	0.007	0.000	0.014	ft/ft	Glide Slope to Average Water Surface Slope (S_g / S)	2.92	0.00	5.85
Step Slope (S_s)	0.000	0.000	0.000	ft/ft	Step Slope to Average Water Surface Slope (S_s / S)	0.00	0.00	0.00

Max Depths[a]	Mean	Min	Max		Dimensionless Depth Ratios	Mean	Min	Max
Max Riffle Depth (d_{maxrif})	2.23	2.05	2.37	ft	Max Riffle Depth to Mean Riffle Depth (d_{maxrif} / d_{bkf})	1.38	1.27	1.46
Max Run Depth (d_{maxrun})	2.39	2.23	2.51	ft	Max Run Depth to Mean Riffle Depth (d_{maxrun} / d_{bkf})	1.48	1.38	1.55
Max Pool Depth (d_{maxp})	3.12	3.02	3.21	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	1.93	1.86	1.98
Max Glide Depth (d_{maxg})	1.86	1.63	2.01	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.15	1.01	1.24
Max Step Depth (d_{maxs})	0	0	0	ft	Max Step Depth to Mean Riffle Depth (d_{maxs} / d_{bkf})	0	0	0

Channel Materials

	Reach[b]	Riffle[c]	Bar		Reach[b]	Riffle[c]	Bar	Protrusion Height[d]	
% Silt/Clay	14.85	5		D_{16}	0.1	5.36		69.28	mm
% Sand	10.89	8.33		D_{35}	10.77	27.3		98.04	mm
% Gravel	27.73	28.34		D_{50}	28.47	230.62		118.5	mm
% Cobble	6.93	10		D_{84}	Bedrock	Bedrock		210.12	mm
% Boulder	9.9	15		D_{95}	Bedrock	Bedrock		365.56	mm
% Bedrock	29.7	33.33		D_{100}	Bedrock	Bedrock		1023.98	mm

[a] Min, max & mean depths are measured from Thalweg to bankfull at mid-point of feature for riffles and runs, the deepest part of pools, & at the tail-out of glides.

[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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Worksheet B-4. Dimensionless ratios of the ten pool types (*Second Field Day*).

Stream: Marsh Run Location: Team 4

Observers: Stream Type: Valley Type: Date: 4/16/15

Pool Type		Dimensional Values: Pool Length (L_p)	Pool Max Depth (d_{maxp})	Pool Slope (S_p)		Dimensionless Ratios: Pool Length to Riffle Width (L_p / W_{bkf})	Pool Max Depth to Riffle Mean Depth (d_{maxp}/d_{bkf})	Pool Slope to Average Slope (S_p / S)
1. Lateral Scour Pool (LSP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			
2. Contraction Scour Pool (CSP)	Mean	24.3	3.03	0.0012	Mean	1.35	1.35	0.52
	Min.				Min.			
	Max.				Max.			
3. Step/Pool (SP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			
4. Backwater Pool (BWP)	Mean	251.4	3.21	0.0004	Mean	14.0	1.43	0.17
	Min.				Min.			
	Max.				Max.			
5. Plunge Pool (PP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			
6. Pocket Water Pool (PWP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			
7. Lateral Protrusion Pool (LPP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			
8. Straight Dissipator Pool (SDP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			
9. Converging Confluence Pool (CCP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			
10. Compound Pool (CP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			

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Marsh Run 4/16/15
Team 4

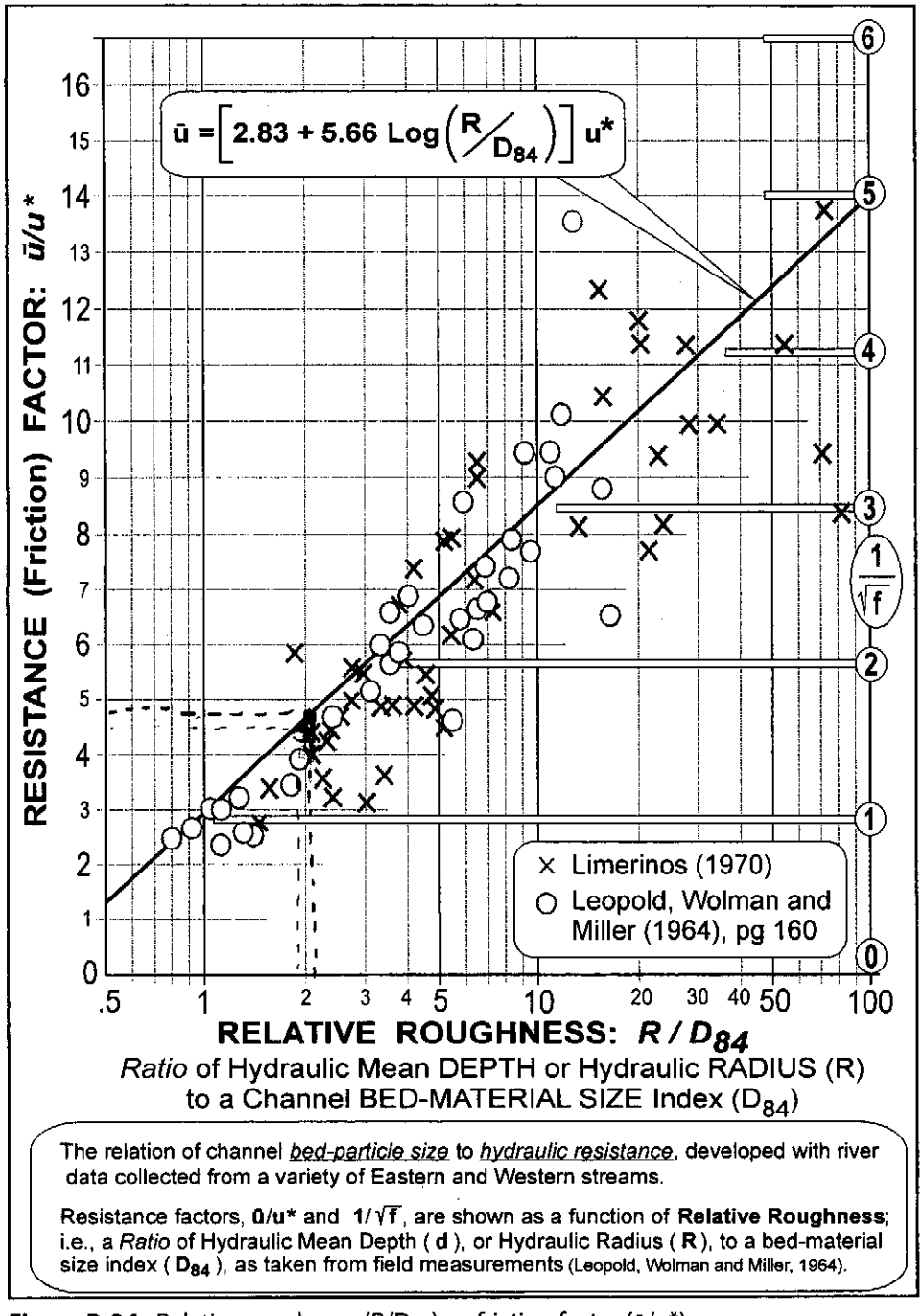

Figure B-34. Relative roughness (R/D_{84}) *vs.* friction factor ($\bar{u}/u^*$).

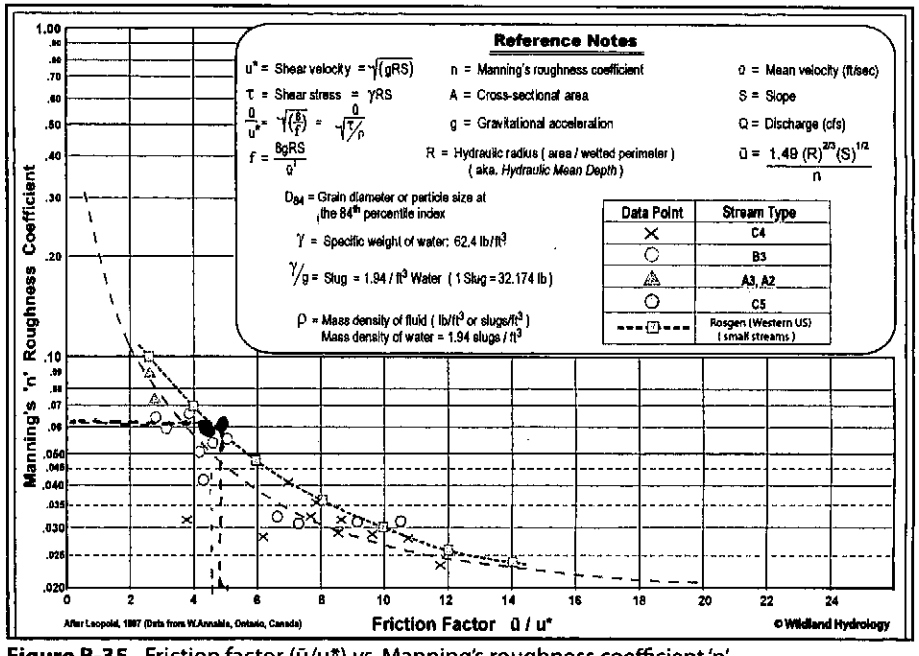

Figure B-35. Friction factor ($\bar{u}/u^*$) *vs.* Manning's roughness coefficient 'n'.

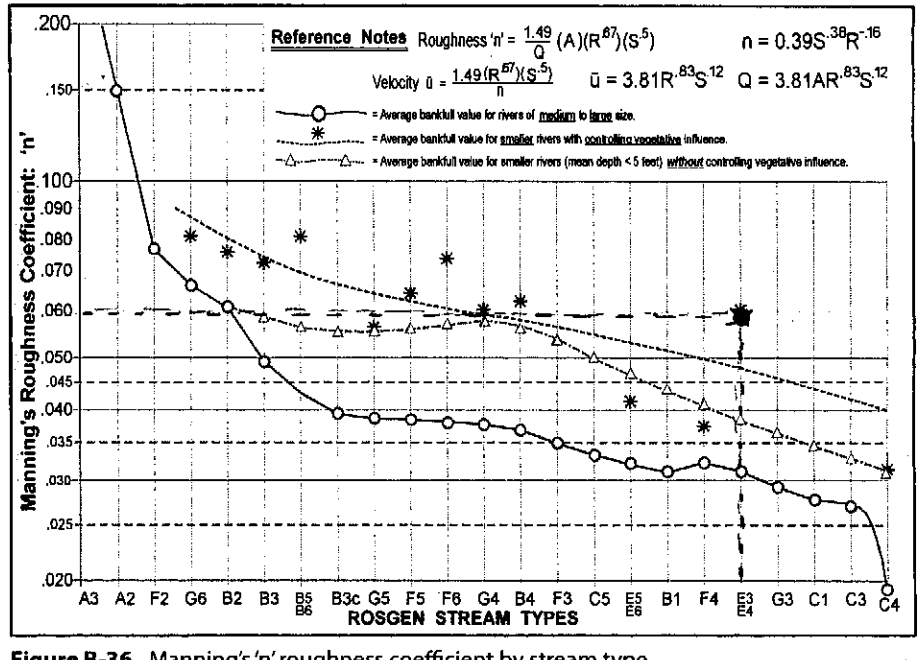

Figure B-36. Manning's 'n' roughness coefficient by stream type.

$\eta = 0.0626$

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Marsh Run
Reach 4
4/16/15

Worksheet B-5. Procedure to validate hydraulic relations using gage station data.

1. Obtain the drainage area associated with the gaging station.
2. Obtain the field-determined bankfull discharge at the gaging station (**Figure B-43**).
3. Obtain the bankfull channel dimensions from the gaging station hydraulic geometry relationships (discharge *vs.* width, depth, area, and velocity).
4. Measure the average water surface slope.
5. Perform an active bed pebble count on the riffle to obtain D_{84}.
6. Determine the stream type.
7. Solve for Manning's 'n' at the bankfull stage: $n = (1.49R^{2/3}S^{1/2})/\bar{u}$ (use the bankfull mean velocity from Step 3).
8. Calculate relative roughness: R/D_{84}. Make sure that D_{84} is converted from millimeters to feet. Hydraulic radius (R) and mean depth (d_{bkf}) are often used interchangeably when width/depth ratios are greater than 12.
9. Calculate shear velocity: $u^* = (gRS)^{1/2}$.
10. Calculate friction factor: $\bar{u}/u^*$.
11. Plot bankfull discharge as a function of drainage area on the appropriate regional curve.
12. Plot bankfull channel dimensions as a function of drainage area on the appropriate regional curve (note stream type of plotted values using unique symbols).
13. Plot relative roughness by friction factor (**Figure B-34**) (Example in **Figure B-39**).
14. Plot Manning's 'n' by friction factor (**Figure B-35**) (Example in **Figure B-40**).
15. Plot Manning's 'n' by stream type (**Figure B-36**) (Example in **Figure B-41**).

Gaging Station Name: **Gaging Station Number:**

Drainage Area (mi^2)	Bankfull Discharge Q_{bkf} (cfs)	Bankfull Width W_{bkf}	Bankfull Mean Depth d_{bkf} (ft)	Bankfull Area A_{bkf} (ft^2)	Bankfull Velocity $\bar{u}_{bkf}$ (ft/s)	Ave. Water Surface Slope S (ft/ft)	D_{84} (mm)	D_{84} (ft)	Stream Type	Manning's 'n'	Relative Roughness R/D_{84} (ft/ft)	Shear Velocity u^* (ft/s)	Friction Factor $\bar{u}/u^*$
18.9	111.5	18.5	1.9	35.5	3.14	1.68	210.12	0.689	E4	0.062	2.16	0.898	4.73

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Summary....*USGS GAGE STATION* Data / Records for STREAM CHANNEL CLASSIFICATION

Station NAME:	Marsh Run	Station Number:	
LOCATION:	Reach 4	4/16/15	
Period of Record:		yrs	Mean Annual DISCHARGE:		cfs
Drainage AREA:		acres		mi^2	Drainage Area Mn Elev:		ft
Reference REACH SLOPE:		ft/ft	Valley Type:	
Stream Type:		HUC:	

"BANKFULL" CHARACTERISTICS

Riffle 43

Determined from FIELD MEASUREMENT			Determined from GAGE DATA Analysis		
Bankfull WIDTH (W_{bkf})	18	ft	Bankfull WIDTH (W_{bkf})	18.5	ft
Bankfull Mean DEPTH (d_{bkf})	1.62	ft	Bankfull MEAN DEPTH (d_{bkf})	1.9	ft
Bankfull Xsec AREA (A_{bkf})	29.2	ft^2	Bankfull Xsec AREA (A_{bkf})	35.5	ft^2
Wetted PERIMETER (W_P)	19.54	ft	Wetted PERIMETER (W_P)	22.3	ft
Bankfull STAGE (Gage Ht)		ft	Bankfull STAGE (Gage Ht)	2.17	ft
Est. Mean VELOCITY (u)	4.25	ft/sec	Mean VELOCITY (u)	3.14	ft/sec
Est. Bkf. DISCHARGE (Q_{bkf})	124	cfs	Bankfull DISCHARGE(Q_{bkf})	111.5	cfs

Bankfull DISCHARGE associated with **"field-determined"** Bankfull STAGE (From Gage Height reading at Staff Plate and tabular Stage-Discharge curve data)	111.5	cfs
Recurrence Interval (Log-Pearson) associated with **"field-determined"** Bankfull Discharge	2	yrs

From the *Annual Peak Flow Frequency Analysis* data for the Gage Station, determine:

1.5 Year R.I. Discharge =	72	cfs	10 Year R.I. Discharge =	276	cfs
2.0 Year R.I. Discharge =	105	cfs	25 Year R.I. Discharge =	442	cfs
5.0 Year R.I. Discharge =	200	cfs	50 Year R.I. Discharge =	458	cfs

MEANDER GEOMETRY

Meander Wavelength (L_m)	575	ft	Radius of Curvature (R_C)	72.5	ft
Belt Width (W_{blt})	152	ft	Meander Width Ratio (W_{blt}/W_{bkf})	8.44	ft/ft

HYDRAULIC GEOMETRY

Based on *USGS Discharge Summary Notes* data (Form 9-207) and regression analyses of measured discharge (**Q**) with the hydraulic parameters of Width (**W**), Area (**A**), Mean Depth (**d**) & Mean Velocity (**u**), determine the *intercept coefficient* (**a**) and the *slope exponent* (**b**) values for a power function of the form $Y = aX^b$, when Y is one of the selected hydraulic parameters and X is a given discharge value (**Q**).

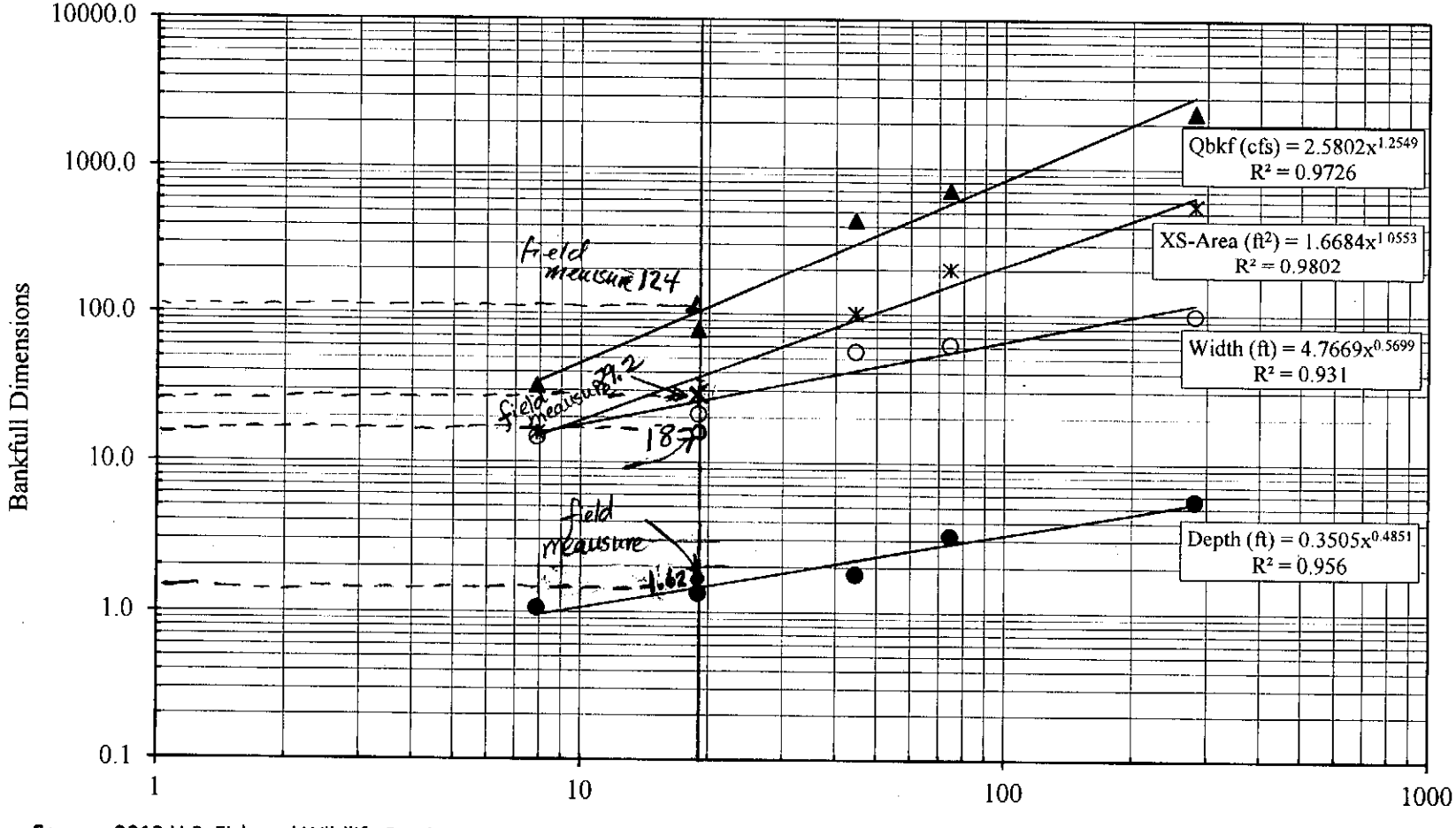
	Width (W)	Depth (d)	Area (A)	Velocity (u)
Intercept Coefficient **a)**	12.704	0.4066	3.916	0.258
Slope Exponent **b)**	0.0438	0.3106	0.504	0.4928

Hydraulic Radius R = A / W_p	1.49	ft	**Manning's "n"** at Bankfull Stage	0.059	Coeff.

$$"n" = 1.4895\,[(\text{Area})\,(\text{Hydraulic Radius}^{2/3})\,(\text{Slope})^{1/2}]\,/\,Q_{bkf}$$

Marsh Run - Team 4
4/16/15

Bankfull Characteristics for Selected USGS Gages in the PA and MD Carbonate Great Valley Section of the Ridge and Valley Province



Source: 2012 U.S. Fish and Wildlife Service, Chesapeake Bay Field Office - Annapolis, MD

Field measures

Discharge = 124 cfs
Area = 29.2 ft²
Width = 18 ft
Depth = 1.62 ft