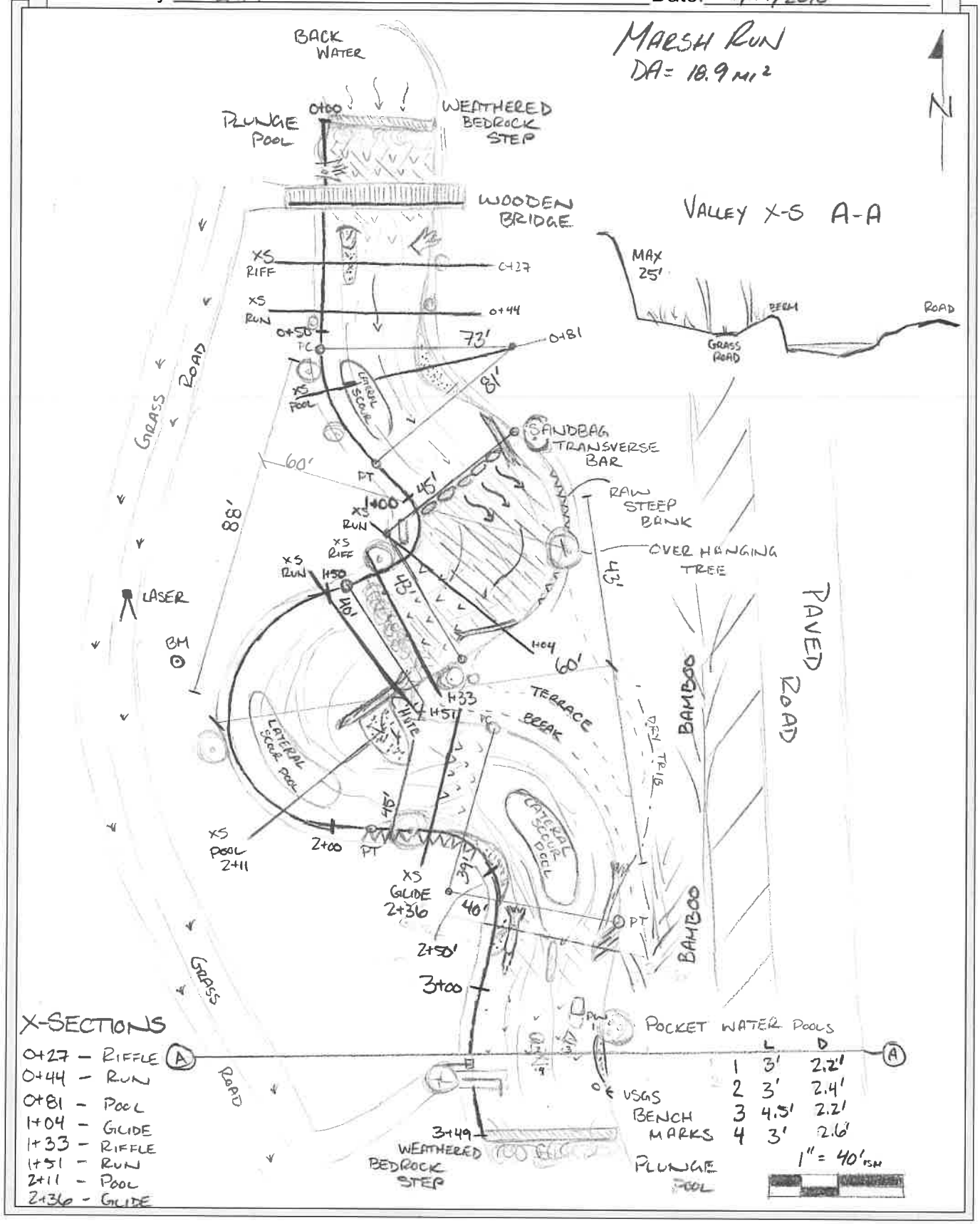
AREA-SITE LOCATION....REACH MAP

Stream/Drainage: MARSH RUN Site/Reach: REACH 1

Drawn By: TEAM 1 Date: 4/19/2018



	L	D
1	3'	2.2'
2	3'	2.4'
3	4.5'	2.2'
4	3'	2.6'

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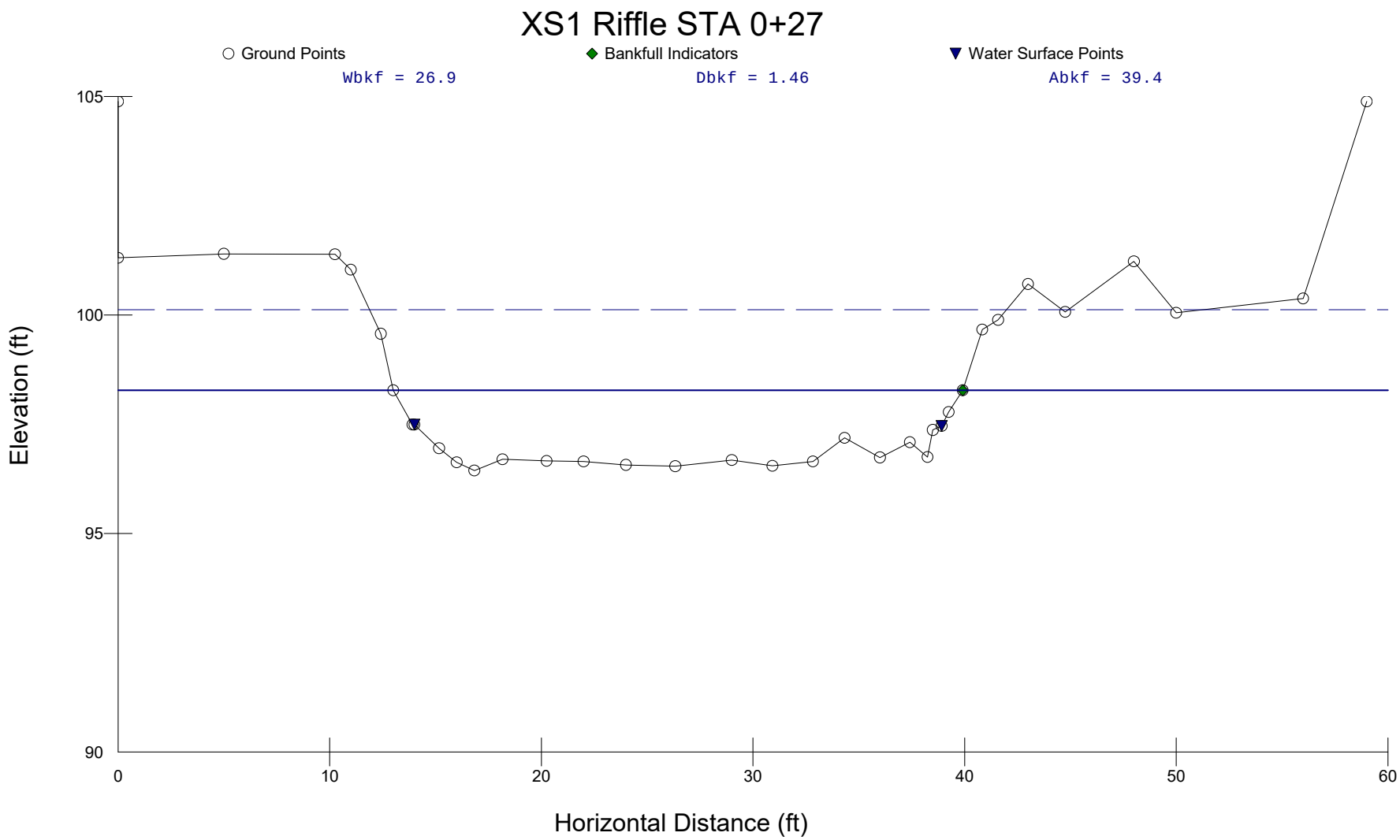
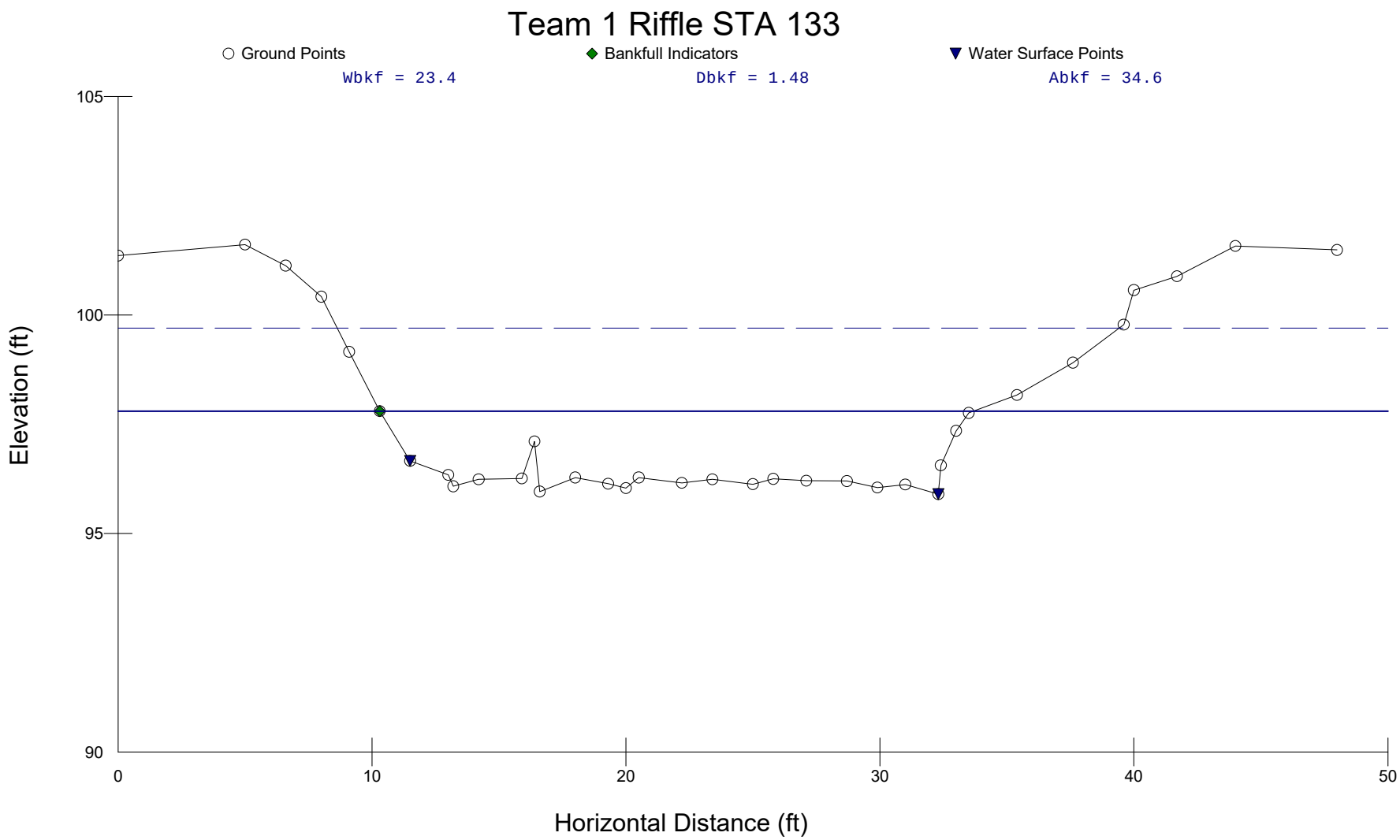
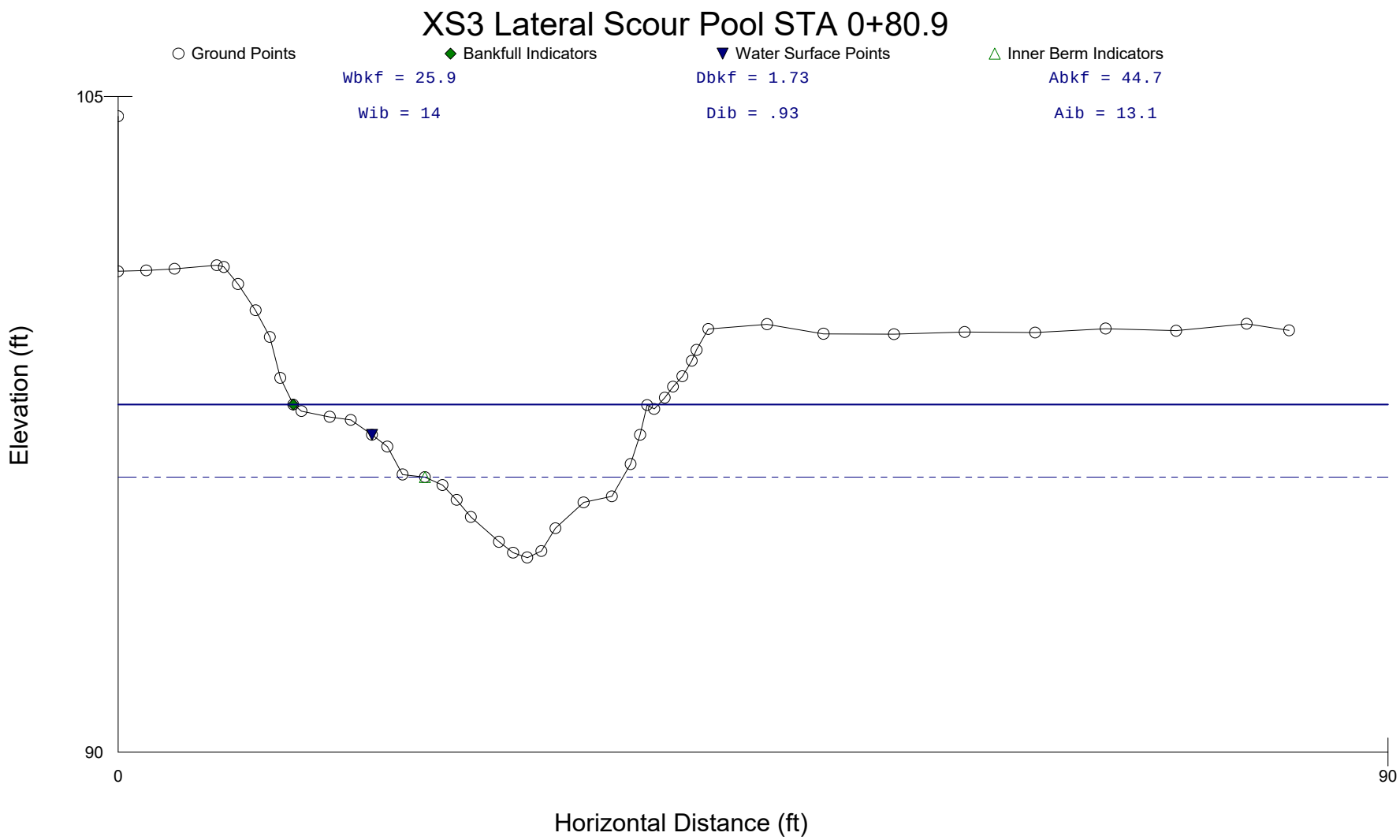
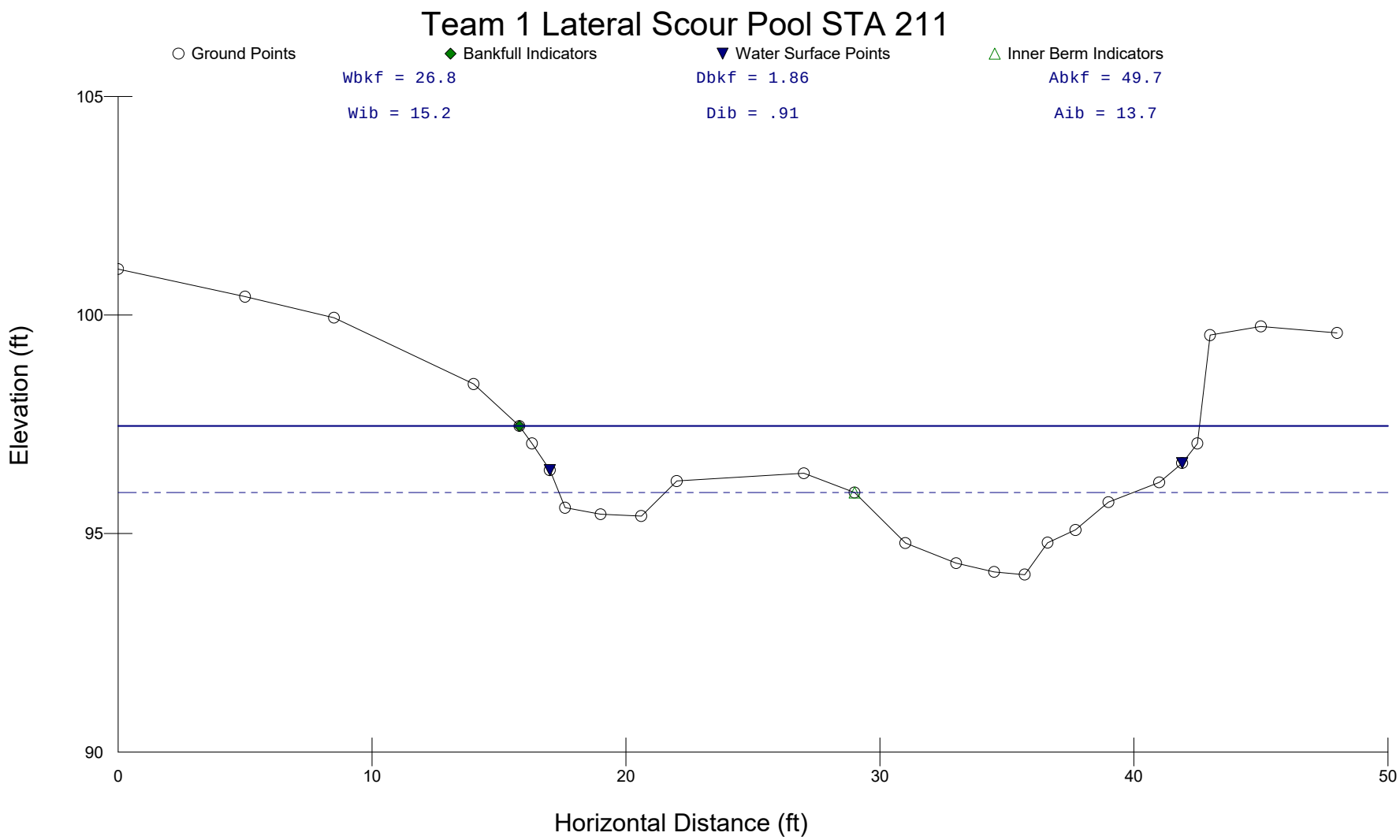
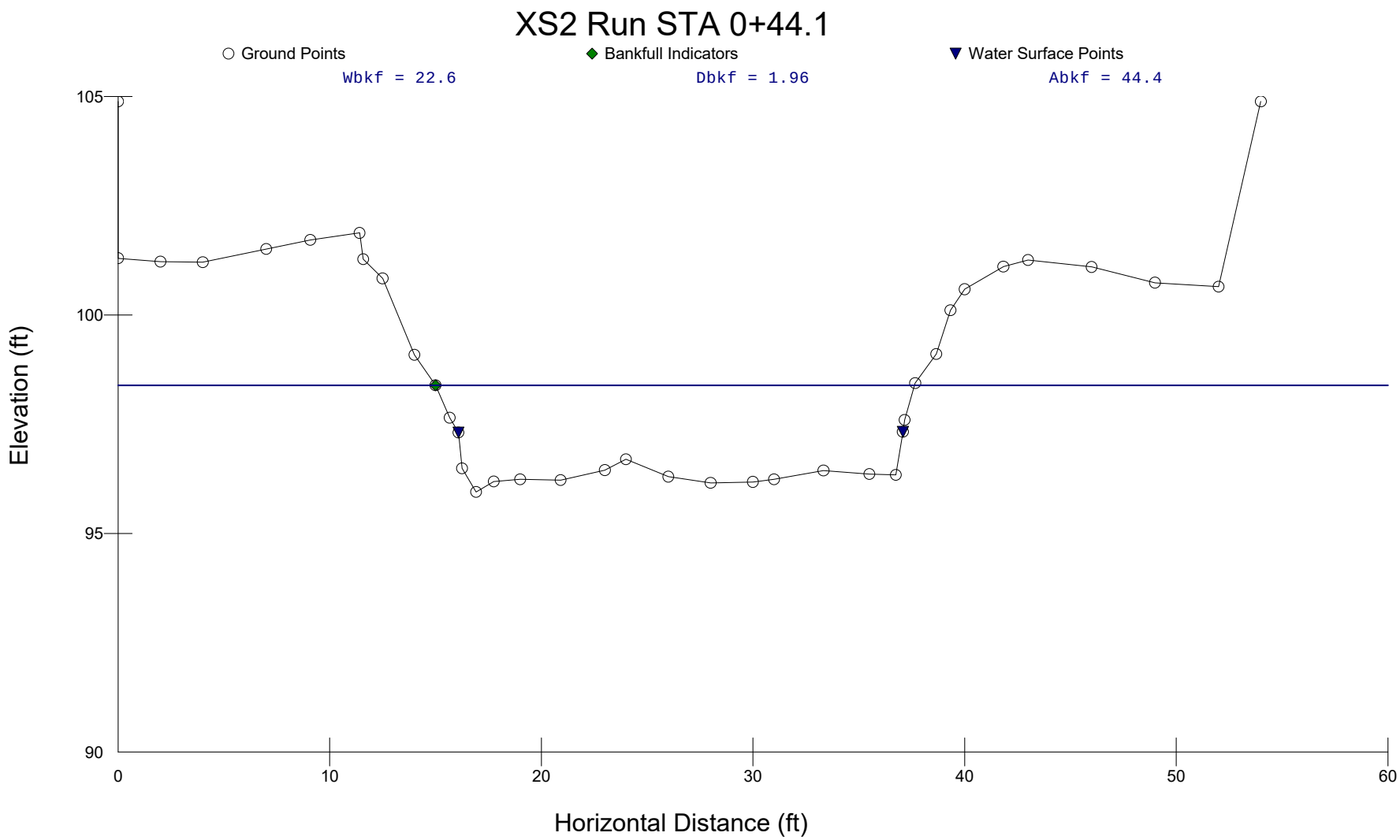
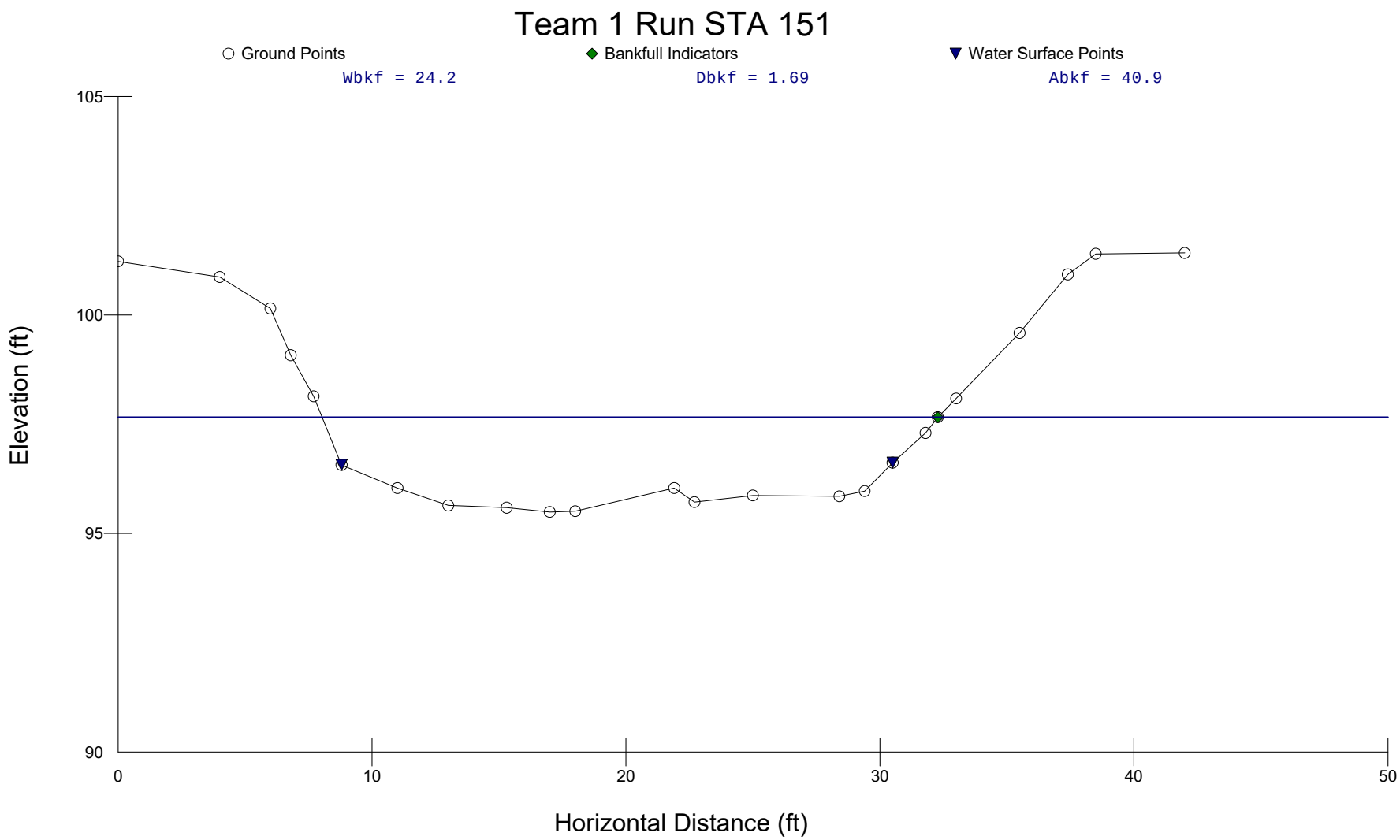

XS1 Riffle STA 0+27
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 26.9
Dbkf = 1.46
Abkf = 39.4
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
60
Horizontal Distance (ft)

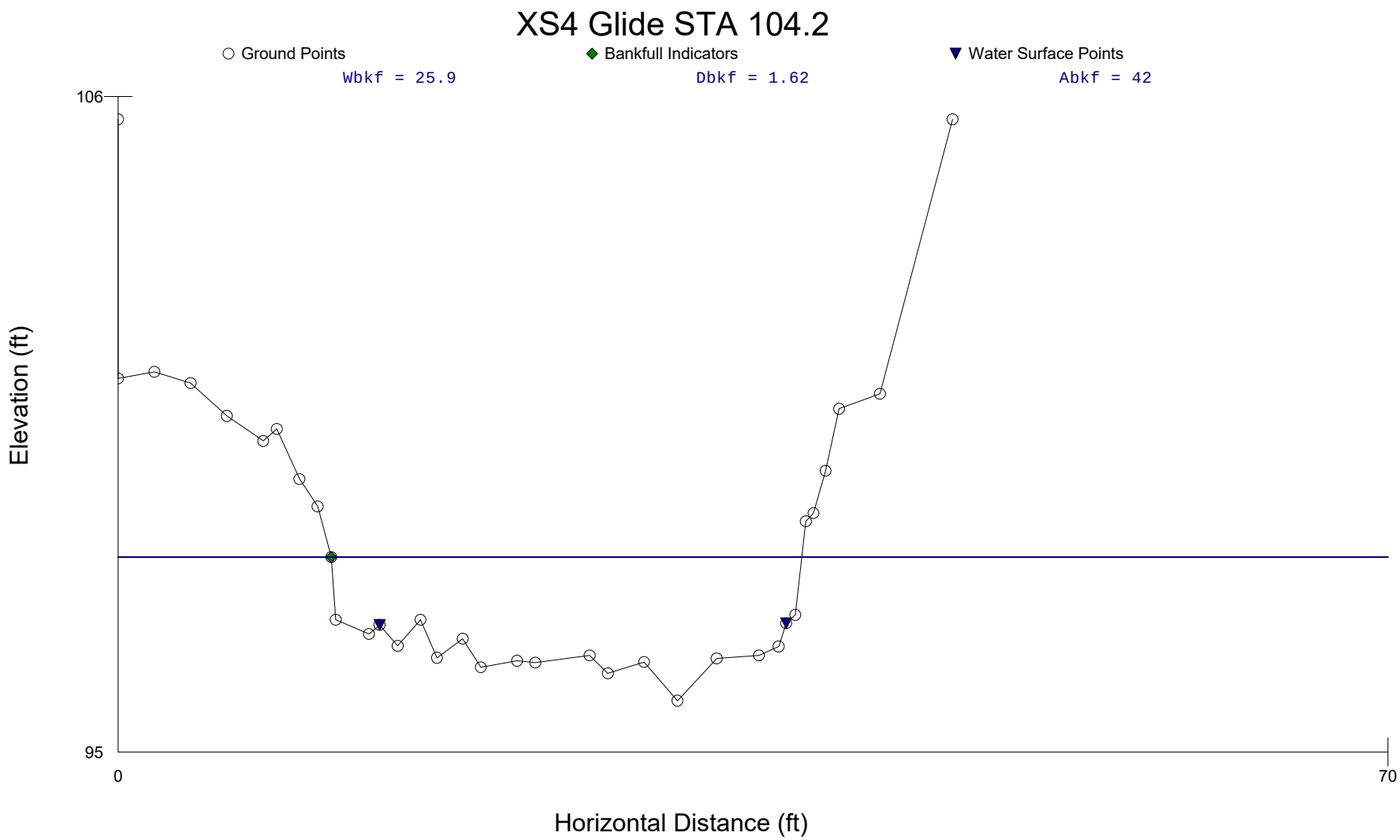

Team 1 Riffle STA 133
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 23.4
Dbkf = 1.48
Abkf = 34.6
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

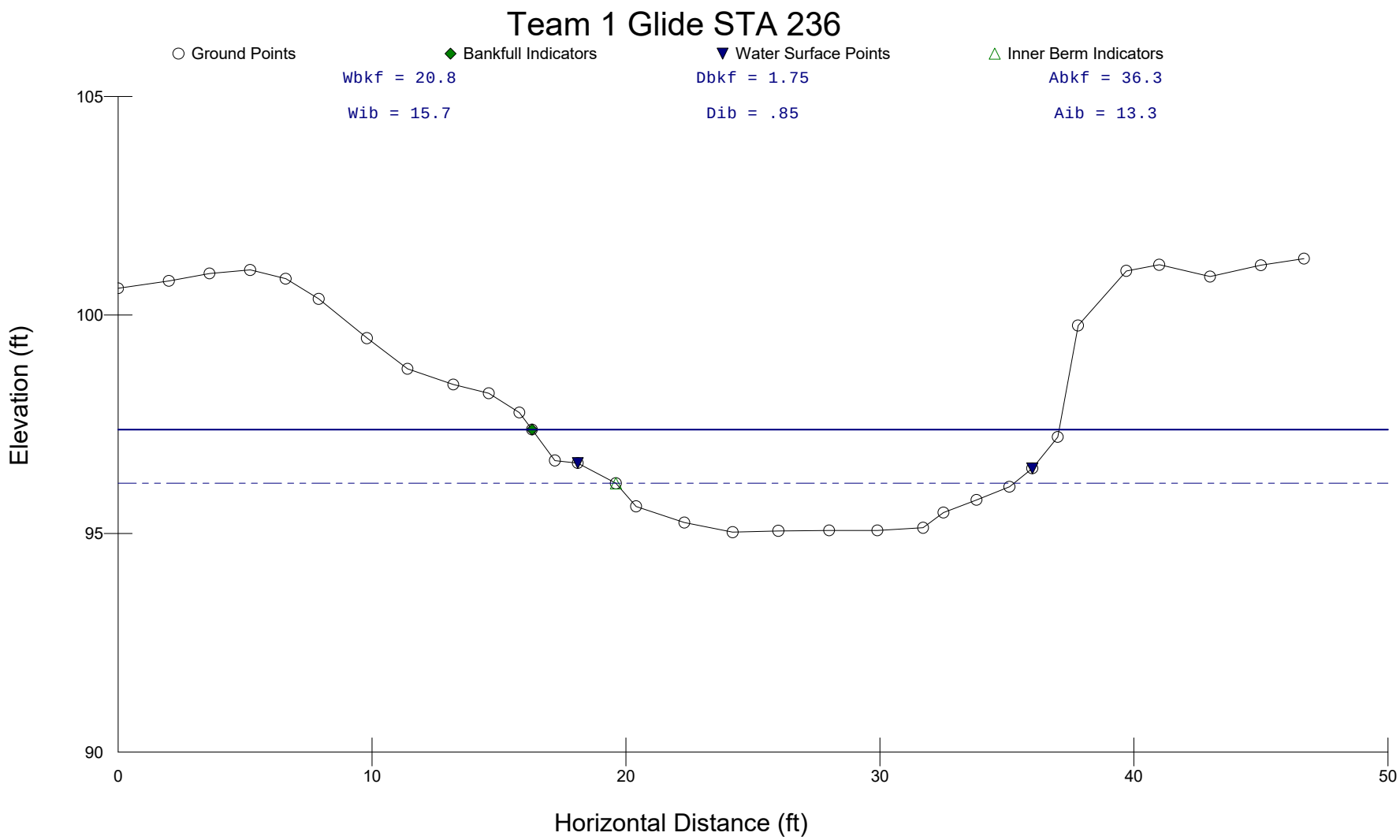

XS3 Lateral Scour Pool STA 0+80.9
Ground Points
Bankfull Indicators
Water Surface Points
Inner Berm Indicators
Wbkf = 25.9
Wib = 14
Dbkf = 1.73
Dib = .93
Abkf = 44.7
Aib = 13.1
105
90
0
90
Elevation (ft)
Horizontal Distance (ft)

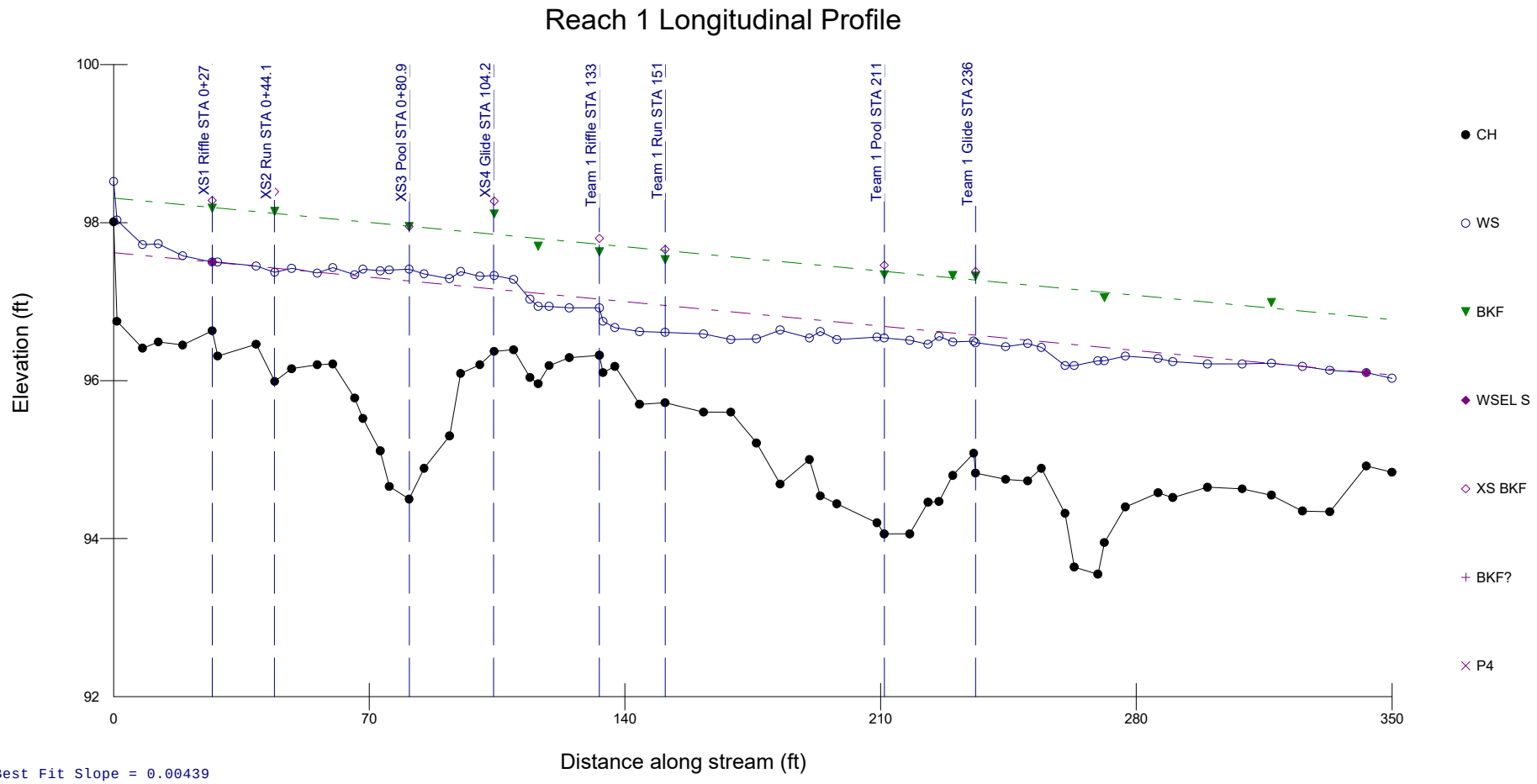

Team 1 Lateral Scour Pool STA 211
Ground Points
Bankfull Indicators
Water Surface Points
Inner Berm Indicators
Wbkf = 26.8
Dbkf = 1.86
Abkf = 49.7
Wib = 15.2
Dib = .91
Aib = 13.7
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)


XS2 Run STA 0+44.1
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 22.6
Dbkf = 1.96
Abkf = 44.4
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
60
Horizontal Distance (ft)

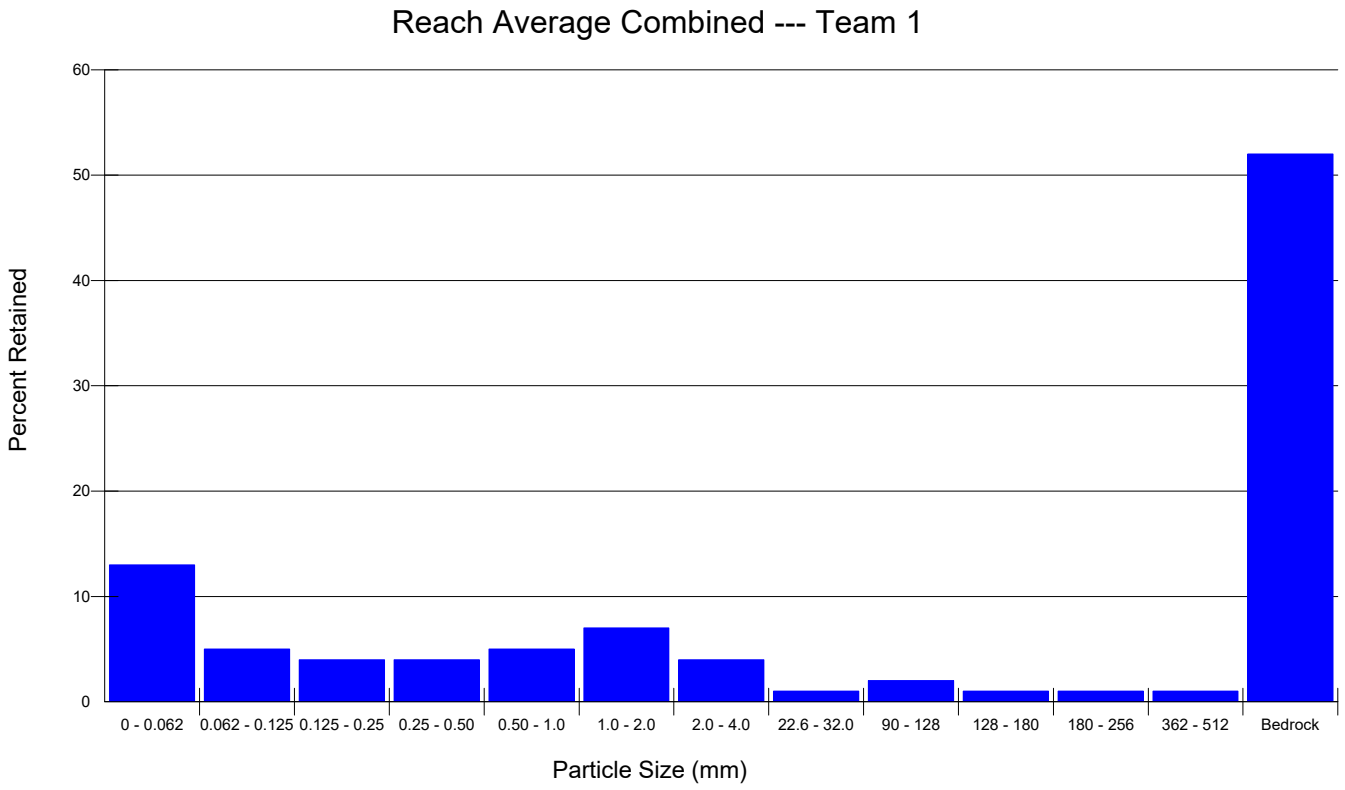

Team 1 Run STA 151
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 24.2
Dbkf = 1.69
Abkf = 40.9
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

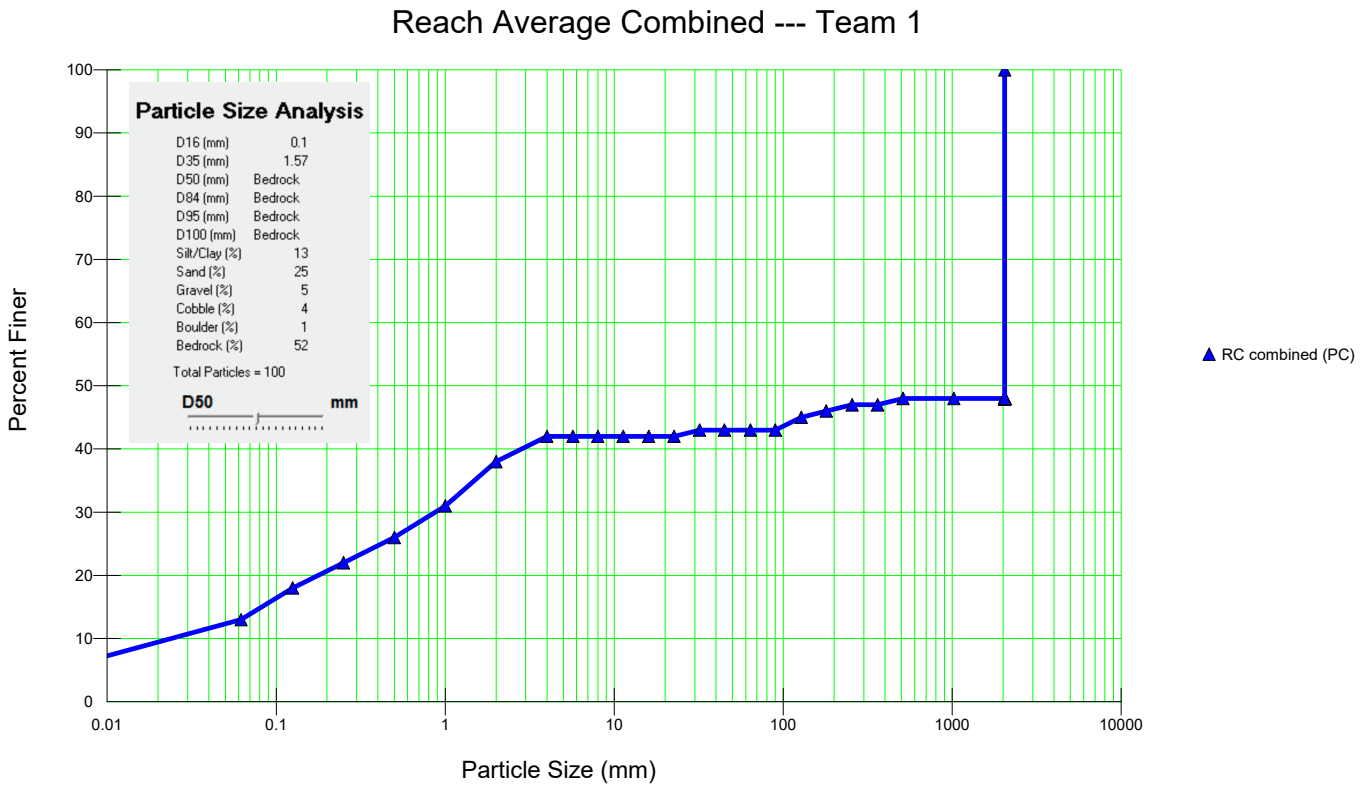

XS4 Glide STA 104.2
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 25.9
Dbkf = 1.62
Abkf = 42
106
95
0
70
Elevation (ft)
Horizontal Distance (ft)

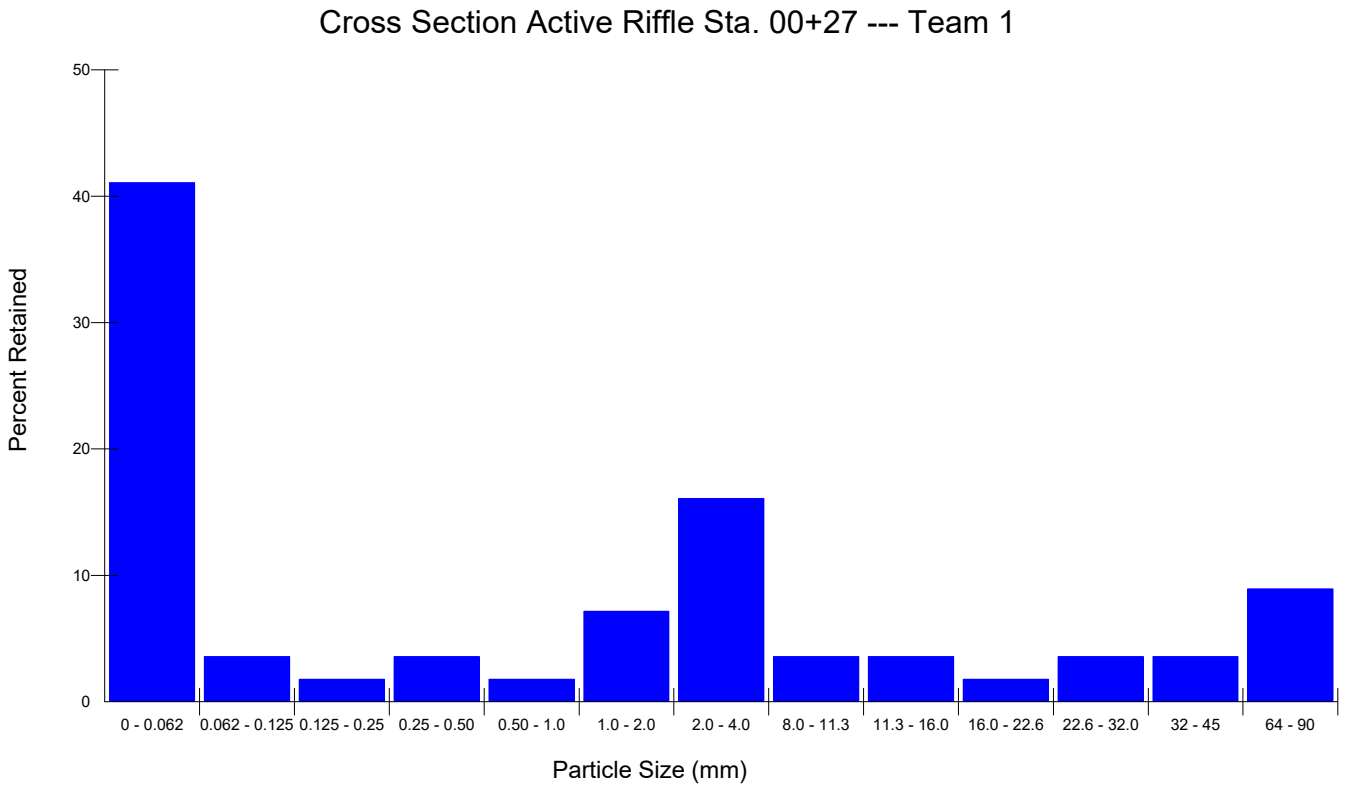

Team 1 Glide STA 236
Ground Points
Bankfull Indicators
Water Surface Points
Inner Berm Indicators
Wbkf = 20.8
Wib = 15.7
Dbkf = 1.75
Dib = .85
Abkf = 36.3
Aib = 13.3
105
100
95
90
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

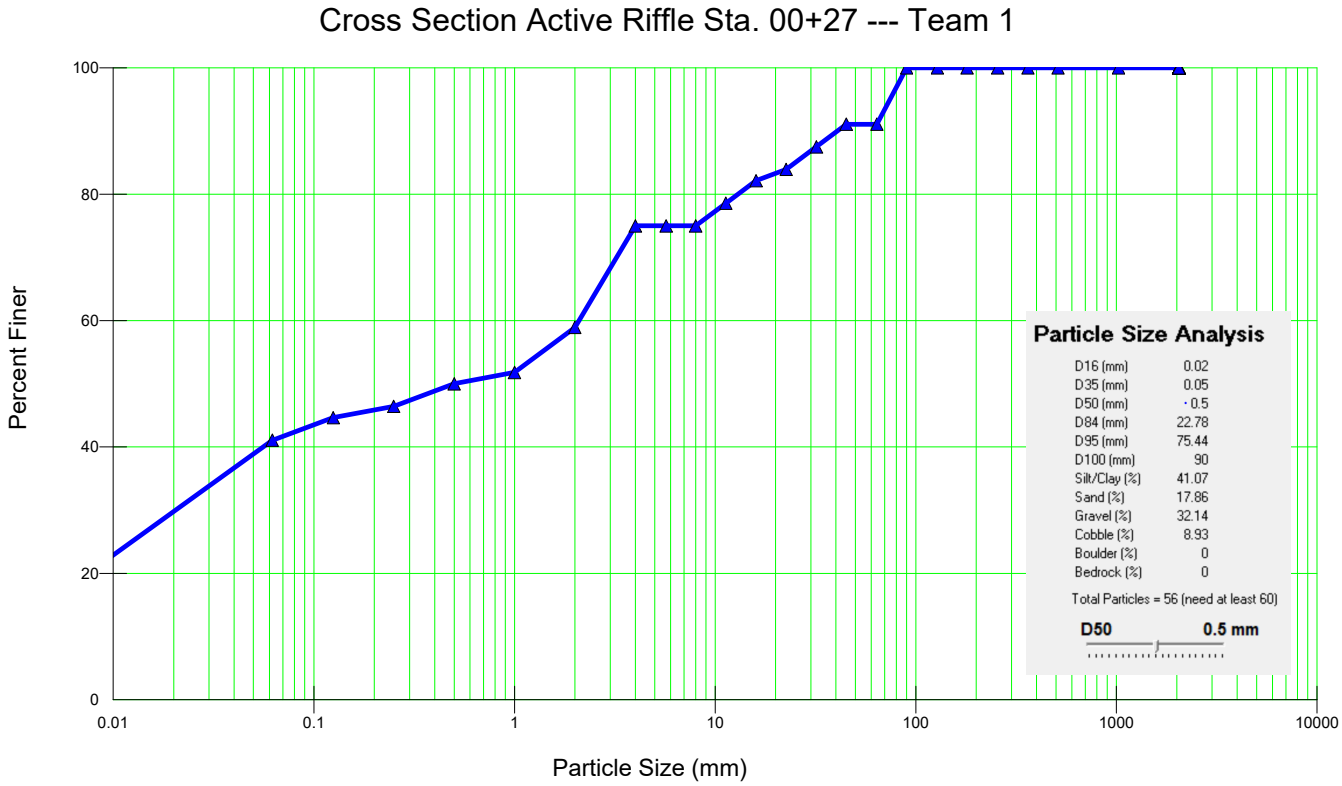


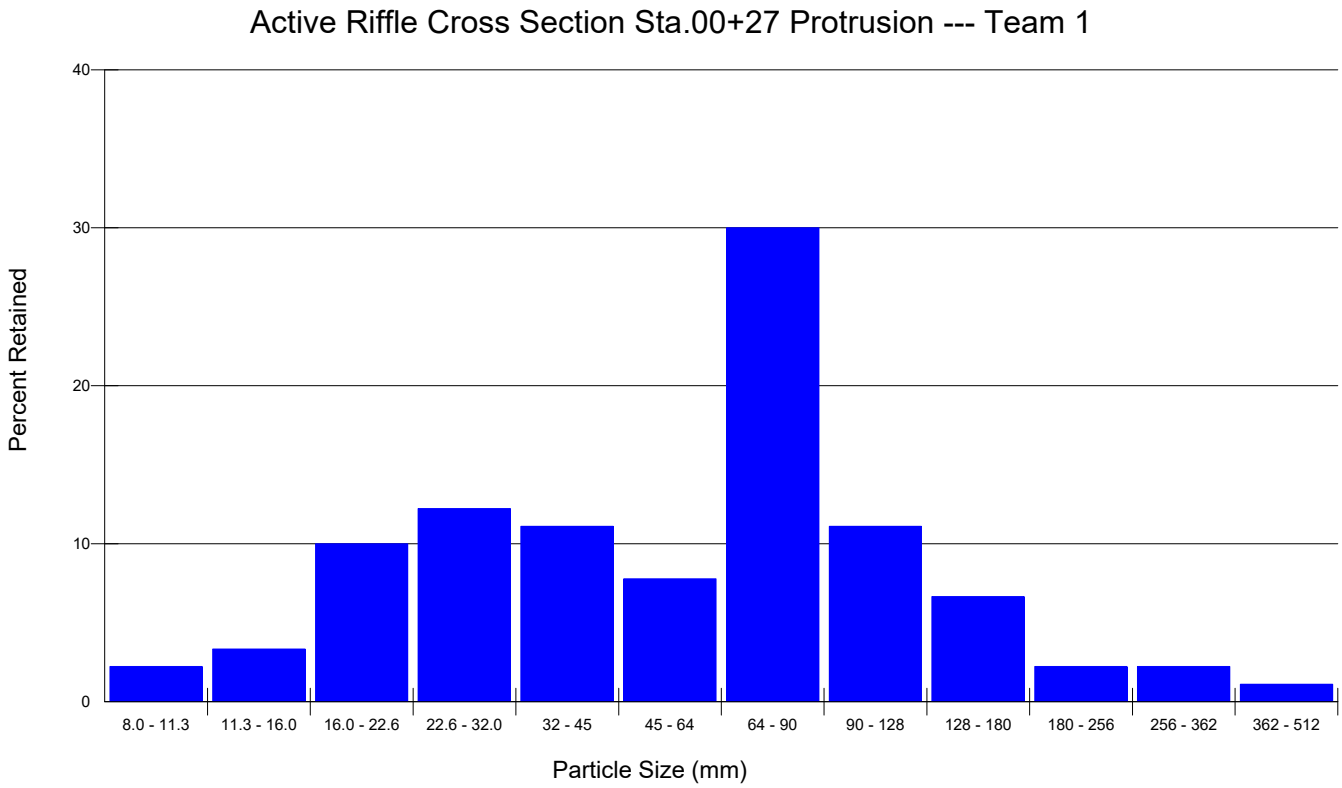
BKF Best Fit Slope = 0.00439
WSEL_S Best Fit Slope = 0.00443

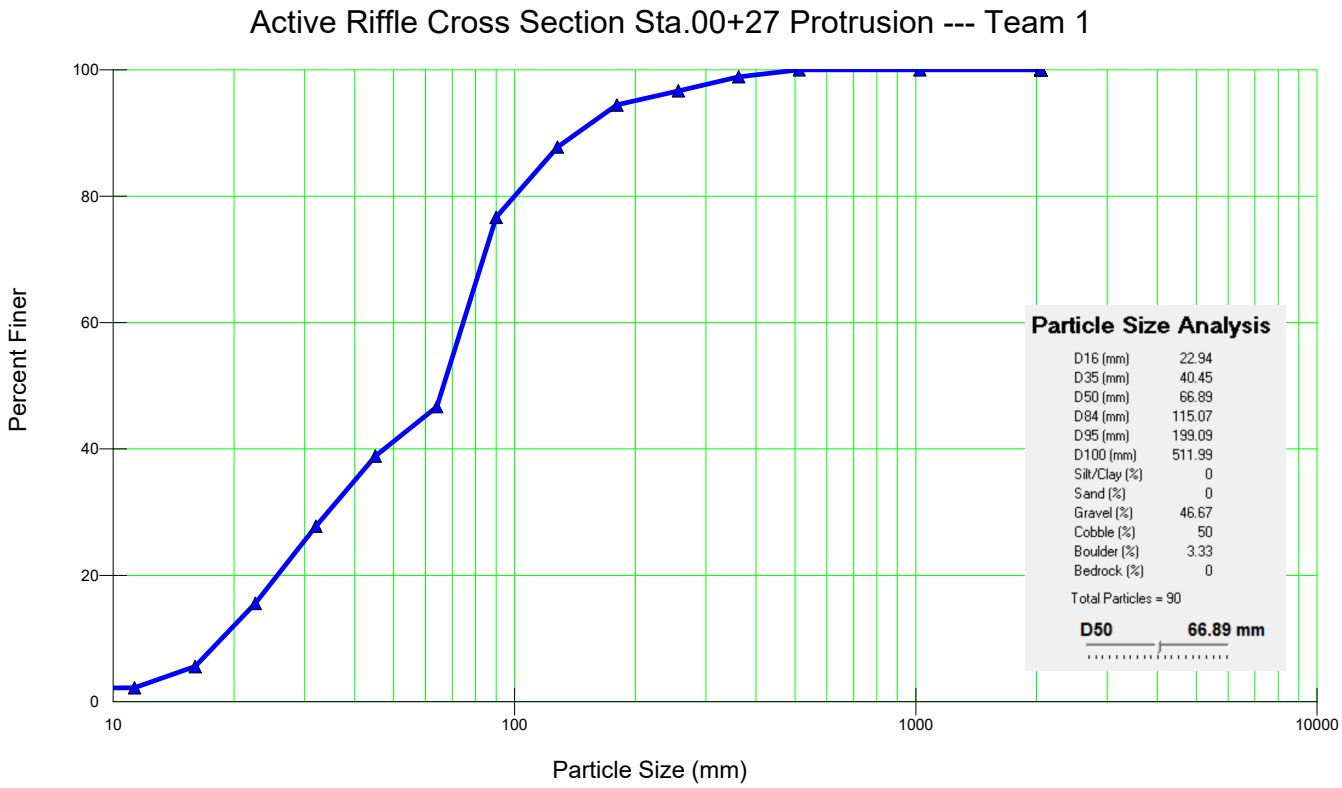

Reach Average Combined --- Team 1
Percent Retained
60
50
40
30
20
10
0
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
2.0 - 4.0
22.6 - 32.0
90 - 128
128 - 180
180 - 256
362 - 512
Bedrock
Particle Size (mm)

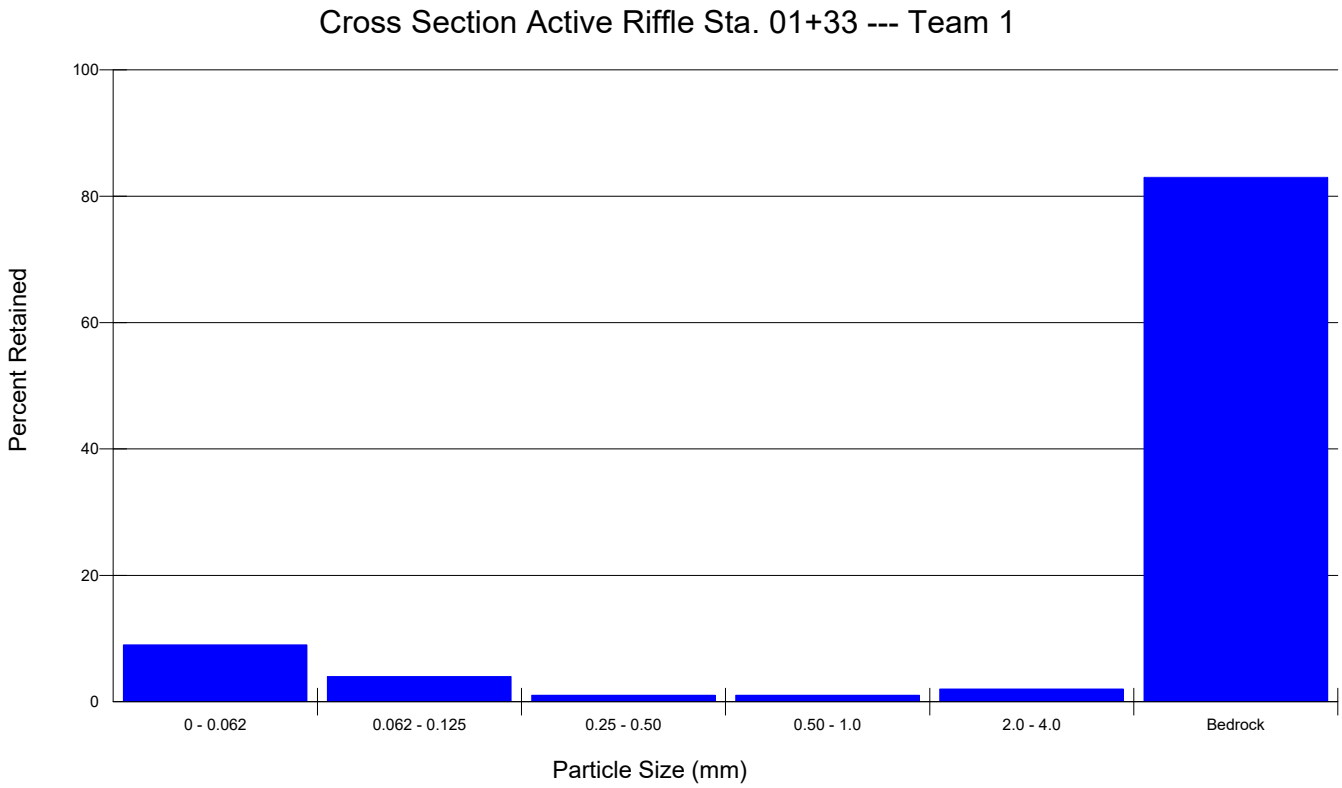

Reach Average Combined --- Team 1
Particle Size Analysis
D16 (mm) 0.1
D35 (mm) 1.57
D50 (mm) Bedrock
D84 (mm) Bedrock
D95 (mm) Bedrock
D100 (mm) Bedrock
Silt/Clay (%) 13
Sand (%) 25
Gravel (%) 5
Cobble (%) 4
Boulder (%) 1
Bedrock (%) 52
Total Particles = 100
D50 mm
Percent Finer
Particle Size (mm)
RC combined (PC)
0
10
20
30
40
50
60
70
80
90
100
0.01
0.1
1
10
100
1000
10000


Cross Section Active Riffle Sta. 00+27 --- Team 1
Percent Retained
50
40
30
20
10
0
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
2.0 - 4.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
64 - 90
Particle Size (mm)

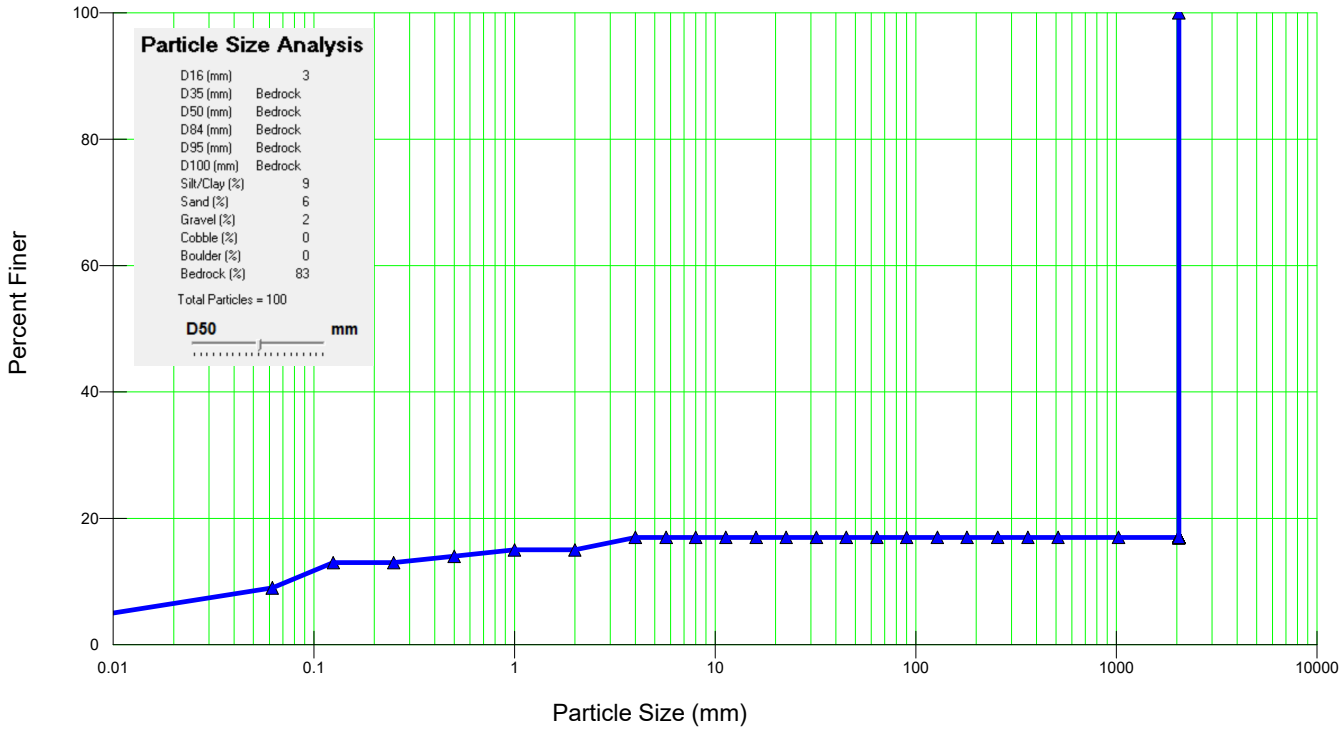

Cross Section Active Riffle Sta. 00+27 --- Team 1
Percent Finer
Particle Size (mm)
100
80
60
40
20
0
0.01
0.1
1
10
100
1000
10000
Particle Size Analysis
D16 (mm) 0.02
D35 (mm) 0.05
D50 (mm) 0.5
D84 (mm) 22.78
D95 (mm) 75.44
D100 (mm) 90
Silt/Clay (%) 41.07
Sand (%) 17.86
Gravel (%) 32.14
Cobble (%) 8.93
Boulder (%) 0
Bedrock (%) 0
Total Particles = 56 (need at least 60)
D50 0.5 mm

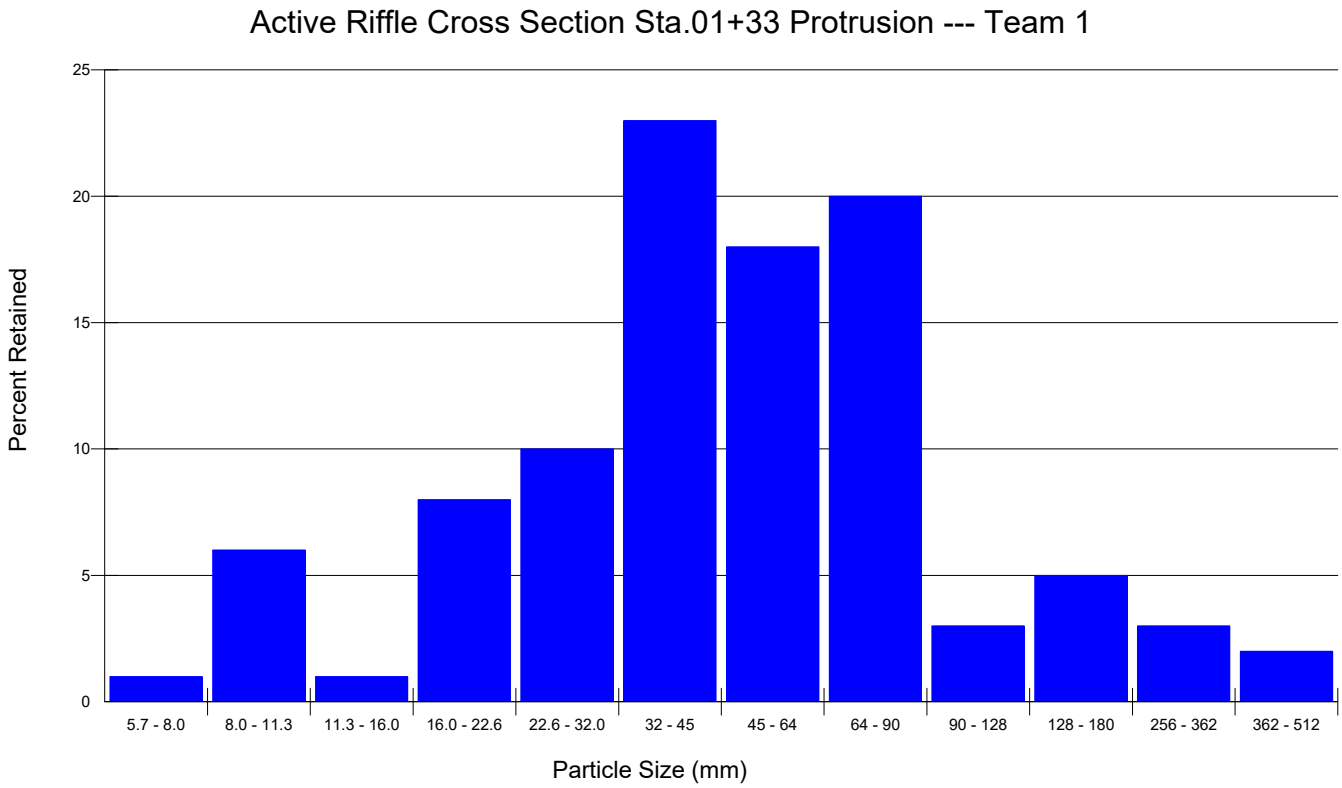

Active Riffle Cross Section Sta.00+27 Protrusion --- Team 1
Percent Retained
40
30
20
10
0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
128 - 180
180 - 256
256 - 362
362 - 512
Particle Size (mm)

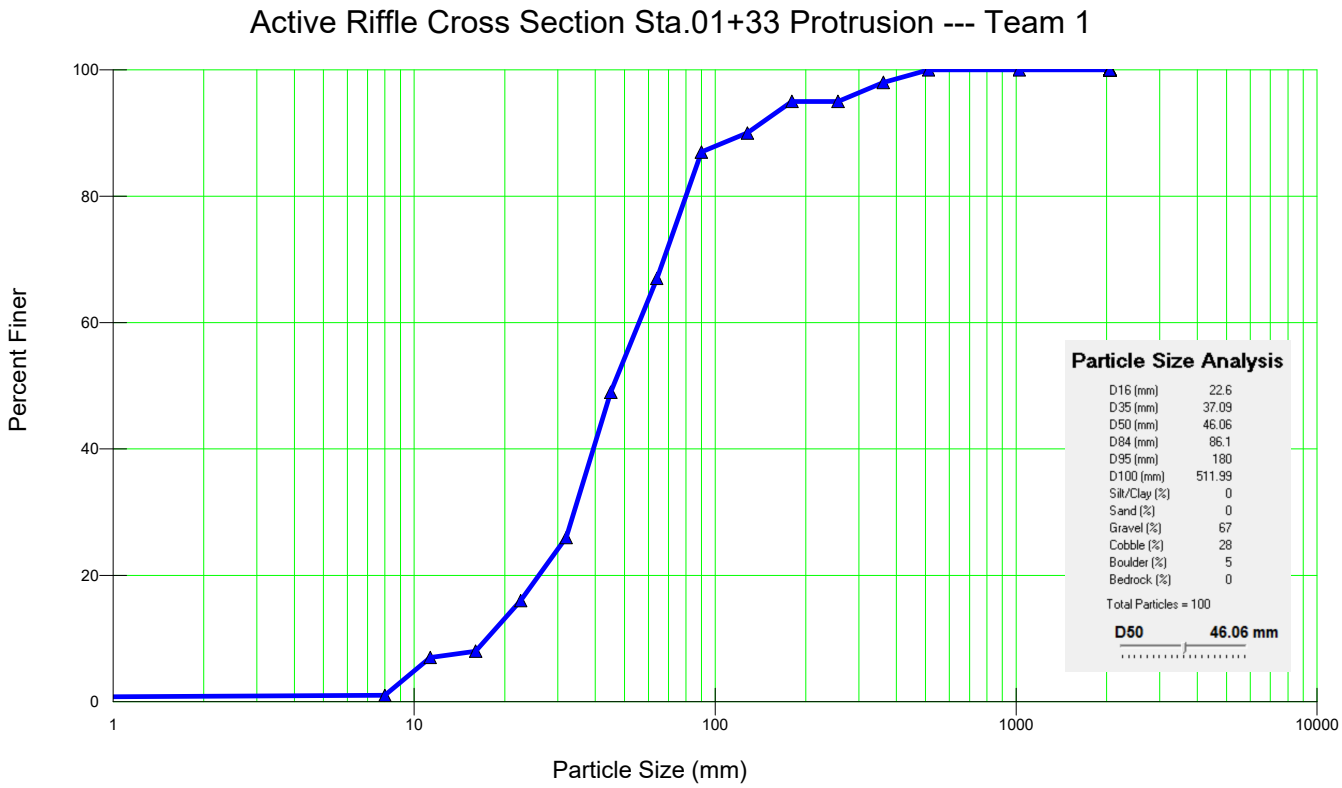

Active Riffle Cross Section Sta.00+27 Protrusion --- Team 1
Percent Finer
Particle Size (mm)
100
80
60
40
20
0
10
100
1000
10000
Particle Size Analysis
D16 (mm) 22.94
D35 (mm) 40.45
D50 (mm) 66.89
D84 (mm) 115.07
D95 (mm) 199.09
D100 (mm) 511.99
Silt/Clay (%) 0
Sand (%) 0
Gravel (%) 46.67
Cobble (%) 50
Boulder (%) 3.33
Bedrock (%) 0
Total Particles = 90
D50 66.89 mm


Cross Section Active Riffle Sta. 01+33 --- Team 1
Percent Retained
100
80
60
40
20
0
0 - 0.062
0.062 - 0.125
0.25 - 0.50
0.50 - 1.0
2.0 - 4.0
Bedrock
Particle Size (mm)

Cross Section Active Riffle Sta. 01+33 --- Team 1




Active Riffle Cross Section Sta.01+33 Protrusion --- Team 1
Percent Retained
25
20
15
10
5
0
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
128 - 180
256 - 362
362 - 512
Particle Size (mm)


Active Riffle Cross Section Sta.01+33 Protrusion --- Team 1
Percent Finer
Particle Size (mm)
100
80
60
40
20
0
1
10
100
1000
10000
Particle Size Analysis
D16 (mm) 22.6
D35 (mm) 37.09
D50 (mm) 46.06
D84 (mm) 86.1
D95 (mm) 180
D100 (mm) 511.99
Silt/Clay (%) 0
Sand (%) 0
Gravel (%) 67
Cobble (%) 28
Boulder (%) 5
Bedrock (%) 0
Total Particles = 100
D50 46.06 mm

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

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	**Marsh Creek**	Location:	**Reach - Reach 1**
Date:	**4/19/2018**	Stream Type: **F1/6**	Valley Type: **U-AL-RD**
Observers:	**Team 1**	HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	39.40	A_{bkf} (ft^2)	Bankfull Riffle Mean DEPTH	1.46	d_{bkf} (ft)
Bankfull Riffle WIDTH	26.92	W_{bkf} (ft)	Wetted PERMIMETER ~ $(2 * d_{bkf}) + W_{bkf}$	28.43	W_p (ft)
D_{84} at Riffle	115.07	Dia. (mm)	D_{84} (mm) / 304.8	0.38	D_{84} (ft)
Bankfull SLOPE	0.0044	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.39	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R(ft) / D_{84} (ft)	3.68	R / D_{84}
Drainage Area	18.9	DA (mi^2)	Shear Velocity $u^* = (gRS)^{1/2}$	0.443	u* (ft/sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $u = [\,2.83 + 5.66 * Log\{R / D_{84}\}\,]\,u^*$	2.67	ft / sec	105.09	cfs
2. Roughness Coefficient: a) Manning's *n* from Friction Factor / Relative Roughness (Figs. 2-18, 2-19) $u = 1.49*R^{2/3}*S^{1/2}/n$ $n =$ 0.041	2.99	ft / sec	117.65	cfs
2. Roughness Coefficient: b) Manning's *n* from Stream Type (Fig. 2-20) $u = 1.49*R^{2/3}*S^{1/2}/n$ $n =$ 0.056	2.19	ft / sec	86.13	cfs
2. Roughness Coefficient: c) Manning's *n* from Jarrett (USGS): $u = 1.49*R^{2/3}*S^{1/2}/n$ $n = 0.39*S^{0.38}*R^{-0.16}$ Note: This equation is applicable to **steep, step/pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for $n =$ 0.047	2.61	ft / sec	102.64	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Manning's Limerinos n=0.0422	2.90	ft / sec	114.30	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach (Leopold, Wolman and Miller)	2.82	ft / sec	111.01	cfs
4. Continuity Equations: a) Regional Curves $u = Q / A$ Return Period for Bankfull Discharge Q = 2.0 year	2.61	ft / sec	103.00	cfs
4. Continuity Equations: b) USGS Gage Data $u = Q / A$	2.91	ft / sec	114.50	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 "**protrustion 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 2-3. Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream:	**Marsh Creek, Reach - Reach 1**			
Basin:	Drainage Area:	**12096** acres	**18.9**	mi^2
Location:				
Twp.&Rge: **;**	Sec.&Qtr.: **;**			
Cross-Section Monuments (Lat./Long.):	**0 Lat / 0 Long**		Date:	**04/19/18**
Observers: **Team 1**			Valley Type:	U-AL-FD

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	**26.92**	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}).	**1.46**	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	**39.4**	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	**18.44**	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.	**1.84**	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.	**31.76**	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	**1.18**	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.	**2048**	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.	**0.00439**	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).	**1.2**	

Stream Type **F 1/6** (See **Figure 2-14**)

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Worksheet 2-4a. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2007; Rosgen, 2008).

Stream: **Marsh Creek** Location: **Reach - Reach 1**

Observers: **Team 1** Date: **04/19/18** Valley Type: **U-AL-FD** Stream Type: **F 1/6**

River Reach Dimension Summary Data…..1

Riffle Dimensions*, **, **

Riffle Dimensions*, **, ***	Mean	Min	Max		Riffle Dimensions & Dimensionless Ratios****	Mean	Min	Max
Riffle Width (W_{bkf})	25.2	23.4	26.9	ft	Riffle Cross-Sectional Area (A_{bkf}) (ft^2)	36.98	34.56	39.40
Mean Riffle Depth (d_{bkf})	1.47	1.46	1.48	ft	Riffle Width/Depth Ratio (W_{bkf} / d_{bkf})	17.12	15.80	18.44
Maximum Riffle Depth (d_{max})	1.87	1.84	1.9	ft	Max Riffle Depth to Mean Riffle Depth (d_{max} / d_{bkf})	1.272	1.260	1.284
Width of Flood-Prone Area (W_{fpa})	31.2	30.8	31.8	ft	Entrenchment Ratio (W_{fpa} / W_{bkf})	1.248	1.180	1.316
Riffle Inner Berm Width (W_{ib})	0	0	0	ft	Riffle Inner Berm Width to Riffle Width (W_{ib} / W_{bkf})	0.000	0.000	0.000
Riffle Inner Berm Depth (d_{ib})	0	0	0	ft	Riffle Inner Berm Depth to Mean Depth (d_{ib} / d_{bkf})	0.000	0.000	0.000
Riffle Inner Berm Area (A_{ib})	0	0	0	ft^2	Riffle Inner Berm Area to Riffle Area (A_{ib} / A_{bkf})	0.000	0.000	0.000
Riffle Inner Berm W/D Ratio (W_{ib} / d_{ib})	0	0	0					

Pool Dimensions*, **, **

Pool Dimensions*, **, ***	Mean	Min	Max		Pool Dimensions & Dimensionless Ratios****	Mean	Min	Max
Pool Width (W_{bkfp})	26.3	25.9	26.8	ft	Pool Width to Riffle Width (W_{bkfp} / W_{bkf})	1.047	1.028	1.064
Mean Pool Depth (d_{bkfp})	1.8	1.73	1.86	ft	Mean Pool Depth to Mean Riffle Depth (d_{bkfp} / d_{bkf})	1.224	1.177	1.265
Pool Cross-Sectional Area (A_{bkfp})	47.2	44.7	49.7	ft	Pool Area to Riffle Area (A_{bkfp} / A_{bkf})	1.277	1.209	1.344
Maximum Pool Depth (d_{maxp})	3.45	3.4	3.5	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	2.347	2.313	2.381
Pool Inner Berm Width (W_{ibp})	14.6	14	15.2	ft	Pool Inner Berm Width to Pool Width (W_{ibp} / W_{bkfp})	0.555	0.543	0.566
Pool Inner Berm Depth (d_{ibp})	0.92	0.91	0.93	ft	Pool Inner Berm Depth to Pool Depth (d_{ibp} / d_{bkfp})	0.513	0.487	0.539
Pool Inner Berm Area (A_{ibp})	13.4	13.1	13.7	ft^2	Pool Inner Berm Area to Pool Area (A_{ibp} / A_{bkfp})	0.285	0.276	0.293
Point Bar Slope (S_{pb})	0.295	0.201	0.390	ft/ft	Pool Inner Berm Width/Depth Ratio (W_{ibp} / d_{ibp})	15.899	15.058	16.739

Run Dimensions*

Run Dimensions*	Mean	Min	Max		Run Dimensionless Ratios****	Mean	Min	Max
Run Width (W_{bkfr})	23.4	22.6	24.2	ft	Run Width to Riffle Width (W_{bkfr} / W_{bkf})	0.932	0.900	0.963
Mean Run Depth (d_{bkfr})	1.83	1.69	1.96	ft	Mean Run Depth to Mean Riffle Depth (d_{bkfr} / d_{bkf})	1.245	1.150	1.333
Run Cross-Sectional Area (A_{bkfr})	42.7	40.9	44.4	ft	Run Area to Riffle Area (A_{bkfr} / A_{bkf})	1.153	1.107	1.200
Maximum Run Depth (d_{maxr})	2.31	2.17	2.44	ft	Max Run Depth to Mean Riffle Depth (d_{maxr} / d_{bkf})	1.571	1.476	1.660
Run Width/Depth Ratio (W_{bkfr} / d_{bkfr})	13	11.6	14.3	ft				

Glide Dimensions*

Glide Dimensions*	Mean	Min	Max		Glide Dimensions & Dimensionless Ratios****	Mean	Min	Max
Glide Width (W_{bkfg})	23.4	20.8	25.9	ft	Glide Width to Riffle Width (W_{bkfg} / W_{bkf})	0.928	0.825	1.031
Mean Glide Depth (d_{bkfg})	1.69	1.62	1.75	ft	Mean Glide Depth to Mean Riffle Depth (d_{bkfg} / d_{bkf})	1.150	1.102	1.190
Glide Cross-Sectional Area (A_{bkfg})	39.2	36.3	42	ft	Glide Area to Riffle Area (A_{bkfg} / A_{bkf})	1.059	0.982	1.137
Maximum Glide Depth (d_{maxg})	2.38	2.35	2.41	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.619	1.599	1.639
Glide Width/Depth Ratio (W_{bkfg} / d_{bkfg})	13.9	11.9	16	ft/ft	Glide Inner Berm Width/Depth Ratio (W_{ibg} / d_{ibg})	9.264	0.000	18.528
Glide Inner Berm Width (W_{ibg})	7.84	0	15.7	ft	Glide Inner Berm Width to Glide Width (W_{ibg}/W_{bkfg})	0.378	0.000	0.755
Glide Inner Berm Depth (d_{ibg})	0.42	0	0.85	ft	Glide Inner Berm Depth to Glide Depth (d_{ibg} / d_{bkfg})	0.242	0.000	0.483
Glide Inner Berm Area (A_{ibg})	6.63	0	13.3	ft^2	Glide Inner Berm Area to Glide Area (A_{ibg} / A_{bkfg})	0.183	0.000	0.365

Step**

Step**	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 2-4b. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2007; Rosgen, 2008).

Stream: **Marsh Creek**		Location: **Reach - Reach 1**	
Observers: **Team 1**	Date: **04/19/18**	Valley Type: **U-AL-FD**	Stream Type: **F 1/6**

River Reach Summary Data…..2

Hydraulic

Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	2.89	ft/sec	Estimation Method	Manning's Limerinos	
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	114	cfs	Drainage Area	18.9	mi^2

Channel Pattern

Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Linear Wavelength (λ)	66	43	88	ft	Linear Wavelength to Riffle Width (λ / W_{bkf})	2.623	1.709	3.498
Stream Meander Length (L_m)	63	37	95	ft	Stream Meander Length Ratio (L_m / W_{bkf})	2.504	1.471	3.776
Radius of Curvature (R_c)	52	39	81	ft	Radius of Curvature to Riffle Width (R_c / W_{bkf})	2.067	1.550	3.219
Belt Width (W_{blt})	59	59	60	ft	Meander Width Ratio (W_{blt} / W_{bkf})	2.345	2.345	2.385
Arc Length (L_a)	53	31	70	ft	Arc Length to Riffle Width (L_a / W_{bkf})	2.107	1.232	2.782
Riffle Length (L_r)	20.9	12.6	29.1	ft	Riffle Length to Riffle Width (L_r / W_{bkf})	0.829	0.502	1.155
Individual Pool Length (L_p)	36.2	27.5	44.9	ft	Individual Pool Length to Riffle Width (L_p / W_{bkf})	1.438	1.093	1.783
Pool to Pool Spacing (P_s)	133	133	133	ft	Pool to Pool Spacing to Riffle Width (P_s / W_{bkf})	5.267	5.267	5.267

Channel Profile

Valley Slope (S_{val})	0.00527	ft/ft	Average Water Surface Slope (S)	0.00439	ft/ft	Sinuosity (S_{val} / S)	1.2	
Stream Length (SL)	349	ft	Valley Length (VL)	293	ft	Sinuosity (SL / VL)	1.2	
Low Bank Height (LBH)	start 0	ft	Max Depth (d_{max})	start 0	ft	Bank-Height Ratio (BHR) (LBH / d_{max})	start	
	end 0	ft		end 0	ft		end	

Facet Slopes	Mean	Min	Max		Dimensionless Facet Slope Ratios	Mean	Min	Max
Riffle Slope (S_{rif})	0.014	0.007	0.022	ft/ft	Riffle Slope to Average Water Surface Slope (S_{rif} / S)	3.289	1.583	4.995
Run Slope (S_{run})	0.006	0.003	0.011	ft/ft	Run Slope to Average Water Surface Slope (S_{run} / S)	1.287	0.613	2.522
Pool Slope (S_p)	0.001	0.001	0.001	ft/ft	Pool Slope to Average Water Surface Slope (S_p / S)	0.273	0.210	0.337
Glide Slope (S_g)	0.002	0.002	0.002	ft/ft	Glide Slope to Average Water Surface Slope (S_g / S)	0.378	0.362	0.394
Step Slope (S_s)	0.000	0.000	0.000	ft/ft	Step Slope to Average Water Surface Slope (S_s / S)	0.000	0.000	0.000

Max Depths[a]	Mean	Min	Max		Dimensionless Depth Ratios	Mean	Min	Max
Max Riffle Depth (d_{maxrif})	1.49	1.42	1.56	ft	Max Riffle Depth to Mean Riffle Depth (d_{maxrif} / d_{bkf})	1.01	0.966	1.06
Max Run Depth (d_{maxrun})	1.95	1.93	1.97	ft	Max Run Depth to Mean Riffle Depth (d_{maxrun} / d_{bkf})	1.33	1.313	1.34
Max Pool Depth (d_{maxp})	3.39	3.33	3.44	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	2.31	2.265	2.34
Max Glide Depth (d_{maxg})	1.8	1.41	2.18	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.22	0.959	1.48
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	13	41.07		D_{16}	0.1	0.02		22.94	mm
% Sand	25	17.86		D_{35}	1.57	0.05		40.45	mm
% Gravel	5	32.14		D_{50}	Bedrock	0.5		66.89	mm
% Cobble	4	8.93		D_{84}	Bedrock	22.78		115.07	mm
% Boulder	1	0		D_{95}	Bedrock	75.44		199.09	mm
% Bedrock	52	0		D_{100}	Bedrock	90		511.99	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: Grimes, MD Washington CO

Observers: Team 1 Stream Type: Landscape Type: U-AL-AD Date: 4-19-2018

Pool Type		Dimensional Values: Pool Length (L_p)	Dimensional Values: Pool Max Depth (d_{maxp})	Dimensional Values: Pool Slope (S_p)		Dimensionless Ratios: Pool Length to Riffle Width (L_p / W_{bkf})	Dimensionless Ratios: Pool Max Depth to Riffle Mean Depth (d_{maxp} / d_{bkf})	Dimensionless Ratios: Pool Slope to Average Slope (S_p / S)
1. Lateral Scour Pool (LSP)	Mean	43.75	3.42	.00462	Mean	1.63	2.34	1.05
	Min.	27.89	3.35	.00455	Min.	1.04	2.30	1.03
	Max.	59.60	3.48	.00469	Max.	2.22	2.39	1.07
2. Contraction Scour Pool (CSP)	Mean	38.01	3.54	.00320	Mean	1.41	2.42	.72
	Min.	38.01	3.54	.00320	Min.	1.41	2.42	.72
	Max.	38.01	3.54	.00320	Max.	1.41	2.42	.72
3. Step/Pool (SP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			
4. Backwater Pool (BWP)	Mean				Mean			
	Min.				Min.			
	Max.				Max.			
5. Plunge Pool (PP)	Mean	5.4	1.84		Mean	.20	1.26	5
	Min.	5.4	1.84		Min.	.20	1.26	
	Max.	5.4	1.84		Max.	.20	1.26	5
6. Pocket Water Pool (PWP)	Mean	3.0	2.35	0.2	Mean	.11	1.61	
	Min.	3.4	2.2	0.2	Min.	.13	1.51	
	Max.	4.5	2.6	0.3	Max.	.17	1.78	.18
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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Team 1 4-19-2018 Marsh Run

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

Validation of Hydraulic Relationships Using Gaging 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**).

2.94 / 0.452

$[32.2(1.44)(.0044)]^{0.5}$

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

1	2	3a	3b	3c	3d	4	5a	5b	6	7	8	9	10
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	114.5	26	1.5	39	2.94	0.0044	115.07	0.378	F1/6	0.043	3.81	0.452	6.5

$$n = \frac{1.49R^{2/3}S^{1/2}}{\bar{u}} = \frac{(1.49)(1.44^{2/3})(.0044^{1/2})}{2.94}$$

$$\frac{A}{WP} = \frac{39}{27} = 1.44 \quad / .378$$

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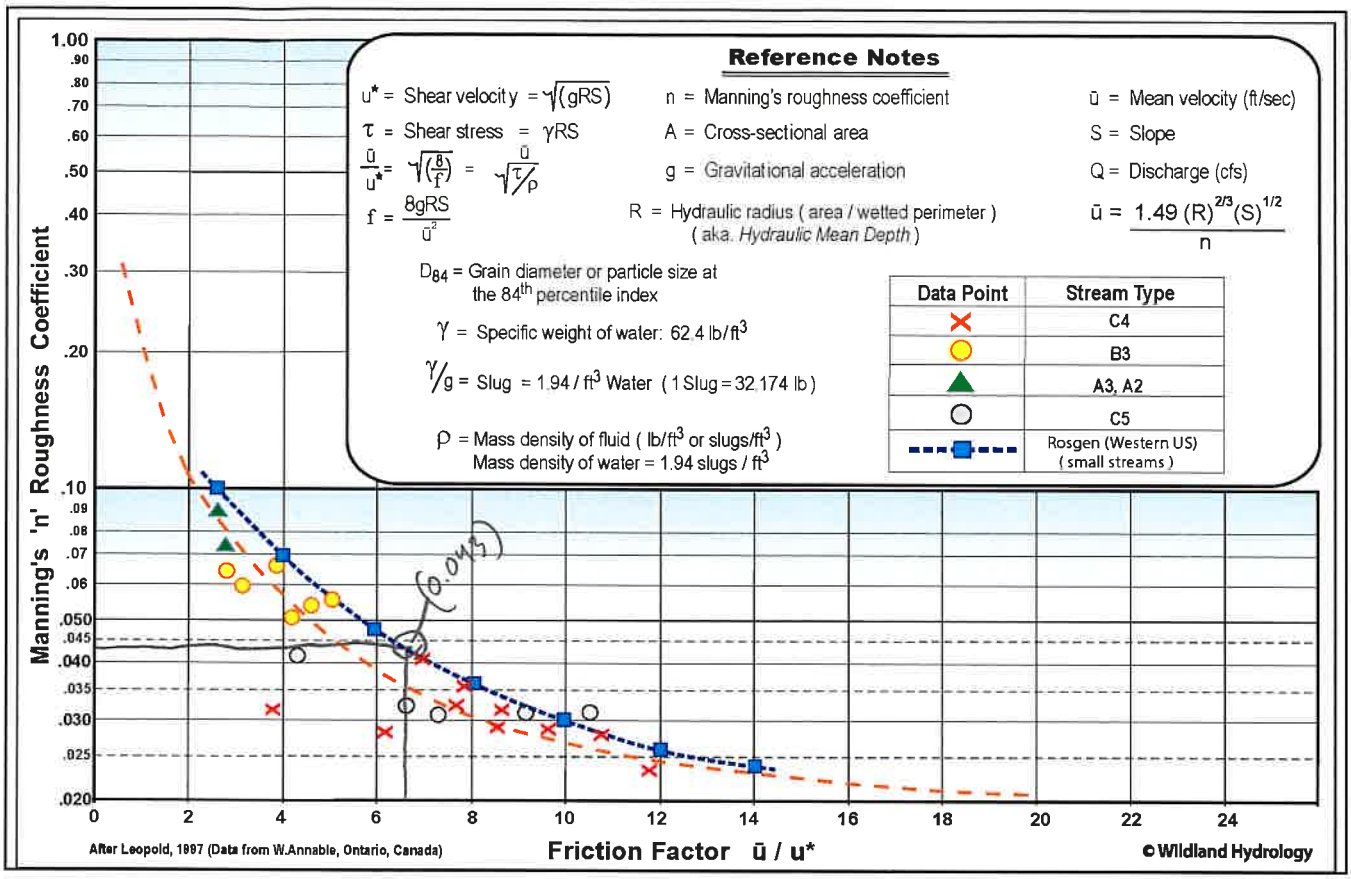

Figure B-35. Friction factor (ū/u*) *vs.* Manning's roughness coefficient 'n' (Rosgen, 2006b).

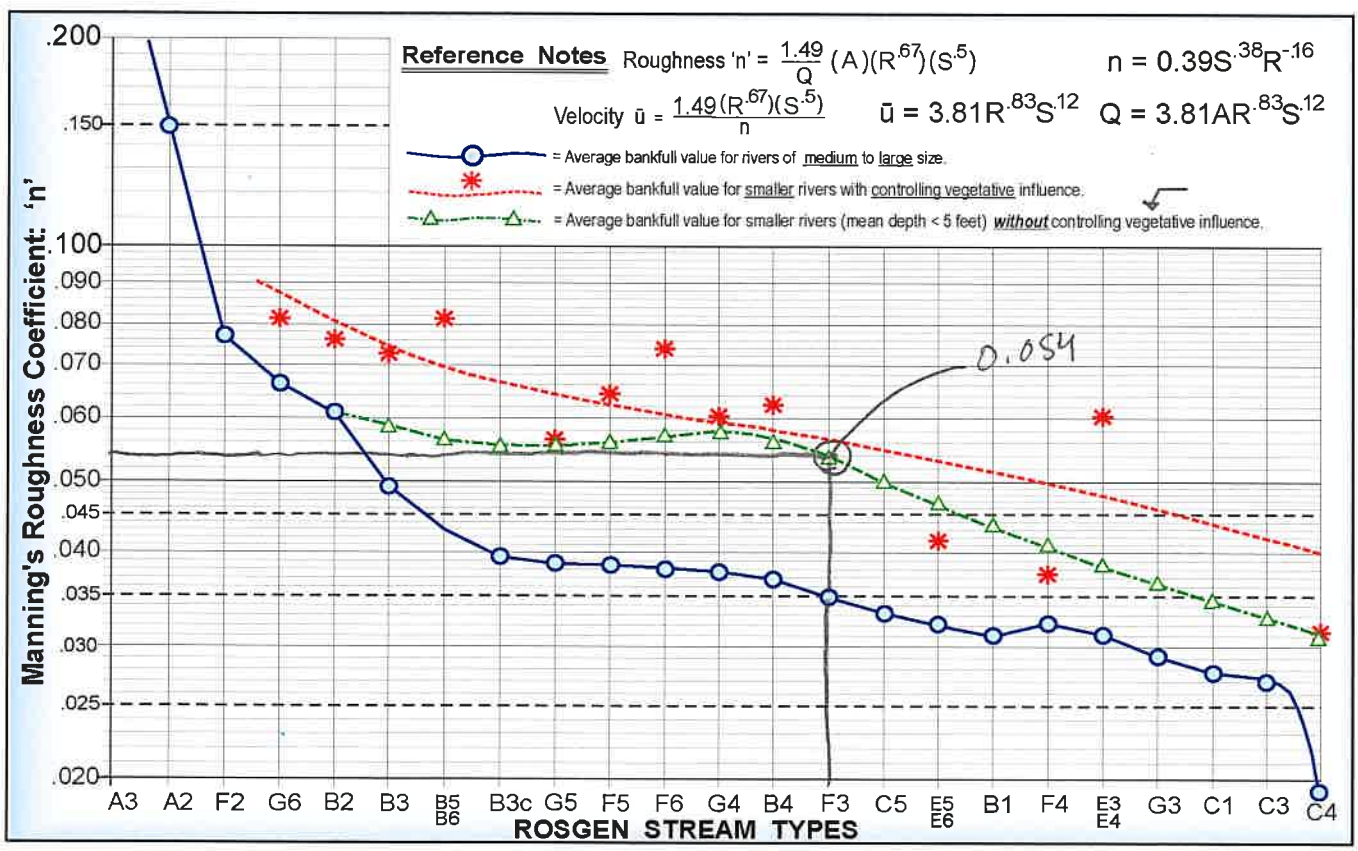

Figure B-36. Manning's 'n' by stream type.

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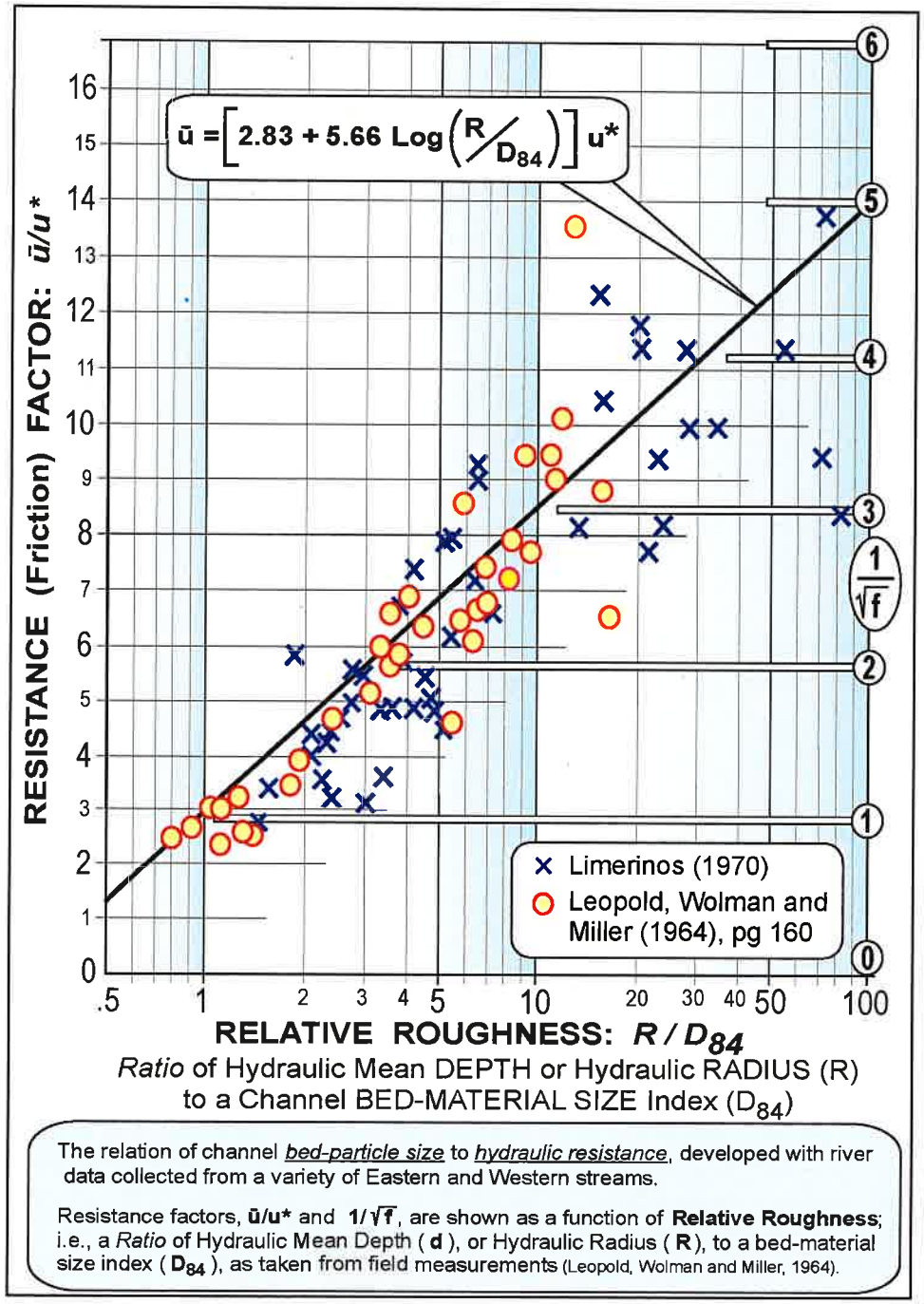

The relation of channel *bed-particle size* to *hydraulic resistance*, developed with river data collected from a variety of Eastern and Western streams.

Resistance factors, $\bar{u}/u^*$ and $1/\sqrt{f}$, are shown as a function of **Relative Roughness**; i.e., a *Ratio* of Hydraulic Mean Depth (**d**), or Hydraulic Radius (**R**), to a bed-material size index ($\mathbf{D_{84}}$), as taken from field measurements (Leopold, Wolman and Miller, 1964).

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

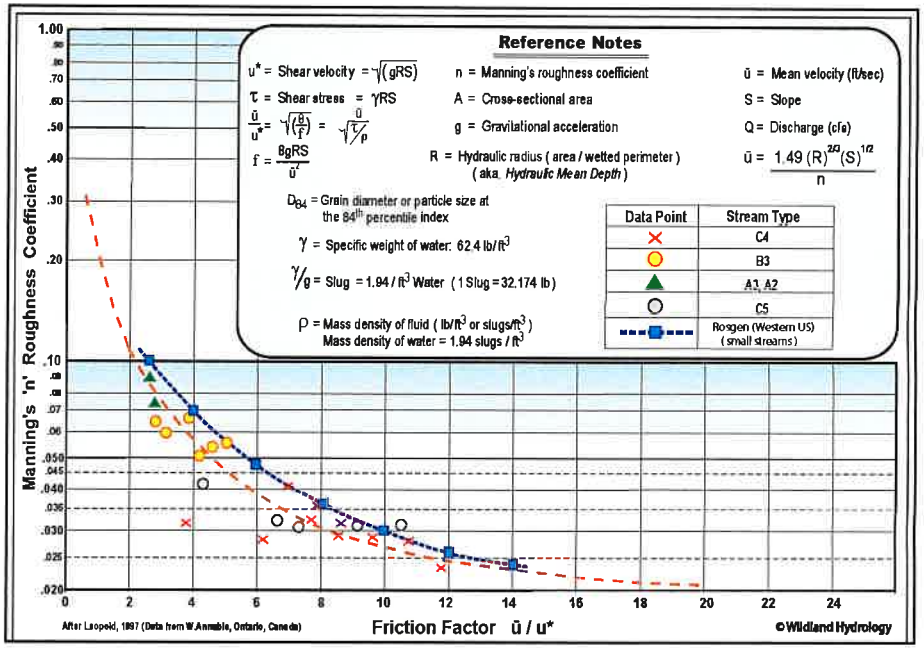

Figure B-35. Friction factor ($\bar{u}/u^*$) *vs.* Manning's roughness coefficient 'n'.

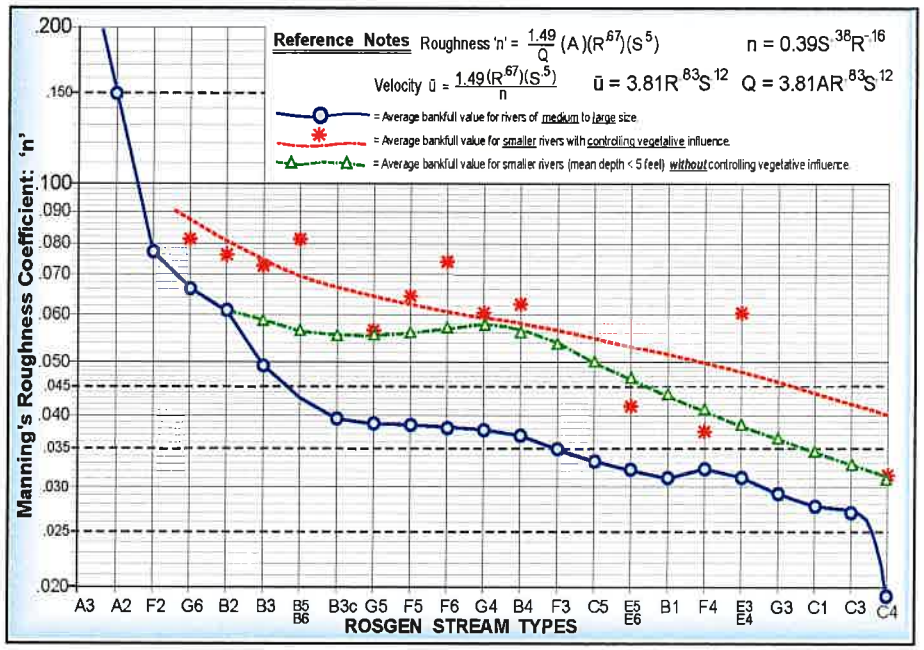

Figure B-36. Manning's 'n' roughness coefficient by stream type.

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