River Morphology and Applications
National Conservation Training Center
Shepherdstown, WV
04/15/2013 - 04/19/2013

<u>Team 4</u> Breakout Room 157-IW

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Pebble Theresa Hage
Pebble Mark Hepner
Sketch Christiana Manville
Long P Erik Neidy
Long P Michael Shema
Sketch Kimi Schmidt
Long P Brent Showalter
XS Anna Allie

Each team is responsible for identifying a **FOLDER HOLDER** and an **EQUIPMENT PERSON.**

The **FOLDER HOLDER** on each team will be responsible for collecting photo copies of raw data from field books, cross sections, longitudinal profiles, pebble counts, bank profiles and photo copies of all completed forms and finalized plots, making sure they are inserted into the appropriate team field folder, and providing the team folder to the field instructor after they present the data to the class.

The **EQUIPMENT PERSON** will be responsible for ensuring that the team's field equipment is accounted for and back on the bus at the end of each field day. Each team will have an equipment list in their team bag that the EQUIPMENT PERSON can use to inventory the field equipment.

Presentation Order – *Second Field Day*

As a team, prepare to present the following items in order:

1. Sketch Map
2. Cross-Section Graphs:
   - Riffle Cross-Section(s)
   - Pool Cross-Section(s)
   - Run Cross-Section(s) (if applicable)
   - Glide Cross-Section(s) (if applicable)
3. Longitudinal Profile Graph
4. Representative Pebble Count for Stream Classification (Graph)
5. Active Bed Riffle Pebble Count for Hydraulic Calculations (Graph)
6. Velocity Computation Form (**Worksheet B-2**)
7. Stream Classification Form (**Worksheet B-1**)
8. Morphological Relations & Dimensionless Ratios Form (**Worksheet B-3**)
9. Validation of Hydraulic Relationships Form (**Worksheet B-4, Figures B-34** to **B-36**)

Checklist for Team Folder – *Second Field Day*

Folder Holder: Please collect the following items from your team members and insert into your team folder in the order listed below. Please make sure all corrections have been made following your team presentation & give your completed team folder to Dave.

- ☐ Sketch Map
- ☐ Cross-Section Raw Data and Graphs for all Cross-sections Measured
- ☐ Longitudinal Profile Raw Data and Graph
- ☐ Representative Pebble Count Raw Data and Graph
- ☐ Active Bed Riffle Pebble Count Raw Data and Graph
- ☐ Stream Classification Form (**Worksheet B-1**)
- ☐ Velocity Computation Form (**Worksheet B-2**)
- ☐ Morphological Relations & Dimensionless Ratios Form (**Worksheet B-3**)
- ☐ Validation of Hydraulic Relationships Form (**Worksheet B-4, Figures B-34** to **B-36**)
- ☐ USB Drive that includes final RIVERMorph™ project file and any other electronic files you may have (e.g., photos, PowerPoint, etc.)

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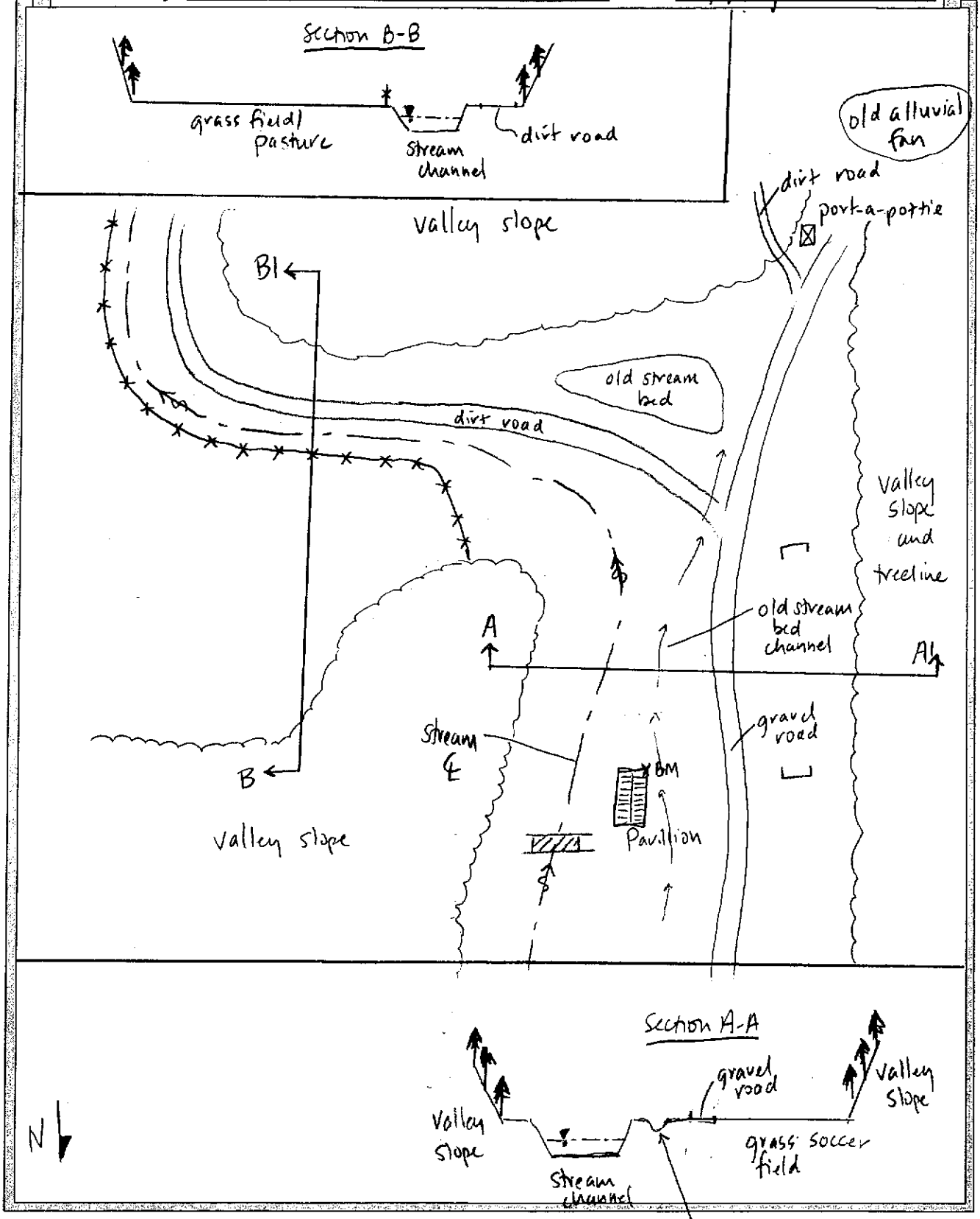
AREA-SITE LOCATION....REACH MAP

Stream: Marsh Run Reach: 4

Drawn By: TEAM 4 - K|M| Date: 4/18/13



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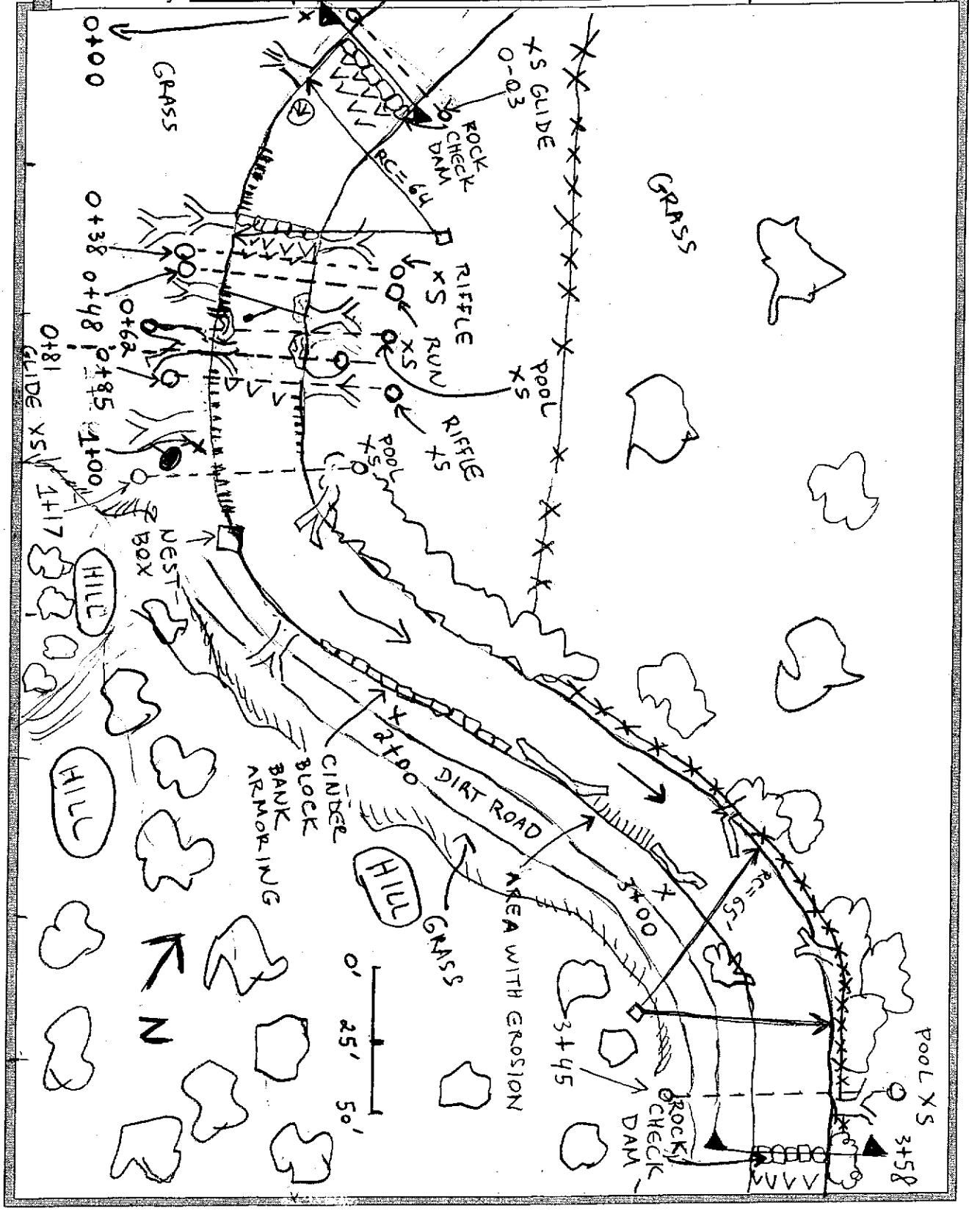
AREA-SITE LOCATION...REACH MAP

Stream: MARSH RUN AT GRIMES Reach: 4

Drawn By: TEAM 4 - CHRISTIANA Date: 4/18/13



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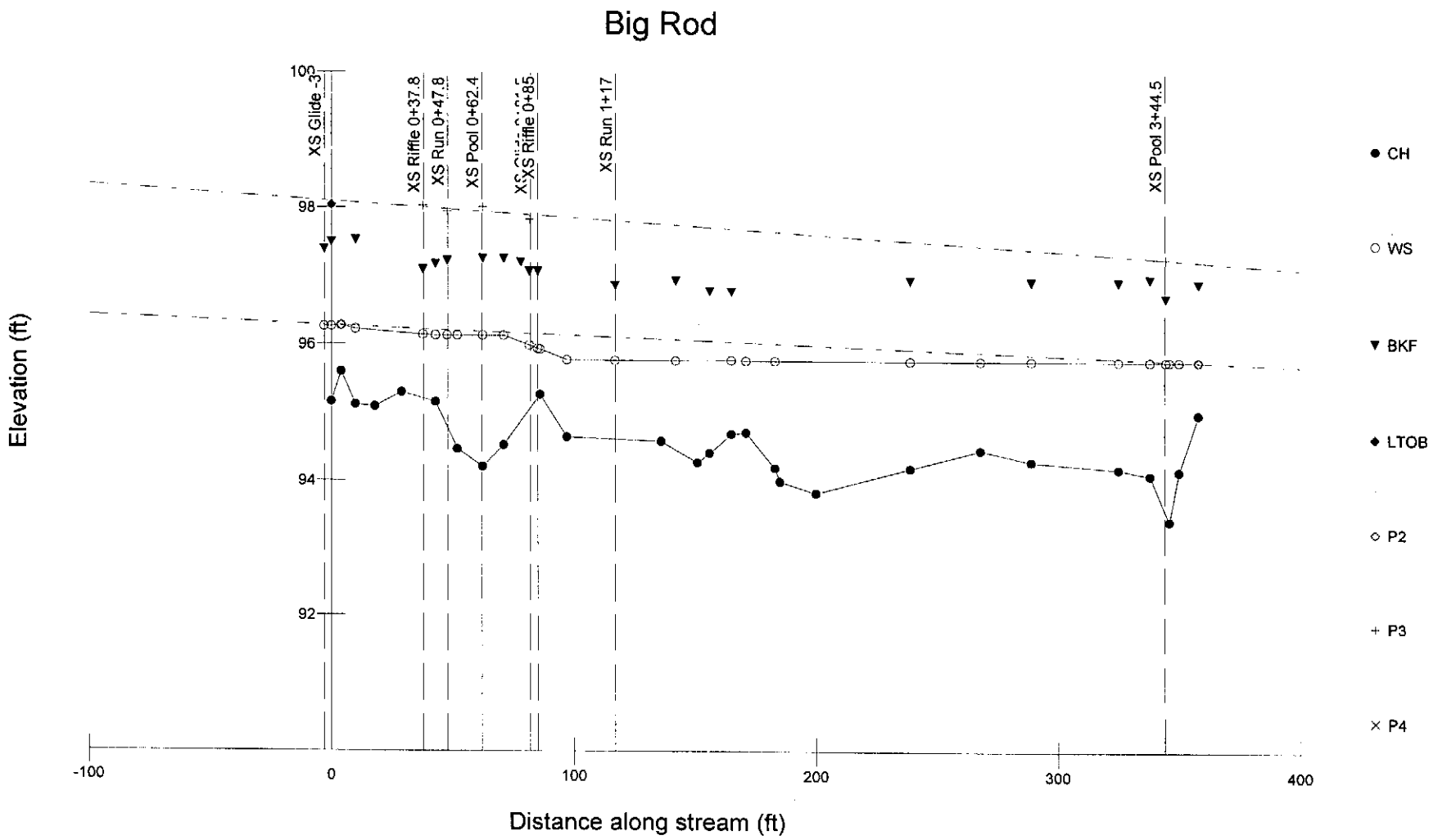
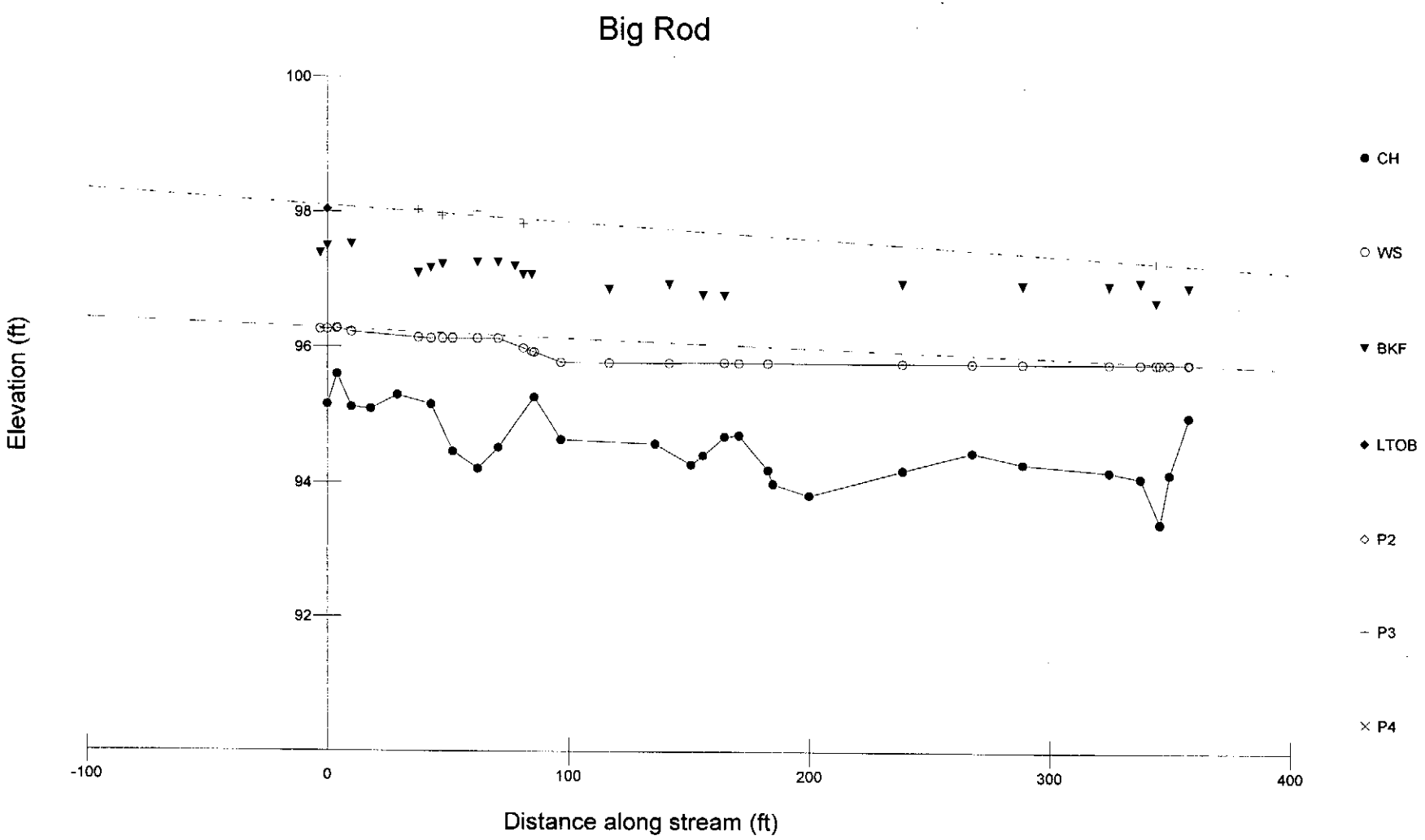
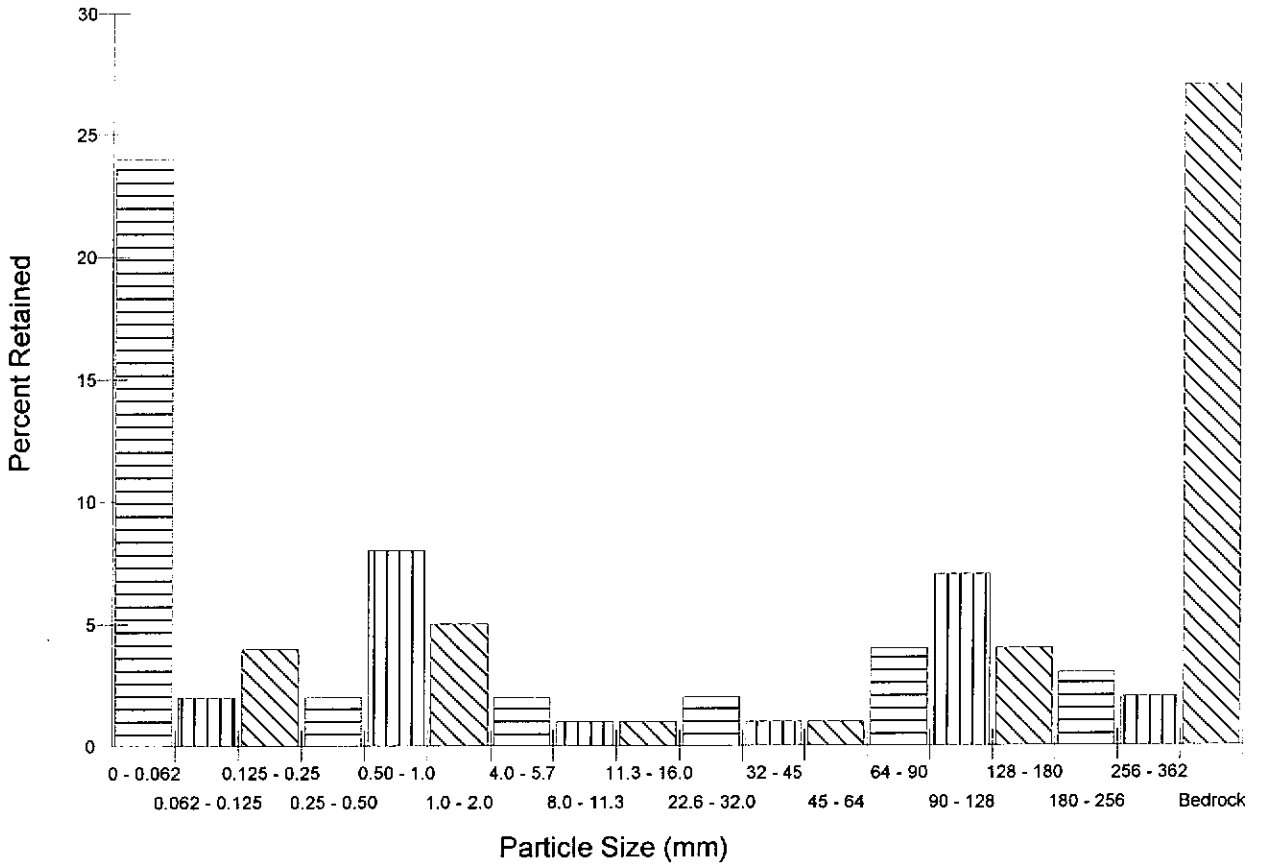

Big Rod
Elevation (ft)
Distance along stream (ft)
XS Glide -3
XS Riffle 0+37.8
XS Run 0+47.8
XS Pool 0+62.4
XS Riffle 0+85
XS Run 1+17
XS Pool 3+44.5
100
98
96
94
92
-100
0
100
200
300
400
CH
WS
BKF
LTOB
P2
P3
P4


Big Rod
Elevation (ft)
100
98
96
94
92
-100
0
100
200
300
400
Distance along stream (ft)
CH
WS
BKF
LTOB
P2
P3
P4


Percent Retained
30
25
20
15
10
5
0
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
4.0 - 5.7
8.0 - 11.3
11.3 - 16.0
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
128 - 180
180 - 256
256 - 362
Bedrock
Particle Size (mm)

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

Stream:	**MARSH Run - Reach 4**		
Basin:	Drainage Area: **12096** acres	**18.9**	mi^2
Location:			
Twp.&Rge: ;	Sec.&Qtr.: ;		
Cross-Section Monuments (Lat./Long.):	**0 Lat / 0 Long**	Date: **04/18/13**	
Observers: **Team 4**		Valley Type: VIII(c)	

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	**18.5**	ft
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A / W_{bkf}$).	**2.18**	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	**40.36**	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	**8.49**	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.	**3.04**	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.	**205**	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	**11.08**	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.	**27.3**	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.	**0.00141**	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 **E1/6** (See **Figure 2-14**)

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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:	MARSHMASTER	Location:	Reach - Reach 1
Date: 4/18/2013	Stream Type: E1/6	Valley Type:	8C
Observers:	Team 4	HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	40.36	A_{bkf} (ft^2)	Bankfull Riffle Mean DEPTH	2.18	d_{bkf} (ft)
Bankfull Riffle WIDTH	18.50	W_{bkf} (ft)	Wetted PERMIMETER ~ $(2 * d_{bkf}) + W_{bkf}$	20.24	W_p (ft)
D_{84} at Riffle	137.45	Dia. (mm)	D_{84} (mm) / 304.8	0.45	D_{84} (ft)
Bankfull SLOPE	0.0024	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.99	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R(ft) / D_{84} (ft)	4.41	R / D_{84}
Drainage Area	18.9	DA (mi^2)	Shear Velocity $u^* = (gRS)^{1/2}$	0.392	u^* (ft/sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66 * Log\ \{ R / D_{84} \}\ ]\ u^*$	2.55	ft / sec	102.73	cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor / Relative Roughness (Figs. 2-18, 2-19) $u = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ 0.0417	2.77	ft / sec	111.68	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	0.00	ft / sec	0.00	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 Stream Types A1, A2, A3, B1, B2, B3, C2 & E3 $n =$ 0.035	3.27	ft / sec	131.90	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach (Leopold, Wolman and Miller)	2.77	ft / sec	111.96	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 $u = Q / A$ Return Period for Bankfull Discharge Q = 2.0 year	2.55	ft / sec	102.73	cfs
4. Continuity Equations: b) USGS Gage Data $u = Q / A$	2.66	ft / sec	107.20	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 B-2. Computations of velocity and discharge using various methods (*Second Field Day*).

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	Marsh Run	Location:	Grimes, MD
Date:	4/18/	Stream Type:	
Observers:		Valley Type:	
		HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	40.36	A_{bkf} (ft^2)	Bankfull Riffle Mean DEPTH	2.18	d_{bkf} (ft)
Bankfull Riffle WIDTH	18.5	W_{bkf} (ft)	Wetted PERIMETER ~ $(2 * d_{bkf}) + W_{bkf}$	20.24	W_P (ft)
D_{84} at Riffle	137.49	Dia. (mm)	D_{84} (mm) / 304.8	0.45	D_{84} (ft)
Bankfull SLOPE	0.0024	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.99	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R(ft) / D_{84} (ft)	4.412	R / D_{84}
Drainage Area	19.1	DA (mi^2)	Shear Velocity $u^* = (gRS)^{1/2}$	0.39	u^* (ft/sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $\bar{u} = [2.83 + 5.66 * Log\{R / D_{84}\}] u^*$	2.55	ft / sec	102.7	cfs
2. Roughness Coefficient: a) Manning's *n* from Friction Factor / Relative Roughness (Figs. B-34, B-35) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$		ft / sec		cfs
2. Roughness Coefficient: b) Manning's *n* from Stream Type (Fig. B-36) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ .035	3.3	ft / sec	133	cfs
2. Roughness Coefficient: c) Manning's *n* from Jarrett (USGS): $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n = 0.39 * S^{0.38} * R^{-0.16}$ Note: This equation is applicable to steep, step/pool, high boundary roughness, cobble- and boulder-dominated stream systems; i.e., for Stream Types A1, A2, A3, B1, B2, B3, C2 & E3 $n =$		ft / sec		cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)		ft / sec		cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)		ft / sec		cfs
4. Continuity Equations: a) USGS Gage Data $\bar{u} = Q / A$ Return Period for Bankfull Discharge Q = year		ft / sec		cfs
4. Continuity Equations: b) Regional Curves $\bar{u} = Q / A$	2.59	ft / sec	104.5	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 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2007; Rosgen, 2008).

Stream: **MARSHMASTER** Location: **Reach - Reach 1**

Observers: **Team 4** Date: **04/18/13** Valley Type: **XIV** Stream Type: **E1/6**

River Reach Dimension Summary Data.....1

Riffle Dimensions*, **, **

Riffle Dimensions*, **, ***	Mean	Min	Max		Riffle Dimensions & Dimensionless Ratios****	Mean	Min	Max
Riffle Width (W_{bkf})	20.1	18.5	21.6	ft	Riffle Cross-Sectional Area (A_{bkf}) (ft^2)	41.13	40.36	41.90
Mean Riffle Depth (d_{bkf})	2.06	1.94	2.18	ft	Riffle Width/Depth Ratio (W_{bkf} / d_{bkf})	9.82	8.49	11.15
Maximum Riffle Depth (d_{max})	2.94	2.84	3.04	ft	Max Riffle Depth to Mean Riffle Depth (d_{max} / d_{bkf})	1.429	1.394	1.464
Width of Flood-Prone Area (W_{fpa})	124	42	205	ft	Entrenchment Ratio (W_{fpa} / W_{bkf})	6.512	1.942	11.081
Riffle Inner Berm Width (W_{ib})	0	0	0	ft	Riffle Inner Berm Width to Riffle Width (W_{ib} / W_{bkf})	0.736	0.736	0.736
Riffle Inner Berm Depth (d_{ib})	0	0	0	ft	Riffle Inner Berm Depth to Mean Depth (d_{ib} / d_{bkf})	0.338	0.338	0.338
Riffle Inner Berm Area (A_{ib})	0	0	0	ft^2	Riffle Inner Berm Area to Riffle Area (A_{ib} / A_{bkf})	0.248	0.248	0.248
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})	26.7	20	33.4	ft	Pool Width to Riffle Width (W_{bkfp} / W_{bkf})	1.329	0.995	1.663
Mean Pool Depth (d_{bkfp})	2.07	1.44	2.69	ft	Mean Pool Depth to Mean Riffle Depth (d_{bkfp} / d_{bkf})	1.005	0.699	1.306
Pool Cross-Sectional Area (A_{bkfp})	50.9	48.1	53.6	ft	Pool Area to Riffle Area (A_{bkfp} / A_{bkf})	1.237	1.170	1.304
Maximum Pool Depth (d_{maxp})	3.93	3.91	3.95	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	1.908	1.898	1.917
Pool Inner Berm Width (W_{ibp})	0	0	0	ft	Pool Inner Berm Width to Pool Width (W_{ibp} / W_{bkfp})	0.763	0.763	0.763
Pool Inner Berm Depth (d_{ibp})	0	0	0	ft	Pool Inner Berm Depth to Pool Depth (d_{ibp} / d_{bkfp})	0.489	0.489	0.489
Pool Inner Berm Area (A_{ibp})	0	0	0	ft^2	Pool Inner Berm Area to Pool Area (A_{ibp} / A_{bkfp})	0.373	0.373	0.373
Point Bar Slope (S_{pb})	0.000	0.000	0.000	ft/ft	Pool Inner Berm Width/Depth Ratio (W_{ibp} / d_{ibp})	11.581	11.581	11.581

Run Dimensions*

Run Dimensions*	Mean	Min	Max		Run Dimensionless Ratios****	Mean	Min	Max
Run Width (W_{bkfr})	23.7	23.7	23.7	ft	Run Width to Riffle Width (W_{bkfr} / W_{bkf})	1.178	1.178	1.178
Mean Run Depth (d_{bkfr})	1.83	1.83	1.83	ft	Mean Run Depth to Mean Riffle Depth (d_{bkfr} / d_{bkf})	0.888	0.888	0.888
Run Cross-Sectional Area (A_{bkfr})	43.3	43.3	43.3	ft	Run Area to Riffle Area (A_{bkfr} / A_{bkf})	1.054	1.054	1.054
Maximum Run Depth (d_{maxr})	2.78	2.78	2.78	ft	Max Run Depth to Mean Riffle Depth (d_{maxr} / d_{bkf})	1.350	1.350	1.350
Run Width/Depth Ratio (W_{bkfr} / d_{bkfr})	12.9	12.9	12.9	ft				

Glide Dimensions*

Glide Dimensions*	Mean	Min	Max		Glide Dimensions & Dimensionless Ratios****	Mean	Min	Max
Glide Width (W_{bkfg})	20.2	19.2	21.2	ft	Glide Width to Riffle Width (W_{bkfg} / W_{bkf})	1.006	0.957	1.054
Mean Glide Depth (d_{bkfg})	1.83	1.7	1.96	ft	Mean Glide Depth to Mean Riffle Depth (d_{bkfg} / d_{bkf})	0.888	0.825	0.951
Glide Cross-Sectional Area (A_{bkfg})	36.8	36	37.6	ft	Glide Area to Riffle Area (A_{bkfg} / A_{bkf})	0.894	0.875	0.914
Maximum Glide Depth (d_{maxg})	2.71	2.26	3.16	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.316	1.097	1.534
Glide Width/Depth Ratio (W_{bkfg} / d_{bkfg})	11.1	9.8	12.5	ft/ft	Glide Inner Berm Width/Depth Ratio (W_{ibg} / d_{ibg})	18.818	14.918	22.718
Glide Inner Berm Width (W_{ibg})	14.8	11.8	17.8	ft	Glide Inner Berm Width to Glide Width (W_{ibg}/W_{bkfg})	0.728	0.614	0.842
Glide Inner Berm Depth (d_{ibg})	0.79	0.78	0.79	ft	Glide Inner Berm Depth to Glide Depth (d_{ibg} / d_{bkfg})	0.433	0.404	0.461
Glide Inner Berm Area (A_{ibg})	11.7	9.33	14	ft^2	Glide Inner Berm Area to Glide Area (A_{ibg} / A_{bkfg})	0.319	0.248	0.389

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

Stream: **MARSHMASTER**		Location: **Reach - Reach 1**	
Observers: **Team 4**	Date: **04/18/13**	Valley Type: **XIV**	Stream Type: **E1/6**

River Reach Summary Data.....2

Hydraulics

Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	2.55	ft/sec	Estimation Method	u/u*	
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	102.73	cfs	Drainage Area	18.9	mi^2

Channel Pattern

Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Linear Wavelength (λ)	353	308	399	ft	Linear Wavelength to Riffle Width (λ / W_{bkf})	17.588	15.346	19.880
Stream Meander Length (l_m)	415	383	447	ft	Stream Meander Length Ratio (l_m / W_{bkf})	20.678	19.083	22.272
Radius of Curvature (R_c)	64.5	64	65	ft	Radius of Curvature to Riffle Width (R_c / W_{bkf})	3.214	3.189	3.239
Belt Width (W_{blt})	106	102	110	ft	Meander Width Ratio (W_{blt} / W_{bkf})	5.282	5.082	5.481
Arc Length (L_a)	43.3	35.6	51	ft	Arc Length to Riffle Width (L_a / W_{bkf})	2.157	1.774	2.541
Riffle Length (L_r)	32.8	26.3	39.4	ft	Riffle Length to Riffle Width (L_r / W_{bkf})	1.636	1.308	1.963
Individual Pool Length (L_p)	81.8	24	173	ft	Individual Pool Length to Riffle Width (L_p / W_{bkf})	4.076	1.196	8.640
Pool to Pool Spacing (P_s)	103	84.7	121	ft	Pool to Pool Spacing to Riffle Width (P_s / W_{bkf})	5.121	4.218	6.023

Channel Profile

Valley Slope (S_{val})	0.0014	ft/ft	Average Water Surface Slope (S)	0.00141	ft/ft	Sinuosity (S_{val} / S)	1.2	
Stream Length (SL)	358	ft	Valley Length (VL)	299	ft	Sinuosity (SL / VL)	1.1973	
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})	0.009	0.004	0.014	ft/ft	Riffle Slope to Average Water Surface Slope (S_{rif} / S)	6.277	2.603	9.943
Run Slope (S_{run})	0.001	0.000	0.002	ft/ft	Run Slope to Average Water Surface Slope (S_{run} / S)	0.546	0.000	1.085
Pool Slope (S_p)	0.000	0.000	0.001	ft/ft	Pool Slope to Average Water Surface Slope (S_p / S)	0.262	0.000	0.390
Glide Slope (S_g)	0.000	0.000	0.001	ft/ft	Glide Slope to Average Water Surface Slope (S_g / S)	0.333	0.000	0.667
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})	2.91	2.88	2.93	ft	Max Riffle Depth to Mean Riffle Depth (d_{maxrif} / d_{bkf})	1.4126	1.3981	1.4223
Max Run Depth (d_{maxrun})	3.19	3.17	3.21	ft	Max Run Depth to Mean Riffle Depth (d_{maxrun} / d_{bkf})	1.5485	1.5388	1.5583
Max Pool Depth (d_{maxp})	3.63	3.44	3.76	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	1.7621	1.6699	1.8252
Max Glide Depth (d_{maxg})	2.67	2.46	2.96	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.2961	1.1942	1.4369
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	24	13.33		D_{16}	0.04	0.19		26.36	mm
% Sand	21	20		D_{35}	0.69	64		52.92	mm
% Gravel	8	1.67		D_{50}	27.3	141.02		74.95	mm
% Cobble	18	25		D_{84}	Bedrock	Bedrock		137.45	mm
% Boulder	2	0		D_{95}	Bedrock	Bedrock		201.71	mm
% Bedrock	27	40		D_{100}	Bedrock	Bedrock		256	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 5-4. Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2007; Rosgen, 2008).

Stream: **MARSHMASTER**		Location: **Reach - Reach 1**	
Observers: **Team 4**	Date: **04/18/13**	Valley Type: **XIV**	Stream Type: **E1/6**

River Reach Summary Data.....2

Hydraulics

Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})	2.55	ft/sec	Estimation Method	u/u*
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})	102.73	cfs	Drainage Area	18.9 mi^2

Channel Pattern

Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Linear Wavelength (λ)	353	308	399	ft	Linear Wavelength to Riffle Width (λ / W_{bkf})	19.081	16.649	21.568
Stream Meander Length (L_m)	415	383	447	ft	Stream Meander Length Ratio (L_m / W_{bkf})	22.432	20.703	24.162
Radius of Curvature (R_c)	64.5	64	65	ft	Radius of Curvature to Riffle Width (R_c / W_{bkf})	3.486	3.459	3.514
Belt Width (W_{blt})	106	102	110	ft	Meander Width Ratio (W_{blt} / W_{bkf})	5.730	5.514	5.946
Arc Length (L_a)	43.3	35.6	51	ft	Arc Length to Riffle Width (L_a / W_{bkf})	2.341	1.924	2.757
Riffle Length (L_r)	32.8	26.3	39.4	ft	Riffle Length to Riffle Width (L_r / W_{bkf})	1.775	1.419	2.129
Individual Pool Length (L_p)	81.8	24	173	ft	Individual Pool Length to Riffle Width (L_p / W_{bkf})	4.422	1.297	9.373
Pool to Pool Spacing (P_s)	103	84.7	121	ft	Pool to Pool Spacing to Riffle Width (P_s / W_{bkf})	5.555	4.576	6.534

Channel Profile

Valley Slope (S_{val})	0.0014	ft/ft	Average Water Surface Slope (S)	0.00141	ft/ft	Sinuosity (S_{val} / S) 1.2
Stream Length (SL)	358	ft	Valley Length (VL)	299	ft	Sinuosity (SL / VL) 1.19732

Low Bank Height (LBH)	start	3.04	ft	Max Depth (d_{max})	start	3.04	ft	Bank-Height Ratio (BHR) (LBH / d_{max}) start 1
	end	3.04	ft		end	3.04	ft	end 1

Facet Slopes	Mean	Min	Max		Dimensionless Facet Slope Ratios	Mean	Min	Max
Riffle Slope (S_{rif})	0.009	0.004	0.014	ft/ft	Riffle Slope to Average Water Surface Slope (S_{rif} / S)	6.277	2.603	9.943
Run Slope (S_{run})	0.001	0.000	0.002	ft/ft	Run Slope to Average Water Surface Slope (S_{run} / S)	0.546	0.000	1.085
Pool Slope (S_p)	0.000	0.000	0.001	ft/ft	Pool Slope to Average Water Surface Slope (S_p / S)	0.262	0.000	0.390
Glide Slope (S_g)	0.000	0.000	0.001	ft/ft	Glide Slope to Average Water Surface Slope (S_g / S)	0.333	0.000	0.667
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})	2.91	2.88	2.93	ft	Max Riffle Depth to Mean Riffle Depth (d_{maxrif} / d_{bkf})	1.3348624	1.3211	1.34404
Max Run Depth (d_{maxrun})	3.19	3.17	3.21	ft	Max Run Depth to Mean Riffle Depth (d_{maxrun} / d_{bkf})	1.4633028	1.45413	1.47248
Max Pool Depth (d_{maxp})	3.63	3.44	3.76	ft	Max Pool Depth to Mean Riffle Depth (d_{maxp} / d_{bkf})	1.6651376	1.57798	1.72477
Max Glide Depth (d_{maxg})	2.67	2.46	2.96	ft	Max Glide Depth to Mean Riffle Depth (d_{maxg} / d_{bkf})	1.2247706	1.12844	1.3578
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	24	13.33		D_{16}	0.04	0.19		26.36	mm
% Sand	21	20		D_{35}	0.69	64		52.92	mm
% Gravel	8	1.67		D_{50}	27.3	141.02		74.95	mm
% Cobble	18	25		D_{84}	Bedrock	Bedrock		137.45	mm
% Boulder	2	0		D_{95}	Bedrock	Bedrock		201.71	mm
% Bedrock	27	40		D_{100}	Bedrock	Bedrock		256	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. 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: Marsh Run at Grimes, MD **Gaging Station Number:** 01617800

Drainage Area (mi²)	Bankfull Discharge Q_{bkf} (cfs)	Bankfull Width W_{bkf}	Bankfull Mean Depth d_{bkf} (ft)	Bankfull Area A_{bkf} (ft²)	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	102.73	18.5	2.18	40.36	2.55	0.0014	304.8	0.45	E1/6	0.043	4.41	0.392	6.53

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

Station NAME:	MARSH RUN A GRIMES	Station Number:	01617200
LOCATION:	MD		
Period of Record:	yrs	Mean Annual DISCHARGE:	cfs
Drainage AREA:	acres / mi²	Drainage Area Mn Elev:	ft
Reference REACH SLOPE:	ft/ft	Valley Type:	
Stream Type:		HUC:	

"BANKFULL" CHARACTERISTICS

Determined from FIELD MEASUREMENT			Determined from GAGE DATA Analysis		
Bankfull WIDTH (W_{bkf})	18.5	ft	Bankfull WIDTH (W_{bkf})	22	ft
Bankfull Mean DEPTH (d_{bkf})	2.18	ft	Bankfull MEAN DEPTH (d_{bkf})	1.8	ft
Bankfull Xsec AREA (A_{bkf})	40.36	ft²	Bankfull Xsec AREA (A_{bkf})	40	ft²
Wetted PERIMETER (W_P)	20.24	ft	Wetted PERIMETER (W_P)	25.6	ft
Bankfull STAGE (Gage Ht)	3.12	ft	Bankfull STAGE (Gage Ht)	2.38	ft
Est. Mean VELOCITY (u)	2.55	ft/sec	Mean VELOCITY (u)	2.7	ft/sec
Est. Bkf. DISCHARGE (Q_{bkf})	102.7	cfs	Bankfull DISCHARGE (Q_{bkf})	107	cfs

Bankfull DISCHARGE associated with **"field-determined"** Bankfull STAGE (From Gage Height reading at Staff Plate and tabular Stage-Discharge curve data)	107	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 =	70	cfs	10 Year R.I. Discharge =	280	cfs
2.0 Year R.I. Discharge =	100	cfs	25 Year R.I. Discharge =	450	cfs
5.0 Year R.I. Discharge =	190	cfs	50 Year R.I. Discharge =	459	cfs

MEANDER GEOMETRY

Meander Wavelength (L_m)	415	ft	Radius of Curvature (R_C)	64.5	ft
Belt Width (W_{blt})	106	ft	Meander Width Ratio (W_{blt}/W_{bkf})	5.73	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)	9.6307	0.4066	3.916	0.258
Slope Exponent b)	0.1934	0.3106	0.504	0.4928

Hydraulic Radius R = A / W_P	1.99	ft	Manning's "n" at Bankfull Stage	0.0435	Coeff.

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

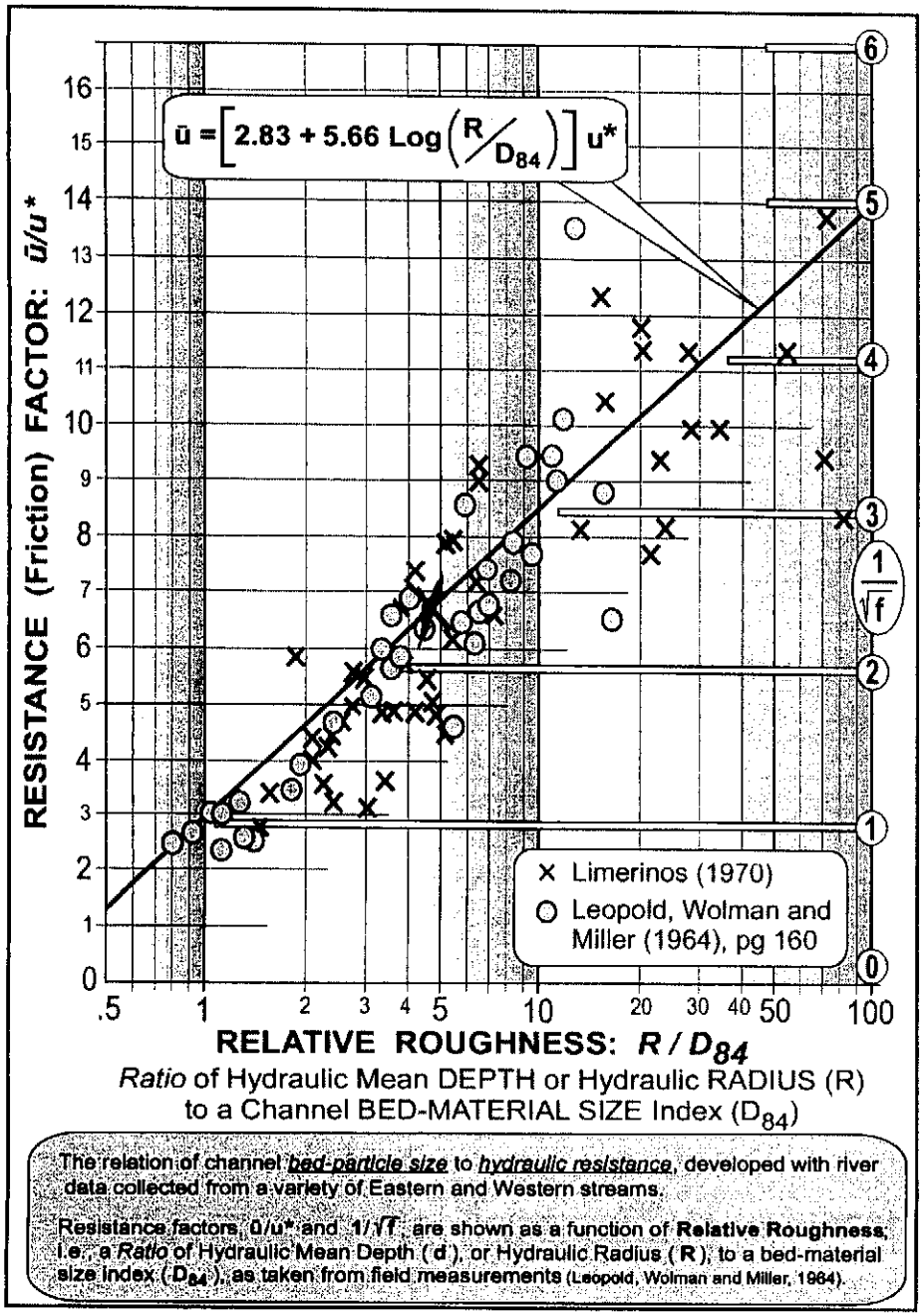

Figure B-34. Relative roughness (R/D_{84}) *vs.* friction factor ($\bar{u}/u^*$).

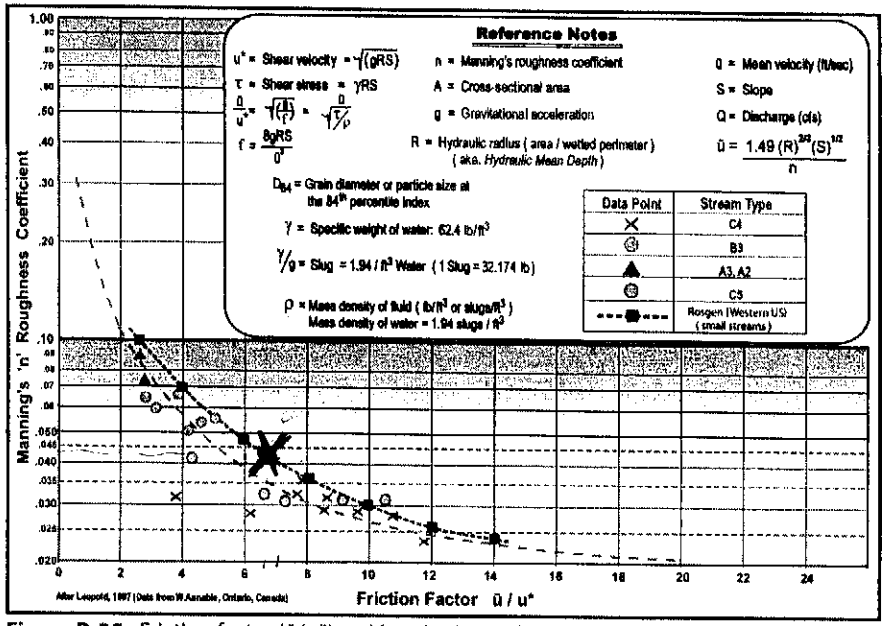

Figure B-35. Friction factor ($\bar{u}/u^*$) *vs.* Manning's roughness coefficient 'n'.

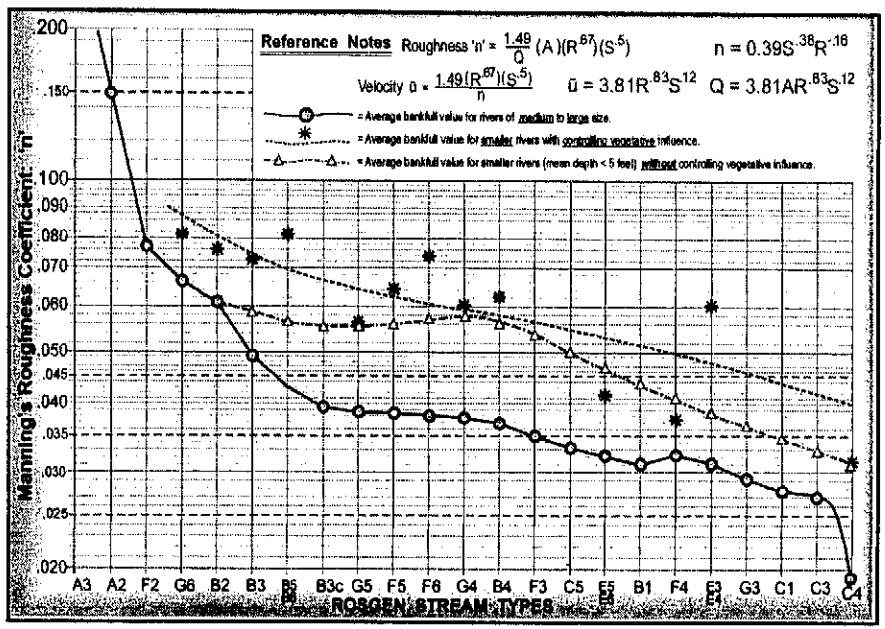

Figure B-36. Manning's 'n' roughness coefficient by stream type.

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BKF = 1.15
BM = 5.19/5.17

STA	TW	WS	BKF	WS − BKF	LTOB	Notes
0+00 TRIFF	5	4.7	3.7	1.0	3.7	
LS TRUN	5.5					
0+00 [illegible]	~~10.01~~	8.91	7.68	1.23	7.13	[illegible]
0+04 TRIFF	9.57	8.90				
0+10 X-SEC	10.5	8.95	7.65	1.10		
0+18 TS	10.08					
0+29 TS	9.87					
0+43 TRUN	10.01	9.04	~~8.3~~ 8.04			
0+47 X SECT		9.04	7.92	1.12		
0+49 TS	9.97					
0+52 TP	10.70	9.04	7.92			
0+62 $D_{max\ pool}$	10.96					
TS						
0+71 TG	10.64	9.04	~~7.92~~	1.12		
0+78 BKF			7.97			
0+86 T_{RIFF}	9.9	9.24				
0+97 T_{RUN}	10.52	9.39				
0+136 T_{POOL}	10.58					
0+142		9.40	8.23	1.17		
0+151 $D_{MAX\ P}$	10.89					
0+165 TRIFF	10.47	9.39	8.39			
0+156 T	10.75	9.38		1.01		
0+162			8.39			
0+170.6						

RIFF 0+37.8
RUN @ 0+17
POOL @
GLIDE @ 0+81.5

STA	THW	WS	BKF	WS-BKF	LTOB	NOTES
0+171 TRUN	10.45	9.4				
0+183 TPOOL	10.97	9.4				
0+185	11.17					
0+200	11.34					
0+239	10.97		8.22	1.18		
0+268	10.70	9.4				
0+289	10.87	9.4	8.24	1.16		
3+25	10.98	9.4	8.24	1.16		
3+38	11.07	9.4	8.19	1.21		
3+46 DWYT	11.74					
3+50 TGLI	11.01	9.4				
3+58 TRIFF	10.17	9.4	8.26	1.14		

11.74
9.40
2.34

SURVEY DATA → CROSS - SECTION 7

SITE: Riffle station 0+85 Date:

stations	Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES / COMMENTS / REMARKS
0	29	5.45					
11.4	30	4.97					
☆ 13.4	31	5.70					
water surface 17.0	32	7.98					
BNF 15.9	33	6.85					
20.9	34	8.54					
24.7	35	8.22					
28.2	36	8.27					
H_2O surface 29.7	37	8.04					
SB 31.3	38	7.19					
Top of bank 35.4	39	5.55					
Terrace 42.	40	5.32					
	41						
terrace	42	0+02	5.03				terrace
	43	0+05	5.42				terrace
	44	0+08	5.46				top bank
	45	0+10	5.94				slope
	46	0+11.4	6.72				BKF
	47	0+12.3	7.84				WS.
	48	0+13.8	8.56				channel 1
	49	0+16.7	8.50				" 2
	50	0+20	8.76				" 3
	51	0+25.7	8.98				FW
	52	0+28.3	8.51				thalweg
	53	0+31.7	7.26				edge of water
	54	0+33.2	6.32				top of bank
	55	0+37	5.62				terrace
	56	0+41	5.27				terrace
	57						
	58						
	59						

top of glide

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SURVEY DATA → CROSS-SECTION 2

SITE: XS 2 station 0+37.8 Date:

bkf ~ 11' ds

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES COMMENTS REMARKS
29	0			4.91		start
30	6			4.47		slope br
31	11.6			4.2		slope br
32	18			4.56		~~slope br~~ + bank
33	19.8			5.02		~~+ ba~~ roots
34	21.1			6.09		roots (br
35	21.9			6.91		WS
36	23			7.46		CS
37	24.2			7.74		CS
38	25.9			8.06		thal
39	27			7.84		CS
40	29.1			7.83		CS
41	30.3			7.64		CS
42	31.5			7.93		CS
43	32.8			7.55		CS
44	34.6			7.22		CS
45	35.6			6.88		WS
46	36.5			6.42		sl br (rock)
47	37.3			5.63		sl br (rock top)
48	39.6			4.22		+ bank
49	42.6			3.94		sl br
50	54			4.02		end
51						
52						
53						
54						
55						
56						
57						
58						
59						

W_{fp} = 205

20.8 - bkf
5.96

WS → bkf
1.12

8.06
- 5.96 bkf
- 2.10
3.86

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SURVEY DATA → CROSS-SECTION 3

SITE: X3 run st 0+47.8 **Date:**

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES / COMMENTS / REMARKS
29	0			4.00		start
30	9			4.67		sl br
31	20.1			5.41		t bank
32	20.7			5.86		bkf
33	21.2			6.58		back bench
34	21.7			6.94		ws
35	23.5			7.35		cs
36	25.2			7.32		cs
37	27.6			7.65		cs
38	29.2			7.69		cs
39	30.6			7.94		thal
40	31.9			7.50		cs
41	33			7.72		cs
42	34.4			7.14		cs
43	35.7			7.94		cs (scour)
44	37			7.64		cs (scour)
45	38.8			6.98		ws
46	40			5.16		sl br
47	41.2			4.23		t bank
48	54			4		end
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						

$W_{fp}=260$

ws → bkf 1.12

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SURVEY DATA → CROSS-SECTION 4

SITE: XS4 pool st 0+62.4 Date:

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES COMMENTS REMARKS
29	0			4.38		start
30	16.3			4.58		+ bank
31	18			5.08		sl br
32	19.3			6.04		back beach
33	21.3			6.38		sl br
34				5.84		bkf
35	21.9			6.96		ws
36	24			8.18		cs
37	26.6			8.72		cs
38	28.7			8.99		thal
39	31			8.56		cs
40	35			8.1		cs
41	37.1			6.98		ws
42	37.8			6.33		sl br
43	38			4.80		+ bank
44	54			4.16		end
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						

ws → bkf
1.12

8.99
- 5.84
- 3.15
2.69

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SURVEY DATA ⟶ **CROSS - SECTION 5**

SITE: XS Slice 0+81.5 **Date:**

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES COMMENTS REMARKS
29	0			4.65		start
30	15			4.00		tree roots
31	19			4.28		t bank
32	20.4			5.12		sl br
33	22			5.88		bkf?
34	24.1			6.96		ws
35	25.3			7.42		cs
36	28.4			7.86		cs
37	29.4			7.83		cs
38	31.2			7.83		cs
39	33.6			8.28		thal
40	34.5			8.07		cs
41	35.9			6.96		ws
42	37.7			5.96		sl br (rock
43	39.5			5.15		sl br
44	42.6			4.32		t bank
45	54			4.51		end
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						

WS → bkf
1.12

8.28
5.88
2.40
3.48

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SURVEY DATA ⟶ **CROSS - SECTION** 6

SITE: XS run 1+17 **Date:**

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES COMMENTS REMARKS
29	0			3.87		start
30	5			5.97		depression
31	13.7			3.32		tree root
32	19.6			3.5		+ bank
33	21.6			4.82		bkf ?
34	22.3			5.52		back bench
35	23.9			6.18		WS
36	27.9			7.22		CS
37	29.8			7.12		CS
38	33.1			7.06		CS
39	37.9			7.09		thal
40	40.9			7.02		CS
41	46.4			6.20		WS
42	48.4			3.76		+ bank
43	52			3.82		sl br loods
44	60			3.75		end
45						
46						
47						
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SURVEY DATA → **CROSS - SECTION 8**

SITE: XS pool 3+441.5 **Date:**

Item	STATION ft	B S ft	H I ft	F S ft	Elevation ft	NOTES COMMENTS REMARKS
29	0			4.03		start
30	6			4.29		+ bank
31	6.9			4.63		bkf ?
32	8			5.59		ws
33	9			7.45		cs
34	11			7.77		cs
35	13.2			7.73		cs
36	14.8			8.05		thal
37	17.5			7.42		cs
38	19.2			6.68		cs
39	20			5.59		ws
40	21.1			4.8		+ bank
41	23.7			4.7		bkf ?
42	35			4.1		end (road
43						
44						
45						
46						
47						
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0+38

Protrusion at XS

Site: Marsh Branch Date: 4/18/13

Location: HUC:

Party:

Inches	PARTICLE	Millimeters		Dot Count for RIFFLE 1	POOL 2	COMP. 3	RIFFLE (1) TOT #	ITEM %	% CUM	POOL (2) TOT #	ITEM %	% CUM	COMPOSITE (3) TOT #	ITEM %	% CUM
							Reach:			Reach:			Reach:		
							Date:			Date:			Date:		
	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		•		1									
.22 - .31	Fine	5.7 - 8													
.31 - .44	Medium	8 - 11.3		⁝		3									
.44 - .63	Medium	11.3 - 16		⁞		7									
.63 - .89	Coarse	16 - 22.6		⁝		2									
.89 - 1.3	Coarse	22.6 - 32		⁞		5									
1.3 - 1.8	Very Coarse	32 - 45		⊠ •		11									
1.8 - 2.5	Very Coarse	45 - 64		⊠ ⁝		12									
2.5 - 3.5	Small	64 - 90	COBBLE	⊠ ⊠		19									
3.5 - 5.0	Small	90 - 128		⊠ ⊠ •		21									
5.0 - 7.1	Large	128 - 180		⊠ •		11									
7.1 - 10.1	Large	180 - 256		⊡		7									
10.1 - 14.3	Small	256 - 362	BOULDER	•		1									
14.3 - 20	Small	362 - 512													
20 - 40	Medium	512 - 1024													
40 - 80	Large-Vry Large	1024 - 2048													
	Bedrock		BDRK												
Stream Type:			**Valley Type:**			TOTAL→									

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