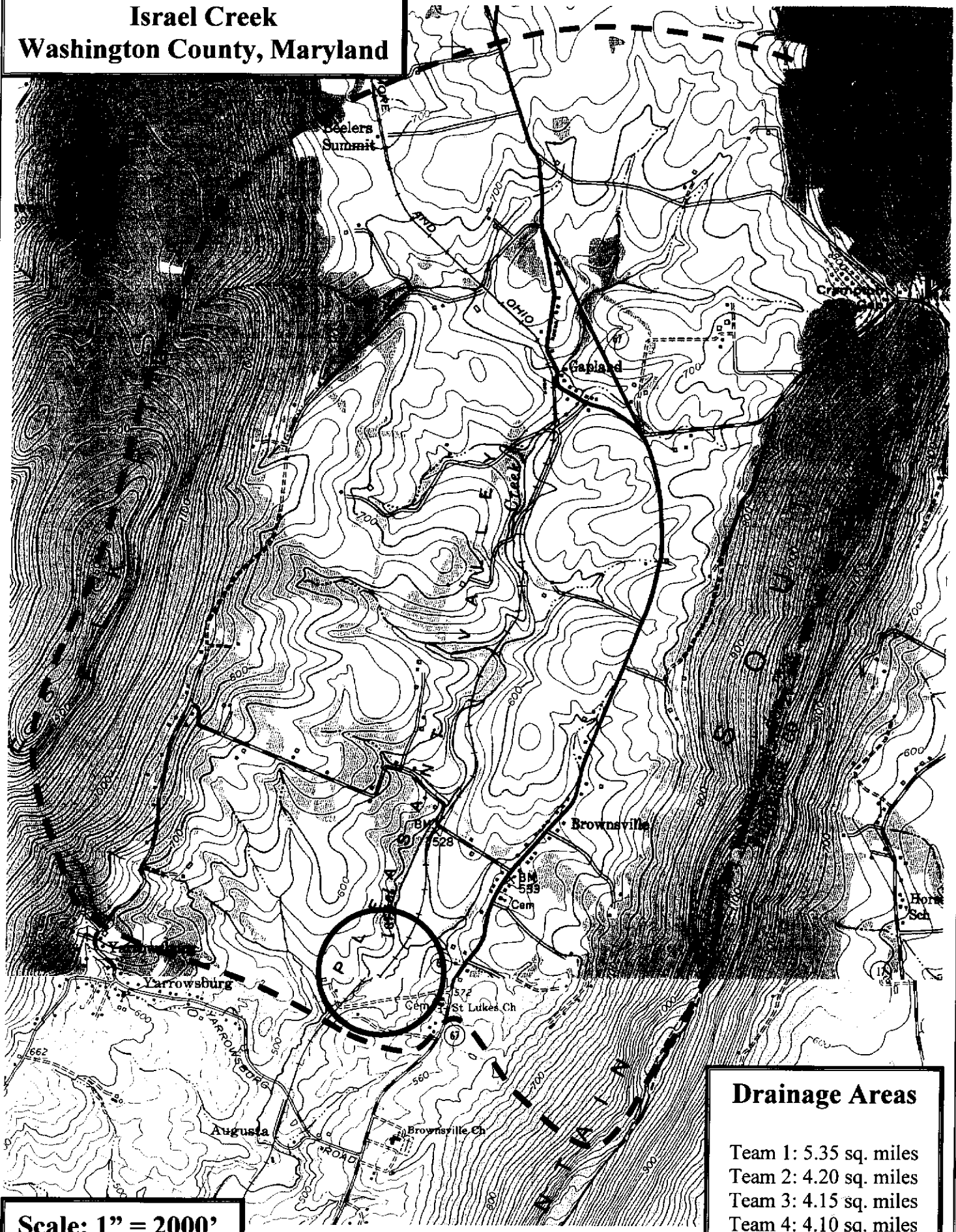
Israel Creek
Washington County, Maryland



Scale: 1" = 2000'

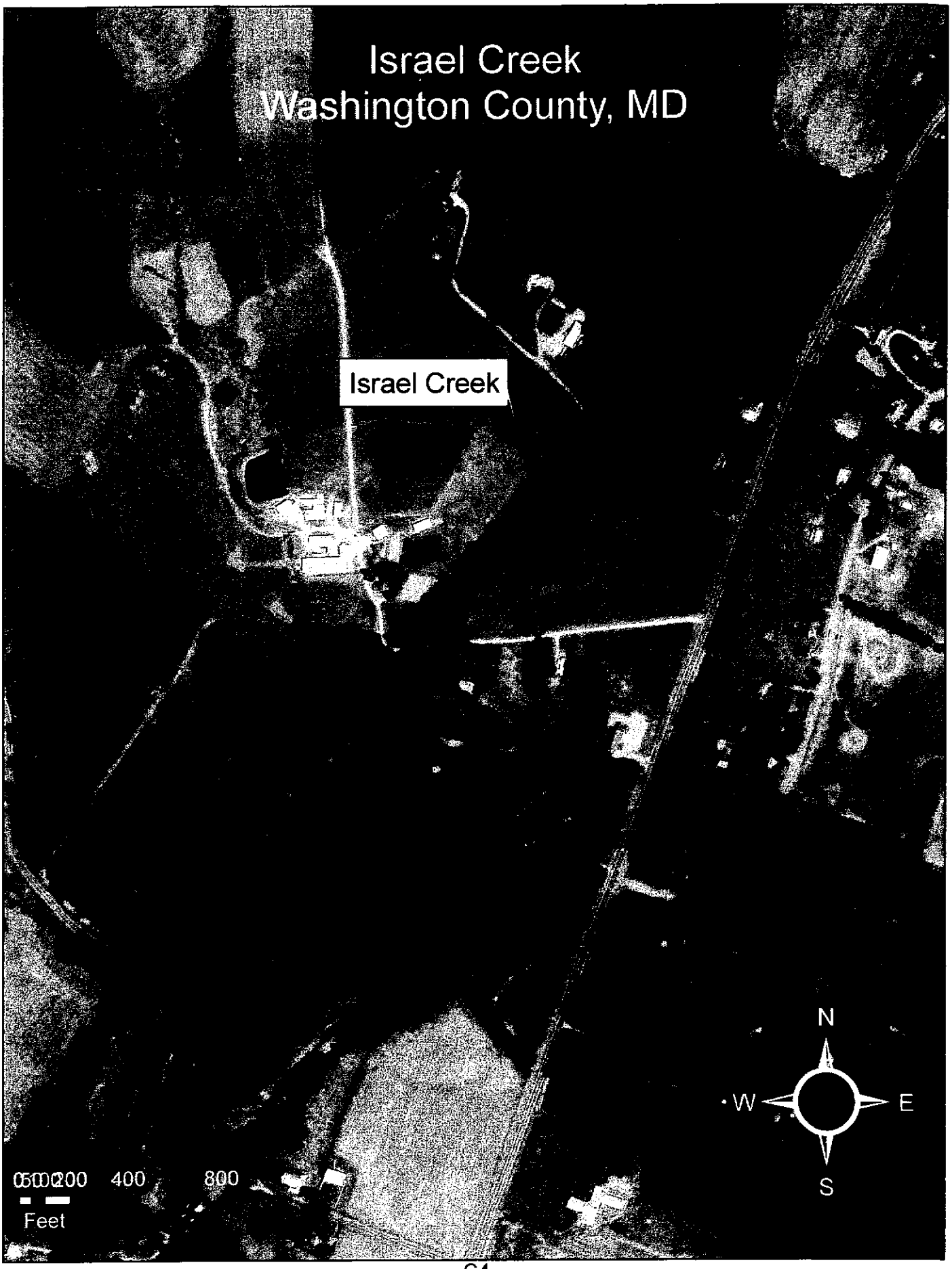
Drainage Areas

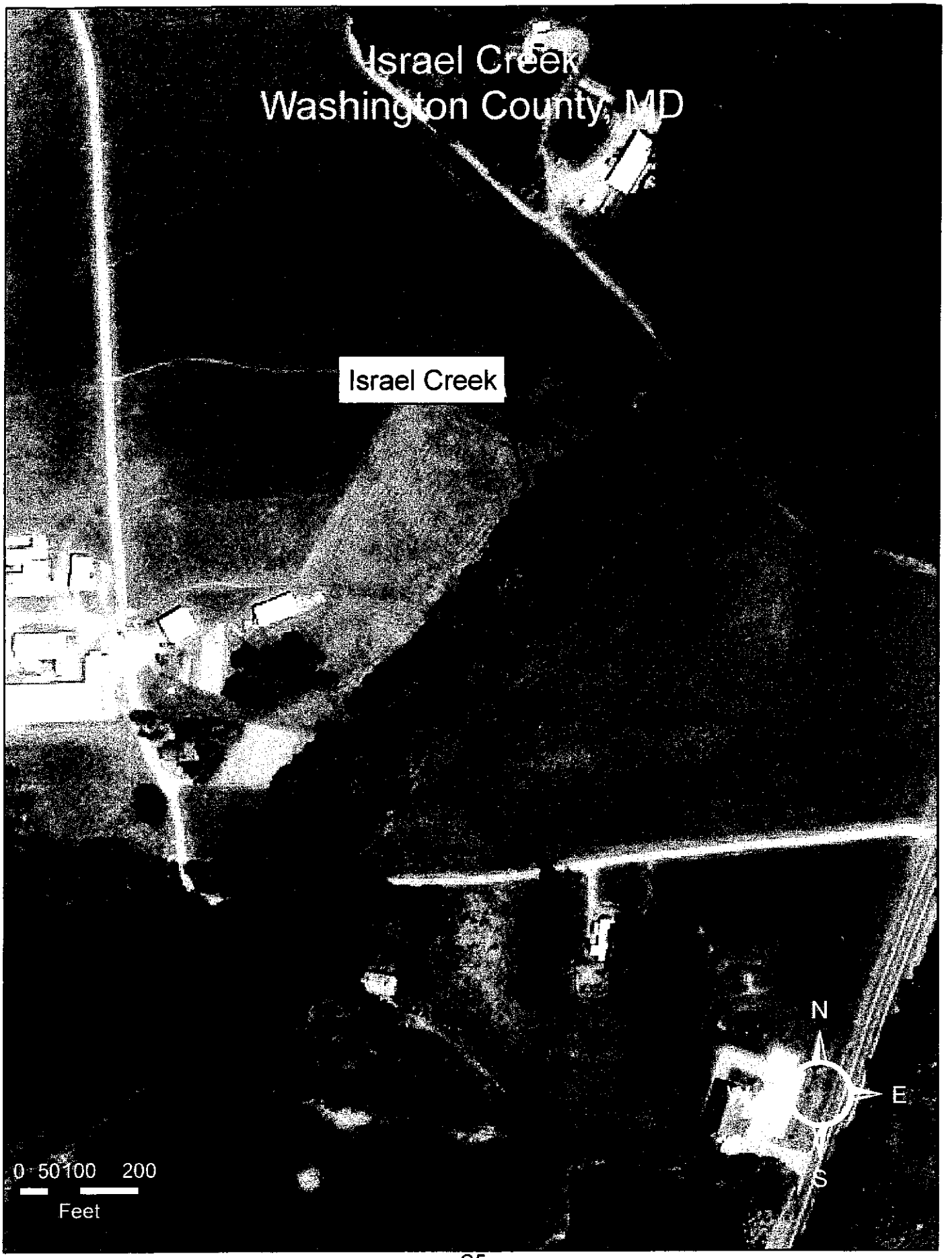
Team 1: 5.35 sq. miles
Team 2: 4.20 sq. miles
Team 3: 4.15 sq. miles
Team 4: 4.10 sq. miles

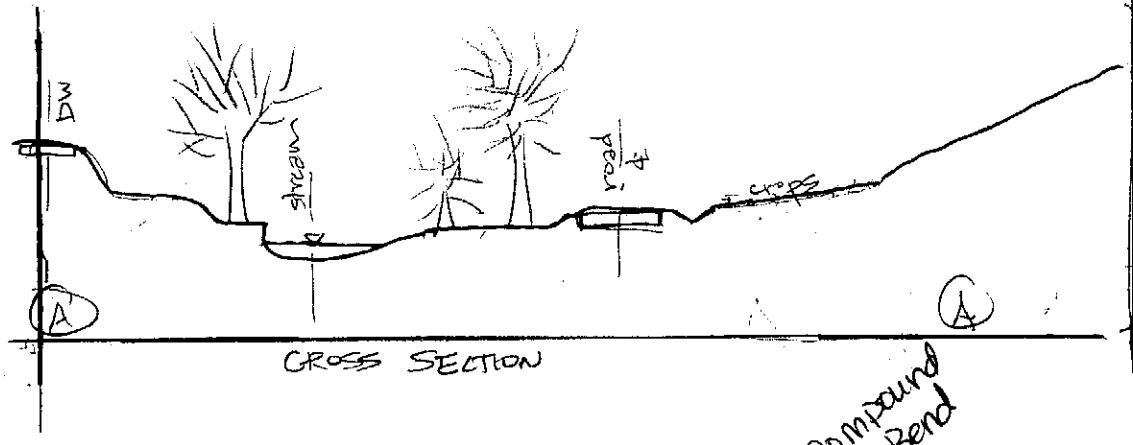
Applied Fluvial Geomorphology
National Conservation Training Center
Shepherdstown, WV
04/8/2013 - 04/12/2013

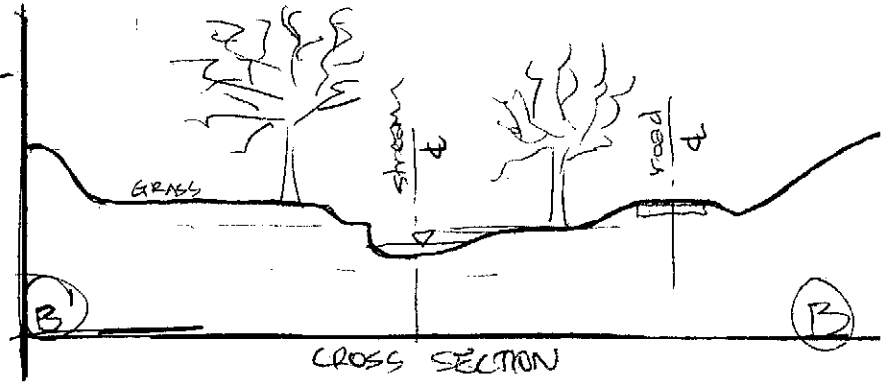
Team 3

Matthew Bennett
Joseph Gerbyshak
Rebecca Harris
Brian Jameson
Dheepa Jayakumar
Erin Murphy
Margaret Perdue
Avi Sareen
Brent Showalter
Leah Szafranski
Patrick Zinkan


Israel Creek
Washington County, MD
Israel Creek
N
W
E
S
0 200 400 800
Feet

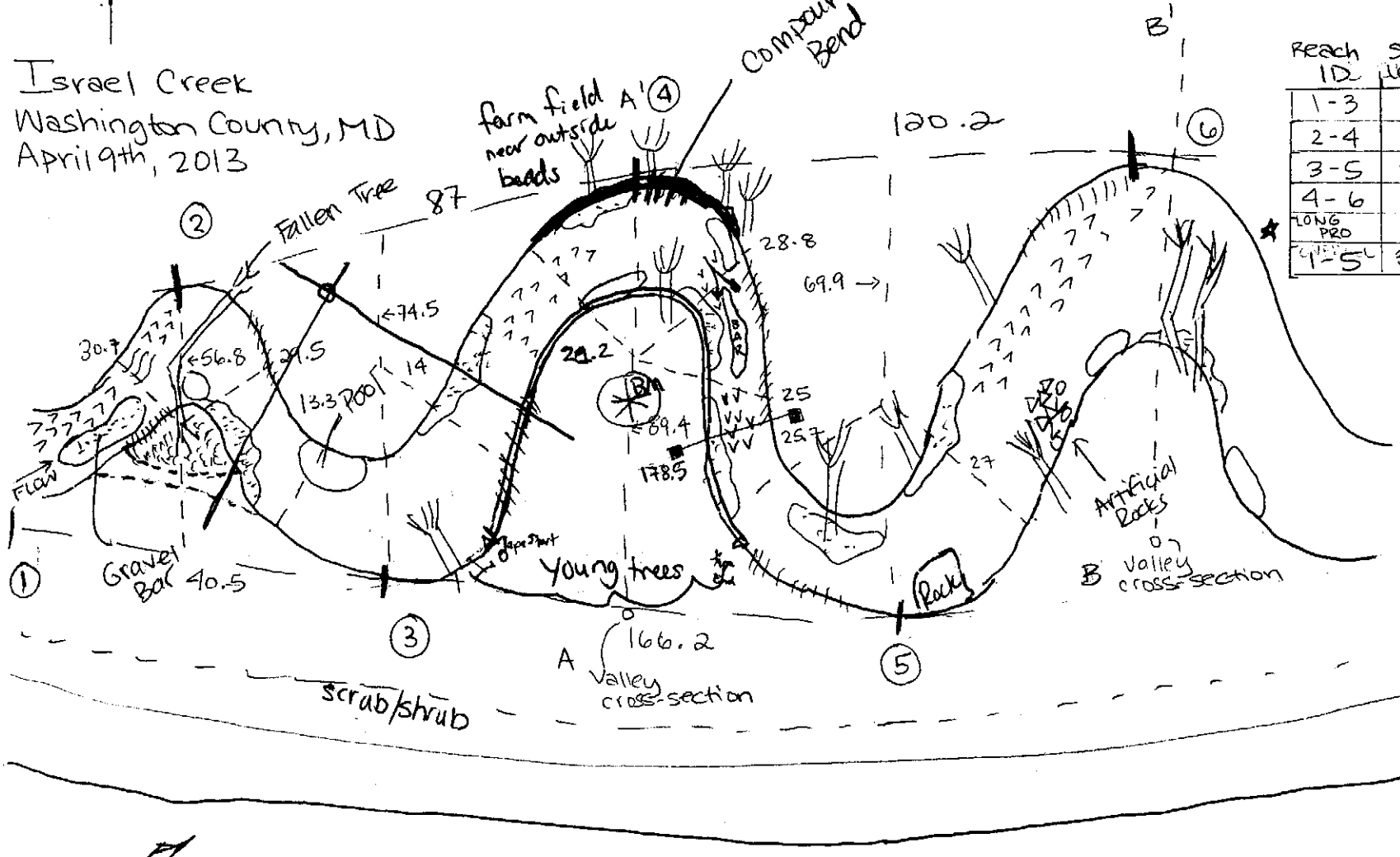

Israel Creek
Washington County, MD
Israel Creek
N
E
S
0 50100 200
Feet





Israel Creek
Washington County, MD
April 9th, 2013

Reach ID	Stream Length	Valley Length	Sinuosity (k)
1-3	138	40.5	3.41
2-4	167	87	1.92
3-5	215	166.2	1.29
4-6	237	120.2	1.97
LONG PRO	180.3	122.2	1.48
1-5	353	206.7	1.71



1 inch = 50 feet

Team/Reach #3
Surveyors:
Matthew Bennett
Brent Showalter
Dheepa Jayakumar

Max depth = 2.73 · 2 = 5.46
90.33 + 2.73 = 101.06 Flood prone elevation
area = 36.0

SURVEY DATA → CROSS - SECTION 1

SITE: Date: 4/9/13

Location: Israel Creek - Reach 3 Washington County, Md

Party / Notes: Riffle X-section HUC:

Item	Distance, Point, or STATION (ft)	Back-Sight BS (ft)	Height of Instrument HI (ft)	Fore-Sight FS (ft)	Elevation (ft)	NOTES / COMMENTS / REMARKS
1	~~BM~~	~~5.06~~	~~105.06~~	~~5.40~~		
2	BM	3.9	103.89			
3	0			[illegible]	100.12	[illegible]
4	3			4.[illegible]	99.62	[illegible]
5	4.0			4.35	99.31	left top of bank
6	5.1			5.00	98.69	left bank?
7	5.6			5.43	98.26	left bank? LEW
8	5.[illegible]			7.[illegible]	96.6	left water edge Δ
9	6.7			7.76	95.93	left channel
10	7.5			5.[illegible]	95.6	left flowline
11	5.4			[illegible]	95.65	left channel
12	[illegible]			[illegible]	95.71	[illegible]
13	[illegible]			[illegible]	96.35	[illegible]
14	[illegible]			7.[illegible]	96.41	channel thal
15	[illegible]			7.[illegible]	96.46	[illegible]
16	15.5			7.35	96.39	channel
17	16.5			7.4[illegible]	96.29	channel
18	17.1			7.41	96.55	right edge of water Δ
19	~~[illegible]~~				~~97.36~~	~~[illegible]~~
20	~~[illegible]~~				~~96.94~~	~~[illegible]~~
21	21.4			5.4[illegible]	98.21	[illegible] 1.66
22	[illegible]			5.[illegible]	98.53	[illegible] 1.9
23	21.[illegible]			5.[illegible]	98.33	[illegible] 1.78 ←
24	[illegible]			[illegible]	98.65	[illegible] 2.1 REW
25	[illegible]			[illegible]	98.88	[illegible]
26	[illegible]			[illegible]	98.9	[illegible]
27	[illegible]				99.15	
28		3.69				[illegible]

X SECTION TAKEN @ 178.5 ON LONG PRO TAPE

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* Water surface → bank full elevational difference

SURVEY DATA → LONGITUDINAL PROFILE 1

SITE: ISRAEL CREEK Team 3 / Reach 3 **Date:** 4/8/13

Location: MD

Party / Notes: Leah, Joseph, Brian **HUC:**

	Distance, Point, or STATION (ft)	Back-Sight BS (ft)	Height of Instrument HI (ft)	Thalweg Fore-Sight FS (ft)	Thalweg Elevation Elev. (ft)	Water Surface Fore-Sight FS (ft)	Water Surface Elevation Elev. (ft)	Bankfull Fore-Sight FS (ft)	Bankfull Elevation Elev. (ft)	Low Bank Hl Fore-Sight FS (ft)	Low Bank Hl Elevation Elev. (ft)	NOTES e.g. Riffle Run Pool Glide	
1		5.09	105.09									BM 1	
2	0			8.78	96.31	8.0	97.09	6.95	98.14	5.94	99.15	TOP OF RIFFLE	1.05 LOW
* 3	14			8.54	96.55	8.1	96.99	6.59	98.50			Riffle	1.01 LOW
4	11			8.66	96.43	8.05	97.04	6.62	98.47			Riffle	1.43 LOW
5	11						"	5.99	99.1			Riffle	2.06 HIGH
6	11						"	6.33	98.76			Riffle	1.72 LOW
→ 7	30			9.14	95.95	8.23	96.86	6.53	98.56	5.47	99.62	END OF RIFFLE	1.7
8	40			9.20	95.89	8.24	96.85	6.47	98.68	5.61	99.48	MID RUN	1.83*
9	54			9.53	95.56	8.29	96.85	6.4	98.69			END RUN TOP POOL	1.84*
10	63			9.74	95.35	8.27	96.82	6.11	98.98	6.11	98.98	POOL	
11	71			9.57	95.52	8.22	96.87					POOL - START OF GLIDE	
12	78			9.40	95.69	8.22	96.87					GLIDE	? POOL
→ 13	82			9.56	95.53	8.22	96.87					POOL	END OF GLIDE
→ 14	88			9.86	95.23	8.22	96.89			5.27	99.82	POOL	
15	95			8.91	96.18	8.21	96.88					RUN	
16	97			9.49	95.6	8.22	96.87					BEG. POOL	
17	102			10.02	95.07	8.24	96.85			5.43	99.66	MID POOL	
18	109			9.09	96.00	8.25	96.84	6.38	98.71			END POOL BEG GLIDE	1.87*
19	120			8.91	96.18	8.29	96.80					BEG. RIFFLE	
20	135			9.16	95.93	8.32	96.77					MID RIFFLE	
21	140			8.95	96.14	8.35	96.74			5.44	99.65	RIFFLE	
22	153			9.27	95.82	8.39	96.70					RIFFLE	
23	162			9.01	96.08	8.41	96.68			6.04	99.05	RIFFLE	
24	170			8.91	96.18	8.43	96.66					RIFFLE	
25	179			9.42	95.67	8.48	96.61	6.49	98.6			RIFFLE	1.99
26	193			9.34	95.75	8.53	96.56			6.3	98.79	RIFFLE	
27	209			9.35	95.74	8.60	96.49			5.74	99.35	RIFFLE	END

BKF

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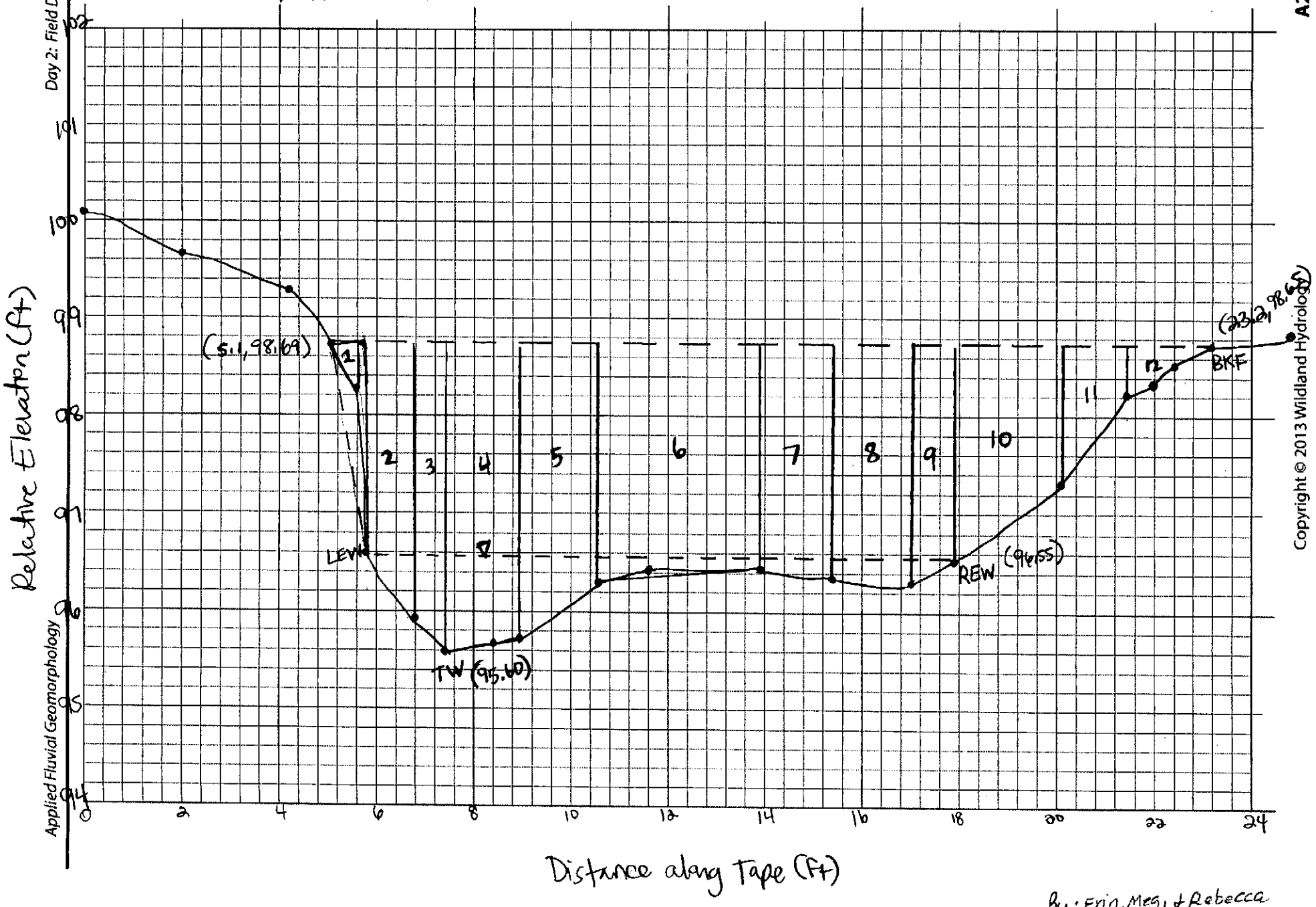
Team 3 Reach 3 Riffle Cross-Section 4/9/2013

$W_{BKF} = 18.1$ $A_{BKF} = 36.0$ $D_{BKF} = 1.99$ (mean) Max depth = 3.05 Entrenchment Ratio = 11.05

Bankfull Elevation = 98.65, diff from WS = 2.10 W/D = 9.1



By: Erin, Meg, & Rebecca
Group 3

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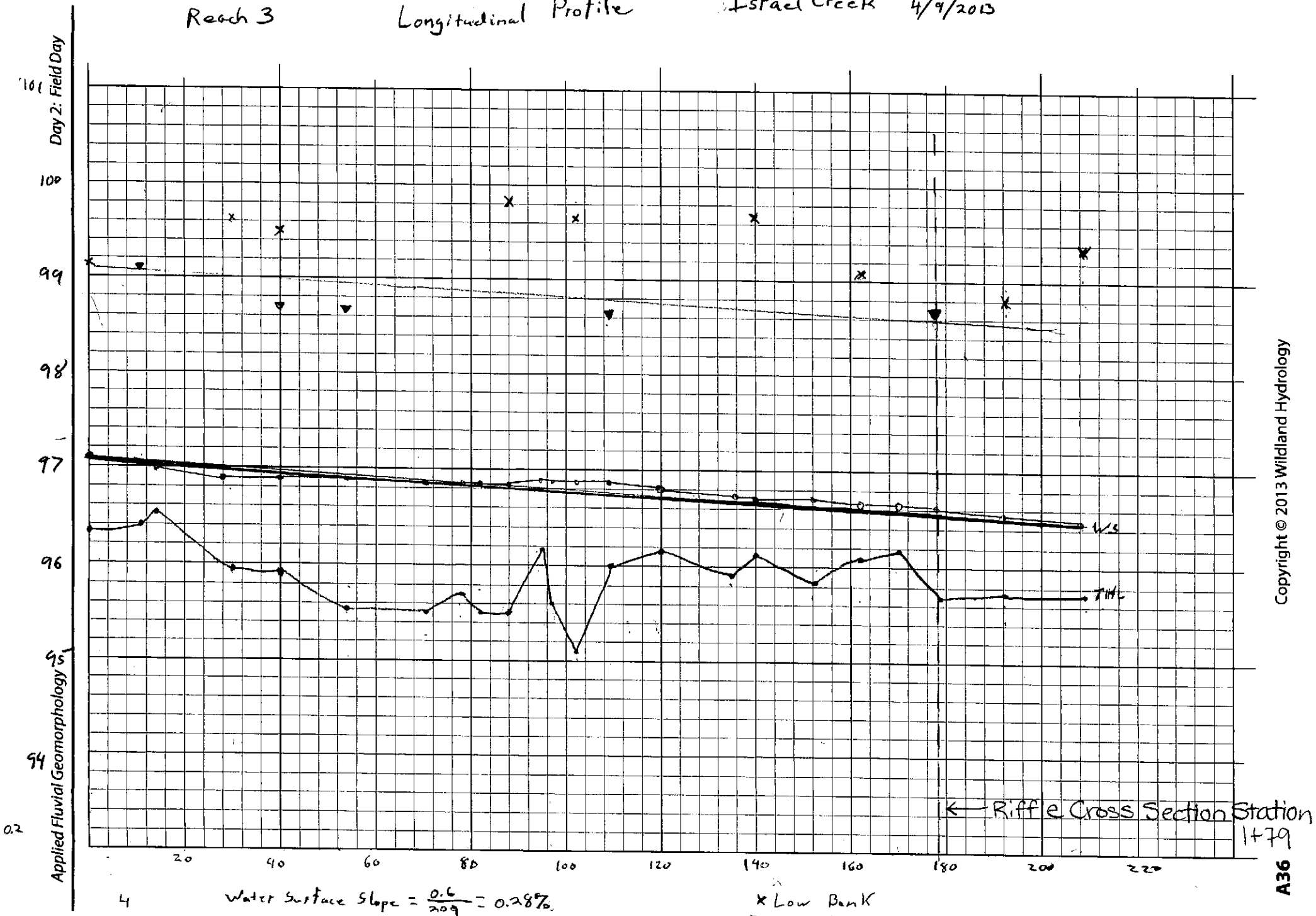
Team 3
Reach 3

Longitudinal Profile

Israel Creek 4/9/2013



4

Water Surface Slope = $\frac{0.6}{209}$ = 0.28%

BF - WS = 2.1

× Low Bank
▼ Bankfull
O Water Surface
• Thalweg

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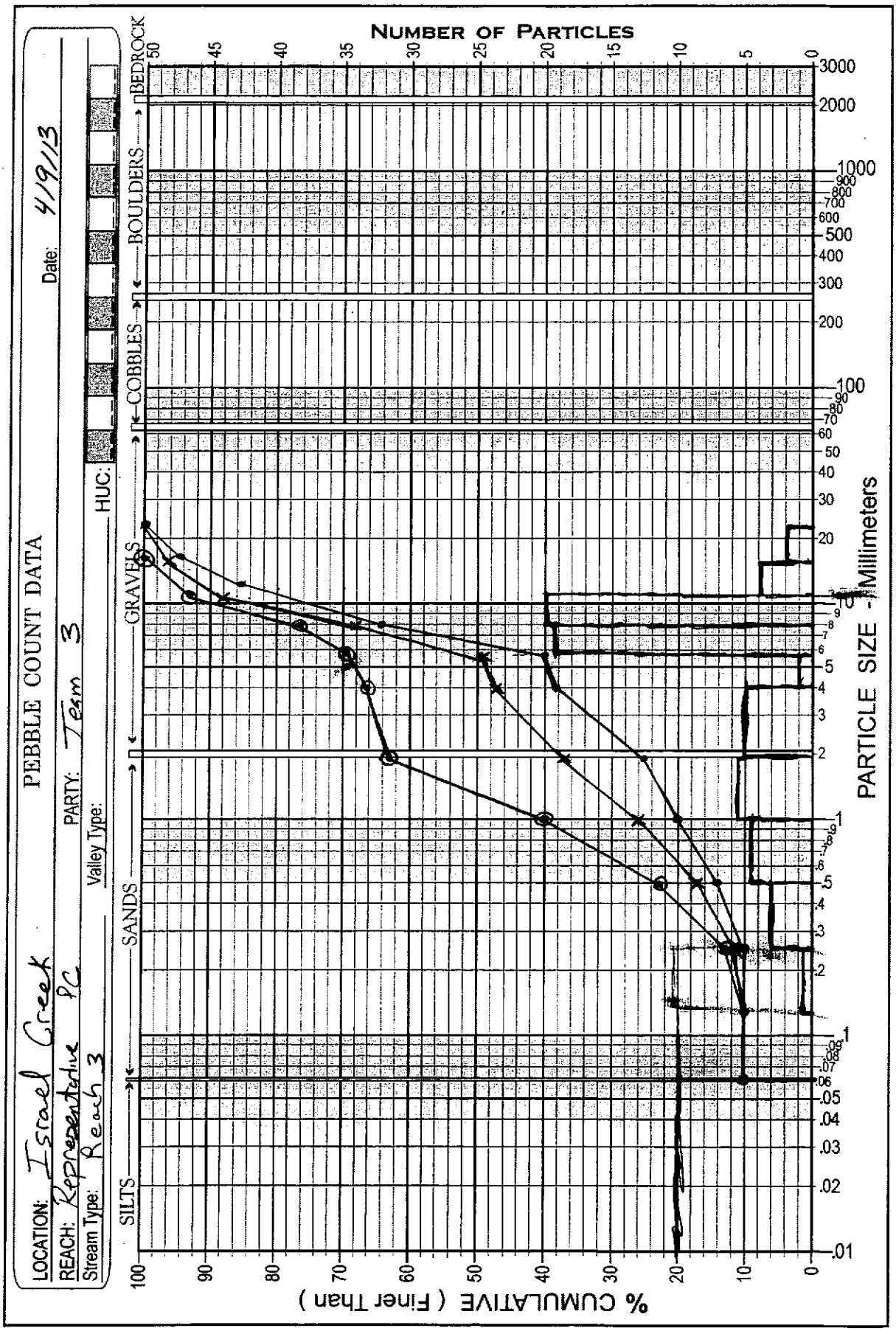

$D_{50} = 5.7$ mm

$D_{84} = 10$ mm

• Riffle
⊙ Pool
✕ Composite

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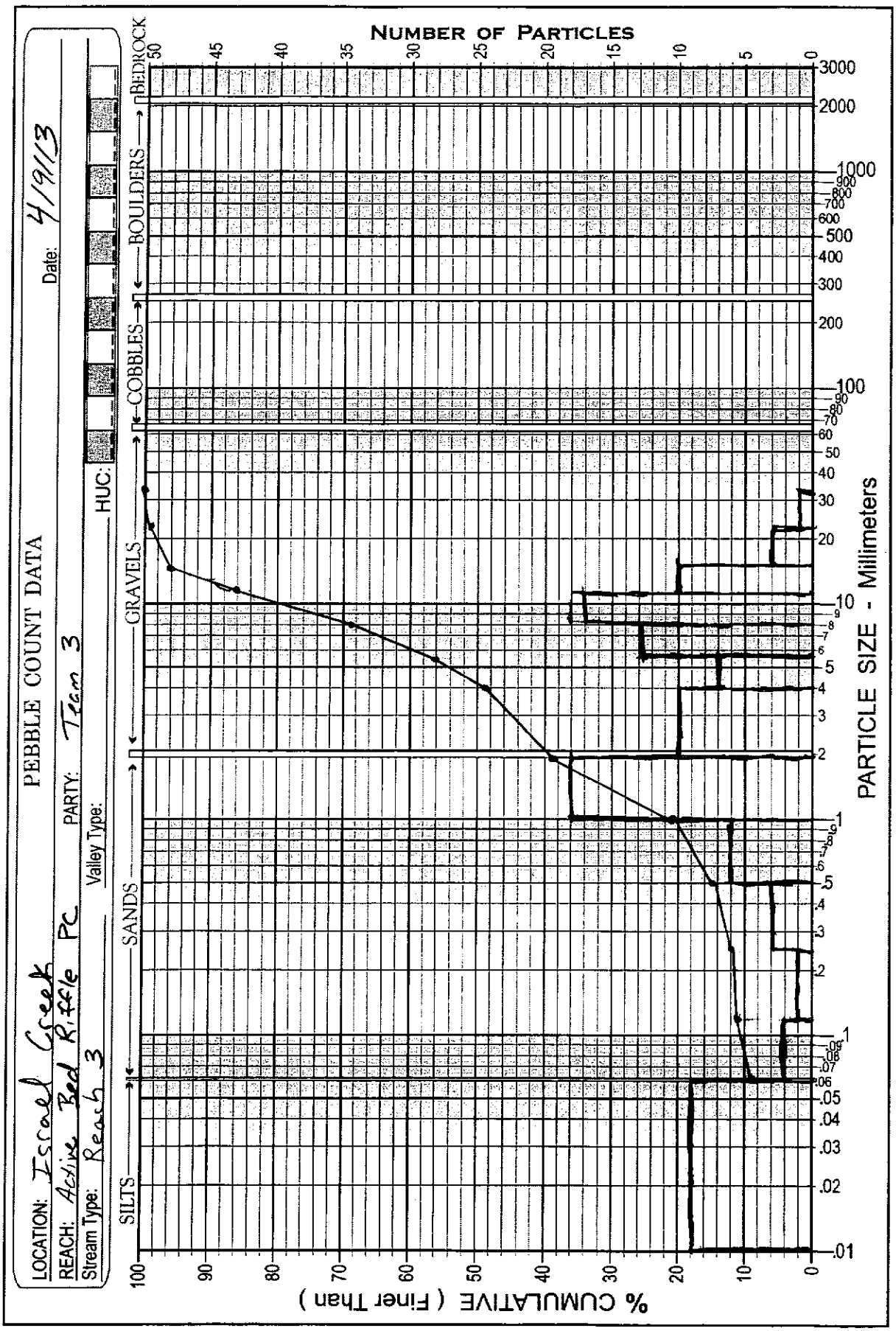

$D_{84} = 10.3$ mm

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0→52 = NP
52→116 = P
116→180 = NP

116' of NP / 70% = 7 transects
64' of P / 30% = 3 tsects

Site: Isral Crk Date: 4/9/13
Location: BFE, MD HUC:
Party: Team 3 / Reach 3

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				7	10	10	3	10	10	10	10	10
	Very Fine	.062 - .125	SAND				0	0	10	0	0	10	0	0	10
	Fine	.125 - .25	SAND				0	0	10	1	3.3	13.3	1	0	11
	Medium	.25 - .50	SAND				3	4.3	14.3	3	10	23.3	6	6	17
	Coarse	.50 - 1.0	SAND				4	5.7	20.0	5	16.7	40.0	9	9	26
.04 - .08	Very Coarse	1.0 - 2	SAND				4	5.7	25.7	7	23.3	63.3	11	11	37
.08 - .16	Very Fine	2 - 4	GRAVEL				9	12.9	38.6	1	3.3	66.6	10	10	47
.16 - .22	Fine	4 - 5.7	GRAVEL				1	1.4	40	1	3.3	69.9	2	2	49
.22 - .31	Fine	5.7 - 8	GRAVEL				17	24.3	64.3	2	6.7	76.6	19	19	68
.31 - .44	Medium	8 - 11.3	GRAVEL				15	21.4	85.7	5	16.7	93.3	20	20	88
.44 - .63	Medium	11.3 - 16	GRAVEL				6	8.6	94.3	2	6.7	100	8	8	96
.63 - .89	Coarse	16 - 22.6	GRAVEL				4	5.7	100	0	0	100	4	4	100
.89 - 1.3	Coarse	22.6 - 32	GRAVEL				0	—	—	0	0	100	0	0	100
1.3 - 1.8	Very Coarse	32 - 45	GRAVEL												
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												
7.1 - 10.1	Large	180 - 256	COBBLE												
10.1 - 14.3	Small	256 - 362	BOULDER												
14.3 - 20	Small	362 - 512	BOULDER												
20 - 40	Medium	512 - 1024	BOULDER												
40 - 80	Large-Vry Large	1024 - 2048	BOULDER												
	Bedrock		BDRK												
Stream Type:			**Valley Type:**			TOTAL→	170			30			100		

Tape along RB
Bank sample on even #'s
Sampled LB→RB

Bank samples ⊓ silt

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Site: Israel Creek Date: 4/9/13
Location: Active Bed Riffle HUC:
Party: Team 3 / Reach 3

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				9	9%	9%						
	Very Fine	.062 - .125	SAND				2	2%	11%						
	Fine	.125 - .25	SAND				1	1%	12%						
	Medium	.25 - .50	SAND				3	3%	15%						
	Coarse	.50 - 1.0	SAND				6	6%	21%						
.04 - .08	Very Coarse	1.0 - 2	SAND				18	18%	39%						
.08 - .16	Very Fine	2 - 4	GRAVEL				10	10%	99%						
.16 - .22	Fine	4 - 5.7	GRAVEL				7	7%	56%						
.22 - .31	Fine	5.7 - 8	GRAVEL				13	13%	69%						
.31 - .44	Medium	8 - 11.3	GRAVEL				17	17%	86%						
.44 - .63	Medium	11.3 - 16	GRAVEL				10	10%	96%						
.63 - .89	Coarse	16 - 22.6	GRAVEL				3	3%	99%						
.89 - 1.3	Coarse	22.6 - 32	GRAVEL				1	1%	100%						
1.3 - 1.8	Very Coarse	32 - 45													
1.8 - 2.5	Very Coarse	45 - 64													
2.5 - 3.5	Small	64 - 90	COBBLE												
3.5 - 5.0	Small	90 - 128	COBBLE												
5.0 - 7.1	Large	128 - 180	COBBLE												
7.1 - 10.1	Large	180 - 256	COBBLE												
10.1 - 14.3	Small	256 - 362	BOULDER												
14.3 - 20	Small	362 - 512	BOULDER												
20 - 40	Medium	512 - 1024	BOULDER												
40 - 80	Large-Vry Large	1024 - 2048	BOULDER												
	Bedrock		BDRK												
Stream Type:			**Valley Type:**			TOTAL→	100								

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Worksheet A-1. Field Form for Level II Stream Classification.

Stream: Israel Creek	
Basin: —	Drainage Area: 3424 acres 5.35 mi^2
Location: Washington Co., Md	
Twp.&Rge: —	Sec.&Qtr.: —
Cross-Section Monuments (Lat./Long.): —	Date: 4/9/13
Observers: Team 3 / Reach 3	Valley Type: VIIIc

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	18.1	ft
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A_{bkf} / W_{bkf}$).	1.99	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	36.0	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	9.0955	ft/ft
Maximum DEPTH (d_{max}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	3.05	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.	200	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	11.05	ft/ft
Channel Materials (Particle Size Index) D_{50} The D_{50} particle size index represents the median or dominant diameter of channel materials, as sampled proportionately from the channel surface, between the bankfull stage and Thalweg elevations.	[redacted]	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.	0.0028	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 (S_{val} / S).	1.48	

Stream Type [redacted] **See Classification Key (Figure A-2)**

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Worksheet A-2. Computations of velocity and discharge using various methods.

Bankfull VELOCITY & DISCHARGE Estimates

Stream:	Israel Creek	Location:	Washington County, MD
Date:	4/9/13	Stream Type:	C4/5
Valley Type:	VIIIc		
Observers:	Team 3 / Reach 3	HUC:	-- -- -- -- -- -- -- -- -- -- --

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional AREA	36.0	A_{bkf} (ft²)	Bankfull Riffle Mean DEPTH	1.99	d_{bkf} (ft)
Bankfull Riffle WIDTH	18.1	W_{bkf} (ft)	Wetted PERIMETER ~ $(2 * d_{bkf}) + W_{bkf}$	22.08	W_p (ft)
D_{84} at Riffle	10.3	Dia. (mm)	D_{84} (mm) / 304.8	0.0338	D_{84} (ft)
Bankfull SLOPE	0.0028	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	1.63	R (ft)
Gravitational Acceleration	32.2	g (ft / sec²)	Relative Roughness R(ft) / D_{84} (ft)	48.225	R / D_{84}
Drainage Area	5.35	DA (mi²)	Shear Velocity $u^* = (gRS)^{1/2}$	0.383	u^* (ft/sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $\bar{u} = [2.83 + 5.66 * Log\{R / D_{84}\}] u^*$	4.7	ft / sec	169.2	cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor / Relative Roughness (Figs. A-28, A-29) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ .025	4.37	ft / sec	157.25	cfs
2. Roughness Coefficient: b) Manning's n from Stream Type (Fig. A-30) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$ .040	2.73	ft / sec	98.28	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 $n =$ .0386	2.83	ft / sec	101.8	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 = N/A year	no gage ~~4.72~~	ft / sec	N/A ~~170~~	cfs
4. Continuity Equations: b) Regional Curves $\bar{u} = Q / A$	4.72	ft / sec	170	cfs

[illegible]

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 A-3. Summary of Morphological Variables.

Stream: Israel Creek		Location:	
Team: 3 Reach 3	Date: 4/9/13	Drainage Area: 3,424	

Riffle Channel Dimensions

1. Bankfull Width (W_{bkf}) (ft)	18.1	2. Bankfull Mean Depth (d_{bkf}) (ft)	1.99
3. Width/Depth Ratio (W_{bkf} / d_{bkf})	9.0955	4. Bankfull Cross-Sectional Area (A_{bkf}) (ft^2)	36.0
5. Bankfull Maximum Depth (d_{max}) (ft)	[illegible]	6. Width of Flood-Prone Area (W_{fpa}) (ft)	200
7. Entrenchment Ratio (ER) (W_{fpa} / W_{bkf})	11.05		

Channel Pattern / ***Dimensionless Ratios***

8. Belt Width (W_{blt}) (ft)	Mean	72.6	9. Meander Width Ratio (MWR) (W_{blt} / W_{bkf})	Mean	4.01
	Min	56.8		Min	3.14
	Max	89.4		Max	4.94
10. Stream Meander Length (L_m) (ft)	Mean	211.75	11. Meander Length Ratio (MLR) (L_m / W_{bkf})	Mean	11.7
	Min	167		Min	9.23
	Max	251		Max	13.87
12. Linear Wavelength (λ) (ft)	Mean	103.475	13. Linear Wavelength to Bankfull Width (λ / W_{bkf})	Mean	5.72
	Min	40.5		Min	2.34
	Max	166.2		Max	9.18
14. Radius of Curvature (R_c) (ft)	Mean	24.02	15. Radius of Curvature to Bankfull Width (R_c / W_{bkf})	Mean	1.33
	Min	13.65		Min	0.75
	Max	30.1		Max	1.66

Channel Particles

Representative Pebble Count

16. D_{16} (mm)	0.42	17. D_{35} (mm)	1.7	18. D_{50} (mm)	5.7
19. D_{84} (mm)	10.0	20. D_{95} (mm)	15	21. D_{100} (mm)	22

Active Bed Riffle Pebble Count

22. D_{16} (mm)	0.55	23. D_{35} (mm)	0.7	24. D_{50} (mm)	5.4
25. D_{84} (mm)	10.3	26. D_{95} (mm)	10.5	27. D_{100} (mm)	30.3

Classification

28. Sinuosity (k)	1.48	29. Average Water Surface Slope (S)	0.0028
30. Stream Type	C4/5	31. Valley Type	~~VIII~~ C

Velocity & Discharge

32. Friction Factor ($\bar{u}$ / u^*)	12.74	33. Relative Roughness (R / D_{84})	48.225
34. Manning's 'n' from Friction Factor / Relative Roughness	0.0325	35. Manning's 'n' from Stream Type	0.090
36. Estimated Bankfull Mean Velocity ($\bar{u}_{bkf}$) (ft/sec)	4.7	37. Estimated Bankfull Discharge (cfs)	169.2
38. Estimation Method Selected for Velocity & Discharge	Friction Factor		

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