Zacks Fork Creek
Stream Restoration Monitoring Report

Monitoring Year: 2006
Measurement Year: 1
As-Built Date: 2005
NCEEP Project #: AW03003A

Submitted on January 2, 2007

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1619 Mail Service Center
Raleigh, NC 27299-1619

Prepared by: Environmental Services, Inc.
3661 Alamance Road
Burlington, NC 27215

Original Design: FMSM
1901 Nelson Miller Parkway
Louisville, KY 40223

Zacks Fork Creek
Year 1 (2006) Monitoring Report

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I. Executive Summary

This stream restoration encompasses approximately 3,900 linear feet of a reach that had become incised and degraded due to hydrologic alteration secondary to land use changes in the watershed. The project seeks to establish a more suitable morphology to the reach through a combination of natural channel design, grade-control structures and excavation of a bankfull bench.

This initial assessment indicates that the hydrology of the restored reach is functioning within design specifications. The dimension, pattern and profile data collected post-construction remain within the designed Rosgen stream type parameters. Six minor stream problem areas were identified, associated with mid-bars or displacement of erosion-control matting. One of the 28 total grade-control structures has partial flow piping through the vane arms.

The Year-1 assessment of vegetation indicates successful initial establishment of planted specimens. Although baseline counts were not available for direct quantification of survival rates, six woody species were identified within the sample plots and silky willow, *Salix sericea*, was noticeably vigorous where it has been live-staked into banks. Five discrete and limited vegetative problem areas were noted, where erosion control matting is displaced.

II. Project Background

The project site is located in Caldwell County to the north of Lenoir on Zacks Fork Road, adjacent to a municipal soccer field complex (Figure 1). The surrounding land use includes residential developments within the watershed to the north and east of the site that have likely altered the hydrologic regimen, resulting in higher peak events as evidenced by down-cutting and bank erosion Restoration was undertaken in 2004-5, a more complete description of the project background and design is given in "Geomorphologic Assessment & Stream Restoration Preliminary Design Report" prepared by FMSM Engineers. The as-built plan view of the entire project area is presented in Figure 2.

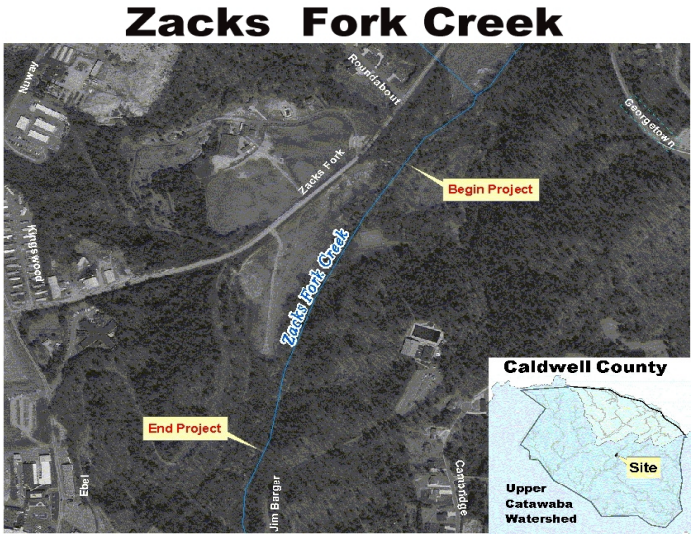

Figure 1. Zacks Fork Creek Location Map

Table 1. Project Mitigation Structure	
Project Segment or Reach ID	Linear Footage or Acreage
Reach I	3,900 lf

Table 2: Project Background	
Project County	Caldwell
Drainage Area	12.3 square miles
Rosgen Classification of As-Built	C
Dominant Soil Types	Chewacla
Reference Site ID	
USGS HUC for Project and Reference	
NCDWQ Sub-Basin for Project and Reference	03050101-027
NCDWQ Classification for Project and Reference	
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	-
% of project easement fenced	0

Table 3. Project Contacts	Firm Address, Phone, Contact
Designer FMSM Engineers Attn: George Athanasakes, PE	1901 Nelson Miller Parkway Louisville, KY 40223 (502) 212-5000
Construction Contractor Environmental Services, Inc. Attn: Steve Jones	1980-A Parker Court Stone Mountain, GA 30087 (770) 736-9101
Planting Contractor Coastal Plain Conservation Nursery Attn: Ellen Colodney	3067 Conners Drive Edenton, NC 27932 (252) 482-5707
Seeding Contractor Environmental Services, Inc. Attn: Steve Jones	1980-A Parker Court Stone Mountain, GA 30087 (770) 736-9101
Vegetation Monitoring Environmental Services, Inc. Attn: Charles Johnston	3661 Alamance Road Burlington NC 27215 (336) 570-3002
Stream Monitoring Environmental Services, Inc. Attn: Matthew O'Brien	3661 Alamance Road Burlington NC 27215 (336) 570-3002

Figure 2

Figure 3

Figure 4

III. Project Condition and Monitoring Results

A. Vegetation Assessment

As specified by the guidelines in *Content, Format and Data Requirements for EEP Monitoring Reports*, upon completion of stream construction eleven vegetation sampling plots (10m x 10m) were staked at intervals in the riparian zone of the project reach. Planting was done on a per-acre scale using a combination of live stakes, containerized plants and seeding. Baseline counts for the individual sampling plots were not assessed or recorded at the time of planting. Year-1 vegetative assessments were performed on December 12, 2006. Results are given in Tables 4 and 5. As Chewacla loam is the only mapped soil series within floodplain of the project, direct on-site soil sampling was not done in the 1st year's assessment. The spatial location of the vegetation sampling plots is given in Figure 4. Photographs of sampling plots are contained in Appendix C; all shots were taken from the outer downstream corners of the plots.

This Year-1 evaluation of vegetation in the riparian zone of the Zacks Fork project indicates successful initial establishment of planted specimens. Within the sampling plots the cumulative total of stems counted was 159, or a mean of 14.5 stems/plot, encompassing six different woody species. Stem counts were generally higher in those plots immediately adjacent to or encompassing the bankfull margins; these areas evidenced good establishment of silky willow (*Salix sericea*) which had been live-staked into bank matting. This species accounts for almost 70% of the cumulative total. The plots located in the floodplain generally had fewer specimens, primarily containerized trees which had been appropriately planted more thinly. The spatial distribution of the plots along a gradient from water's edge to upper floodplain results in correspondingly wide ranges among individual plots in both number (1 – 35 stems/plot) and diversity (1 – 6 spp/plot). Numerous individuals of other planted species were observed at bankside and in the floodplain of the project area. Successful reestablishment of grasses, sedges and herbs is reflected in >85% ground coverage rates for each sampling plot.

Several problem areas have been identified (Table 4, Figure 3) where erosion control matting is inadequately re-vegetated, undercut on outer bends, and/or displaced into the streambed. In these areas, the primary recommendation is to re-secure or replace the matting. Additional planting of willow live-stakes in these areas would help to establish longer-term bank stabilization.

Table 4. Vegetative Problem Areas

Feature/Issue	Station#/Range	Probable Cause	Photo #
Bare Bank	21+00 – 21+50	Needs additional live stakes	24
	23+00 – 21+75	Needs additional live stakes	
Displaced EC Matting	17+50 – 17+80	Not adequately secured.	17
	20+50 – 21+00	Not adequately secured.	
	27+00 – 27+25	Not adequately secured.	

Table 5. Stem counts for each species arranged by plot.

Species	Plot #											Species Totals	Survival %
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**		
Alnus serrulata	2	6	4	0	3	1	1	0	3	2	2	24	na
Sambucus canadensies	0	0	0	0	2	1	1	0	3	2	1	10	na
Cornus samomun	0	0	0	0	0	0	2	0	0	0	0	2	na
Platanus occidentalis	0	1	1	0	2	0	1	1	0	0	0	6	na
Salix sericea	21	0	24	35	0	0	14	0	5	0	10	109	na
Betula nigra	0	0	0	0	1	1	1	0	0	0	0	3	na
Stems / Plot	23	7	29	35	8	3	20	1	11	4	13		
Spp. / Plot	2	2	3	1	4	3	6	1	3	2	3		
Est. % Cover	90	100	100	100	85	100	80	85	100	95	100		

B. Stream Assessment

This stream restoration incorporates 28 in-stream grade-control structures such as cross vanes, J-hooks, and log vanes. Root wads, erosion control matting, and rip-rap have also been used at appropriate points for bank stabilization. In December, 2006 the Year-1 monitoring assessment collected hydraulic performance parameters which include longitudinal profile, cross-sectional profiles, pebble counts, and visual stability assessment. Spatial locations of grade-control structures and problem areas are depicted in Figure 3; the locations of cross-sections and structure photo stations are shown in Figure 4. Longitudinal and cross-sectional profiles are given in graphical and tabular form in Appendix A. Photographs are contained in Appendix B, arranged sequentially moving downstream and shooting upstream.

In this Year-1 assessment, the overall hydrology appears to functioning within design specifications. There is good development of scour pools and riffle runs, thalweg alignment, sediment sorting, bank re-vegetation, and stability of installed structures. For the entire reach, only seven total stream problem areas were identified, only one of which is associated with a grade-control structure. Longitudinal and cross-sectional profiles reveal that the restored reach is functioning in a stable manner. There is minimal stream bed aggradation and the pools appear to be cleaning out sediment adequately. The dimension, pattern and profile data collected post-construction remain within the designed Rosgen stream type parameters

Pebble counts of the restored reach show adequate sorting of bed materials within the constructed and naturalized riffles. The visual assessment of the entire restored reach show a well-established riparian vegetative community, in-stream habitat development and functioning grade-control structures. Evidence of functioning structures is demonstrated by the deposition of fine silt/sediment on the upstream side of cross-vane, log vane and j-hook arms.

Table 6. Stream Problem Areas

Feature Issue	Station #	Suspected Cause	Photo #
Aggradation/Bar Formation	13+50	Mid-stream bar	6
	16+50	Mid-stream bar	
Bank Scour	23+00	Water velocity	29
	26+50	Thalweg migration	
	33+50	Water velocity	
	34+25	Water velocity	
Structure Scour/Piping	36+00	Inadequate EC matting	44, 45

Table 7. Summary of Cross-Sectional Morphology						
	Cross-Section	**1 - pool**	**2 - riffle**	**3 -pool**	**4 -riffle**	**5 - pool**
DIMENSION	BF Width (ft)	30	24	30	27	31
	Floodprone Width (ft)	-	80	-	70	-
	BF Cross-sectional area (sq.ft)	126	49	97	36	131
	BF Mean Depth (ft)	4.2	2.0	3.3	1.4	4.3
	BF Max Depth (ft)	6.7	2.7	4.7	2.4	8.1
	Width/Depth Ratio	-	12.1	-	19.8	-
	Entrenchment Ratio	-	3.3	-	2.6	-
	Wetted Perimeter (ft)	34	26	32	28	37
	Hydraulic Radius (ft)	3.7	1.9	3.0	1.3	3.5
SUBSTRATE	D50 (mm)	2.0	7.3	0.2	18.8	128.0
	D84 (mm)	26	26	676	294	326
	Cross-Section	**6 - pool**	**7 - riffle**	**8 -pool**	**9 -riffle**	**10 - pool**
DIMENSION	BF Width (ft)	25	30	16	28	19
	Floodprone Width (ft)	-	120	-	NA	-
	BF Cross-sectional area (sq.ft)	76	51	28	20	44
	BF Mean Depth (ft)	3.0	1.7	1.8	0.7	2.3
	BF Max Depth (ft)	5.1	2.7	3.9	1.4	3.7
	Width/Depth Ratio	-	17.9	-	39.1	-
	Entrenchment Ratio	-	4.0	-	NA	-
	Wetted Perimeter (ft)	28	41	18	29	20
	Hydraulic Radius (ft)	2.7	1.6	1.6	0.7	2.2
SUBSTRATE	D50 (mm)	0.2	45.0	0.4	64.0	0.4
	D84 (mm)	461	84	9	119	18

Table 8. Summary of Reach Morphology				
		Min	Max	Med
PATTERN	Channel Beltwidth (ft)	70	150	110
	Radius of Curvature (ft)	-	-	-
	Meander Wavelength (ft)	180	300	240
	Meander Width Ratio	6.9	11.5	9.2
PROFILE	Riffle Length (ft)	30	120	75
	Riffle Slope (ft/ft)	0.005	0.015	0.010
	Pool Length (ft)	20	75	48
	Pool Spacing (ft)	10	375	193

Table 9. Visual Morphological Stability Assessment						
Feature Category	**Metric**	**# Stable**	**# per As-built**	**LF of unstable state**	**% Stable**	**Feature Mean %**
A. Riffles	1. Present?	20	22	≈30	91	
	2. Armor stable?	22	22	0	100	
	3. Facet grade appears stable?	22	22	0	100	
	4. Minimal evidence of embedding/fining?	22	22	0	100	
	5. Length appropriate?	22	22	0	100	**98%**
B. Pools	1. Present?	28	28	0	100	
	2. Sufficiently deep (maxD:mean bkfl >1.6?	28	28	0	100	
	3. Length appropriate?	100	100	100	100	**100%**
C. Thalweg	1. Upstream of meander bend centering?	14	17	≈90	82	
	2. Downstream of meander centering?	15	17	≈60	88	**85%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	8	11	≈90	73	
	2. If eroding, # with concomitant bar formation?	2	NA	2	100	
	3. Apparent Rc within specifications?	11	11	0	100	
	4. Sufficient floodplain access and relier?	11	11	0	100	**93%**
E. Bed	1. General channel bed aggradation areas?	20	22	≈60	91	
	2. Channel bed degradations (downcuts/headcuts)?	0	0	0	100	**96%**
F. Vanes	1. Free of back or arm scour?	27	28	0	96	
	2. Height appropriate?	28	28	0	100	
	3. Angle and geometry appear appropriate	28	28	0	100	
	4. Free of piping or other structural failures?	27	28	≈20	96	**98%**
G. Wads/Boulders	1. Free of scour?	6	8	≈60	75	
	2. Footing stable?	8	8	0	100	**88%**

Table 10. Categorical Stream Feature Visual Stability Assessment						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	NA	98%				
B. Pools	NA	100%				
C. Thalweg	NA	85%				
D. Meanders	NA	93%				
E. Bed General	NA	96%				
F. Structures	NA	98%				
G. Wads/Boulders	NA	88%				

VI. Methodology and References

Field work was performed using usual and customary methods based on U.S. Army Corps of Engineers and N.C. Division of Water Quality guidelines. Data analysis was done using Microsoft Excel and other non-proprietary software.

References include but are not limited to:

USACOE. (2003) *Stream Mitigation Guidelines*. .

NCDWQ (2005) *Content, Format and Date Requirements for EEP Monitoring Reports*

D.L. Rosgen. *Applied River Morphology*. (1996) Wildland Hydrology, Pagosa Springs CO.

ZACKS FORK STREAM RESTORATION
APPENDIX C
YEAR 1 (2006) VEGETATIVE PLOT PHOTOS

Photo Station 1

Photo Station 2

Photo Station 3

Photo Station 4

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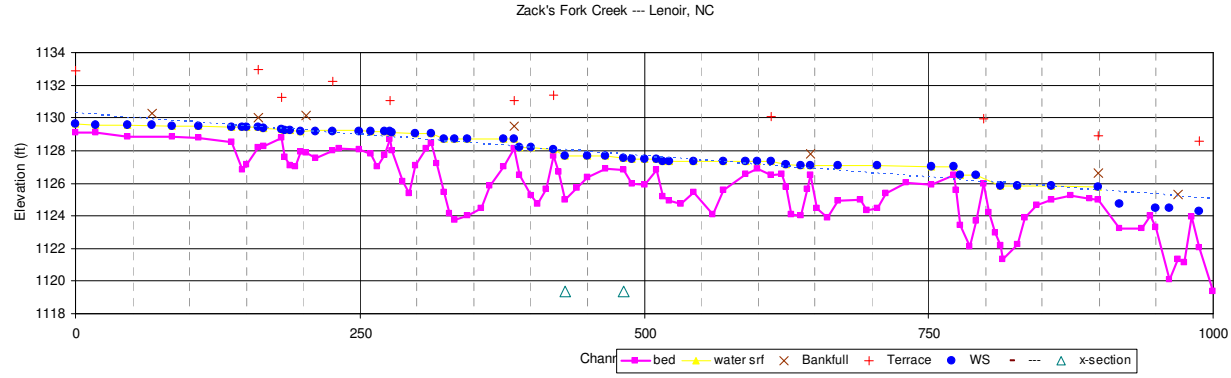
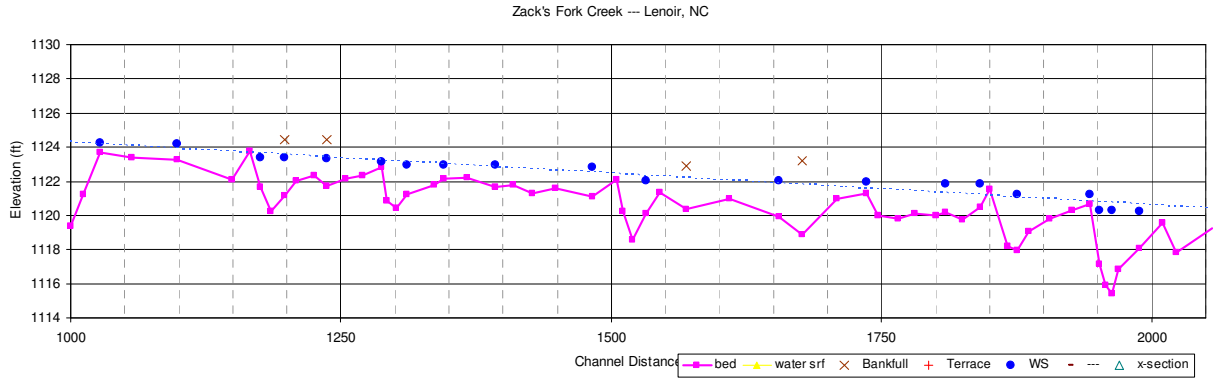
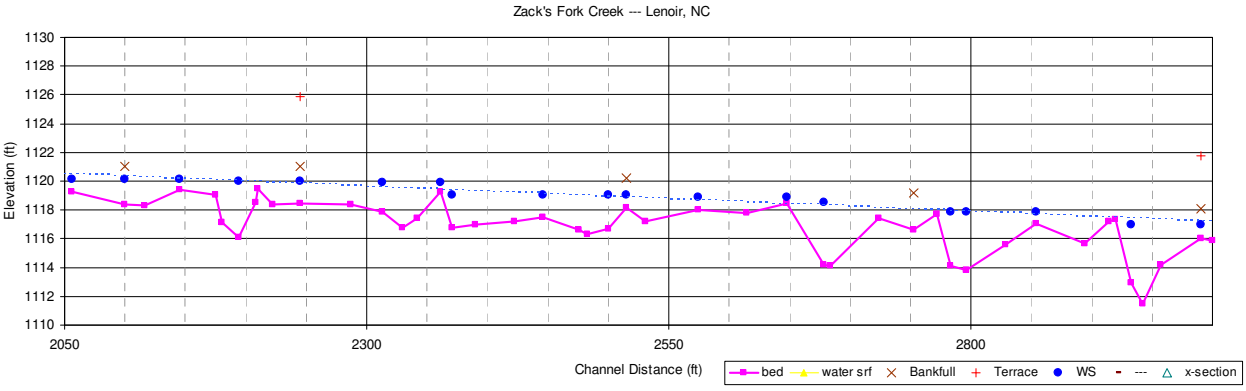
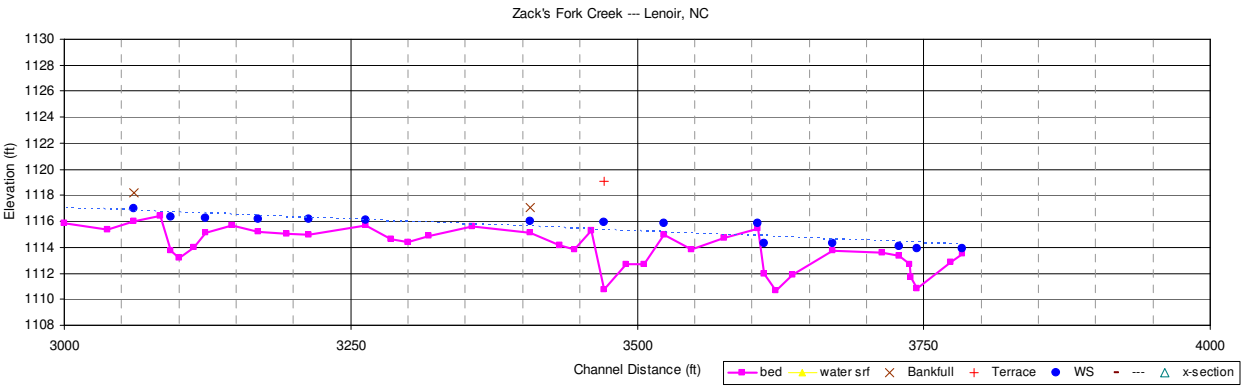
Photo Station 48

Zacks Fork Creek, Year 1 (2006) Monitoring Report
APPENDIX A

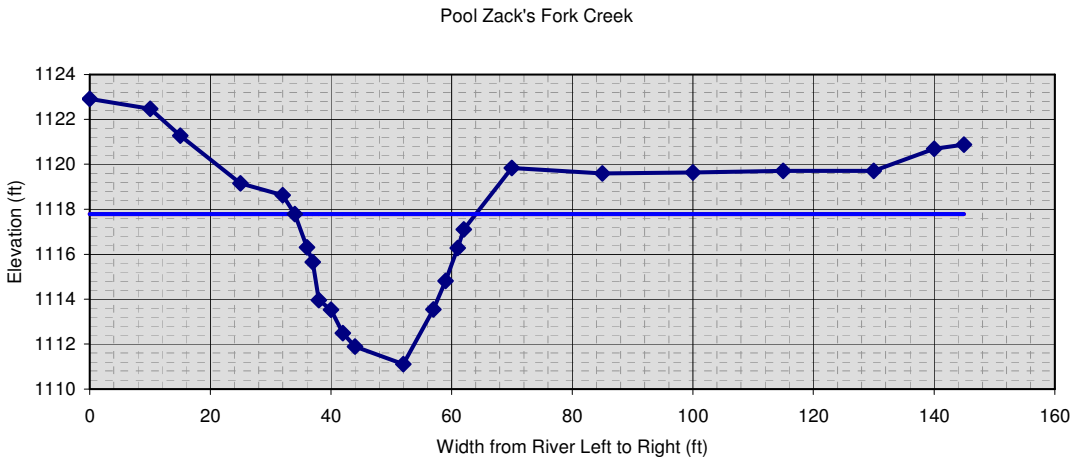








Cross Section



section:	
	Pool Zack's Fork Creek ---
description:	XS-1 POOL
height of instrument (ft):	1129.33

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	6.43	1122.9
	☐	10	6.86	1122.47
	☐	15	8.06	1121.27
	☐	25	10.17	1119.16
TOB	☐	32	10.7	1118.63
BKF	☐	34	11.55	1117.78
REW	☐	36	13.02	1116.31
	☐	37	13.67	1115.66
	☐	38	15.38	1113.95
	☐	40	15.8	1113.53
	☐	42	16.85	1112.48
TWG	☐	44	17.43	1111.9
	☐	52	18.22	1111.11
	☐	57	15.79	1113.54
	☐	59	14.52	1114.81
LEW	☐	61	13.05	1116.28
	☐	62	12.23	1117.1
	☐	70	9.5	1119.83
	☐	85	9.73	1119.6
	☐	100	9.7	1119.63
	☐	115	9.62	1119.71
	☐	130	9.62	1119.71
	☐	140	8.64	1120.69
	☐	145	8.46	1120.87
	☐			

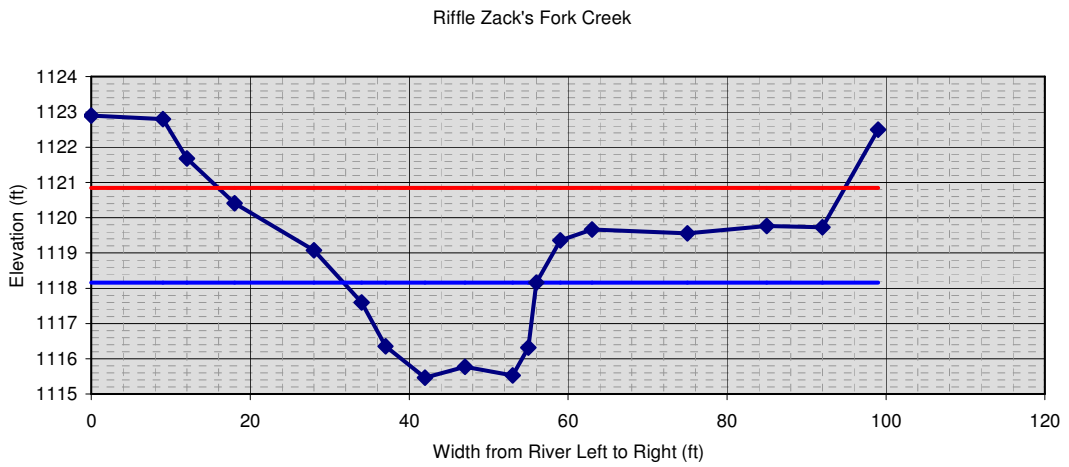
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
11.55	10.7			
1117.78	1118.63			

dimensions			
126.0	x-section area	4.2	d mean
30.0	width	33.9	wet P
6.7	d max	3.7	hyd radi
7.5	bank ht	~~7.1~~	w/d ratio
~~0.0~~	W flood prone area	~~0.0~~	ent ratio

hydraulics	
~~0.0~~	velocity (ft/sec)
~~0.0~~	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
~~0.000~~	unit stream power (lbs/ft/sec)
~~0.00~~	Froude number
~~0.0~~	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
~~26~~	measured D84 (mm)		
~~50.1~~	relative roughness	~~12.5~~	fric. factor
~~0.000~~	Manning's n from channel material		

Cross Section



section:	
	Riffle Zack's Fork Creek ---
description:	XS-2 Riffle
height of instrument (ft):	1129.33

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	6.43	1122.9
TOB	☐	9	6.53	1122.8
	☐	12	7.65	1121.68
	☐	18	8.92	1120.41
	☐	28	10.25	1119.08
	☐	34	11.73	1117.6
REW	☐	37	12.98	1116.35
TWG	☐	42	13.86	1115.47
	☐	47	13.55	1115.78
	☐	53	13.8	1115.53
LEW	☐	55	13.01	1116.32
BKF	☐	56	11.17	1118.16
TOB	☐	59	9.97	1119.36
	☐	63	9.66	1119.67
	☐	75	9.77	1119.56
	☐	85	9.57	1119.76
	☐	92	9.6	1119.73
EIP	☐	99	6.83	1122.5
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

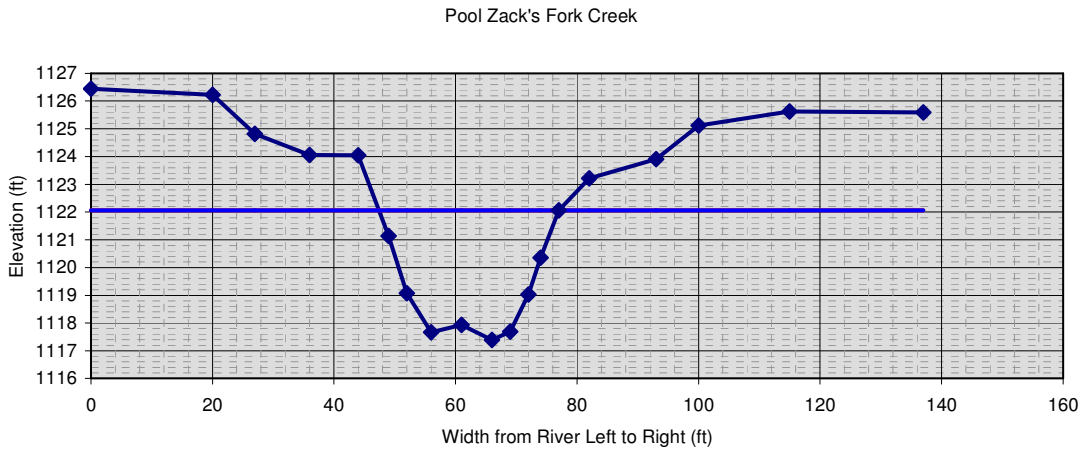
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
11.17	9.97			
1118.16	1119.36			

dimensions			
48.5	x-section area	2.0	d mean
24.3	width	25.9	wet P
2.7	d max	1.9	hyd radi
3.9	bank ht	12.1	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
26	measured D84 (mm)		
23.8	relative roughness	10.7	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	
	Pool Zack's Fork Creek ---
description:	XS-3 Pool
height of instrument (ft):	1131.74

notes	omit pt.	distance (ft)	FS (ft)	elevation
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	☐	20	5.51	1126.23
	☐	27	6.92	1124.82
	☐	36	7.68	1124.06
TOB	☐	44	7.69	1124.05
	☐	49	10.61	1121.13
REW	☐	52	12.67	1119.07
	☐	56	14.07	1117.67
	☐	61	13.8	1117.94
TWG	☐	66	14.35	1117.39
	☐	69	14.05	1117.69
LEW	☐	72	12.72	1119.02
	☐	74	11.38	1120.36
	☐	77	9.67	1122.07
	☐	82	8.52	1123.22
	☐	93	7.83	1123.91
	☐	100	6.62	1125.12
	☐	115	6.11	1125.63
	☐	137	6.15	1125.59
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

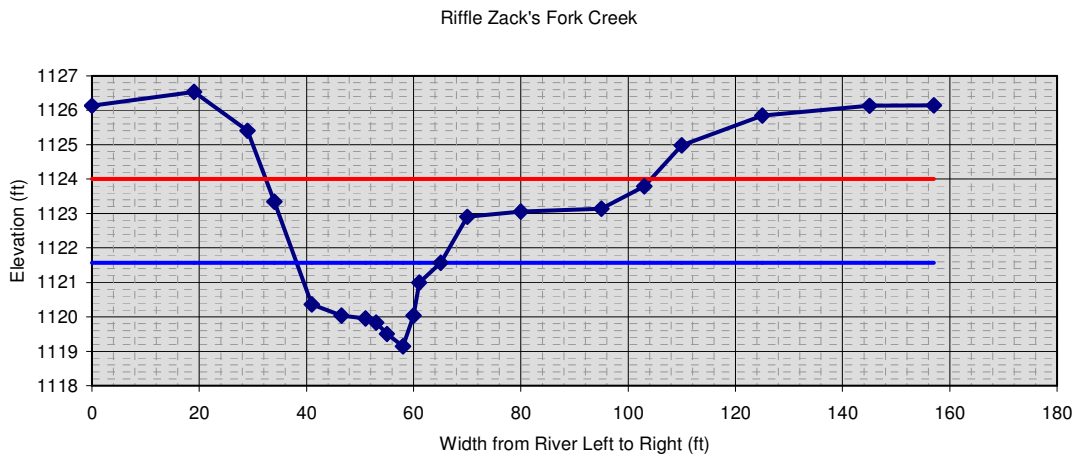
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
9.67	7.69			
1122.07	1124.05			

dimensions			
96.9	x-section area	3.3	d mean
29.6	width	31.9	wet P
4.7	d max	3.0	hyd radi
6.7	bank ht	~~9.0~~	w/d ratio
~~0.0~~	W flood prone area	~~0.0~~	ent ratio

hydraulics	
~~0.0~~	velocity (ft/sec)
~~0.0~~	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
~~0.000~~	unit stream power (lbs/ft/sec)
~~0.00~~	Froude number
~~0.0~~	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
~~26~~	measured D84 (mm)		
~~39.0~~	relative roughness	~~11.9~~	fric. factor
~~0.000~~	Manning's n from channel material		

Cross Section



section:	
	Riffle Zack's Fork Creek ---
description:	XS-4 RIFFLE
height of instrument (ft):	1131.74

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	5.61	1126.13
	☐	19	5.21	1126.53
TOB	☐	29	6.34	1125.4
	☐	34	8.4	1123.34
	☐	41	11.38	1120.36
REW	☐	46.5	11.7	1120.04
	☐	51	11.79	1119.95
	☐	53	11.91	1119.83
	☐	55	12.24	1119.5
TWG	☐	58	12.6	1119.14
LEW	☐	60	11.7	1120.04
	☐	61	10.75	1120.99
	☐	65	10.17	1121.57
TOB	☐	70	8.84	1122.9
	☐	80	8.68	1123.06
	☐	95	8.6	1123.14
	☐	103	7.95	1123.79
	☐	110	6.76	1124.98
	☐	125	5.9	1125.84
	☐	145	5.61	1126.13
	☐	157	5.6	1126.14
	☐			
	☐			
	☐			
	☐			

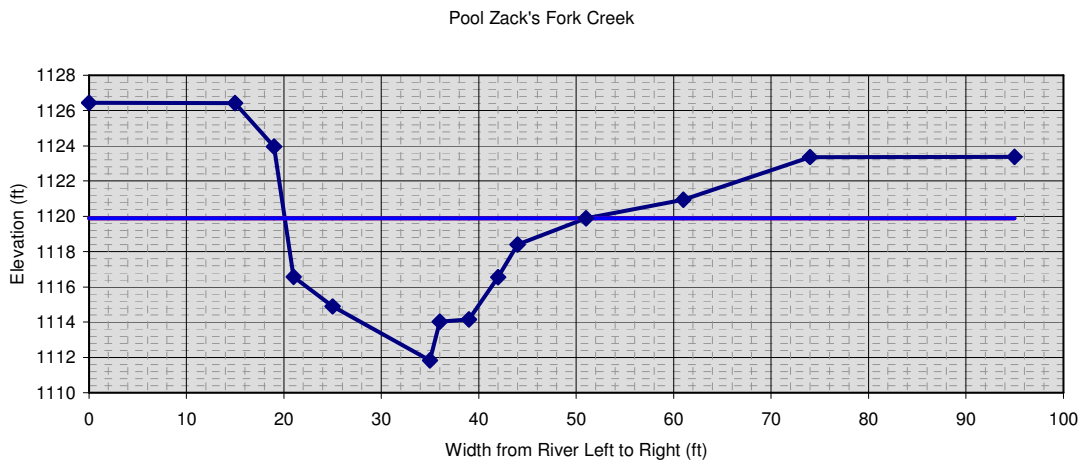
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
10.17	6.34			
1121.57	1125.4			

dimensions			
36.4	x-section area	1.4	d mean
26.8	width	27.8	wet P
2.4	d max	1.3	hyd radi
6.3	bank ht	19.8	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
26	measured D84 (mm)		
16.2	relative roughness	9.7	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	
	Pool Zack's Fork Creek ---
description:	XS-5 POOL
height of instrument (ft):	1133.73

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	7.29	1126.44
TOB	☐	15	7.31	1126.42
	☐	19	9.78	1123.95
REW	☐	21	17.16	1116.57
	☐	25	18.84	1114.89
	☐	35	21.9	1111.83
	☐	36	19.7	1114.03
	☐	39	19.56	1114.17
LEW	☐	42	17.18	1116.55
	☐	44	15.33	1118.4
	☐	51	13.84	1119.89
	☐	61	12.79	1120.94
	☐	74	10.37	1123.36
	☐	95	10.35	1123.38
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

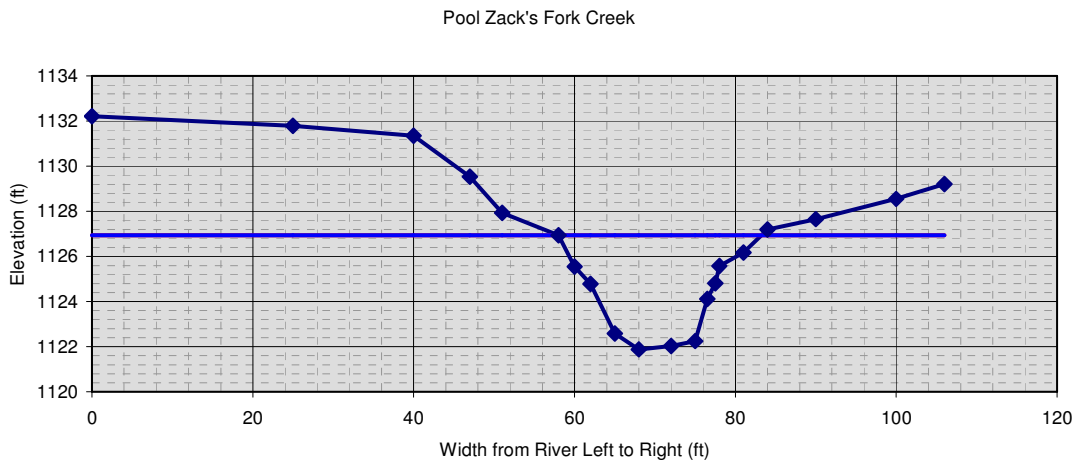
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
13.84	7.31			
1119.89	1126.42			

dimensions			
131.4	x-section area	4.3	d mean
30.9	width	37.4	wet P
8.1	d max	3.5	hyd radi
14.6	bank ht	~~7.3~~	w/d ratio
~~0.0~~	W flood prone area	~~0.0~~	ent ratio

hydraulics	
~~0.0~~	velocity (ft/sec)
~~0.0~~	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
~~0.000~~	unit stream power (lbs/ft/sec)
~~0.00~~	Froude number
~~0.0~~	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
~~26~~	measured D84 (mm)		
~~50.7~~	relative roughness	~~12.6~~	fric. factor
~~0.000~~	Manning's n from channel material		

Cross Section



section:	
	Pool Zack's Fork Creek ---
description:	XS-6 POOL
height of instrument (ft):	1135.74

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	3.52	1132.22
	☐	25	3.94	1131.8
TOB	☐	40	4.39	1131.35
	☐	47	6.21	1129.53
	☐	51	7.81	1127.93
BKF	☐	58	8.8	1126.94
	☐	60	10.19	1125.55
REW	☐	62	10.96	1124.78
	☐	65	13.15	1122.59
TWG	☐	68	13.86	1121.88
	☐	72	13.71	1122.03
	☐	75	13.49	1122.25
	☐	76.5	11.62	1124.12
LEW	☐	77.5	10.93	1124.81
	☐	78	10.17	1125.57
	☐	81	9.56	1126.18
TOB	☐	84	8.54	1127.2
	☐	90	8.09	1127.65
	☐	100	7.19	1128.55
	☐	106	6.53	1129.21
	☐			
	☐			
	☐			
	☐			
	☐			

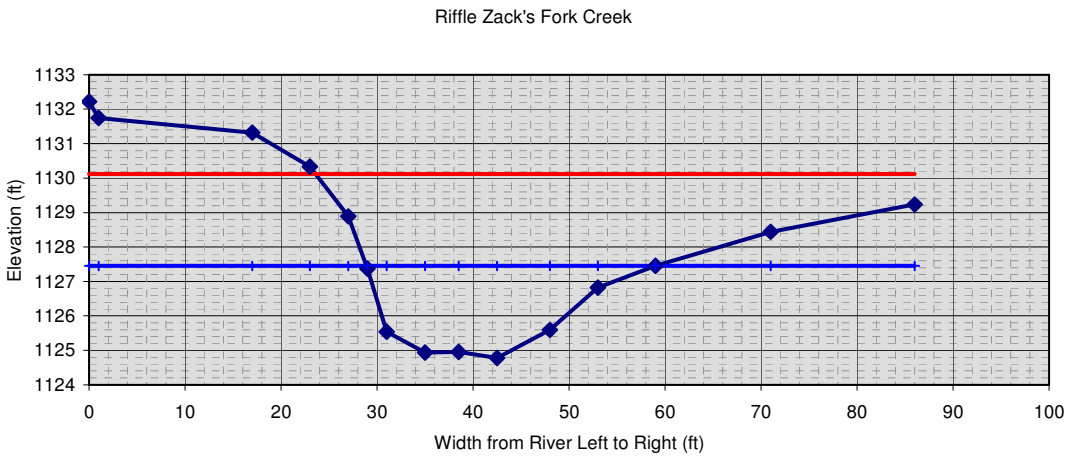
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
8.8	4.39			
1126.94	1131.35			

dimensions			
76.2	x-section area	3.0	d mean
25.2	width	28.3	wet P
5.1	d max	2.7	hyd radi
9.5	bank ht	~~8.4~~	w/d ratio
~~0.0~~	W flood prone area	~~0.0~~	ent ratio

hydraulics	
~~0.0~~	velocity (ft/sec)
~~0.0~~	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
~~0.000~~	unit stream power (lbs/ft/sec)
~~0.00~~	Froude number
~~0.0~~	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
~~26~~	measured D84 (mm)		
~~36.0~~	relative roughness	~~11.7~~	fric. factor
~~0.000~~	Manning's n from channel material		

Cross Section



section:	
	Riffle Zack's Fork Creek ---
description:	XS-7 RIFFLE
height of instrument (ft):	1135.74

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	3.52	1132.22
	☐	1	3.99	1131.75
	☐	17	4.42	1131.32
TOB	☐	23	5.41	1130.33
	☐	27	6.85	1128.89
	☐	29	8.37	1127.37
REW	☐	31	10.2	1125.54
	☐	35	10.8	1124.94
	☐	38.5	10.79	1124.95
	☐	42.5	10.96	1124.78
LEW	☐	48	10.15	1125.59
	☐	53	8.92	1126.82
	☐	59	8.29	1127.45
	☐	71	7.3	1128.44
	☐	86	6.51	1129.23
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

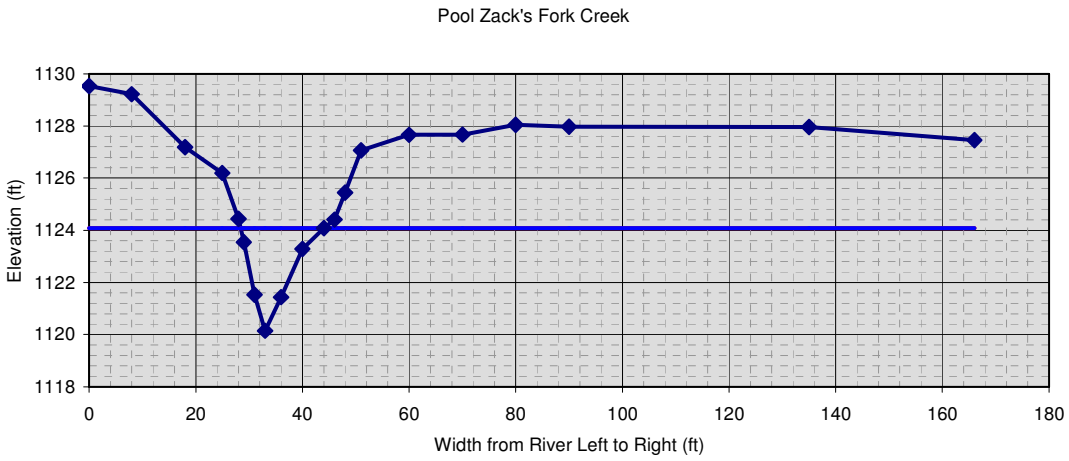
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
8.29	5.41			
1127.45	1130.33			

dimensions			
50.5	x-section area	1.7	d mean
30.1	width	31.1	wet P
2.7	d max	1.6	hyd radi
5.6	bank ht	17.9	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
26	measured D84 (mm)		
20.0	relative roughness	10.2	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	
	Pool Zack's Fork Creek ---
description:	XS-8 POOL
height of instrument (ft):	1132.68

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	3.15	1129.53
TOB	☐	8	3.46	1129.22
	☐	18	5.5	1127.18
	☐	25	6.48	1126.2
REW	☐	28	8.24	1124.44
	☐	29	9.13	1123.55
	☐	31	11.15	1121.53
TWG	☐	33	12.53	1120.15
	☐	36	11.24	1121.44
	☐	40	9.4	1123.28
BKF	☐	44	8.6	1124.08
LEW	☐	46	8.27	1124.41
	☐	48	7.24	1125.44
TOB	☐	51	5.62	1127.06
	☐	60	5.02	1127.66
	☐	70	5.01	1127.67
	☐	80	4.63	1128.05
	☐	90	4.71	1127.97
	☐	135	4.72	1127.96
	☐	166	5.23	1127.45
	☐			
	☐			
	☐			
	☐			
	☐			

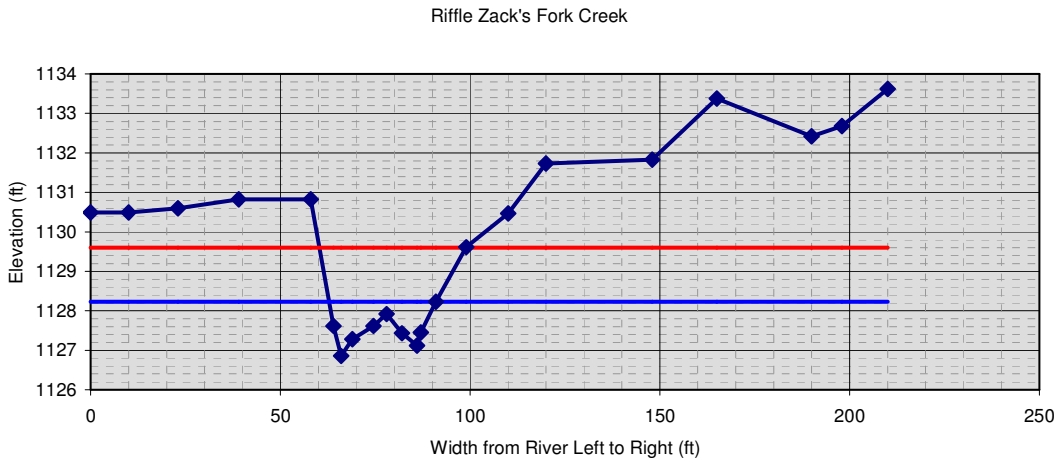
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
8.6	3.46			
1124.08	1129.22			

dimensions			
28.1	x-section area	1.8	d mean
15.6	width	17.8	wet P
3.9	d max	1.6	hyd radi
9.1	bank ht	~~8.7~~	w/d ratio
~~0.0~~	W flood prone area	~~0.0~~	ent ratio

hydraulics	
~~0.0~~	velocity (ft/sec)
~~0.0~~	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
~~0.000~~	unit stream power (lbs/ft/sec)
~~0.00~~	Froude number
~~0.0~~	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
~~26~~	measured D84 (mm)		
~~21.5~~	relative roughness	~~10.4~~	fric. factor
~~0.000~~	Manning's n from channel material		

Cross Section



section:	
	Riffle Zack's Fork Creek ---
description:	XS-9 Riffle
height of instrument (ft):	1137.38

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	6.89	1130.49
	☐	10	6.89	1130.49
	☐	23	6.78	1130.6
	☐	39	6.56	1130.82
TOB	☐	58	6.56	1130.82
REW	☐	64	9.76	1127.62
TWG-1	☐	66	10.52	1126.86
	☐	69	10.1	1127.28
B-R	☐	74.5	9.76	1127.62
B-TOP	☐	78	9.46	1127.92
B-L	☐	82	9.95	1127.43
TWG-2	☐	86	10.26	1127.12
LEW	☐	87	9.93	1127.45
BKF	☐	91	9.15	1128.23
TOB	☐	99	7.77	1129.61
	☐	110	6.91	1130.47
	☐	120	5.65	1131.73
	☐	148	5.55	1131.83
	☐	165	4	1133.38
	☐	190	4.96	1132.42
	☐	198	4.7	1132.68
	☐	210	3.76	1133.62
	☐			
	☐			
	☐			

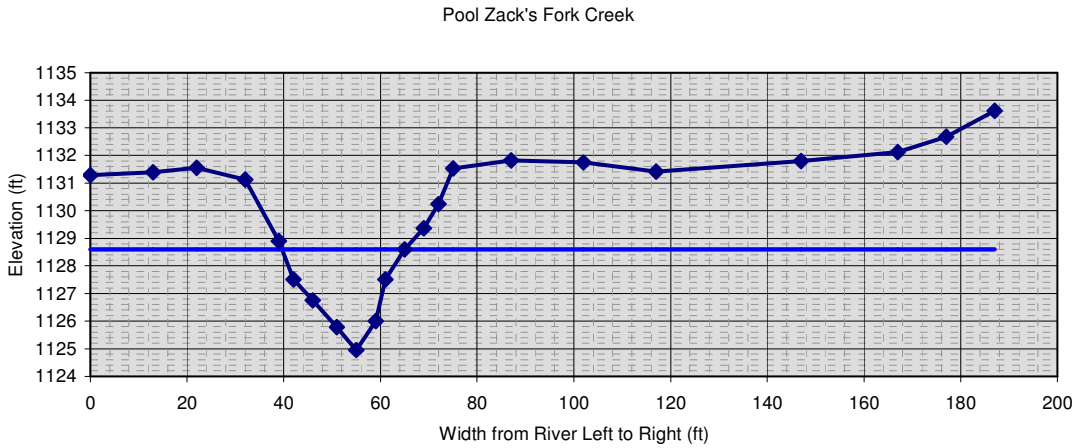
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
9.15	6.56			
1128.23	1130.82			

dimensions			
20.3	x-section area	0.7	d mean
28.1	width	28.7	wet P
1.4	d max	0.7	hyd radi
4.0	bank ht	39.1	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
26	measured D84 (mm)		
8.6	relative roughness	8.2	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	
	Pool Zack's Fork Creek ---
description:	XS-10 Pool
height of instrument (ft):	1137.38

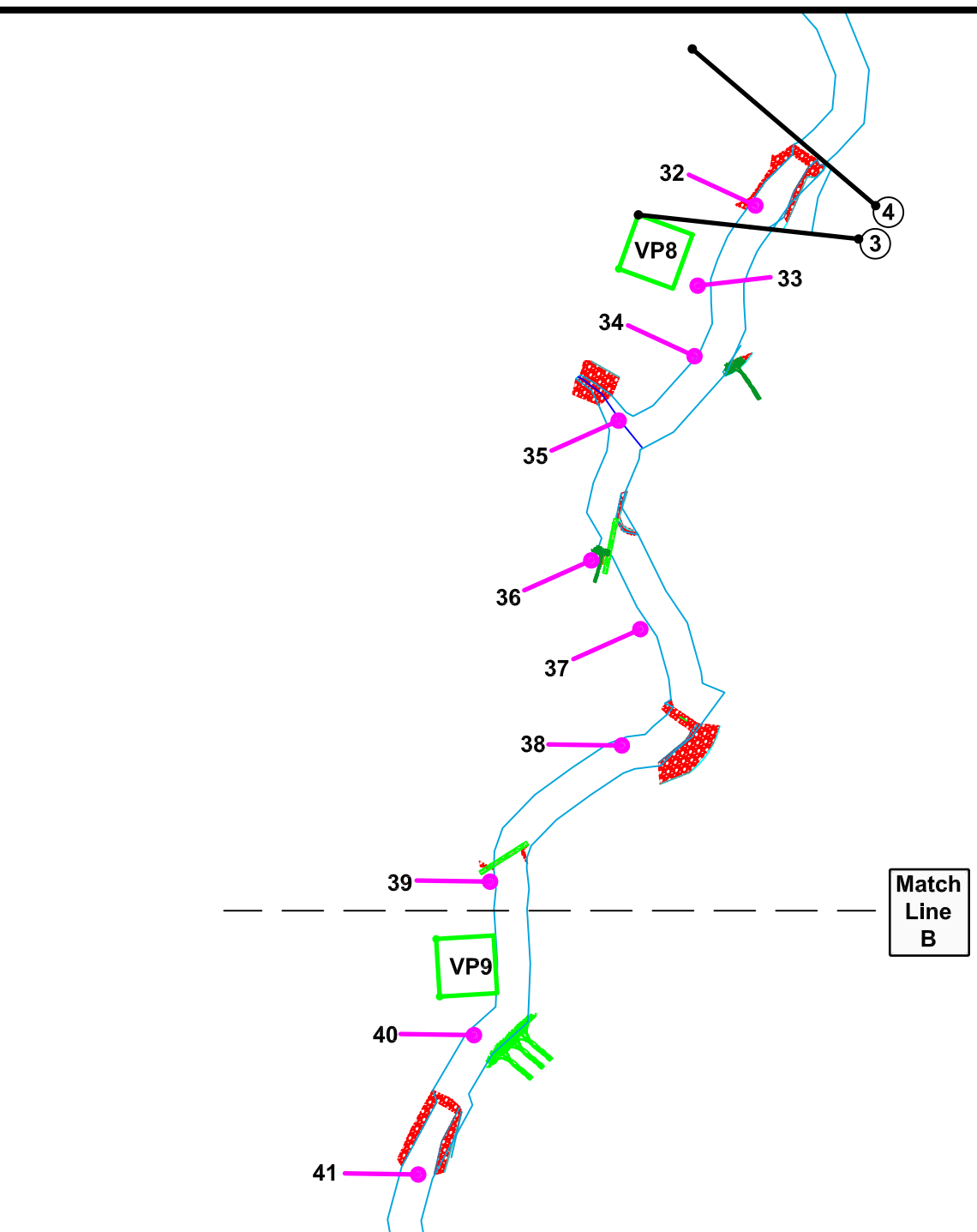
notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	0	6.09	1131.29
	☐	13	5.99	1131.39
	☐	22	5.82	1131.56
TOB	☐	32	6.25	1131.13
	☐	39	8.48	1128.9
REW	☐	42	9.87	1127.51
	☐	46	10.63	1126.75
	☐	51	11.6	1125.78
TWG	☐	55	12.43	1124.95
	☐	59	11.38	1126
LEW	☐	61	9.87	1127.51
BKF	☐	65	8.78	1128.6
	☐	69	8.02	1129.36
	☐	72	7.14	1130.24
TOB	☐	75	5.85	1131.53
	☐	87	5.56	1131.82
	☐	102	5.63	1131.75
	☐	117	5.96	1131.42
	☐	147	5.58	1131.8
	☐	167	5.26	1132.12
	☐	177	4.7	1132.68
	☐	187	3.76	1133.62
	☐			
	☐			
	☐			

FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
8.78	6.25			
1128.6	1131.13			

dimensions			
50.1	x-section area	2.0	d mean
25.4	width	26.6	wet P
3.7	d max	1.9	hyd radi
6.2	bank ht	~~12.8~~	w/d ratio
~~0.0~~	W flood prone area	~~0.0~~	ent ratio

hydraulics	
~~0.0~~	velocity (ft/sec)
~~0.0~~	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
~~0.000~~	unit stream power (lbs/ft/sec)
~~0.00~~	Froude number
~~0.0~~	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
~~26~~	measured D84 (mm)		
~~23.6~~	relative roughness	~~10.7~~	fric. factor
~~0.000~~	Manning's n from channel material		



Stream
Veg Plots
Cross Sections
Photo Locations

0 50 100
Feet
1 inch equals 100 feet.

Source: Plan Map provided by Spaulding and Norris PA, Civil Engineering and Planning.

Disclaimer: The information depicted on this figure is for informational purposes only and was not prepared for, and is not suitable for legal or engineering purposes.

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3661 Alamance Road
Burlington, North Carolina 27215
(336) 570-3002
(336) 570-9566 FAX
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Ecosystem Enhancement Program

Vegetative Plots, Cross-Sections, and Photo Stations

Zacks Fork Monitoring Report

Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Dec 2006
Drwn/Chkd:	KT/CSJ
Figure:	**4.3**

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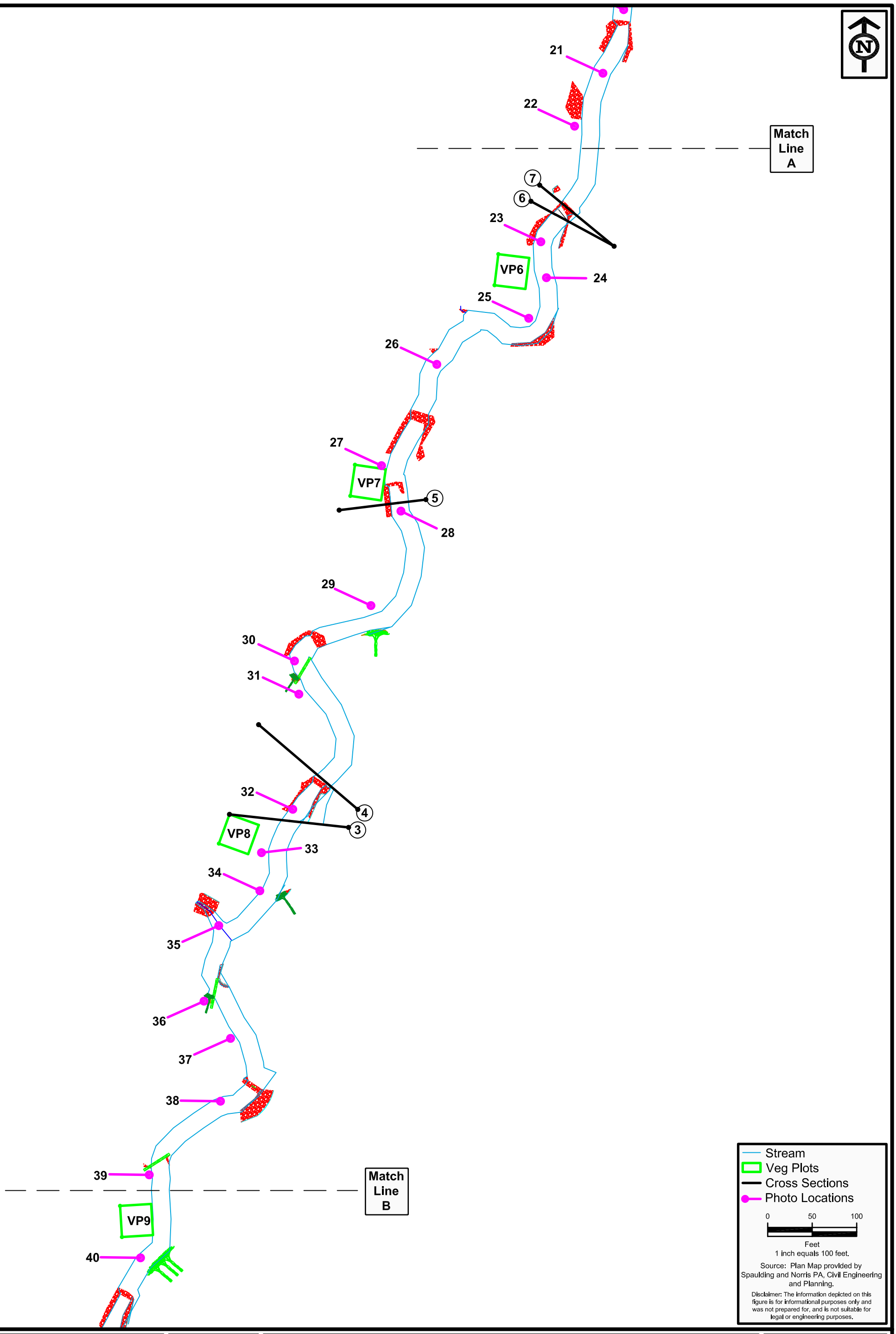

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(336) 570-9566 FAX
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Zacks Fork Monitoring Report

Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Dec 2006
Drwn/Chkd:	KT/CSJ
Figure:	4.2

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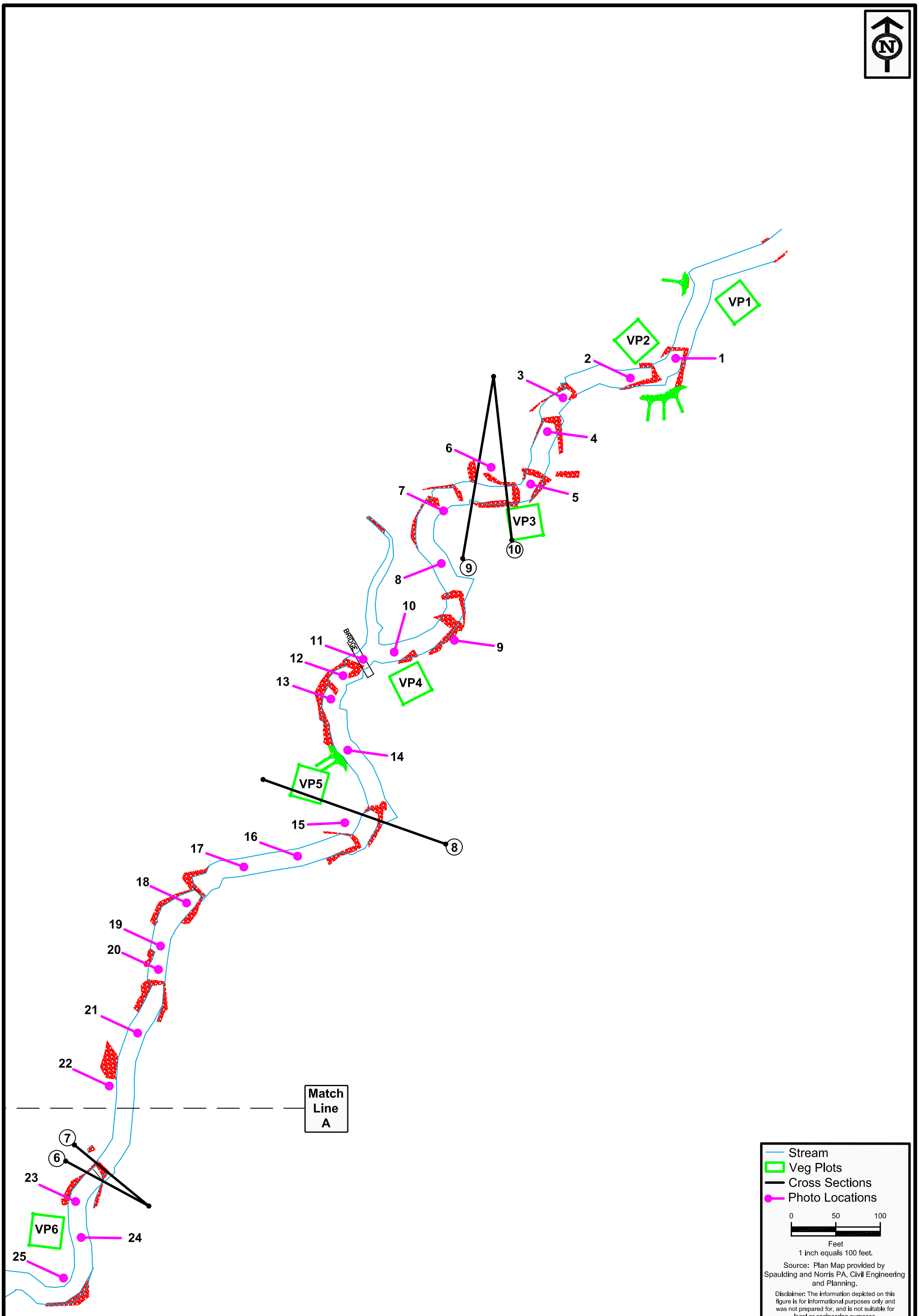

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Burlington, North Carolina 27215
(336) 570-3002
(336) 570-9566 FAX
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Ecosystem Enhancement Program

Vegetative Plots, Cross-Sections, and Photo Stations

Zacks Fork Monitoring Report

Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Dec 2006
Drwn/Chkd:	KT/CSJ
Figure:	4.1

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