Zacks Fork Creek
Stream Restoration Monitoring Report

Monitoring Year: 2010
Measurement Year: 5
As-Built Date: 2005
NCEEP Project #: AW03003A

Submitted on August 12, 2011

Delivered to: NCDENR - Ecosystem Enhancement Program
1619 Mail Service Center
Raleigh, NC 27299-1619

Prepared by: Environmental Services, Inc.
524 S. New Hope Road
Raleigh, NC 27610

Original Design: Spaulding & Norris, PA
972 Trinity Road
Raleigh, NC 27607

Ecosystem Enhancement

NCDENR

Zacks Fork Creek
Year 5 (2010) Monitoring Report

TABLE OF CONTENTS

I. Executive Summary

The monitoring assessment of this project for Year 5 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. During the site reconnaissance for this Report, there were a total of nine stream problem areas identified, three of which were significant structural issues (displaced log vanes). There were five areas exhibiting mid-bar accretion or bank scour. One area was experiencing severe bank failure. In April 2011, field work occurred to address the problem areas and bank failures noted during the site reconnaissance. Further, additional plantings were installed in June 2011 to re-vegetate buffer areas disturbed by the equipment completing the above referenced repairs. Photographs of these repair areas are provided in the Appendix D.

The Year-5 assessment of vegetation indicates continued success in the establishment of both planted and indigenous vegetation. An upward trend of stem counts throughout the restoration reach was noted in the Year 5 stem counts. There is minimal evidence of beaver herbivory in the middle and lower reaches, but it does not appear to have adversely impacted stem counts during previous infestations.

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 The stream restoration encompasses approximately 3,900 linear feet of a reach that had become incised and degraded. Through a combination of natural channel design, grade-control structures and excavation of a bankfull bench this project seeks to address deficiencies in the stream dimension, pattern and profile as well improve both in-stream and riparian habitat. 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 and "Mitigation Report for Zack's Fork Creek Stream Restoration" prepared by Spaulding & Norris, as revised in February 14, 2008. The as-built plan view of the project area is given in Figure 2; more detailed maps are also available in the "Mitigation Report".

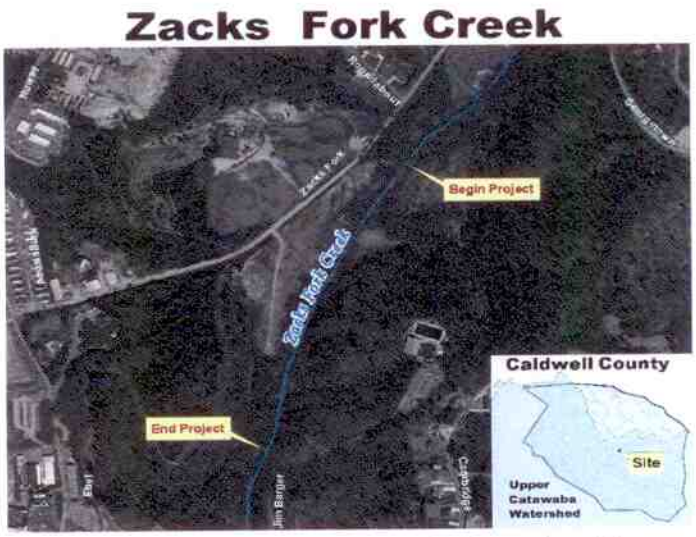


Figure 1. Zacks Fork Creek Location Map

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
Project Manager Spaulding & Norris, PA Attn: Stephanie L. Norris, PE	972 Trinity Road Raleigh, NC 27607 (919) 854-7990
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 Phone: 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 Phone: 770-736-9101
Vegetation Monitoring Environmental Services, Inc. Attn: Charles Johnston	524 S. New Hope Road Raleigh, NC 27610 (919) 212-1760
Stream Monitoring Environmental Services, Inc. Attn: Steve Jones	1980-A Parker Court Stone Mountain, GA 30087 Phone: 770-736-9101

Figure 2.1 – As-Built Plan

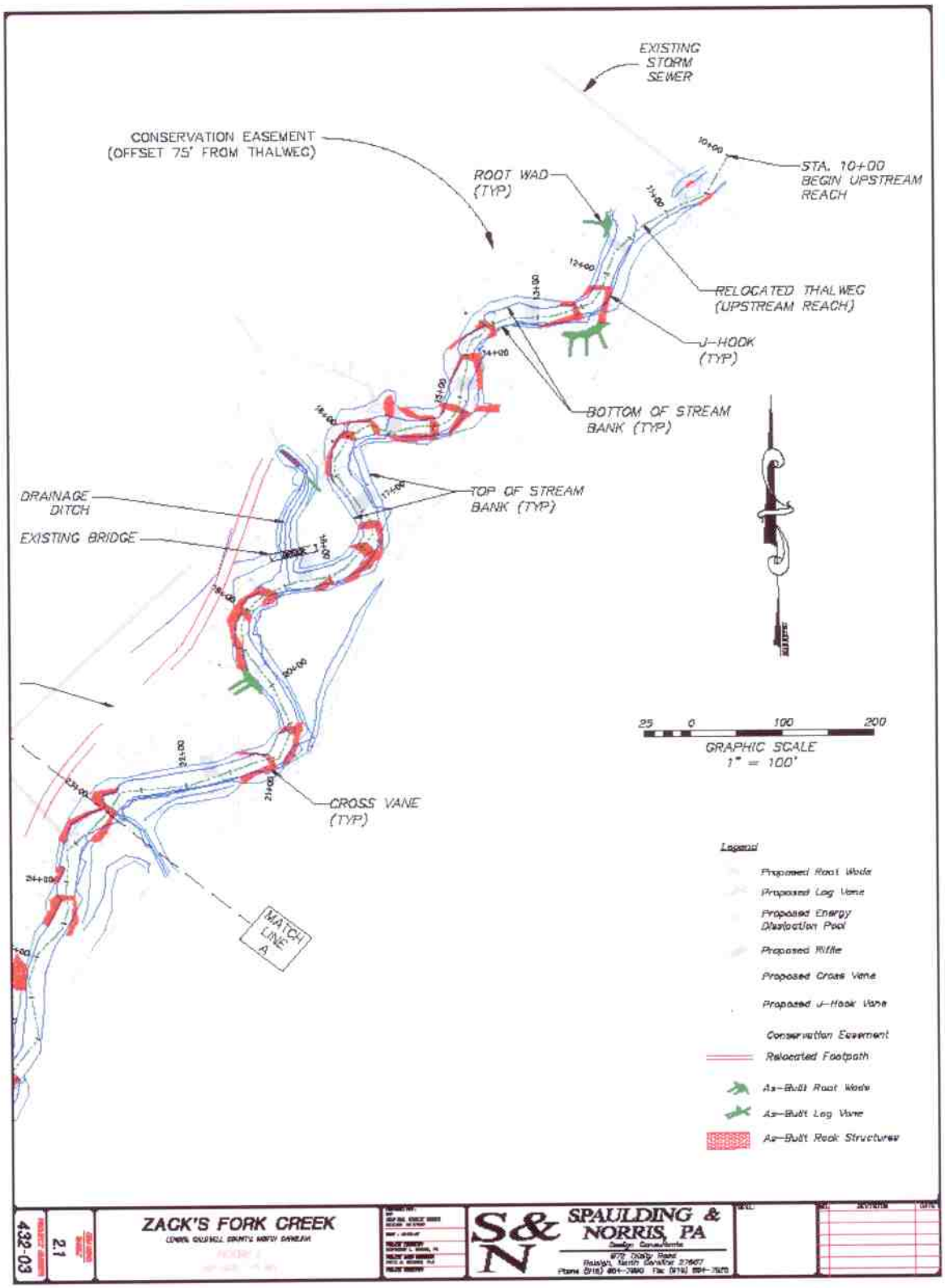


Figure 2.2 – As-Built Plan

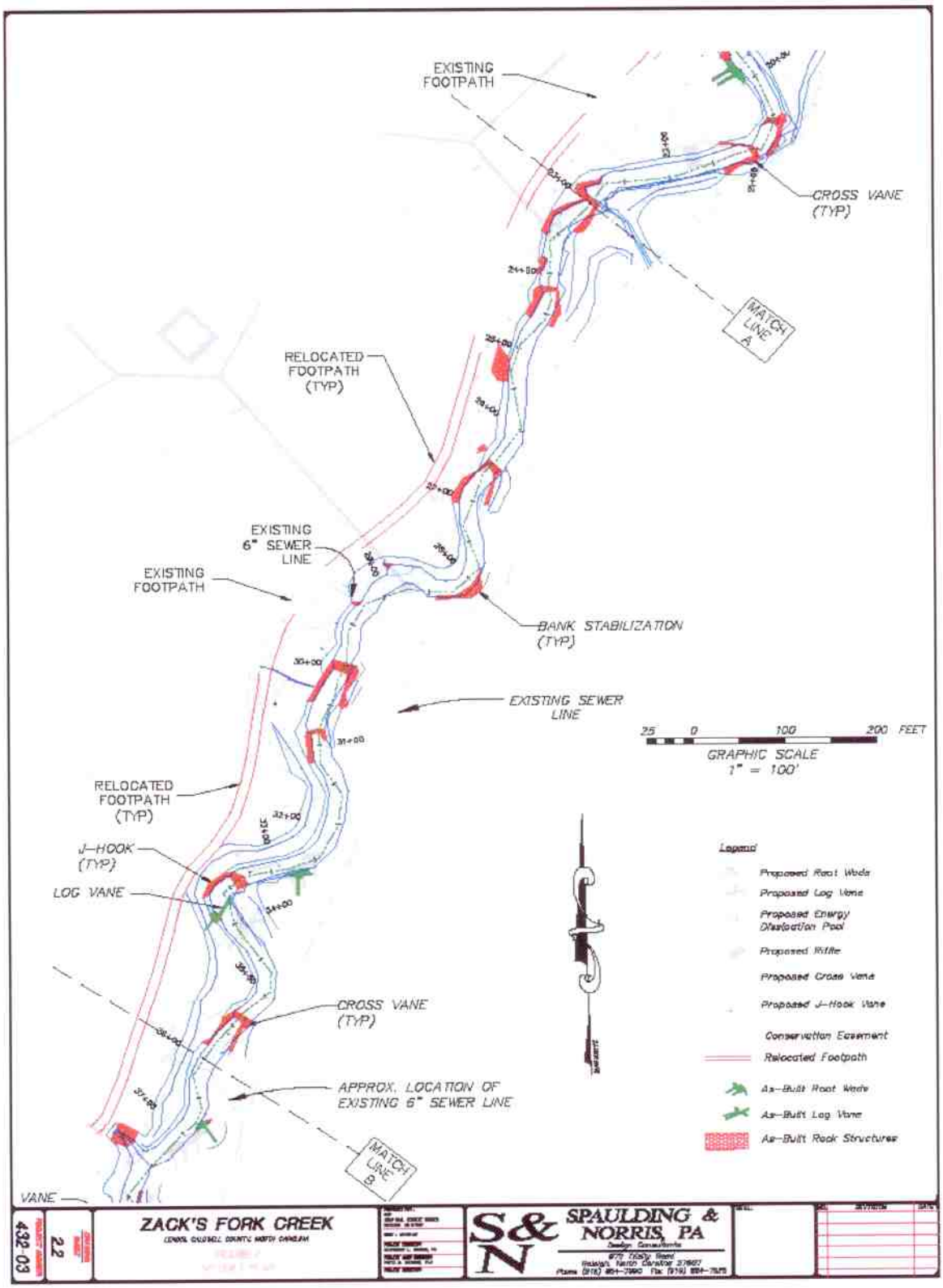
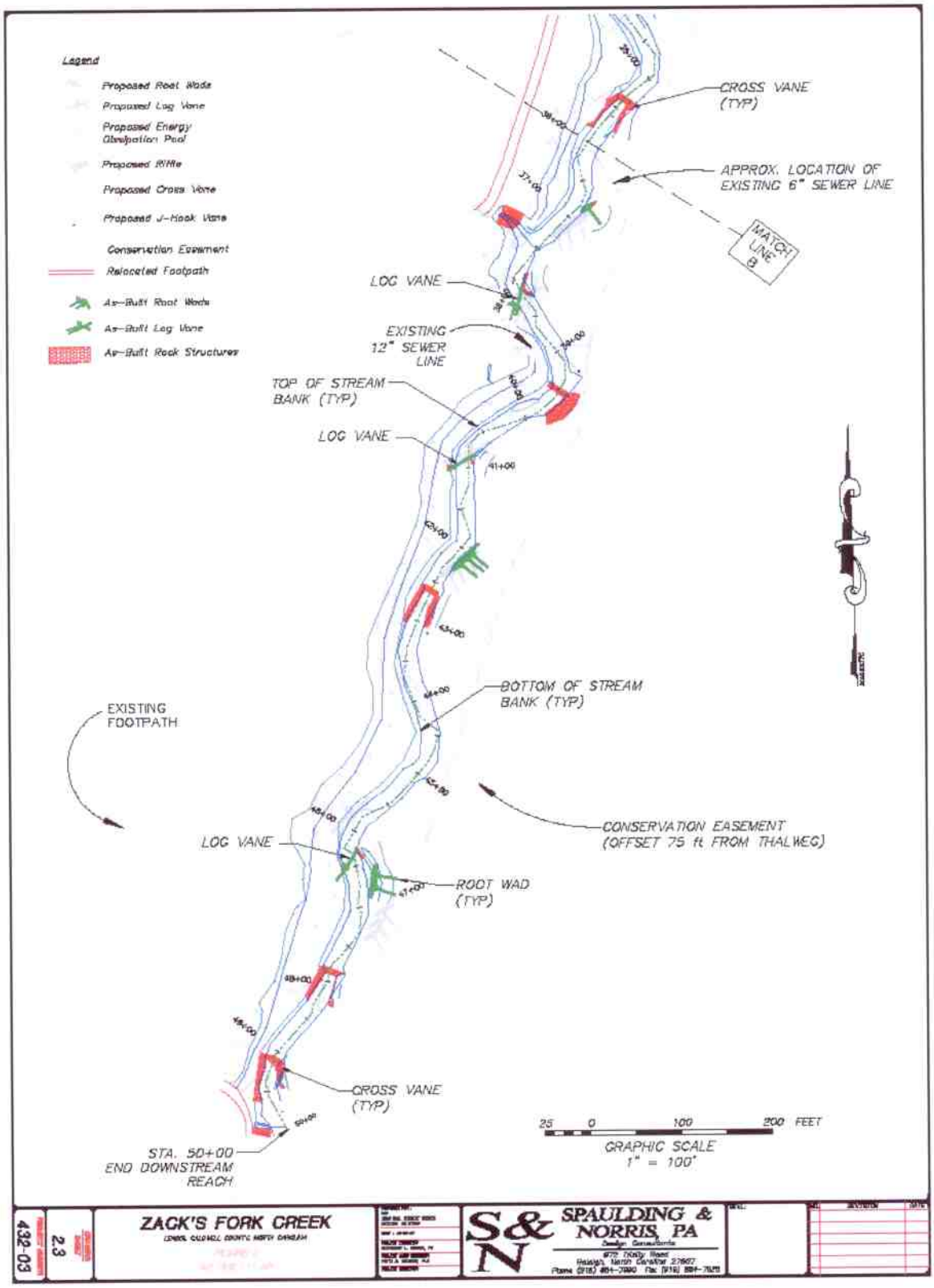


Figure 2.3 – As-Built Plan



II. 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 (11) 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. The Year 1, 2, 3, and 4 vegetation assessments were performed on: December 12, 2006; November 21, 2007; November 6, 2008; and September 12, 2009 respectively. The Year-5 assessment was completed on October 25, 2010, and the results are given in Tables 4 and 5. Chewacla loam is the only mapped soil series within the floodplain of the project and no direct on-site soil sampling was performed as part of the yearly monitoring process. The spatial location of the vegetation sampling plots is given in Figure 3. Representative photographs of the vegetative sampling plots are contained in Appendix C.

The Year 5 vegetation plot data (Table 5) indicates an upward trend of stem counts throughout the restoration's reach. This increase is likely due to transplants previously not counted, but now tall enough to be above the grass/sedge cover, and potentially due to natural recruitment via seed set or seed bank. The 5th year counts equal or exceed the prior 4-year counts for all 11 vegetation plots with a mean 41 percent increase. There has also been considerable natural recruitment in many plots, most notably of river birch (*Betula nigra*), silky willow *(Salix sericea)*, and sycamore (*Platanus occidentalis*). Stem counts were limited to specimens greater than four feet high, in an attempt to reflect only originally or subsequently transplanted trees. Silky willow continues to dominate the plots abutting the stream bank (e.g. Vegetation plots # 1, 3, 4, 7, and 11) while those plots higher in the floodplain have a more varied species distribution (e.g. Vegetation plots # 2, 6, 9, and 10). Herbaceous and shrub strata groundcover in all plots is equal to or greater than 90 percent coverage.

Two vegetative problem areas were identified in the Year 5 assessment (Table 4). There are several areas with evidence of minimal to moderate beaver herbivory. The beaver activity does not appear to be recent, however this activity is likely to continue unless the beavers are removed or eliminated. The City of Lenoir Public Works Department is actively working to remove beavers from the area and appear to respond to the outcropping of dens in a timely manner to avoid further damage to the stream cross-section and structures. From previous monitoring reports, the areas noted to have beaver activity problems have successfully re-sprouted and have been successful in natural regeneration. The beavers do not appear to be adversely impacting stem counts at this time.

The second vegetative problem area consists of the wild rose *(Rosa multiflora)* growth within the riparian zone. In June 2008, selective spot-spraying using a glycophosphate-based herbicide was conducted. Evaluation in November 2008 showed this treatment to be partially effective as evidenced by leaf/stem kill of treated plants. It was apparent, however, that the wild rose growth is not limited to the restoration corridor and that re-colonization from mature plants in adjacent areas and any existing *insitu* seed bank was likely. The Year-5 evaluation shows this re-growth to have occurred, as wild rose is still prevalent, though not dominant. However, as tree growth continues, it is expected that the canopy will begin to limit the sunlight into the herbaceous layer, which should inhibit the wild rose growth in these areas.

The partially re-graded area near the bridge and walking trail at Plot 4 is a vegetative problem area that was noted in the Year 4 monitoring report. The grading extended to within approximately 10 feet of the stream bank. The remaining sapling vegetation along the stream

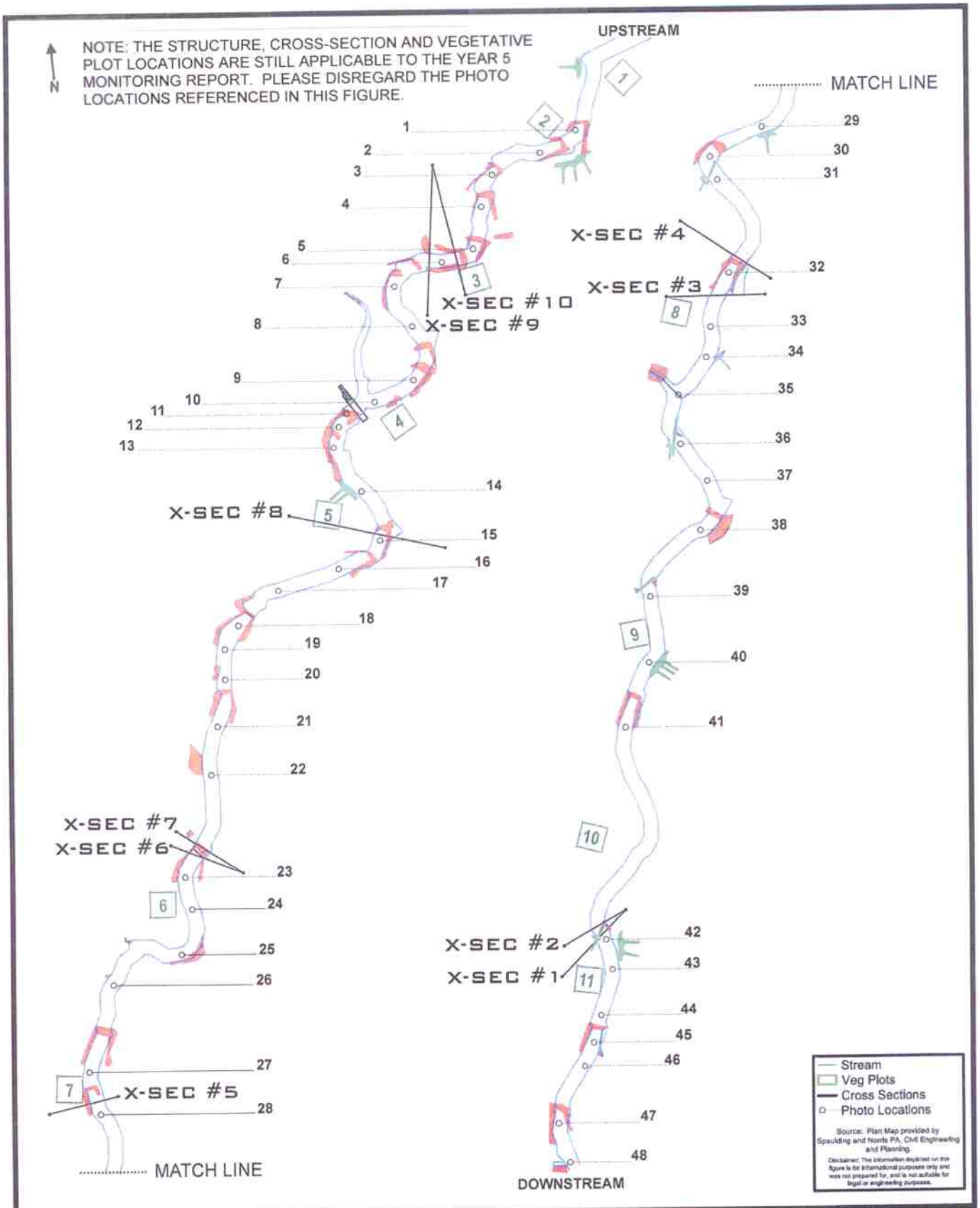
bank is vigorous and appears at to be sufficient to maintain bank integrity. The graded area has regenerated and a stable groundcover of various grasses and young saplings was noted. In June 2011, the City installed approximately 20 trees (verigated dogwood, sycamore and birch) throughout the disturbed area, which included Plot 4. These trees have a minimum of 5 years of growth. The added trees are not included in the Year 5 Stem counts provided in Table 5 below.

Table 4. Vegetative Problem Areas

Feature/Issue	Station#/Range	Probable Cause	Photo #
Wild rose	Multiple areas	Successional growth	VPA 1

Table 5. Year 5 Stem counts by species and plot, October 2010.

Species	Plot #											
	1	2	3	4	5	6	7	8	9	10	11	Spp total
Alnus serrulata (common alder)	3	5	6	2	3	3	3	4	7	6	3	45
Betula nigra (river birch)	0	16	2	3	1	8	3	12	24	19	15	103
Cornus amomun (silky dogwood)	0	2	0	0	0	0	0	2	1	0	0	5
Ilex opaca (American holly)	0	0	0	0	0	0	0	0	0	0	0	0
Lindera benzoin (spicebush)	2	1	0	0	1	2	1	0	0	0	0	7
Liriodendron tulipifera (tulip poplar)	2	7	3	0	0	2	2	1	4	8	8	37
Platanus occidentalis (sycamore)	4	16	16	8	24	2	1	2	1	3	11	88
Salix sericea (silky willow)	18	4	18	25	0	0	20	0	5	0	8	98
Sambucus canadensis (elderberry)	0	0	0	0	0	0	0	0	0	0	0	0
Stems / Plot	29	51	45	38	26	17	30	21	42	36	45	
Stems/ Acre	1175	2066	1823	1539	1053	689	1215	851	1701	1458	1823	
Est. % Groundcover	100	100	90	100	90	90	100	100	100	100	90	



ENVIRONMENTAL SERVICES, INC.
7220 Financial Way, Suite 100
Jacksonville, Florida 32256
(904) 470-2200
(904) 470-2112 Fax
www.environmentalservicesinc.com

Structures, Cross-Sections,
Vegetative Plots, Photo Locations

Zack's Fork, Year 4 Monitoring Report

Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Oct 2009
Drwn/Chkd:	csj/csj
Figure:	3

Q:\Team\Corel\Letter_portrait_bound.cdr; 01/11/06; 3:30pm

B. Stream Assessment

This stream restoration incorporates 28 in-stream grade controls (cross vanes, log vanes) and other natural channel design structures (J-hooks, root wads). The Year-5 monitoring assessment collected hydraulic performance parameters, which include longitudinal profile, ten cross-sectional profiles, pebble counts, and visual stability assessment. Spatial locations of grade-control structures, cross-sections and vegetative plots are depicted in Figure 3. Longitudinal and cross-sectional profiles are given in Appendix A. Structural photographs are enclosed in Appendix B, arranged sequentially moving downstream.

The overall hydrology of the restoration appears to functioning within design specifications. There is strong establishment of stable riffle-pool sequences, maintenance of thalweg alignment, strong sediment sorting, well-vegetated banks, formation of point bars, and integrity of grade-control structures. There are vegetated bankfull benches in multiple locations and pools appear to be clearing out sediment adequately.

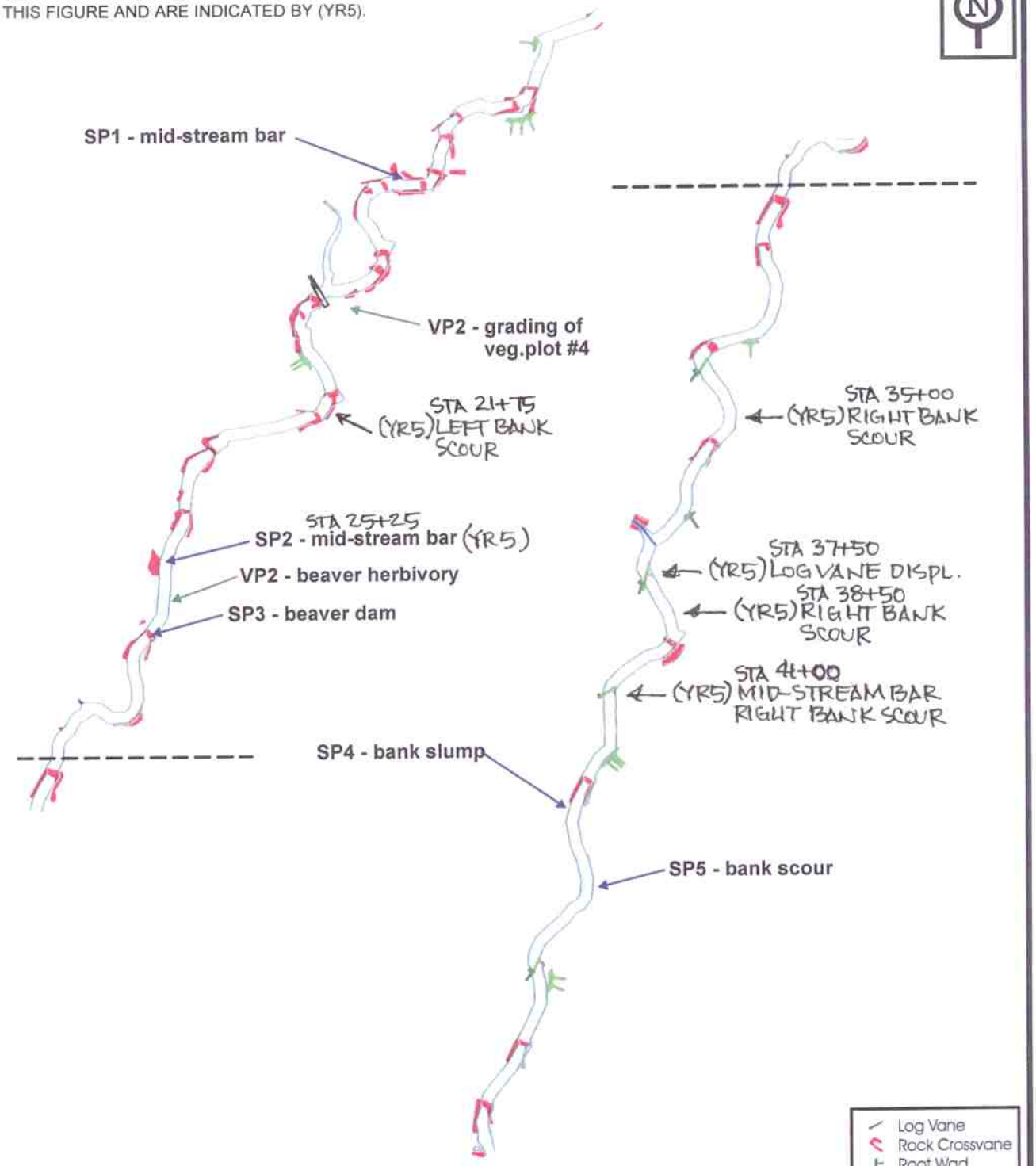
A total of nine stream problems are identified in Table 7. The majority of these problems did not involve grade control structures. Bank scours were the main issues that were documented. These issues occurred due to a recent bankfull event. One of the grade control structures which utilized a log vane has been displaced which will eventually cause increased flow around the base where these are keyed into the outer curve of the stream bank. There were two areas experiencing aggradation due to mid channel bars that have formed. Visually, the top two-thirds of the reach are in good condition and are functioning as a natural channel should be. However, the wooded area contains the multiple issues that are noted. As reflected by the stability of the longitudinal profile, these structures are still adequately holding grade; however, repair or replacement may become necessary in the future if structural integrity and stability further deteriorates. A total of nine (9) stream problem areas were cataloged, locations are shown in Figure 4 and representative photographs are contained in Appendix D. Cross-sectional morphology and sediment sorting characteristics are given in Table 8 and Table 9. For the most part, the profiles are suitably congruent.

As previously referenced in the Executive Summary, repairs to the stream problem areas noted above, in particular bank stabilization, were successfully completed in April 2011. Photographs of these areas are also included in Appendix D.

The Year-5 assessment also included Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) analysis. The BEHI evaluates variables including bank height ratio, bank angle, root depth and density, bank protection and bank materials; it generates a descriptive index of erosion risk. The NBS is similar but incorporates variables such as pool/riffle slope(s), velocity profile estimates, and near-bank maximum depth. Results of for these two evaluation indices are given in Tables 6.R and 6.L; the evaluation reaches for each bank are shown in Figures 5.R and 5.L.

The entire geomorphological range the restoration appears to be maintaining stability (Table 11). The visual assessment of the entire restored reach shows a natural progression of the riparian vegetative community, in-stream habitat development and functioning grade-control structures. Both planted and natural recruitment of vegetation in the riparian corridor continues to provide good ground cover and buffering functions. The presence of stream macroinvertebrates and finfish gives a qualitative verification of in-stream habitat and good water quality.

NOTE: STREAM PROBLEM AREAS REFERENCED IN THE YEAR 5 MONITORING REPORT HAVE BEEN ADDED TO THIS FIGURE AND ARE INDICATED BY (YR5).



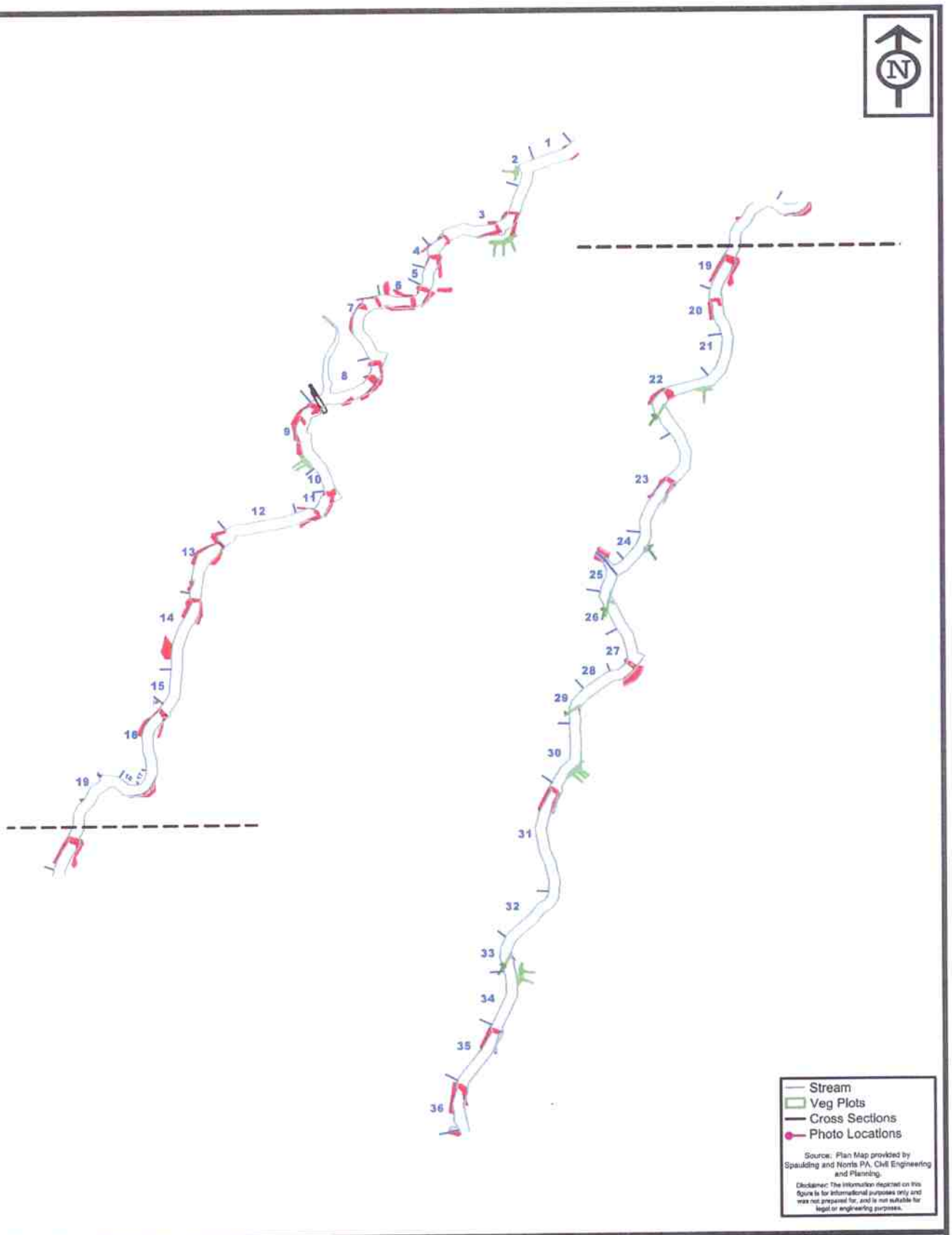
ENVIRONMENTAL SERVICES, INC.
7220 Financial Way, Suite 100
Jacksonville, Florida 32256
(904) 470-2200
(904) 470-2112 Fax
www.environmentalservicesinc.com

Stream Problem Areas

Zack's Fork, Year 4 Monitoring Report

Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Nov 2009
Drwn/Chkd:	csj/csj
Figure:	4



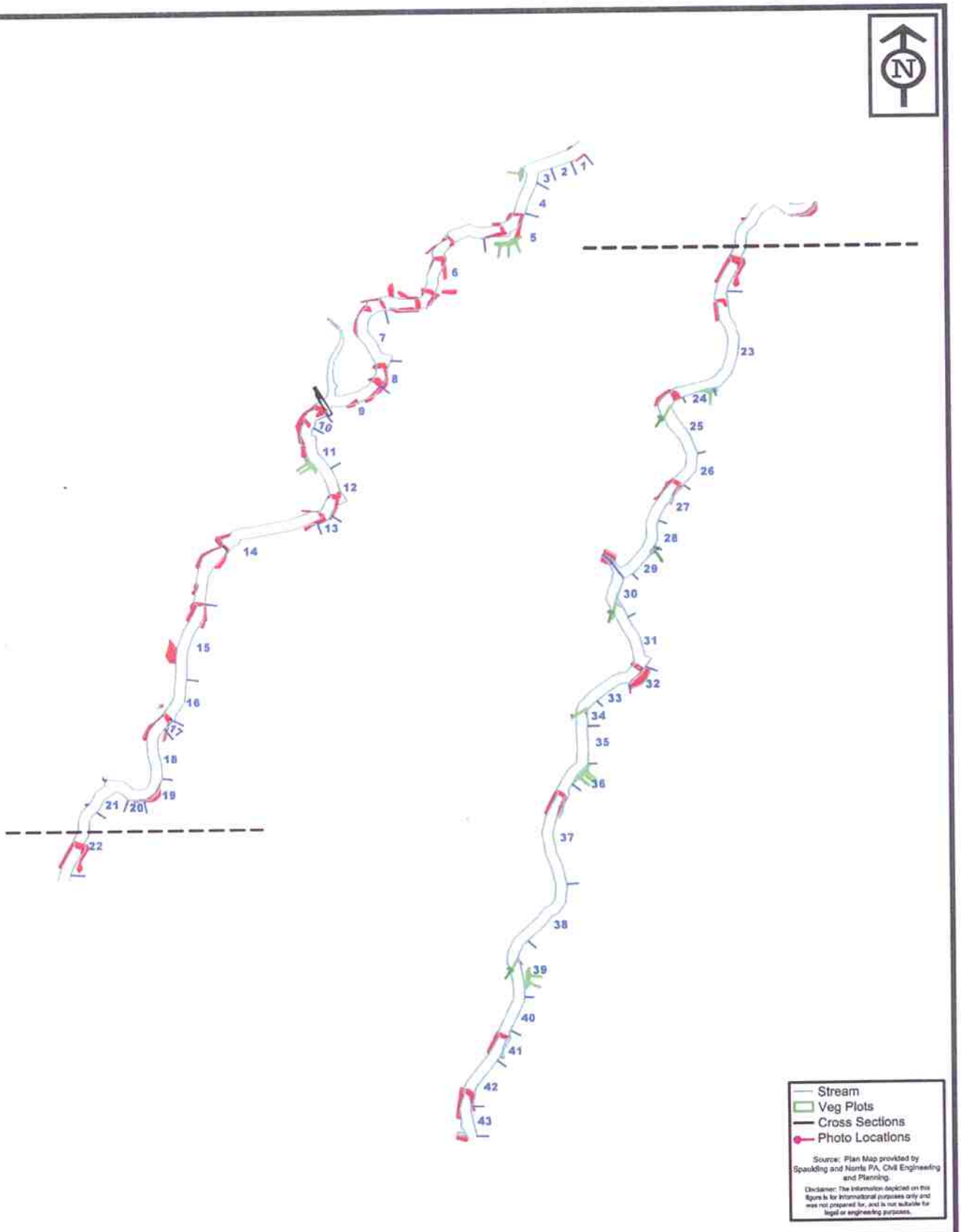
ENVIRONMENTAL SERVICES, INC.
7220 Financial Way, Suite 100
Jacksonville, Florida 32256
(904) 470-2200
(904) 470-2112 Fax
www.environmentalservicesinc.com

BEHI/NBS Reaches, Right Bank

Zack's Fork, Year 3 Monitoring Report

Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Nov 2008
Drwn/Chkd:	csj/csj
Figure:	5R



ENVIRONMENTAL SERVICES, INC.
7220 Financial Way, Suite 100
Jacksonville, Florida 32256
(904) 470-2200
(904) 470-2112 Fax
www.environmentalservicesinc.com

BEHI/NBS Reaches, Left Bank

Zack's Fork, Year 3 Monitoring Report

Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Nov 2008
Drwn/Chkd:	csj/csj
Figure:	5L

Table 6R. Bank Erosion Hazardous Index (BEHI) and Near-Bank Stress (NBS) Assessments				
Reach	*BEHI Adjective Rating*	*NBS Adjective Rating*	*Study Bank Height*	*Length*
Right Bank 1	Low	Low	2.5	68
Right Bank 2	Low	Low	2.0	77
Right Bank 3	Very Low	Low	2.5	220
Right Bank 4	Very Low	Very Low	2.5	35
Right Bank 5	Low	Moderate	3.0	37
Right Bank 6	Low	Moderate	2.5	94
Right Bank 7	Low	Moderate	3.0	153
Right Bank 8	Low	Very Low	3.0	128
Right Bank 9	Very Low	Very Low	3.0	171
Right Bank 10	Low	Low	3.0	43
Right Bank 11	Very Low	Low	3.0	77
Right Bank 12	Very Low	Very Low	3.5	126
Right Bank 13	Low	Low	3.0	153
Right Bank 14	Low	Very Low	3.5	157
Right Bank 15	Very Low	Low	3.0	65
Right Bank 16	Low	Low	3.0	139
Right Bank 17	Moderate	High	3.5	24
Right Bank 18	Moderate	Low	3.5	71
Right Bank 19	Low	Low	3.0	225
Right Bank 20	Moderate	Moderate	4.0	100
Right Bank 21	Low	Very Low	2.5	70
Right Bank 22	Low	Moderate	3.5	190
Right Bank 23	Very Low	Low	3.0	195
Right Bank 24	Very Low	Low	3.0	73
Right Bank 25	Low	Very Low	4.0	65
Right Bank 26	Very High	Very High	5.5	70
Right Bank 27	Moderate	Moderate	4.5	118
Right Bank 28	Low	Moderate	3.0	56
Right Bank 29	Moderate	Very High	4.0	69
Right Bank 30	Low	Very Low	3.5	136
Right Bank 31	Very High	Extreme	5.0	197
Right Bank 32	Moderate	Moderate	4.0	105
Right Bank 33	Very High	Very High	5.0	105
Right Bank 34	Moderate	Moderate	3.0	88
Right Bank 35	Low	High	3.0	107
Right Bank 36	Low	High	3.5	93
			total...	**3900**

Table 6L. Bank Erosion Hazardous Index (BEHI) and Near-Bank Stress (NBS) Assessments				
Reach	*BEHI Adjective Rating*	*NBS Adjective Rating*	*Study Bank Height*	*Length*
Left Bank 1	Low	Moderate	3.0	25
Left Bank 2	Low	Moderate	3.0	45
Left Bank 3	Low	Very Low	2.5	58
Left Bank 4	Low	Low	2.0	60
Left Bank 5	Low	Low	3.0	101
Left Bank 6	Low	Low	3.0	217
Left Bank 7	Very Low	Very Low	2.0	143
Left Bank 8	Low	Low	2.5	43
Left Bank 9	Low	Moderate	2.5	114
Left Bank 10	Moderate	Moderate	3.0	41
Left Bank 11	Very Low	Low	3.0	97
Left Bank 12	Low	Low	3.0	103
Left Bank 13	Moderate	Moderate	4.5	27
Left Bank 14	Very Low	Low	2.0	288
Left Bank 15	Very Low	Very Low	2.5	150
Left Bank 16	Moderate	Low	4.5	82
Left Bank 17	High	High	5.0	21
Left Bank 18	Low	Very Low	2.0	104
Left Bank 19	Low	Low	2.5	57
Left Bank 20	Very High	Extreme	5.0	24
Left Bank 21	Low	Low	2.5	91
Left Bank 22	Low	Low	3.0	132
Left Bank 23	High	High	5.0	193
Left Bank 24	Moderate	Moderate	4.0	64
Left Bank 25	Low	Low	4.0	129
Left Bank 26	Very High	Extreme	6.0	67
Left Bank 27	Moderate	Moderate	4.5	94
Left Bank 28	Low	Low	3.0	43
Left Bank 29	Moderate	Moderate	3.0	64
Left Bank 30	Low	Moderate	3.0	105
Left Bank 31	Very High	Very High	6.5	109
Left Bank 32	Moderate	Moderate	3.5	45
Left Bank 33	Very High	Extreme	5.0	62
Left Bank 34	Low	Moderate	3.0	54
Left Bank 35	Moderate	Moderate	4.5	56
Left Bank 36	Low	Low	3.0	52
Left Bank 37	Low	Low	3.0	196
Left Bank 38	High	Moderate	4.5	127
Left Bank 39	Low	Moderate	3.0	114
Left Bank 40	High	High	7.0	67
Left Bank 41	Low	Low	3.0	68
Left Bank 42	Very High	High	7.0	102
Left Bank 43	Low	Low	3.5	66
			total...	**3900**

Table 7. Stream Problem Areas				
Feature Issue	**Station #**	**Suspected Cause**	**Location #**	**Photo #**
Aggradation / Bar Formation	25+25	Mid-stream bar	2	2
	41+00	Mid-stream bar	6	6
Bank Scour	21+75	Water velocity	1	1
	35+00	Water velocity	3	3
	38+50	Lack of vegetation	5	5
	41+50	Water velocity	7	7
Structure Change	37+50	Log vane displaced	4	4

Table 8. Summary of Cross-Sectional Morphology						
	Cross-Section	**1 - pool**	**2 - riffle**	**3 -pool**	**4 -riffle**	**5 - pool**
DIMENSION	BF Width (ft)	35.5	30.8	29.2	33.1	29.3
	Floodprone Width (ft)	200	130.0	80.0	400	51.0
	BF Cross-sectional area (sq.ft)	89.1	95.0	79.9	120.7	65.8
	BF Mean Depth (ft)	2.5	3.1	2.7	3.6	2.3
	BF Max Depth (ft)	4.6	5.2	3.8	5.3	3.0
	Width/Depth Ratio	14.1	10.0	10.7	9.1	13
	Entrenchment Ratio	5.6	4.2	2.7	12.1	1.7
	Wetted Perimeter (ft)	38.5	34.2	32.1	36.8	30.5
	Hydraulic Radius (ft)	2.3	2.8	2.5	3.3	2.2
SUBSTRATE	D50 (mm)	-	3.6	-	.125	-
	D84 (mm)	-	14	-	2.3	-
	Cross-Section	**6 - pool**	**7 - riffle**	**8 -pool**	**9 -riffle**	**10 - pool**
DIMENSION	BF Width (ft)	21.7	24.1	24.3	47.7	24.4
	Floodprone Width (ft)	600	92.9	500	300	300
	BF Cross-sectional area (sq.ft)	76.0	32.6	70.5	106.6	53.9
	BF Mean Depth (ft)	3.5	1.4	2.9	2.2	2.2
	BF Max Depth (ft)	5.0	2.8	5.4	4.1	4.2
	Width/Depth Ratio	6.2	17.9	8.4	21.5	11.1
	Entrenchment Ratio	27.6	3.9	20.6	6.3	12.3
	Wetted Perimeter (ft)	25.9	25.4	27.5	51.2	27.1
	Hydraulic Radius (ft)	2.9	1.3	2.6	2.1	2.0
SUBSTRATE	D50 (mm)	-	.3	-	5.5	-
	D84 (mm)	-	4.3	-	13.5	-

Table 9. 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)	60.1	126	81.3
	Riffle Slope (ft/ft)	.001	.009	.004
	Pool Length (ft)	45.8	287.3	117.7
	Pool Spacing (ft)	43.35	330.0	146.9

Table 10. Visual Morphological Stability Assessment						
Feature Category	Metric	# Stable	# per As-built	LF of unstable state	% Stable	Feature Mean %
A. Riffles	1. Present?	22	22	-	90	
	2. Armor stable?	22	22	-	100	
	3. Facet grade appears stable?	22	22	-	100	
	4. Minimal evidence of embedding/fining?	22	22	-	100	
	5. Length appropriate?	22	22	-	100	**98%**
				-		
B. Pools	1. Present?	28	28	-	100	
	2. Sufficiently deep (maxD:mean bkfl >1.6?	28	28	-	100	
	3. Length appropriate?	100	100	100	100	**100%**
C. Thalweg	1. Upstream of meander bend centering?	15	17	100	83	
	2. Downstream of meander centering?	14	17	100	81	**82%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	10	11	140	90	
	2. If eroding, # with concomitant bar formation?	2	2	35	80	
	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?	22	22	0	100	

	2. Channel bed degradations (downcuts/headcuts)?	0	0	0	100	**100%**
F. Vanes	1. Free of back or arm scour?	26	28	30	95	
	2. Height appropriate?	26	28	0	91	
	3. Angle and geometry appear appropriate	27	28	0	96	
	4. Free of piping or other structural failures?	25	28	40	96	**95%**
G. Wads/Boulders	1. Free of scour?	5	8	100	62	
	2. Footing stable?	8	8	0	100	**81%**

Table 11. Categorical Stream Feature Visual Stability Assessment

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles	NA	98%	98%	99%	100%	98%
B. Pools	NA	100%	100%	100%	100%	100%
C. Thalweg	NA	85%	88%	88%	94%	82%
D. Meanders	NA	93%	93%	93%	93%	93%
E. Bed General	NA	96%	96%	100%	100%	100%
F. Structures	NA	98%	98%	94%	97%	95%
G. Wads/Boulders	NA	88%	88%	88%	94%	81%

IV. 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.

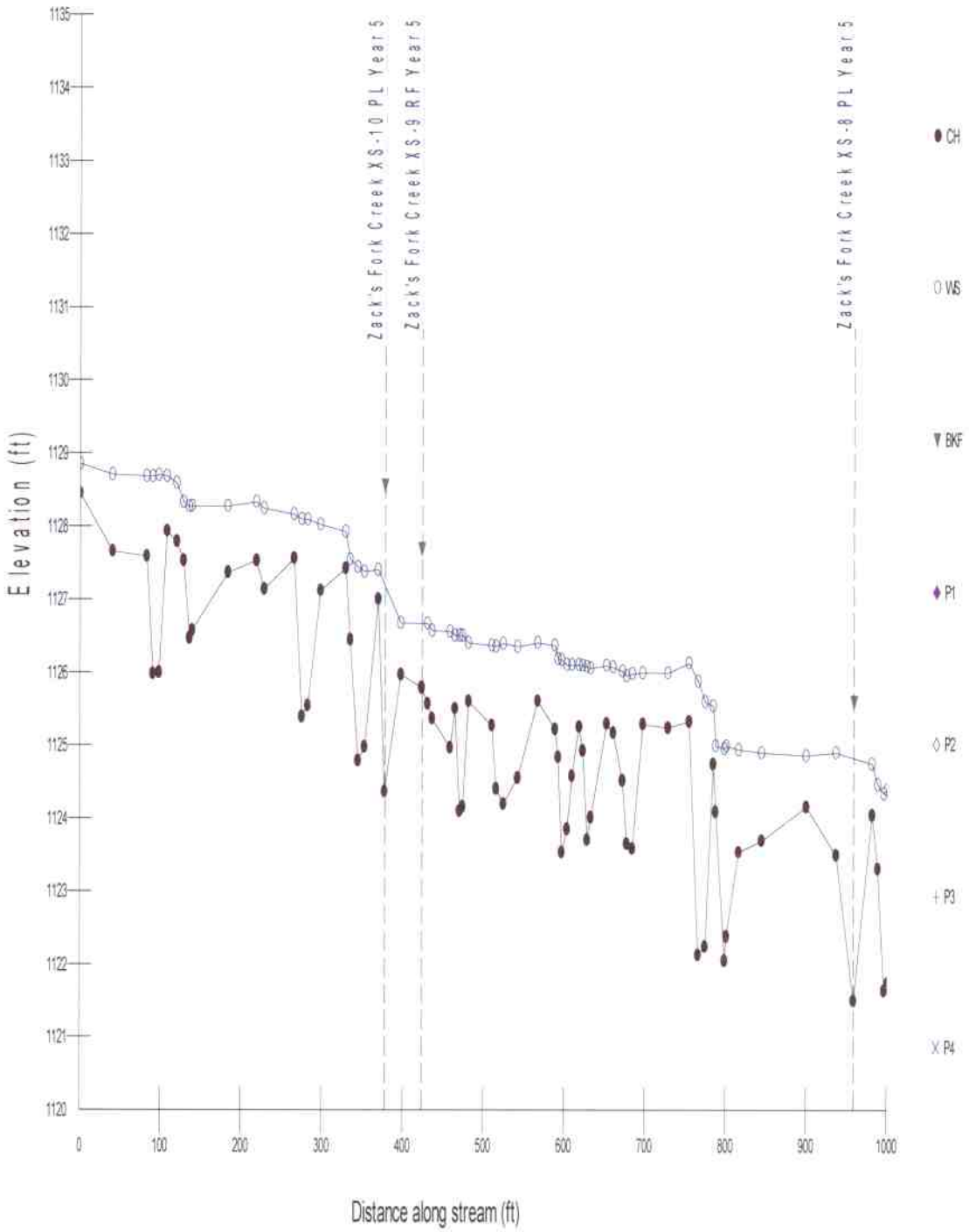
References include but are not limited to:

USACOE. (2003) *Stream Mitigation Guidelines*.

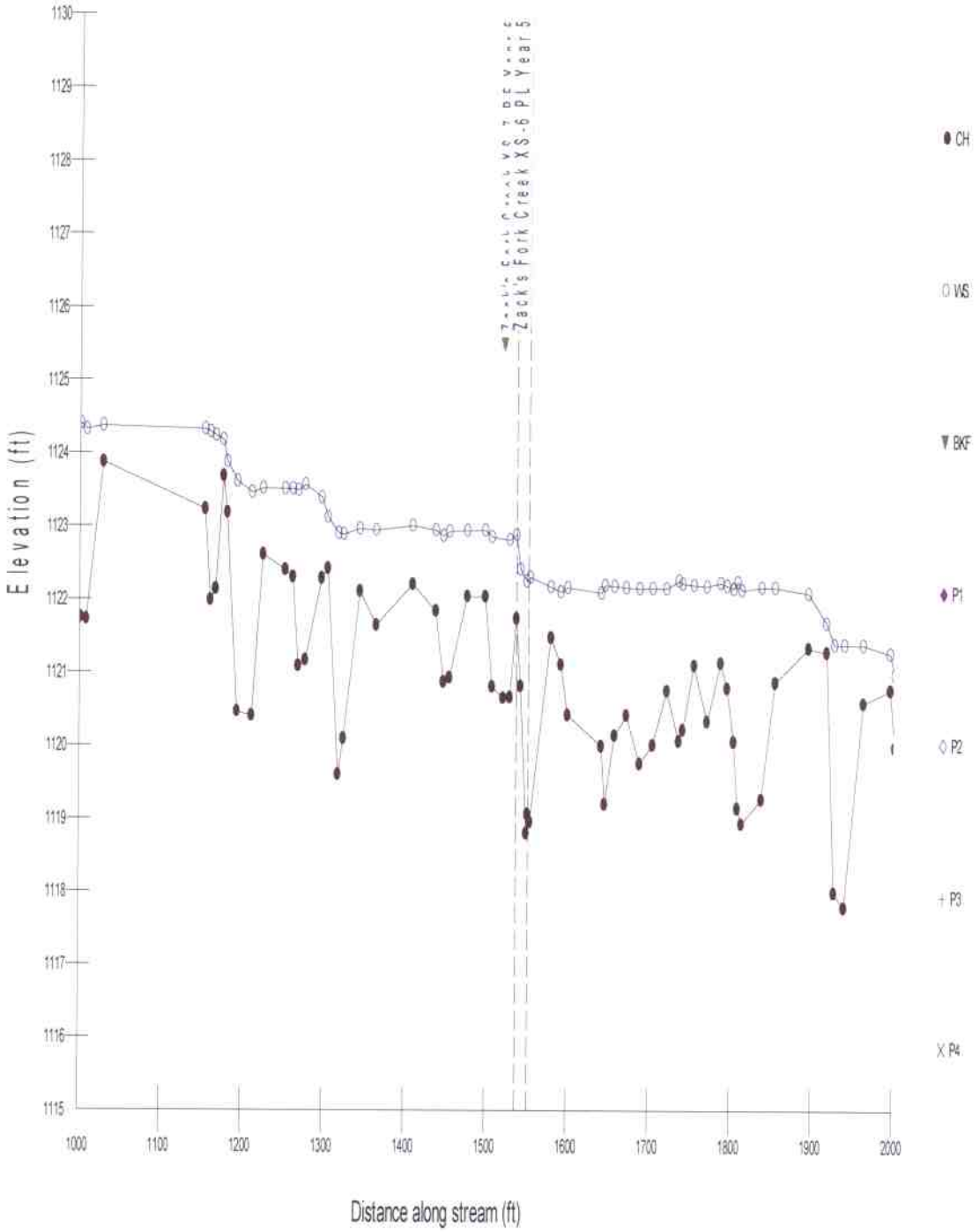
NCDWQ. (2005) *Content, Format and Date Requirements for EEP Monitoring Reports.*

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

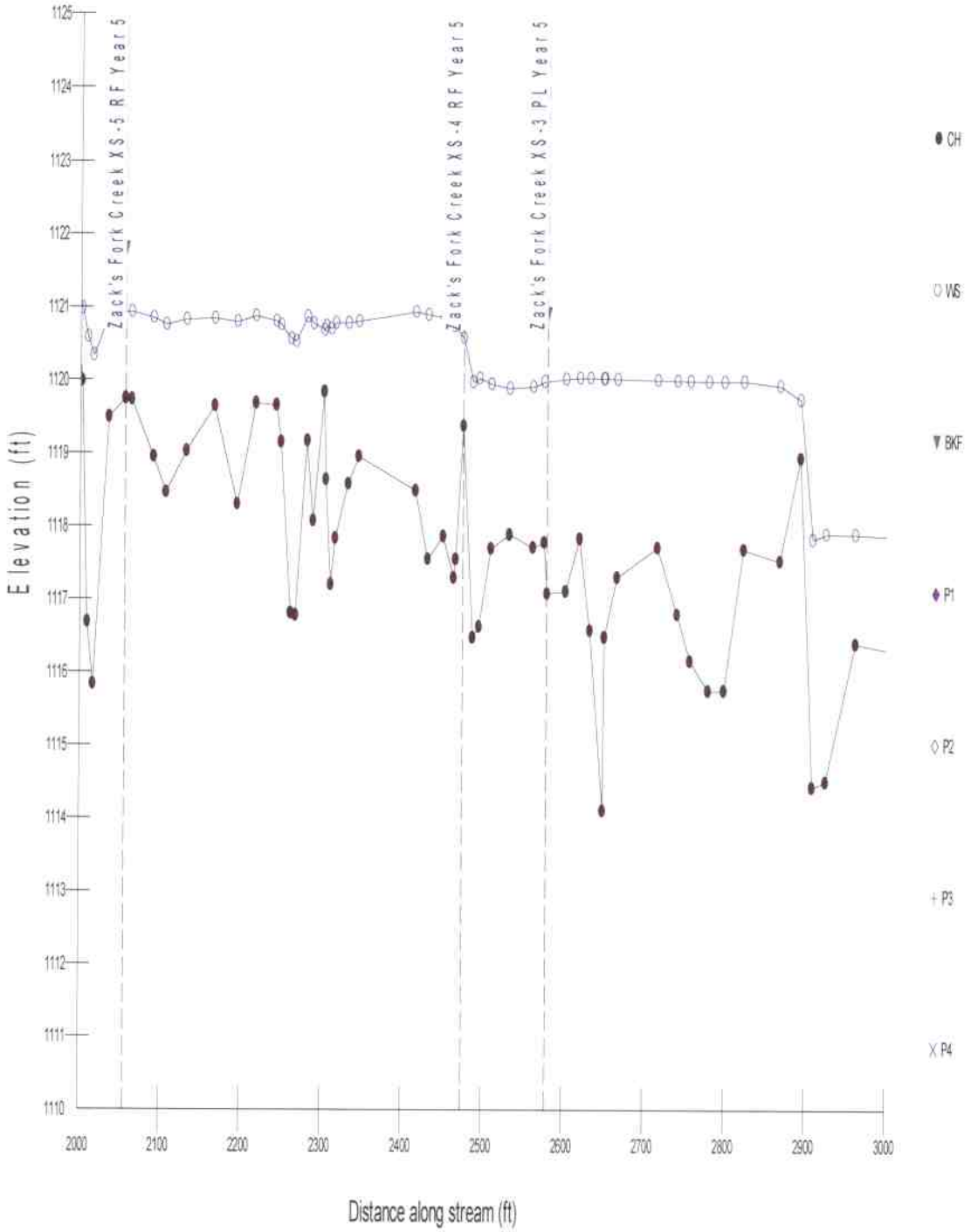
APPENDIX A
Longitudinal and Cross-sectional Profiles and Data

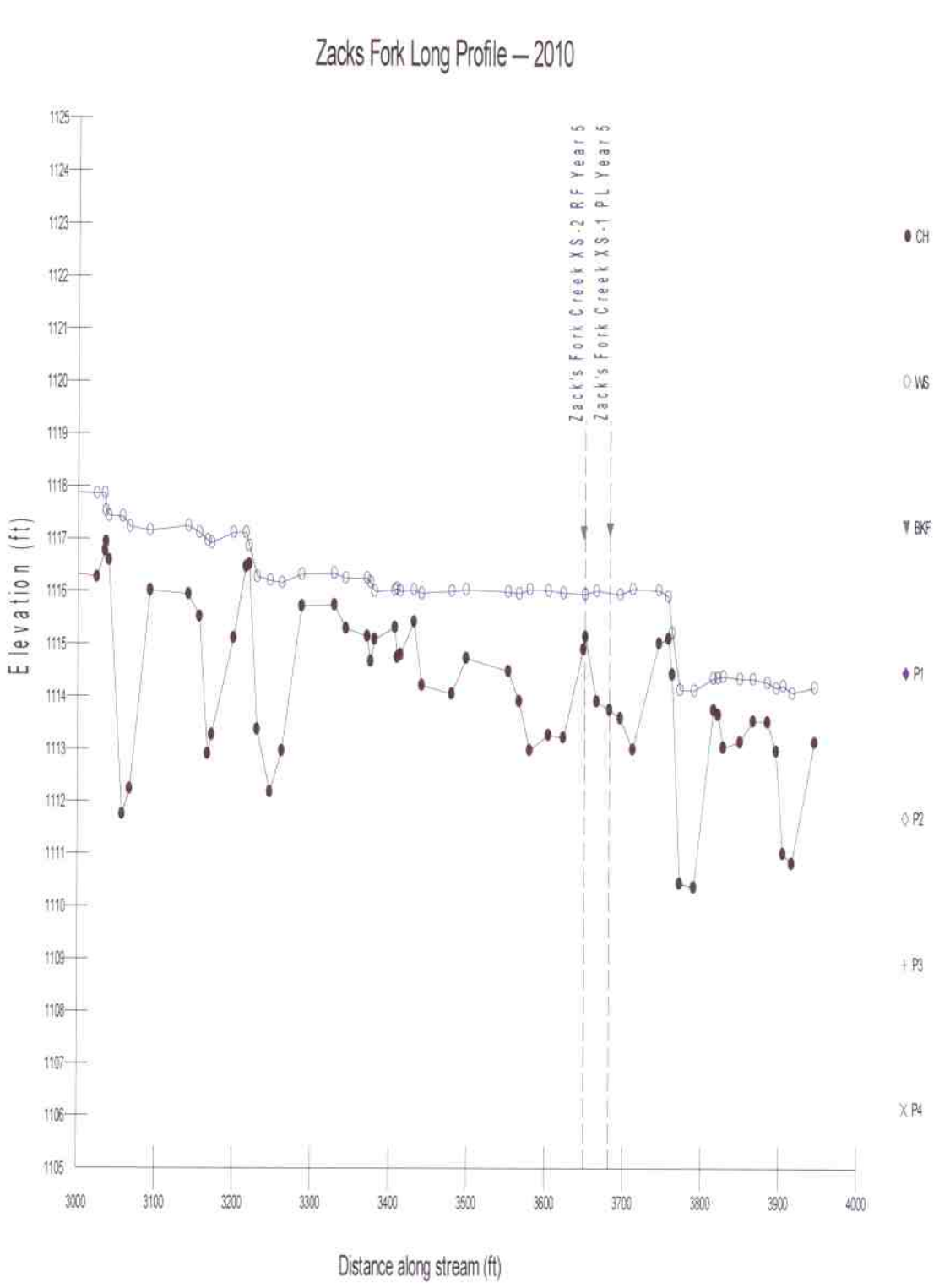

Zacks Fork Long Profile – 2010
Zack's Fork Creek XS-10 PL Year 5
Zack's Fork Creek XS-9 RF Year 5
Zack's Fork Creek XS-8 PL Year 5
CH
WS
BKF
P1
P2
P3
P4
Elevation (ft)
Distance along stream (ft)
1135
1134
1133
1132
1131
1130
1129
1128
1127
1126
1125
1124
1123
1122
1121
1120
0
100
200
300
400
500
600
700
800
900
1000

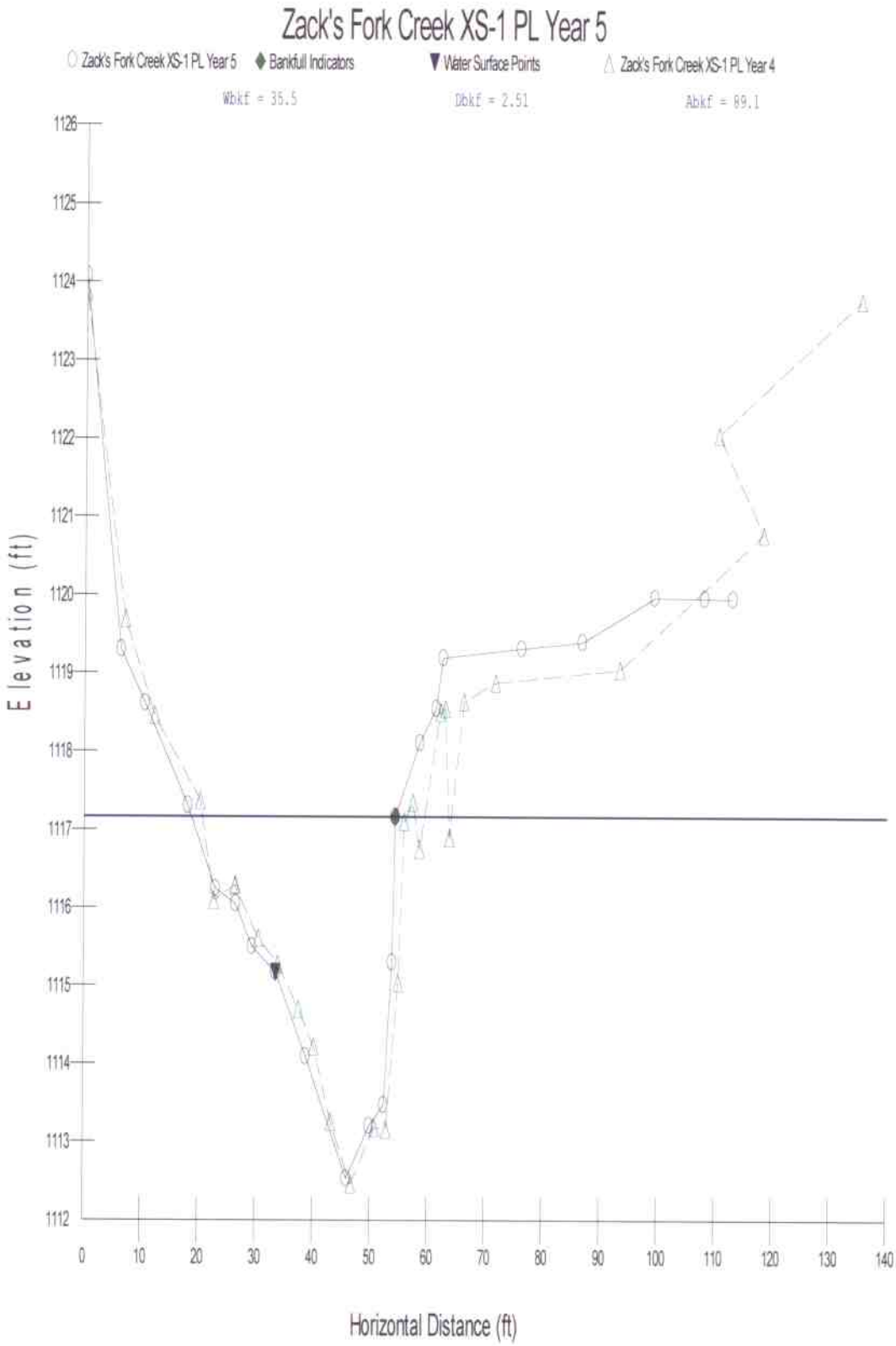
Zacks Fork Long Profile – 2010

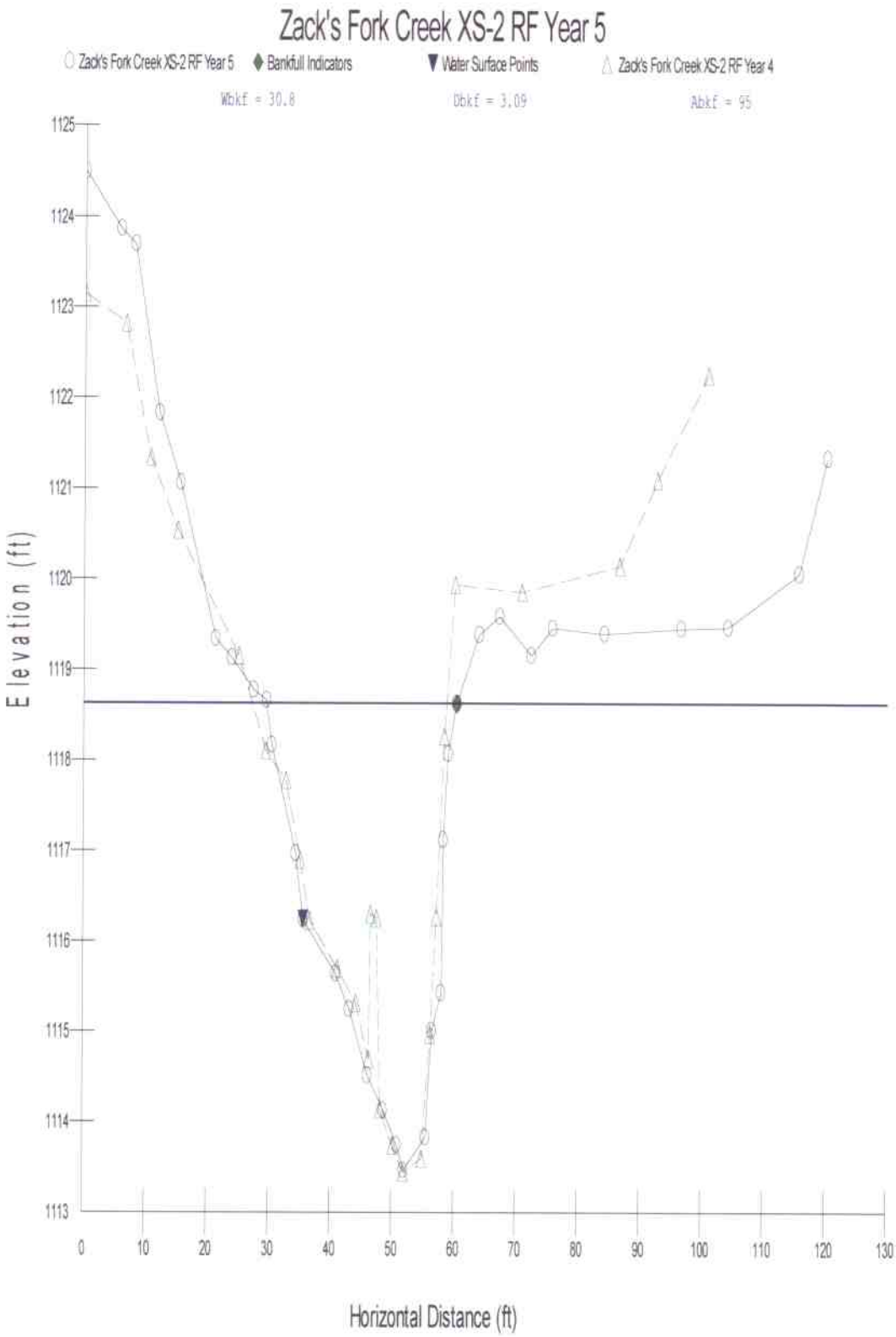


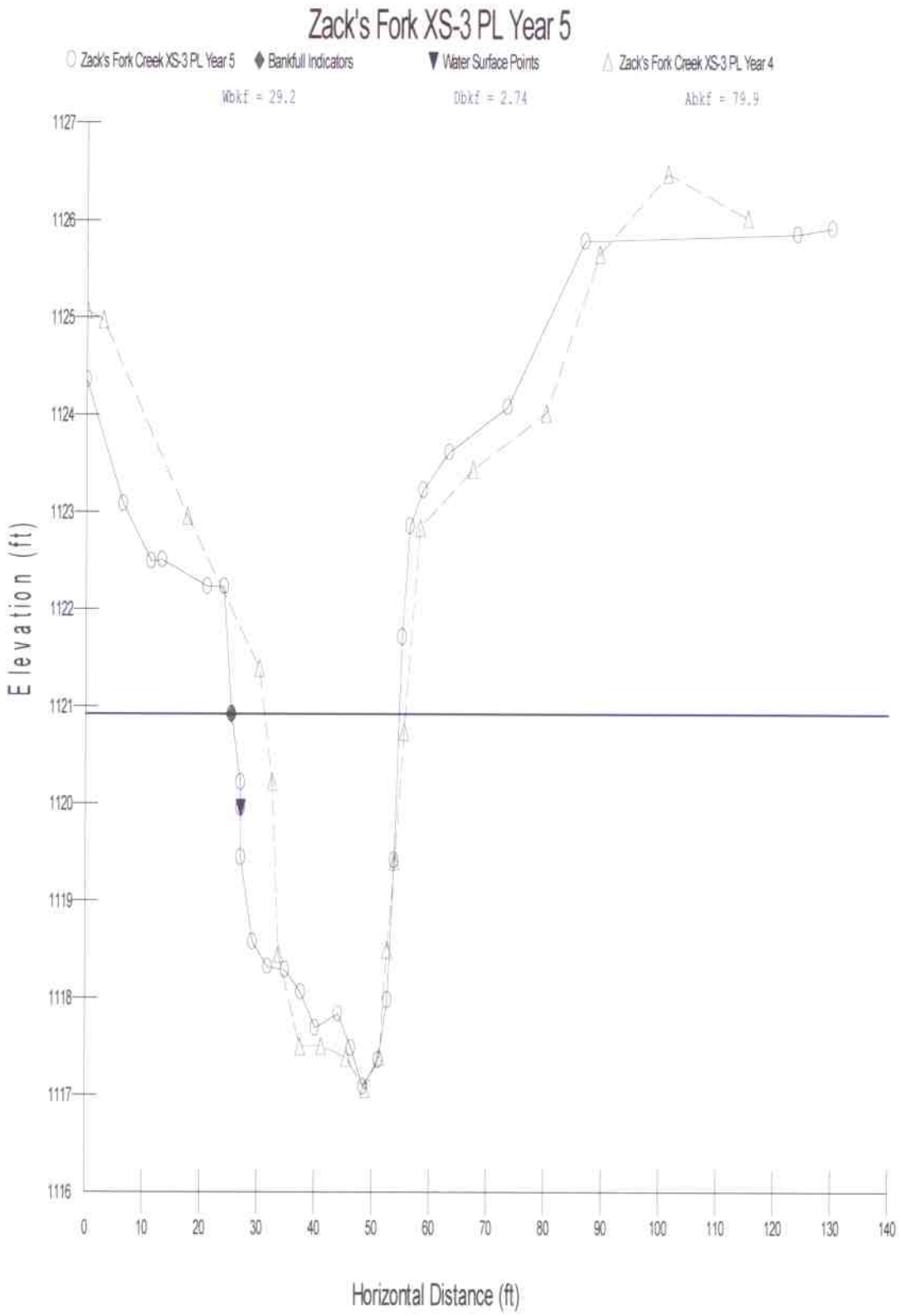
Zacks Fork Long Profile – 2010

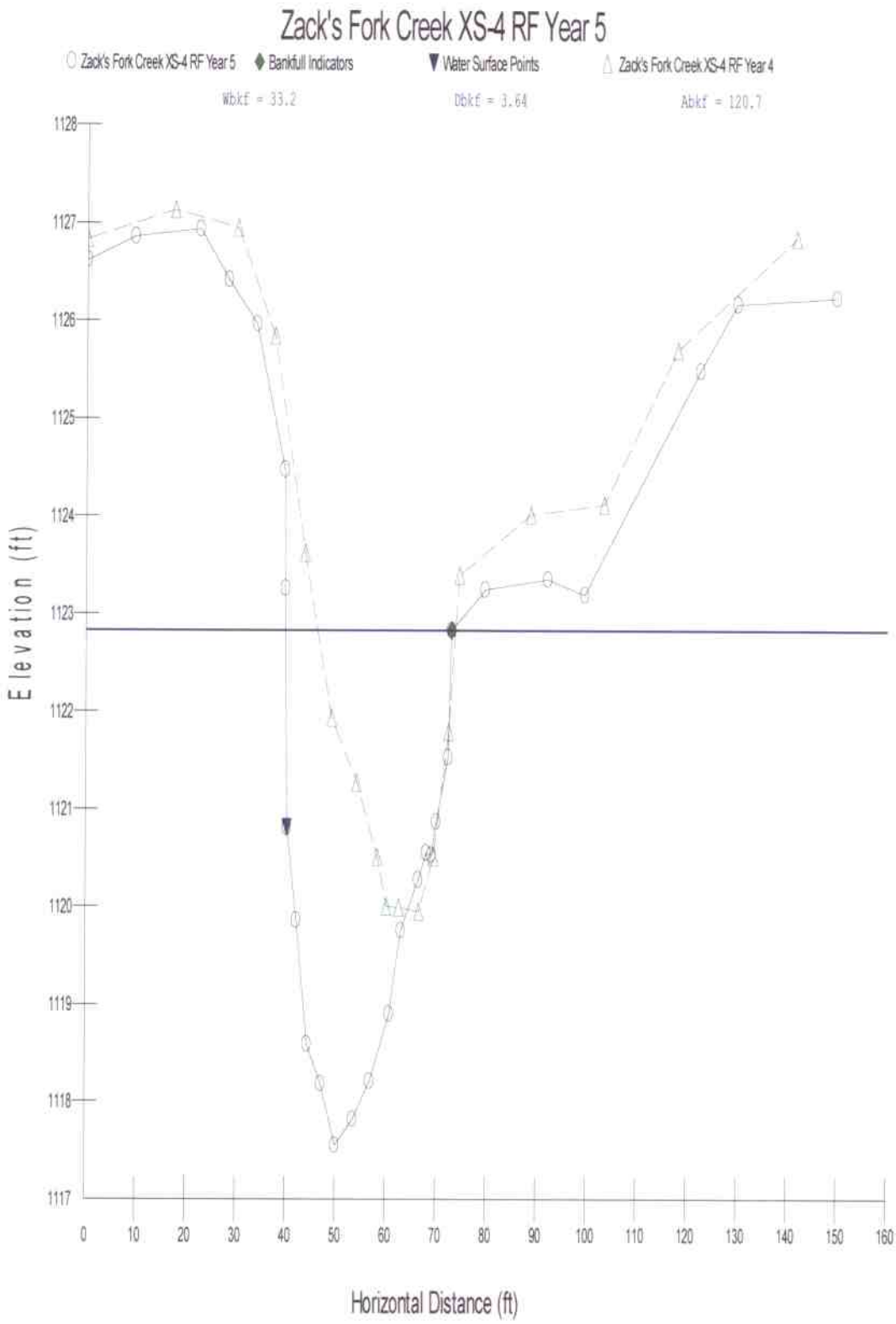


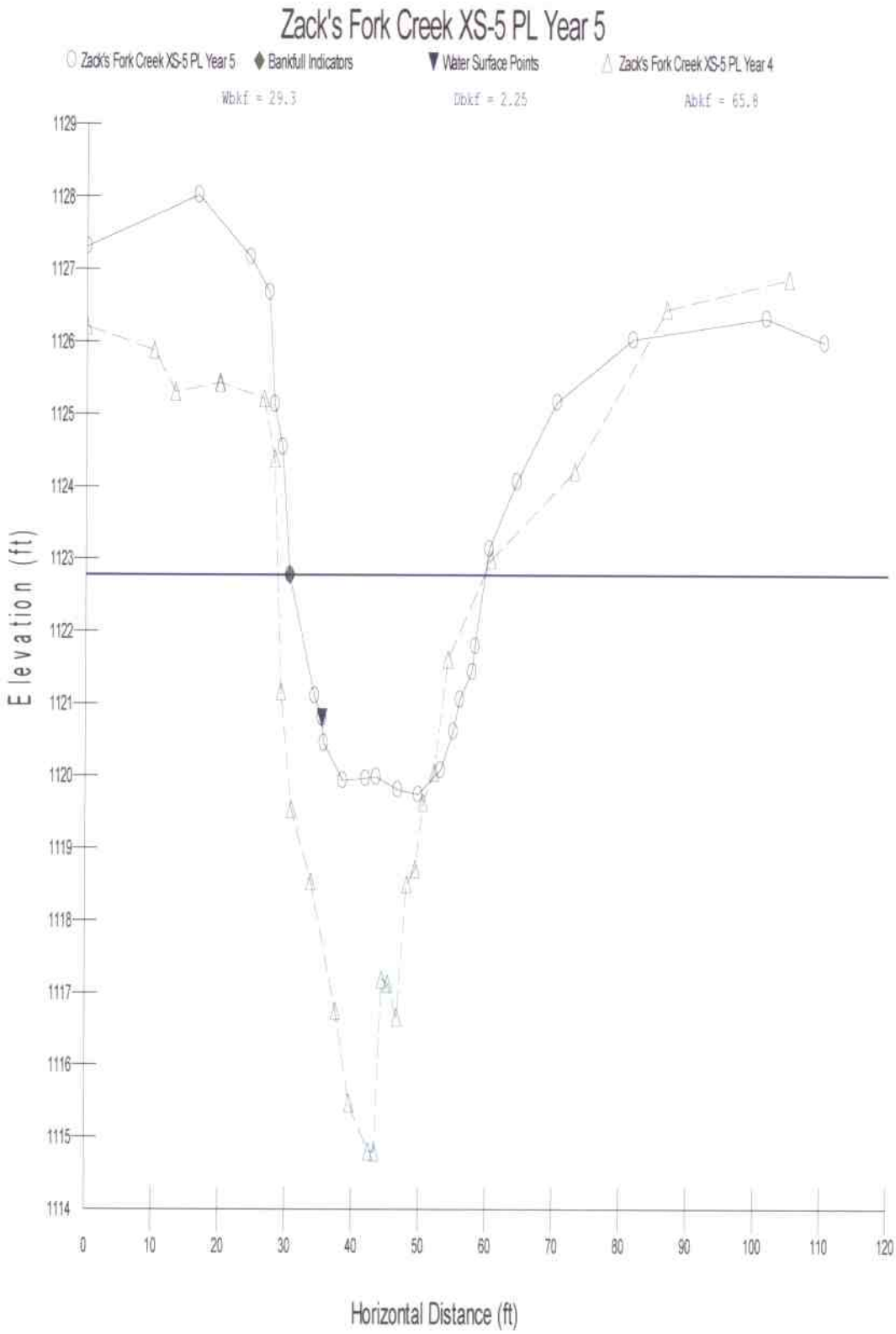

Zacks Fork Long Profile – 2010
Zack's Fork Creek XS-2 RF Year 5
Zack's Fork Creek XS-1 PL Year 5
CH
WS
BKF
P1
P2
P3
P4
Elevation (ft)
Distance along stream (ft)
1125
1124
1123
1122
1121
1120
1119
1118
1117
1116
1115
1114
1113
1112
1111
1110
1109
1108
1107
1106
1105
3000
3100
3200
3300
3400
3500
3600
3700
3800
3900
4000

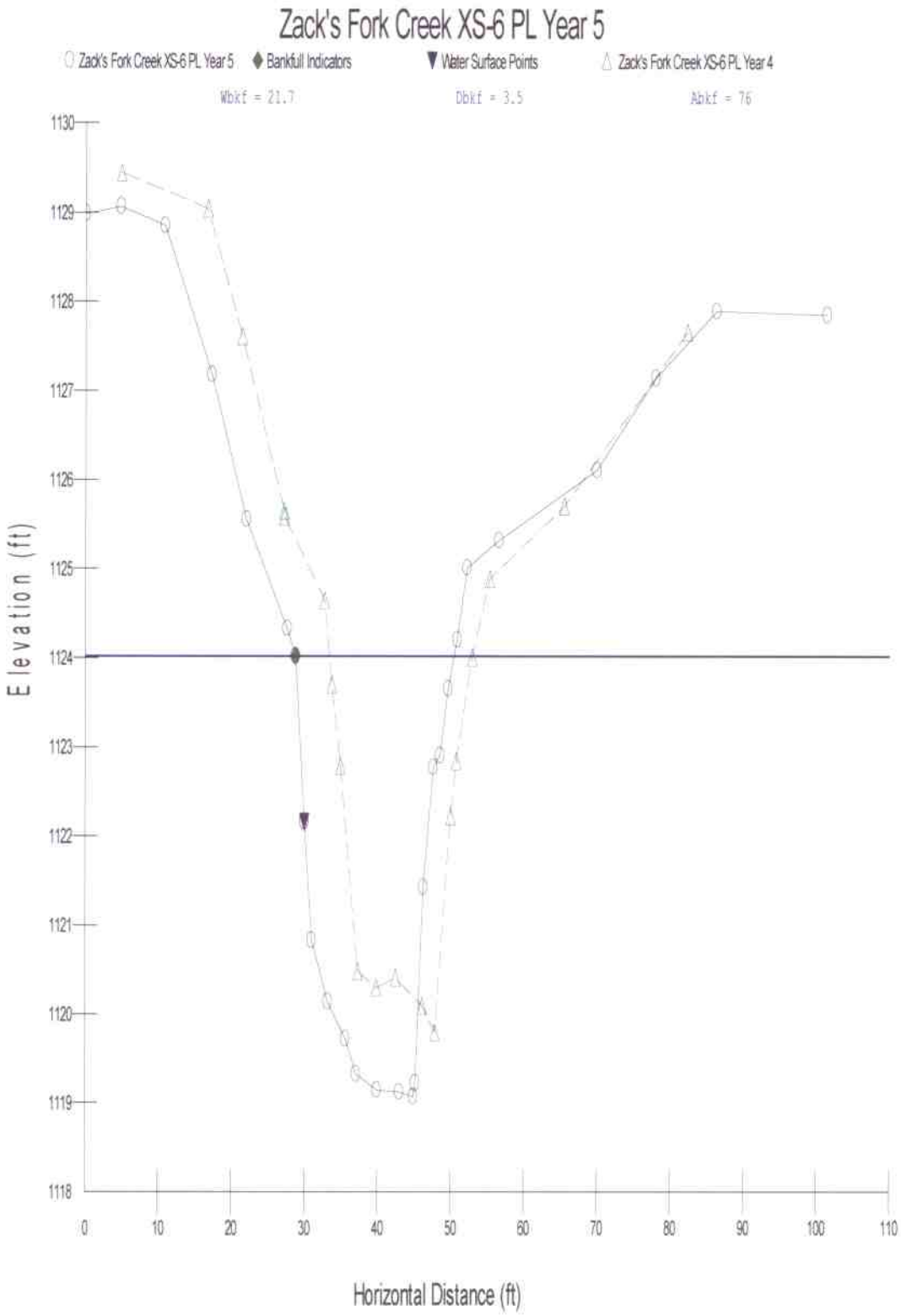

Zack's Fork Creek XS-1 PL Year 5
Zack's Fork Creek XS-1 PL Year 5
Bankfull Indicators
Water Surface Points
Zack's Fork Creek XS-1 PL Year 4
Wbkf = 35.5
Dbkf = 2.51
Abkf = 89.1
Elevation (ft)
1126
1125
1124
1123
1122
1121
1120
1119
1118
1117
1116
1115
1114
1113
1112
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Horizontal Distance (ft)

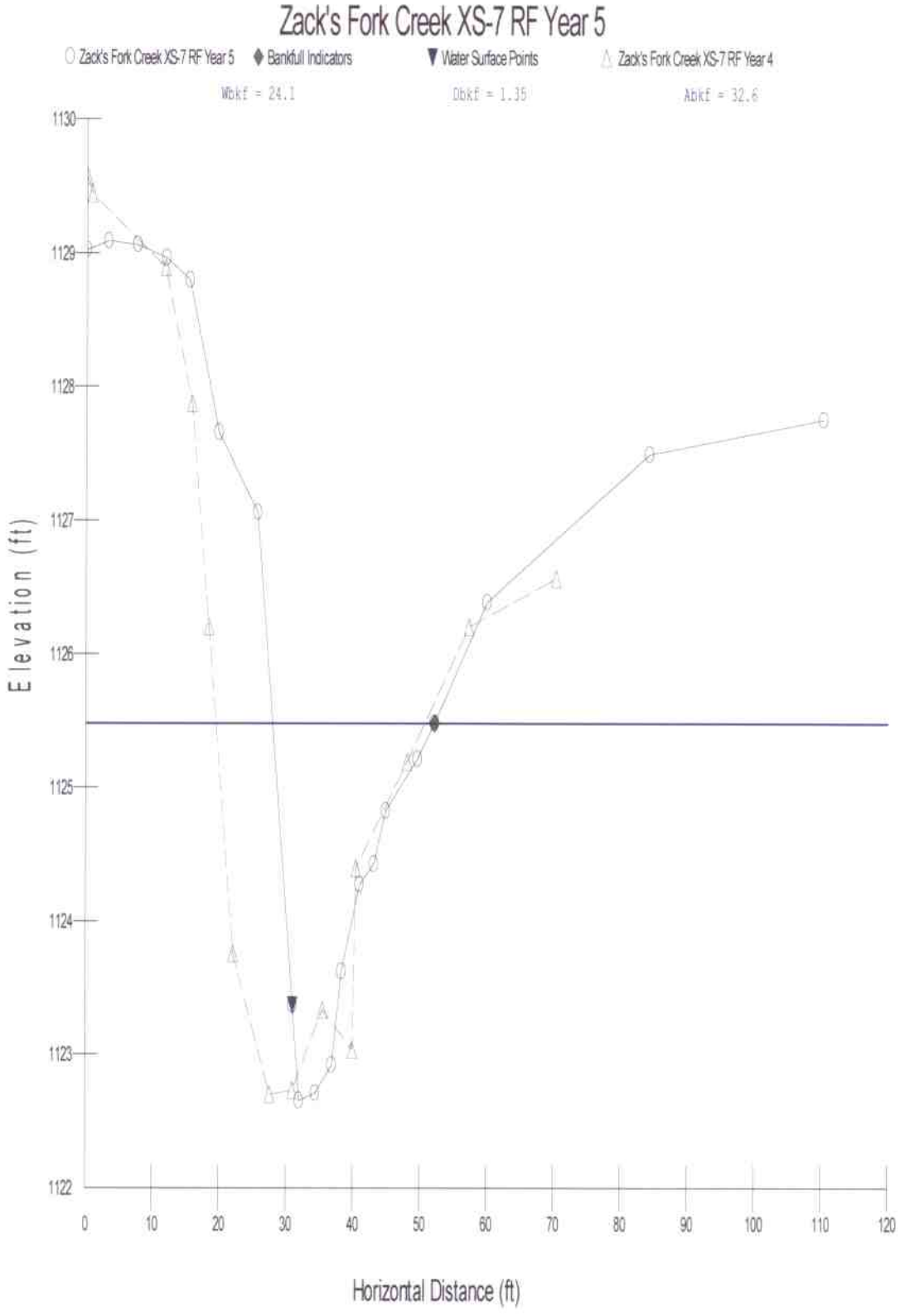

Zack's Fork Creek XS-2 RF Year 5
Zack's Fork Creek XS-2 RF Year 5
Bankfull Indicators
Water Surface Points
Zack's Fork Creek XS-2 RF Year 4
Wbkf = 30.8
Dbkf = 3.09
Abkf = 95
Elevation (ft)
1125
1124
1123
1122
1121
1120
1119
1118
1117
1116
1115
1114
1113
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Horizontal Distance (ft)


Zack's Fork XS-3 PL Year 5
Zack's Fork Creek XS-3 PL Year 5
Bankfull Indicators
Water Surface Points
Zack's Fork Creek XS-3 PL Year 4
Wbkf = 29.2
Dbkf = 2.74
Abkf = 79.9
Elevation (ft)
1127
1126
1125
1124
1123
1122
1121
1120
1119
1118
1117
1116
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Horizontal Distance (ft)

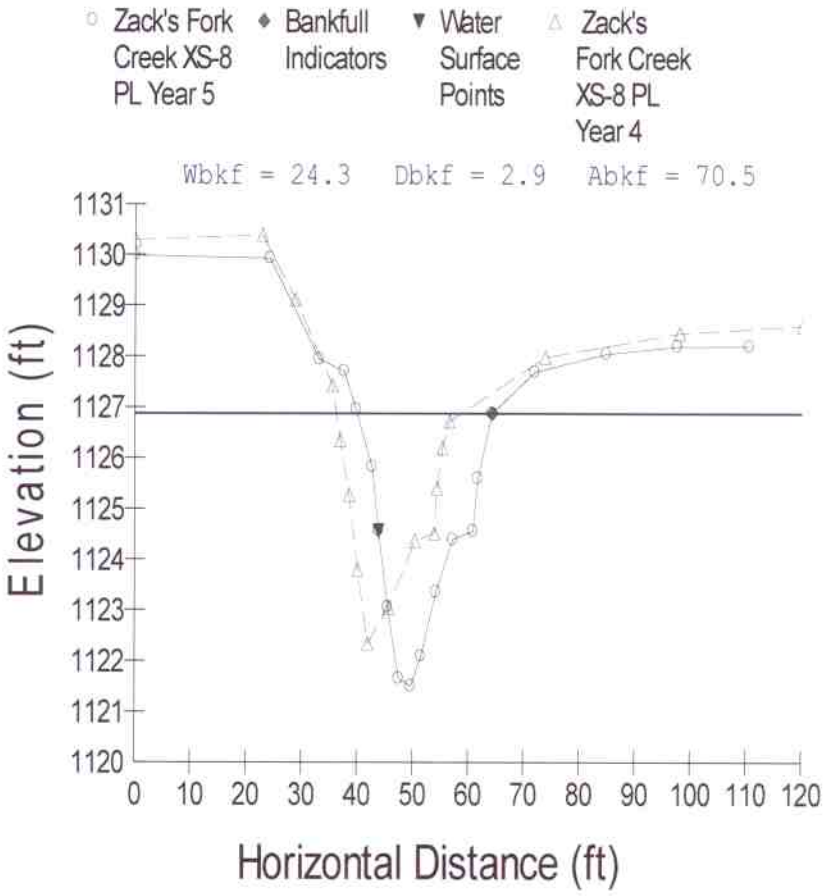

Zack's Fork Creek XS-4 RF Year 5
Zack's Fork Creek XS-4 RF Year 5
Bankfull Indicators
Water Surface Points
Zack's Fork Creek XS-4 RF Year 4
Wbkf = 33.2
Dbkf = 3.64
Abkf = 120.7
Elevation (ft)
Horizontal Distance (ft)
1128
1127
1126
1125
1124
1123
1122
1121
1120
1119
1118
1117
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

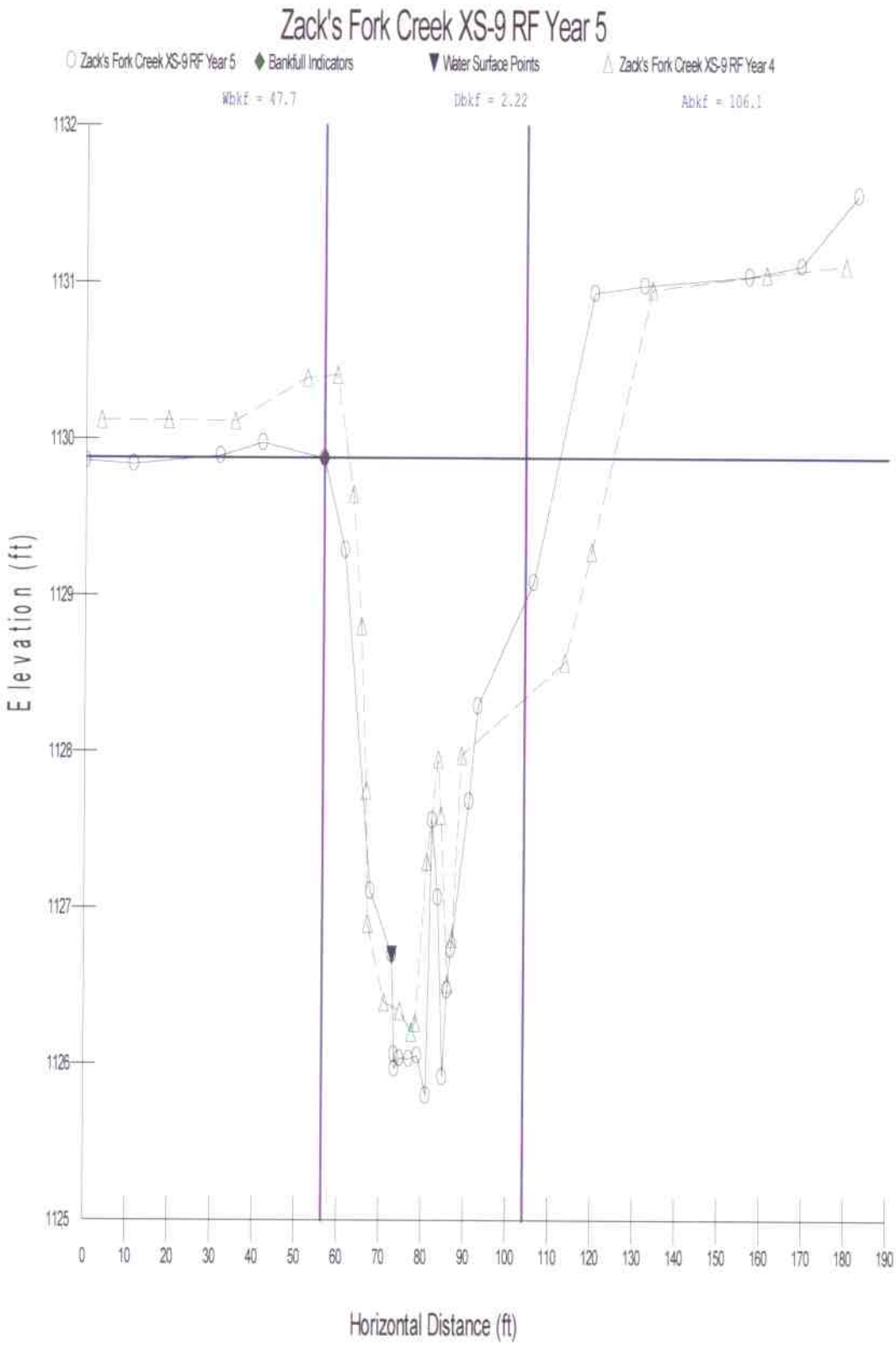

Zack's Fork Creek XS-5 PL Year 5
Zack's Fork Creek XS-5 PL Year 5
Bankfull Indicators
Water Surface Points
Zack's Fork Creek XS-5 PL Year 4
Wbkf = 29.3
Dbkf = 2.25
Abkf = 65.8
Elevation (ft)
1129
1128
1127
1126
1125
1124
1123
1122
1121
1120
1119
1118
1117
1116
1115
1114
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)

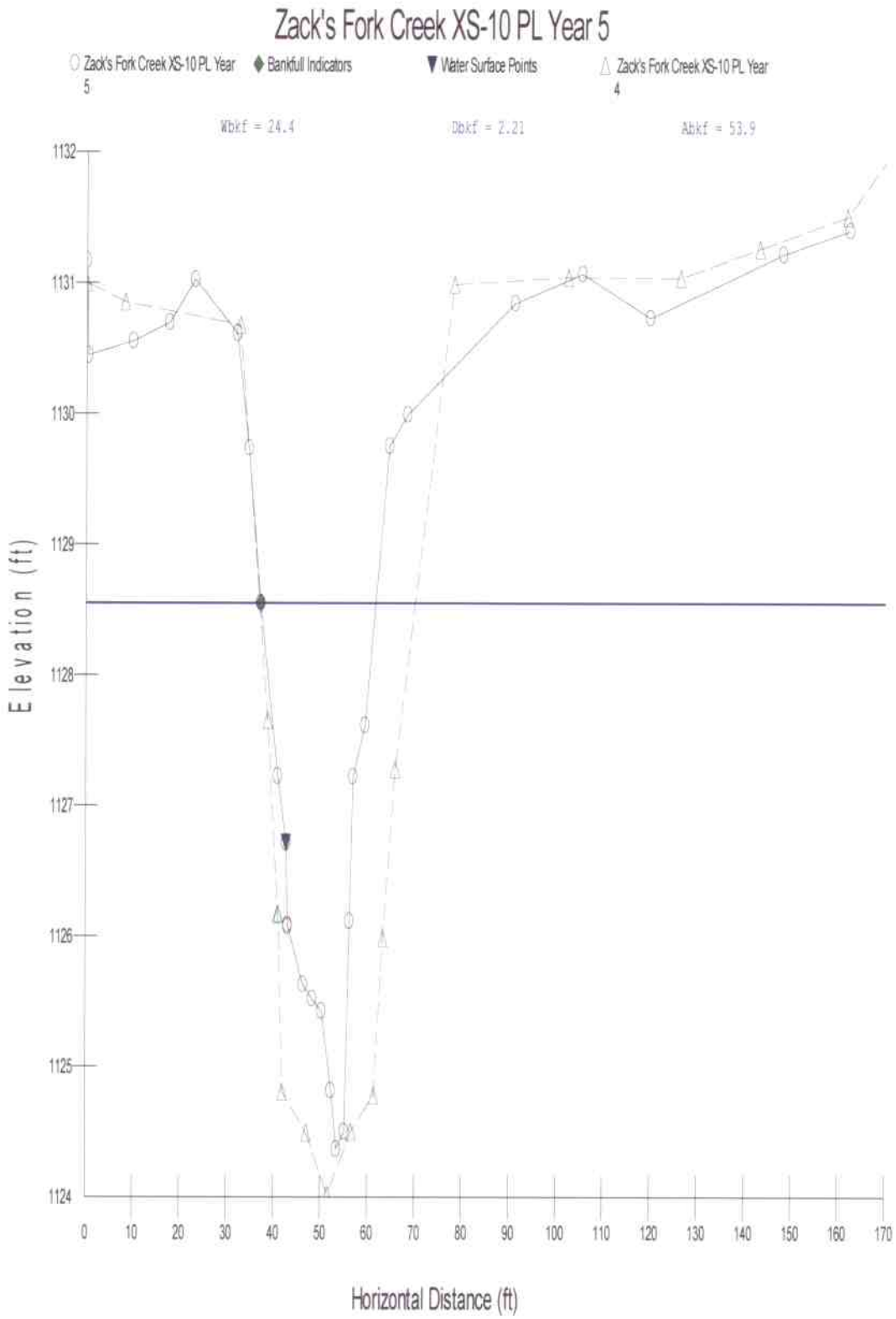

Zack's Fork Creek XS-6 PL Year 5
Zack's Fork Creek XS-6 PL Year 5
Bankfull Indicators
Water Surface Points
Zack's Fork Creek XS-6 PL Year 4
Wbkf = 21.7
Dbkf = 3.5
Abkf = 76
Elevation (ft)
1130
1129
1128
1127
1126
1125
1124
1123
1122
1121
1120
1119
1118
0
10
20
30
40
50
60
70
80
90
100
110
Horizontal Distance (ft)


Zack's Fork Creek XS-7 RF Year 5
Zack's Fork Creek XS-7 RF Year 5
Bankfull Indicators
Water Surface Points
Zack's Fork Creek XS-7 RF Year 4
Wbkf = 24.1
Dbkf = 1.35
Abkf = 32.6
Elevation (ft)
1130
1129
1128
1127
1126
1125
1124
1123
1122
0
10
20
30
40
50
60
70
80
90
100
110
120
Horizontal Distance (ft)

Zack's Fork Creek XS-8 PL Year 5




Zack's Fork Creek XS-9 RF Year 5
Zack's Fork Creek XS-9 RF Year 5
Bankfull Indicators
Water Surface Points
Zack's Fork Creek XS-9 RF Year 4
Wbkf = 47.7
Dbkf = 2.22
Abkf = 106.1
Elevation (ft)
Horizontal Distance (ft)


Zack's Fork Creek XS-10 PL Year 5
Zack's Fork Creek XS-10 PL Year 5
Bankfull Indicators
Water Surface Points
Zack's Fork Creek XS-10 PL Year 4
Wbkf = 24.4
Dbkf = 2.21
Abkf = 53.9
Elevation (ft)
Horizontal Distance (ft)

APPENDIX B
Structures, Representative Photographs

Photo Station 1

Photo Station 2

Photo Station 3

Photo Station 4

Photo Station 5

Photo Station 6

Photo Station 7

Photo Station 8

Photo Station 9

Photo Station 10

Photo Station 11

Photo Station 12

Photo Station 13

Photo Station 14

Photo Station 15

Photo Station 16

Photo Station 17

Photo Station 18

Photo Station 19

Photo Station 20

Photo Station 21

Photo Station 22

Photo Station 23

Photo Station 24

Photo Station 25

Photo Station 26

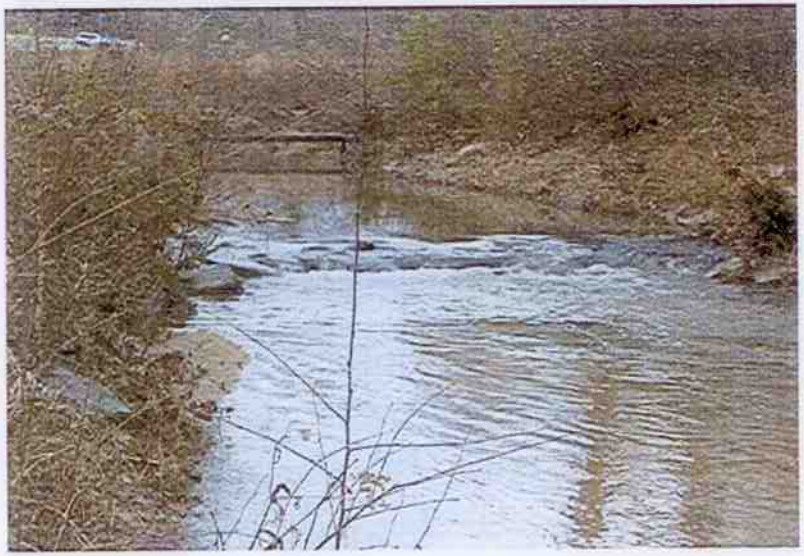


Photo Station 27

Photo Station 28

Photo Station 29

Photo Station 30

Photo Station 31

Photo Station 32

Photo Station 33

Photo Station 34

Photo Station 35

Photo Station 36

Photo Station 37

Photo Station 38

Photo Station 39

Photo Station 40

Photo Station 41

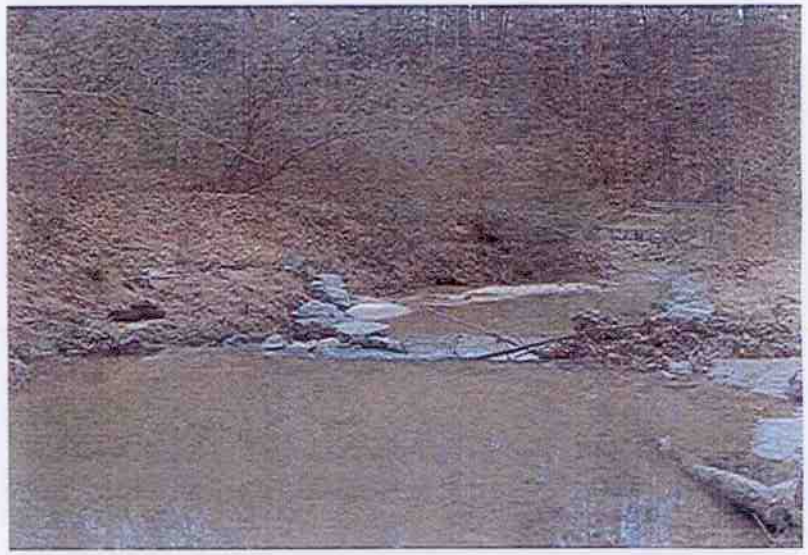


Photo Station 42

Photo Station 43

Photo Station 44

Photo Station 45

Photo Station 46

Photo Station 47

Photo Station 48

APPENDIX C
Vegetative Plots, Representative Photographs

Vegetation Plot 1

Vegetation Plot 2

Vegetation Plot 3

Vegetation Plot 4

Vegetation Plot 5

Vegetation Plot 6

Vegetation Plot 7

Vegetation Plot 8

Vegetation Plot 9

Vegetation Plot 10

Vegetation Plot 11

VPA

APPENDIX D
Stream Problem Areas, Representative Photographs

Problem Area 1 - Left Bank Scour

Problem Area 2 – Mid Channel Bar

Problem Area 3 - Left Bank Scour

Problem Area 4 – Log vane displacement

Problem Area 5 - Right Bank Failure

Problem Area 6 – Mid Channel Bar

Problem Area 7 - Left Bank Scour

ZACKS FORK STREAM RESTORATION
APRIL 2011 REPAIR AREAS
(Photos taken April 28, 2011)

STATION 27+25 – RIGHT BANK REPAIR

STATION 27+25 – RIGHT BANK REPAIR

STATION 31+50 – RIGHT BANK REPAIR

STATION 31+50 – RIGHT BANK REPAIR

STATION 35+00 – RIGHT BANK REPAIR

STATION 35+00 – RIGHT BANK REPAIR

ZACKS FORK STREAM RESTORATION
APRIL 2011 REPAIR AREAS
(Photos taken April 28, 2011)

STATION 36+75 – RIGHT BANK REPAIR

STATION 38+25 – RIGHT BANK REPAIR

STATION 41+00 – RIGHT BANK REPAIR

STATION 41+00 – RIGHT BANK REPAIR

STATION 44+00 – RIGHT BANK REPAIR

STATION 46+50 – RIGHT BANK REPAIR

ZACKS FORK STREAM RESTORATION
JUNE 2011 REVEGETATION AREAS
(Photos taken July 7, 2011)

VEGETATION PLOT 4

VEGETATION PLOT 6

STATION 31+50 – RIGHT BANK REPAIR

STATION 31+50 – RIGHT BANK REPAIR

STATION 35+00 – RIGHT BANK REPAIR

VEGETATION PLOT 8

ZACKS FORK STREAM RESTORATION
JUNE 2011 REVEGETATION AREAS
(Photos taken July 7, 2011)

STATION 36+75 – RIGHT BANK REPAIR

STATION 38+25 – RIGHT BANK REPAIR

STATION 41+00 – RIGHT BANK REPAIR

STATION 44+00 – RIGHT BANK REPAIR

STATION 46+50 – RIGHT BANK REPAIR

STATION 46+50 – RIGHT BANK REPAIR