MITIGATION PLAN and AS-BUILT REPORT

PLEMMONS/KIRKPATRICK-SPRING CREEK MITIGATION SITE

Madison County, North Carolina

FINAL

EEP Project Number: 92607
Contract Number: D06082; Task Order: 06FB05

Period Covered: September 2006 – September 2008

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Prepared by the North Carolina Wildlife Resources Commission
in Partnership with the
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I. Executive Summary

This report summarizes the as-built condition of the Plemmons/Kirkpatrick-Spring Creek stream mitigation project located in Madison County, North Carolina and completed in August 2006. A total of 680 ft of stream channel within a 2.1 acre permanent conservation easement was restored. The riparian buffer averaged 50 feet in width; the buffer area encompassed 1.3 acres.

During construction the left bank berm was removed, a bankfull bench established, and the channel banks reshaped to stable slopes. Additionally, two rock vanes, two J-hook vanes, a log vane, and root wad structures were installed to promote channel stability and enhance aquatic habitat. As-built channel dimension data were collected from eight cross-sections. Riffle bankfull widths ranged from 46 to 54 ft; cross-sectional areas ranged from 152 to 183 ft^2. Riffle mean and maximum depths at bankfull ranged from 2.8 to 3.8 ft and 4.5 to 5.4 ft. The water surface slope was found to be 0.010 ft/ft and the bank height ratio was 1.0. The D50 particle size of the reach-wide pebble count was 31.2 mm, coarse gravel. The D50 of the riffle pebble count at cross-section 8 was 90.0 mm, small cobble.

The project site was revegetated with native plants. Herbaceous plants were established using a perennial seed mixture, whereas, woody vegetation was established by installing livestakes and containerized shrubs and trees. Three vegetation survey plots were established to identify and enumerate planted stems. The average plant density of the three plots was 648 stems per acre. A farm management plan was implemented to eliminate the impacts cattle were having on the stability of the stream banks. The as-built geomorphic, vegetative, and visual assessment surveys of the mitigation site were within the design criteria for this C4 stream channel.

II. Project Background

A. Project Objectives

Project objectives, as stated in the restoration design plan document, were as follows:

- Establish a conservation easement on both stream banks for the entire length of the restoration project;
- Remove the existing invasive exotic vegetation;
- Remove an abandoned barn, automobile bodies, school bus, and other foreign materials from the stream banks and riparian area;
- Remove the berm from the top of the left bank;
- Remove the channel constrictions at stations 3+50 and 4+75;
- Reduce stream bank erosion on the right bank of the meander bend by establishing a stable radius of curvature and installing in-stream structures and bank protection;
- Install two additional in-stream structures to enhance aquatic habitat features;
- Shape banks to a stable slope, create a bankfull bench and inner berm features;
- Re-establish native vegetation within the riparian zone; and
- Design and construct a livestock corral and feed/waste structure, watering system, and install fencing to exclude livestock from the conservation easement and stream.

B. Project Structure, Restoration Type, and Approach

Channel morphology was adjusted by implementing a restoration component type (USACE 2003; Exhibit Table I). Restoration involved removing invasive vegetation, lowering the existing stream banks, and creating a bench so that bankfull or greater flows can access the floodplain. Also, two rock vanes (left bank) and a J-hook log vane (right bank) were installed. Priority III methodologies (NCSRI 2003) were used to eliminate bank sloughing and contain lateral channel migration, including construction of a meander bend to the desired channel dimension, pattern, and profile. J-hook structures were installed at the point-of-curvature and point-of-tangency of the constructed meander. Root-wad structures were placed along the near bank of the restored meander bend to provide added bank protection and aquatic habitat diversity. Overall, the project included 680 ft of stream channel restoration (Exhibit Table I.).

Exhibit Table I. Project Restoration Components
Spring Creek (EEP project number 92607)

Project Segment or Reach ID	Existing Feet	Type	Approach	Footage	Stationing	Comment
Reach I	680	R	P3	680	0+00 to 6+80	

C. Location and Setting

The Spring Creek stream mitigation project is a 2.1 acre site in the west-central portion of Madison County, N.C. (Figure 1). The site is located just off of NC 209, beginning at the downstream side of the Baltimore Branch Road bridge (SR 1151), approximately 3.5 miles north of Trust and 11.5 miles south of Hot Springs, N.C. The Spring Creek project site is located in the U.S. Geological Survey 14 digit hydrologic unit 06010105120010, has a 29.3 mi^2 drainage area, is a fourth order stream at the project location, and is on a tributary to the French Broad River. The project site is in a rural setting of pasture, farmland, and low density dwellings.

D. Project History and Background

Prior to the project, the stream had been destabilized through channelizing, berming (left bank), and livestock hoof-shear (right bank). Landowners had tried to stabilize sloughing vertical banks using buses and automobile bodies, but this approach was unsightly and in most areas created additional problems. The North Carolina Wildlife Resources Commission (NCWRC) performed the initial site assessment, designed the restoration plans, and provided construction oversight (NCWRC 2005). The North Carolina Department of Transportation acquired the site under a previous agreement with the NCWRC. Construction of the Spring Creek project began on 1 Aug 2006 and was completed 25 Aug 2006. Stream and riparian impacts were addressed using natural channel design techniques, eliminating livestock access to the creek, and removing all foreign materials (automobile bodies, storage shed, etc.). The as-built survey was completed in September 2006. Vegetation planting was completed in December 2006; the baseline vegetation survey was completed in January 2007. Additional

project details regarding project history, timeline, background, and contact information are provided in Exhibit Tables II, III, and IV.

Exhibit Table II. Project Activity and Reporting History Spring Creek (EEP project number 92607)		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Conservation easement acquired (by N.C. Department of Transportation)		October 2005
Restoration Plan	July 2005	December 2005
Final Design - 90%	NA	December 2005
Construction		August 2006
Temporary S&E seed mix applied to entire project area		August 2006
Permanent seed mix applied to entire project area		August 2006
As-built physical survey	September 2006	
Containerized plantings installed over entire project area		December 2006
As-built vegetation survey	March 2007	
Mitigation Plan/As-built (Year 0 Monitoring - baseline)		February 2009
Year 1 Monitoring		
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5+ Monitoring		

Bolded items represent those events or deliverables that are variable. Non-bolded items represent events that are standard components over the course of a typical project

Exhibit Table III. Project Contacts Table Spring Creek (EEP project number 92607)	
Designer(s): Jeff Ferguson Scott Loftis	**Firm Information / Address** North Carolina Wildlife Resources Commission 1751Varsity Drive NCSU Centennial Campus Raleigh, NC 27695
Construction Contractor: Todd Hodges	**Firm Information / Address** Constructioneering, LLC P.O. Box 537 Patterson, NC 28661
Planting Contractor: Chad Bradley	**Company Information / Address** Construction and Landscape Services, Inc. 77 Paradise Ridge Marshall, NC 28753
Seeding Contractor: Todd Hodges and NCWRC **Seed Mix Sources** Ernst Conservation Seeds, LLP **Nursery Stock Suppliers** Carolina Native Nursery	**Company Information / Address** Same as above **Company and Contact Phone** 1-800-873-3321 **Company and Contact Phone** 828-682-1471
Monitoring Performers	**Firm Information / Address**
Stream Monitoring POC	
Vegetation Monitoring POC	
Wetland Monitoring POC	

Exhibit Table IV. Project Background Table Spring Creek (EEP project number 92607)	
Project County	Madison
Drainage Area	29.3 mi^2
Drainage impervious cover estimate (%)	<1%
Stream Order (at project location)	4th
Physiographic Region	Blue Ridge Mountains
Ecoregion	Southern Crystalline Ridges and Mountains
Rosgen Classification of As-built	C4
Dominant soil types	Reddies Series
Reference site ID	Basin Creek, Wilkes County, N.C.
USGS HUC for Project and Reference	Project: 06010105120010, Reference: 03040101060010
NCDWQ Sub-basin for Project/Reference	French Broad sub-basin 04-03-04/Yadkin-Pee Dee sub-basin 03-07-01
NCDWQ classification for Project/Reference	C, Tr/C, Tr, ORW
Any portion of any project segment 303d listed?	No
Any portion of project upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	NA
N.C. Division of Water Quality Permit Number	06-0288 Madison County
N.C. Division of Land Resources Permit Number	MADIS-2006-018
U.S. Army Corps of Engineers Action ID Number	200630639
Percent of project easement fenced	Left bank 0% (berm), Right bank 100%.

E. As-built Plan View

The as-built survey defines the baseline condition of the project reach's geomorphology, stability, and vegetation following construction (Figure 2). Eight cross-sections were established for the as-built survey (two each of riffle, run, pool, and glide) to compare channel dimension and stability over time. The channel profile was surveyed for a distance of 680 ft from the upper project boundary at the downstream side of the Baltimore Branch Road bridge (SR 1151) to the lower project boundary. Three vegetation monitoring plots were established following revegetation of the project site. One vegetation plot is located on the left bank at sta. 3+00, and two are located on the right bank at stations 0+50 and 4+50. Fixed position photo-stations were established at seven locations.

III. Methodology

As-built conditions for the Spring Creek mitigation site were determined during September 2006 (channel survey) and March 2007 (vegetation survey). Representative cross-sectional dimension and longitudinal profile data were collected using standard stream channel survey techniques (Harrelson et al. 1994; Doll et al. 2003). The geomorphology of the stream was classified using the Rosgen (1996) stream classification system. Project site, reference reach, and as-built conditions were analyzed and the project design developed using RIVERMorph stream assessment and restoration software, Version 4.0.1 (RSARS 2006) and AutoCAD (2004) Version 2004.0.0. U.S. Geological Survey 1:24,000 topographical maps were used to determine stream drainage area (Maptech 2006). Mountain and piedmont regional hydraulic geometry curve data were used as a field guide and in the mitigation design plan (Harman et al. 1999, 2000; Doll et al. 2002). Bed material composition and mobility was assessed by doing one reach-wide and one riffle cross-section pebble count (NCSRI 2003). Data reduction and vegetation surveys were conducted following protocols of the North Carolina Ecosystem Enhancement Program (NCEEP 2007) and the Carolina Vegetation Survey (CVS 2006). References to the left and right banks in this document are oriented when viewing the channel in the downstream direction.

IV. Project Condition and As-Built Results

A. Vegetation Assessment

The Spring Creek mitigation site was revegetated during December 2006 with a variety of plant types (Appendix A.1.). Annual seed mixes of winter rye grass *Secale cereale* and brown top millet *Panicum ramosum* (30-40 lb/acre) and perennial seed mixes (15 lb/acre) were sown during construction over the entire site (Appendix Table A.7.). Following construction, 1,150 livestakes composed of silky dogwood *Cornus amomum*, nine bark *Physocarpus opulifolius*, and silky willow *Salix sericea* were installed between the water's edge and the bankfull elevation on both banks. Woody plant material (20 species), grown in 1 to 7 gallon size nursery containers, was installed between the top of the channel banks and the conservation easement boundary (Appendix Table A.8.). The conservation easement boundary on the left bank was delineated by a constructed berm 2.5 ft in height; whereas, the right bank conservation easement boundary was defined by a barbed wire fence installed to exclude cattle. The woody vegetation was in good condition upon delivery to the site. A mulch soil conditioner and all purpose plant food were used during the installation of all containerized woody plants. Woody plant material appeared to be performing well following installation and was beginning to bud in late March 2007. A late severe freeze occurred in April 2007, damaging many of the tender stems. Vegetation monitoring following the 2007 growing season will provide insight into the extent of the freeze damage.

Baseline vegetation monitoring occurred just prior to the late freeze. Three 10 m x 10 m vegetation survey plots were established (Figure 2.). Plot 1 is on the left bank at sta. 3+00 and is oriented with the origin (X = 0, Y = 0) located on the upstream left corner of the plot. Plots 2 and 3 are located on the right bank at sta. 0+50 and sta. 4+50 with the origin located on the upstream left corners. Stem counts, plant vigor, and plant damage was assessed for each plot (Appendix Tables A.1.-A.4.).

Stem counts by plot and species were conducted for all three plots. Six planted stems were documented in vegetation plot 1. This equates to a density of 243 stems per acre. Nine planted stems were found in vegetation plot 2 (364 stems per acre). In vegetation plot 3, 33 planted stems were recorded (1,336 stems per acre). Roughly half of the woody stems counted in vegetation plot 3 were live stakes. The average density for the three plots was 648 stems per acre (Appendix Table A.5.).

Eighteen mature trees were left standing within the conservation easement (Figure 2) so as to maintain bank integrity to the extent possible. Most of these trees were located along the top of bank in the proposed design plans. These trees ranged in size from 10-24 in. DBH and included white pine *Pinus strobus*, sycamore *Platanus occidentalis*, black walnut *Juglans nigr*a, black locust *Robinia pseudoacacia*, black willow *Salix nigra*, black cherry *Prunus serotina*, and basswood *Tilia americana*. The bank contours were shaped to reduce the potential for bank scour and to minimize damage to the root masses.

1. Vegetation Problem Areas Plan View

A vegetation problem areas plan view was not required for the as-built report.

2. Vegetation Problem Areas Table

Sparse sprigs of multiflora rose *Rosa multiflora* and Chinese privet *Ligustrum sinense* were observed while performing the as-built site assessment (Appendix Table A.6.).

B. Stream Assessment

1. Procedural Items

a. Morphometric Criteria

As-built morphometric data for eight channel cross-sections, channel pattern, and the longitudinal profile were collected on the 7th and 27th of September 2006 to document baseline conditions. In addition, the locations of all constructed stream features (i.e., rock vanes, log vane, and J-hook vanes) were documented (Figure 2).

b. Hydrologic Criteria

One bankfull event was documented between the end of construction and completion of the as-built survey (Exhibit Table V). A wrack line above the bankfull elevation was observed and photographed for verification on 5 Sep 2006 (Appendix B.9.). To monitor additional bankfull events, a simple crest gauge was installed on the left bank at sta. 2+30, downstream of cross-section 2 and adjacent to a large sycamore tree.

Exhibit Table V. Verification of Bankfull Events
Spring Creek (EEP project number 92607)

Date of Data Collection	Date of Occurrence	Method	Photo # (if available)
5 Sep 2006	1 Sep 2006	Wrack line observation	Appendix B.9.

c. Bank Stability Assessments

Bank erosion hazard index and near bank stress assessments are not conducted as a routine part of the as-built survey. As such, Table VI below is a place holder and not populated with data.

Exhibit Table VI. BEHI and Sediment Export Estimates Spring Creek (EEP project number 92607)															
Time Point	**Segment/Reach**	**Linear Footage or Acreage**	**Extreme**		**Very High**		**High**		**Moderate**		**Low**		**Very Low**		**Sediment Export**
			ft	**%**	**ft**	**%**	**ft**	**%**	**ft**	**%**	**ft**	**%**	**ft**	**%**	**Ton/year**

2. Stream Problem Areas Plan View

No problem areas with regards to channel morphology or stability were observed during the as-built survey (Appendix B.1.). As such, a problem area plan view was not generated.

3. Stream Problem Areas Table

No problem areas were observed during the as-built survey (Appendix B.2.). Appendix Table B.1., Stream Problem Areas, is used as a place holder for future monitoring reports.

4. Numbered Issue Photo Section

No stream channel problem areas were observed during the as-built survey; therefore, no issue or problem area photos are included in the as-built report (Appendix B.3.).

5. Fixed Station Photos

Fixed station photos collected at the time of the as-built survey are provided in Appendix B.4. The fixed station photo log provides views of the mitigation site floodplain and channel (Figure 2).

6. Stability Assessment Table

A visual assessment of the project reach was performed to inspect the morphological stability of the as-built channel condition and to serve as a baseline comparison with future stability monitoring (Appendix B.5.). Channel features, including meanders, stream bed, stream banks, and in-stream structures were examined and enumerated (Appendix Table B.2.). Based on the morphological data, all stream features were found to be stable (Exhibit Table VII).

Exhibit Table VII. Categorical Stream Feature Visual Stability Assessment Spring Creek (EEP project number 92607)						
	Reach I (sta. 0+00 to 6+80)					
Features	**As-built 2006**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	100%					
B. Pools	100%					
C. Thalweg	100%					
D. Meanders	100%					
E. Bed General	100%					
F. Bank Condition	100%					
G. Vanes/J Hooks etc.	100%					
F. Wads and Boulders	100%					

7. Quantitative Measures Summary Tables

As-built morphological data obtained from the cross-sectional and longitudinal profile surveys and pebble counts will be compared with future monitoring data (Exhibit Tables VIII and IX). These data, along with the cross-sectional, longitudinal, and pebble count survey data plots, will be used to evaluate the degree of departure of the channel from the as-built condition (Appendices B.6.-B.8.).

As-built channel dimension data from eight cross-sections were collected along the project reach (Appendix B.6.). As-built channel dimensions were then compared with the range of values for the design, reference reach, and pre-existing conditions for each parameter (Exhibit Table VIII). Design values for riffle bankfull width ranged from 49 to 53 ft; values from the as-built survey approximated the design values and ranged from 46 to 54 ft. The as-built range in bankfull widths were derived from data collected at riffle cross-sections 2, 3, and 8. Cross-section 3 at station 3+24 had a bankfull width of 46 ft, slightly narrower than the design values. Both riffle cross-sections 2 at station 1+77 and 8 at station 6+27 had bankfull widths of 54 ft.

Riffle bankfull cross-sectional area ranged from 152 to 183 ft^2 for the as-built channel. Design values for cross-sectional area ranged from 173 to 200 ft^2. Each of the three riffle cross-sections surveyed approximated the range of design values for cross-sectional area (Exhibit Tables VIII and IX).

Mean depth at bankfull for as-built riffle cross-sections ranged from 2.8 to 3.8 ft (Exhibit Tables VIII and IX). Cross-section 2 had an as-built mean depth of 2.8, slightly below the 3.3-

3.8 ft design values. As-built cross-sections 3 and 8 had as-built mean depths within the design range.

Riffle maximum depth at bankfull design values ranged from 4.6 to 5.4 ft. The existing maximum depth at bankfull for cross-section 8 was 5.4 ft. and remained unchanged following construction. The maximum depth at cross-section 3 was 5.0 ft and was within the range of design values. Maximum depth of 4.5 ft at cross-section 2 (Sta. 1+77) was slightly below the range of design values (Exhibit Tables VIII and IX).

Although the mean entrenchment ratio declined from 3.2 in the pre-existing survey to 2.7 in the as-built survey (Exhibit Table VIII), this change is an artifact of differences in the survey data, particularly the data collected from cross section 8. The metric for vertical containment or channel entrenchment was calculated using the actual length of the riffle cross-section measurements obtained during the existing (longer cross-section measurements) and as-built surveys (shorter cross-section measurements). In neither survey was the true floodprone width determined. Because the Rivermorph software used to evaluate the existing and as-built data assumes floodprone width to be the same as the length of a particular cross section and the distances measured for the pre-existing and as-built cross-sections floodprone widths were different, the resulting decline in the entrenchment ratio does not reflect any real change in the channel morphology. Although the user can override this assumption and enter a value other than the actual cross-section length, this was not done in either survey assessment because the entrenchment ratios for both the existing and as-built riffle cross-sections were >2.2, an indication of a desirable slightly entrenched condition. Entrenchment ratios for both the existing and as-built surveys would be much higher if the actual floodprone width (estimated to be >500 ft) had been used in the calculations. This would have resulted in very small differences between the existing condition and as-built entrenchment ratios. As an example, the entrenchment ratio for cross section 8 would be 9.2 using a floodprone width of 500 ft rather than 2.2 as would be found using the 118.5 ft measured in the as-built survey.

Bank height ratio (BHR), a measure of vertical stability of the channel banks, was improved from conditions of moderately unstable and unstable (BHR = 1.2-1.5) before construction, to a stable condition (BHR = 1.0; Exhibit Table VIII) post-construction. This was accomplished by removing the berm on the left bank and lowering the top of the existing low bank to the design bankfull elevation, thereby creating a bench that will allow bankfull flows to access the floodplain and dissipate stream energy.

The entire 680 ft of as-built channel was surveyed to obtain longitudinal and channel pattern data (Figure 2; Appendix B.7.) from which channel characteristics were calculated (Exhibit Table VIII). The reach water surface slope was 0.010 ft/ft. Following construction, riffle slopes were found to range from 0.002 ft/ft to 0.019 ft/ft.

Reach-wide substrate particle analysis revealed that the D50 and D84 for the existing channel were 43.4 mm and 128.0 mm (Exhibit Table VIII). These values fall within the very coarse gravel and small cobble particle categories. Slight changes were noted for the as-built channel where the D50 was 31.2 mm, coarse gravel, and the D84 was 115.7 mm, small cobble. Plots of

the cumulative percent of particles finer than a specific particle size for the as-built reach-wide and riffle pebble counts are presented in Appendix B.8.

Exhibit Table IX, Morphology and Hydraulic Monitoring Summary, is populated with data for each of the eight cross-sections surveyed during the as-built assessment. It will be used as a baseline for comparison of data collected during future monitoring surveys.

Exhibit Table VIII. Baseline Morphology and Hydraulic Summary
Spring Creek (EEP project number 92607)
Entire Project Reach - 680 feet

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition[b]			Project Reference Stream[b]			Design[b]			As-built		
							n = 2			n = 2			n = 3			n = 3		
Dimension (Riffles only)	Min	Max	Med	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Med
BF Width (ft)						58.0	51.1	52.6	51.8	29.5	37.2	33.3	49.2	52.9	51.6	46.3	54.5	54.3
Floodprone Width (ft)							158.8	168.6	163.7	150.0	329.0	239.5	236.5	518.6	377.5	118.5	157.9	148.6
BF Cross-Sectional Area (ft^2)						200.0	170.4	173.2	171.8	64.9	75.5	70.2	173.2	200.0	182.1	152.2	183.8	175.0
BF Mean Depth (ft)						3.7	3.3	3.3	3.3	2.0	2.2	2.1	3.3	3.8	3.5	2.8	3.8	3.4
BF Max Depth (ft)							5.4	5.4	5.4	3.0	3.3	3.2	4.6	5.4	5.0	4.5	5.4	5.0
Width/Depth Ratio						15.7	15.3	15.9	15.6	13.4	18.3	15.9	14.0	14.0	14.0	12.3	19.4	16.3
Entrenchment Ratio							3.0	3.3	3.2	4.0	11.2	7.6	9.4	10.2	9.8	2.2	3.4	2.7
Bank Height Ratio							1.2	1.5	1.4	1.2	1.3	1.2	1.0	1.0	1.0	1.0	1.0	1.0
Wetted Perimeter (ft)							54.0	55.4	54.7	31.6	38.2	34.9				48.9	59.1	55.9
Hydraulic Radius (ft)							3.1	3.2	3.1	2.0	2.1	2.0	3.1	3.2	3.2	2.7	3.6	3.1
Pattern																		
Channel Beltwidth (ft)							210	250	230	59	75	65	93	118	104	134	134	134
Radius of Curvature (ft)							29	402	156	40	69	51	63	109	85	193	193	193
Meander Wavelength (ft)							860	1518	1188	350	350	350	552	660	589	564	564	564
Meander Width Ratio							4.0	4.8	4.4	1.8	2.3	1.9	3.7	5.7	4.7	2.4	2.4	2.4
Profile																		
Riffle Length (ft)							17.1	42.7	27.8	28.9	120.0	63.6	25.0	75.0	50.0	18.3	69.1	25.4
Riffle Slope (ft/ft)							0.007	0.024	0.016	0.011	0.032	0.022	0.008	0.023	0.016	0.002	0.019	0.010
Pool Length (ft)							50.1	100.2	75.1	16.3	42.7	32.9	25.7	67.2	46.8	20.9	45.1	27.9
Pool Spacing (ft)							302.6	349.5	326.5	285.8	343.9	307.9	450.5	542.0	485.3	82.3	189.1	143.0
Substrate (reach-wide)	Values determined from pooled reach-wide pebble counts based on the proportions of the number of riffles and pools																	
D50 (mm)							43.4			54.5						31.2		
D84 (mm)							128.0			180						115.7		
Additional Reach Parameters																		
Valley Length (ft)								600			900			600			600	
Channel Length (ft)								680			953			680			680	
Sinuosity								1.13			1.06			1.13			1.13	
Water Surface Slope (ft/ft)								0.010			0.014			0.010			0.010	
BF Slope (ft/ft)								0.010			0.014			0.010			0.010	
Rosgen Classification								C4			C4			C4			C4	
Habitat Index[a]																		
Macrobenthos[a]																		

[a]Inclusion will be project specific and determined by as-built monitoring/plan success criteria.
[b] Median values were not generated for existing, reference, or design parameters based on low sample sizes and Rivermorph outputs only provide mean values.

Exhibit Table IX. Morphology and Hydraulic Monitoring Summary
Spring Creek (EEP project number 92607)
Spring Creek, Entire Project Reach - 680 feet

Parameter	**Cross Section 1**						**Cross Section 2**						**Cross Section 3**					
	Sta. 0+85, Run						**Sta. 1+77, Riffle**						**Sta. 3+24, Riffle**					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	54.8						54.3						46.3					
Floodprone Width (ft)	145.6						148.6						157.9					
BF Cross-sectional Area (ft^2)	166.0						152.2						175.0					
BF Mean Depth (ft)	3.0						2.8						3.8					
BF Max Depth (ft)	5.7						4.5						5.0					
Width/Depth Ratio	18.1						19.4						12.3					
Entrenchment Ratio	2.7						2.7						3.4					
Bank Height Ratio	1.0						1.0						1.0					
Wetted Perimeter (ft)	57.6						55.9						48.9					
Hydraulic Radius (ft)	2.9						2.7						3.6					
Substrate (riffle)																		
D50 (mm)																		
D84 (mm)																		

Parameter	**Cross Section 4**						**Cross Section 5**						**Cross Section 6**					
	Sta. 3+91, Pool						**Sta. 4+26, Glide**						**Sta. 4+59, Pool**					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	56.1						53.1						58.1					
Floodprone Width (ft)	145.1						141.8						151.3					
BF Cross-sectional Area (ft^2)	207.2						166.1						196.2					
BF Mean Depth (ft)	3.7						3.1						3.4					
BF Max Depth (ft)	6.6						5.8						6.4					
Width/Depth Ratio	15.2						16.7						17.3					
Entrenchment Ratio	2.6						2.7						2.6					
Bank Height Ratio	1.0						1.0						1.0					
Wetted Perimeter (ft)	59.8						55.7						62.1					
Hydraulic Radius (ft)	3.5						3.0						3.2					
Substrate (riffle)																		
D50 (mm)																		
D84 (mm)																		

Exhibit Table IX. Continued.																		
Parameter	**Cross Section 7**						**Cross Section 8**											
	Sta. 4+77, Glide						**Sta.6+72, Riffle**											
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5						
BF Width (ft)	51.8						54.5											
Floodprone Width (ft)	152.0						118.5											
BF Cross-sectional Area (ft^2)	165.0						182.7											
BF Mean Depth (ft)	3.2						3.4											
BF Max Depth (ft)	5.0						5.4											
Width/Depth Ratio	16.2						16.3											
Entrenchment Ratio	2.9						2.2											
Bank Height Ratio	1.0						1.0											
Wetted Perimeter (ft)	53.4						59.1											
Hydraulic Radius (ft)	3.1						3.1											
Substrate (riffle)																		
D50 (mm)							90.0											
D84 (mm)							154.6											

Parameter	**MY0 (2007)**			**MY1 (XXXX)**			**MY2 (XXXX)**			**MY3 (XXXX)**			**MY4 (XXXX)**			**MY5 (XXXX)**		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	134	134	134															
Radius of Curvature (ft)	193	193	193															
Meander Wavelength (ft)	564	564	564															
Meander Width Ratio	2.4	2.4	2.4															
Profile																		
Riffle Length (ft)	18.3	69.1	25.4															
Riffle Slope (ft/ft)	0.002	0.019	0.010															
Pool Length (ft)	20.9	45.1	27.9															
Pool Spacing (ft)	82.3	189.1	143.0															
Additional Reach Parameters																		
Valley Length (ft)	600																	
Channel Length (ft)	680																	
Sinuosity	1.13																	
Water Surface Slope (ft/ft)	0.010																	
BF Slope (ft/ft)	0.010																	
Rosgen Classification	C4																	
Habitat Index*																		
Macrobenthos*																		

*Inclusion will be project specific and determined by as-built monitoring/plan success criteria.

V. Acknowledgements

Scott Loftis, Jeff Ferguson, and Brent Burgess with the NCWRC watershed enhancement group collected and analyzed the field data. Scott loftis and Jeff Ferguson prepared this report. Jim Borawa with the NCWRC provided comments for improving this report.

VI. References

AutoCAD. 2004. Version 2004.0.0. Copyright 2004, AutoDesk, Inc., San Rafael, California.

CVS (Carolina Vegetation Survey). 2006. CVS-EEP protocol for recording vegetation, version 4, levels 1-2. University of North Carolina at Chapel Hill, Department of Biology, Chapel Hill. Available: http://cvs.bio.unc.edu/protocol/cvs-eep-manual-v4_lev1-2.pdf. (March 2008).

Doll, B. A., D. E. Wise, C. M. Buckner, S. D. Wilkerson, W. A. Harman, R. E. Smith, and J. Spooner. 2002. Hydraulic geometry relationships for urban streams throughout the piedmont of North Carolina. Journal of American Water Resources Association, 38(3):641-651.

Harman, W. A., G. D. Jennings, J. M. Patterson, D. R. Clinton, L. O. Slate, A G. Jessup, J. R. Everhart, and R. E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Pages 401-408 *in* D. S. Olsen and J. P. Potyondy, editors. American Water Resources Association, Wildland Hydrology Symposium Proceedings. American Water Resources Association, Middleburg, Virginia.

Harman, W. A, D. E. Wise, M. A. Walker, R. Morris, M. A. Cantrell, M. Clemmons, G. D. Jennings, D. Clinton, and J. Patterson. 2000. Bankfull regional curves for North Carolina mountain streams. Pages 185-190 *in* D. L. Kane, editor. Proceedings of the American Water Resources Association Conference: Water Resources in Extreme Environments. American Water Resources Association, Middleburg, Virginia.

Harrelson, C. C., J. P. Potyondy, and C. L. Rawlins. 1994. Stream channel reference sites: an illustrated guide to field technique. General Technical Report RM-245, U.S. Department of Agriculture, Forest Service, Fort Collins, Colorado.

Maptech. 2006. Terrain navigator pro. Copyright 2006. Maptech Inc., Amesbury, Maine. Available: www.maptech.com. (March 2008).

NCSRI (North Carolina Stream Restoration Institute). 2003. Stream restoration: a natural channel design handbook. North Carolina Stream Restoration Institute and North Carolina Sea Grant, North Carolina State University, Raleigh. Available: www.bae.ncsu.edu/programs/extension/wqg/sri/. (July 2007).

NCEEP (North Carolina Ecosystem Enhancement Program). 2007. The North Carolina Ecosystem Enhancement Program (Website) Raleigh. Available: http://www.nceep.net. (March 2008).

NCWRC (North Carolina Wildlife Resources Commission, Divisions of Inland Fisheries and Engineering Services). 2005. Stream and riparian restoration plan, Plemmons/Kirkpatrick mitigation site, Spring Creek, Madison County, N.C. North Carolina Wildlife Resources Commission, Raleigh.

Rosgen, D. L. 1996. Applied river morphology. Printed Media Companies, Minneapolis, Minnesota.

RSARS (RIVERMorph Stream Assessment and Restoration Software). 2006. Version 4.0.1 Professional edition. Copyright 2002-2006, RIVERMorph LLC, Louisville, Kentucky. Available: www.rivermorph.com. (July 2007).

USACE (United States Army Corps of Engineers). 2003. Stream Mitigation Guidelines. Prepared with cooperation from the U.S. Environmental Protection Agency, N.C. Wildlife Resources Commission, and the N.C. Division of Water Quality. U.S. Army Corps of Engineers, Wilmington District, N.C. Available: www.sw.usace.army.mil/wetlands/mitigation/stream_mitigation.html.

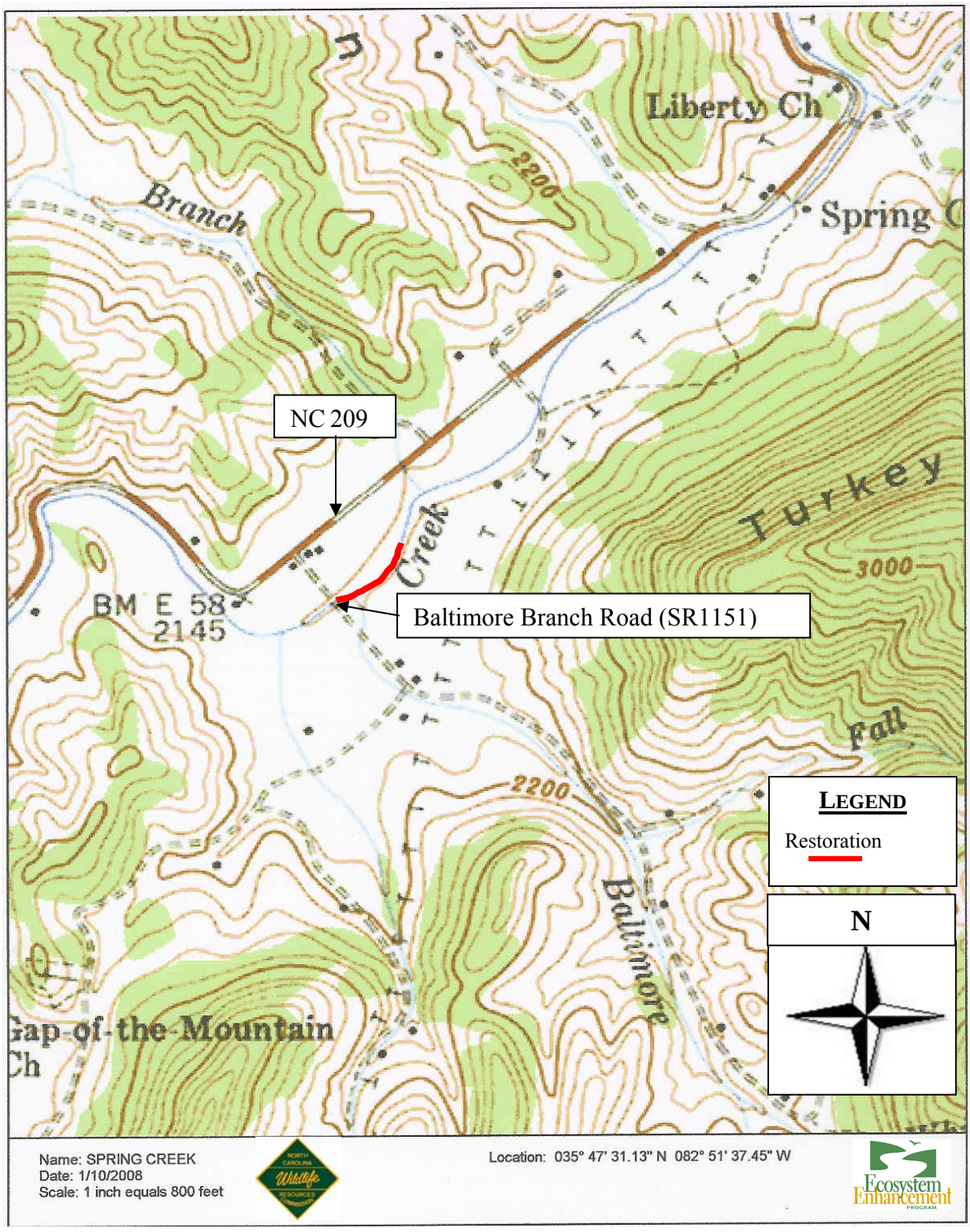


FIGURE 1.—Plemmons/Kirkpatrick mitigation site, Spring Creek, French Broad River basin, Madison County, N.C. EEP project number 92607.

NOTE:

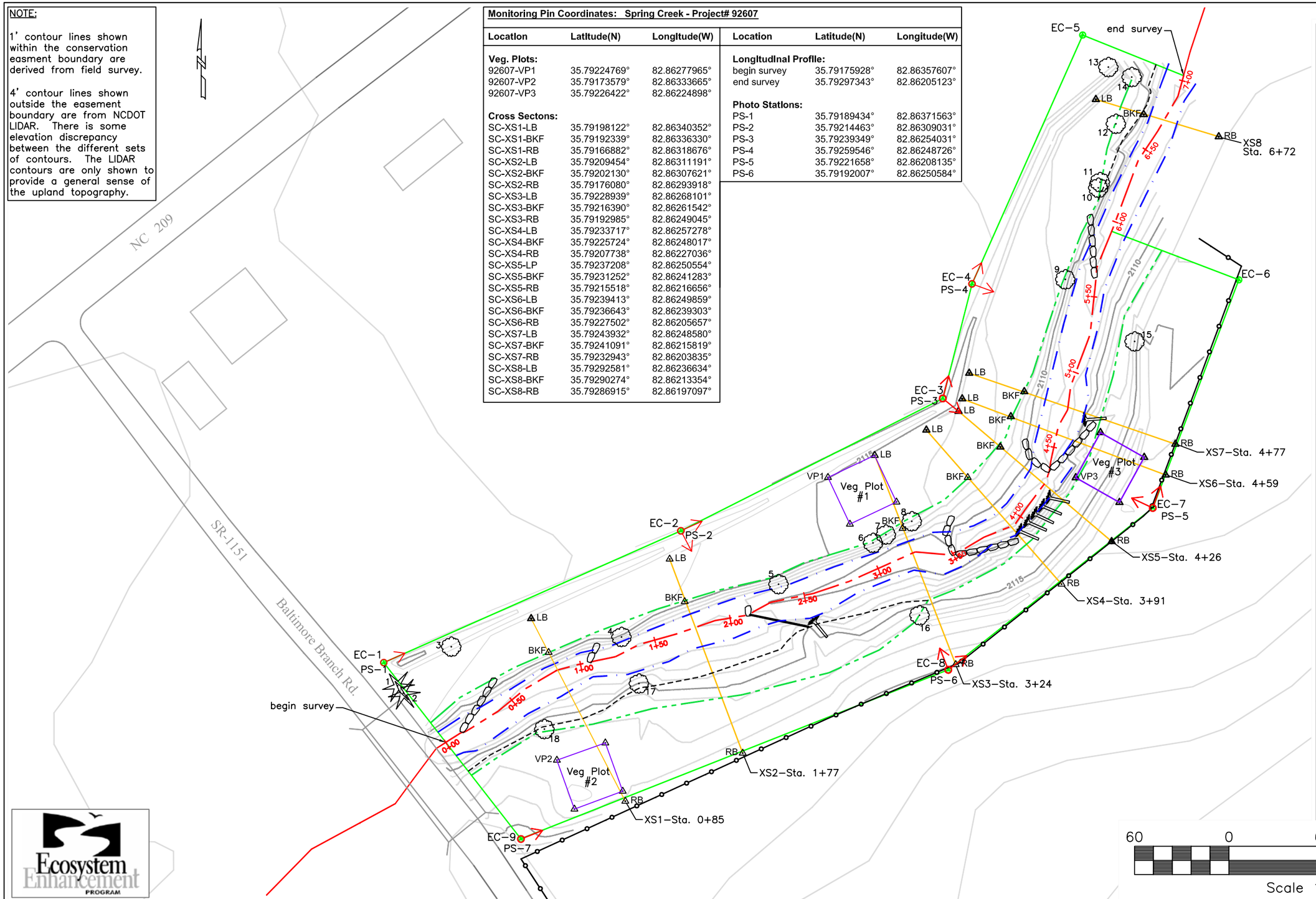
1' contour lines shown within the conservation easment boundary are derived from field survey.

4' contour lines shown outside the easement boundary are from NCDOT LIDAR. There is some elevation discrepancy between the different sets of contours. The LIDAR contours are only shown to provide a general sense of the upland topography.

Monitoring Pin Coordinates: Spring Creek - Project# 92607

Location	Latitude(N)	Longitude(W)
Veg. Plots:		
92607-VP1	35.79224769°	82.86277965°
92607-VP2	35.79173579°	82.86333665°
92607-VP3	35.79226422°	82.86224898°
Cross Sectons:		
SC-XS1-LB	35.79198122°	82.86340352°
SC-XS1-BKF	35.79192339°	82.86336330°
SC-XS1-RB	35.79166882°	82.86318676°
SC-XS2-LB	35.79209454°	82.86311191°
SC-XS2-BKF	35.79202130°	82.86307621°
SC-XS2-RB	35.79176080°	82.86293918°
SC-XS3-LB	35.79228939°	82.86268101°
SC-XS3-BKF	35.79216390°	82.86261542°
SC-XS3-RB	35.79192985°	82.86249045°
SC-XS4-LB	35.79233717°	82.86257278°
SC-XS4-BKF	35.79225724°	82.86248017°
SC-XS4-RB	35.79207738°	82.86227036°
SC-XS5-LP	35.79237208°	82.86250554°
SC-XS5-BKF	35.79231252°	82.86241283°
SC-XS5-RB	35.79215518°	82.86216656°
SC-XS6-LB	35.79239413°	82.86249859°
SC-XS6-BKF	35.79236643°	82.86239303°
SC-XS6-RB	35.79227502°	82.86205657°
SC-XS7-LB	35.79243932°	82.86248580°
SC-XS7-BKF	35.79241091°	82.86215819°
SC-XS7-RB	35.79232943°	82.86203835°
SC-XS8-LB	35.79292581°	82.86236634°
SC-XS8-BKF	35.79290274°	82.86213354°
SC-XS8-RB	35.79286915°	82.86197097°

Location	Latitude(N)	Longitude(W)
Longitudinal Profile:		
begin survey	35.79175928°	82.86357607°
end survey	35.79297343°	82.86205123°
Photo Stations:		
PS-1	35.79189434°	82.86371563°
PS-2	35.79214463°	82.86309031°
PS-3	35.79239349°	82.86254031°
PS-4	35.79259546°	82.86248726°
PS-5	35.79221658°	82.86208135°
PS-6	35.79192007°	82.86250584°



Legend

- Thalweg
- Edge of Water
- Top of Bank
- Bankfull (when not @ TB)
- Existing Fence Line
- Easement Boundary
- Permanent Cross Section
- Veg. Plot
- EC-# Easement Cap
- PS-# Photo Station Location
- Rebar Pin Set
- Root Wad
- Rock J-hook
- Rock Vane
- Log Vane
- Deciduous Tree
- Coniferous Tree

Large Tree Legend

1. 12" White Pine	10. 32" Sycamore
2. 18" White Pine	11. 24" Sycamore
3. 14" Black Locust	12. 20" Basswood
4. 24" Sycamore	13. 22" Black Walnut
5. 18" Sycamore	14. 28" Basswood
6. 16" Sycamore	15. Triple Sycamore
7. 24" Sycamore	16. 20" Forked Cherry
8. 24" Sycamore	17. 10" Black Willow
9. 22" Sycamore	18. 10" Black Walnut

60 0 60 120 180

Scale 1" = 60'

Ecosystem Enhancement Program

NORTH CAROLINA WILDLIFE RESOURCES COMMISSION
WATERSHED ENHANCEMENT GROUP
20830 GREAT SMOKY MOUNTAIN EXPRESSWAY
WAYNESVILLE, NORTH CAROLINA 28786
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Spring Creek Project #92607

Madison County — Plemmons-Kirkpatrick Site

As-Built Survey

DRAWN BY: JCF	DATE: 01-08
APPROVED:	DATE:
SURVEY BY: CSL, JCF	DATE: 09-06
CAD FILE ID: pkasblt.dwg	

SHEET 1 OF 1

FIGURE 2. - Plemmons/Kirkpatrick Mitigation Site, Spring Creek, French Broad River Drainage, Madison County, NC. EEP Project #92607, As-Built Plan View.

APPENDIX A

Appendix A.1. Vegetation Survey Data Tables

Appendix Table A.1: Vegetation Metadata Spring Creek (EEP project number 92607)	
Report Prepared By	C. Scott Loftis
Date Prepared	15 Jan 08 16:35
Database Name	NCWRCBalsam-07-A.mdb
Database Location	C:\Documents and Settings\Micky Clemmons\My Documents\ My Data\Restoration Projects\CVS-EEP veg data
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT	
Metadata	This worksheet, which is a summary of the project and the project data.
Plots	List of plots surveyed.
Vigor	Frequency distribution of vigor classes.
Vigor by Spp.	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp.	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Stem Count by Plot and Spp.	Count of living stems of each species for each plot; dead and missing stems are excluded.
PROJECT SUMMARY	
Project Code/Number	92607
Project Name	Plemmons/Kirkpatrick-Spring Creek
Description	Spring Creek, Madison County, NC
Length (ft)	680
Stream-to-Edge Width (ft)	50
Area (sq m)	8,498.4 (2.1 acres)
Required Plots (calculated)	3
Sampled Plots	3

- **Appendix A.1. Continued.**

Appendix Table A.2: Vegetation Vigor by Species Spring Creek (EEP project number 92607)							
Species	**4**	**3**	**2**	**1**	**0**	**Missing**
Acer rubrum	1					
Aesculus flava	1					
Alnus serrulata	1	1				
Amelanchier laevis	5					
Aronia arbutifolia	1					
Cephalanthus occidentalis	4					
Cornus amomum	6					
Halesia carolina	1					
Hamamelis virginiana	3					
Ilex decidua	2					
Lindera benzoin	3					
Nyssa aquatica	1					
Oxydendrum arboreum	2					
Physocarpus opulifolius	4					
Quercus coccinea	2					
Rhododendron catawbiense	1					
Salix sericea	3					
Sambucus canadensis	2					
Sorbus americana	2					
Viburnum dentatum	2					
TOT: 20	**47**	**1**				

Appendix Table A.3: Damage by Species Spring Creek (EEP project number 92607)		
Species	**All Damage Categories**	**No Damage**
Acer rubrum	1	1
Aesculus flava	1	1
Alnus serrulata	2	2
Amelanchier laevis	5	5
Aronia arbutifolia	1	1
Cephalanthus occidentalis	4	4
Cornus amomum	6	6
Halesia carolina	1	1
Hamamelis virginiana	3	3
Ilex decidua	2	2
Lindera benzoin	3	3
Nyssa aquatica	1	1
Oxydendrum arboreum	2	2
Physocarpus opulifolius	4	4
Quercus coccinea	2	2
Rhododendron catawbiense	1	1
Salix sericea	3	3
Sambucus canadensis	2	2
Sorbus americana	2	2
Viburnum dentatum	2	2
TOT: 20	**48**	**48**

Appendix A.1. Continued.

Appendix Table A.4: Damage by Plot Spring Creek (EEP project number 92607)		
Plot	**All Damage Categories**	**No Damage**
92607-SL/BB-VP1	6	6
92607-SL/BB-VP2	9	9
92607-SL/BB-VP3	33	33
TOT: 3	**48**	**48**

Appendix Table A.5: Stem Count by Plot and Species Spring Creek (EEP project number 92607)						
Species	**Total Stems**	**# Plots**	**Avg # Stems**	**Plot 92607-SL/BB-VP1**	**Plot 92607-SL/BB-VP2**	**Plot 92607-SL/BB-VP3**
Acer rubrum	1	1	1	1		
Aesculus flava	1	1	1	1		
Alnus serrulata	2	1	2			2
Amelanchier laevis	5	2	2.5		4	1
Aronia arbutifolia	1	1	1			1
Cephalanthus occidentalis	4	1	4			4
Cornus amomum	6	1	6			6
Halesia carolina	1	1	1		1	
Hamamelis virginiana	3	3	1	1	1	1
Ilex decidua	2	2	1		1	1
Lindera benzoin	3	2	1.5		1	2
Nyssa aquatica	1	1	1			1
Oxydendrum arboreum	2	2	1		1	1
Physocarpus opulifolius	4	1	4			4
Quercus coccinea	2	1	2	2		
Rhododendron catawbiense	1	1	1			1
Salix sericea	3	1	3			3
Sambucus canadensis	2	1	2			2
Sorbus americana	2	1	2			2
Viburnum dentatum	2	2	1	1		1
TOT: 20	**48**	**20**		**6**	**9**	**33**
Density (stems/acre)	**648**			**243**	**364**	**1,336**

Appendix Table A.6: Vegetative Problem Areas Spring Creek (EEP project number 92607)			
Feature/Issue	**Station # / Range**	**Probable Cause**	**Photo #**
Chinese privet present – sprouting	3+00, left bank	Root stock	
Multi-flora rose present - sprouting	5+75, right bank	Parent Stock	

Appendix A.1. Continued.

Appendix Table A.7: Permanent Herbaceous Seed Mixture Spring Creek (EEP project number 92607)		
Scientific Name	**Common Name**	**Percent of Mix**
Andropogon gerardii	Big bluestem	5
Andropogon scoparius	Little bluestem	10
Bidens aristosa	Bur-marigold	4
Cephalanthus occidentalis	Buttonbush	3
Chamaecrista fasciculata	Partridge Pea	11
Coreopsis lanceolata	Lanceleaf coreopsis	6
Cornus amomum	Silky dogwood	3
Elymus riparius	Riverbank wild rye	5
Helianthus maximiliani	Maximilian sunflower	3
Oenothera biennis	Evening primrose	6
Panicum dichotomiflorum	Smooth panicgrass	6
Panicum virgatum	Switchgrass	15
Polygonum lapathifolium	Slender smartweed	4
Polygonum pennsylvanicum	Pennsylvania smartweed	4
Rudbeckia hirta	Black-eyed Susan	3
Sorghastrum nutans	Osage Indiangrass	6
Uniola latifolia	River oats	4
Viburnum dentatum	Southern arrowwood	4
Total	**18**	**100**

Appendix Table A.8. Woody Vegetation Planted Spring Creek (EEP project number 92607)					
			Number Planted		
Type	**Scientific name**	**Common name**	**Zone 1**	**Zone 2**	**Zone 3**
Live stakes					
	Cornus amomum	Silky dogwood	450		
	Physocarpus opulifolius	Ninebark	350		
	Salix sericea	Silky willow	350		
Shrubs and small trees					
	Alnus serrulata	Tag alder	41		
	Aronia arbutifolia	Red chokeberry	41		
	Cephalanthus occidentalis	Button bush	41		
	Ilex deciduas	Possum haw	41		
	Lindera benzoin	Spice Bush	41		
	Rhododendron arborescens	Smooth azalea	41		
	Rhododendron calendulaceum	Flame azalea	2		
	Rhododendron catawbiense	Rhododendron	41		
	Sambucus canadensis	Elderberry	41		
Medium trees					
	Amelanchier arborea	Serviceberry		37	
	Halesia caroliniana			37	
	Hamamelis virginiana	Witch hazel		37	
	Oxydendrum arboreum	Sourwood		37	
	Viburnum dentatum	Arrowood Viburnum		37	
Large Trees					
	Acer rubrum	Red maple			13
	Aesculus octandra (*flava)*	Yellow Buckeye			17
	Nyssa sylvatica	Black gum			17
	Quercus coccinea	Scarlet oak			4
	Quercus prinus	Chestnut oak			17
	Quercus rubra	Red oak			17
	Total		1,480	185	85

Zone 1 – Includes the area from the waters edge to the bankfull elevation.
Zone 2 – Includes the inner half of the bankfull bench (half closest to the stream).
Zone 3 – Includes the outer half of the bankfull bench (half furthest from the stream) to the conservation easement.

Appendix A.2. Vegetation Problem Areas Photos

No vegetation problem areas photos associated with the as-built survey.

Appendix A.3. Vegetation As-built Plot Photos

Appendix Table A.9: Vegetative Monitoring Plot Photos Spring Creek (EEP project number 92607)		
Stream	**Location**	**Bearing (Degrees from North)**
Spring Creek	Plot 1 left bank sta. 3+00	Plot origin (x,y) 180^{o}
Spring Creek	Plot 2 right bank sta. 0+50	Plot origin (x,y) 190^{o}
Spring Creek	Plot 3 right bank sta. 4+50	Plot origin (x,y) 200^{o}

Vegetation plot 1, facing downstream (0,0), 19 Jun 2007.

Vegetation plot 1, facing upstream (10,10), 19 Jun 2007.

Vegetation plot 2, facing downstream (0,0), 19 Jun 2007.

Appendix A.3. Continued

Vegetation plot 3, facing downstream (0,0), 19 Jun 2007.

Vegetation plot 3, facing upstream (10,10), 19 Jun 2007.

APPENDIX B

Appendix B.1. Stream Problem Areas Plan View

No Problem areas were observed during the as-built survey; see Figure 2 for the as-built plan view of the restoration site.

Appendix B.2. Stream Problem Areas Table

No problem areas were observed during the as-built survey. Appendix Table B.1, Stream Problem Areas, is used as a place holder for future monitoring reports.

Appendix Table B.1. Stream Problem Areas
Spring Creek (EEP project number 92607)

Feature/Issue	Station numbers	Suspected Cause	Photo number
Aggradation/Bar Formation			
Bank Scour			
Engineered structures — back or arm scour, Etc.			
Etc.			

Appendix B.3. Representative Stream Problem Area Photos

No problem areas were observed during the as-built survey; therefore, no issue or problem photos are provided for the as-built survey.

Appendix B.4. Fixed Photo-Station Photos

Photo station 1, left bank facing downstream, 5 Sep 2006.

Photo station 2, left bank facing downstream, 5 Sep 2006.

Photo Station 2, left to right bank, 5 Sep 2006.

Appendix B.4. Continued.

Photo station 3, left bank facing downstream, 5 Sep 2006.

Photo station 3, left to right bank, 5 Sep 2006.

Photo station 4, left bank facing downstream, 5 Sep 2006.

Photo station 4, left to right bank, 5 Sep 2006.

Appendix B.4. Continued.

Photo station 5, right bank facing downstream, 5 Sep 2006.

Photo station 5, right to left bank, 5 Sep 2006.

Photo station 6, right bank facing downstream, 5 Sep 2006.

Photo station 6, right to left bank, 5 Sep 2006.

Appendix B.4. Continued.

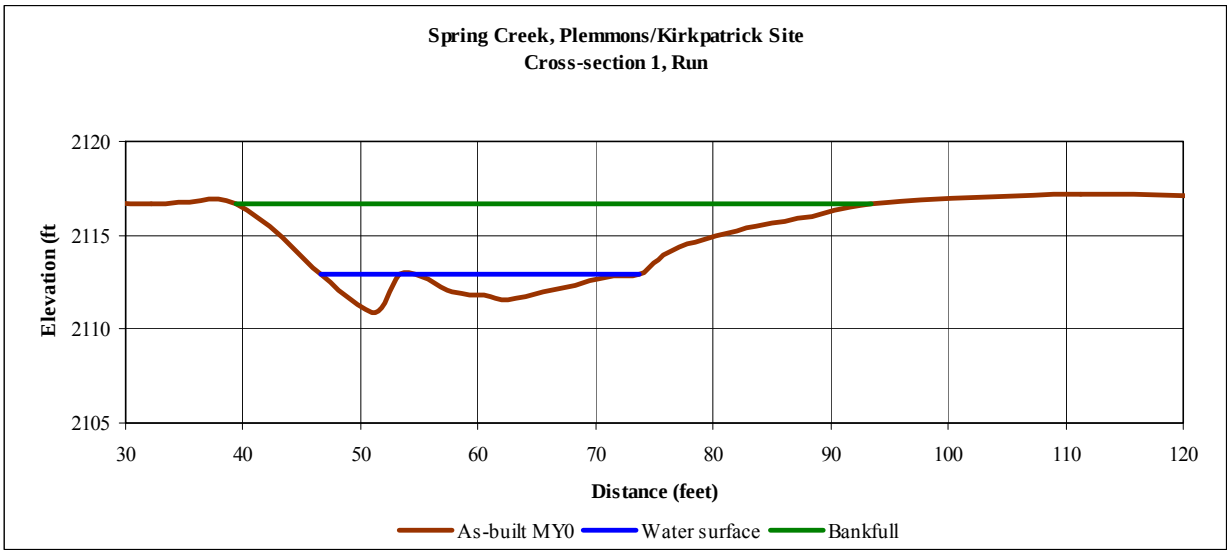
Photo station 7, right bank facing downstream, 6 Jan 2004.

Photo station 7, right bank facing downstream, 5 Jan 2007.

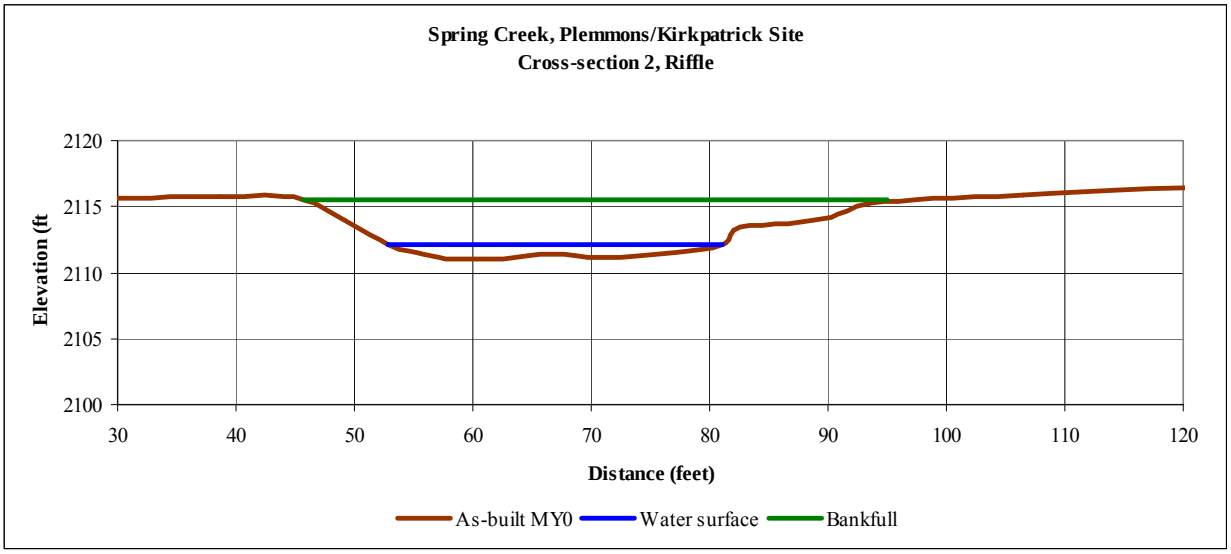
Appendix B.5. Visual Morphological Stability Assessment Table.

Appendix Table B.2. Visual Morphological Stability Assessment Spring Creek (EEP project number 92607) Sta. 0+00 to 6+80 (Entire project length)						
Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total Number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?		5	NA		
	2. Armor stable (e.g. no displacement)?		5	NA		
	3. Facet grade appears stable?		5	NA		
	4. Minimal evidence of embedding/fining?		5	NA		
	5. Length appropriate?		5	NA		
B. Pools	1. Present? (e.g. not subject to severe aggrad. Or migrat.)?		5	NA		
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6)?		5	NA		
	3. Length appropriate?		5	NA		
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?		1	NA		
	2. Downstream of meander (glide/inflection) centering?		1	NA		
D. Meanders	1. Outer bend in state of limited/controlled erosion?		1	NA		
	2. Of those eroding, # w/concomitant point bar formation?		1	NA		
	3. Apparent Rc within specifications?		1	NA		
	4. Sufficient floodplain access and relief?		1	NA		
E. Bed	1. General channel bed aggradation areas (bar formation)?		NA	0 / 0		
General	2. Channel bed degradation – areas of increasing down cutting or head cutting?		NA	0 / 0		
F. Bank	1. Actively eroding, wasting, or slumping bank?		NA	0 / 0		
G. Vanes	1. Free of back or arm scour?		5	NA		
	2. Height appropriate?		5	NA		
	3. Angle and geometry appear appropriate?		5	NA		
	4. Free of piping or other structural failures?		5	NA		
H. Wads/ Boulders	1. Free of scour?		6	NA		
	2. Footing stable?		6	NA		

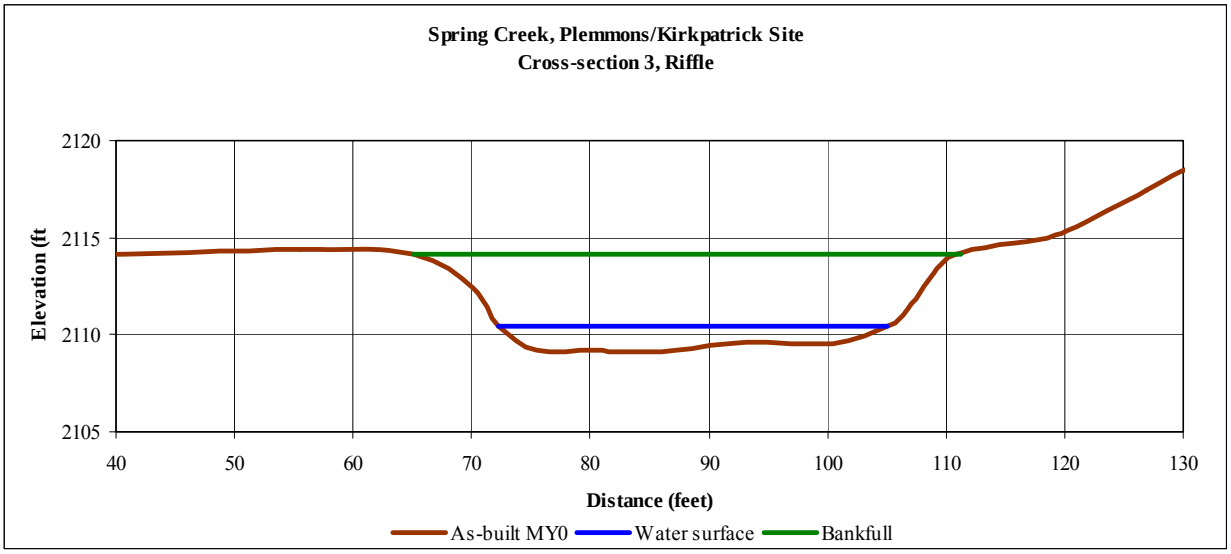
Appendix B.6. As-built Cross Section Plots and Photographs. Solid red line in photograph represents location where surveyed transect crossed the stream channel.



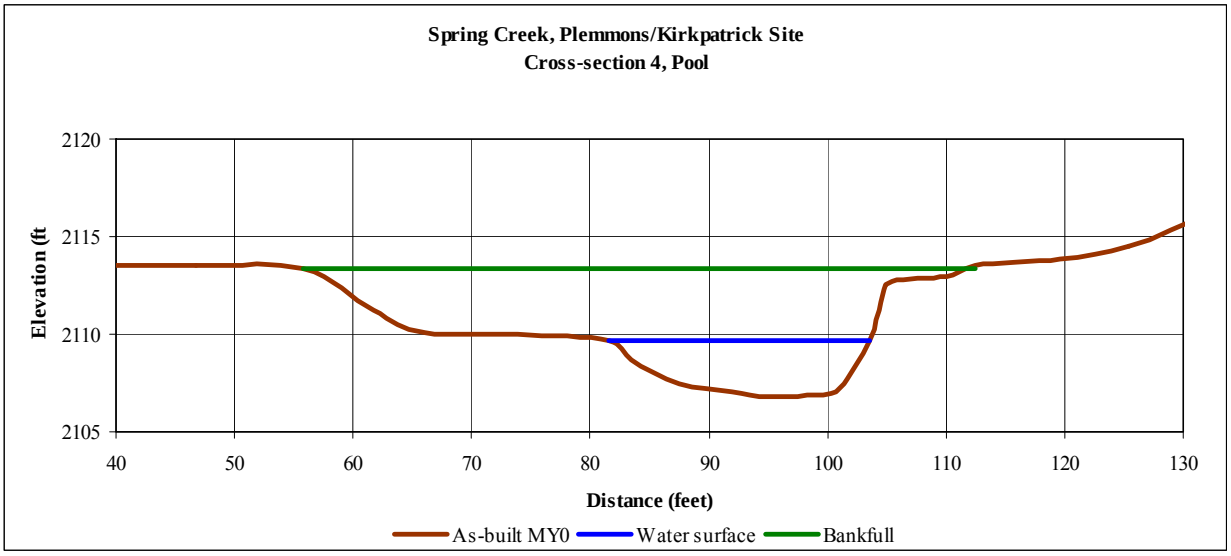
Appendix B.6. Continued.



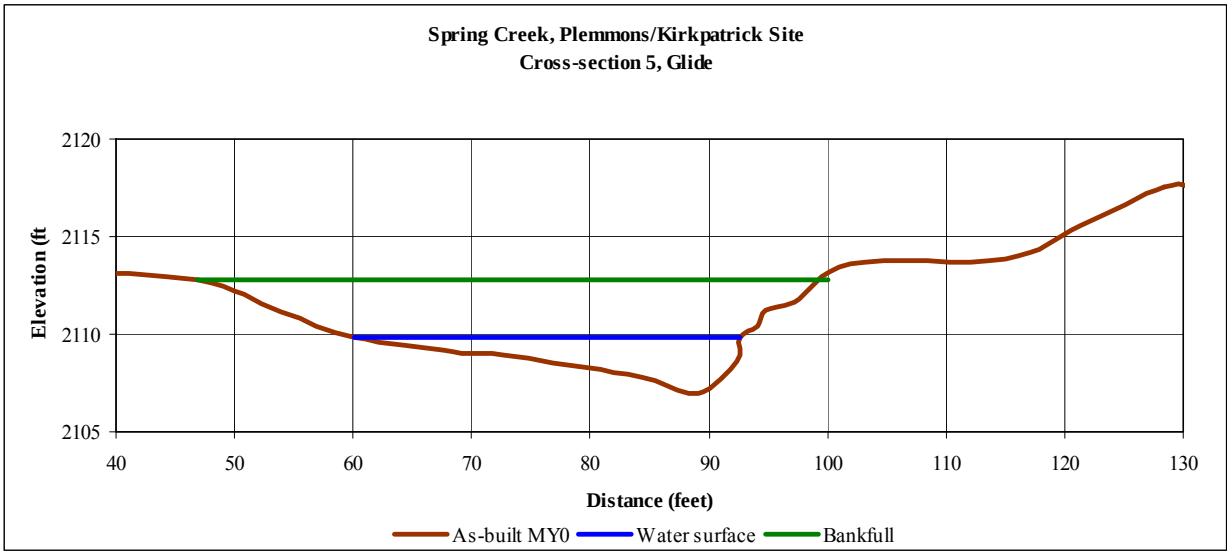
Appendix B.6. Continued.



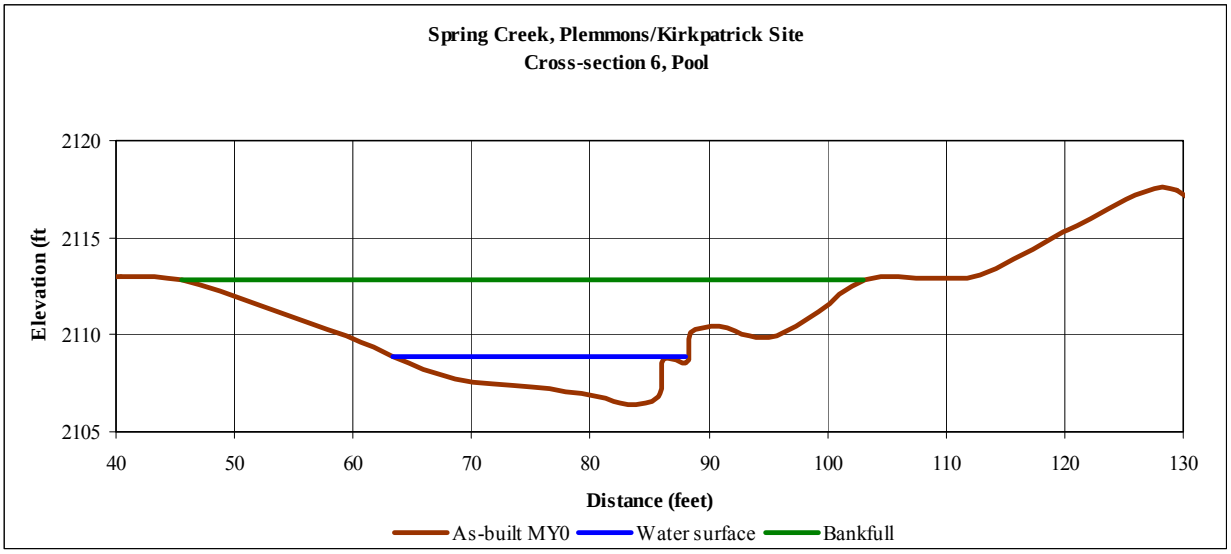
Appendix B.6. Continued.



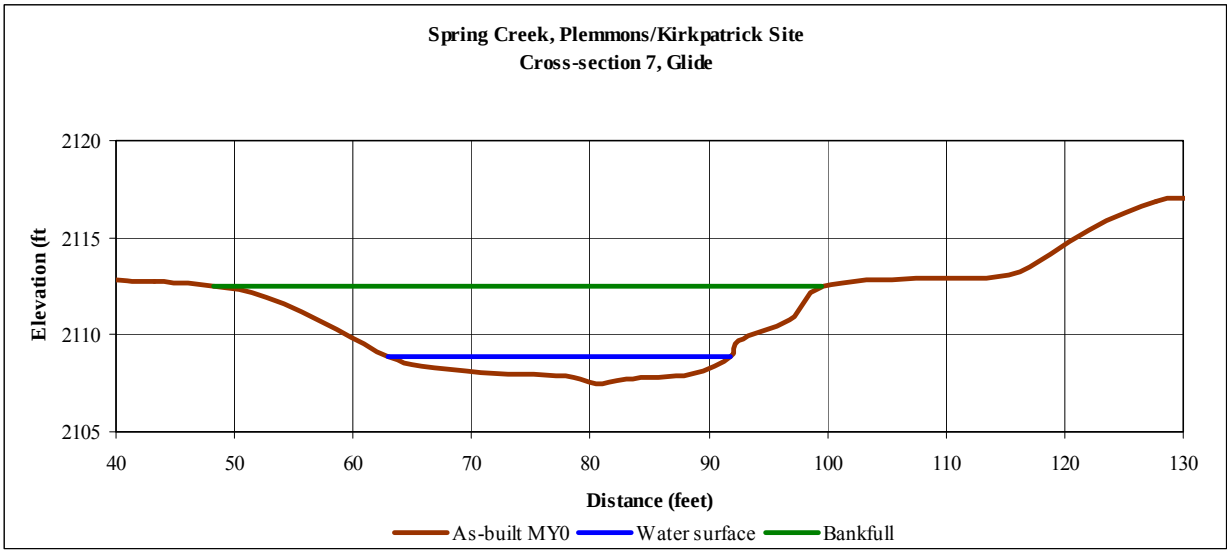
Appendix B.6. Continued.



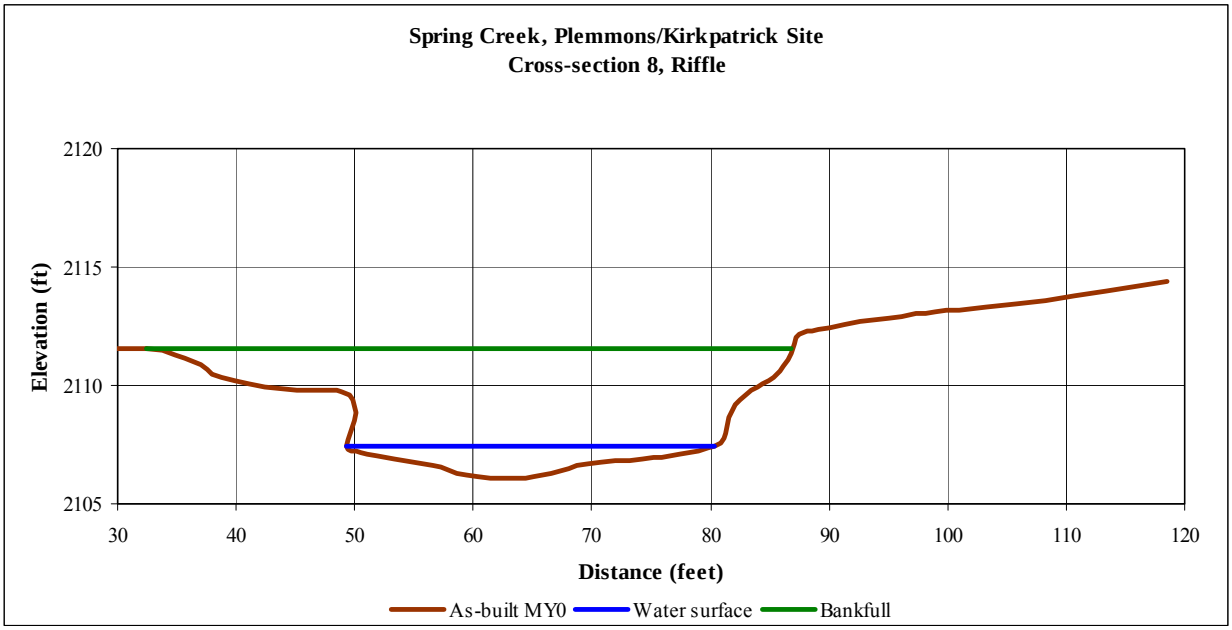
Appendix B.6. Continued.



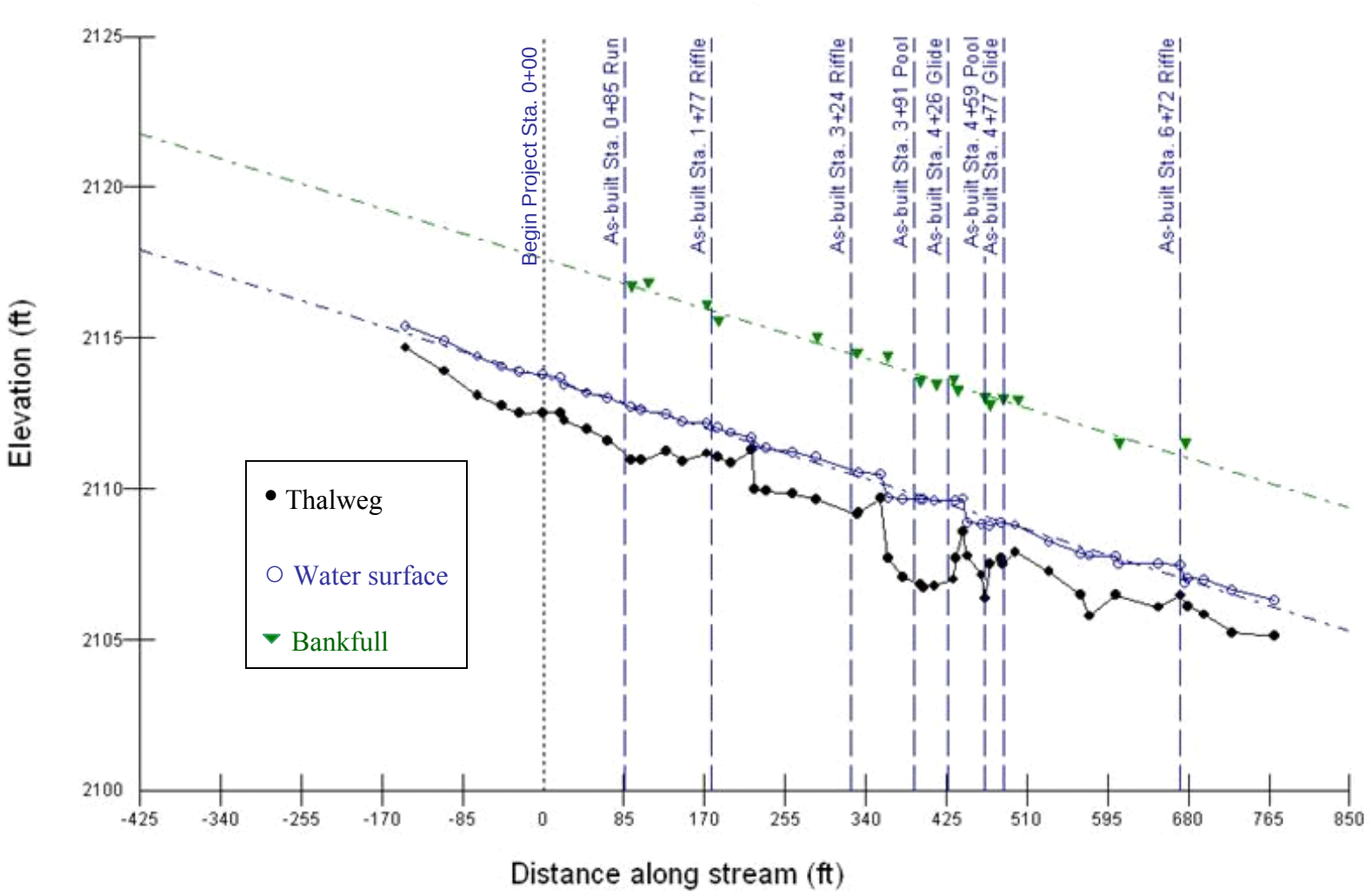
Appendix B.6. Continued.



Appendix B.6. Continued.

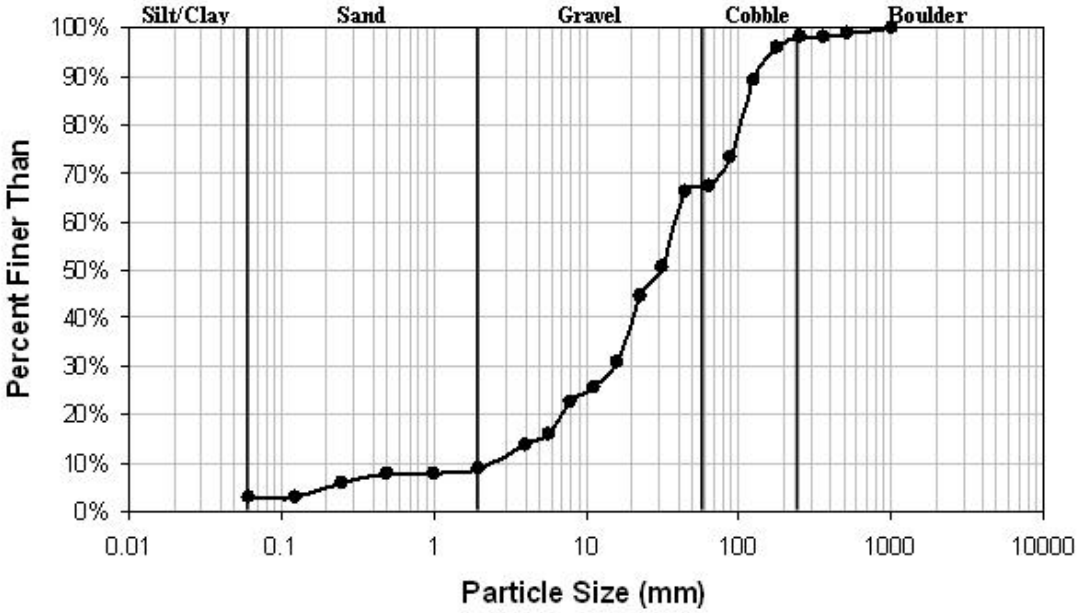


Appendix B.7. As-built Longitudinal Profile Plot.

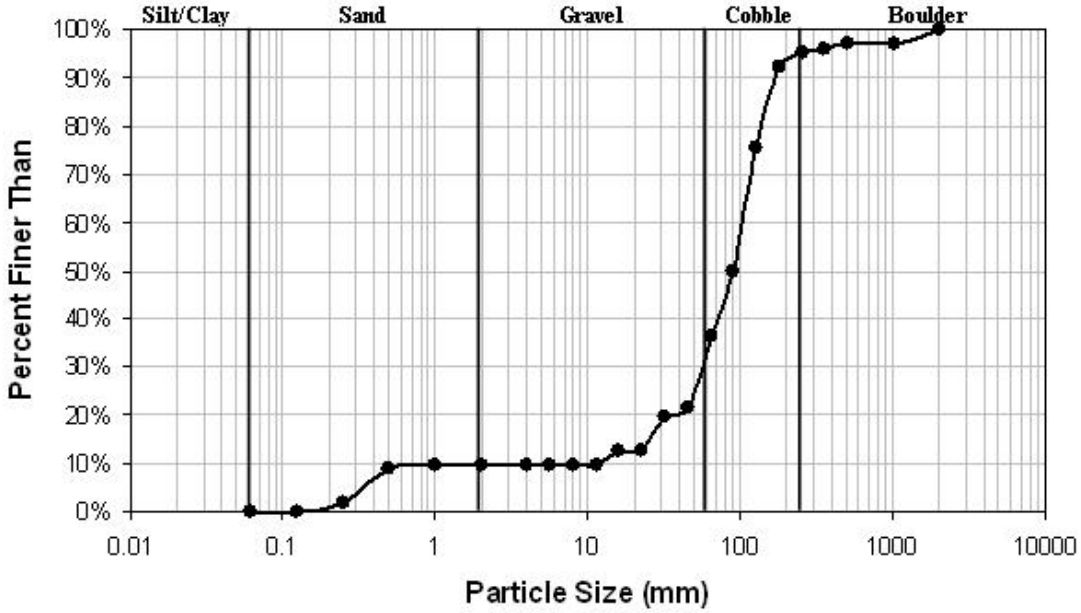


Appendix B.8. Pebble Count Cumulative Frequency Distribution Plots.

Reach-Wide Pebble Count



Riffle Pebble Count



Appendix B.9. Bankfull Event Verification Photos.

Wrack line following bankfull event on 1 Sep 2006.