YEAR 3 MONITORING and CLOSEOUT REPORT
for
CHARLES/McGINNIS MITIGATION SITE
SOUTH FORK BIG PINE CREEK,
MADISON COUNTY, NORTH CAROLINA

EEP PROJECT NUMBER 92701


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North Carolina Wildlife Resources Commission
Watershed Enhancement Group

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1.0 Executive Summary

The Charles/McGinnis mitigation site, North Carolina Ecosystem Enhancement Program Project Number 92701, South Fork Big Pine Creek, Madison County, North Carolina, was constructed and as-built data collected by the North Carolina Wildlife Resources Commission (NCWRC) in August 1999. It was originally constructed as mitigation for the North Carolina Department of Transportation's (NCDOT) Transportation Improvement Project Number A-10 C& D (I-26) road project. Monitoring year 1 (MY1) and monitoring year 2 (MY2) survey data were collected in 2003 and 2004. The following report summarizes stream survey activities associated with monitoring year 3 (MY3), 2007, the eighth year following project construction, and is proposed to serve as the closeout report for the Charles/McGinnis mitigation site.

Morphometric parameters of the channel are within the range of values expected, based on design values and the values recorded during MY1 and MY2. The project reach was classified as an E4b stream type. Although the project reach is dominated by a series of riffle/run features and low sinuosity, the low width/depth ratio of the project reach is the main factor in making the reach classify as an E stream type. Based on a surrogate flow gage hydrograph, >30 bankfull events have occurred between September 1999 and September 2007.

Density of woody stems in the vegetation plots exceeded the minimum success criteria for woody stems/acre. However, species diversity within the vegetation plots was limited to fewer than 8 species. Silky dogwood *Cornus amomum* comprised 70-90% of the woody stems in the tree plots. Fencing on the left bank has prevented livestock access from the stream and allowed the vegetation to become well established. The left bank vegetation is not only contributing to channel bank stability, but also helping buffer solar warming of surface water; shade was absent in the pre-project assessment.

Overall, the project site has benefited from the exclusion of livestock and establishment of the riparian vegetation on the left bank. Unfortunately, the proximity of SR 1185 (Big Pine Road) to the stream channel and lack of woody vegetation on the right channel bank will continue to be a maintenance challenge following flood events. With this exception, the Charles/McGinnis site is performing well and should be proposed for closeout by the North Carolina Ecosystem Enhancement Program (EEP) to the regulatory agencies.

2.0 Introduction

This monitoring report is submitted as partial fulfillment of the off-site stream mitigation requirements for the NCDOT A-10 road project (I-26) in Madison County. From 1999 to 2004 all reports associated with this mitigation site were prepared for the NCDOT stream mitigation program. In 2005, responsibility for this site was transferred from NCDOT to the EEP. This document was prepared using the framework developed by Mulkey, Inc. This was done to maintain consistency with methods used in earlier field collections and reports and to facilitate the comparison of the 2007 data with previous years' data.

2.1 Project Description

The Charles/McGinnis mitigation site (1.11 acres) is located on South Fork Big Pine Creek, immediately adjacent to Big Pine Road (SR 1158), in the southwestern portion of Madison County, approximately 16 miles west-southwest of Mars Hill and 18 miles northwest of Asheville (Figure 1). The project reach is 1,100 linear feet, has a 2.7 mi^2 watershed, and is located in the French Broad River basin.

2.2 Purpose

The purpose of the project was to improve water quality, riparian habitat quality, channel bank stability, and to enhance aquatic habitat of South Fork Big Pine Creek (NCWRC 1999). Specific objectives were as follows:

1) to increase floodplain width at the bankfull elevation by removing the left bank berm;
2) to install rock vanes, log vanes, root wads, and vortex weirs to reduce near bank stress and to create pool habitat in sections of long riffles;
3) to reshape channel banks to a stable slope from the bankfull elevation up to the existing grade (left bank);
4) to establish a conservation easement on the left bank of the project reach;
5) to re-vegetate the project area with native flora; and
6) to install a livestock watering system and fencing to exclude livestock from the conservation easement and stream.

2.3 Project History

The effort to provide mitigation for the A-10 road construction project began in 1996 when a Memorandum of Agreement (MOA) between the NCDOT and the NCWRC was signed. Under the MOA, the NCWRC was to provide stream mitigation on NCDOT's behalf for jurisdictional waters as defined by the U.S. Army Corps of Engineers (USACE). The original USACE section 404 permit and amendments called for providing 25,912 linear feet of mitigation for unavoidable impacts to trout streams.

The NCDOT established a mitigation review (MRT) team comprised of representatives from the USACE, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, Natural Resources Conservation Service (NRCS), North Carolina Division of Water Quality, and the Madison County Soil and Water Conservation District. The purpose of the MRT was to develop criteria and policies for selecting and approving stream reaches for mitigation. Members of the MRT also collaborated on project monitoring components and success parameters.

The Charles/McGinnis site was the first of five sites selected by the MRT to provide compensatory mitigation for the A-10 road project. The site and conceptual mitigation plan was approved by the MRT in 1998 (Exhibit Table 1; NCWRC 1998). The construction plan was completed in April of 1999 (NCWRC 1999). Project construction occurred in August 1999; as-built data collection, analysis and report preparation was completed by October 2000 (monitoring year 0, MY0; NCWRC 2000).

Although it has been eight years since construction was completed, the 2007 site survey reflects only the third monitoring year (MY3). The first monitoring year (MY1) for morphometric and vegetative surveys was 2003 (Mulkey 2003). Monitoring surveys were conducted twice during 2004 (MY2), once in May and June and a second time in August (Mulkey 2004).

Exhibit Table 1. Project History	
Completion Date	**Activity**
May 1995	USACE issued permit for A-10 project - 199505135
June 1998	NCWRC Conceptual Site Plan Completed
April 21, 1999	Conservation Easement Acquired
April 1999	NCWRC Construction Site Plan Completed
August 1999	Site Grading Commenced
August 1999	Site Planted with Native Perennial Seed Mix
October 2000	NCWRC As-built Report Completed
January 2000	Site Planted with Live Stakes and Bare Rooted Trees
June – July 2003	Stream Channel Monitoring (MY1)
June – July 2003	Vegetation Monitoring (MY1)
2003	MY1 report submitted – Mulkey, Inc
May/June 2004	Stream Channel Monitoring (MY2)
May 2004	Vegetation Monitoring (MY2)
August 2004	Additional Stream Channel Monitoring following bankfull event (MY2)
2004	MY2 report submitted – Mulkey, Inc.
September 2007	Stream Channel Monitoring (MY3)
September 2007	Vegetation Monitoring (MY3)
May 2008	MY3/closeout report submitted - NCWRC

2.4 Debit Ledger

The MRT anticipated that the Charles/McGinnis project would generate 1,100 linear feet of stream mitigation credits. This was based on a ratio of one mitigation credit for every foot of channel placed in the conservation easement.

2.5 Success Criteria

The MRT developed the framework of success criteria used to evaluate the A-10 mitigation projects that included a number of metrics (Exhibit Table 2). These criteria, developed by the MRT with input from the USACE, were the early framework of monitoring success criteria and were later adopted by USACE in its stream mitigation guidelines document (USACE 2003). These criteria included a combination of the following parameters: two bankfull events over a five-year monitoring period, reference photos, channel stability, riparian vegetation survival, and response of fish and invertebrate populations, if specifically required by permit conditions. Overall success or failure of the A-10 mitigation project sites was to be based on a combination of three of these four parameters.

Exhibit Table 2. Early Framework of Mitigation Monitoring Success Criteria			
Parameter	**Success[a] (requires no action)**	**Failure[a]**	**Action**
Photo Reference Sites			
Longitudinal Photos Lateral Photos	No significant aggradation, degradation, or erosion	Significant aggradation, degradation or erosion	When significant aggradation, degradation or erosion occurs, remedial actions will be undertaken
Channel Stability			
Cross-Sections Longitudinal Profiles Pebble Counts	Minimal evidence of instability (down-cutting, deposition, erosion, decrease in particle size)	Significant evidence of instability	When significant evidence of instability occurs, remedial actions will be undertaken
Plant Survival			
Survival Plots Stake Counts Tree Counts	>75% coverage in Photo Plots >80% survival of stakes 4/m^2 >80% survival of bare rooted trees	<75% coverage in Photo Plots <80% survival of stakes, 4/m^2 <80% survival of bare-rooted trees	Areas <75% coverage will be re-seeded and/or fertilized. Live stakes and bare-rooted trees will be re-planted to achieve >80% survival
Biological indicators (only used for projects with potential to make watershed level changes)			
Invertebrate Population Fish Population	Population measures remain the same or improve	Population measures indicate a negative trend	Reasons for failure will be evaluated and remedial action plans developed and implemented

[a] Subjective determinations of significance or success was to be determined by majority decision of the MRT.

3.0 Stream Assessment

3.0.1 Pre-Construction Conditions

The project reach was classified as an E3b stream type having an entrenchment ratio of 3.6, width/depth ratio of 7.4, and sinuosity of 1.1 during the initial site assessment (Exhibit Table 3; Rosgen 1996; NCWRC 1999). Bankfull width was 14.0 ft, bankfull mean depth 1.9 ft, and bankfull cross-sectional area 26.5 ft^2. Historically, flood water encroachment on the adjoining agricultural fields was addressed by dredging the stream channel (Russell Blevins, NRCS, personal communication). A berm, created from dredged channel material and field stone, was present on top of the left bank. Woody vegetation was absent on the left bank, with the exception of few mature trees; livestock were not excluded from the riparian area or the stream. The right bank was constrained by SR 1158 and had sparse woody vegetation, except for the lower project reach (beginning at station 8+00). Herbaceous vegetation consisted primarily of reed canarygrass *Phalaris arundinacea* and tall fescue *Festuca sp.* (NCWRC 1998).

3.0.2 Post-Construction Conditions

By removing the existing berm, floodplain width was increased on the left bank. The left channel bank was sloped and shaped to a more natural condition. Coir logs were installed on the left bank to define the bankfull channel width and elevation. A single arm rock vane was installed on the left bank (sta. 0+95). Because the right channel bank is within the SR 1158 right-of-way along most of the project reach, little work was done in that area. However, one area of near bank stress was addressed by installing a single arm rock vane at sta. 1+97. A single root wad also was installed on the left bank at sta. 5+75. Neither vortex weirs nor log vanes were installed as originally proposed. The riparian zone was replanted with native herbaceous and woody vegetation (Exhibit Table 4). A farm management plan that included the installation of fencing (left bank) and three gravity fed watering tanks was implemented to exclude livestock from easement area and provide drinking water.

Additional components of the farm management plan, implemented by NRCS at the project site, included fencing livestock out of a wetland area (left bank pasture) and out of a short section of a natural spring developed to supply water to the watering tanks. A livestock crossing also was constructed at this location. Although beneficial to water quality improvements, these additional best management practices were outside the conservation easement and, therefore, not eligible as mitigation.

3.1 Stream Assessment Results

This report contains the MY3 survey data and serves as a closeout report summarizing project conditions including channel dimension and profile surveys, pebble counts, bankfull hydrologic events documentation, vegetative condition, and a photographic log for the Charles/McGinnis site. Locations of all fixed survey stations, established for the purpose of post-construction monitoring, are presented in the plan view drawing (Figure 2).

3.1.1 Cross-Section Surveys

Five cross-sections were established following construction and have been surveyed during each of the three monitoring years (Figure 2; Appendix A.1). The morphological characteristics summary of all cross-sections combined provides a comparison of mean values of the channel dimensions (Exhibit Table 3). Of particular interest, are the width/depth ratio (mean 9.9) and the entrenchment ratio (mean 12.6). These values drive the broad level channel classification and are the reasons for the overall E stream type classification. Additionally, by removing the left bank berm and sloping the left channel bank, the width of the floodprone area was increased from approximately 50 ft to ≥200 ft.

Morphological characteristics for the five individual cross-sections, cross-section plot overlays, and representative cross-section photos are presented for comparative purposes (Appendix A.1).

Cross-section 1, Riffle (Appendix Table A.1.1).–There has been little change in this cross-section between MY0 (as-built) and MY3. This cross-section has remained stable with no lateral movement (bank erosion) observed along either streambank. The left bank is under cut at the waters edge; however, the bank is stable and well vegetated. The channel bottom has shown some minor aggradation.

Cross-section 2, Run (Appendix table A.1.2).–The right bank of this cross-section is adjacent to SR 1158 and has been susceptible to erosion during high flow events in the past. The SR 1158 road shoulder between cross-section 2 and 3 has been repaired with large boulders and rip-rap at least twice after flood events. Aggradation on the left bank, from the water's edge up to easement fence line, is likely resulting from the vegetation capturing bed material during flood events. At the time of the MY3 survey, both the right and left banks were stable, and the left bank vegetation was well established.

Cross-section 3, Riffle (Appendix Table A.1.3).–The right bank of this cross-section is adjacent to SR 1158. The right bank has been susceptible to erosion during high flow events in the past. The SR 1158 road shoulder between cross-section 2 and 3 has been repaired with large boulders and rip-rap at least twice following flood events. The thalweg has shifted towards the right bank when compared with its location following construction. The left bank is stable and well vegetated.

Cross-section 4, Riffle (Appendix Table A.1.4).–The right bank of this cross-section is adjacent to SR 1158 and has been susceptible to erosion during high flow events in the past. The SR 1158 road shoulder has been repaired with large boulders and rip-rap at least twice following flood events. This cross-section is located in a slight meander (to the left) that creates near bank stress against the right bank and road shoulder during high flows. The thalweg has deepened (±0.8 ft) since the as-built survey; likely resulting from stream energy scouring the stream bed due to the confining of the channel laterally (on the right) by the large boulders used to stabilize the road shoulder. The root mass from an oak tree (present before construction) has protected the left bank from damage during flood events. That root mass combined with the reestablished woody plants should aid in keeping the left bank stable.

Cross-section 5, Riffle (Appendix Table A.1.5).–Cross-section 5 was the only location where the width/depth ratio (13.9) exceeded that of an E stream type. Although the bankfull width of cross-section 5 (14.1 ft) was within the range of the other cross-sectional bankfull widths (10.4–16.9 ft), the bankfull mean depth (1.0 ft) was low, resulting in the B stream type classification. Also note, the survey was conducted during a year of record low rainfall, which resulted in reduced baseflow that was revealed by the presence of a shallower mean stream depth.

The left end of this cross-section was changed when repairs to the stream channel were made following high flow events caused by the remnants of two hurricanes in the fall of 2004. A short section of the left bank was excavated to the bankfull elevation and a single arm rock vane constructed. This is likely the cause for the noticeable shift (to the left) of the thalweg and the lower elevation of the left bank. This cross-section has stabilized since the repair work was completed; the vegetation on the left bank is now well established.

3.1.2 Longitudinal Survey

The MY3 longitudinal profile survey began 35 ft downstream of the upper project boundary and ended slightly upstream of the lower project boundary (sta. 0+35 to sta. 10+75; Appendix A.2). Elevations of the stream bed, water surface, bankfull indicators, and top of the low banks were obtained. Channel sinuosity was 1.2, while the average water surface slope was 0.030 ft/ft. Typically, water surface slopes of E stream types are <0.020 ft/ft; however, E stream types with a water surface slopes between 0.020 ft/ft and 0.039 ft/ft are categorized as Eb stream types, which is the case for this project reach. The MY3 longitudinal profile survey found that the thalweg has remained stable with minimal aggradation, degradation, and lateral movement occurring along the entire reach.

Stream structures.–Of the three structures (2 rock vanes and 1 root wad) installed during construction, none remain in the as-built condition. The first rock vane (sta.0+95) has been covered with sediment deposits, and the vegetation has become well established, making it very hard to distinguish this feature. The second rock vane (sta. 1+97) was altered during high flow events. This structure (adjacent to SR 1158) was impacted by flood events and road shoulder improvements. Although rock is still apparent, these perturbations have changed the intent of the original structure; it now serves more as toe protection for the road shoulder. The single root wad structure installed during construction was blown out during a flood event in 2003; the structure was not replaced. Lastly, an additional rock vane was constructed in 2005 as part of the flood damage repair work conducted at the site. This structure was installed at cross-section 5 (sta. 7+70). The left bank was excavated to create a bankfull bench, and the structure's arm was keyed into the channel bank at this elevation. The structure was found to be stable and functioning as intended during the MY3 survey, two years following the repair activities.

3.1.3 Pebble Counts

Pebble counts were taken at each cross-section to determine the extent of change, if any, in bed material composition (Appendix A.3). Mean particle size for each of the particle size classes has fluctuated during the monitoring surveys (Exhibit Table 3). The D50 and D84 mean particle sizes prior to construction were 55 mm and 175 mm, very coarse gravel and large cobble. The D50 and D84 in MY3 were 21.4 mm and 80.6 mm, which are classified as medium gravel and small cobble.

The smallest mean D50 and D85 particles sizes observed since project completion occurred during MY3. With the livestock excluded from the stream channel and the left bank vegetation well established, one would expect the D50 and D84 particle sizes to increase. The decrease in particle sizes may be influenced by upstream land use practices (development, agriculture) or from channel dredging. Back wash from dredging can wash small particles and fine material downstream during the excavation process. This could result in smaller than normal particle sizes remaining in the active channel following dredging. Nonetheless, mid-channel and transverse bars were not observed and the substrate did not appear to be embedded or adversely affecting channel stability.

Exhibit Table 3. Morphological Characteristics Summary of all Cross-Sections						
Variable	Pre-construction	MY0 As-built 2000	MY1 2003	MY2 2004	MY2 2004	MY3 2007
Drainage Area (mi^2)	2.7	2.7	2.7	2.7	2.7	2.7
Bankfull Width (ft) (mean)	14.0	15.6	11.1	9.1	13.3	13.5
Bankfull Mean Depth (ft) (mean)	1.9	1.6	1.6	1.2	1.8	1.4
Width/Depth Ratio (mean)	7.4	10.3	7.9	8.1	8.3	9.9
Bankfull Cross Sectional Area (ft^2) (mean)	26.5	24.6	17.8	10.7	23.8	19.2
Maximum Bankfull Depth (ft) (mean)	3.0	2.6	2.6	1.9	2.8	2.2
Width of Floodprone Area (ft) (mean)	>50	>200	>200	>200	>200	>200
Entrenchment Ratio (mean)	3.6	12.9	>18	>22	>15	12.6
Water Surface Slope (ft/ft)	0.025	0.032	0.029	0.033	0.031	0.030
Particle Size Class (mean) [a]						
D16 (mm)	6.0		0.6	0.9	11.9	4.0
D35 (mm)	35.0		17.7	8.5	49.4	11.0
D50 (mm)	55.0		49.5	23.1	70.2	21.4
D84 (mm)	175.0		140.0	97.0	126.0	80.6
D95 (mm)	275.0		257.0	128.0	175.0	134.7

[a] Particle size class data were not collected during the as-built survey.

3.2 Hydrologic Data and Bankfull Verification

In the absence of a stream gage in the project drainage, the Ivy River stream gage was used as a surrogate (Appendix A.4). The Ivy River gage is in USGS Hydrologic Unit 06010105, at 1,700 ft above mean sea level and has a drainage area of 158 mi^2. Based on the North Carolina rural mountain regional hydraulic geometry curves, a discharge of 450-500 cfs at the Ivy River gage correlates to the bankfull flow at the Charles site (Mulkey 2003). A review of the USGS data for the period between the end of construction (September 1999) and September 2007 (MY3) found there were >30 flow events >500 cfs at the Ivy River gage (USGS 2008). Seventeen of these events exceeded 1,000 cfs (Appendix Table A.4.1).

Four bankfull events at the project site occurring between July 2001 and August 2004 were photographically documented (Appendices A.4 and A.5). Two additional bankfull events occurred in back-to-back weeks during September 2004 resulting from the rainfall associated with the remnants of hurricanes Francis and Ivan.

3.3 Fixed Station Photos

Fixed station photos document project site conditions from 1999 (before construction) through 2007 (Appendix A.6). The planted vegetation along the left bank has become well established over the eight years since its installation. Planted woody vegetation is ≥15 ft in height and has enhanced stability of the left channel bank. In fact, the silky dogwood have attained a size large enough to extend over the conservation easement fence. These large specimens provide the opportunity to be used as a source for live stake cuttings. Herbaceous vegetation, also apparent in the fixed station photos, included blackberry *Rubus sp.*, goldenrod S*olidago virgaurea,* jewel weed *Impatiens sp.*, and Joe Pye weed *Eupatorium sp*., among others.

3.4 Problem Areas

Two chronic problem areas exist along the stream channel that are susceptible to scouring at high flows (Appendix A.7). Both areas are adjacent to SR 1158, and were noted as problem areas before project construction due to their proximity to the road shoulder (<3 ft from the active channel) (NCWRC 1998). Problem area one (sta. 1+50 to 3+50) was addressed during construction by installing a single arm rock vane on the right bank in an attempt to reduce bank stress during high flows. A short section (<50 ft) of channel also was moved away from the road right-of-way at this location (NCWRC 2000). The second problem area (sta. 5+50 to 6+50) is a channel bend adjacent to SR 1158 that includes cross section 4. This meander bend has migrated closer to SR 1158 since project completion. Much of this lateral movement occurred during the 2003 and 2004 flood events (Appendix A.1.4). Both of these problem areas have been repaired on multiple occasions by NCDOT. They have armored the road shoulder and channel bank with large boulders and rip-rap following each of the scouring events.

Additionally, Emergency Watershed Protection (EWP) funds were used to conduct repair work following the 2004 hurricane floods. As part of the EWP work, a single arm rock vane also was installed on the left bank to address a scour problem occurring at station 7+70, cross section 5 (Appendix A.1.5).

4.0 Vegetation Assessment

4.1 Description of Planted Species

During winter 2000, the left bank of the conservation easement was planted with a large quantity (no numbers available) of live stakes and bare-root shrubs and trees (NCWRC 2000; Exhibit Table 4).

Exhibit Table 4. Native Seed Mix and Woody Vegetation Planted		
Type	**Scientific Name**	**Common Name**
Native Seed Mix		
	Acer rubrum	Red maple
	Acer saccharinum	Silver maple
	Aronia arbutifolia	Red chokeberry
	Asclepias incarnata	Swamp milkweed
	Carex lupilina	Hop sedge
	Cephalanthus occidentalis	Button bush
	Cornus amomum	Silky dogwood
	Eleocharis palustris	Creeping spikerush
	Elymus virginicus	Virginia wild rye
	Eupatorium fistulosa	Joe Pye weed
	Fraxinus pennsylvanica	Green ash
	Ilex verticillata	Winterberry
	Juncus effusus	Soft rush
	Leersia oryzoides	Rice cut grass
	Nyssa sylvatica	Black gum
	Onoclea sensibilis	Sensitive fern
	Panicum clandestinum	Deertongue
	Prunus serotina	Black cherry
	Quercus palustris	Pin oak
	Sambucus canadensis	Elderberry
	Scirpus americanus	Three square spikerush
	Scirpus atrovirens	Green bulrush
	Scirpus cyperinus	Woolgrass
	Scirpus validus	Softstem bulrush
	Tripascum dactyloides	Eastern gamagrass
Live Stakes		
	Cornus amomum	Silky dogwood
	Salix nigra	Black willow
	Salix sericea	Silky willow
Bare-Rooted Trees		
	Acer rubrum	Red maple
	Betula nigra	River birch
	Cornus sericea	Red-osier dogwood
	Diospyros virginiana	Persimmon
	Fraxinus pennsylvanica	Green ash
	Juglans nigra	Black walnut
	Quercus phellos	Willow oak
	Salix nigra	Black willow

4.2 Vegetation Plot Descriptions, Photographs, and Sampling

In 2003, two large (1,000 ft^2; plots A and B) tree plots and four smaller (10.8 ft^2; plots 1-4) vegetation monitoring plots were established (Mulkey 2003). All plots were also used to provide photo reference points of vegetation performance (Appendix B.1). In both the tree plots and all four vegetation plots woody stems were tagged, identified to species, and enumerated. All tree and vegetation plots were resurveyed in MY3, except for vegetation plot 4, which could not be relocated. All counted stems for MY3 included both planted and naturally recruited stems.

Tree plot A is located upstream of the existing culvert crossing, on the left bank near station 2+50. Tree plot B is located on the left channel bank beginning downstream of the culvert crossing near station 4+00 (Figure 2). The four vegetation plots were located within the tree plots and also were used to assess stem density (planted and wild).

4.3 Vegetation Monitoring Results

Tree Plot A.–Woody vegetation has formed a very dense leaf canopy in this plot, effectively shading out most of the understory. Several of the original planted stems were dead, presumably due to self-thinning (shading). The number of woody stems decreased by 30% between MY2 and MY3 from 98 to 70 (Exhibit Table 5). Silky dogwood comprised approximately 90% of the woody stems. Natural recruitment of plants also has occurred; several untagged silky dogwoods and two small yellow buckeyes *Aesculus octandra* have recruited into this plot. Other installed woody species present include black willow *Salix nigra*, river birch *Betula nigra*, and green ash *Fraxinus pennsylvanica*.

Tree Plot B.–Woody stem numbers increased by 10% from MY2 to MY3 in this plot (Exhibit Table 5). Woody vegetation has formed a very dense leaf canopy in this plot, effectively shading out most of the understory vegetation. Several of the original planted stems were dead, presumably shaded out by the canopy. Recruitment of silky dogwood stems has offset this loss. Silky dogwood was the dominant species, comprising 70% of stems present; however, this plot is more diverse than plot A. Black willow and silky willow *Salix sericea* stems were abundant. Other species in this plot include river birch and green ash. A southern red oak *Quercus falcata* and yellow buckeye have naturally recruited into plot B.

Vegetation Plot 1.–There was very little herbaceous growth within this plot due to shading from the dense canopy of leaves created by the woody vegetation. Tree density within this plot did not change since MY2, with only one silky willow stem present (Exhibit Table 5) each year.

Vegetation Plot 2.–There was very little herbaceous growth within this plot due to shading from the dense canopy of leaves created by the woody vegetation. Tree density increased from MY2 to MY3 as a result of an increase in the number of silky dogwood stems (from two to three).

Vegetation Plot 3.–There was very little herbaceous growth within this plot due to shading from the dense canopy created by the woody vegetation. The increase in tree density within this plot between MY2 to MY3 was due to an increase in the number of silky dogwood stems (from two to three; Exhibit Table 5).

*Vegetation Plot 4.–*Plot 4 was not located during the MY3 survey. This plot contained only one silky willow in MY1 and MY2 (Mulkey 2004).

A density criterion of 260 stems per acre for planted woody stems is used to determine vegetation success after five growing seasons following plant installation at mitigation sites (USACE 2003). After eight growing seasons, the density of woody stems at the Charles/McGinnis site was 3,681 per acre, far exceeding the established woody stem success criterion (Exhibit Table 5). Woody stem counts from the tree plots more accurately represent woody stem densities throughout the site. The smaller vegetation plots were subsamples of the larger plots and covered insufficient area to accurately depict actual woody stem density. In fact, only a single stem needed to be present in the plot for it to meet the woody stem success criterion.

Exhibit Table 5. Vegetation Monitoring Results

Plots	Black Willow	Silky Willow	Silky Dogwood	River Birch	Green Ash	[a] Southern Red Oak	[a] Yellow Buckeye	Total Stem Count 2003 (MY1)	Total Stem Count 2004 (MY2)	Total Stem Count 2007 (MY3)	Density (Stems/ Acre) 2007 (MY3)
Tree Plots	MY3 Woody Stem Counts										
Plot A (1,000 ft^2)	2	1	63	1	1		2	104	98	70	3,049
Plot B (1,000 ft^2)	12	13	70	1	2	1	1	94	90	100	4,356
									Average Density		**3,681**
Vegetation Plots	MY3 Woody Stem Counts										
Plot 1 (1 m^2)		1						1	1	1	4,047
Plot 2 (1 m^2)			3					2	2	3	12,141
Plot 3 (1 m^2)			3					2	2	3	12,141
Plot 4 (1 m^2)								1	1	[b]	
									Average Density		**9,443**

[a] Species not observed in prior surveys.
[b] Plot 4 was not relocated in MY3.

4.4 Invasive Exotic Vegetation Occurrence

Exotic invasive plant species were present within the project area, with reed canarygrass being the most prevalent. Although not a major component of the monitoring plots, reed canarygrass was predominant along the stream channel in the upper half of the project reach. This species was planted by the NRCS during the 1980s as a stabilizing ground cover (NCWRC 1998). Other invasive exotic species present within the project area, albeit at low densities, included multiflora rose *Rosa multiflora*, oriental bittersweet *Celastrus orbiculatus,* Japanese honeysuckle *Lonicera japonica*, and tall fescue.

5.0 Biological Indicators

As a condition of the USACE section 404 permit for the A-10 project, NCDOT was to develop a biological monitoring plan for the mitigation sites. To the best of our knowledge, no fish or aquatic insect sampling was completed.

6.0 Closeout Summary

The Charles/McGinnis mitigation site on South Fork Big Pine Creek in Madison County, N.C. was monitored for the third time (MY3) in September 2007, eight years since project completion. Initial project objectives to enhance and protect water and riparian habitat quality, channel bank stability, and aquatic habitat have been achieved.

Channel Cross-Sections.–Morphometric parameters for MY3 are within the range of values expected for the site based on design and as-built values and the values recorded during MY1 and MY2. Stream type did change slightly from the pre-project assessment (E3b), in 1998, to an E4b stream type in 2007, but only as a result of bed material (D50) shifting from cobble to gravel. The entrenchment ratio was improved from moderately to slightly entrenched, which is attributed to the removal of the left bank berm. The project reach has maintained a low width/depth ratio (mean 9.9). Although the project reach is dominated by a series of riffle and run features, with a minimal amount of meander, the low width/depth ratio is the main factor that this stream reach is being maintained as an E stream type. Cross-section 5 was the only location where the width/depth ratio (13.9) exceeded that of an E stream type (<12) and resulted in a B stream type classification.

Longitudinal Profile.–Channel sinuosity (1.2) is low and the average water surface slope (0.030 ft/ft) is high for an E stream type. Typically E stream types have a sinuosity of ≥1.5 and a water surface slope of <0.02 ft/ft. Because of the low width/depth ratio, high water surface slope, and low sinuosity, the project reach has maintained the Eb channel classification since construction was completed. Little opportunity exists for the channel to increase in sinuosity and thereby decrease in slope due to constraints on the left (agricultural field) and right (SR 1158) channel banks. Most likely, the channel will attempt to extend laterally (towards SR 1158) to increase in sinuosity following the next flood event. As in the past, road maintenance activities will be required to stabilize the road shoulders. Otherwise, the channel thalweg has and is expected to remain stable with little aggradation, degradation, or lateral movement under typical hydrologic conditions.

Pebble Counts.–Mean particle size for each of the particle size classes has fluctuated between monitoring surveys. The smallest mean D50 and mean D84 particles sizes observed since project completion occurred in MY3. The decrease in particle sizes may be influenced by upstream land use practices (development, agricultural), numerous flood events, or from channel dredging. Nonetheless, mid-channel and transverse bars were not observed, and the substrate did not appear to be embedded or adversely affecting channel stability.

Hydrologic Data and Bankfull Verification.–The small drainage of South Fork Big Pine Creek has experienced a large number of flashy and sustained bank full or higher stream flows.

Based on mean daily discharge, there were >30 flow events of >500 cfs at the surrogate Ivy River between September 1999 and September 2007. Twenty-one of these events exceeded 1,000 cfs; four of these bankfull events were photo documented and illustrate the elevation of the water in relation to the floodplain vegetation and reveal sediment deposits in SR 1158.

Fixed Station Photos.–The planted vegetation along the left bank has become well established over the eight years since installation. Field observation and photo documentation of planted woody vegetation revealed that woody riparian vegetation is ≥15 ft in height and has enhanced stability of the left channel bank. The two areas of channel problems are not the result of sparse vegetation, but because of the stream's proximity of SR 1158. In fact, the vegetated left bank has faired much better following high flow events when compared to the channel banks adjacent to the road shoulder, which are only protected by shallow rooting herbaceous plants, boulders, and rip-rap.

Problem Areas.–Although two problem areas (sta. 1+50 to 3+50, 5+50 to 6+50) were noted during MY3, these areas were of concern before the project was constructed as both areas are adjacent to SR 1158. Whenever high flow events have scoured the channel banks to the degree where the integrity of the road shoulder and surface is jeopardy of failing, NCDOT has repaired the problem by installing large boulders and rip-rap to armor the channel bank and stabilize the road bed.

Vegetation.–Density of woody stems in all the plots exceeded the minimum required criterion of 260 stems/acre. Stem diversity for the larger tree plots consisted of seven woody species; however, the plots were dominated by silky dogwood, which comprised 70–90% of the woody stems. The silky dogwoods should self-thin over time, allowing a more diverse mixture of flora to become established, while still providing channel bank stability. Several naturally recruited silky dogwoods, two small yellow buckeyes, and a southern red oak were observed. In addition to the vegetation within the survey plots, woody stems were abundant throughout the conservation easement, were well established, and performing as would be desired eight years after replanting.

Farm Management Plan.–Installation of livestock fencing on the left bank of the conservation easement boundary has allowed the vegetation to become well established. The left bank vegetation is not only enhancing channel bank stability, but also providing shading to the stream channel, which was absent in the pre-project assessment (NCWRC 1998).

Overall, the project site has benefited from the exclusion of livestock and establishment of the riparian vegetation on the left bank. Unfortunately, proximity of SR 1158 to the stream channel and lack of woody vegetation on the right bank will likely continue to create a maintenance challenge following flood events. With this exception, the Charles/McGinnis site is performing as purposed under the mitigation guidance in place at the time. This site should be approved for closeout, monitoring discontinued, and mitigation credits released.

7.0 Acknowledgements

Scott Loftis, Jeff Ferguson, Brent Burgess, and Todd Ewing of the NCWRC watershed enhancement group collected and analyzed the field data. Scott Loftis, Jeff Ferguson, and Todd Ewing prepared this report. Jim Borawa with the NCWRC provided comments for improving this report. Mulkey Engineering collected and analyzed the data and prepared the reports for MY1 and MY2. Madison County NRCS developed the farm management plan and provided oversight during implementation of that plan.

7.0 References

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USGS (United States Geological Survey). 2008. Real-time Data for USGS 03453000 Ivy River near Marshall, N.C. Available. http://waterdata.usgs.gov/nc/nwis.

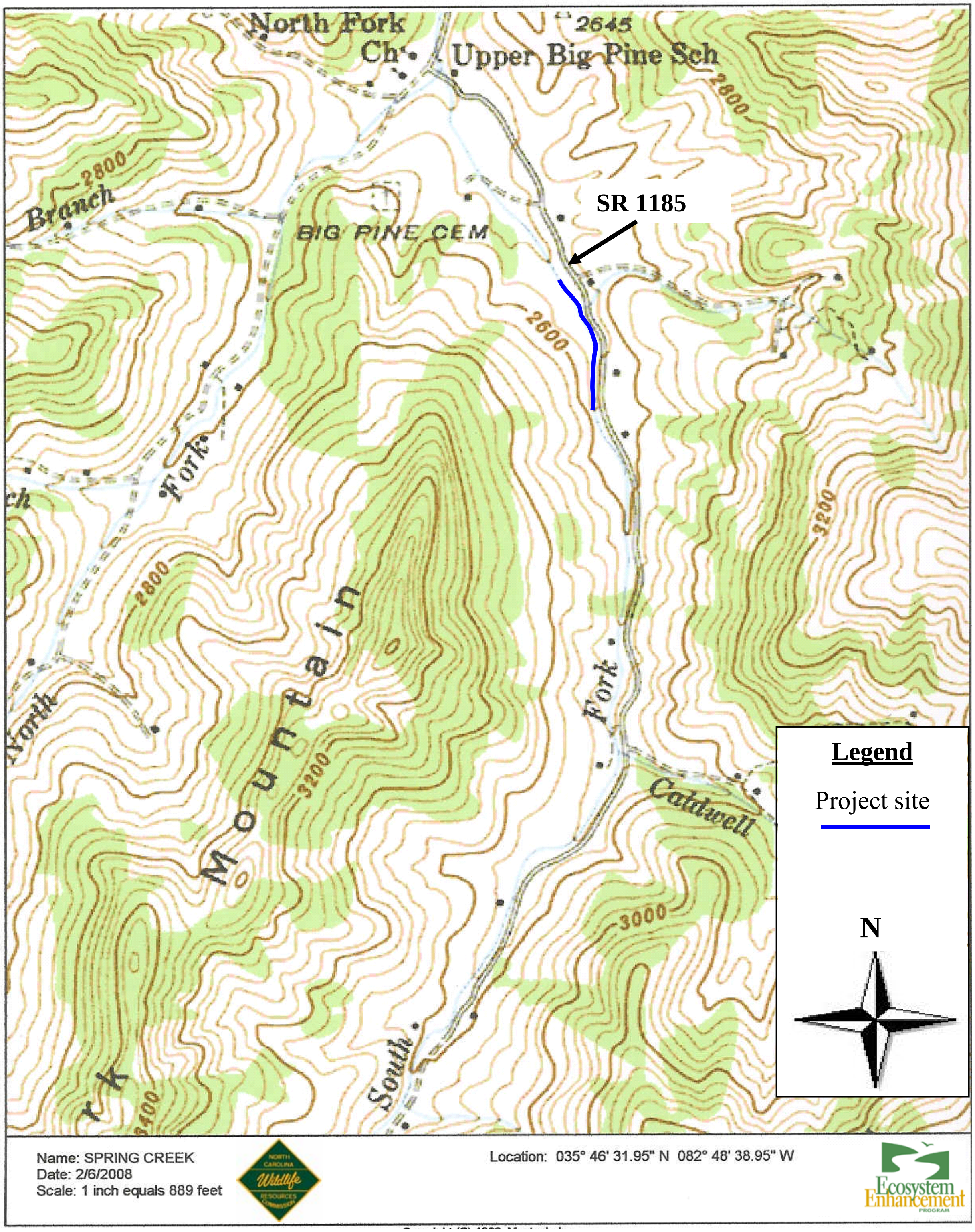
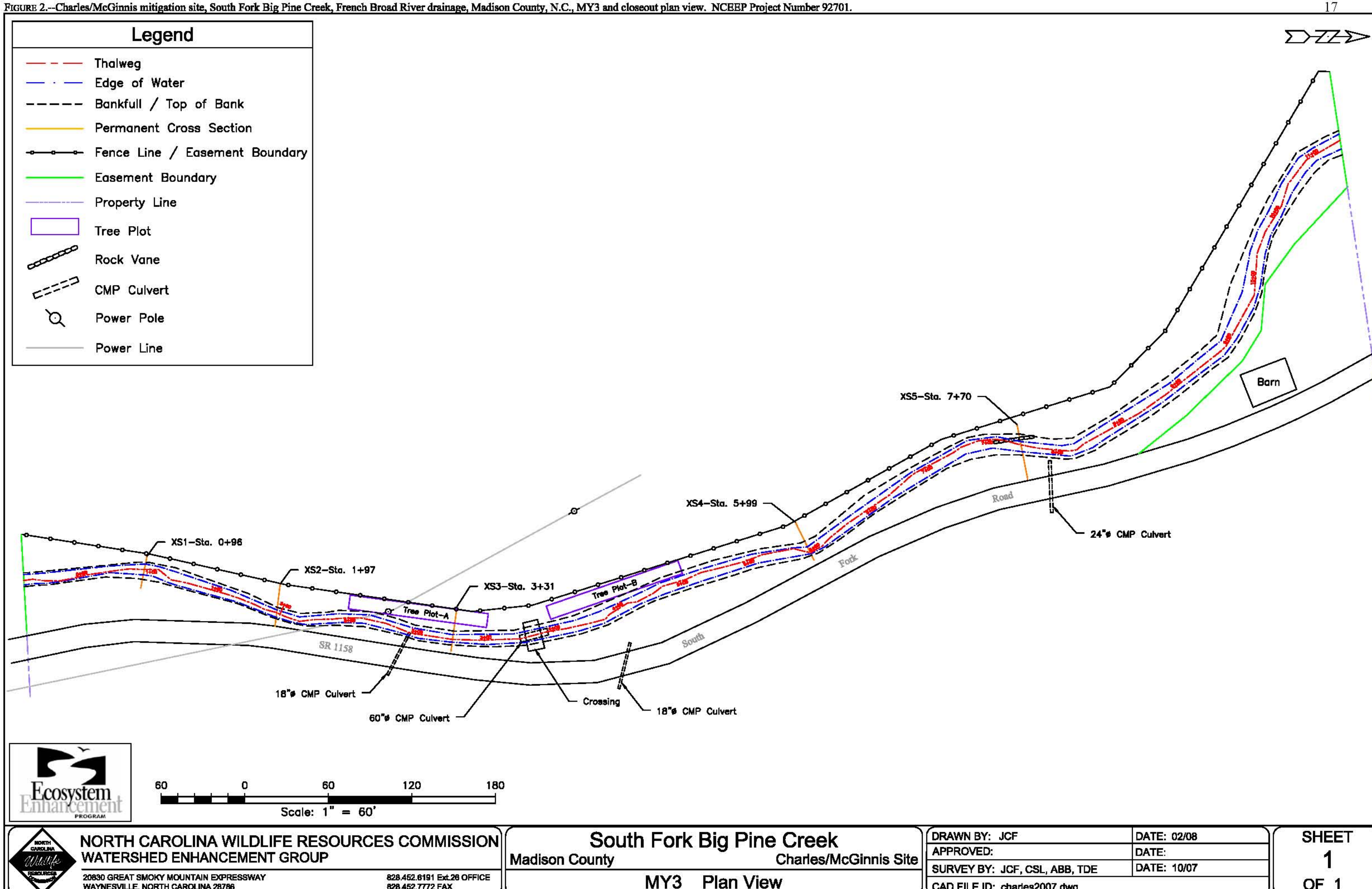


Figure 1.—Charles/McGinnis mitigation site, South Fork Big Pine Creek, French Broad River basin, Madison County, North Carolina; EEP Project Number 92701.

FIGURE 2.--Charles/McGinnis mitigation site, South Fork Big Pine Creek, French Broad River drainage, Madison County, N.C., MY3 and closeout plan view. NCEEP Project Number 92701.

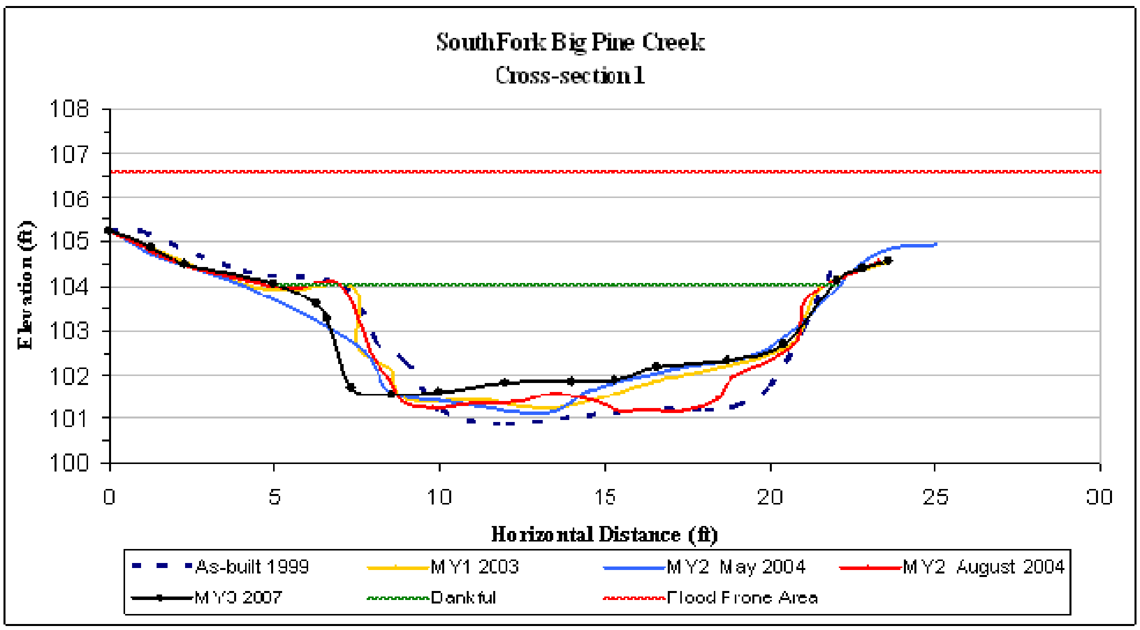


APPENDIX A

Appendix A.1. Cross-Sections Plots and Photographs.

Appendix Table A.1.1. Cross-Section 1 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2003	2004	2004b[a]	2007
Station (ft)	0+96			
Feature	Riffle			
Stream Type	E4b	C4b	E4b	E4b
Bankfull Cross Sectional Area (ft^2)	29.5	10.8	29.9	30.5
Maximum Bankfull Depth (ft)	2.8	1.5	2.7	2.5
Bankfull Mean Depth (ft)	2.1	0.9	2.1	1.8
Width/Depth Ratio	6.8	14.4	6.6	9.4
Entrenchment Ratio	>1.4	>1.6	>1.4	11.8
Bankfull Width (ft)	14.2	12.5	14.1	16.9

[a] Measurements taken after bankfull event.

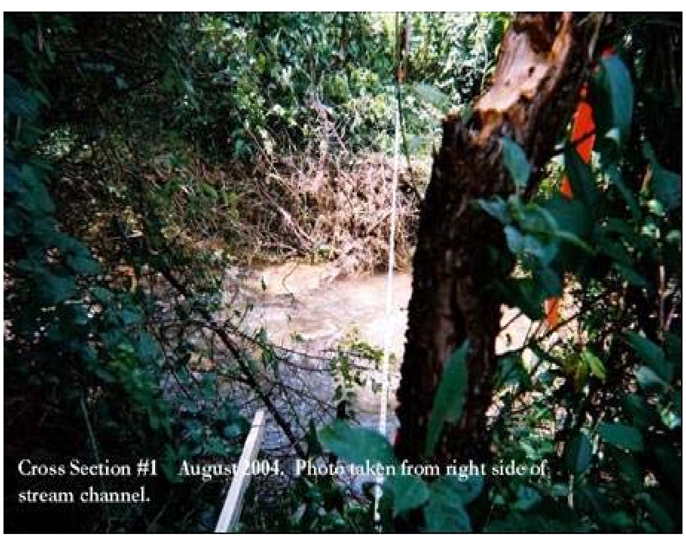


Cross-section 1, upstream to downstream, November 1999.

Cross-section 1, upstream to downstream, January 2001.

Cross-section 1, left bank to right bank, July 2003.

Cross-section 1, right bank to left bank, June 2004.



Cross-section 1, right bank to left bank, August 2004.

Cross-section 1, right bank to left bank, October 2007.

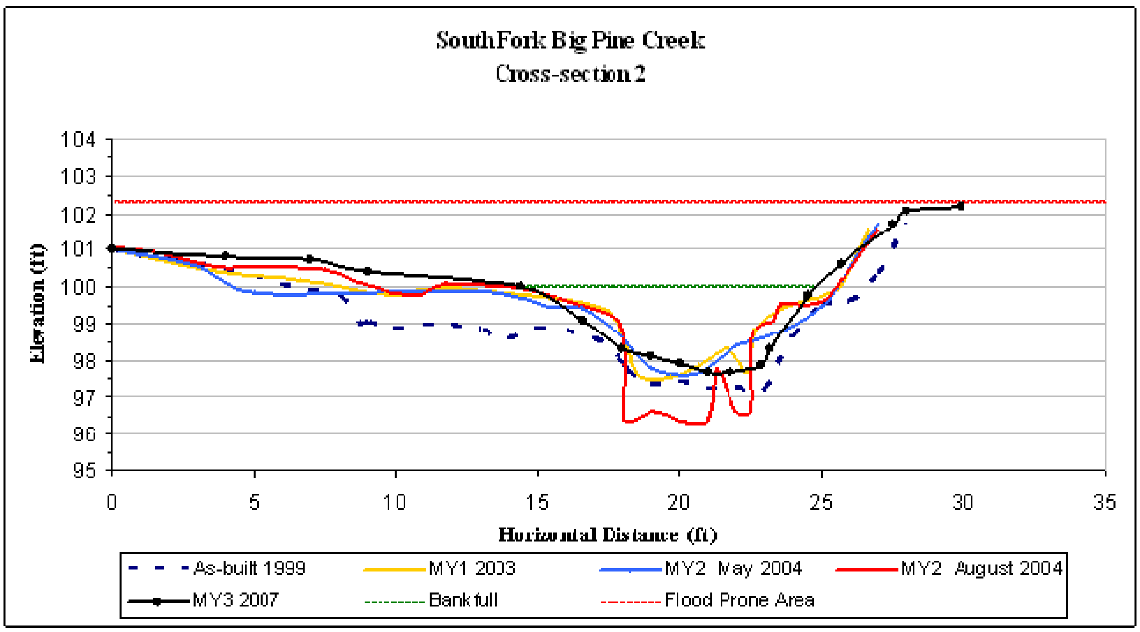

Cross-section 1, right bank to left bank, October 2007


Cross-section 1, upstream to downstream, October 2007

Appendix A.1. Continued.

Appendix Table A.1.2. Cross-Section 2 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2003	2004	2004b[a]	2007
Station (ft)	1+97			
Feature	Run			
Stream Type	E4b	E4b	E4b	E4b
Bankfull Cross Sectional Area (ft^2)	9.8	8.1	15.4	15.0
Maximum Bankfull Depth (ft)	2.1	1.8	3.4	2.3
Bankfull Mean Depth (ft)	1.1	1	1.7	1.4
Width/Depth Ratio	8.1	8.4	5.5	7.2
Entrenchment Ratio	>4.0	>4.0	>4.0	19.2
Bankfull Width (ft)	8.9	8.3	9.3	10.4

[a] Measurements taken after bankfull event.



Cross-section 2, right bank to left bank, November 1999.

Cross-section 2, right bank to left bank, January 2001.

Cross-section 2, right bank to left bank, July 2003.

Cross-section 2, left bank to right bank, June 2004.

Cross-section 2, right bank to left bank, August 2004.

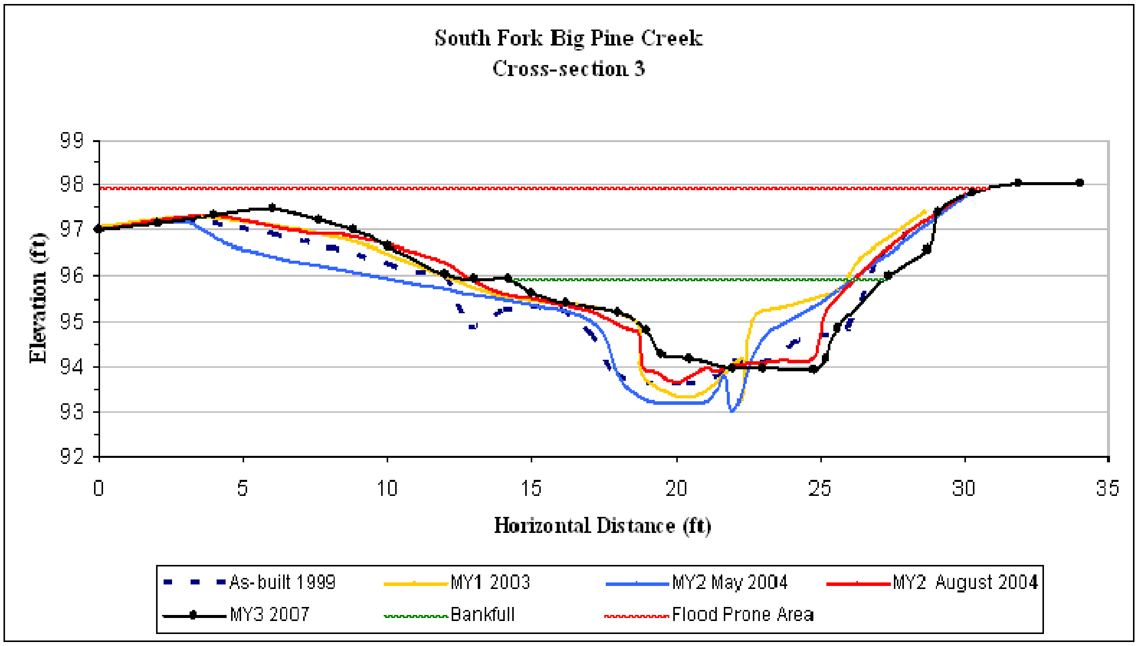
Cross-section 2, right bank to left bank, September 2007.

Cross-section 2, upstream to downstream, September 2007.

Appendix A.1. Continued.

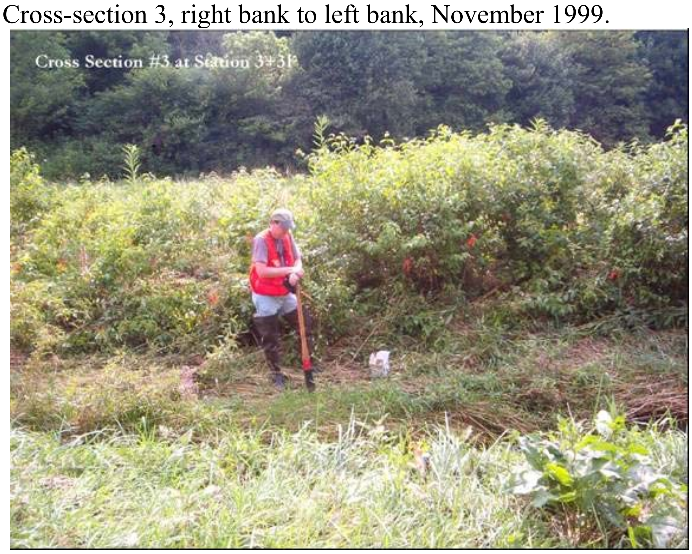
Appendix Table A.1.3. Cross-Section 3 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2003	2004	2004b[a]	2007
Station (ft)	3+31			
Feature	Riffle			
Stream Type	C4b	E4b	E4b	E4b
Bankfull Cross Sectional Area (ft^2)	10.7	8.6	17.0	15.6
Maximum Bankfull Depth (ft)	2.5	2	2.4	2.0
Bankfull Mean Depth (ft)	0.9	1.2	1.3	1.2
Width/Depth Ratio	14.2	5.7	10.8	11.0
Entrenchment Ratio	>3.0	>3.5	>3.0	15.3
Bankfull Width (ft)	12.3	7	13.5	13.1

[a] Measurements taken after bankfull event.



Cross-section 3, right bank to left bank, November 1999.

Cross-section 3, right bank to left bank, January 2001.



Cross-section 3, right bank to left bank, July 2003.

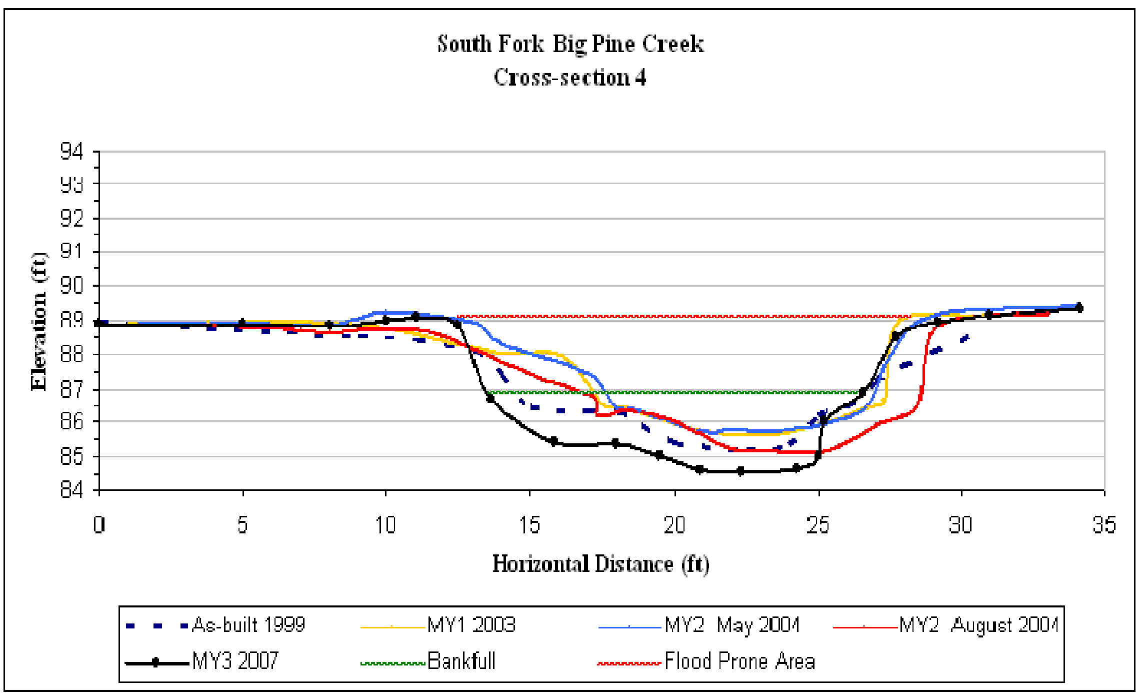
Cross-section 3, right bank to left bank, September 2007.

Cross-section 3, upstream to downstream, September 2007.

Appendix A.1. Continued.

Appendix Table A.1.4. Cross-Section 4 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2003	2004	2004b[a]	2007
Station (ft)	5+99			
Feature	Riffle			
Stream Type	E4b	E4b	E4b	E4b
Bankfull Cross Sectional Area (ft2)	20.0	13.4	31.1	20.5
Maximum Bankfull Depth (ft)	2.3	1.7	3.0	2.3
Bankfull Mean Depth (ft)	1.7	1.3	2.0	1.6
Width/Depth Ratio	6.6	7.8	7.9	8.3
Entrenchment Ratio	>3.0	>3.0	>3.0	15.3
Bankfull Width (ft)	11.5	10.2	15.8	13.1

[a] Measurements taken after bankfull event.



Cross-section 4, left bank to right bank, November 1999.

Cross-section 4, left bank to right bank, January 2001.

Cross-section 4, right bank to left bank, July 2003.

Cross-section 4, downstream to upstream, July 2003.

Cross-section 4, right bank to left bank, June 2004.

Cross-section 4, right bank to left bank, August 2004.

Cross-section 4, downstream to upstream, August 2004.

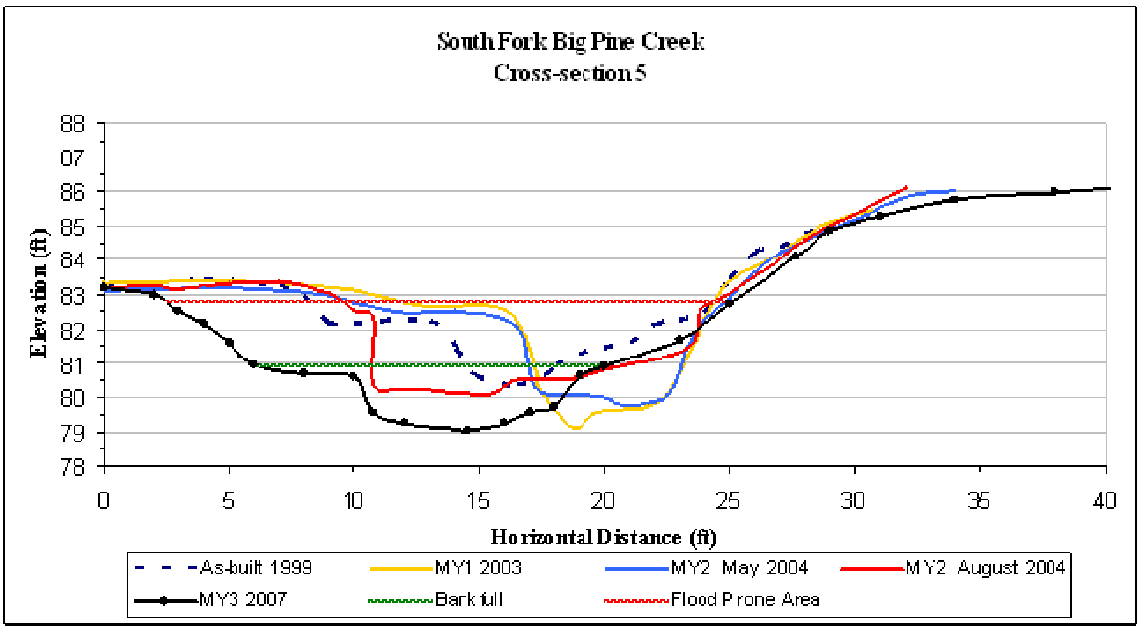
Cross-section 4, looking downstream, September 2007.

Cross-section 4, right bank to left bank, September 2007.

Appendix A.1. Continued.

Appendix Table A.1.5. Cross-Section 5 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2003	2004	2004b[a]	2007
Station (ft)	7+70			
Feature	Riffle			
Stream Type	E4b	E4b	E4b	B4
Bankfull Cross Sectional Area (ft2)	19.0	12.5	25.4	14.3
Maximum Bankfull Depth (ft)	3.5	2.3	2.5	1.9
Bankfull Mean Depth (ft)	2.2	1.7	1.8	1.0
Width/Depth Ratio	3.9	4.3	7.5	13.9
Entrenchment Ratio	>4.0	>4.0	>4.0	1.6
Bankfull Width (ft)	8.6	7.3	13.8	14.1

[a] Measurements were taken after above bankfull event.

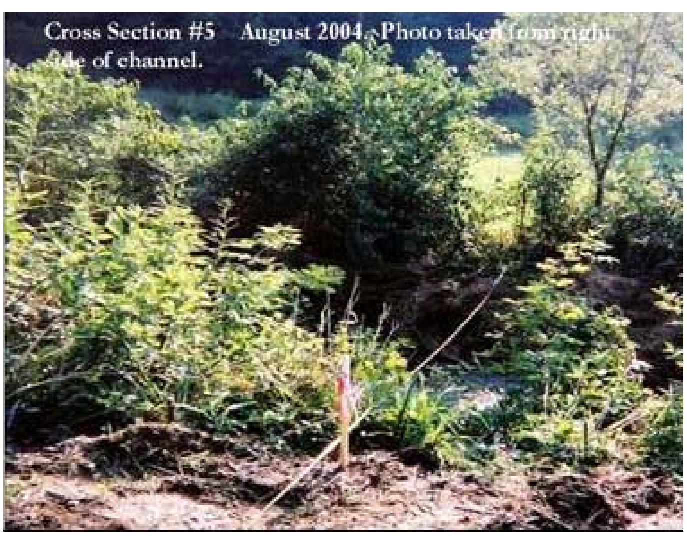


Cross-section 5, left bank to right bank, November 1999.

Cross-section 5, left bank to right bank, January 2001.

Cross-section 5, right bank to left bank, July 2003.

Cross-section 5, right bank to left bank, May 2004.



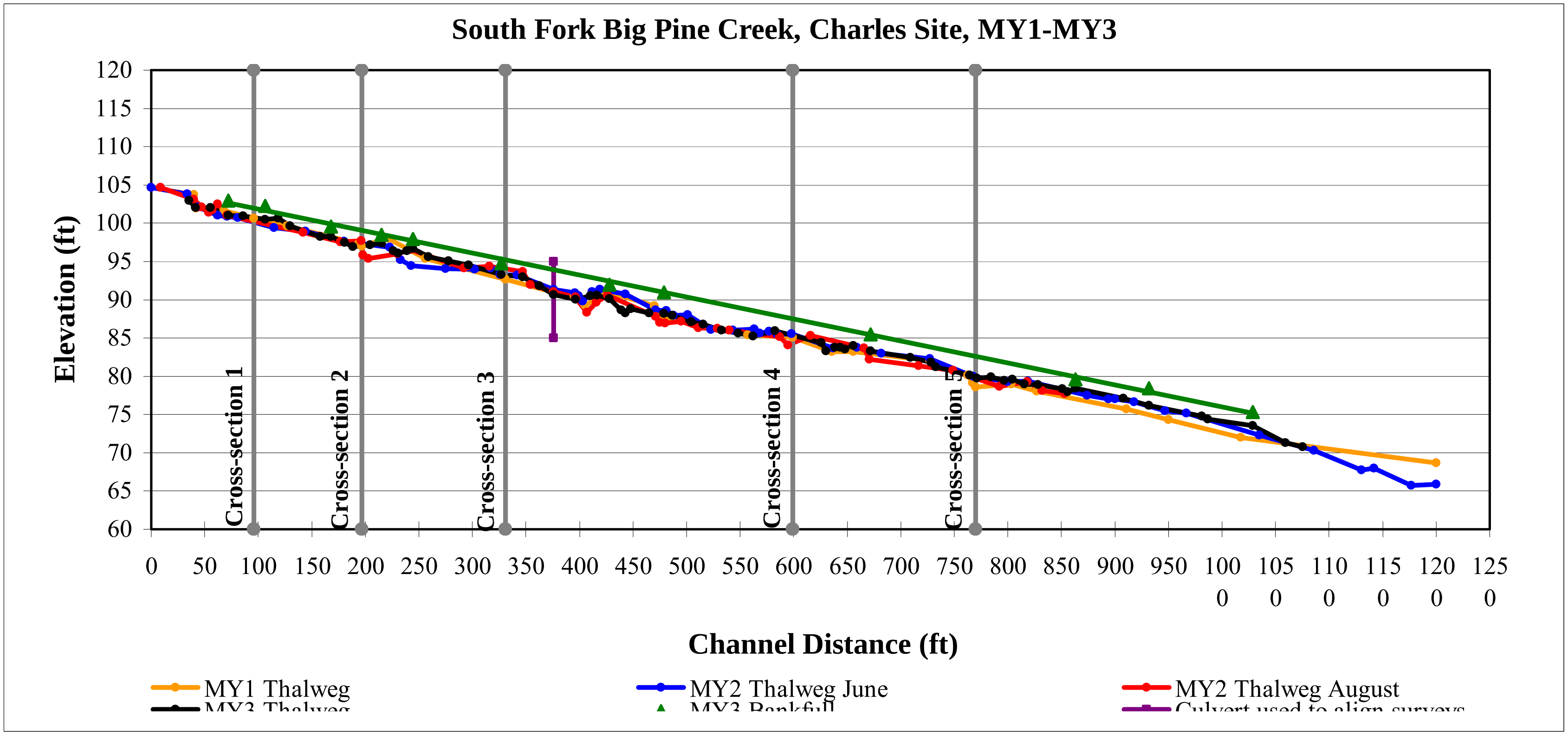
Cross-section 5, right bank to left bank, August 2004.

Cross-section 5, looking downstream, September 2007.

Cross-section 5, right bank to left bank, September 2007.

Cross-section 5, right bank to left bank, September 2007

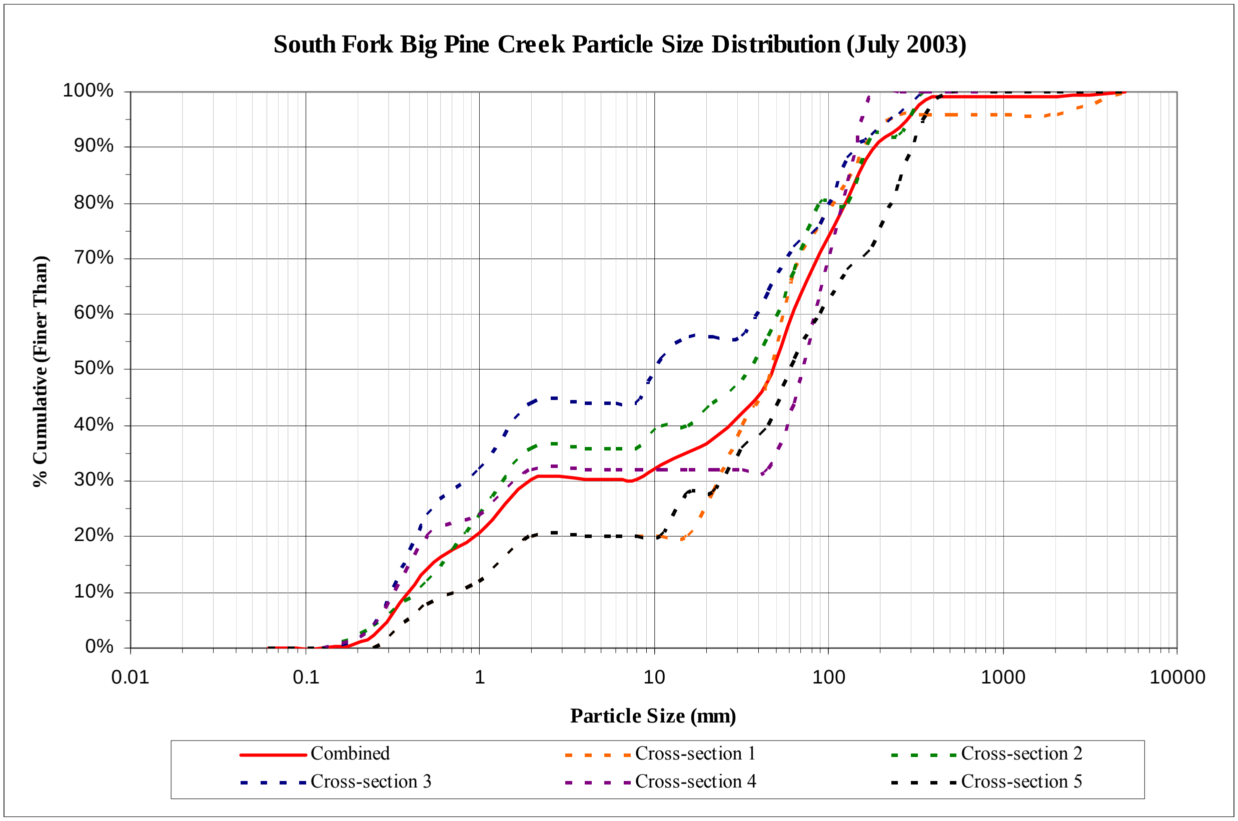
Appendix A.2. Longitudinal Profile Plots.

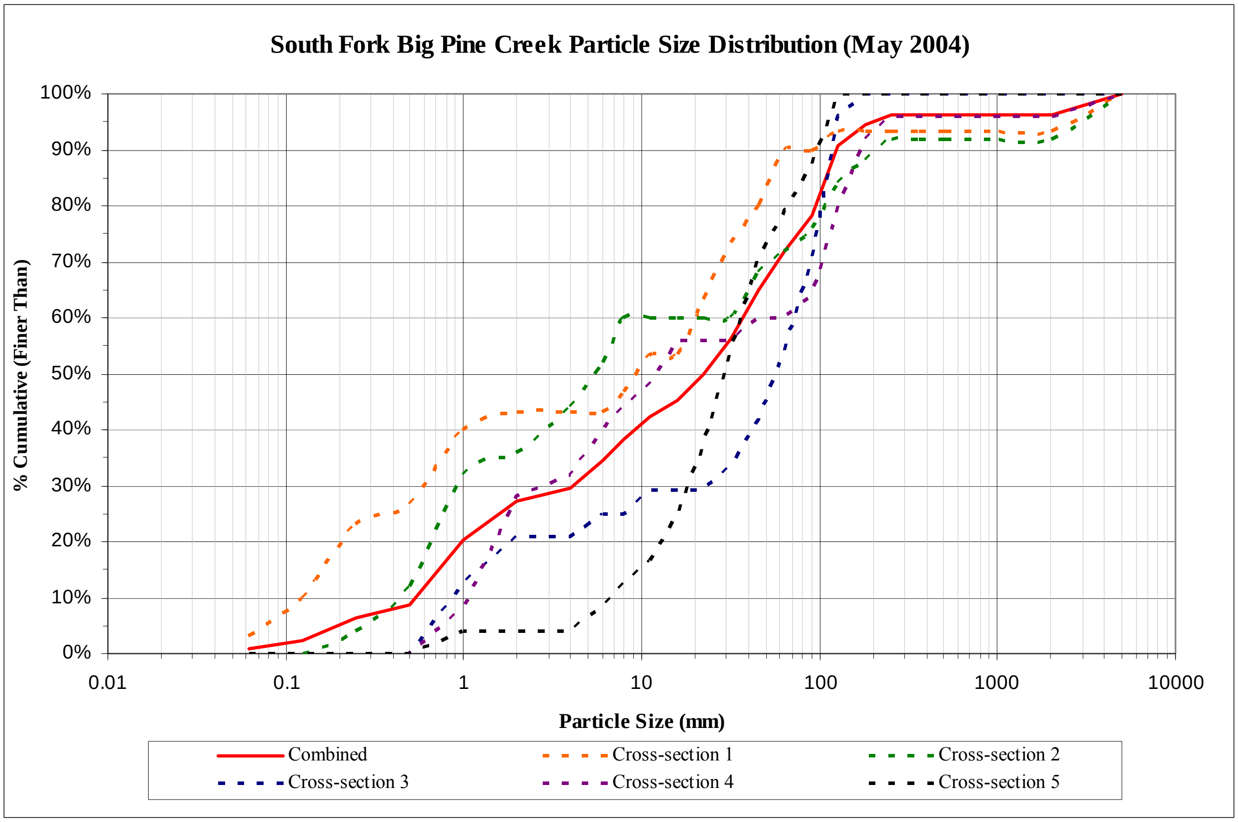


Note 1: The lower project boundary crosses the stream at approximately station 11+25; see Figure 2 plan view drawing. The MY1 and MY2 (June) surveys extended beyond the lower property boundary. The MY2 (August) longitudinal profile survey ended at station 8+50, upstream of the lower project boundary.

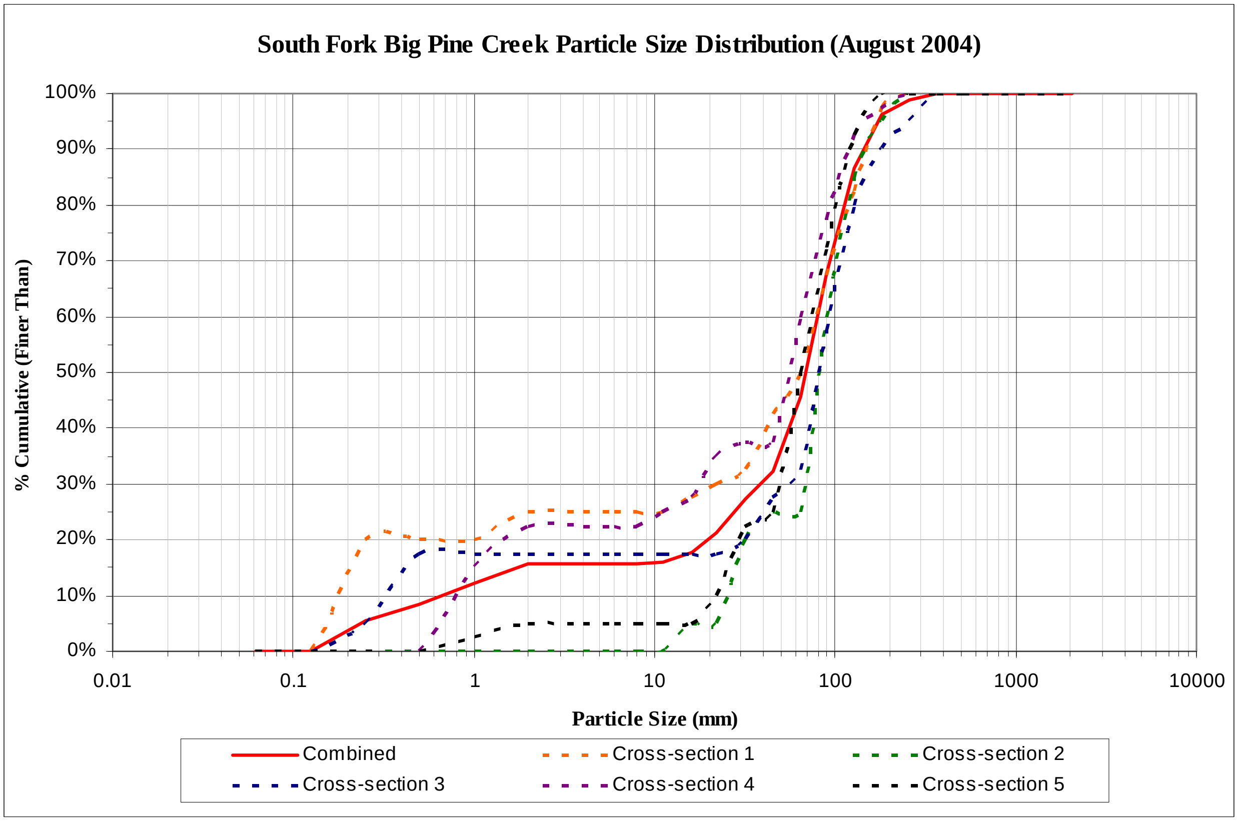
Note 2: Water surface elevations were taken, but not plotted because they would coincide with the thalweg profile data. Water levels were low due to an ongoing regional drought.

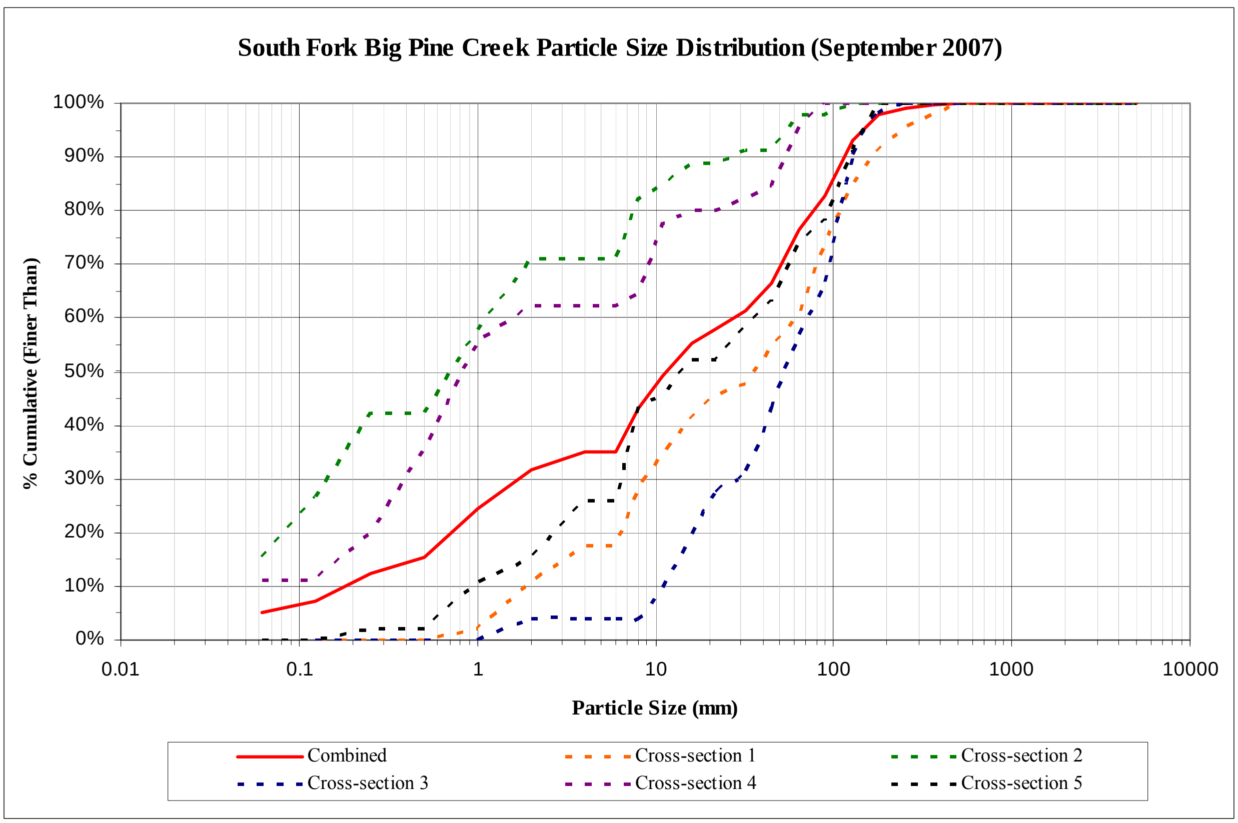
Appendix A.3. Pebble Count Cumulative Frequency Distributions Plots





Appendix A.3. Continued.

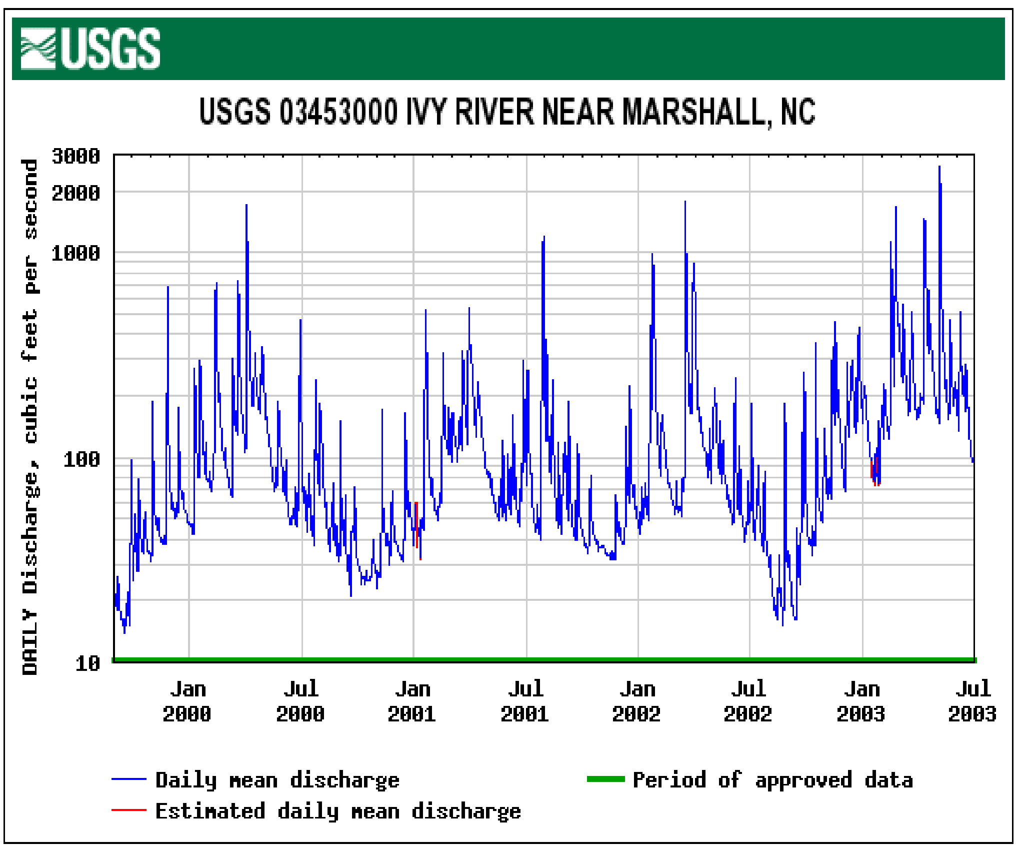




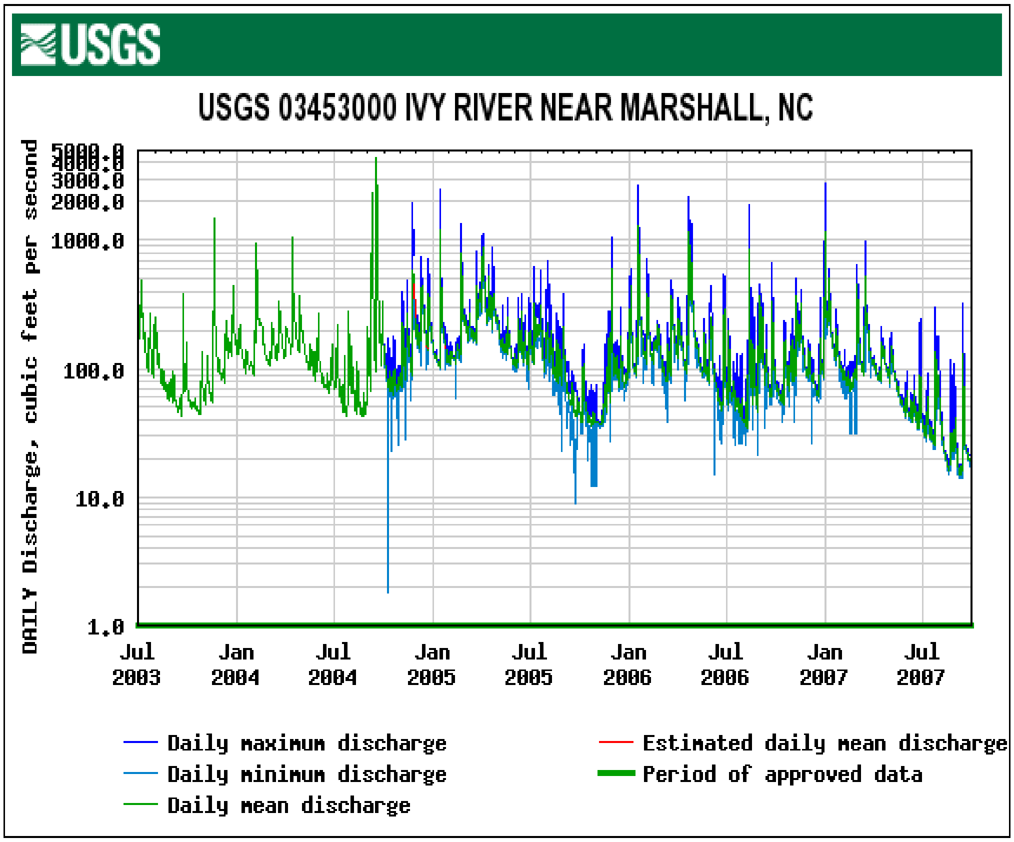
Appendix A.4. Surrogate gage hydrograph data table and supporting graphs.

Appendix Table A.4.1. USGS gage 03453000, Ivy River , near Marshall, N.C.			
Date	**Flow (ft3/s)**[a]	**Gage height (ft)**[a]	**Comments**
4/4/2000	1,720	6.89	Bankfull event
7/29-30/2001	1,135	5.44	Bankfull event; photo verification
3/17-18/2002	1,580	6.40	Bankfull event
2/15/2003	1,120	5.62	Bankfull event
2/22-23/2003	1,535	6.37	Bankfull event
4/10-11/2003	1,435	6.19	Bankfull event
5/06-07/2003	2,195	8.83	Bankfull event
8/20/2003	N/A[b]	N/A[a]	Photo verification
11/19/2003	1,500	5.81	Photo verification
4/13/2004	1,050	5.29	Bankfull event
8/04/2004	N/A[b]	N/A[b]	Photo verification
9/08/2004	2,330	7.59	Bankfull event
9/17-18/2004	3,030	8.12	Bankfull event
1/14/2005	1,200	5.68	Bankfull event
1/18/2006	1,290	5.82	Bankfull event
4/22/2006	1,160	5.60	Bankfull event
1/01/2007	1,150	5.51	Bankfull event

[a]Flow and gage height were averaged for high flow events occurring on consecutive days and counted as one event.
[b]Mean daily discharge at surrogate gage did not exceed 1,000 cfs.



Appendix A.4. Continued.



Appendix A.5. Bankfull Event Verification Photos.

Bankfull event, July 2001.

Bankfull event, August 2003.

Bankfull event, November 2003.

Bankfull event, August 2004

Appendix A.6. Fixed Station Photo Log.

Photo sta. 0+40, looking downstream, July 2003.

Photo sta. 0+40, looking downstream, June 2004.

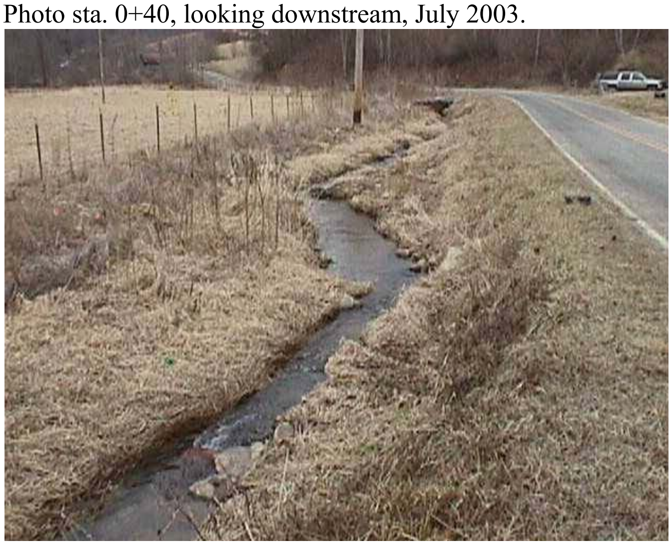


Photo sta. 2+21, looking downstream, January 2001.

Photo sta. 2+21, looking downstream, June 2004.

Photo sta. 2+21 looking downstream, August 2004

Photo sta. 2+21, looking downstream, September 2007.

Appendix A.6. Continued.

Photo sta. 3+00, looking upstream from bridge, January 2001.

Photo sta. 3+00, looking upstream, July 2003

Photo sta. 3+00, looking upstream from bridge, June 2004.

Photo sta. 3+00, looking upstream from bridge, August 2004.

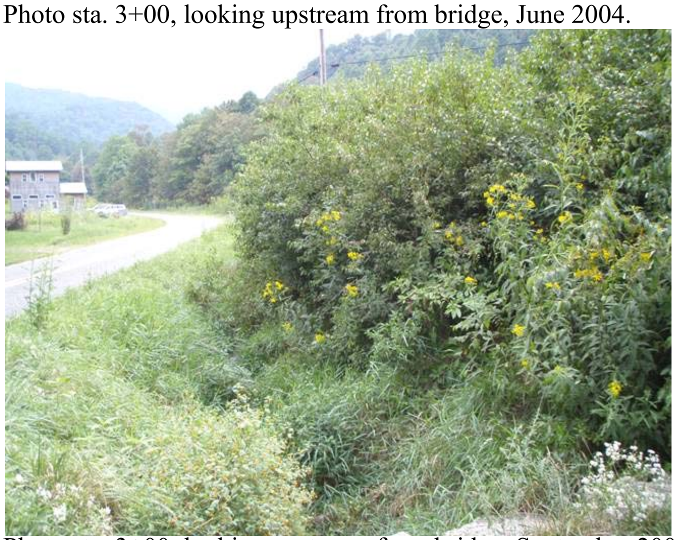


Photo sta. 3+00, looking upstream from bridge, September 2007.

Appendix A.6. Continued.

Photo sta. 5+99, looking downstream, August 1999.

Photo sta. 5+99, looking downstream, July 2003.

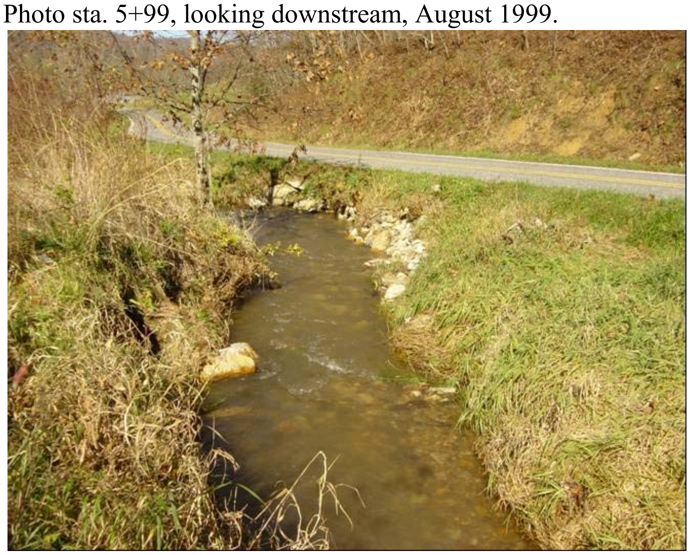


Photo sta. 5+99, looking downstream, November 2003.

Photo sta. 5+99, looking downstream, June 2004.

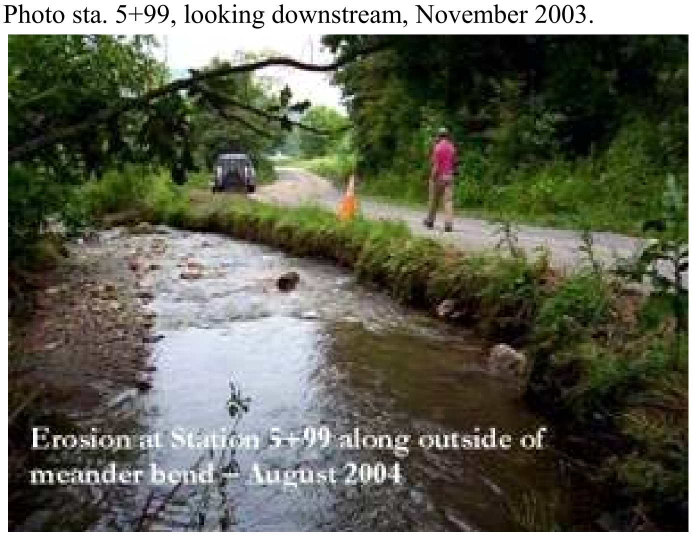


Photo sta. 5+99, looking downstream, August 2004.

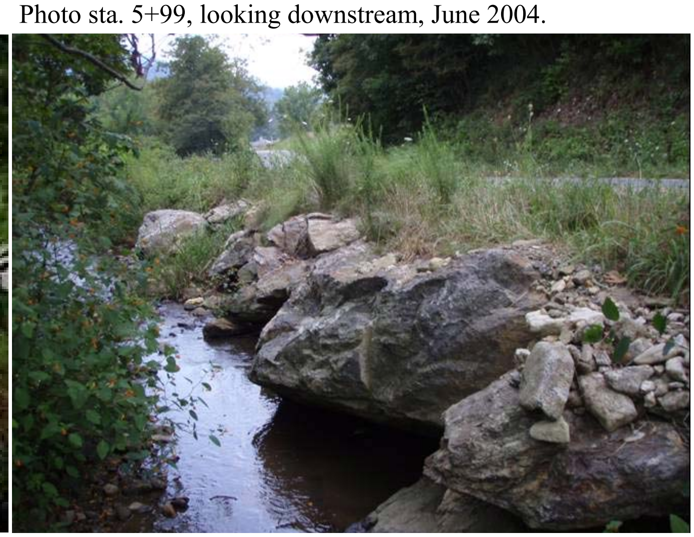


Photo sta. 5+99 looking downstream, September 2007.

Appendix A.6. Continued.

Photo sta. 7+70, looking downstream, March 2000.

Photo sta. 7+70, looking downstream, November 2003.

Photo sta. 7+70, looking downstream, July 2003.

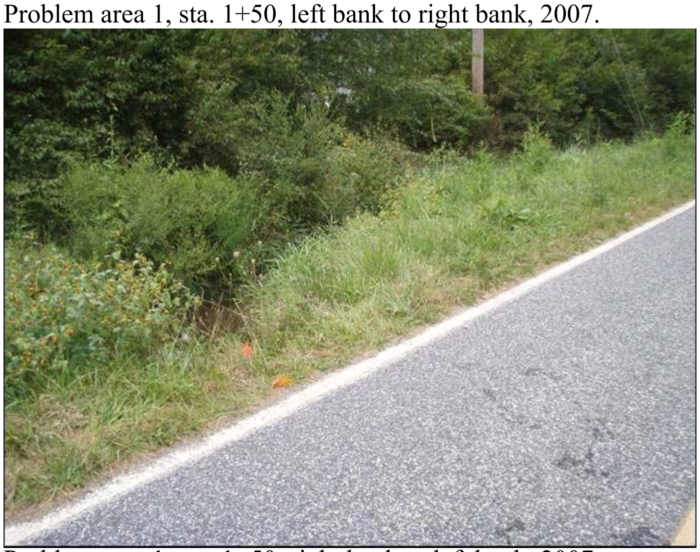
Photo sta. 7+70, looking downstream, June 2004.

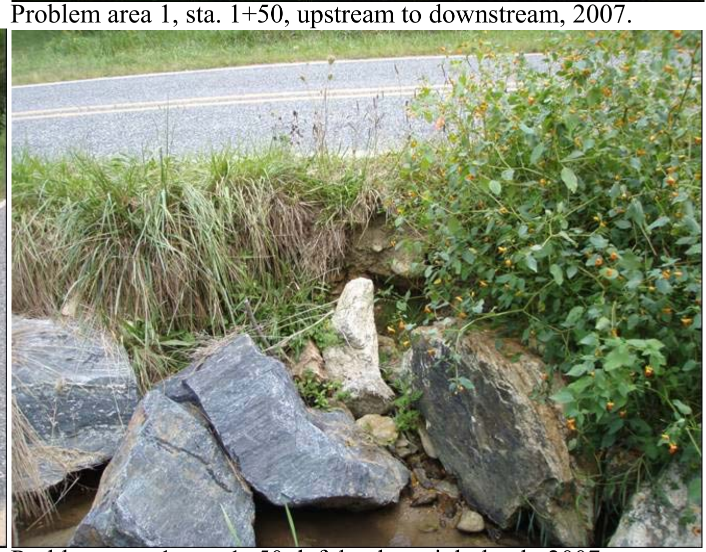
Photo sta. 7+70, looking downstream, September 2007.

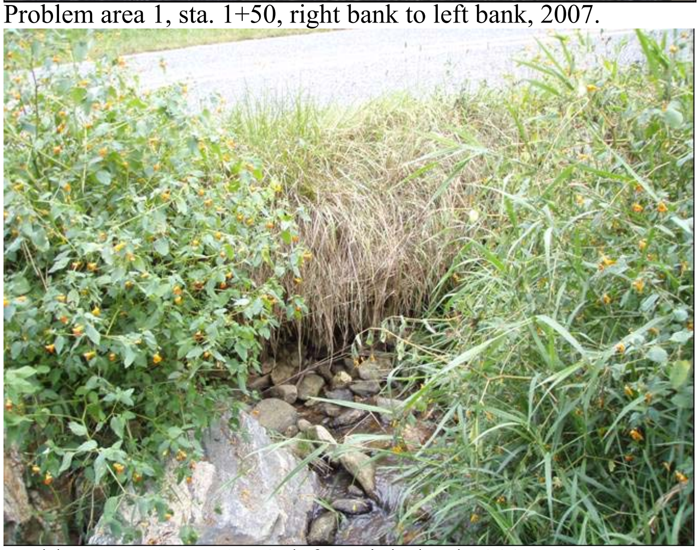
Appendix A.7. Stream Problem Area Photos.

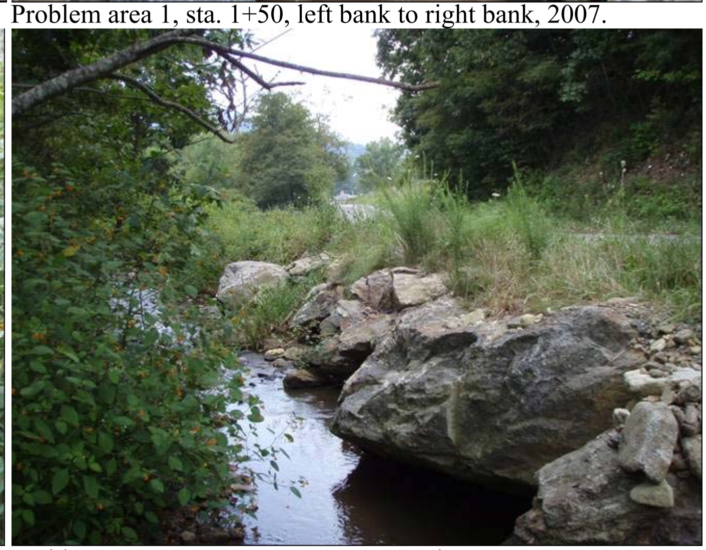

Problem area 1, sta. 1+50, left bank to right bank, 2007.


Problem area 1, sta. 1+50, upstream to downstream, 2007.


Problem area 1, sta. 1+50, right bank to left bank, 2007.


Problem area 1, sta. 1+50, left bank to right bank, 2007.

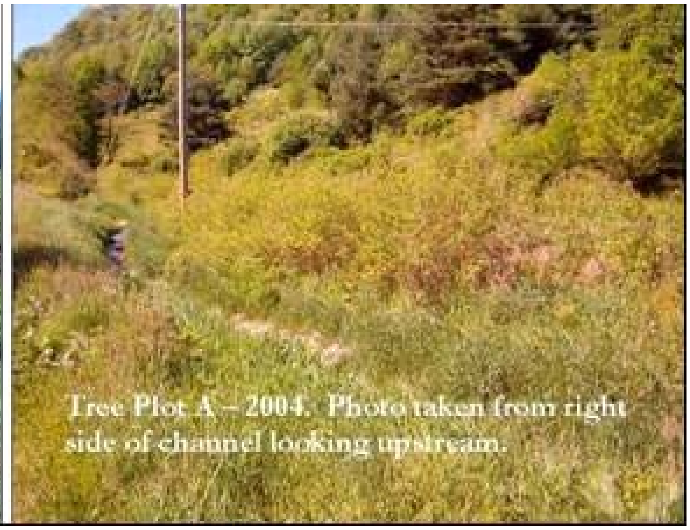

Problem area 1, sta. 1+50, left to right bank, 2007.


Problem area 2, sta. 5+99, upstream to downstream, 2007.

APPENDIX B

Appendix B.1. Vegetation Plot Photographs.

Tree plot A, looking downstream, July 2003.



Tree plot A, looking upstream, May 2004.

Tree plot A, top of plot looking downstream, September 2007.

Tree plot A, bottom, field side, looking upstream 2007.

Appendix B.1. Continued.

Tree plot B, left bank, looking downstream from bridge, 2003.

Tree plot B, looking downstream from bridge, May 2004.

Tree plot B, left bank, looking downstream from bridge, 2007.

Tree plot B, top, field side, looking downstream, 2007.

Appendix B.1. Continued.

Vegetation plot 1, left bank, sta. 0+96, July 2003.

Vegetation plot 1, left bank, May 2004.

Vegetation plot 1, left bank, September 2007.

Appendix B.1. Continued.

Vegetation plot 2, left bank within Tree Plot A, July 2003.

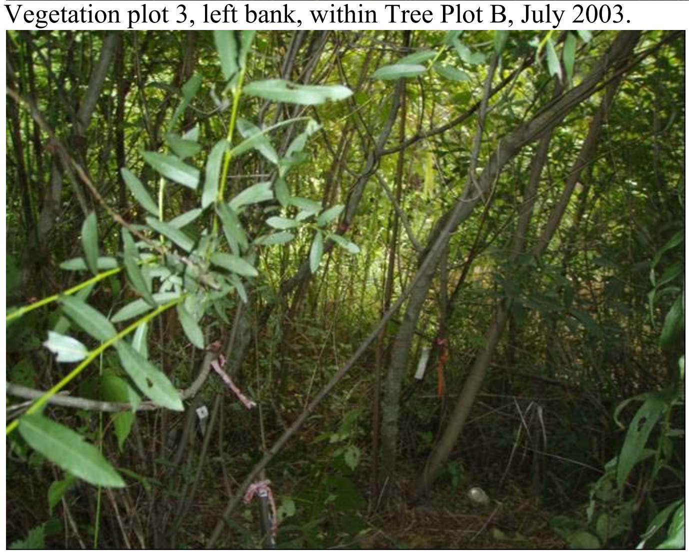
Vegetation plot 2, left bank, May 2004.

Vegetation plot 2, left bank within Tree Plot A, September 2007.

Appendix B.1. Continued.

Vegetation plot 3, left bank, within Tree Plot B, July 2003.

Vegetation plot 3, left bank, May 2004.



Vegetation plot 3, left bank, within tree plot B, September 2007.

Vegetation plot 4, sta. 7+00, left bank, July 2003.

Vegetation plot 4, left bank. May 2004.