YEAR 3 MONITORING and CLOSEOUT REPORT
for the
BRIGMON MITIGATION SITE
PAINT FORK CREEK,
MADISON COUNTY, NORTH CAROLINA

EEP PROJECT NUMBER 92700

Prepared in Partnership with the
North Carolina Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, N.C. 27699-1652

North Carolina Wildlife Resources Commission
Watershed Enhancement Group

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1.0 Executive Summary

The Brigmon mitigation site on Paint Fork Creek in Madison County, North Carolina Ecosystem Enhancement Program (NCEEP) Project Number 92700, was constructed during April-June 2000, and the as-built report was completed in October 2000. 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 the 2007 stream survey activities for monitoring year 3 (MY3), the seventh year following project construction, and will serve as the closeout report for the Brigmon mitigation site.

Morphometric parameters for Paint Fork Creek are within the range of values expected based on design values, and the values recorded during MY1 and MY2. The project reach is classified as an E4 stream type. Although the project reach is characterized by low slope (0.007 ft/ft) and low sinuosity, the width/depth ratio (mean = 10.6) and entrenchment ratio (>2.2) are the main factors for the reach being classified as an E stream type. Based on a surrogate flow gage hydrograph, >30 potential bankfull events occurred between June 2000 and November 2007, 15 of the events exceeded 1,000 cfs.

Average density of woody stems at the site was 370 stems/acre in the larger tree plots, which exceeds the 260 stems/acre minimum success criteria set forth in the stream mitigation guidance document (USACE 2003). A total of 17 woody stems representing 5 species were counted during the MY3 survey, seven fewer than the MY2 survey. Green ash stems made up approximately 35% of the total stems counted in the two tree plots. However, no other species comprised more than 24% of the total. Woody stems were observed throughout the conservation easement and performing as would be desired seven years after planting. Planted vegetation is not only contributing to channel bank stability, but also helping buffer solar warming of surface water.

A farm management plan was implemented in conjunction with the physical adjustments to the stream channel. The plan included installation of livestock exclusion fencing, culvert crossings, a livestock watering system, and a feed/waste structure. The farm management plan was administered by the Madison County Natural Resource Conservation Service (NRCS).

Overall, the project site has benefited from sloping and reshaping of the channel banks where needed, planting of woody vegetation, excluding livestock from the riparian area, and the establishment of a permanent conservation easement. The Brigmon mitigation site is performing as proposed and should be considered for closeout by NCEEP and state and federal regulatory agencies and the 5,398 feet of mitigation credits released.

2.0 Introduction

This monitoring report is submitted as partial fulfillment of the off-site stream mitigation requirements for the NCDOT A-10 (I-26) road project 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 NCEEP. This document was prepared using the framework developed by Mulkey, Inc. (2003, 2004) for the MY1 and MY2 reports. This was done to maintain consistency with methods used in earlier field data collections and reports and to facilitate the comparison of the 2007 data with previous years' data.

2.1 Project Description

The Brigmon mitigation site consists of four permanent conservation easements covering 5.14 acres on Paint Fork Creek and two unnamed tributaries and is located in the French Broad River basin. It is adjacent to Paint Fork Road (SR 1530) southeastern Madison County, approximately 3.0 miles east-southeast of Mars Hill, N.C. and 14.1 miles northeast of Asheville, N.C. (Figure 1). The main stem portion of the project is 3,098 ft long and has a 13.6 mi^2 watershed, the upper unnamed tributary portion is 1,263 ft long and has a drainage area of 0.15 mi^2, and the lower unnamed tributary portion is 1,037 ft long and has a drainage area of 0.16 mi^2.

2.2 Purpose

The purpose of the project was to improve water quality, riparian habitat diversity, channel bank stability, and to enhance aquatic habitat of Paint Fork Creek and tributaries (NCWRC 2000a). Specific objectives were to:

1) Adjust channel dimensions on Paint Fork Creek and both tributaries by reshaping and sloping channel banks and excavating a floodplain bench. Improve bank stability by establishing the correct width/depth and entrenchment ratios;
2) Remove junked automobile bodies from the large meander bend below the driveway bridge, construct a floodplain bench, and stabilize the meander using boulders and root wads;
3) Narrow the channel width downstream of the large meander bend (below the driveway bridge) and establish a floodplain bench on the right bank;
4) Install J-hook and cross vanes structures to reduce near bank shear stress, provide grade control, and to enhance aquatic habitat;
5) Install native woody vegetation along Paint Fork Creek and both unnamed tributaries;
6) Establish a conservation easement on Paint Fork Creek and portions of both tributaries contained upon the Brigmon property;
7) Implement agricultural best management practices including livestock exclusion fencing, livestock watering system, three permanent stream crossings, and a feed/waste structure.

2.3 Project History

The effort to provide mitigation for the I-26 road construction project began in 1996 when a Memorandum of Agreement between the NCDOT and the North Carolina Wildlife Resources Commission (NCWRC) was signed. Under the Memorandum of Agreement, the NCWRC was to provide stream mitigation on NCDOT's behalf for jurisdictional stream impacts. The original U.S. Army Corps of Engineers (USACE) section 404 permit and amendments called for providing 25,912 linear feet of mitigation for unavoidable impacts to trout streams.

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

The Brigmon site was selected by the MRT to provide compensatory mitigation for the I-26 road project. The project site and conceptual mitigation plan were approved by the MRT in August 1998 (Exhibit Table 1; NCWRC 1998). The construction plan was completed in January of 2000 (NCWRC 2000a). Project construction began in April 2000, and the as-built report was completed in October of 2000 (NCWRC 2000b).

Although it has been seven years since construction was completed, the 2007 site survey reflects only the third monitoring year. The morphometric and vegetative conditions were first monitored in April 2003 (Mulkey, Inc. 2003); the MY2 survey was conducted in May 2004 (Mulkey, Inc. 2004).

Exhibit Table 1. Project History

Completion Date	Activity
May 1995	USACE issued permit for A-10 project – 199505135
August 1998	NCWRC Conceptual Site Plan Completed
September 1999	Conservation Easement Acquired
January 2000	NCWRC Construction Plan Completed
April 2000	Site Construction Commenced
April 2000	Site Planted with Temporary and Native Perennial Seed Mix
October 2000	NCWRC As-built Report Completed
January 2001	Site Planted with Live Stakes and Bare Rooted Trees
April 2003	Stream Channel Monitoring (MY1)
April 2003	Vegetation Monitoring (MY1)
May 2004	Stream Channel Monitoring (MY2)
May 2004	Vegetation Monitoring (MY2)
November 2007	Stream Channel Monitoring (MY3/closeout)
November 2007	Vegetation Monitoring (MY3/closeout)
September 2008	NCWRC Monitoring Year 3 and Closeout Report Completed

2.4 Debit Ledger

The MRT anticipated that the Brigmon project would generate 5,175 ft of stream mitigation credits. This was based on an allowance of one mitigation credit for every foot of channel placed in a permanent conservation easement as measured during pre-construction surveys.

2.5 Success Criteria

The MRT developed the framework of success criteria used to evaluate the I-26 mitigation projects that included several 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 their stream mitigation guidelines document (USACE 2003). Included in these criteria was a combination of the following parameters: two bankfull flow events over a five–year monitoring period, reference photos, channel stability indicators, riparian vegetation survival, and response of fish and invertebrate populations, if specifically required by permit conditions. Overall, success or failure of the I-26 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, or 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 success or failure were to be determined by majority decision of the MRT.

3.0 Pre-Construction Conditions

Paint Fork Creek

This reach was classified as a B4c stream type according to the Rosgen (1996) stream classification system. It had an entrenchment ratio of 2.4, width/depth ratio of 12.8, and a sinuosity of 1.2 during the initial site assessment (Exhibit Table 3.1). The classification was based measurements from a single cross-section (NCWRC 2000a). Bankfull width was 30.7 ft, mean depth at bankfull was 2.4 ft, and cross-sectional area at bankfull was 81.6 ft^2. The channel is confined by a narrow valley, has a slope of 0.007 ft/ft, and a drainage area of 13.6 mi^2. The upper half of the project reach on Paint Fork Creek, above the Brigmon driveway bridge, had a slightly steeper slope, exposed bedrock, and narrower channel width compared to the lower portion. Below the Brigmon driveway bridge, a severe meander bend had been stabilized using automobile bodies. Below the meander bend in the lower half of the reach, the channel was over-wide, had a lower slope, and a higher width/depth ratio. The existing left channel bank and riparian area were in poor condition. Row crop cultivation and livestock access resulted in a riparian area of <30 ft. The riparian zone was dominated by multiflora rose *Rosa multiflora,* a variety of herbaceous plant species, and a few mature trees. A small berm also was present along portions of the left bank. The right bank of Paint Fork Creek is adjacent to SR 1530 for the entire project length. Although the floodplain width is constricted by the narrow valley and the presence of SR 1530, the riparian zone along right side of the creek contained a large number of mature trees and the stream bank was largely intact.

Upper Unnamed Tributary

The upper tributary was classified as a B type channel with a 0.15 mi^2 drainage area and a 0.07 ft/ft slope (Exhibit Table 3.2; NCWRC 2000a). An abandoned pond is located in the middle portion of this reach. Just below the old pond dam, the topography makes an abrupt change and the channel has a nearly vertical ≈10 ft drop. Upstream of the vertical drop and old pond dam, unconsolidated bed material (silt) from the old pond was unstable and the channel banks were actively eroding. The riparian area on the right bank had abundant woody vegetation along most of the reach (middle and upper sections). The left bank riparian area was devoid of vegetation and the channel banks were severely degraded from livestock access.

Lower Unnamed Tributary

The lower tributary also was classified as a B type channel with a 0.16 mi^2 drainage area and a 0.05 ft/ft slope (Exhibit Table 3.3; NCWRC 2000a). Livestock had full access to the majority of the lower tributary. The vegetation present along the channel had been altered by livestock grazing and consisted of tall fescue *Festuca arundinacea* with sparse clumps of tag alder *Alnus serrulata*. Channel banks were severely degraded from livestock access. Several locations where livestock congregated in the creek were over-wide, mucky, and without a defined base flow channel. The lower most portion of this reach was in better condition. The lower portion of this reach is separated from the middle and upper portions by a short segment of stream channel that crosses the corner of a neighboring landowner's property that was not included in this project. Livestock access was limited in the lower reach by the steep terrain on the right bank and the proximity of SR 1539 on the left bank; mature woody vegetation was present.

3.1 Post-Construction Conditions

Paint Fork Creek

The right channel bank is flanked by SR 1530 along the entire the project reach. The wooded riparian area between SR 1530 and the stream channel has provided sufficient protection to the channel banks; therefore, minimal work was needed. By sloping and reshaping targeted sections of the left channel bank, vertical bank sloughing problems were restored to a more natural condition. Two J-hook rock vanes were installed on the left bank in the upper portion (sta. 4+85 and sta. 6+25) and one single arm rock vane was constructed in the lower portion (sta. 23+60; left bank) of the project reach. These structures are intended to provide grade control, bank protection, and pool habitat. The large meander bend with a tight radius of curvature was corrected by first removing the automobile bodies used to armor the left bank. A bankfull bench was then excavated along the outside of the meander bend, and the channel bank gently sloped to the existing grade. The outside of the meander bend was reshaped and stabilized using large boulders and root wads. The over-wide section of channel below the meander bend (sta. 15+50 to 16+50) was narrowed by constructing a rock toe revetment at the desired channel width. Additional rock and soil where then used to backfill from the bank-side of the revetment up to the existing grade. A bankfull bench was created on the right bank as part of the backfilling process. In addition to the bank sloping and bankfull bench excavation along the lower portion of the reach, three cross vane structures were installed (sta. 19+00, rock; sta. 21+25, log; sta. 29+80, rock). Cross vanes were constructed to provide channel grade control, bank protection, and pool habitat. All disturbed areas were stabilized with temporary and permanent seed mixes (Exhibit Table 4), covered with coir erosion control matting, and planted with woody vegetation. The entire left bank was then fenced to exclude livestock from the riparian area and provide long-term protection to the conservation easement.

Upper Unnamed Tributary

Minimal in-stream work was conducted on the upper tributary. The sloughing left bank above the old pond dam (sta. 5+25 to 5+75) was sloped and stabilized using coir logs. Coir logs were installed to narrow the channel width and to reduce bank erosion. Areas disturbed during construction were seeded with a mixture comprised of temporary and permanent plant species (Exhibit Table 4) and covered with coir matting. The left bank was further stabilized with livestakes and an unknown number of bare-rooted woody plants. From the lower culvert crossing to confluence with Paint Fork Creek, both the left and right banks were reshaped, and the riparian areas planted with livestakes and bare-rooted woody plants (Exhibit Table 4). Fencing to exclude livestock from the riparian areas was installed along both channel banks from the upper property/easement boundary line to the confluence with Paint Fork Creek.

Lower Unnamed Tributary

Minimal in-stream work was conducted on the lower tributary. The over-wide area in the upper portion of the reach, where livestock had routinely crossed, was repaired by defining the base flow channel with coir logs; a bankfull bench and sloped channel banks also were constructed (sta. 0+00 to 0+30). Two root wads were installed on the left bank between cross-sections 2 and 3 (sta. 6+50). Channel banks were gently sloped and a floodplain bench excavated in the middle portion of the reach. Areas disturbed during construction were seeded and covered with coir matting as was done in the upper tributary (Exhibit Table 4). The left and right banks were further stabilized with livestakes and bare-rooted woody plants. Downstream of the lower culvert crossing (lower most portion of the reach), minimal work was conducted because the channel banks were stable, and a mature riparian area was present. Livestock exclusionary fencing was installed along both channel banks from the upper property/easement boundary line to the point where the stream channel leaves the Brigmon property above the SR 1539 culvert crossing. Exclusionary fencing was continued along both banks below the SR 1539 culvert crossing, where the tributary (lower most portion of the reach) reenters the Brigmon property (sta. 8+72 to 11+69).

3.2 Farm Management Plan

A farm management plan was implemented in conjunction with the physical adjustments to the stream channel. The plan included installing livestock exclusion fencing, three culvert crossings, a livestock watering system, and a feed/waste structure. The change in farm and livestock management at the Brigmon site, particularly excluding livestock from the stream channels, has resulted in improved riparian area conditions and stability of the channel banks.

4.0 Stream Assessment Results

This report presents the MY3 survey data and serves as a closeout report summarizing current project conditions and includes the following: channel dimension and longitudinal profile surveys, pebble counts, hydrologic events documentation, vegetative condition, and a photographic log for the Brigmon mitigation site. Locations of all fixed survey stations, established for the purpose of post–construction monitoring, are presented in the plan view drawings (Figure 2).

4.1 Cross-Section Surveys

Twelve cross-sections were established for monitoring at this site following construction; six on Paint Fork Creek, three on the upper tributary, and three on the lower tributary (Figure 2). The means of the channel dimensions in Exhibit Tables 3.1-3.3 were calculated using the values of all cross-sections for each reach (Appendix A.1.; Paint Fork Creek cross-sections 7-12; upper tributary cross-sections 4-6; lower tributary cross-sections 1-3). Of particular interest are the width/depth ratio (mean = 10.6) and the entrenchment ratio (mean = 2.3) for Paint Fork Creek. These values drive the broad level channel classification and are the reasons for concluding the channel was classified as an E stream type in MY3. Morphological characteristics for all cross-sections, cross-section plot overlays, and representative cross-section photos are presented for comparative purposes (Appendix A).

Paint Fork Creek

Cross-section 7 (Run; Appendix Table A.1.).–The left channel bank has degraded slightly (≈1.0 ft) and the right channel bank has aggraded >0.5 ft since project construction. However, during the MY3 survey both channel banks at this cross-section appeared stable. The thalweg degraded ≈1.0 ft following the as-built survey, as revealed during MY1 and MY2, but was found to be at the same elevation as the as-built thalweg elevation during the MY3. Although minor changes in channel bank location and thalweg elevation have been observed over the course of monitoring, this cross-section appeared stable with no areas of active erosion observed in MY3. The width/depth ratio for this cross-section was below 12.0 for MY2 and MY3, and the entrenchment ratio was 2.2 (slightly entrenched), making this cross-section an E stream type. Adjustments were not made to the right bank during construction because of the proximity to SR 1350.

Cross-section 8 (Pool; Appendix Table A.2.).–Following the removal of automobile bodies and construction of a bench on the left bank at this location, cross-section 8 has remained stable with little observed change in the left bank location or thalweg elevation. Aggradation has occurred on the point bar side of this large meander bend since construction. Installed vegetation, along with boulder and root wad protection, on the outside of the meander bend have aided in the long-term stability of this cross-section. Bankfull mean depth values recorded during the MY1 and MY2 surveys combined with bankfull widths resulted in width/depth ratios exceeding 12.0, therefore outside the E stream type classification. However, the MY3 width/depth ratio was 11.4 suggesting an E stream type classification.

Cross-section 9 (Riffle; Appendix Table A.3.).–Channel dimension at this cross-section was determined to be over-wide during pre-project assessment. During construction, the channel width was narrowed by constructing a rock toe and back filling the narrowed portion up to the bankfull elevation. Even with the channel narrowing, the width/depth ratios at this cross-section have exceeded 12.0 during each of the three monitoring surveys. This was the only cross-section with a width/depth ratio above 12.0 during MY3 and resulted in a C stream type classification. Minimal to no variation in channel bank location or thalweg elevation has been observed at this cross-section during each of the monitoring surveys, including the as-built survey. Mature hardwood vegetation was observed during the MY3 survey, and both channel banks were stable.

Cross-section 10 (Run; Appendix Table A.4.).–Channel dimensions at this cross-section have changed since the as-built survey in 2000. The left and right channel banks aggraded between the as-built survey and MY1, but the left bank then degraded ≈1.5 ft during the three years between the MY2 and MY3 surveys, although not to the contour found in the as-built survey. The thalweg elevation aggraded ≈1.0 ft following the as-built survey, but has remained at the same elevation during each of the three monitoring surveys. Vegetation observed along both channel banks was dominated by multiflora rose and various herbaceous species. Although the channel banks appeared stable with no active erosion during MY3, the reestablishment of woody vegetation (particularly on the left bank) has provided not only long-term bank stability, but also provided shade and nutrient input to the stream channel.

Cross-section 11 (Glide; Appendix Table A.5.).–Channel dimensions at this cross-section have changed since the as-built survey in 2000. The left and right channel banks degraded between the as-built survey and the MY1 survey. Both channel banks have remained stable since the MY1 survey. Although the thalweg aggraded ≈1.0 ft following the as-built survey, it remained at the same elevation during each of the three monitoring years. The riparian vegetation primarily consists of multiflora rose and various herbaceous species. The channel banks appeared stable with no active erosion observed during the MY3 survey.

Cross-section 12 (Run; Appendix Table A.6.).–The channel banks at this cross-section are stable with only minimal aggradation observed over the seven years since project completion. The thalweg aggraded >1.0 ft between the as-built survey and MY1; however, no change in thalweg elevation has been observed during the three monitoring surveys. The observed aggradation may be the result of the in-stream structure (rock cross vane) directly below this cross-section contributing to the accumulation of bed material. In fact, the channel bed surface at this location was observed to be flat and dominated by finer particle sizes. This was observed at the two previous cross-sections as well, all of which are just upstream of in-stream structures. Otherwise, channel adjustments made following the as-built survey appeared to have stabilized and no areas of active erosion were observed during MY3.

Upper Unnamed Tributary

Cross-section 4 (Riffle; Appendix Table A.7.).–The channel banks and thalweg at cross-section 4 have shown little evidence of change over the seven years since project completion. Minor aggradation on the left channel bank was noted between the as-built survey and the MY1 survey. Thalweg elevation has not changed since the MY1 survey. Variation in morphological values was noted during each of the three monitoring years (Appendix Table A.4.). Morphological values varied the most for MY1 when compared to MY2 and MY3. This variation is likely the result of a bankfull determination that was higher in elevation for MY1 than for MY2-3. Although the channel was moderately entrenched (1.9) in MY3, the left and right channel banks are stable.

Cross-section 5 (Riffle; Appendix Table A.8.).–The channel bed at cross-section 5 has migrated laterally towards the left bank since the as-built survey was completed. In fact, coir logs that defined the toe of the left bank after construction are now incorporated into the aggraded material that forms the right channel bank. Because the channel bed has shifted ≈3-4 ft towards the left bank, the conservation easement fence is ≈3 ft from the top of the channel bank. Approximately 50 ft or 4% of the left bank of the upper tributary is unstable. As such, it is suggested that the left channel bank be considered for maintenance repairs. Repairs using live stakes would be the minimal approach. A more aggressive approach would be to move the channel back to its original position following construction, protect the left bank with a rock toe, and use geo-lifts to gradually raise the bank elevation from the rock toe up to the existing grade. Although the thalweg has shifted and is now against the left bank, the elevation of the thalweg has remained relatively unchanged. Morphological values of the channel characteristics for

MY2 fell below the values derived from the MY1 and MY3 survey data, particularly for bankfull cross-sectional area and bankfull width. This suggests that the bankfull indicator elevation was deemed lower by field crews in MY2 when compared with MY1 and MY3.

*Cross-section 6 (Riffle; Appendix Table A.9.).–*The channel banks and thalweg have remained stable with very little lateral movement or change in elevation in the seven years since construction. Planted vegetation was noted along both channel banks; instability at this cross-section was not observed.

Lower Unnamed Tributary

*Cross-section 1 (Riffle; Appendix Table A.10.).–*This location was used as a livestock crossing before project construction and establishment of the conservation easement. Since project completion, the thalweg has decreased in elevation ≈0.6 ft and moved laterally towards the left bank. Although the left channel bank is slightly under-cut, both channel banks appeared stable, and vegetation has become well established. Overall, the channel is in far better condition at this location compared to the pre-project form.

*Cross-section 2 (Riffle; Appendix Table A.11.).–*The thalweg has experienced only minor aggradation (≈0.2 ft) in the four years since MY1; more aggradation was noted between the as-built condition and the observations made in MY1 (≈1.0 ft). Aggradation of the channel bed in MY1 may have resulted from substrate movement during several high water events that occurred following construction. Degradation of the left bank and aggradation to the right bank was noted between MY2 and MY3. Nonetheless, the channel bed and channel banks appeared stable and functioning as desired seven years post-construction. Vegetation is very dense on both banks and is performing as desired.

*Cross-section 3 (Riffle; Appendix Table A.12.).–*The thalweg at cross-section 3 has shown no evidence of change in elevation during each of the three monitoring years. However, the thalweg is now approximately 1 ft lower in elevation when compared to the as-built thalweg elevation. Over the course of the three monitoring surveys, the channel has shown minor lateral movement towards the left bank. Planted vegetation has become well established since installation; therefore, it is unlikely that there will be additional lateral movement of the channel.

4.2 Longitudinal Survey

Paint Fork Creek

The MY3 longitudinal profile survey covered the entire 3,098 ft of Paint Fork Creek on the Brigmon property, including the short reach not included in the conservation easement, whereas the MY1 and MY2 surveys included only the lower approximately 1,560 ft of channel (Figure 2 and Appendix A.2.). Elevations of the stream bed, water surface, bankfull indicators, and top of the low banks were surveyed. Channel sinuosity was 1.5, and the average water surface slope was 0.007 ft/ft (Exhibit Table 3.1). The MY3 longitudinal profile survey data revealed that the thalweg has remained stable with minimal aggradation, degradation, or lateral movement along the entire reach, particularly over the course of the three monitoring surveys. Aggradation of bed material was observed downstream of cross-section 9. A mid-channel bar has formed just upstream of cross-section 10 (sta. 18+00 to 18+40). Bar formation and aggradation of bed material at this location may be an artifact of a slightly over-wide channel (sta. 17+50 to 18+50) compared to the remaining lower portion of the reach. Channel width was observed to be narrower along the lower reach of the main stem compared to the pre-project condition. Active erosion and instability of channel banks and in-stream structures were not observed during the MY3 survey.

Stream structures.–Ten stream structures (2 J-hook vanes, 1 single arm vane, 3 cross vanes, root wads at 3 locations, and 1 rock toe revetment) were installed during construction. Two J-hook rock vane structures were installed on the left bank in the upper portion (sta. 4+80; 6+25), and one single arm rock vane (sta. 23+60) was installed in the lower portion of the project reach. Seven years following construction these three structures are largely incorporated into the left bank with only the hook portion of the structures visible. Root wads were installed for bank protection and habitat enhancement in the upper (sta. 5+15) and lower sections (sta. 28+50) of the project reach. These structures have become incorporated into the left bank at both locations and were very difficult to distinguish in the field. Junked automobile bodies were replaced with root wads and rock boulders in the large meander bend at sta. 4+50 to stabilize the tight radius of curvature at that point; a floodplain bench also was constructed. This tight meander bend was stable with no sign of channel bank erosion. The rock toe revetment, located on the right bank in the middle portion of the reach (sta. 15+50 to 16+50), was constructed to narrow an over-wide section of the channel. The over-wide section was back filled to create a floodplain bench, which was stable and performing as designed during the MY3 survey. The three cross vanes (sta. 19+00, rock; 21+25, log; 29+80, rock) constructed in the lower portion of the project reach for grade control and habitat enhancement remain intact, stable, and performing as designed.

Upper Unnamed Tributary

The MY3 upper tributary longitudinal profile survey began at the upper Brigmon property/conservation easement line and extended to its confluence with Paint Fork Creek (1,263 ft; Appendix A.2.). Elevations of the stream bed, bankfull indicators, and top of the low banks were surveyed. Channel sinuosity was 1.2, and the average water surface slope was 0.061 ft/ft (Exhibit Table 3.2). The MY3 longitudinal profile survey data revealed that the thalweg has remained stable with minimal aggradation, degradation, or lateral movement along the majority of the surveyed reach. Lateral migration of the thalweg was noted above and below cross-section 5 (sta. 5+25 to 5+75). The thalweg and left channel bank have migrated to the left ≈4.0 ft over a distance ≤50 ft, or less than 4% of the total reach length. The channel bank is not vertical at this location, but it does lack woody vegetation; only shallow rooting grasses were present. As a result, the left channel bank has migrated to within ≈3.0 ft of the fence line marking the easement boundary. Otherwise, little active erosion and bank instability were observed in this reach during the MY3 survey.

Stream structures.–Adjustments were made to the upper tributary channel to reduce channel width (sta. 5+25 to 5+75). Livestock access and remnant pond sediments contributed to the instability and erosion along a section in the middle portion of the reach. Coir logs were used to define the desired active channel width. Following construction however, the channel began to slowly but steadily lateral migrate and is now ≈4.0 ft behind the coir logs installed to stabilize the bank. Because this section is ≤50 ft in length and does not contain a high vertical bank, the installation of live stakes should be adequate to stabilize the left bank and avoid future impacts to the easement fence line.

Lower Unnamed Tributary

The MY3 lower tributary longitudinal profile began at the Brigmon property/conservation easement line and extended downstream to the lower most property and conservation easement line adjacent to Angel Road (SR 1359), just upstream of an adjoining landowner's barn. A short section of channel (sta. 7+41 to 8+72) that crosses over to the adjoining landowner's property then back to the Brigmon property was included to maintain continuity between the two sections. This is in the vicinity of the culvert crossing on SR 1359. The length of the lower tributary longitudinal profile was 1,037 ft (Appendix A.2.). Elevations of the stream bed, bankfull indicators, and top of the low banks were surveyed. In MY3 the channel sinuosity was 1.2 and the average water surface slope was 0.046 ft/ft (Exhibit Table 3.3). The MY3 longitudinal profile survey revealed the thalweg has remained stable with minimal aggradation, degradation, or lateral movement.

Stream structures.–One short section of over-wide channel between sta. 0+00 and sta. 0+30 was narrowed and one stream structure consisting of two root wads was installed on the lower tributary. The over-widened channel was caused by hoof shear at a former livestock crossing and in-stream watering location. Desired channel width was achieved using coir logs to define the active channel. The areas behind the coir logs were back-filled to create floodplain benches. The constructed floodplain benches and channel banks were observed to be stable with established vegetation during the MY3 survey. Two root wads were installed between cross-sections 2 and 3 near sta. 6+50 to stabilize an area of near bank stress and for habitat enhancement. The root wad used at this location has become incorporated into the left channel bank and was not easily discernible during the MY3 survey.

4.3 Pebble Counts

Pebble counts were taken at each of the twelve cross-sections to determine the extent of change, if any, in bed material composition and are presented as cumulative frequencies for each individual cross-section and as combined cumulative frequency for each of the three project reaches (Appendix A.3.). The mean particle size for each category in Exhibit Tables 3.1-3.3 was estimated by averaging the particle size class data from each cross-section for the three project reaches. The pre-construction pebble count values were derived by pooling pebble count data from two cross-sections. As-built pebble counts were taken at three cross-sections located in the general vicinity of monitoring cross-sections 10, 11, and 12.

Paint Fork Creek

Between the pre-construction and MY3 surveys, mean particle sizes increased for the D16 category, remained about the same for the D35 category, and decreased for the D50, D84, and D95 categories (Exhibit Table 3.1.). Mean particle size for the D50 size class was found to be very coarse/coarse gravel during the pre-construction (33.0 mm) and the MY1 (18.4 mm) surveys, fine gravel (4.9 mm) in MY2, and coarse gravel (20.0 mm) in MY3. The mean D84 particle size class was found to be large cobble (150.0 mm) in the pre-construction survey, but small cobble in all three monitoring years (MY1 - 82.3 mm; MY2 - 77.6 mm; MY3 - 93.2 mm). With the exception of the D95, mean particle sizes were trending higher over the monitoring period. The cause for the lower mean sizes found in MY2 is unknown. The higher D16 mean particle size in MY3 suggests that elimination of erosion and sedimentation resulting from unstable channel banks and livestock access to the channel have reduced the amount of fine sediments in the channel substrate.

Upper Unnamed Tributary

During the monitoring period, mean particle size increased for the D16, D35, and D50 particle size class categories, but decreased for the D84 and D95 categories; pre-construction and as-built particle surveys were not conducted on the upper tributary (Exhibit Table 3.2). The largest mean D16 particle size (3.3 mm, very fine gravel) was observed in MY3. Mean particle size for the D50 size class was found to be very coarse sand (2.0 mm) in MY1, declining to very fine sand (0.1 mm) in MY2, and increasing to fine gravel (6.9 mm) in MY3. The mean D84 particle size class was very coarse gravel in MY1 (34.7 mm), decreasing to fine gravel (4.4 mm) in MY2, and returning to coarse gravel (25.1 mm) in MY3. The upward trend in the mean particle size for the D16, D35, and D50 categories suggests that livestock exclusion and the repairs made to formerly unstable channel banks has helped reduce erosion and sedimentation. Significant amounts of sediment also may have been flushed from this catchment by the high rainfall events associated with the remnants of two hurricanes that passed over the area in fall of 2004.

Lower Unnamed Tributary

Mean particle size trended towards larger sizes for the D16, D35, and D50 particle size class categories over the monitoring period, but decreased for the D84 and D95 categories; pre-construction and as-built particle surveys were not conducted on the lower tributary (Exhibit Table 3.3). The mean D16 particle size varied little over the monitoring period. Mean particle size for the D50 size class was medium gravel (8.5 mm) in MY1, declined to fine gravel (5.2 mm) in MY2, but returned to medium gravel (11.3 mm) in MY3. The mean D84 particle size was very coarse gravel in the MY1 (54.5 mm) and MY2 (34.8 mm), but decreased to coarse gravel (29.9 mm) in MY3. The increases in mean particle sizes for the D16, D35, and D50 categories suggest that the restoration activities have had a positive influence on removing the finest bed material components. As with the upper unnamed tributaries, significant amounts of sediment may have been flushed from this catchment by the rainfall associated with the remnants of two hurricanes that passed over the area in fall of 2004.

Exhibit Table 3.1. Morphological Characteristics Summary, Paint Fork Creek, Cross-Sections 7-12.					
Variable[a]	Pre-construction[b]	As-built 2000[c]	MY1 2003	MY2 2004	MY3 2007
Drainage Area (mi^2)	13.6	13.6	13.6	13.6	13.6
Bankfull Width (ft) (mean)	30.7	23.5	21.0	22.6	22.6
Bankfull Mean Depth (ft) (mean)	2.4	1.8	1.7	1.9	2.2
Width/Depth Ratio (mean)	12.8	15.2	13.1	12.9	10.6
Bankfull Cross Sectional Area (ft^2) (mean)	81.6	40.5	34.9	40.8	49.5
Maximum Bankfull Depth (ft) (mean)	5.3	3.1	2.3	2.7	3.0
Width of Floodprone Area (ft) (mean)	75.0	46.7	200	200	51.7
Entrenchment Ratio (mean)	2.4	2.1	6.9	6.9	2.3
Water Surface Slope (ft/ft)	0.007	0.007	0.006	0.006	0.007
Particle Size Class (mean)	N = 2	N = 3	N = 6	N = 6	N = 6
D16 (mm)	0.15	8.72	0.67	0.34	2.42
D35 (mm)	17.0	28.2	8.2	0.9	13.0
D50 (mm)	33.0	42.7	18.4	4.9	20.0
D84 (mm)	150.0	96.1	82.3	77.6	93.2[d]
D95 (mm)	>2,048.0	171.4	169.7[d]	90.9[d]	127.0[d]

[a]Mean channel dimension values were calculated using the values of all cross-sections (Appendix A.1).
[b]Pre-construction particle size class values were derived from pooled data, not calculated means.
[c]As-built particle size class data were collected in the vicinity of monitoring cross-sections 10, 11, and 12.
[d]Calculation excludes cross-sections with values >2,048.0 (bedrock); in those cases N = 5.

Exhibit Table 3.2. Morphological Characteristics Summary, Upper Tributary, Cross-Sections, 4-6.					
Variable[a]	Pre-construction[bc]	As-built 2000[b]	MY1 2003	MY2 2004	MY3 2007
Drainage Area (mi^2)	0.15	0.15	0.15	0.15	0.15
Bankfull Width (ft) (mean)		6.3	7.8	5.0	6.8
Bankfull Mean Depth (ft) (mean)		0.6	0.8	0.4	0.8
Width/Depth Ratio (mean)		10.2	10.5	12.6	11.3
Bankfull Cross Sectional Area (ft^2) (mean)		4.1	6.0	2.0	4.1
Maximum Bankfull Depth (ft) (mean)		1.1	1.3	0.8	1.1
Width of Floodprone Area (ft) (mean)		14.3	17.7	17.7	14.3
Entrenchment Ratio (mean)		2.3	2.2	2.2	2.1
Water Surface Slope (ft/ft)	0.070	0.070	0.056	0.056	0.061
Particle Size Class (mean)			N = 3	N = 3	N = 3
D16 (mm)			0.06	0.05	3.34
D35 (mm)			0.2	<0.1	5.7
D50 (mm)			2.0	0.1	6.9
D84 (mm)			34.7	4.4	25.1
D95 (mm)			111.0	58.7	36.7

[a]Mean channel dimension values were calculated using the values of all cross-sections (Appendix A.1).
[b]Particle size class data were not collected during the pre-construction and as-built surveys.
[c]Pre-construction morphological values were not available for inclusion in the MY3 report.

Exhibit Table 3.3. Morphological Characteristics Summary, Lower Tributary, Cross-Sections 1-3					
Variable[a]	Pre-construction[bc]	As-built 2000[b]	MY1 2003	MY2 2004	MY3 2007
Drainage Area (mi^2)	0.16	0.16	0.16	0.16	0.16
Bankfull Width (ft) (mean)		4.2	4.2	3.5	4.5
Bankfull Mean Depth (ft) (mean)		0.8	1.1	0.9	1.0
Width/Depth Ratio (mean)		5.8	4.0	4.6	4.7
Bankfull Cross Sectional Area (ft^2) (mean)		3.3	4.7	3.0	4.3
Maximum Bankfull Depth (ft) (mean)		1.2	1.6	1.0	1.3
Width of Floodprone Area (ft) (mean)		12.7	23.3	23.3	13.9
Entrenchment Ratio (mean)		3.0	3.0	3.0	3.2
Water Surface Slope (ft/ft)	0.050	0.050	0.044	0.044	0.046
Particle Size Class (mean)			N = 3	N = 3	N = 3
D16 (mm)			0.48	0.59	0.56
D35 (mm)			2.8	2.5	8.8
D50 (mm)			8.5	5.2	11.3
D84 (mm)			54.5	34.8	29.9
D95 (mm)			101.9	70.4	39.0

[a]Mean channel dimension values were calculated using the values of all cross-sections (Appendix A.1).
[b]Particle size class data were not collected during the pre-construction and as-built surveys.
[c]Pre-construction morphological values were not available for inclusion in the MY3 report.

4.4 Hydrologic Data and Bankfull Verification

In the absence of a stream gage in the project drainage, the USGS stream gage on the Ivy River (gage number 0345300; HUC 06010105) was used as a surrogate (Appendix A.4.). The gage is located at 1,700 ft above mean sea level and has a drainage area of 158 mi^2. Based on the N.C. Rural Mountain Regional Hydraulic Geometry Curves, a discharge at the Ivy River gage of 450 to 500 cfs correlates to the bankfull flow for the project reach (Mulkey, Inc. 2003). Based on the mean daily discharge there were >30 flow events at the Ivy River gage ≥500 cfs for the period from June 2000, following construction, through November 2007, end of MY3 (USGS 2008). Fourteen of these events were ≥1,000 cfs, far exceeding the minimum criteria of 2 bankfull events over a five-year period following construction (Appendix Table A.4.1.). Two additional bankfull events at the project site (August 2, 2001 and May 6, 2003) were photographically documented (Appendix A.5.). High flow discharges ≥500 cfs recorded on consecutive days were counted as a single bankfull event.

4.5 Fixed Station Photos

Six fixed station photo locations document project site conditions from 1999 (before construction) through 2007 (Appendix A.6.). The photo log shows that planted vegetation has performed as desired over the seven years since installation. Now that the riparian vegetation on each channel bank is protected from livestock intrusion by fencing, channel banks have become stable and areas of active erosion were not observed. Tree foliage is blocking direct sunlight to the channel, which should help reduce daytime water temperature increases. Cross vane and J-hook structures were identified and largely intact; whereas, the few root wad structures that were installed have become incorporated into the channel banks and are not readily visible, with the exception of the root wads installed in the large meander bend. Root wads have provided near bank protection in the large meander bend during high flow events, and no sign of erosion was observed.

4.6 Problem Areas

Problem areas, such as active scour and erosion, were not observed during the MY3 survey. The channel banks are stable and vegetation has become well established throughout the site due primarily to the fencing that has excluded livestock from the riparian area. However, invasive exotic vegetation was scattered throughout the project reach and consisted primarily of multiflora rose, Chinese privet *Ligustrum sinense*, and Japanese knotweed *Polygonum cuspidatum*. One of the areas with the highest concentration of multiflora rose is located on the left bank at the lower end of conservation easement on Paint Fork Creek (sta. 30+50 to 27+50). Aggradation in the form of a mid-channel bar (sta. 18+00 to 18+40) also has been noted during each of the three monitoring surveys; however, immediate danger of adjacent bank failure is not expected.

Although the upper unnamed tributary was largely stable, one area of concern was observed. In the vicinity of cross-section 5 (sta. 5+25 to 5+75), the left channel bank has moved laterally and is now ≈3.0 ft from the fence line delineating the conservation easement boundary. At a minimum, installation of woody plant material or rock toe protection should be considered at this location to provide long-term protection to the left channel bank and fence line.

The lower unnamed tributary channel was stable with no bank erosion or problem areas observed during the MY3 survey.

5.0 Vegetation Assessment

During construction, disturbed areas were seeded with a temporary seed mix (brown top millet *Panicum ramosum* and winter wheat *Triticum sp*.) and a perennial native seed mix consisting of herbaceous and woody species (Exhibit Table 4). During winter 2001, all four conservation easement areas planted with a large, but unknown quantity of live stakes and bare-rooted shrubs and trees (NCWRC 2000b; Exhibit Table 4.).

Although 11 woody species' seeds were included with the 14 herbaceous species in the mixture sown at the site, the contribution of the woody species is unknown. Given the keen competition for light and water, it is most likely the woody stems planted as live stakes and bare-rooted specimens are the dominant woody stems present. The herbaceous layer of sown native seed and wild recruited varieties likely out-competed the woody species germinating from seed during the first few years of riparian vegetation re-establishment.

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 stolonifera	Red-osier dogwood
	Diospyros virginiana	Persimmon
	Fraxinus pennsylvanica	Green ash
	Platanus occidentalis	Sycamore
	Salix nigra	Black willow

5.1 Vegetation Plot Descriptions, Photographs, and Sampling

In 2003, two large (1,000 ft^2; plots A and B) tree plots and six smaller (10.8 ft^2; plots 1-6) vegetation monitoring plots were established (Figure 2; Mulkey, Inc. 2003). All plots were used to provide photo reference points of vegetation performance (Appendix B.1.). In both the tree plots and all six vegetation plots woody stems were tagged, identified to species, and enumerated. All tree and vegetation plots were resurveyed in MY3. Total counted stems for MY3 included both planted and naturally germinated stems.

Tree plot A (sta. 9+90), adjacent to Paint Fork Creek, is situated on the left bank upstream of the Brigmon driveway bridge. Tree plot B (sta. 20+25) is located on the left bank of Paint Fork Creek above cross-section 11. Vegetation plot 1 (sta. 3+90, left bank) and vegetation plot 2 (sta. 11+15, right bank) are situated on the upper unnamed tributary. Vegetation plots 3 (sta. 3+50) and 4 (sta. 6+15) are both located on the left bank of the lower unnamed tributary. Vegetation plot 5 is located within tree plot A. Vegetation plot 6 is located within tree plot B. The six smaller vegetation plots also were used to assess woody stem density (planted and naturally recolonized).

5.2 Vegetation Monitoring Results

Tree Plot A.–The number of woody stems in tree plot A decreased from 8 in MY1 to 7 in MY3 (Exhibit Table 5.). However, a black gum *Nyssa sylvatica* and three staghorn sumacs *Rhus typhina* naturally recruited into tree plot A since MY2, helping to offset the loss of three black willows *Salix nigra* observed in MY1. Herbaceous species observed in tree plot A included reed canarygrass *Phalaris arundinacea*, Japanese honeysuckle *Lonicera japonica*, blackberry *Rubus sp*., vetch *Vicia sp*., goldenrod *Solidago sp*., tall fescue, and rush *Juncus sp*.

Tree Plot B.–The number woody stems found in tree plot B (10) in MY3 was 50% less than that found in MY1 (Exhibit Table 5.). This was due to the loss of 8 silky dogwood *Cornus amomum* stems and two green ash *Fraxinus pennsylvanica* stems. Moreover, natural recruitment was not observed in tree plot B during any of the three monitoring years. Herbaceous species included multiflora rose, reed canarygrass, blackberry, tall fescue, and Japanese honeysuckle.

Vegetation Plot 1.–A single green ash, also noted in MY1 and MY2, was again observed in MY3. Tall fescue, goldenrod, multiflora rose, and blackberry were observed in the herbaceous layer.

Vegetation Plot 2.–The lone silky dogwood noted in MY1 and MY2 was observed in MY3. Tall fescue was the predominant plant species in the herbaceous layer.

Vegetation Plot 3.–A single woody stem, a green ash tree, was observed in each of the three monitoring years. Tall fescue and goldenrod were the dominant species in the herbaceous layer.

Vegetation Plot 4.–A silky dogwood clump, also noted in MY1 and MY2 was again observed in MY3. One black cherry *Prunus serotina* recruited into the plot following the MY2 survey. Tall fescue was the predominant plant type in the herbaceous layer.

Vegetation Plot 5.–Japanese honeysuckle, reed canarygrass, and tall fescue were the dominant species in the herbaceous layer. No woody stems were observed in this plot during any of the monitoring surveys, nor has any natural recruitment occurred.

Vegetation Plot 6.–The single green ash stem recorded in MY1 and MY2 was not observed in MY3; recruitment of other woody stem species was not evident. Reed canarygrass, tall fescue, and blackberry were the dominant species in the herbaceous layer.

The success criterion for planted woody stems 5 years after planting is 260 stems/acre (USACE 2003). Average woody stem density at the Brigmon site, seven years after planting, was found to be 370 stems/acre (Exhibit Table 5), thus exceeding the success criteria threshold. This occurred even though the number of stems in tree plot B declined by 50% since MY1. A total of 17 woody stems were counted during MY3, seven fewer than the MY2 survey. Green ash stems (6) made up 35% of the total counted stems in the two tree plots; no other species comprised more than 24% of the total stem count. Woody stem counts for the larger tree plots are of most significance. Although the smaller vegetation plots were used to count woody stems, the 10.8 ft^2 plots cover such a small area only a single stem was needed in the plot to meet the minimum woody stem density success criteria.

Exhibit Table 5. Vegetation Monitoring Results

Plots	Black Willow	Silky Dogwood	Green Ash	Staghorn Sumac	Black Gum	Black Cherry	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)	1	1	1	3	1		8	7	7	305
Plot B (1,000 ft^2)	2	3	5				20	17	10	436
									Average Density	**370**
Vegetation Plots	MY3 Woody Stem Counts									
Plot 1 (10.8 ft^2)			1				1	1	1	4,033
Plot 2 (10.8 ft^2)		1					1	1	1	4,033
Plot 3 (10.8 ft^2)			1				1	1	1	4,033
Plot 4 (10.8 ft^2)		1				1	1	1	2	8,066
Plot 5 (10.8 ft^2)										
Plot 6 (10.8 ft^2)							1	1		
									Average Density	**3,361**

5.3 Invasive Exotic Vegetation Occurrence

Exotic species were present within the project area, with multiflora rose, tall fescue, and Japanese knotweed being the most prevalent. Other invasive exotic species present included Japanese honeysuckle and oriental bittersweet *Celastrus orbiculatus*. Control of exotic invasive plant species is necessary to allow native vegetation to become fully established within the conservation easement. Based on the MY3 survey data, it was determined that invasive exotic plant species coverage is currently estimated at less than one-fifth (<1.0 acre) of the total conservation easement area.

6.0 Biological Indicators

As a condition of the USACE section 404 permit for the I-26 road 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.

7.0 Farm Management Plan

Farm management practices implemented at the Brigmon site were extensive and included ≈7,000 ft of fencing to exclude livestock from the conservation easement area, 4 boxes to capture natural springs, nine watering tanks and supply lines from the captured spring boxes, two holding reservoirs, one solar pump, a cattle guard, nine gates, three livestock and equipment culvert crossings, and a feed/waste structure. The total cost associated with implementing the farm management plan was $25,813.

Exclusionary fencing consisted of five strands of barbed wire mounted on metal "T" posts with 4" x 4" wooden posts used at corners and in areas of high stress; five small gates and four large gates were installed in combination with the fencing. Fencing was installed along the entire left bank of Paint Fork Creek and along both channel banks of the upper and lower tributaries. An exception is along the middle portion of the lower tributary where a cattle guard was installed instead of fencing; this section of the reach is bordered on the right bank by SR 1539.

One spring was developed and piped to one watering tank in the upper pasture adjacent to Paint Fork Creek. Two springs were developed at the head of the upper tributary and supplies three watering tanks. One spring was developed on the lower tributary to supply three watering tanks. The overflow water from the lower most watering tank on this line is retained in a holding reservoir that is then piped using a solar powered water pump to a holding reservoir that supplies two additional watering tanks at the feed/waste structure. Overflow water from the three terminal tanks is piped underground to Paint Fork Creek. The areas surrounding each watering tank were enhanced using filter fabric and washed stone to create a hardened pad to prevent erosion caused by hoof shear.

During the MY3 survey, a number of farm management amenities were observed to be in need of maintenance. In several locations, fallen trees were compromising the integrity of the fencing; the trees need to be removed and the fence repaired. The solar pump that supplies the holding reservoir and two watering tanks at the feed/waste structure has been in disrepair, according to the landowner, since installation. Additionally, a wet area has developed in the lower field where an overflow drain line from a terminal watering tank is piped to Paint Fork Creek near station 18+50. The drain line installed during construction is likely clogged or has been crushed by equipment traffic through the area. This wet area drains to Paint Fork Creek during storm events and should be repaired to eliminate the potential of sediment being washed to the stream channel by overland water flow.

8.0 Closeout Summary

The Brigmon mitigation site on Paint Fork Creek in Madison County, N.C. was monitored for the third time in November 2007, seven years since the project was completed in June 2000. Monitoring of the project reach also occurred in 2003 and 2004 (Mulkey, Inc. 2003, 2004). Initial project objectives to enhance and protect water and riparian quality, channel bank stability, and aquatic habitat have been achieved.

Channel Cross-Sections.–Morphometric data collected in MY3 approximate the range of values expected for Paint Fork Creek when compared to data in the design plan and as–built and previous monitoring reports. Of particular interest is the improvement in the channel characteristics as reflected in the entrenchment and width/depth ratios. Mean values for entrenchment varied the most from MY0 to MY1 and MY2. However, pre–construction MY0 and MY3 values for entrenchment were most similar. The desired level of channel incision is attributed to sloping and reshaping channel banks, which created a slightly wider and more accessible flood prone area during periods of high flow events. Flood prone width drives channel entrenchment values and in MY1 and MY2 the high flood prone width values are likely estimates and not actual field measurements. Nonetheless, entrenchment ratios from all post–construction surveys indicate only slight channel entrenchment, a product of channel restoration and overall stability. The width/depth ratios steadily declined over the course of monitoring, a positive indication of channel narrowing and bank stability. Using these two broad level classification variables, and other physical parameters, stream type changed from Bc in the pre–project assessment to an E stream type in MY3. These morphometric parameters are a strong indication of the stable condition of the Paint Fork Creek channel and riparian area.

Morphological characteristics for the upper unnamed tributary in MY3 were consistent with values observed during MY0–MY2. Stream type (B) remained the same in the upper two-thirds of the reach, but changed to a C stream type at the lower end of the reach because of a lower width/depth ratio, reduced channel incision, and increased flood prone width following construction. Although a portion (≤4%) of the left channel bank has moved within close proximity to the fence line marking the conservation easement boundary, overall the majority of the upper tributary is performing as designed seven years post-construction.

Morphological characteristics for the lower unnamed tributary in MY3 were consistent with values observed from MY0 through MY2. Bank sloping created a more accessible and wider flood prone area. The improved channel dimensions resulted in the stream type classification changing from a B in the pre-project condition to an Eb in MY3. The “b” subclassification is applied because the slope of the channel is out of range for a typical E type channel. Overall, the channel banks and riparian areas are performing as designed seven years post-construction.

Longitudinal Profile and Channel Pattern.–Although Paint Fork Creek’s sinuosity at 1.5 is on the low end for an E stream type channel, the water surface slope (0.007 ft/ft) is typical for an E stream type. Evidence of the channel attempting to increase in sinuosity (laterally extend) was not observed. It is unlikely that lateral extension will occur given that the vegetation on both banks is well established. Overall, the channel thalweg has and is expected to remain stable with little aggradation, degradation, or lateral movement under typical hydrologic conditions. Stream structures installed for grade control and bank stabilization have contributed to channel stability and were functioning as designed.

Evidence of stream channel aggradation, degradation, or lateral movement was minimal on both the upper and lower tributaries. Although some bed degradation and bank scour was observed in earlier monitoring surveys, the MY3 survey revealed stable channel features. As noted, there was only one small section on the upper unnamed tributary where the channel has shifted towards the left bank and conservation easement fence line. Most obvious during MY3 was the marked difference in riparian vegetation diversity and condition along both tributaries as compared to their pre–project conditions. Over–wide sections that were narrowed during construction have stabilized, and the riparian vegetation has further stabilized the channel banks along both tributaries.

Pebble Counts.–Paint Fork Creek mean particle size decreased for all particle size categories when compared to the as-built condition, but the MY3 data are trending towards larger particle size when compared to the MY1 data. Particle size distribution from the pebble counts provided no indication of channel bank instability or other source of fine substrate materials entering the project reach. Although one short section of mid-channel bar formation was observed on Paint Fork Creek over the seven-year monitoring period, the adjacent channel banks have remained stable.

Hydrologic Data and Bankfull Verification.–The Paint Fork Creek drainage has experienced >30 bankfull or higher stream flows in the seven years since project construction. Even with this large number of bankfull events, many occurring in the first few years following construction, the project area stream reaches exhibit no areas of active erosion or instability caused by the high flows.

Fixed Station Photos.–The planted vegetation along the banks of Paint Fork Creek and both tributaries has become well established over the seven years since installation. Field observation and photo documentation of planted woody vegetation revealed that woody riparian vegetation is ≥10 ft in height and has enhanced stability of the channel banks. Mature trees adjacent to the channel are providing shade to the stream corridor. Photos of the channel in MY3 revealed stable banks with little to no lateral migration of the thalweg.

Problem Areas.–Observation of the riparian floodplain and the stream channel revealed a stable project area that is performing as desired seven years post-construction. Other than the previously noted mid-channel bar on Paint Fork Creek and short section of bank sloughing on the upper tributary, the problems identified during MY3 were in large part maintenance issues related to features associated with the farm management plan and not the physical or biological condition of the stream channel or riparian area.

Vegetation.–Density of woody stems for both the larger tree plots exceeded the minimum required density criterion for projects five years or more removed from construction. The riparian vegetation throughout the conservation easement has benefited from the fencing to exclude livestock as it has become well established and is performing as would be desired. The only area of concern is lower third of the conservation easement on Paint Fork Creek (left bank only). The woody vegetation in this area is sparse due to the large amount of multiflora rose. Control of this invasive plant species would give the native woody species a better chance to become fully established.

Farm Management Plan.–Installation of fencing on the left bank of Paint Fork Creek and both banks of the two tributaries to exclude livestock is the single most beneficial factor contributing to the improvement of water and riparian quality at the Brigmon mitigation site. Establishment of the conservation easement has allowed the vegetation to become well established; channel banks are stable, and as a result, morphological characteristics of the three channels have improved.

Overall, the project site has benefited from the prescription of channel restoration, riparian revegetation, and farm management practices set forth in the construction plan. Establishment of the conservation easement, in-stream structures, and woody riparian vegetation has contributed to improved channel stability and function. The Brigmon mitigation site is performing as purposed under the mitigation guidance in place at the time. This site is recommended for closeout to the regulatory agencies.

9.0 Acknowledgements

Scott Loftis, Jeff Ferguson, Brent Burgess, and Todd Ewing with the NCWRC Watershed Enhancement Group collected and analyzed the MY3 field data. Scott Loftis, Jeff Ferguson, and Todd Ewing prepared this report. Jim Borawa with the NCWRC provided comments for improving this report. Mulkey, Inc. collected and analyzed the data and prepared the reports for MY1 and MY2; Mulkey, Inc. also provided the data files used in this report.

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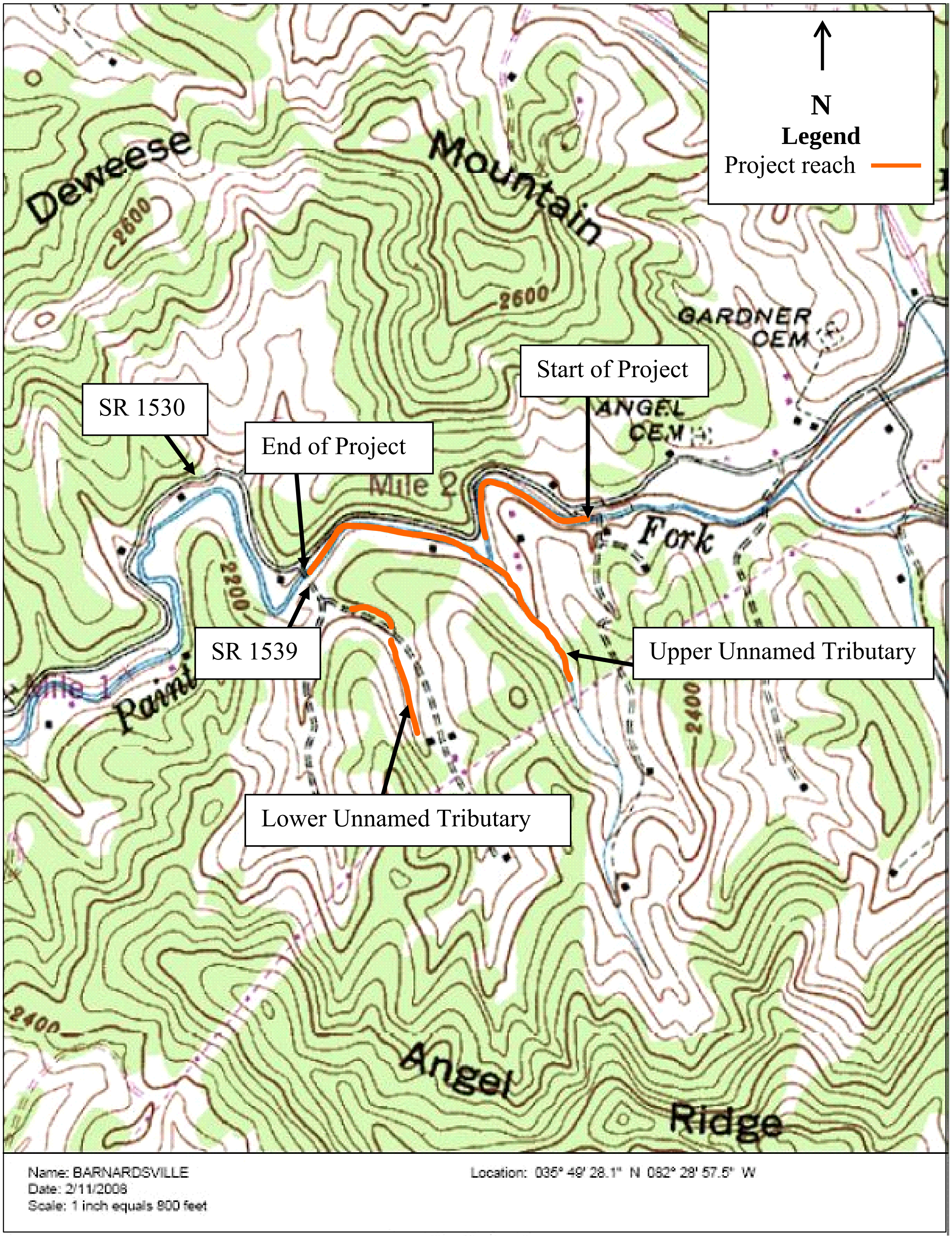

Figure 1.—Brigmon mitigation site, Paint Fork Creek, French Broad River basin, Madison County, North Carolina, EEP Project Number 92700.

FIGURE 2.--Brigmon mitigation site, Paint Fork Creek, French Broad River basin, Madison County, N.C., MY3 and closeout plan view, NCEEP project number 92700.

NORTH CAROLINA WILDLIFE RESOURCES COMMISSION
WATERSHED ENHANCEMENT GROUP
20830 GREAT SMOKY MOUNTAIN EXPRESSWAY
WAYNESVILLE, NORTH CAROLINA 28786
828.452.6191 Ext.26 OFFICE
828.452.7772 FAX

Paint Fork Cr. Mitigation Project #92700
Brigmon Site — Madison County
MY3 and Closeout - Overall Plan View

DRAWN BY: JCF	DATE: 9/08
APPROVED:	DATE:
SURVEY BY: JCF, CSL	DATE: 11/07
CAD FILE ID: brigmon.dwg	

SHEET 1 OF 6

FIGURE 2.--Continued

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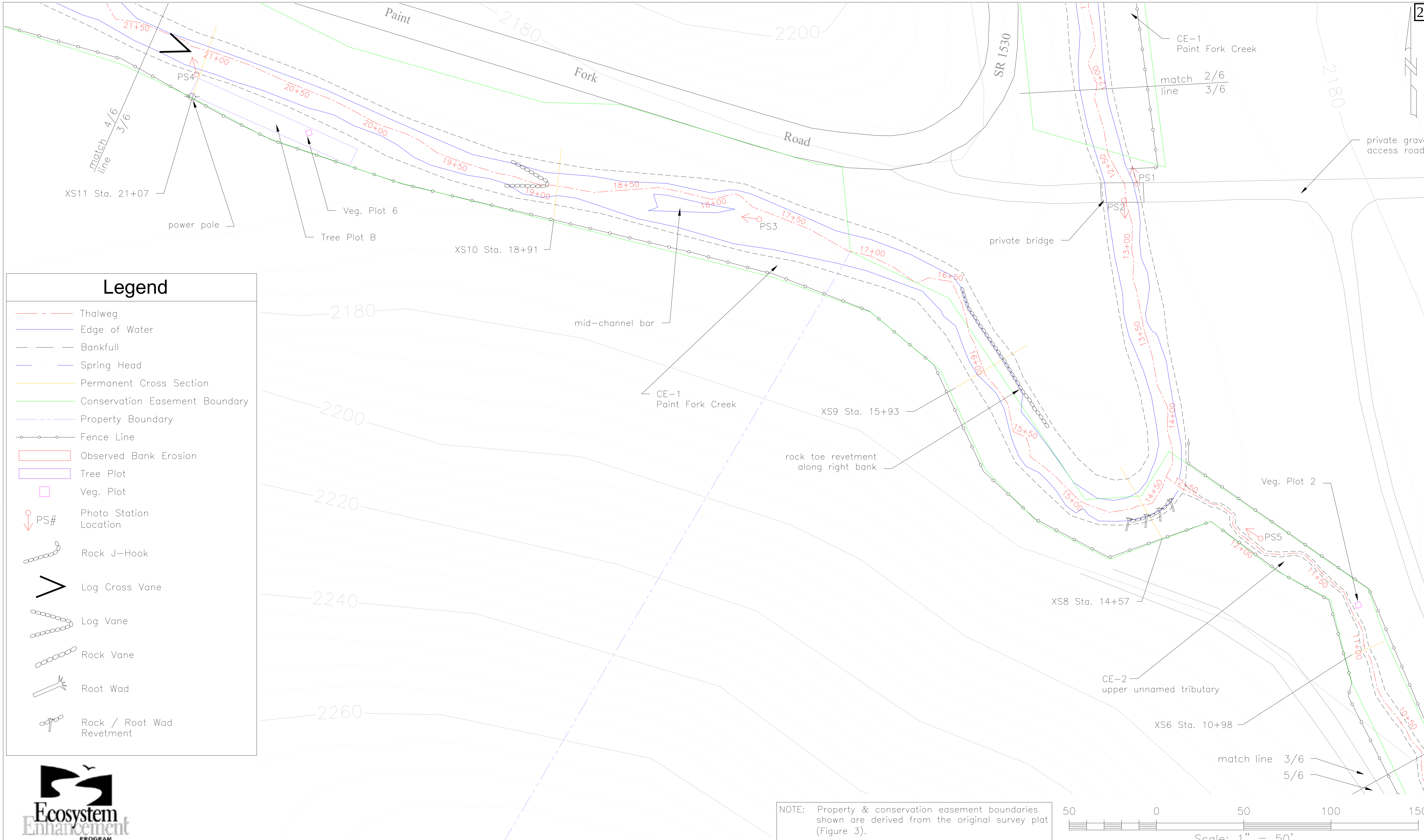
828.452.7772 FAX

Paint Fork Cr. Mitigation Project #92700
Brigmon Site — Madison County
MY3/Closeout - Paint Fork Cr. (Sta. 0+00 - 12+10)

DRAWN BY: JCF	DATE: 9/08
APPROVED:	DATE:
SURVEY BY: JCF, CSL	DATE: 11/07
CAD FILE ID: brigmon.dwg	

SHEET 2 OF 6



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828.452.6191 Ext.26 OFFICE
828.452.7772 FAX

Paint Fork Cr, Mitigation Project #92700

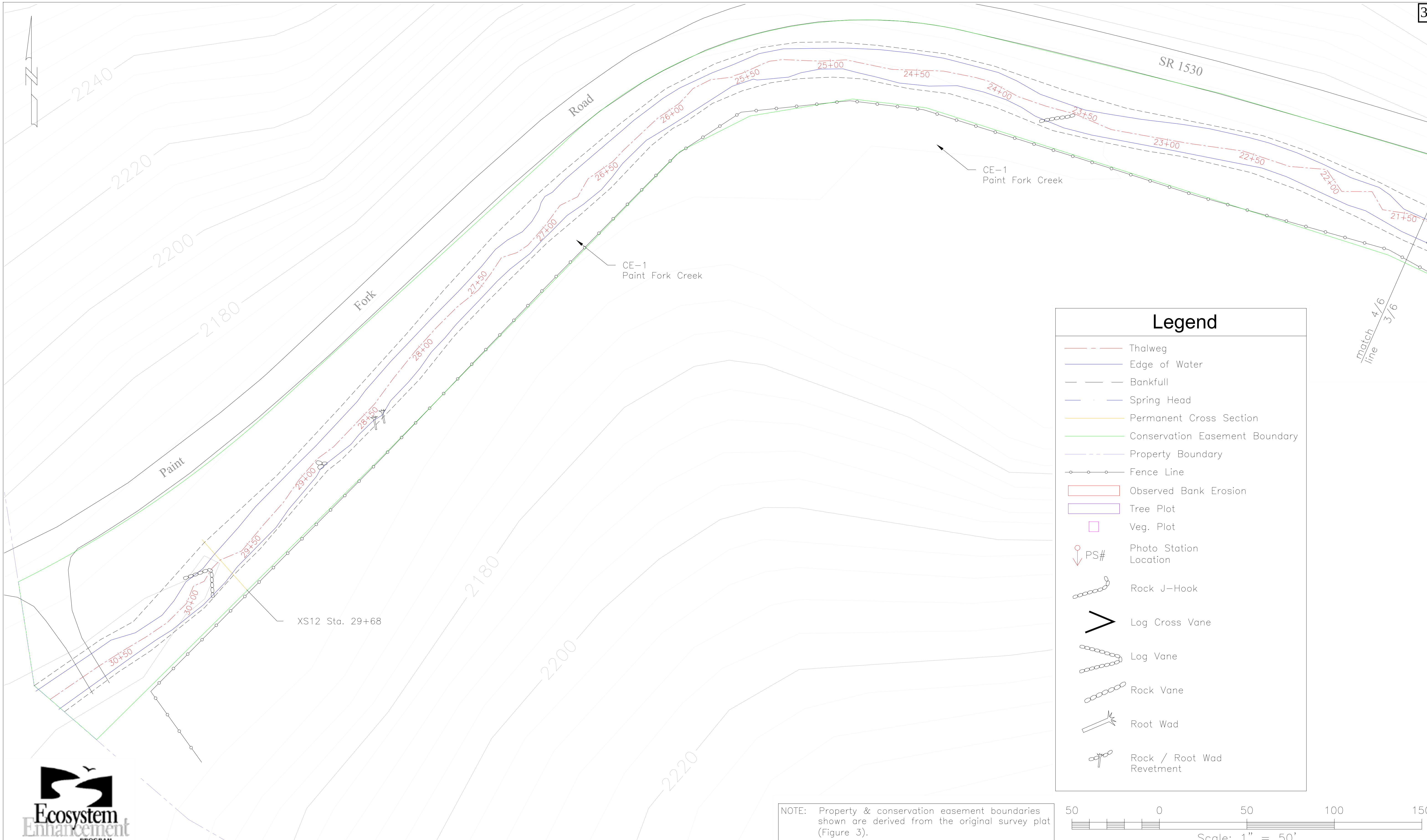
Brigmon Site | Madison County

MY3/Closeout - Paint Fork Cr. Sta. 12+10-21+40
(Includes Upper Tributary Sta. 10+20-12+63)

DRAWN BY: JCF	DATE: 9/08
APPROVED:	DATE:
SURVEY BY: JCF, CSL	DATE: 11/07
CAD FILE ID: brigmon.dwg	

SHEET 3 OF 6

FIGURE 2.--Continued.



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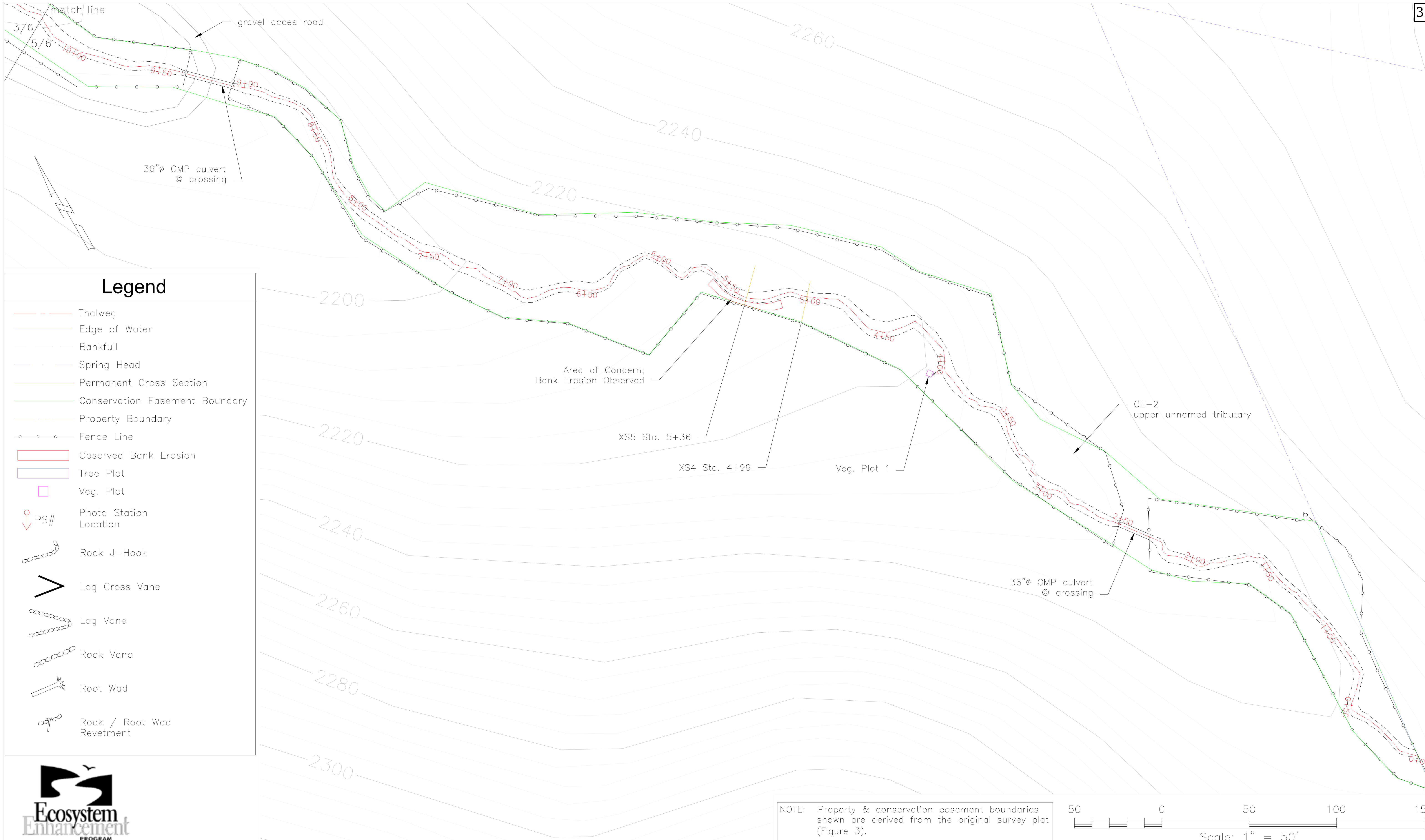
WATERSHED ENHANCEMENT GROUP
20830 GREAT SMOKY MOUNTAIN EXPRESSWAY
WAYNESVILLE, NORTH CAROLINA 28786
828.452.6191 Ext.26 OFFICE
828.452.7772 FAX

Paint Fork Cr. Mitigation Project #92700
Brigmon Site — Madison County
MY3/Closeout - Paint Fork Cr. (Sta. 21+40 - 30+98)

DRAWN BY: JCF	DATE: 9/08
APPROVED:	DATE:
SURVEY BY: JCF, CSL	DATE: 11/07
CAD FILE ID: brigmon.dwg	

SHEET 4 OF 6

FIGURE 2.--Continued.



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828.452.7772 FAX

Paint Fork Cr, Mitigation Project #92700

Brigmon Site — Madison County

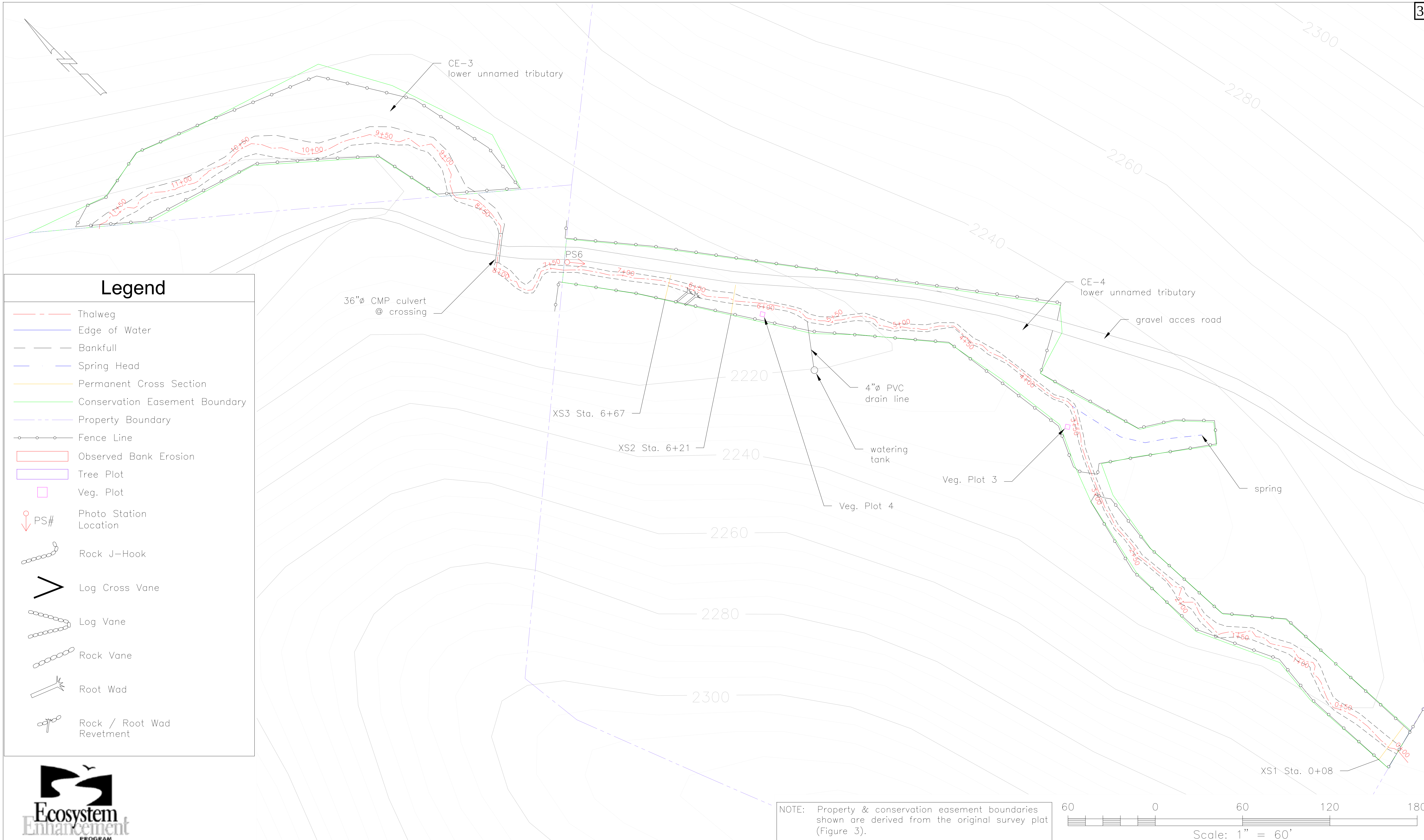
MY3/Closeout - Upper Tributary

Sta. 0+00-12+63 (10+20-12+63 shown on sheet 3 of 6)

DRAWN BY: JCF	DATE: 9/08
APPROVED:	DATE:
SURVEY BY: JCF, CSL	DATE: 11/07
CAD FILE ID: brigmon.dwg	

SHEET 5 OF 6

FIGURE 2.--Continued.



NORTH CAROLINA WILDLIFE RESOURCES COMMISSION
WATERSHED ENHANCEMENT GROUP

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WAYNESVILLE, NORTH CAROLINA 28786
828.452.6191 Ext.26 OFFICE
828.452.7772 FAX

Paint Fork Cr, Mitigation Project #92700

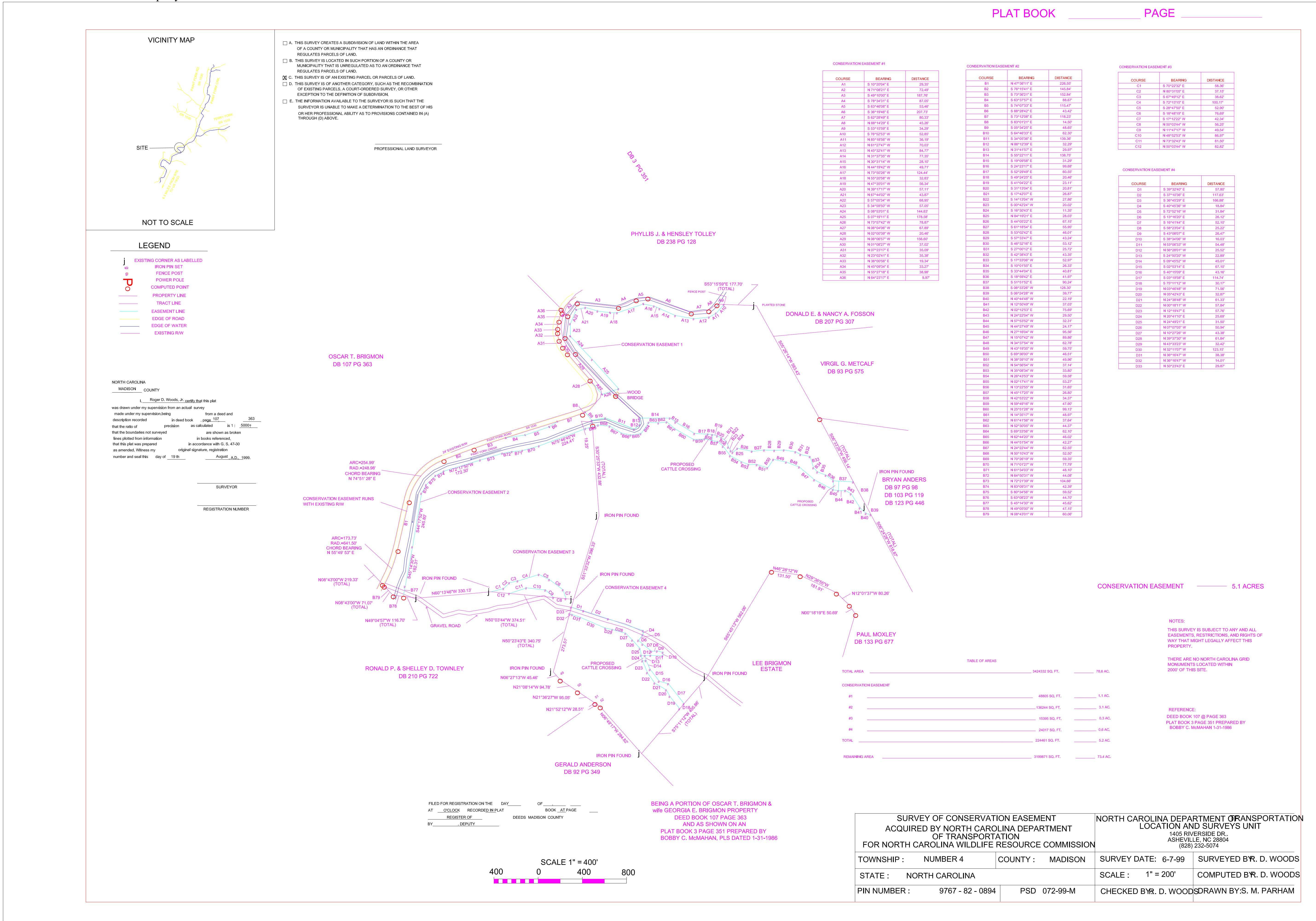
Brigmon Site — Madison County

MY3/Closeout - Lower Tributary
Sta. 0+00-7+41 & Sta. 8+72-11+68 (Total Length in C.E.=1,037')

DRAWN BY: JCF	DATE: 9/08
APPROVED:	DATE:
SURVEY BY: JCF, CSL	DATE: 11/07
CAD FILE ID: brigmon.dwg	

SHEET 6 OF 6

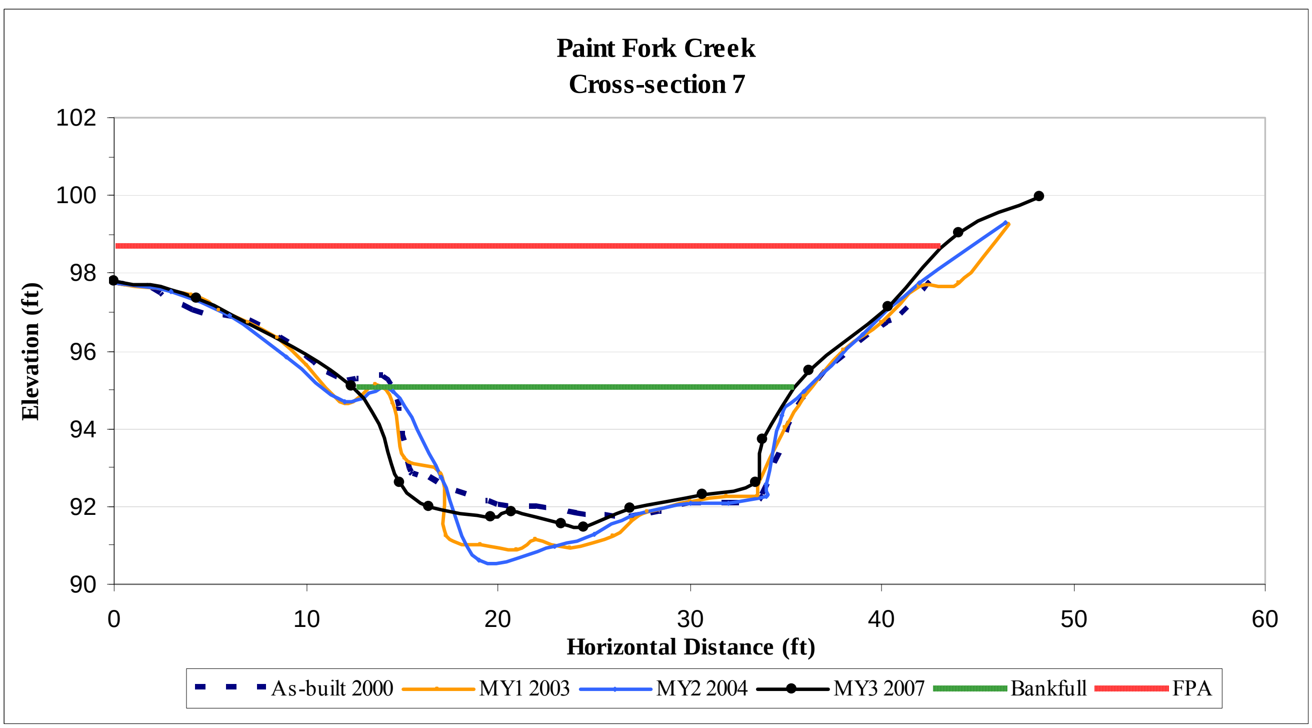
FIGURE 3.--Plat of Recorded Property & Conservation Easement Boundaries.



APPENDIX A

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

Appendix Table A.1. Cross-Section 7 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				4+97
Feature				Run
Stream Type				E
Bankfull Cross Sectional Area (ft^2)	52.0	22.2	50.0	63.0
Maximum Bankfull Depth (ft)	3.0	2.0	3.7	3.6
Bankfull Mean Depth (ft)	2.5	1.3	2.5	2.7
Width/Depth Ratio	8.4	12.7	7.7	8.6
Entrenchment Ratio	1.9	1.4	2.2	2.2
Bankfull Width (ft)	20.9	16.8	19.6	23.3



Cross-section 7, left to right bank, March 2003.

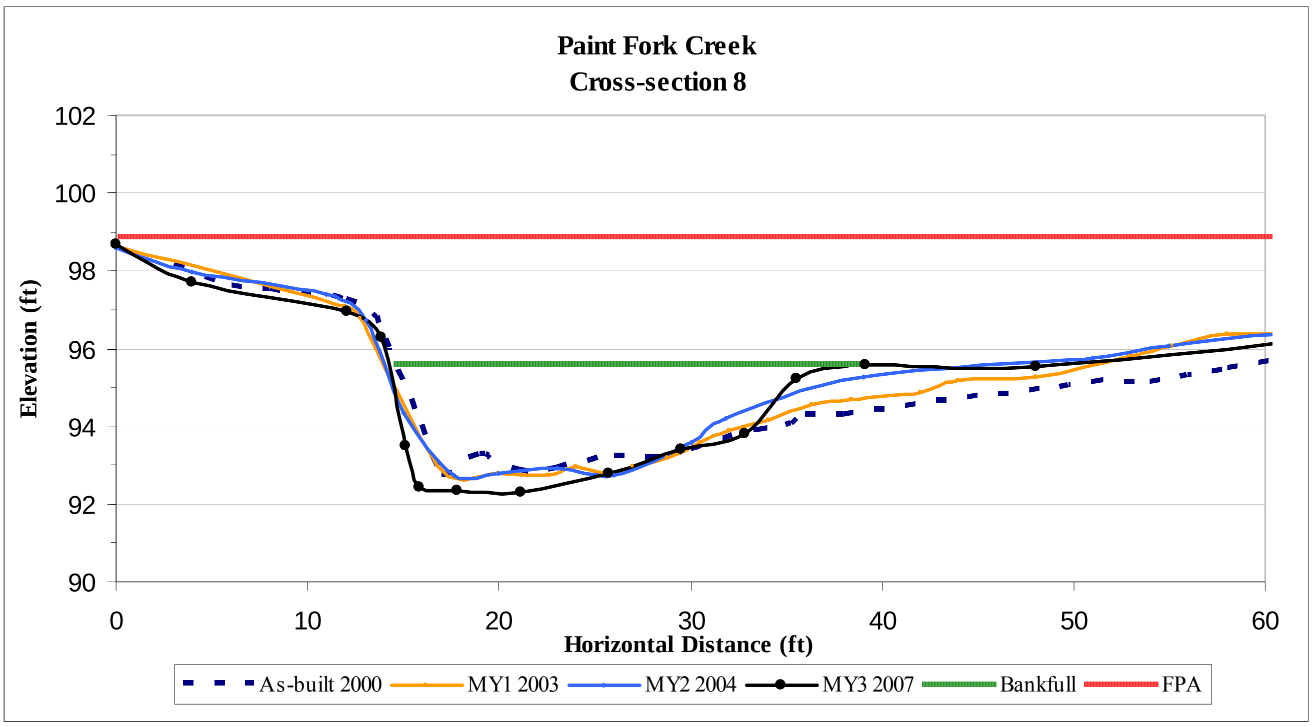
Cross-section 7, left to right bank, May 2004.

Cross-section 7, left to right bank, December 2007.

Cross-section 7, facing downstream, December 2007.

Appendix A.1. Continued.

Appendix Table A.2. Cross-Section 8 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				14+57
Feature				Pool
Stream Type				E
Bankfull Cross Sectional Area (ft^2)	43.3	26.6	55.1	53.8
Maximum Bankfull Depth (ft)	2.4	1.8	3.0	3.3
Bankfull Mean Depth (ft)	1.2	1.3	1.5	2.2
Width/Depth Ratio	30.8	16.2	24.8	11.4
Entrenchment Ratio	1.8	3.8	1.2	2.6
Bankfull Width (ft)	36.5	21.1	37.2	24.8



Cross-section 8, right to left bank, June 2000.

Cross-section 8, right to left bank, March 2003.

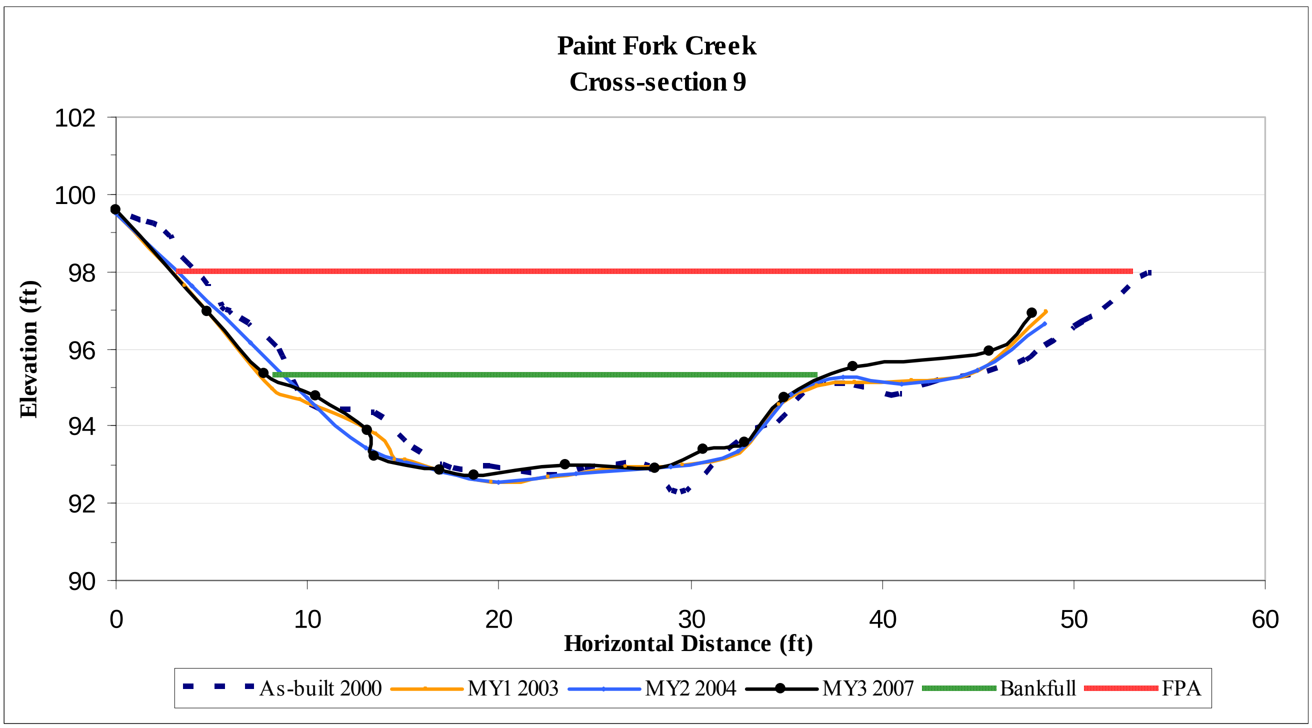
Cross-section 8, right to left bank, May 2004.

Cross-section 8, left to right bank, December 2007.

Cross-section 8, facing downstream, December 2007.

Appendix A.1. Continued.

Appendix Table A.3. Cross-Section 9 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				15+93
Feature				Riffle
Stream Type				C
Bankfull Cross Sectional Area (ft^2)	31.9	49.3	41.7	53.4
Maximum Bankfull Depth (ft)	2.3	2.6	2.3	2.7
Bankfull Mean Depth (ft)	1.3	1.6	1.6	1.8
Width/Depth Ratio	20.3	19.2	15.6	16.9
Entrenchment Ratio	2.0	1.5	1.8	2.2
Bankfull Width (ft)	25.4	30.7	25.5	30.0



Cross-section 9, facing downstream, September 2000.

Cross-section 9, facing upstream, March 2003.

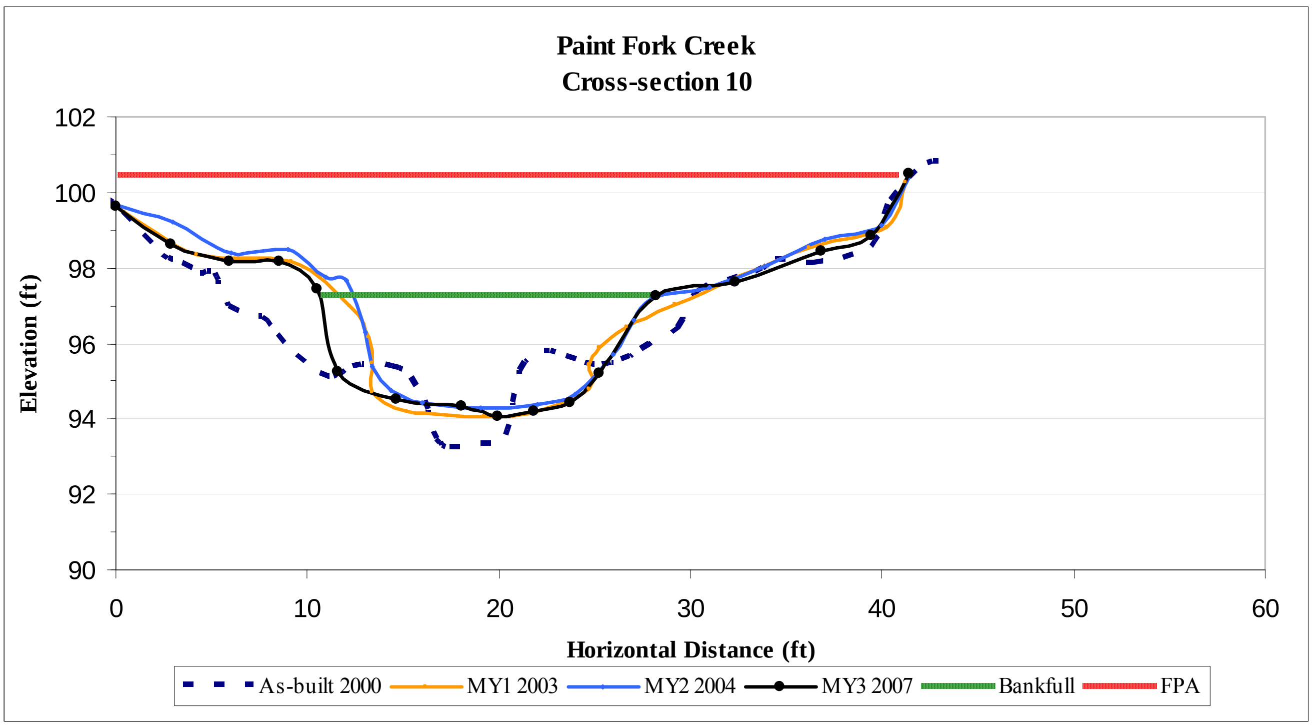
Cross-section 9, right to left bank, May 2004.

Cross-section 9, left to right bank, December 2007.

Cross-section 9, facing downstream, December 2007.

Appendix A.1. Continued.

Appendix Table A.4. Cross-Section 10 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				18+91
Feature				Run
Stream Type				E
Bankfull Cross Sectional Area (ft^2)	26.7	33.8	35.0	42.2
Maximum Bankfull Depth (ft)	3.1	2.9	2.9	3.2
Bankfull Mean Depth (ft)	1.3	2.0	2.2	2.4
Width/Depth Ratio	16.5	8.3	7.0	7.3
Entrenchment Ratio	1.9	3.0	3.2	2.4
Bankfull Width (ft)	21.0	16.7	15.6	17.6



Cross-section 10, right to left bank, March 2003.

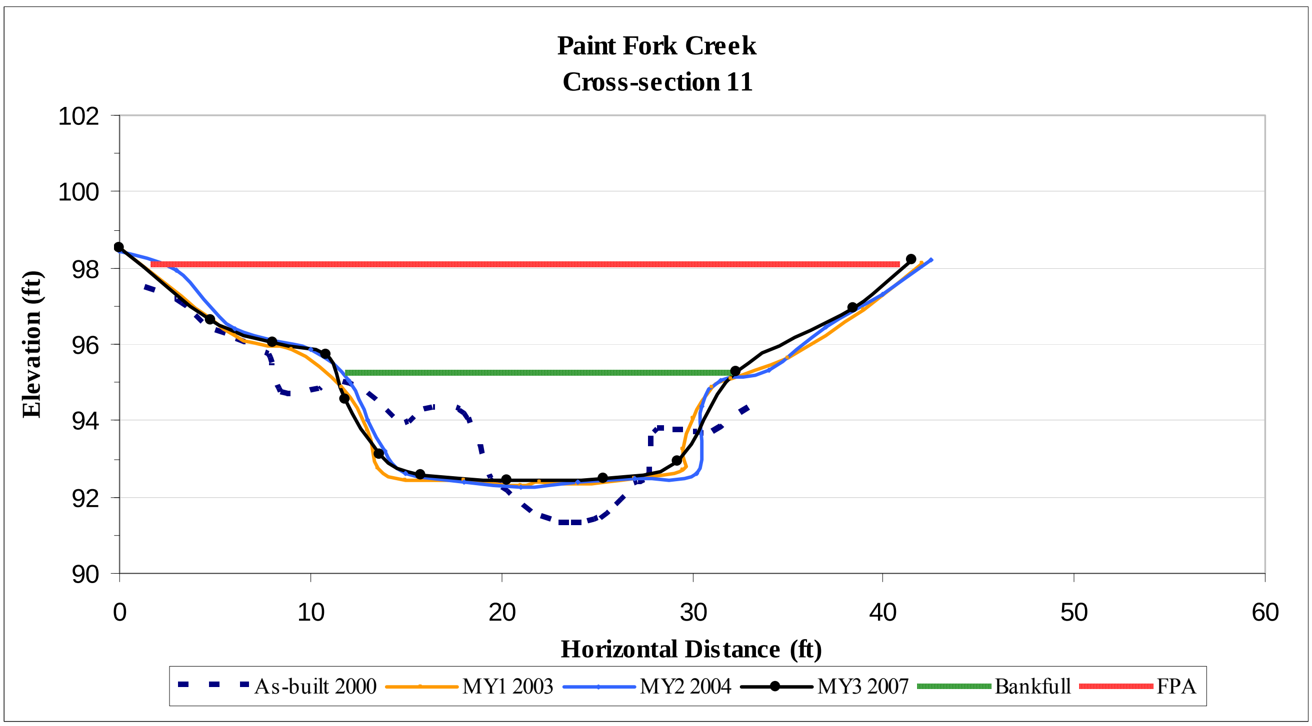
Cross-section 10, left to right bank, May 2004.

Cross-section 10, left to right bank, December 2007.

Cross-section 10, facing downstream, June 2008.

Appendix A.1. Continued.

Appendix Table A.5. Cross-Section 11 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				21+07
Feature				Glide
Stream Type				E
Bankfull Cross Sectional Area (ft^2)	40.5	41.1	32.4	48.3
Maximum Bankfull Depth (ft)	3.7	2.6	2.1	2.8
Bankfull Mean Depth (ft)	2.	2.1	1.8	2.3
Width/Depth Ratio	7.2	9.2	9.9	9.2
Entrenchment Ratio	2.4	1.7	1.8	2.4
Bankfull Width (ft)	17.0	19.4	17.9	21.1



Cross-section 11, right to left bank, March 2003.

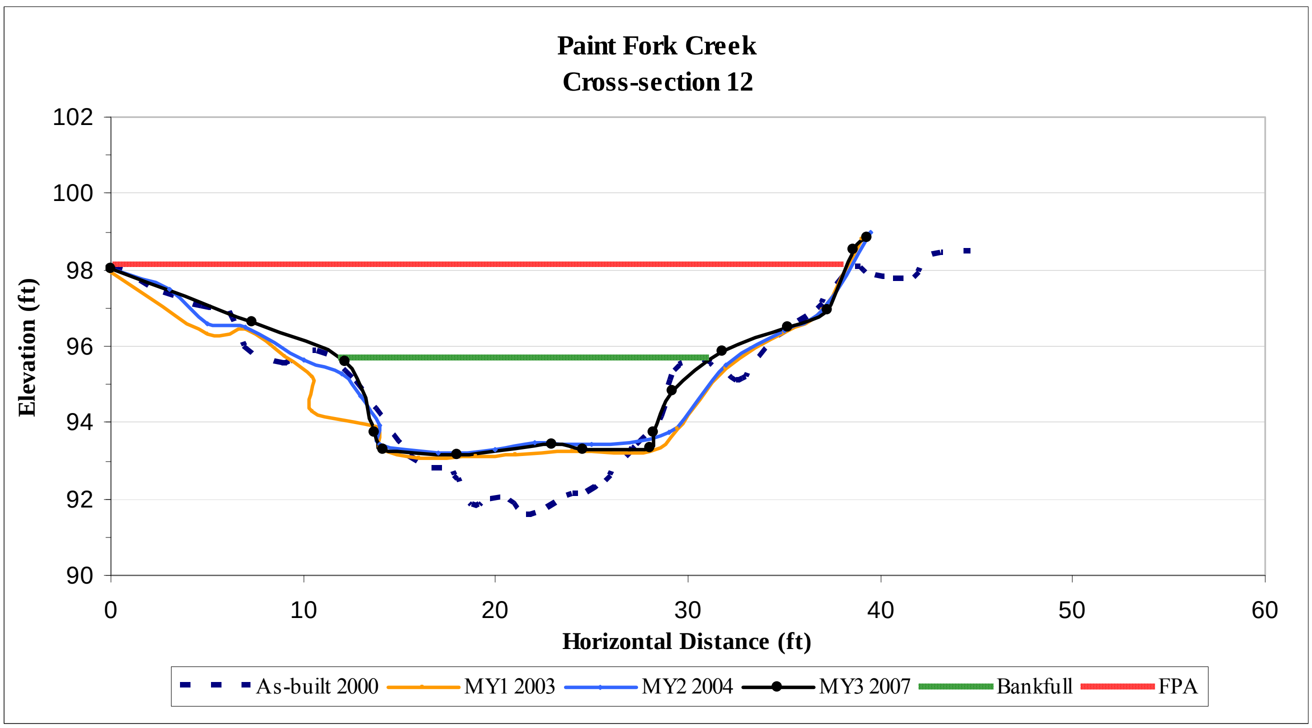
Cross-section 11, left to right bank, May 2004.

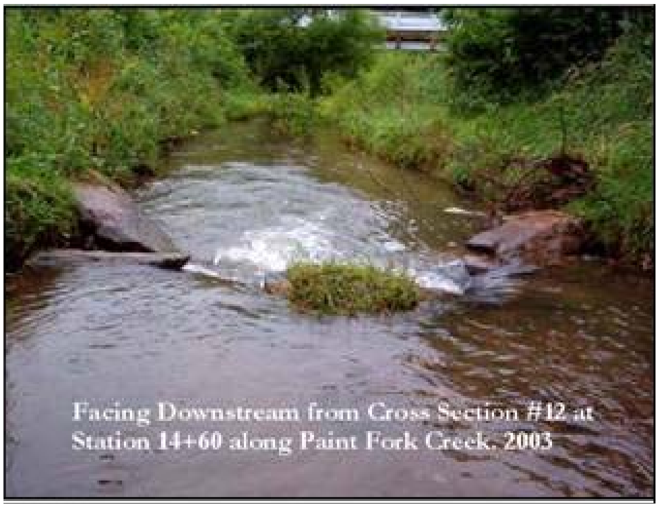
Cross-section 11, left to right bank, December 2007.

Cross-section 11, facing downstream, December 2007.

Appendix A.1. Continued.

Appendix Table A.6. Cross-Section 12 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				29+68
Feature				Run
Stream Type				E
Bankfull Cross Sectional Area (ft^2)	48.6	36.4	30.8	36.5
Maximum Bankfull Depth (ft)	4.1	2.1	2.1	2.4
Bankfull Mean Depth (ft)	2.4	1.7	1.6	1.9
Width/Depth Ratio	8.2	12.3	12.4	9.8
Entrenchment Ratio	2.3	1.7	1.8	2.2
Bankfull Width (ft)	20.0	21.2	19.6	18.9





Cross-section 12, facing downstream, March 2003.

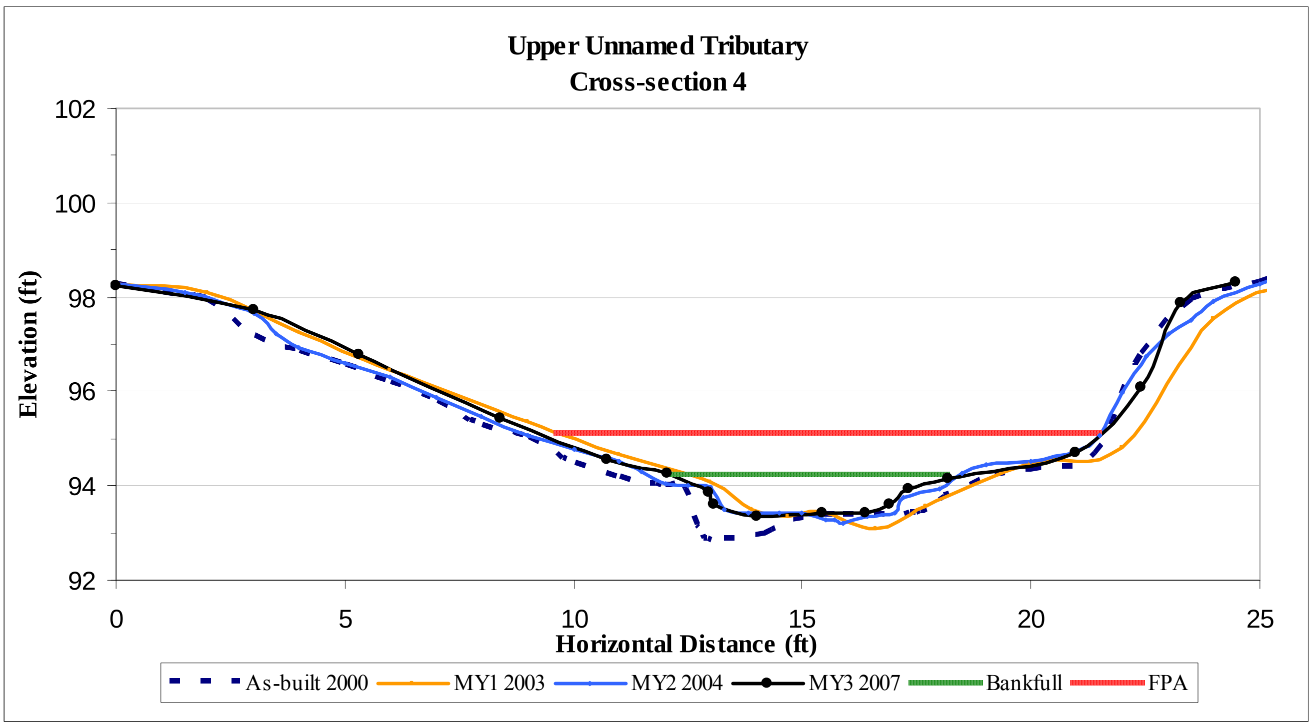
Cross-section 12, left to right bank, May 2004.

Cross-section 12, left to right bank, December 2007.

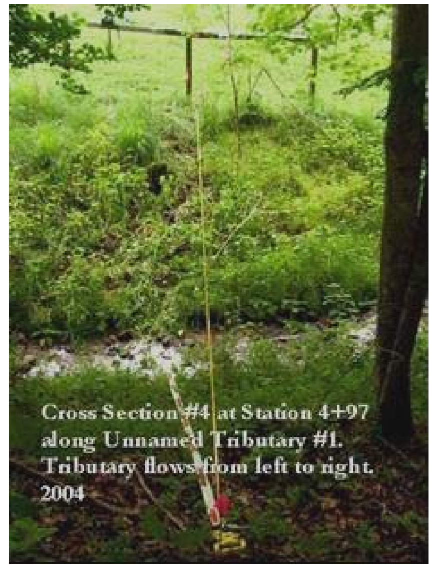
Cross-section 12, facing downstream, June 2008.

Appendix A.1. Continued.

Appendix Table A.7. Cross-Section 4 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				4+99
Feature				Riffle
Stream Type				Ba
Bankfull Cross Sectional Area (ft^2)	5.9	6.3	2.8	3.8
Maximum Bankfull Depth (ft)	1.3	1.4	0.8	0.9
Bankfull Mean Depth (ft)	0.7	0.7	0.5	0.6
Width/Depth Ratio	11.4	11.3	13.6	11.6
Entrenchment Ratio	2.2	2.0	2.1	1.9
Bankfull Width (ft)	8.2	8.4	6.1	6.6



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



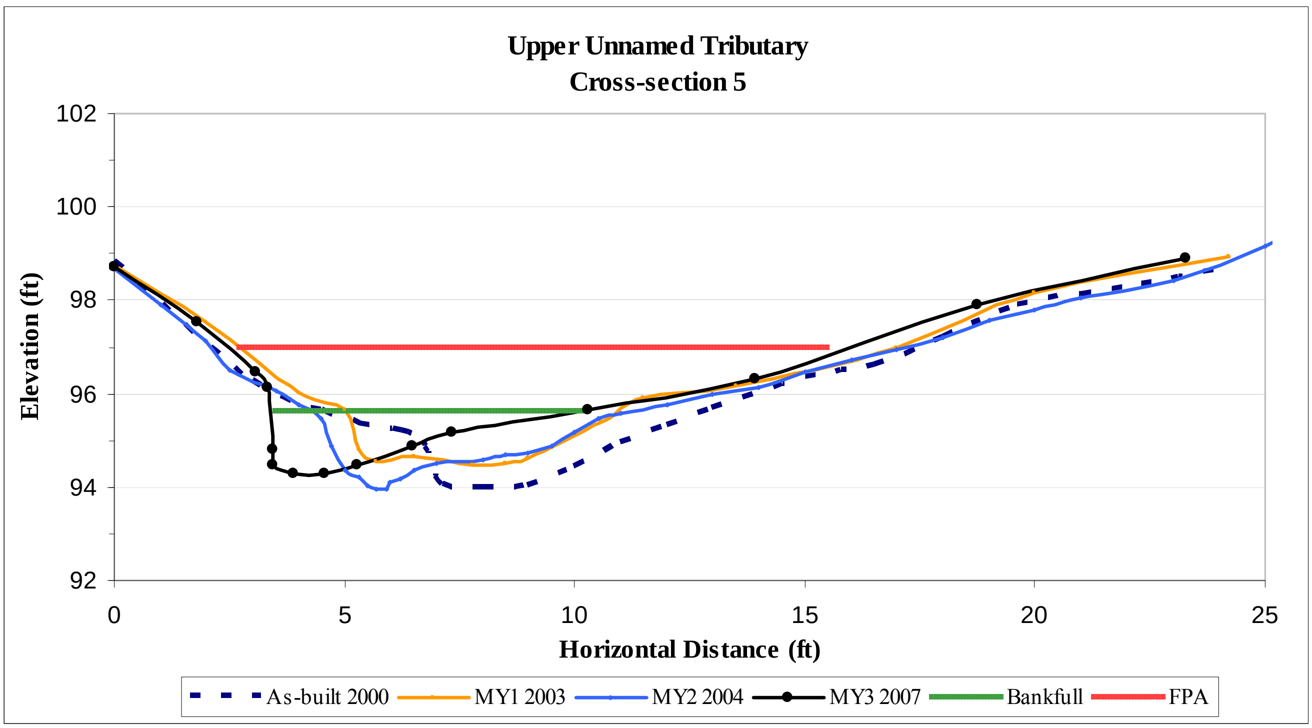
Cross-section 4, right to left bank, May 2004.

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

Cross-section 4, facing downstream, December 2007.

Appendix A.1. Continued.

Appendix Table A.8. Cross-Section 5 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				5+36
Feature				Riffle
Stream Type				Ba
Bankfull Cross Sectional Area (ft^2)	4.4	6.9	1.3	4.8
Maximum Bankfull Depth (ft)	1.3	1.4	0.8	1.4
Bankfull Mean Depth (ft)	0.8	1.0	0.3	0.7
Width/Depth Ratio	7.6	7.4	13.6	9.9
Entrenchment Ratio	2.2	2.1	1.7	2.0
Bankfull Width (ft)	5.8	7.2	4.2	6.9



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

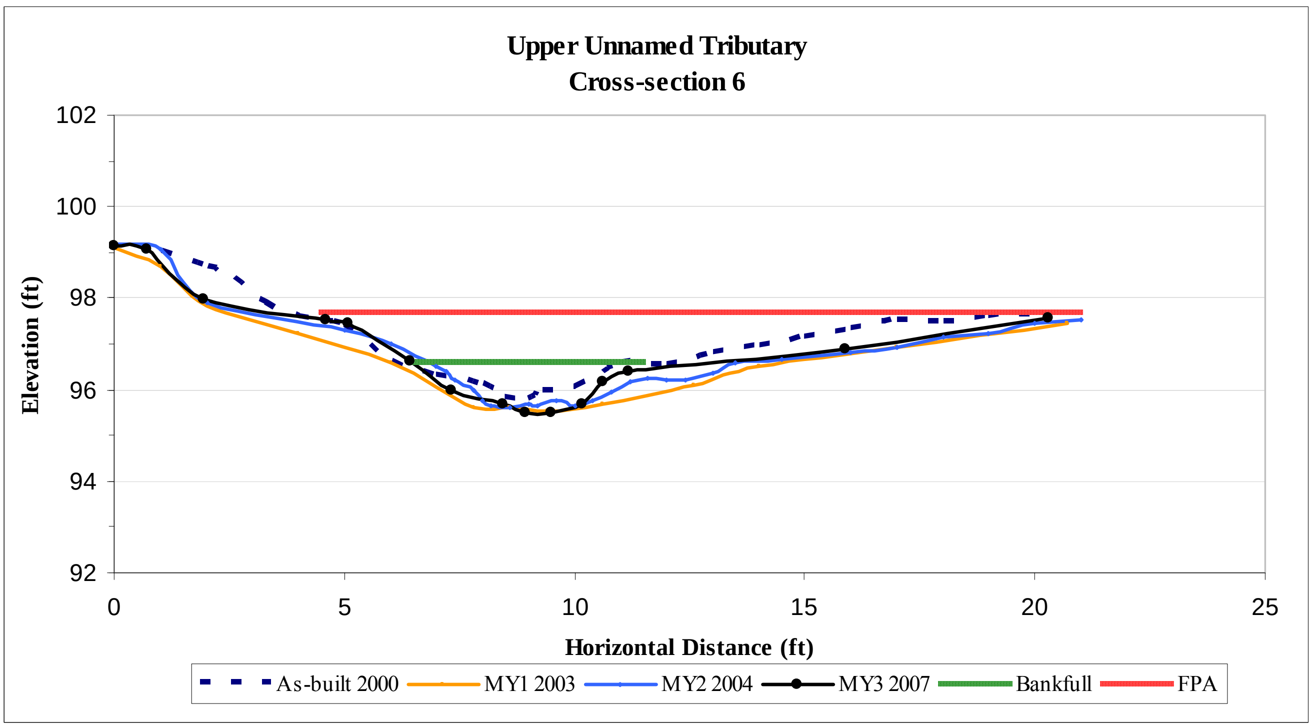
Cross-section 5, facing upstream, May 2004.

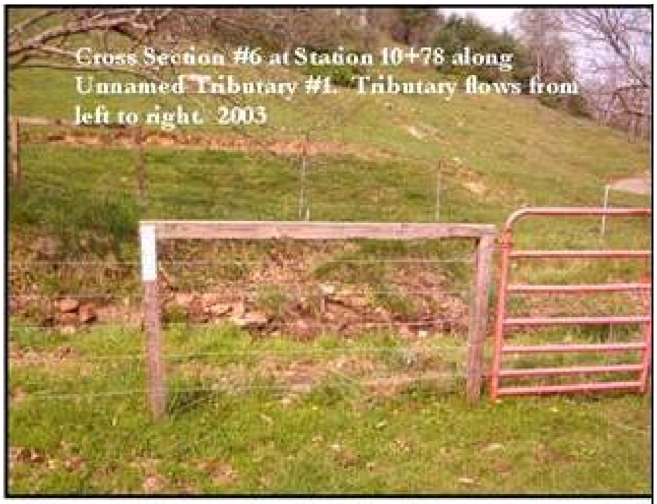
Cross-section 5, left to right bank, December 2007.

Cross-section 5, facing downstream, December 2007.

Appendix A.1. Continued.

Appendix Table A.9. Cross-Section 6 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				10+98
Feature				Riffle
Stream Type				Cb
Bankfull Cross Sectional Area (ft^2)	2.2	4.8	2.5	3.7
Maximum Bankfull Depth (ft)	0.8	1.0	0.8	1.1
Bankfull Mean Depth (ft)	0.4	0.6	0.4	0.5
Width/Depth Ratio	12.5	12.8	13.4	12.4
Entrenchment Ratio	2.4	2.3	2.4	2.5
Bankfull Width (ft)	5.0	7.9	5.8	6.7





Cross-section 6, right to left bank, March 2003.

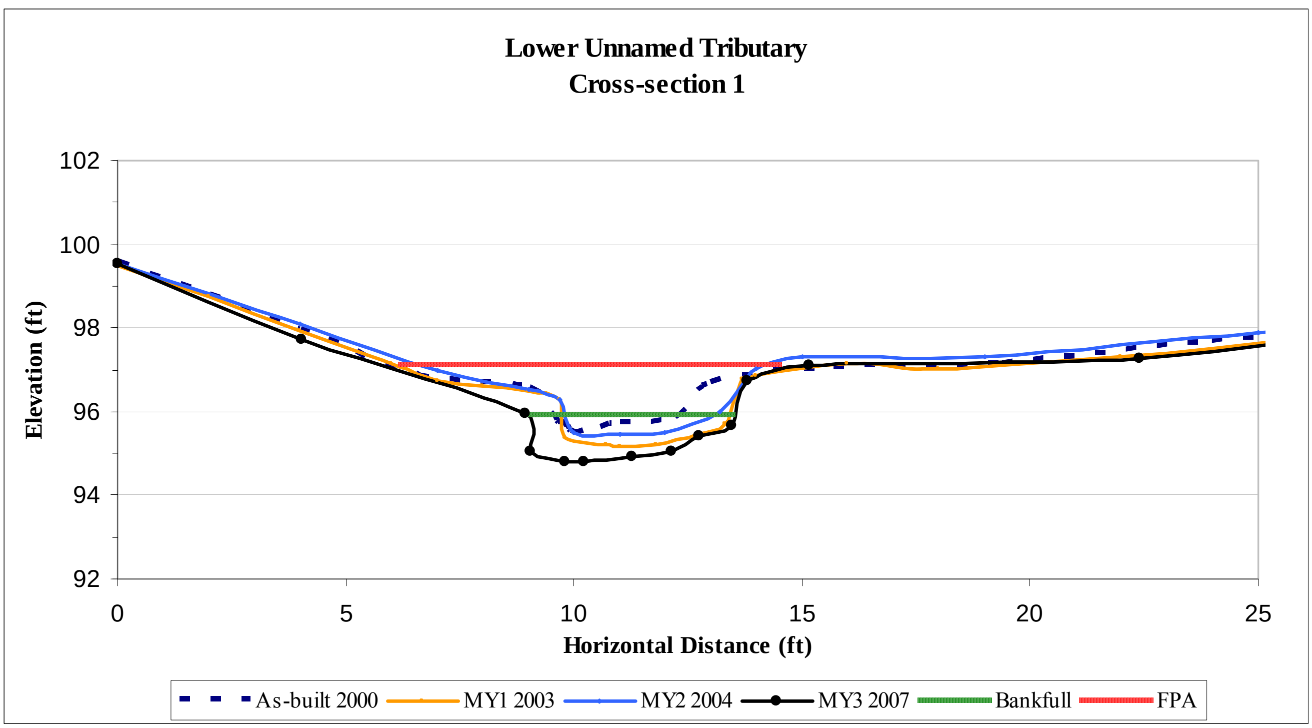
Cross-section 6, facing downstream, May 2004.

Cross-section 6, left to right bank, December 2007.

Cross-section 6, facing downstream, December 2007.

Appendix A.1. Continued.

Appendix Table A.10. Cross-Section 1 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				0+08
Feature				Riffle
Stream Type				Eb
Bankfull Cross Sectional Area (ft^2)	2.5	4.4	2.4	4.1
Maximum Bankfull Depth (ft)	1.1	1.4	0.8	1.2
Bankfull Mean Depth (ft)	0.6	1.0	0.6	0.9
Width/Depth Ratio	6.4	4.8	5.9	5.2
Entrenchment Ratio	2.5	5.9	2.4	2.4
Bankfull Width (ft)	4.0	4.6	3.7	4.6



Cross-section 1, pre-construction right to left bank, August 1999.

Cross-section 1, right to left bank, September 2000.

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

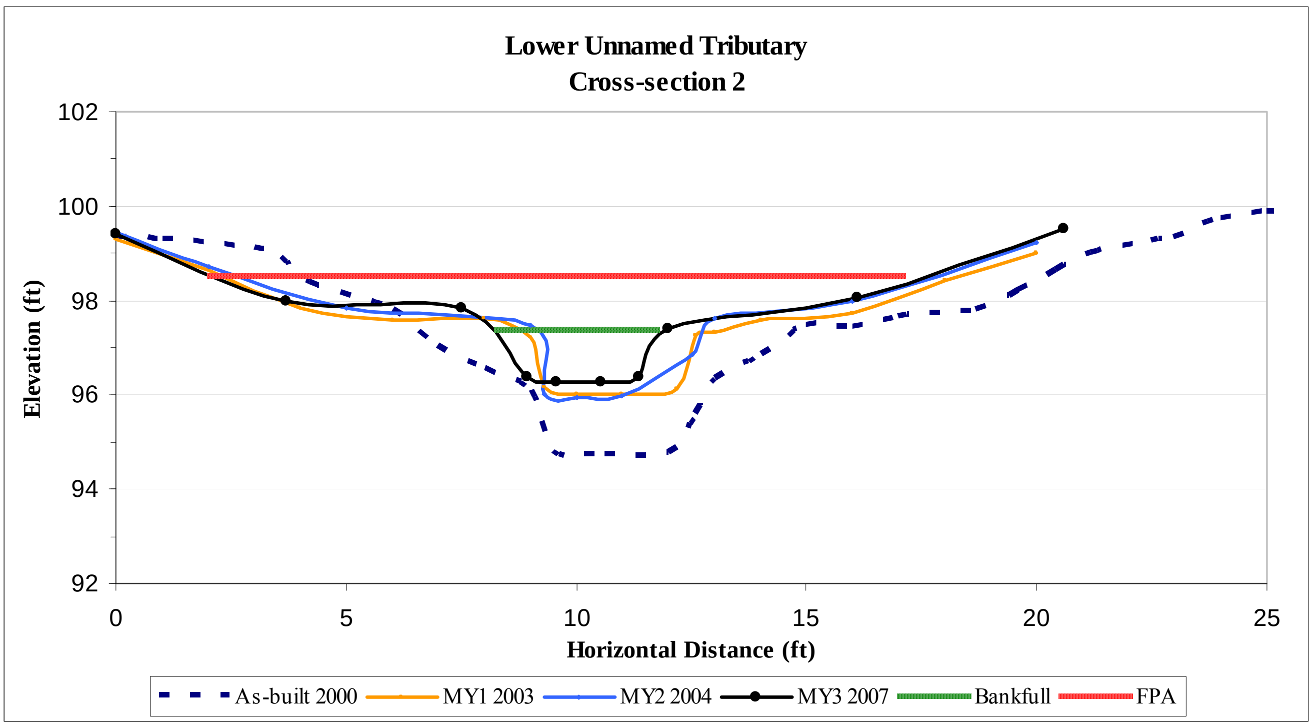
Cross-section 1, right to left bank, May 2004.

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

Cross-section 1, facing downstream, June 2008.

Appendix A.1. Continued.

Appendix Table A.11. Cross-Section 2 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				6+21
Feature				Riffle
Stream Type				Eb
Bankfull Cross Sectional Area (ft^2)	4.5	4.1	2.2	3.5
Maximum Bankfull Depth (ft)	1.5	1.3	0.9	1.1
Bankfull Mean Depth (ft)	1.1	1.0	0.7	0.9
Width/Depth Ratio	3.6	4.4	5.1	4.8
Entrenchment Ratio	3.0	4.0	3.0	3.7
Bankfull Width (ft)	4.0	4.2	3.4	4.1



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

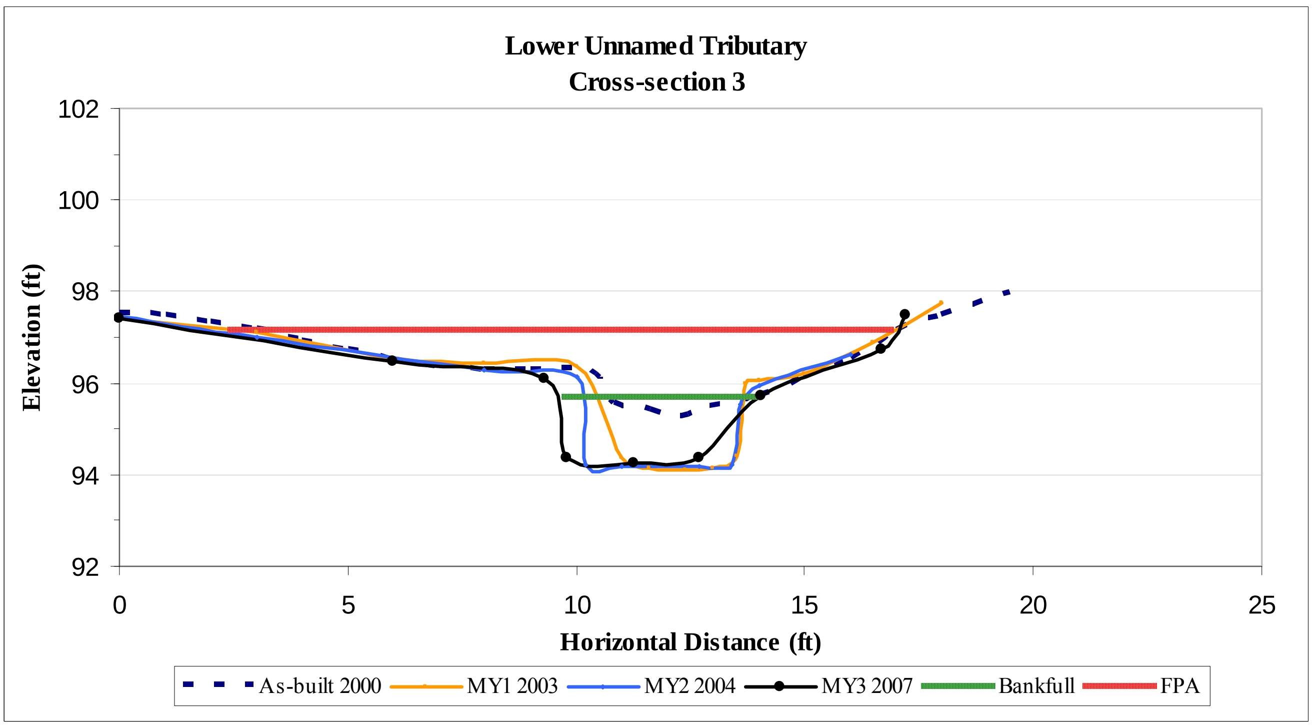
Cross-section 2, left to right bank, May 2004.

Cross-section 2, left to right bank, June 2008.

Cross-section 2, facing downstream, June 2008.

Appendix A.1. Continued.

Appendix Table A.12. Cross-Section 3 Abbreviated Morphological Characteristic Summary				
	Year			
Characteristic	2000 (MY0)	2003 (MY1)	2004 (MY2)	2007 (MY3)
Station (ft)				6+67
Feature				Riffle
Stream Type				Eb
Bankfull Cross Sectional Area (ft^2)	3.0	5.6	4.5	5.3
Maximum Bankfull Depth (ft)	1.0	2.0	1.4	1.5
Bankfull Mean Depth (ft)	0.6	1.4	1.3	1.1
Width/Depth Ratio	7.3	2.7	2.8	4.1
Entrenchment Ratio	3.4	6.5	4.8	3.4
Bankfull Width (ft)	4.7	3.8	3.5	4.6



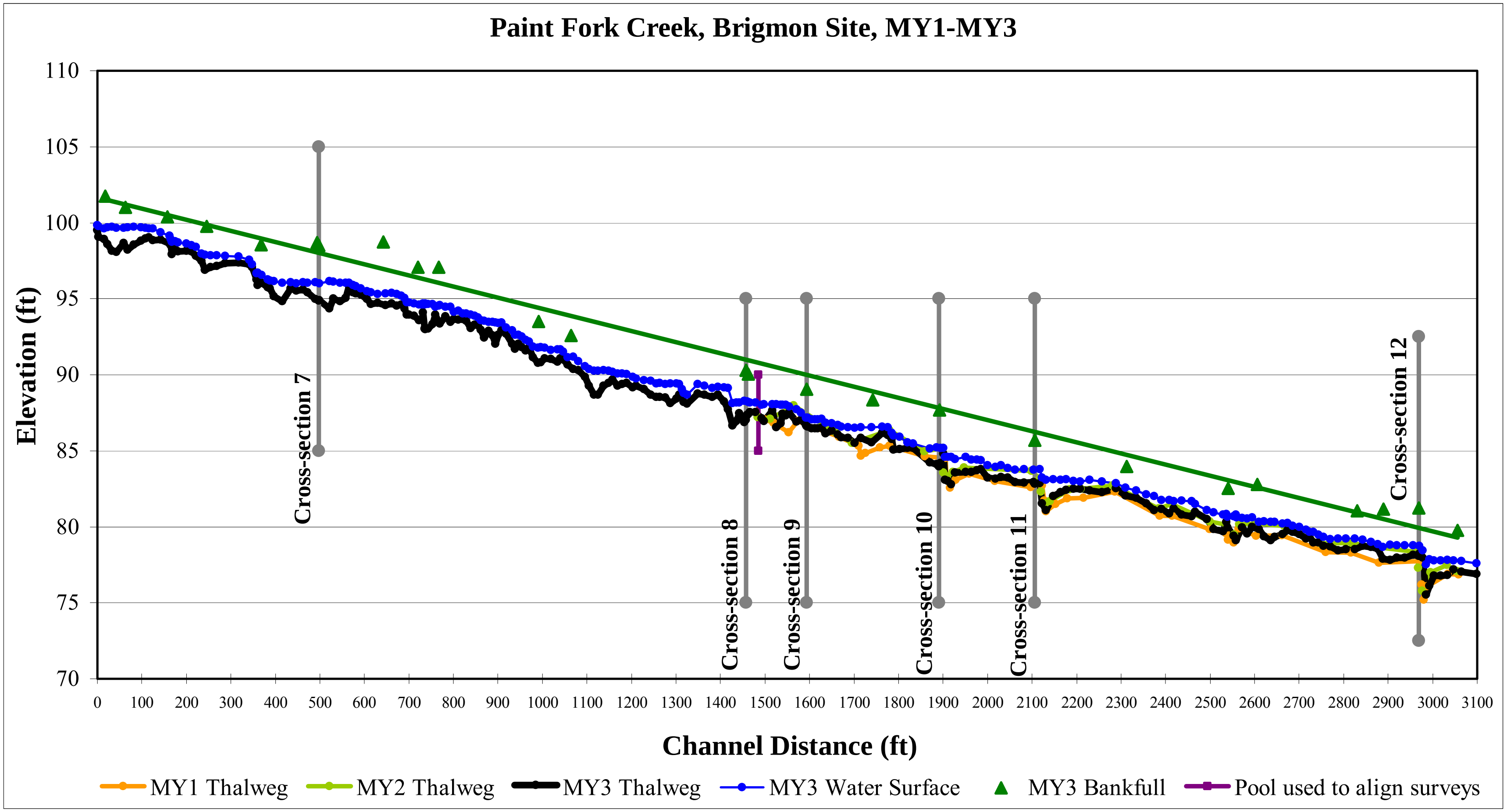
Cross-section 3, right to left bank, March 2003.

Cross-section 3, left to right bank, May 2004.

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

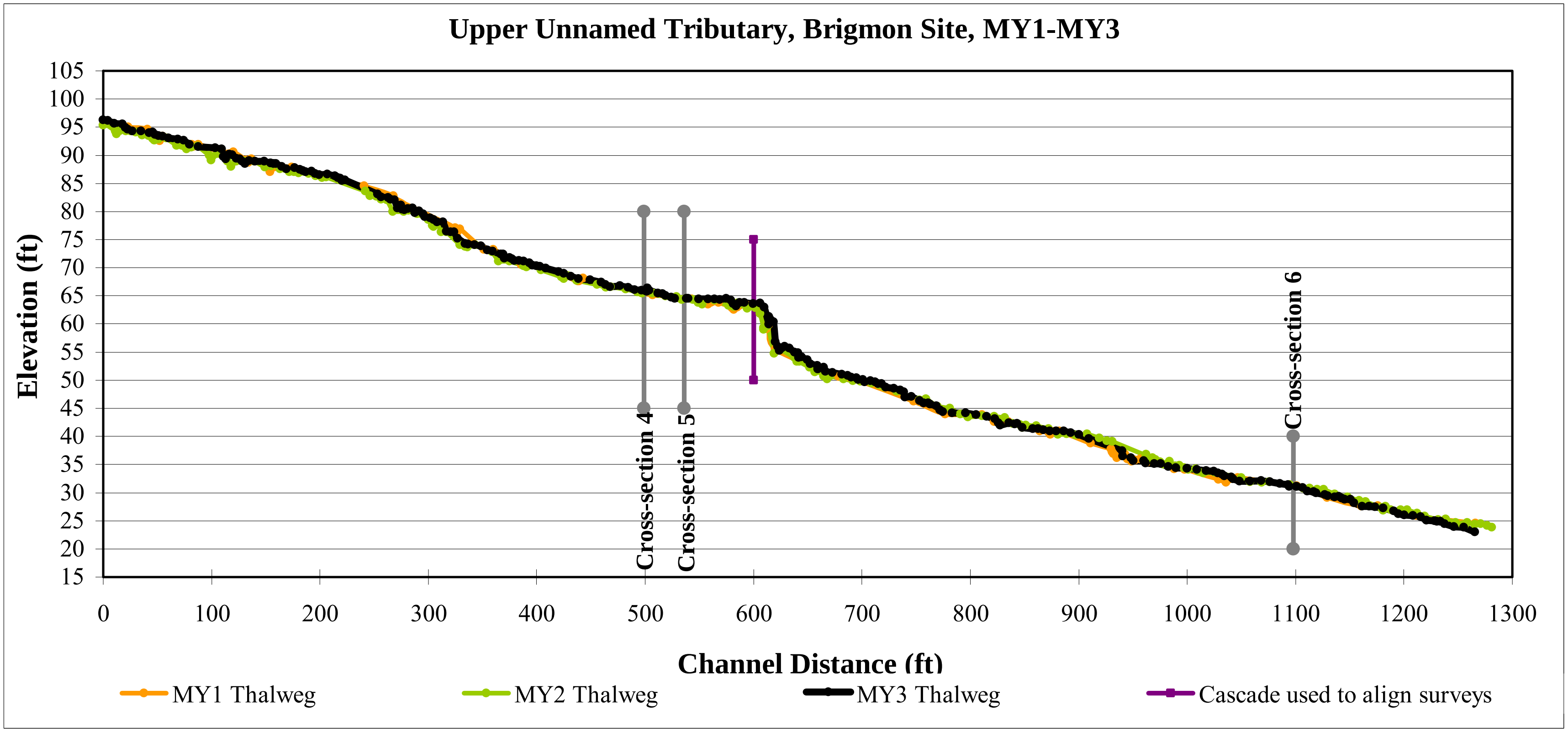
Cross-section 3, facing downstream, June 2008.

Appendix A.2. Longitudinal Profile Plots.



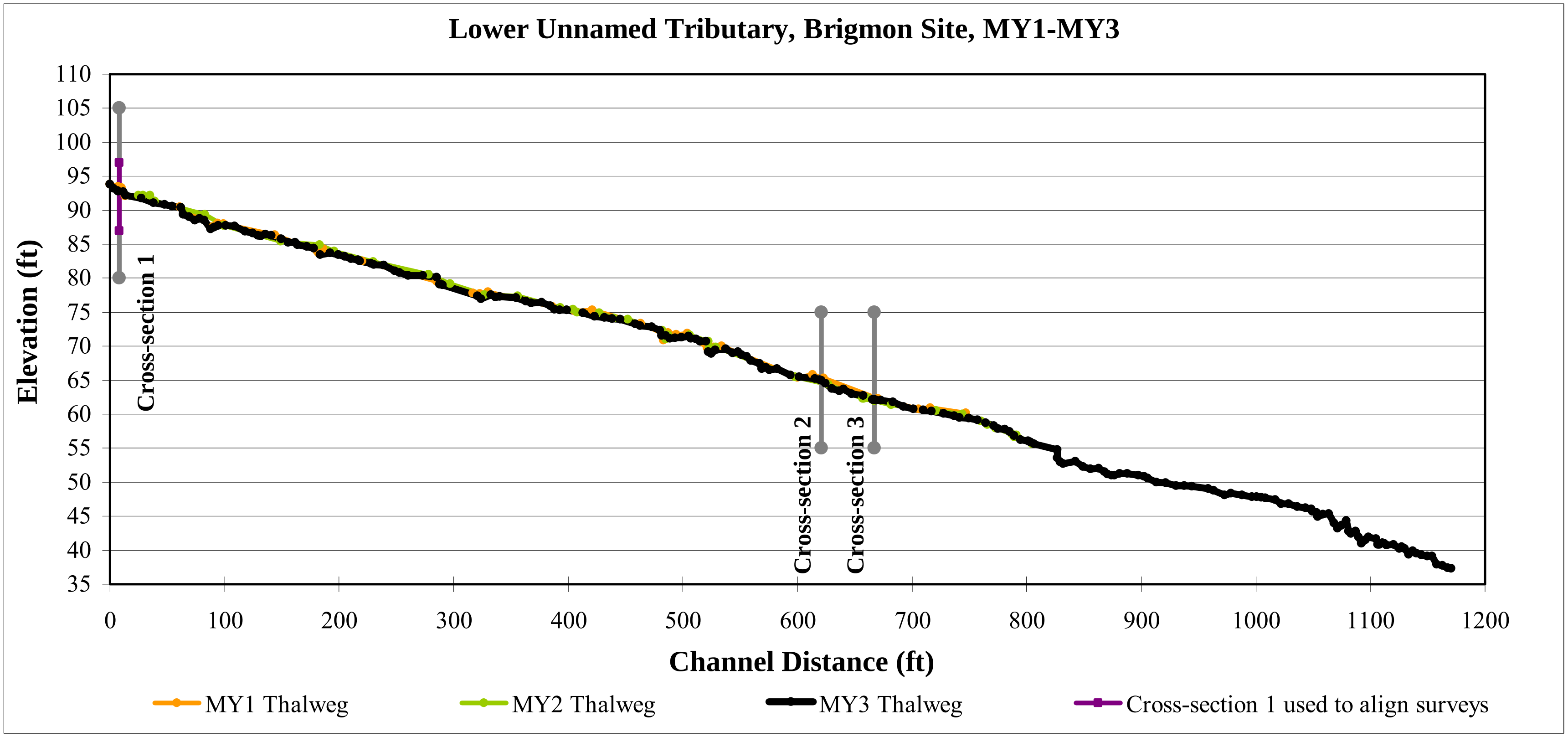
Note: The longitudinal profiles for MY1 and MY2 began in the middle portion of the reach, just downstream of cross-section 8 in the sharp meander bend at station 14+85 as indicated by the vertical line on the graph at that location.

Appendix A.2. Continued.



Note 1: 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.

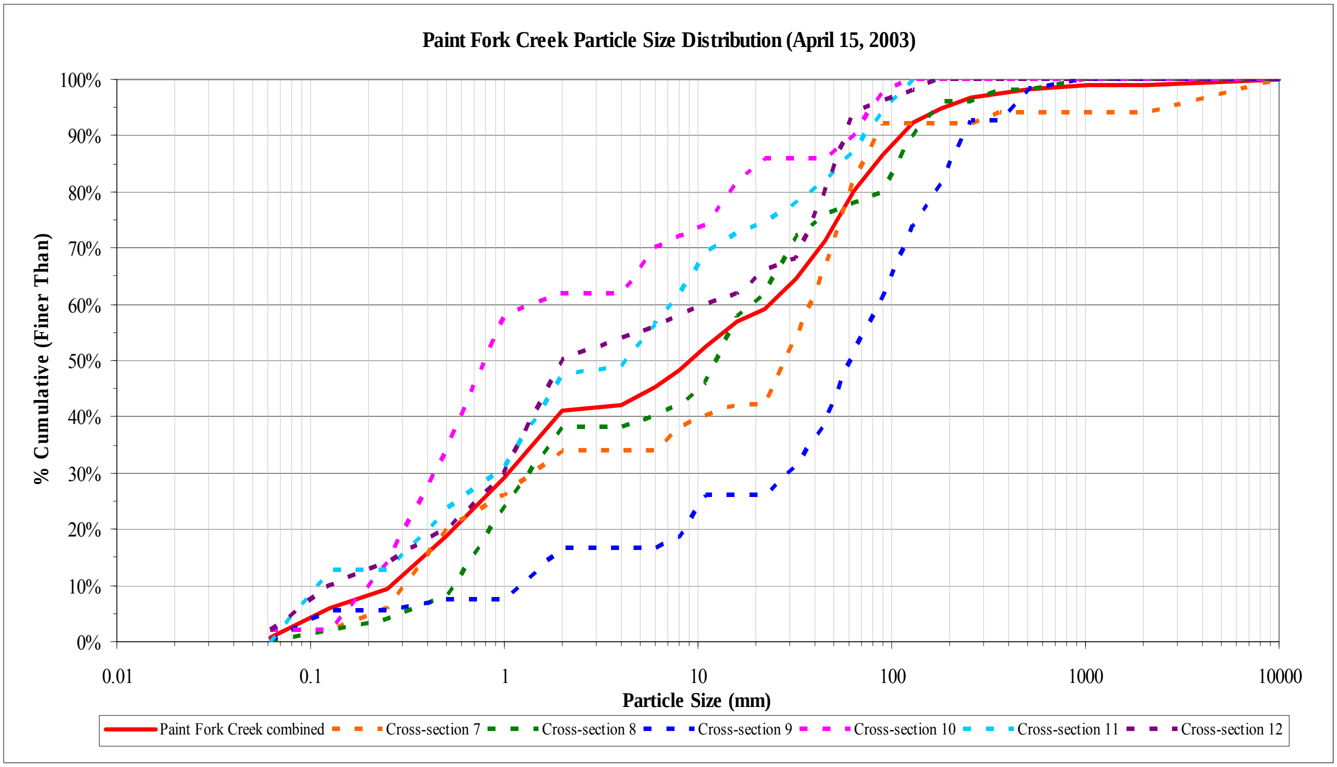
Appendix A.2. Continued.

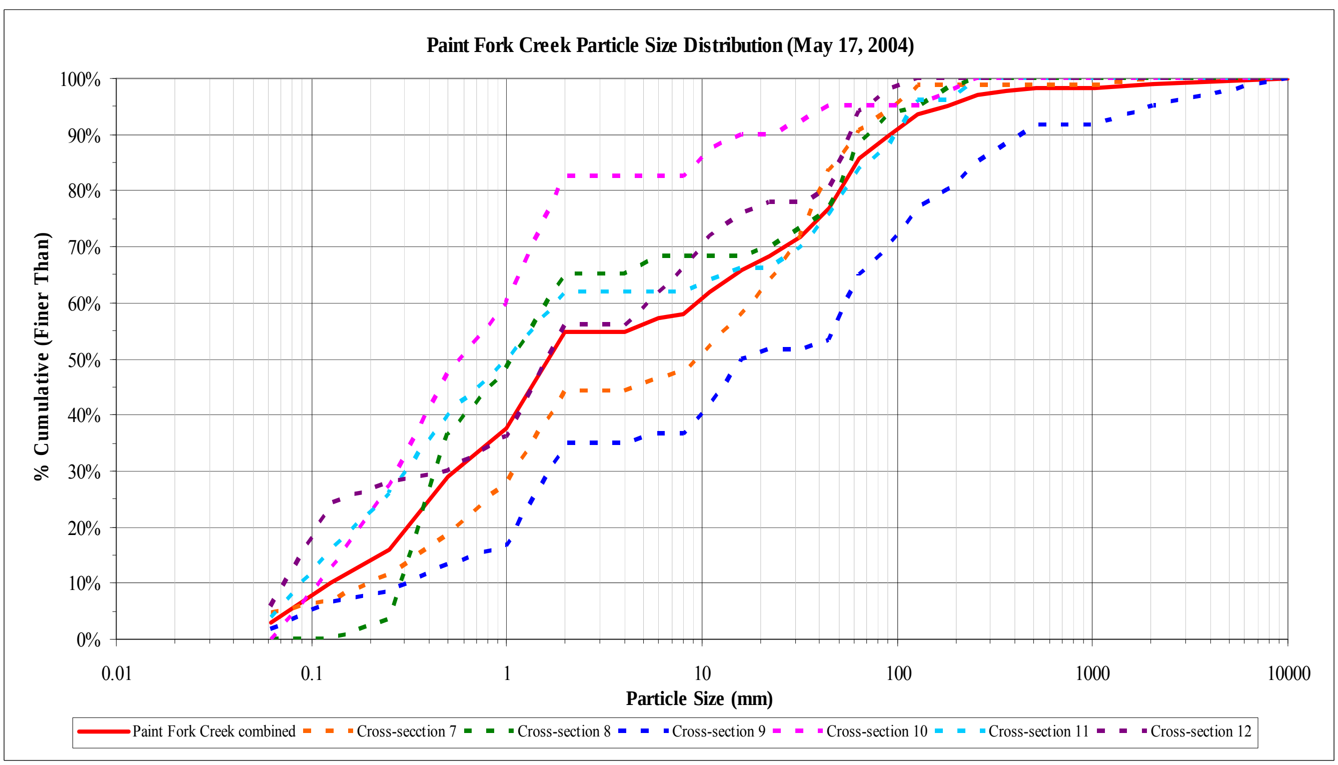


Note: Water surface elevations were taken, but not plotted because they would coincide with the thalweg profile data. Water levels were low due to an ongoing regional drought.

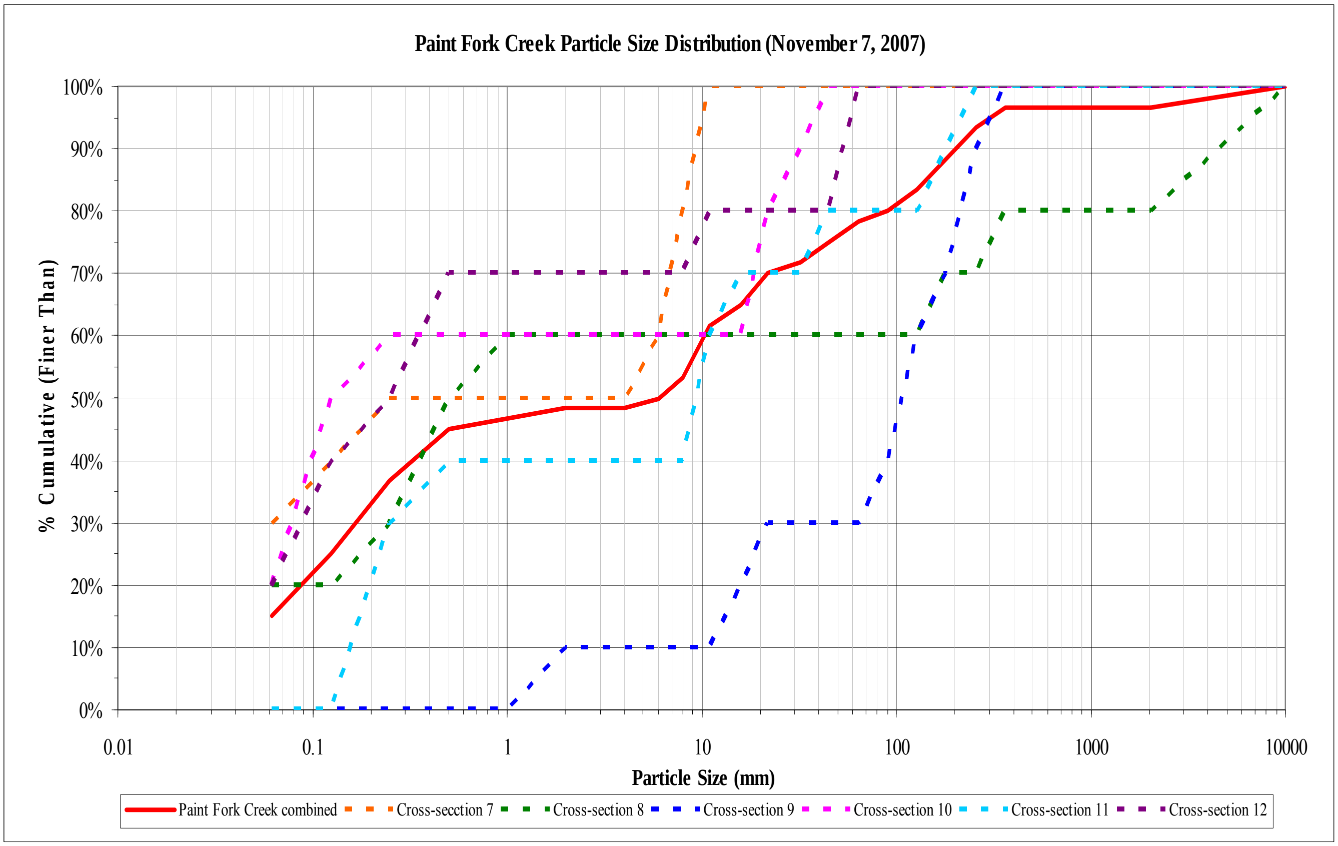
Note 2: Longitudinal profiles for MY1 and MY2 began at station 0+00 but ended at the Brigmon fence line, just above the culverted road crossing, station 7+45.

Appendix A.3. Pebble Count Cumulative Frequency Distributions Plots.

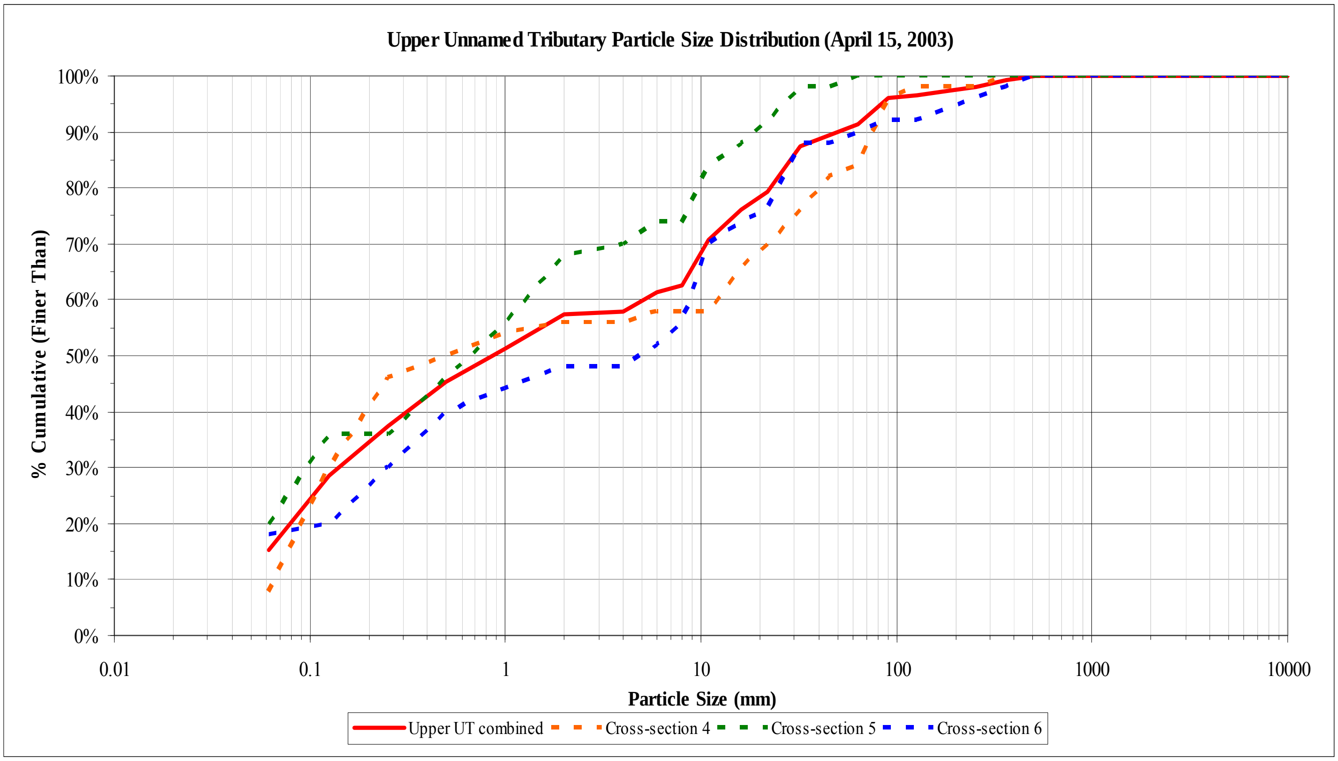


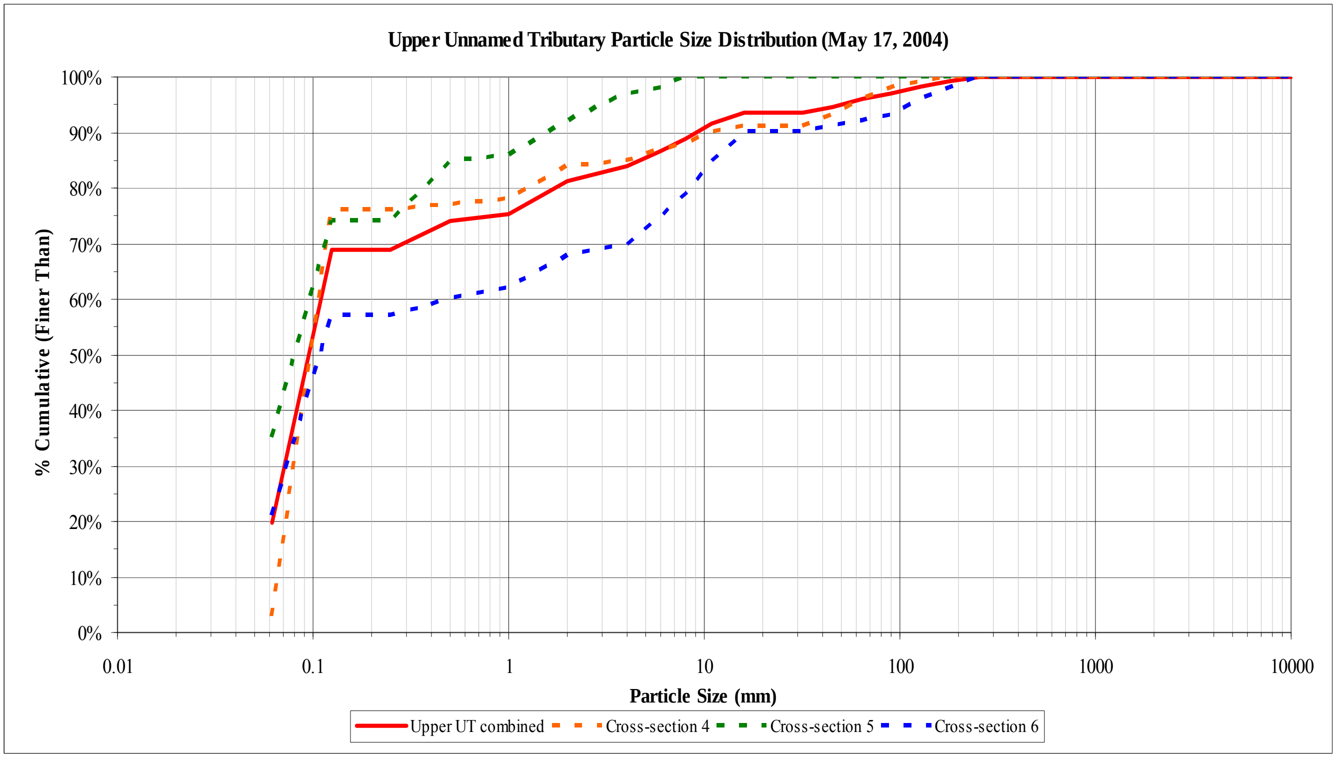


Appendix A.3. Continued.

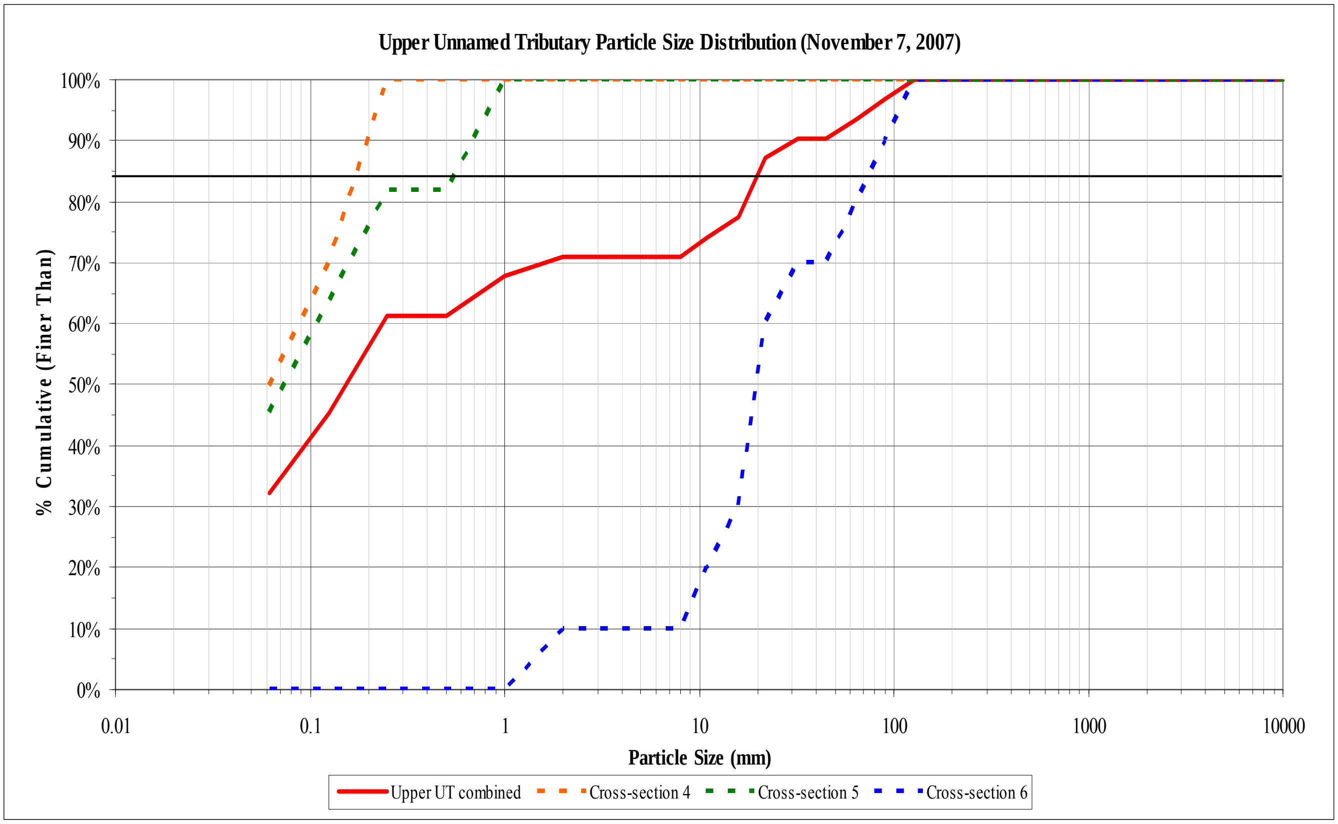


Appendix A.3. Continued.

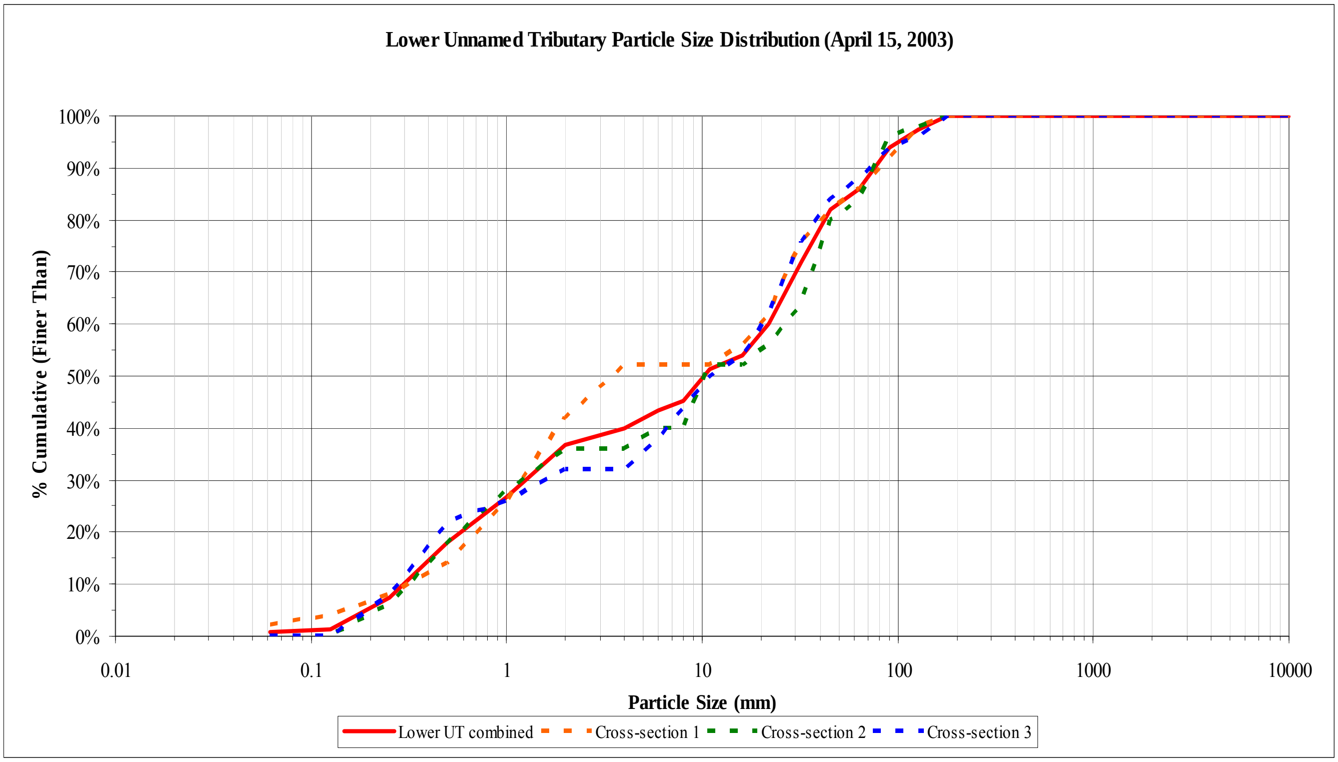


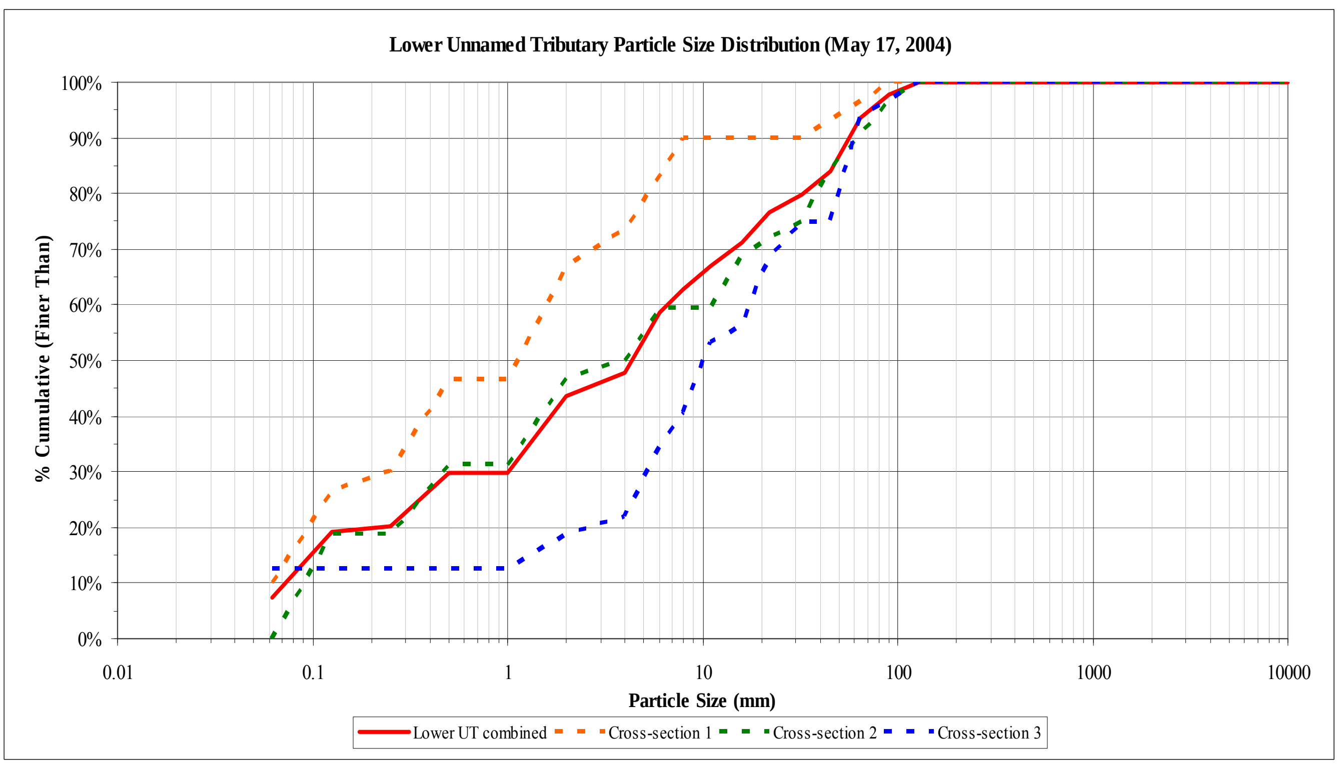


Appendix A.3. Continued.

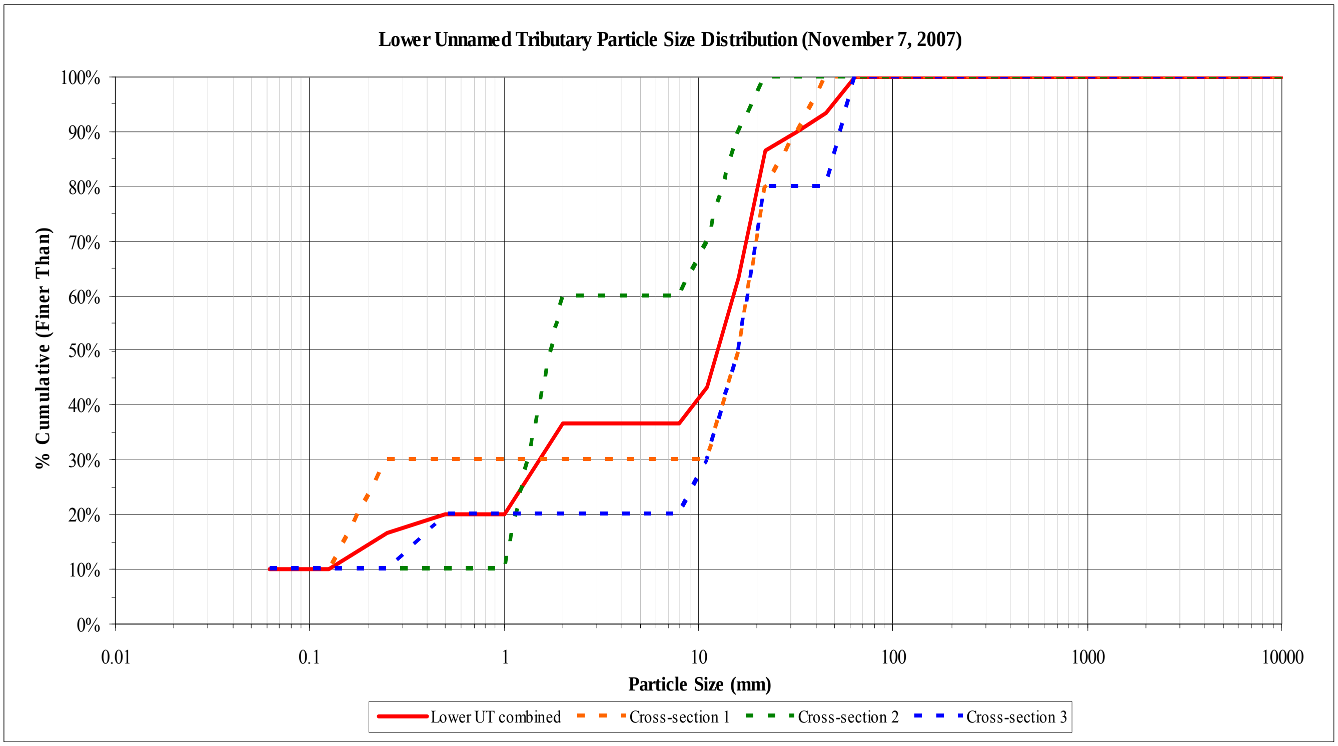


Appendix A.3. Continued.





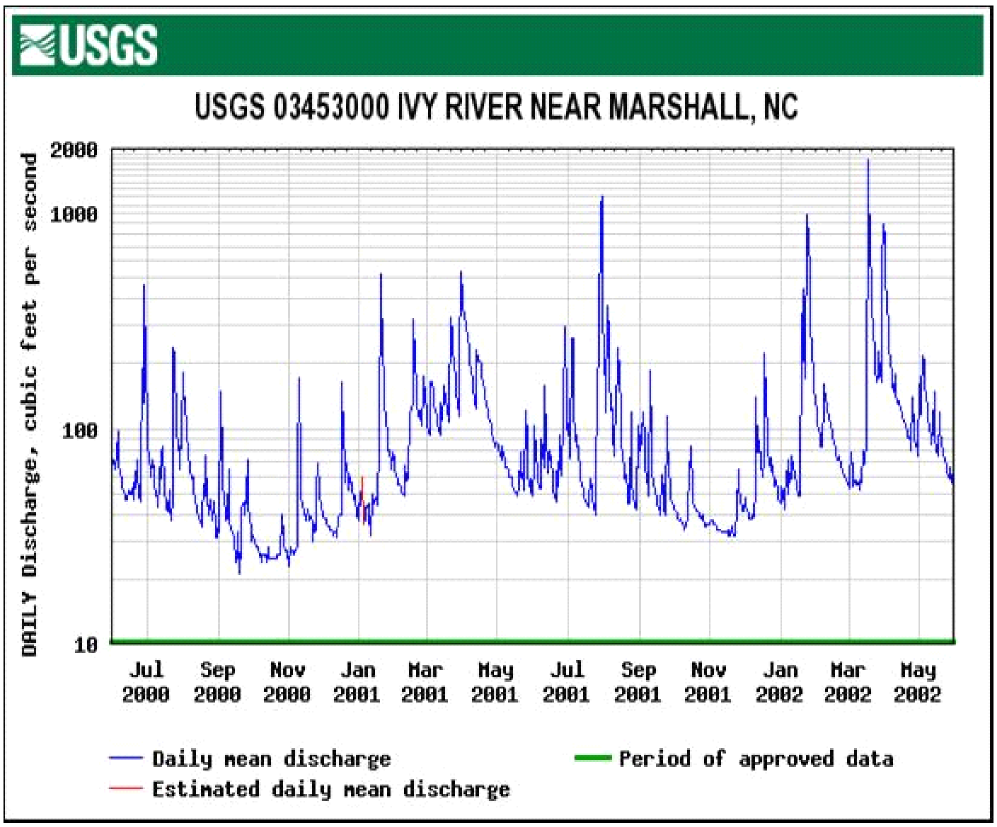
Appendix A.3. Continued.



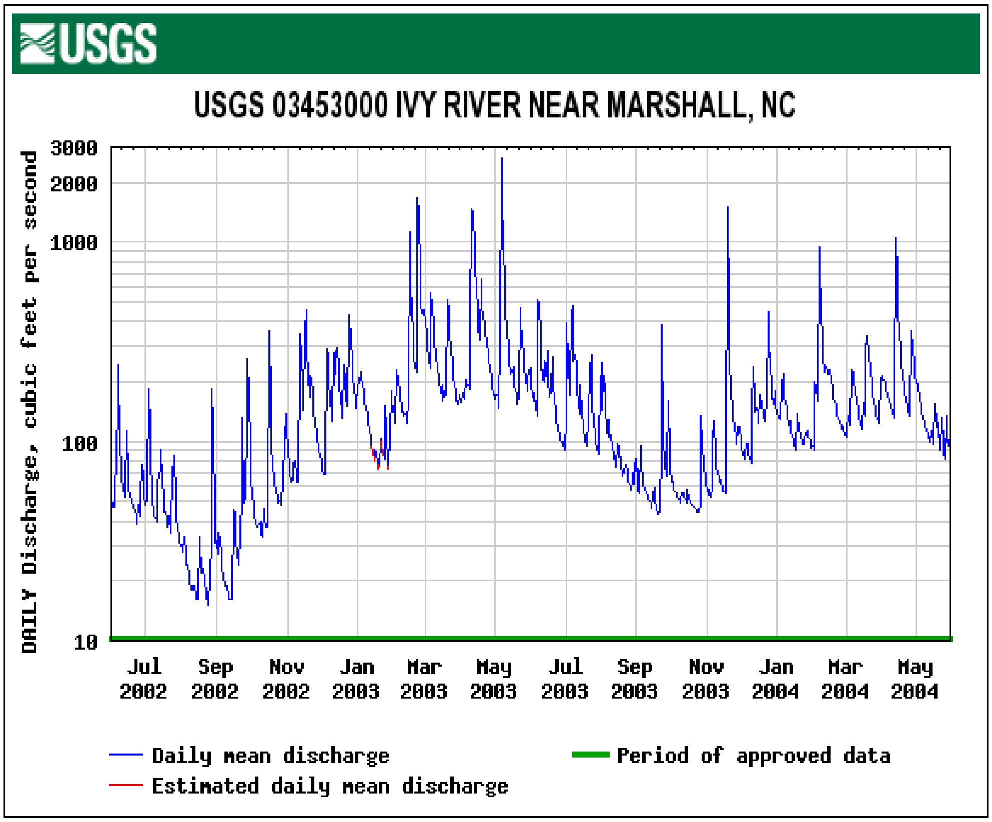
Appendix A.4. Surrogate gage hydrograph data table and graphs.

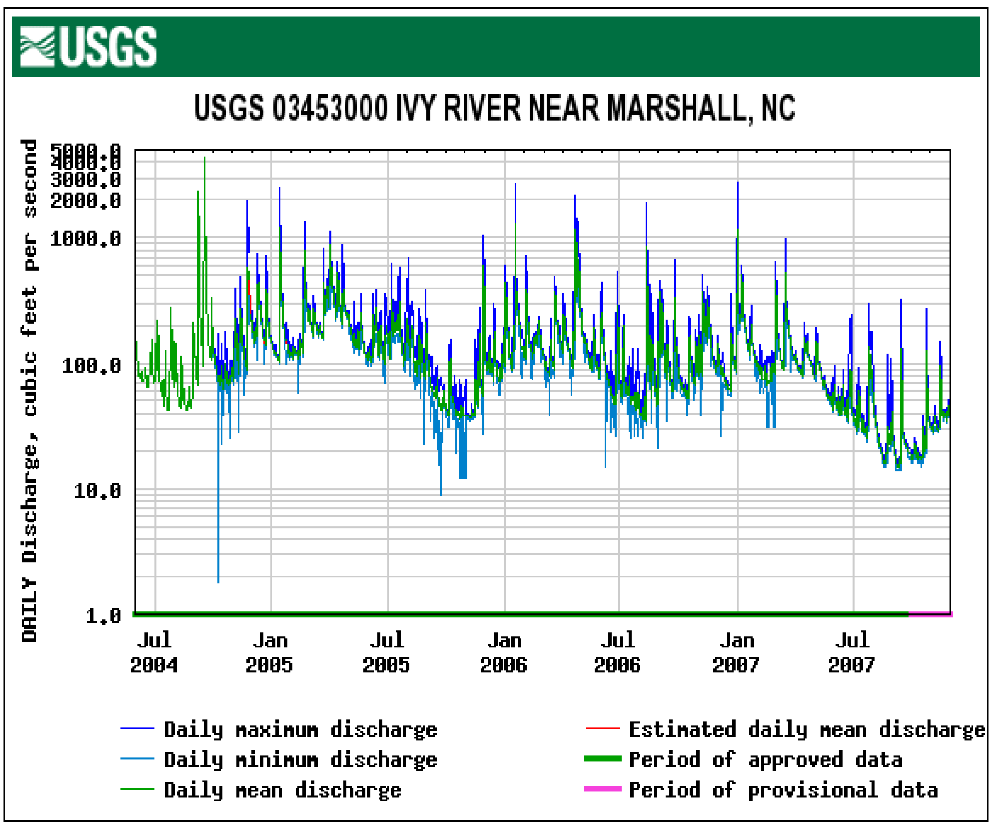
Appendix Table A.4.1. USGS gage 03453000, Ivy River , near Marshall, N.C.			
Date	**Flow (ft^3/s)**	**Gage height (ft)**	**Comments**
7/29-30/2001[a]	1,135	5.44	Bankfull event
3/17-18/2002[a]	1,580	6.40	Bankfull event
2/15/2003	1,120	5.62	Bankfull event
2/22-23/2003[a]	1,535	6.37	Bankfull event
4/10-11/2003[a]	1,435	6.19	Bankfull event
5/6-7/2003[a]	2,195	7.83	Bankfull event
11/19/2003	1,500	5.81	Bankfull event
4/13/2004	1,050	5.29	Bankfull event
9/08/2004	2,330	7.59	Bankfull event
9/17-18/04[a]	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.



Appendix A.4. Continued.





Appendix A.5. Bankfull Event Verification Photos.

Bankfull photo, upstream to Cross-section 9, August 2, 2001.

Bankfull photo, facing downstream from bridge, May 6, 2003.

Appendix A.6. Fixed Station Photo Log.

Photo sta. 1, pre-construction upstream of bridge, November 1999.

Photo sta. 1, facing upstream from bridge, May 2000.

Photo sta. 1, facing upstream from bridge, June 2008.

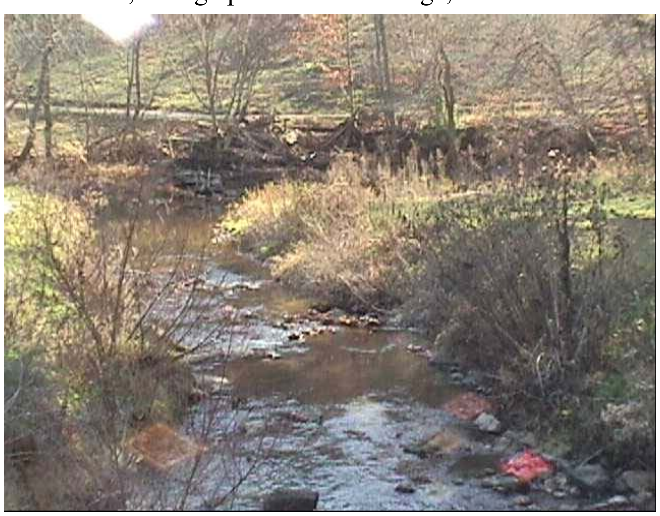


Photo sta. 2, facing downstream from bridge, November 1999.

Photo sta. 2, facing downstream from bridge, June 2008.

Appendix A.6. Continued.

Photo sta. 3, channel bar facing downstream, March 2003.

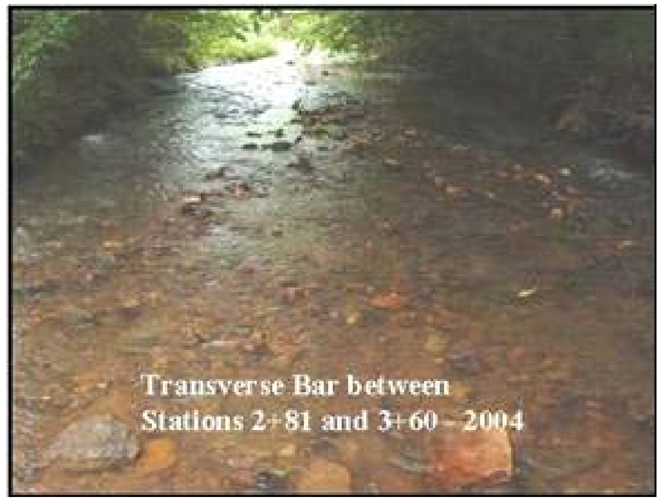


Photo sta. 3, channel bar facing downstream, May 2004.

Photo sta. 3, channel bar facing upstream, December 2007.

Photo sta. 4, hemlock vane facing downstream, May 2000.

Photo sta. 4, hemlock vane facing downstream, March 2003.

Photo sta. 4, hemlock vane facing downstream, June 2008.

Appendix A.6. Continued.

Photo sta. 5, upper tributary facing downstream, November 1999.

Photo sta. 5, upper tributary facing downstream, September. 2000.

Photo sta. 5, upper tributary facing downstream, March 2003.

Photo sta. 5, upper tributary facing downstream, December 2007.

Appendix A.6. Continued.

Photo sta. 6, lower tributary facing upstream, November 1999.

Photo sta. 6, lower tributary facing upstream, September 2000.

Photo sta. 6, lower tributary facing upstream, December 2007.

APPENDIX B

Appendix B.1. Vegetation Plot Photographs.

Tree plot A, left bank, facing upstream, March 2003.

Tree plot A, left bank, facing upstream, March 2004.

Tree plot A, left bank, facing downstream, January 2007.

Appendix B.1. Continued.

Tree plot B, left bank, facing downstream, March 2003.

Tree plot B, left bank, facing upstream, May 2004.

Tree plot B, right bank, facing downstream, January 2007.

Appendix B.1. Continued.

Vegetation plot 1, left bank, March 2003.

Vegetation plot 1, left bank, May 2004.

Vegetation plot 1, left bank, January 2007.

Vegetation plot 2, right bank, March 2003.

Vegetation plot 2, right bank, May 2004.

Vegetation plot 2, right bank, January 2007.

Appendix B.1. Continued.

Vegetation plot 3, left bank, March 2003.

Vegetation plot 3, left bank, May 2004.


Vegetation plot 3, left bank, January 2007.

Vegetation plot 4, left bank, March 2003.

Vegetation plot 4, left bank, May 2004.


Vegetation plot 4, left bank, January 2007.

Appendix B.1. Continued.

Vegetation plot 5, left bank, March 2003.

Vegetation plot 5, left bank, May 2004.

Vegetation plot 5, left bank, January 2007.

Vegetation plot 6, left bank, March 2003.

Vegetation plot 6, left bank, May 2004.

Vegetation plot 6, left bank, January 2007.