ANNUAL REPORT FOR 2004

Big Warrior and Little Warrior Creek Mitigation Site
Wilkes County
WBS Element 34404.4.1
TIP No. R-2239 B

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January 2005

Summary

The following report summarizes the stream monitoring activities that have occurred during the Year 2004 at the Big Warrior and Little Warrior Creek Site in Wilkes County. This site was designed and constructed during 2001 and 2002 by the North Carolina Wildlife Resources Commission (NCWRC) to provide mitigation for stream impacts associated with the construction of Highway 421 in Wilkes County (Transportation Improvement Program [TIP] number R-2239 B). This report provides the monitoring results for the first formal year of monitoring (Year 2004). The Big Warrior and Little Warrior Creek Site will be monitored again in 2005. The actual timeline for formal monitoring will be decided by the Mitigation Review Team.

Based on the overall conclusions of monitoring along Big and Little Warrior Creek, this site has not met the required monitoring protocols for the first formal year of monitoring. Many structures appear to be failing resulting in areas of active bank scour and erosion. These areas have been assessed by the Mitigation Review Team and a plan of action is currently underway to make the necessary repairs.

Based on information obtained from the USGS, the Big and Little Warrior Creek Site has not met the required hydrologic monitoring protocols; however the site has four more years of monitoring to meet this requirement. The mitigation site has met the vegetative success criteria.

NCDOT will continue stream and vegetation monitoring at the site for 2005.

1.0 INTRODUCTION

1.1 Project Description

The following report summarizes the stream monitoring activities that have occurred during the Year 2004 at the Big and Little Warrior Creek Site. The site is situated immediately adjacent to NC 18 in the southwestern portion of Wilkes County (Figure 1). It is approximately 4.0 miles (6.4 kilometers) southwest of Boomer and nearly 13 miles (20.5 kilometers) southwest of Wilkesboro. The Big Warrior and Little Warrior Creek Site was constructed to provide mitigation for stream impacts associated with the construction of Highway 421 in Wilkes County (Transportation Improvement Program [TIP] number R-2239 B).

The mitigation project covers approximately 16,550 linear feet of Big Warrior and Little Warrior Creek and their tributaries. Approximately 3,160 linear feet of Big Warrior Creek and 2,645 linear feet of Little Warrior Creek were surveyed as part of overall monitoring efforts. Several smaller tributaries entering Big Warrior Creek were not surveyed as part of this assessment. Design and construction was implemented during 2001 and 2002 by the North Carolina Wildlife Resources Commission (NCWRC). Priority Level II restorations were completed along both streams and their tributaries at the site. Stream restoration involved the installation of rootwads and rock vanes and sloping the adjacent streambanks to stabilize the channel and to reduce overall erosion. It also included the installation of native vegetation and livestock management practices, including a 40 to 60-foot riparian buffer and several at-grade stream crossings.

1.2 Purpose

According to the as-built report (NCWRC, 2003), the objectives for this mitigation site were to improve water quality, riparian quality and stability, and fisheries habitat associated with Big Warrior and Little Warrior Creeks and their tributaries at the site. The following specific objectives were proposed:

- Establish a conservation easement along Big Warrior, Little Warrior and tributaries to allow for the proper dimension, pattern and profile and to protect vegetation and channel morphology;
- Connect Big and Little Warrior Creeks to their floodplains, in areas where they had become incised, by lowering the banks and increasing channel sinuosity (Priority II restoration);
- Modify dimension and profile along upper Big Warrior Creek to dissipate energy over this steeper reach and realign the channel where it was eroding into steep slopes;
- Planting of native trees, shrubs, and ground cover that will help to stabilize the stream banks, establish shade, and provide wildlife cover and food;
- Enhance fish habitat with structures constructed from natural materials along the primary channels;
- Control existing erosion and sedimentation problems by grading and vegetating problem areas;

- Install a livestock watering system in fields where cattle are fenced out of the stream, so that the livestock will no longer need to drink from the creek.

Successful stream mitigation is demonstrated by a stable channel that does not aggrade or degrade over time. It is also demonstrated by reduced erosion rates, the permanent establishment of native vegetation, and bed features consistent with the design stream type. Vegetation survival is based on federal guidelines denoting success criteria for wetland mitigation. Results of stream monitoring conducted during the 2004 growing season at the Big and Little Warrior Creek Site are included in this report.

Activities in 2004 reflect the first formal year of monitoring following the restoration efforts; however, it is the second year since construction. Included in this report are analyses on stability (primarily the longitudinal profile and cross sections), vegetative monitoring results, and site photographs.

1.3 Project History

November 2001	Construction Completed on Big Warrior Creek
November 2001	Big Warrior Creek Planted with Native Perennial Seed Mix
August 2002	Construction Completed on Little Warrior Creek
August 2002	Little Warrior Creek Planted with Native Perennial Seed Mix
Winter 2002	NCWRC Planted Live Stakes and Bare Rooted Trees along Big Warrior Creek
Winter 2003	NCWRC Planted Live Stakes and Bare Rooted Trees along Little Warrior Creek
July-August 2004	Stream Channel Monitoring (1 yr.)
July-August 2004	Vegetation Monitoring (1 yr.)

2.0 STREAM ASSESSMENT

2.1 Success Criteria

The success criterion, as defined by the Mitigation Site Monitoring Protocol for the NCWRC/NCDOT Mitigation Program (2003), evaluates channel stability and improvements to fish habitat. Specifically, this evaluation includes all or a combination of the following parameters: channel stability, erosion control, seeding, woody vegetation, and overall response of fish and invertebrate populations for stream mitigation projects. This is to be accomplished by comparing time-sequence photography at designated reference sites, sequential measurements of stream dimensions, and profiles at pre-determined sites, analyses of the survival of planted vegetation, including direct sampling of key species. The chart below provides further details of the criteria used to evaluate success or failure at these mitigation sites.

NCWRC/ NCDOT Mitigation Monitoring Criteria

Measurement	Success (requires no action)	Failure	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	≥75% coverage in Photo Plots	<75% coverage in Photo Plots	Areas of less than 75% coverage will be re-seeded and/or fertilized, live stakes and bare-rooted trees will be replanted to achieve >80% survival.
Stake Counts	≥80% survival of stakes, 4/m2	<80% survival of stakes, 4/m2	
Tree Counts	≥80% survival of bare-rooted trees	<80% survival of bare-rooted trees	
Biological Indicators (only used for projects with potential to make watershed level changes)			
Invertebrate Pop. Fish Populations	Population measures remain to same or improve	Population measures indicate a negative trend	Reasons for failure will be evaluted and remedial action plans developed and implemented.
Overall success or failure will be based on success of 3 of the 4 criteria.			

*Significance or subjective determinations of success will be determined by a majority decision of the Mitigation Review Team

Federal guidelines for stream mitigation are relatively consistent with those protocols established by the NCWRC and NCDOT. These guidelines include the following main parameters: no less than two bankfull events for the five-year monitoring period, reference photos, plant survivability analyses, channel stability analyses, and biological data if specifically required by permit conditions (USACE, 2003). This report addresses all of the above mentioned parameters for both the NCWRC/NCDOT protocols and federal guidelines aside from shading and biological data, which was not required at this site.

Natural streams are dynamic systems that are in a constant state of change. Longitudinal profile and cross section surveys will differ from year to year based on rainfall variations and/or physical changes that occur within the watershed, i.e., impervious build-out and landscape modifications such as deforestation. Natural channel stability is achieved by allowing the stream to develop a proper dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades. A stable stream consistently transports its sediment load, both in size and type, associated with local deposition and scour. Channel instability occurs when the scouring process leads to degradation, or excessive sediment deposition results in aggradation (Rosgen, 1996). The following surveys were conducted in support of the monitoring assessment:

- Longitudinal Profile Survey. This survey addressed the overall slope of the reach, as well as slopes between bed features. The bed features are secondary delineative criteria describing channel configuration in terms of riffle/pools, rapids, step/pools,

cascades and convergence/divergence features which are inferred from channel plan form and gradient. The surveys are compared on a yearly basis to note and/or compare aggradation, degradation, head cuts, and areas of mass wasting. The longitudinal profile is expected to change from year to year. Significant changes may require additional monitoring.

- Cross Section Surveys. These surveys addressed the following characteristics at various locations along the reach: entrenchment ratio, width/depth ratio, and dominant channel materials. The entrenchment ratio is a computed index value used to describe the degree of vertical containment. The width/depth ratio is an index value which indicates the shape of the channel cross section. The dominant channel materials refer to a selected size index value, the D_{50}, representing the most prevalent of one of six channel material types or size categories, as determined from a channel material size distribution index.

2.2 Stream Description

2.2.1 Pre-Construction Conditions

Based on the Rosgen Classification of Natural Rivers, Big Warrior Creek has reaches that exhibit characteristics of G, F, B, D, and E stream types. These classifications were subsequently based on the low sinuosity, entrenchment, width/depth ratio, and substrate type. Little Warrior Creek was classified as a G4c stream type according to the Rosgen Classification of Natural Rivers. The conditions of both channels have been strongly influenced by previous channelization and agriculture processes at both the site and throughout the watershed.

Big Warrior Creek was degraded due to livestock and channelization. The livestock had destroyed many of the stream banks as well as limited the amount of lower growing herbaceous vegetation. Deep-water habitat was rare with few pools present. The channelization of the reach had caused it to have low sinuosity and become incised in various locations (NCWRC, 2003).

Little Warrior Creek had also been degraded due to livestock and channelization. The livestock had eliminated the woody vegetation along the lower reach of this stream. Woody vegetation was present along the south bank of the upper reach, however the lower growing herbaceous vegetation was limited by grazing of livestock.

2.2.2 Post-Construction Conditions

The work along Big and Little Warrior Creeks and their tributaries involved the construction of j-hook vanes, rock vanes, rootwad revetments, and additional bank sloping. Coir logs were used to further define and stabilize the streambanks.

2.2.3 Monitoring Conditions

Big Warrior Creek designs followed B-stream type morphologies according to the Rosgen Classification of Natural Rivers. Prior to construction, the channel was incised, entrenched, and had low sinuosity (NCWRC, 2003). Installation of structures, increasing the number of riffle and pool sequences, increasing channel meander, and sloping and vegetating the stream banks aided in stabilizing the channel as well as increasing sinuosity. A total of twenty-one cross sections were surveyed on this stream.

Little Warrior Creek was designed to follow C type stream characteristics. Prior to construction this stream was also incised, entrenched, and had low sinuosity (NCWRC, 2003). Construction also stabilized it and increased sinuosity. A total of ten cross sections were surveyed on Little Warrior Creek and three cross sections were surveyed on its tributaries. A comparison of channel morphology is presented in Table 1.

Table 1. Abbreviated Morphological Summary

Variable		Big Warrior Creek - Combined Cross Sections #1 Thru #21						
		Pre-Const.	As-Built		2005	2006	2007	2008
Drainage Area (mi^2)		1.17-0.7	1.17-0.7	1.17-0.7	1.17-0.7	1.17-0.7	1.17-0.7	1.17-0.7
Bankfull Width (ft)	Mean	18.15	16.3	13.1				
Bankfull Mean Depth (ft)	Mean	1.41	1.32	1.5				
Width/Depth Ratio	Mean	12.9	12.3	8.7				
Bankfull Cross Sectional Area (ft^2)	Mean	25.6	18.2	10.8				
Maximum Bankfull Depth (ft)	Mean	1.9	2.02	1.55				
Width of Floodprone Area (ft)	Mean	34.5	41.8	34.4				
Entrenchment Ratio	Mean	1.9	2.6	2.6				
Slope	Range	0.034-0.012	0.034-0.01	0.034-0.011				
Particle Sizes (Riffle Sections)								
D_{16} (mm)		0.13		0.506				
D_{35} (mm)		0.28		6.05				
D_{50} (mm)		11.3		11.7				
D_{84} (mm)		50		45				
D_{95} (mm)		80		89				

Variable		Little Warrior Creek - Combined Cross Sections #1 Thru #10*						
		Pre-Const.	As-Built	2004	2005	2006	2007	2008
Drainage Area (mi^2)		0.91-0.43	0.91-0.43	0.91-0.43	0.91-0.43	0.91-0.43	0.91-0.43	0.91-0.43
Bankfull Width (ft)	Mean	8.95	11.63	7.41				
Bankfull Mean Depth (ft)	Mean	1.65	0.78	0.92				
Width/Depth Ratio	Mean	5.45	14.9	8.05				
Bankfull Cross Sectional Area (ft^2)	Mean	15.35	8.98	6.84				
Maximum Bankfull Depth (ft)	Mean	2.4	1.67	1.39				
Width of Floodprone Area (ft)	Mean	14.5	33.15	26.33				
Entrenchment Ratio	Mean	1.6	2.85	3.55				
Slope	Range	0.013-0.005	0.016-0.008	0.017-0.007				
Particle Sizes (Riffle Sections)								
D_{16} (mm)		0.07	-	0.139				
D_{35} (mm)		0.17	-	4.42				
D_{50} (mm)		0.26	-	9.3				
D_{84} (mm)		16	-	26				
D_{95} (mm)		-	-	41				

*Cross sections 11, 12, and 13 are located on tributaries to Little Warrior Creek and the data corresponding to those cross sections are not included in the comparison table.

2.2.4 Site Photographs

Photo points were established by NCWRC before restoration efforts began along Big Warrior and Little Warrior Creek in order to visually evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and the effectiveness of erosion control measures. Photographs were taken before construction, immediately after construction, and during the first monitoring year (2004). There are thirteen photo points along Big Warrior Creek and nine photo points along Little Warrior Creek. Locations of the photo points along Big Warrior and Little Warrior Creek are shown in Figures 3 and 5. The photographs are presented in Appendix C.

2.3 Results of the Stream Assessment

2.3.1 Site Data

The assessment included the re-survey of twenty-one cross sections on Big Warrior Creek and thirteen cross sections on Little Warrior Creek and its tributaries. It also included the re-survey of the longitudinal profile of Big Warrior and Little Warrior Creeks established by the NCWRC after construction. The length of the profile along Big Warrior Creek was approximately 3,100 linear feet, approximately 2,400 linear feet along Little Warrior Creek, and approximately 200 linear feet along a UT to Little Warrior Creek. Cross section locations were subsequently based on the stationing of the longitudinal profile and are presented below. The locations of the cross sections and longitudinal profiles are shown in Figures 2 and 4.

Big Warrior Creek

- Cross Section #1. No Longitudinal Profile, glide
- Cross Section #2. No Longitudinal Profile, riffle
- Cross Section #3. Lower Pasture, Station 3+00, riffle
- Cross Section #4. Lower Pasture, Station 2+86, pool
- Cross Section #5. Lower Pasture, Station 1+12, riffle
- Cross Section #6. No Longitudinal Profile, riffle
- Cross Section #7. No Longitudinal Profile, run
- Cross Section #8. Middle Pasture, Station 4+66, riffle
- Cross Section #9. No Longitudinal Profile, riffle
- Cross Section #10. No Longitudinal Profile, pool
- Cross Section #11. Feed Lot, Station 4+19, riffle
- Cross Section #12. Feed Lot, Station 2+50, riffle
- Cross Section #13. Feed Lot, Station 0+81, riffle
- Cross Section #14. No Longitudinal Profile, pool
- Cross Section #15. Upper Pasture, Station 7+58, riffle
- Cross Section #16. Upper Pasture, Station 6+62, riffle
- Cross Section #17. Upper Pasture, Station 4+45, pool
- Cross Section #18. Upper Pasture, Station 4+24, riffle
- Cross Section #19. Upper Pasture, Station 2+07, run
- Cross Section #20. Upper Pasture, Station 0+27, riffle
- Cross Section #21. No Longitudinal Profile, pool

Little Warrior Creek

- Cross Section #1. Lower Pasture, Station 7+65, pool
- Cross Section #2. Lower Pasture, Station 4+38, run
- Cross Section #3. Lower Pasture, Station 2+18, pool
- Cross Section #4. Middle Pasture, Station 8+66, riffle
- Cross Section #5. Middle Pasture, Station 3+65, riffle
- Cross Section #6. Middle Pasture, Station 1+19, run
- Cross Section #7. No Longitudinal Profile, riffle
- Cross Section #8. No Longitudinal Profile, glide
- Cross Section #9. Upper Pasture, Station 7+59, glide
- Cross Section #10. Upper Pasture, Station 4+19, riffle
- Cross Section #11. No Longitudinal Profile, UT to Little Warrior Creek, run
- Cross Section #12. Upper Pasture, UT to Little Warrior Creek, Station 0+59, run
- Cross Section #13. No Longitudinal Profile, UT to Little Warrior Creek, riffle

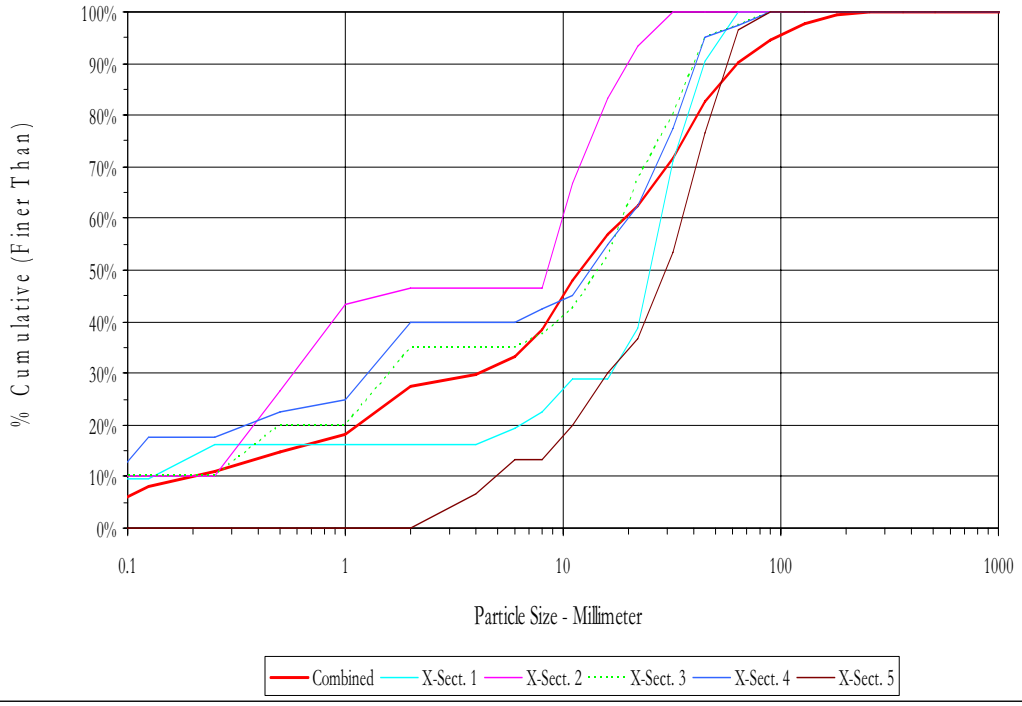
The majority of the cross sections have remained intact based on comparisons with as-built data and visual observations. Several benchmarks associated with the as-built surveys were not found or were deemed not consistent with overall surveys; therefore exact data comparisons were not feasible. These areas included Cross Sections #11 and #20 on Big Warrior Creek and Cross Sections #3, #5, #6, #11 and #12 on Little Warrior Creek. Based on the comparison of Year 2004 cross section survey results with the as-built cross section results, Cross Sections #5, #14, and #16 on Big Warrior Creek and Cross Sections #4 and #13 on Little Warrior Creek appear to be slightly aggrading while Cross Section #13 appears to have slightly shifted to the right. Most of the cross sections appeared stable with little or no active bank erosion. Survey data will also vary depending on actual location of rod placement and alignment; however, this information should remain similar in overall appearance. The cross section comparison is presented in Appendix B.

Pebble counts were taken at each cross section as a means to determine the extent of change in bed material during the monitoring period. Only pebble counts taken at riffle sections were utilized to classify the stream. Existing pre-construction data for Big Warrior Creek noted that the D_{50} (50 percent of the sampled population is equal to or finer than the representative particle diameter) for the riffle sections of this stream were approximately 11.3 mm, which is indicative of a gravel-bed stream. The pre-construction data for Little Warrior Creek and its tributary, noted a D_{50} of 0.26 mm, which is characteristic of a sand-bed stream.

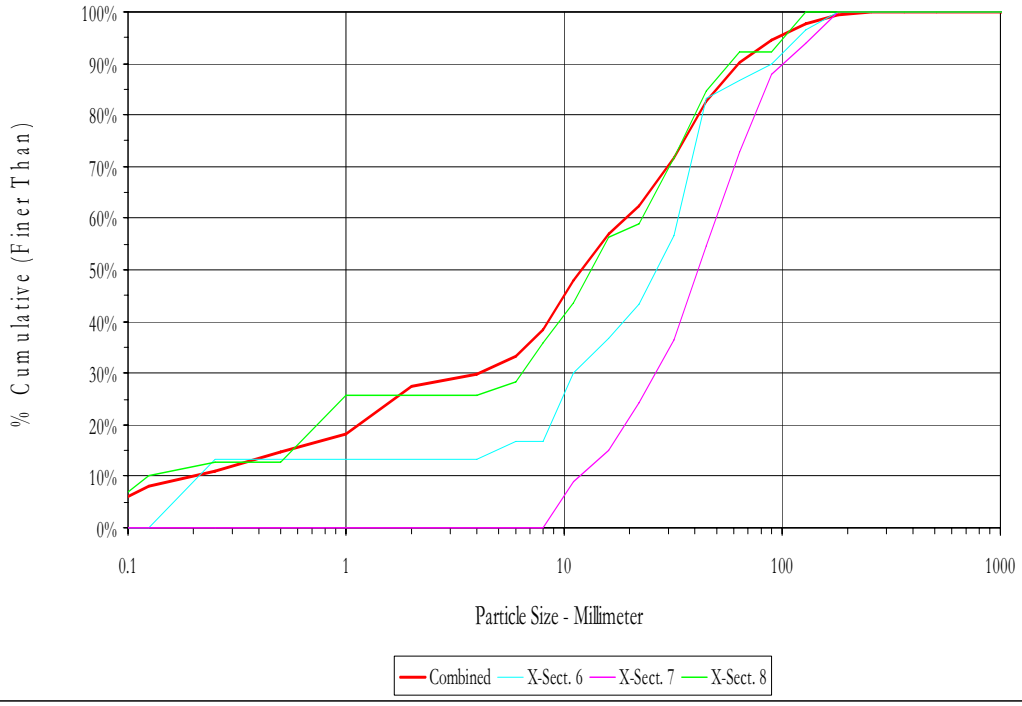
The Year 2004 pebble counts for the riffle sections of Big Warrior Creek indicated a D_{50} of approximately 11.7 mm, which is characteristic of a gravel-bed stream. Compared to the pre-construction data, the bed material of Big Warrior Creek has remained fairly analogous. However, the Year 2004 pebble counts for the riffle sections of Little Warrior Creek and its tributary indicate a D_{50} of 9.3 mm. Compared to the pre-construction data, the bed material of Little Warrior Creek has changed from sand-based to gravel-based. This appears characteristic of bank stabilization efforts along this reach.

Charts depicting the particle size distributions for Big Warrior Creek and Little Warrior Creek and its tributary for the 2004 year are presented below.

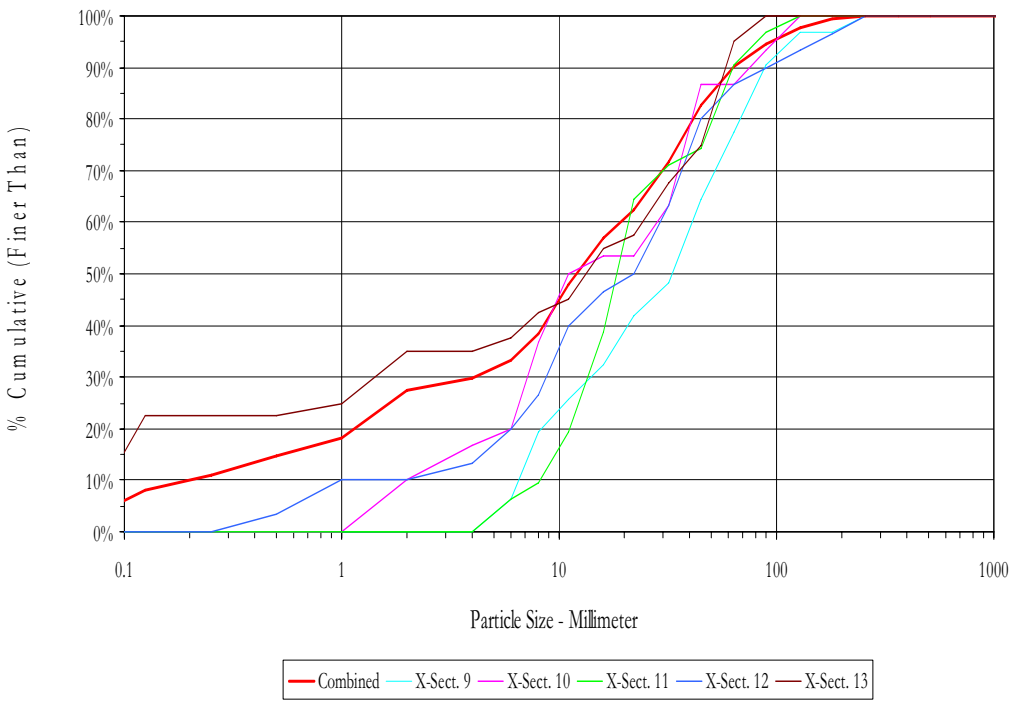
Big Warrior Creek - Lower pasture
Particle Size Distribution 2004



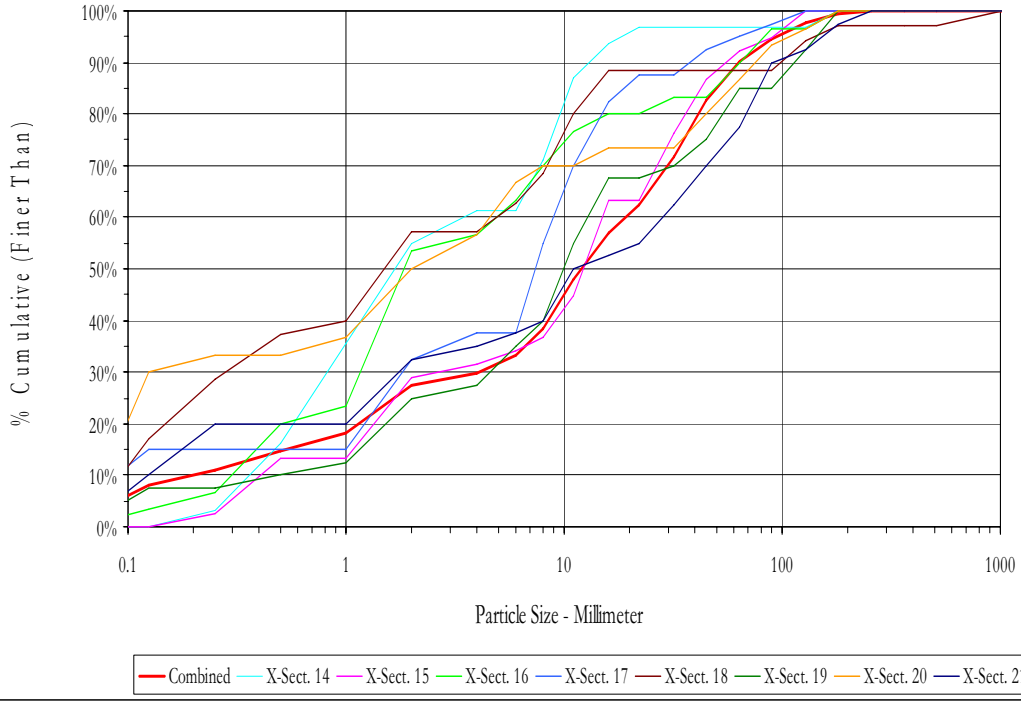
Big Warrior Creek - Middle pasture
Particle Size Distribution 2004



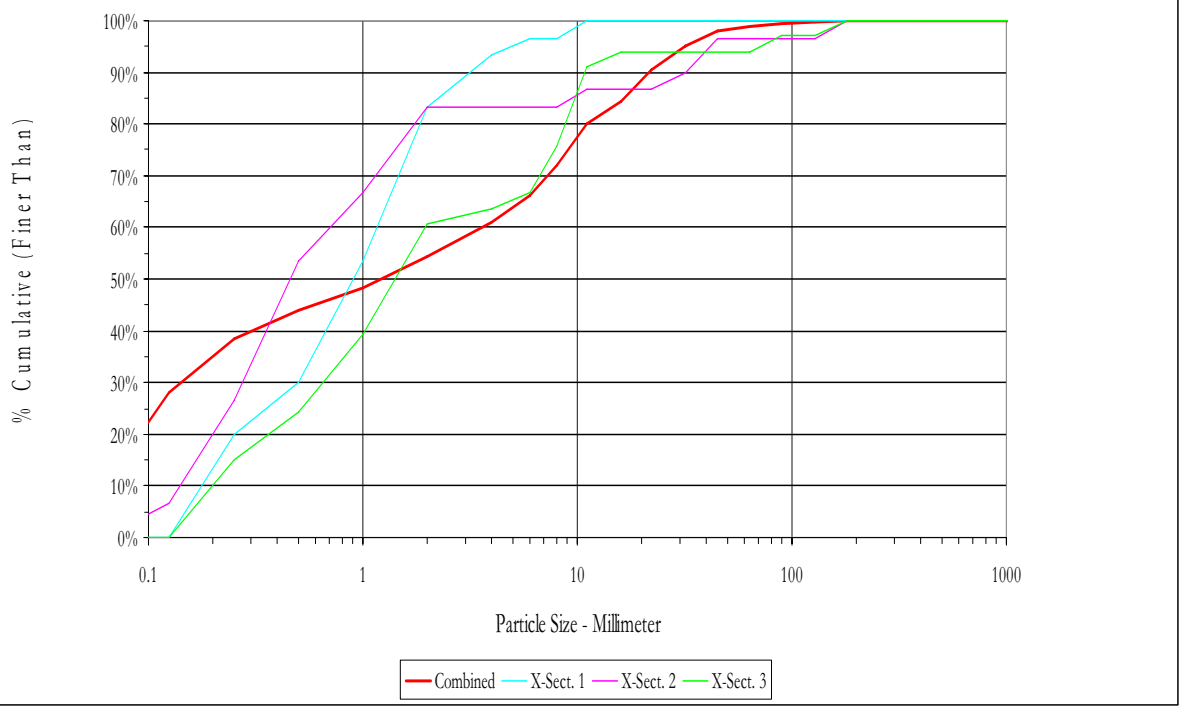
Big Warrior Creek - Feed Lot
Particle Size Distribution 2004



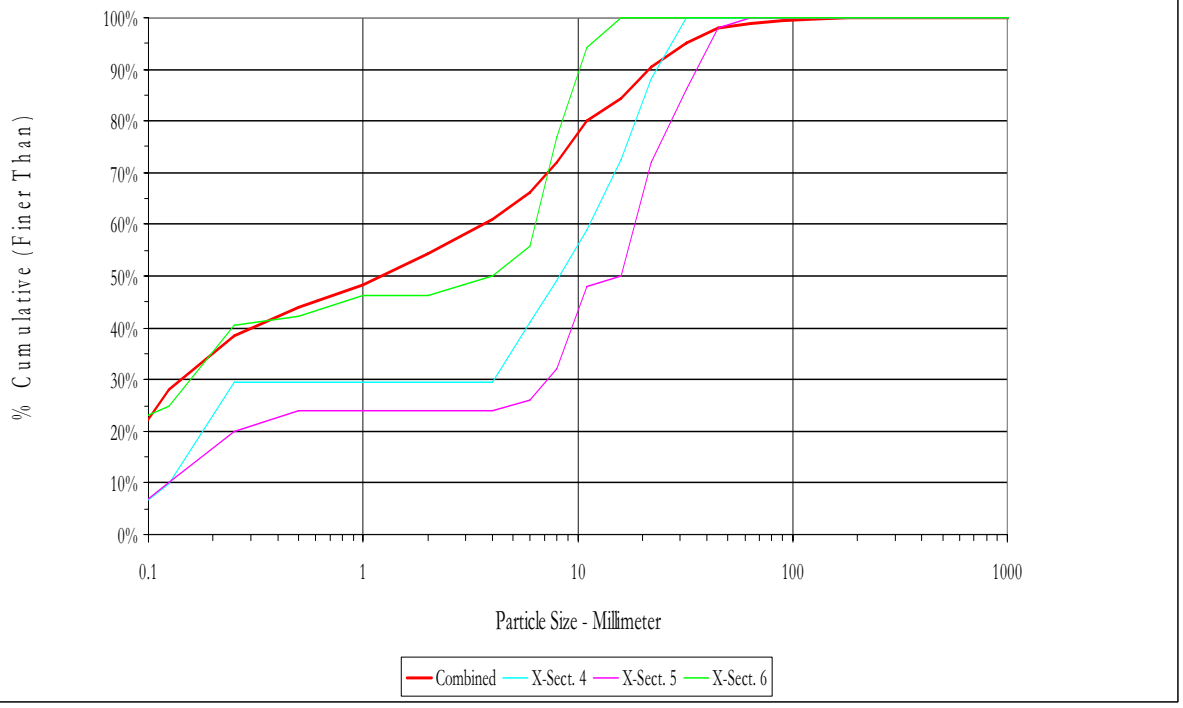
Big Warrior Creek - Upper Pasture
Particle Size Distribution 2004

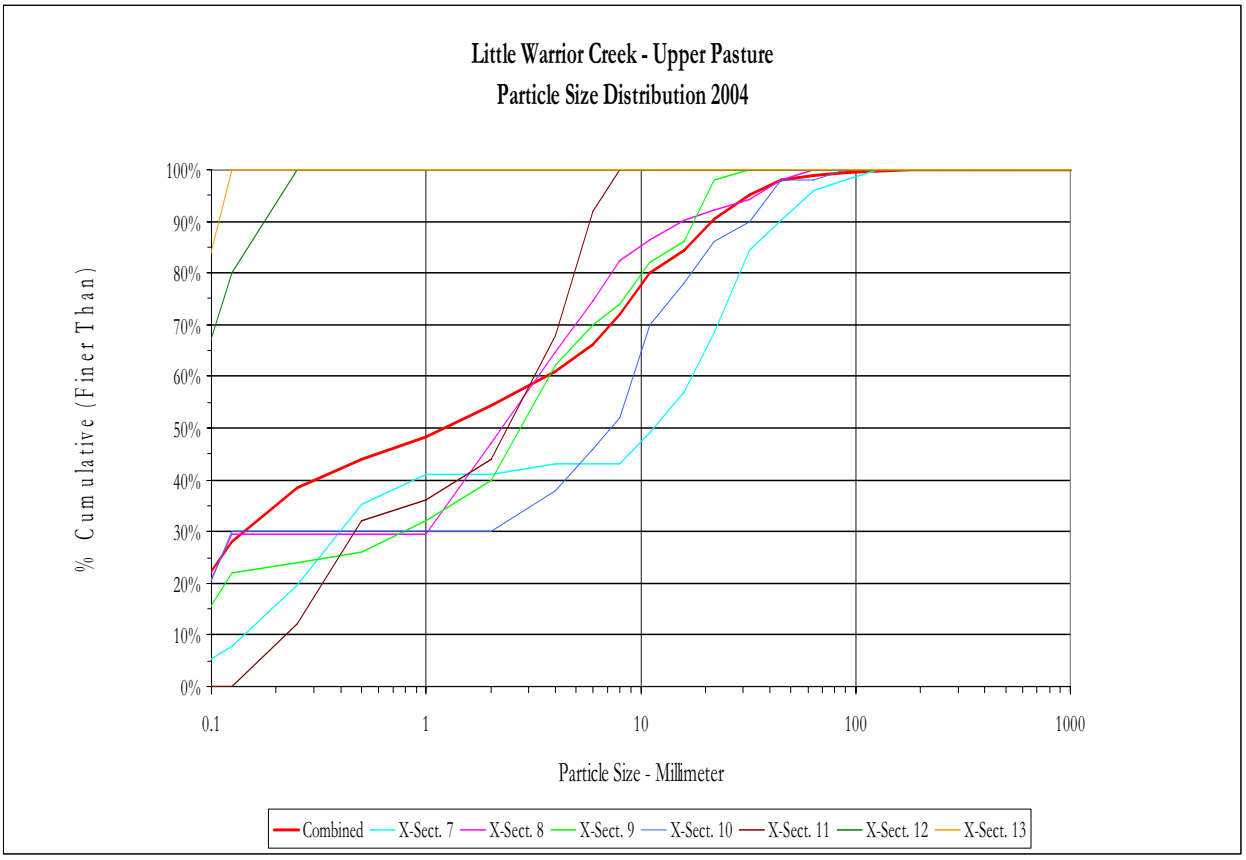


Little Warrior Creek - Lower Pasture
Particle Size Distribution 2004



Little Warrior Creek - Middle Pasture
Particle Size Distribution 2004





A longitudinal profile survey was conducted on the predetermined segments of Big Warrior and Little Warrior Creeks. Bank stability was assessed during the cross section and longitudinal profile surveys. Areas of active scouring and unstable structures were observed in 2004. Descriptions and evaluations of these areas are as follows:

Big Warrior Creek

Upper Pasture Longitudinal Profile

- A large number of the structures within this segment of profile appear unstable. Water was noted either flowing around the structures or underneath the header rocks. In turn, this is causing erosion of the adjacent streambanks in several areas.

Feed Lot Longitudinal Profile

- The majority of the structures appear stable and holding grade through this section; however, there are several that are allowing water to flow underneath the header rocks.

Middle Pasture Longitudinal Profile

- Only a few structures were installed through this section, the majority of which appear to be functioning normally. One rootwad was noted as having significant erosion.

Lower Pasture Longitudinal Profile

- Structures installed in this segment appear to be stable and holding grade. Scour was observed near the end of this segment of profile on the left streambank, facing downstream.

Little Warrior Creek

Lower Pasture Longitudinal Profile

- The structures along this segment of profile are not functioning properly. A structure near the beginning of profile has become unstable. The header rock along with other rocks that make up the structure have become dislodged and are now scattered downstream. A large scour area has formed just downstream of this structure. This scour along the left streambank extends beyond the conservation easement. Other structures in this segment were noted as having water flowing around them or underneath the header rocks.

Middle Pasture Longitudinal Profile

- The structures in this segment of profile are also not functioning properly. The structure immediately downstream of the culvert under Andrew's Road has lost several of its rocks, including the header rock. Other structures in this segment were also noted as having water flowing around them or underneath the header rocks.

Upper Pasture Longitudinal Profile

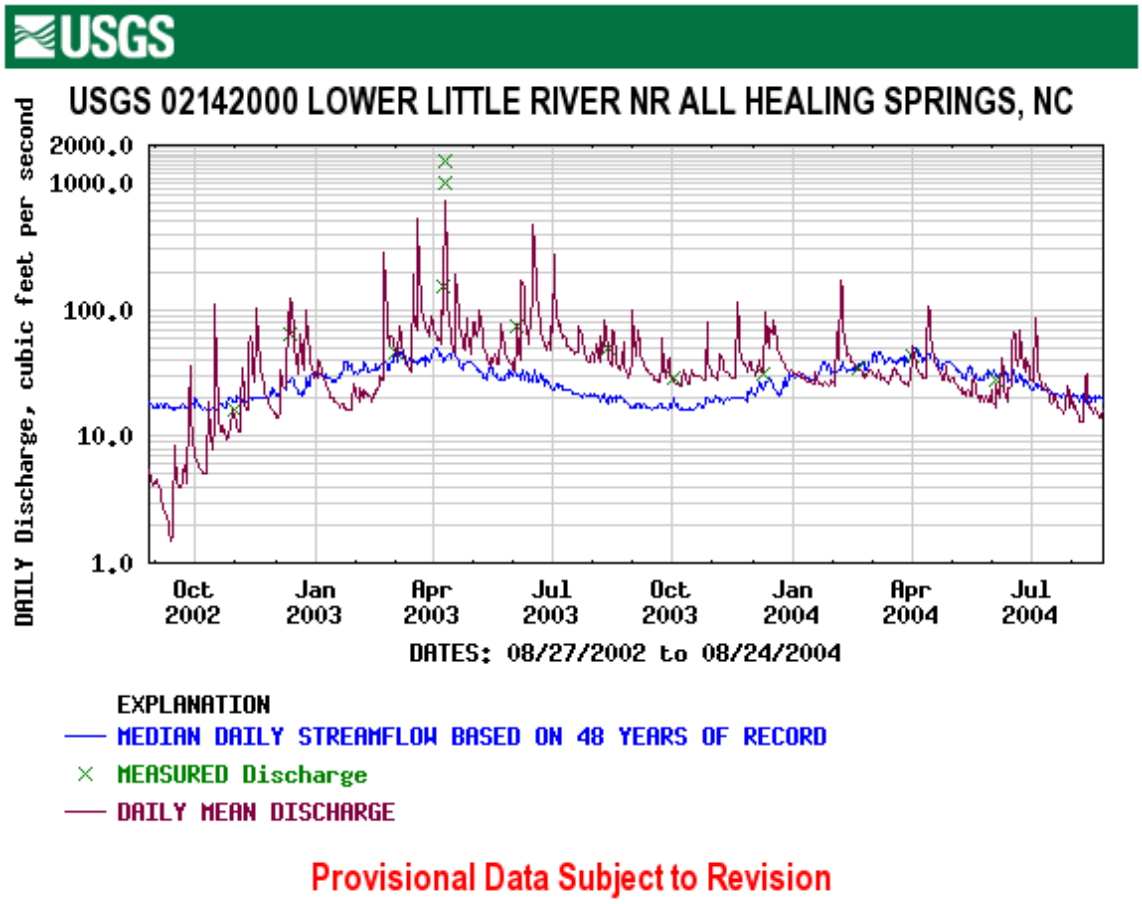
- The structure downstream of Cross Section #8 appears to be stable. However, the structure downstream of Cross Section #12 has water flowing around it instead of over it.

2.3.2 Climatic Data

Monitoring requirements state that at least two bankfull events must be documented through the five-year monitoring period. No surface water gages exist on Big Warrior Creek or Little Warrior Creek. A review of known U.S. Geological Survey (USGS) surface water gages identified one gage approximately 7 miles south of the mitigation site. This gage site is located along the Lower Little River immediately downstream of Big Warrior Creek and has an approximately 28 square-mile drainage area.

The Lower Little River surface water gage is situated in USGS Hydrologic Unit 03050101. Datum of the gage is 1,070.00 feet above sea level NGVD29. Based on the drainage area associated with the gage, the correlated bankfull discharge according to the NC Rural Mountain Regional Curves (USACE, 2003) is between approximately 800 and 2,000 cubic feet per second (cfs). A review of peak flows was conducted for the period between

October 2002 and July 2004. According to the graph, there was one bankfull event that occurred during this period. The USGS graph depicting these peak flows is presented below.



2.4 Conclusions

Big Warrior Creek remains stable; however, there are isolated areas of degradation and instability. A number of the structures are not functioning properly throughout the Upper Pasture and Feed Lot Sections. These areas should be assessed during the next monitoring period to determine if remedial actions are necessary.

Sections of Little Warrior Creek have become unstable. Most of the structures do not appear to be functioning properly. These structures should be closely monitored over the next monitoring period in the case that overall stream stability is compromised. Corrective actions will be determined by the Mitigation Review Team.

Most of the cross sections along Big Warrior and Little Warrior Creek remain stable; however, a few of the cross sections along these two reaches have aggraded.

Based on information obtained from the USGS, the Big Warrior and Little Warrior Creek Site has not yet met the required monitoring protocols for hydrology. However, the hydrology requirement of two bankfull events has to be met within the five year monitoring period, not each year of monitoring.

3.0 VEGETATION

3.1 Success Criteria

The Big Warrior and Little Warrior Creek Site will be monitored for vegetation survival for the first five years after construction. A 320 stems per acre survival criterion for planted seedlings will be used to determine success for the first three years. The required survival criterion decreases by 10 percent per year after the third year of vegetation monitoring (i.e., for an expected 290 stems per acre for year 4, and 260 stems per acre for year 5). The number of plants of one species will not exceed 20 percent of the total number of plants of all species planted.

3.2 Description of Species

According to the As-Built Report (2003) and field observations at the Big Warrior and Little Warrior Creek Mitigation Site, Wilkes County, the following species were planted along the streambanks:

Live Stakes

Black willow (*Salix nigra*)
Sycamore (*Platanus occidentalis*)
Silky dogwood (*Cornus amomum*)

Bare Rooted Trees

Black willow (*Salix nigra*)
Tag alder (*Alnus serrulata*)
Green ash (*Fraxinus pennsylvanica*)
River birch (*Betula nigra*)

Permanent Seeding Mix

Sunburst Switchgrass (*Panicum virgatum*)
Partridge Pea (*Chamaecrista fasciculate*)
Slender smartweed (*Polygonum lapathifolium*)
Lance-leaved coreopsis (*Coreopsis lanceolata*)
Smartweed (*Polygonum pennsylvanicum*)
Smooth panicgrass (*Panicum dichotomiflorum*)
Virginia wild rye (*Elymus virginicus*)
Osage indiangrass (*Sorghastrum nutans*)
Ashy sunflower (*Helianthus mollis*)
Button bush (*Cephalanthus occidentalis*)
River oats (*Uniola latifolia*)
Biannual evening primrose (*Oenothera biennis*)
Bur-marigold (*Bidens aristosa*)
Little bluestem (*Andropogon scoparius*)
Big bluestem (*Andropogon gerardii*)
Southern arrowwood (*Viburnum dentatum*)

3.3 Plot Descriptions

Twelve vegetation (tree) plots, measuring approximately 1,000 square-feet each, were randomly established throughout the mitigation site. Six vegetation plots were installed along the streambanks and floodplain of Big Warrior Creek and six vegetation plots were

installed along the streambanks and floodplain of Little Warrior Creek. Most of the vegetation plots on Big Warrior Creek occur on the right side of stream, while most of the vegetation plots on Little Warrior Creek occur on the left side of the stream. Due to the limited area of the conservation easement a few of the plots include vegetation on both the left and the right streambanks. Each vegetation plot was marked with four stakes on each of the corners. These stakes were flagged and labeled for future identification. Vegetation (trees) within the 1,000 square-foot plots were flagged, tagged, and numbered. Due to the narrow riparian area and ease of access, the locations of these plots were not surveyed. Maps illustrating the approximate locations of the vegetation plots are located in Figures 2 and 4. Section 3.4 provides numerical counts for species found within vegetation Plots.

3.4 Results of Vegetation Monitoring

Vegetation Monitoring Statistics, by Plot on Big Warrior Creek																	
Plot No. (Type)	**Black Willow**	**Tulip Poplar**	**Silky Dogwood**	**Black Cherry**	**Tag Alder**	**River Birch**	**Red Oak**	**Silky Willow**	**Green Ash**	**Sycamore**	**Total 2004 (Year 1)**	**Total 2005 (Year 2)**	**Total 2006 (Year 3)**	**Total 2007 (Year 4)**	**Total 2008 (Year 5)**		**Density (Trees/Acre)**
Plot 1 (100'x10')		1	3			1		1	4		10						436
Plot 2 (50'x20')			8	2							10						436
Plot 3 (50'x20')	1		14		1						16						697
Plot 4 (50'x20')			9				1		6		16						697
Plot 5 (100'x10')						1	1	1	3	2	8						348
Plot 6 (50'x20')			2	1					1	1	5						218
											AVERAGE DENSITY (2004)						**472**

Vegetation Monitoring Statistics, by Plot on Little Warrior Creek																	
Plot No. (Type)	**Black Willow**	**Tulip Poplar**	**Silky Dogwood**	**Black Cherry**	**Tag Alder**	**River Birch**	**Red Oak**	**Silky Willow**	**Green Ash**	**Sycamore**	**Total 2004 (Year 1)**	**Total 2005 (Year 2)**	**Total 2006 (Year 3)**	**Total 2007 (Year 4)**	**Total 2008 (Year 5)**		**Density (Trees/Acre)**
Plot 1 (100'x10')			1		1						2						87
Plot 2 (50'x20')			28		5	2			1	1	37						1,612
Plot 3 (100'x10'			10		1					2	13						566
Plot 4 (100'x10')		1	1	1	6				5	8	22						958
Plot 5 (100'x10')		1	6		8					5	20						871
Plot 6 (100'x10')			31		1	1			3		36						1,568
											AVERAGE DENSITY (2004)						**944**

Site Notes:

The twelve vegetation plots were established during the first year of monitoring. In general these plots contain the following herbaceous species: jewelweed (*Impatiens capensis*),

blackberry (*Rubus* sp.), vetch (*Vicia* sp.), goldenrod (*Solidago* sp.), tearthumb (*Polygonum sagittatum*), smartweed (*Polygonum* sp.), creeping grass (*Microstegium vimineum*), cardinal flower (*Lobelia cardinalis*), sunflower (*Helianthus* sp.), and clover (*Trifolium* sp.). Following are a list of the specific trees occurring in each plot and the location of each plot.

3.5 Conclusions

The 2004 vegetation monitoring of the site, including the vegetation plots along both Big Warrior and Little Warrior Creeks, represents an average density of 708 trees per acre, which is above the minimum required by the success criteria of 320 trees per acre. According to the monitoring results, the average density of the vegetation (trees) along Big Warrior Creek is 472 trees per acre, while Little Warrior Creek averages approximately 944 trees per acre.

4.0 OVERALL CONCLUSIONS

Based on the overall conclusions of monitoring along Big Warrior and Little Warrior Creeks, Little Warrior Creek has not met the required monitoring protocols for the first formal year of monitoring. Big Warrior Creek has only isolated areas of erosion and scour and has remained stable. However, many structures along Little Warrior Creek appear to be compromised resulting in localized areas of active bank scour and erosion. These areas have been assessed by the Mitigation Review Team and a plan of action is currently underway to make the necessary repairs.

Based on information obtained from the USGS, the Big Warrior and Little Warrior Creek Site has experienced only one documented bankfull event. The site has four additional years of monitoring to meet the requirement of two bankfull events. The mitigation site has met the vegetative success criteria. No biological sampling was conducted as part of this monitoring project.

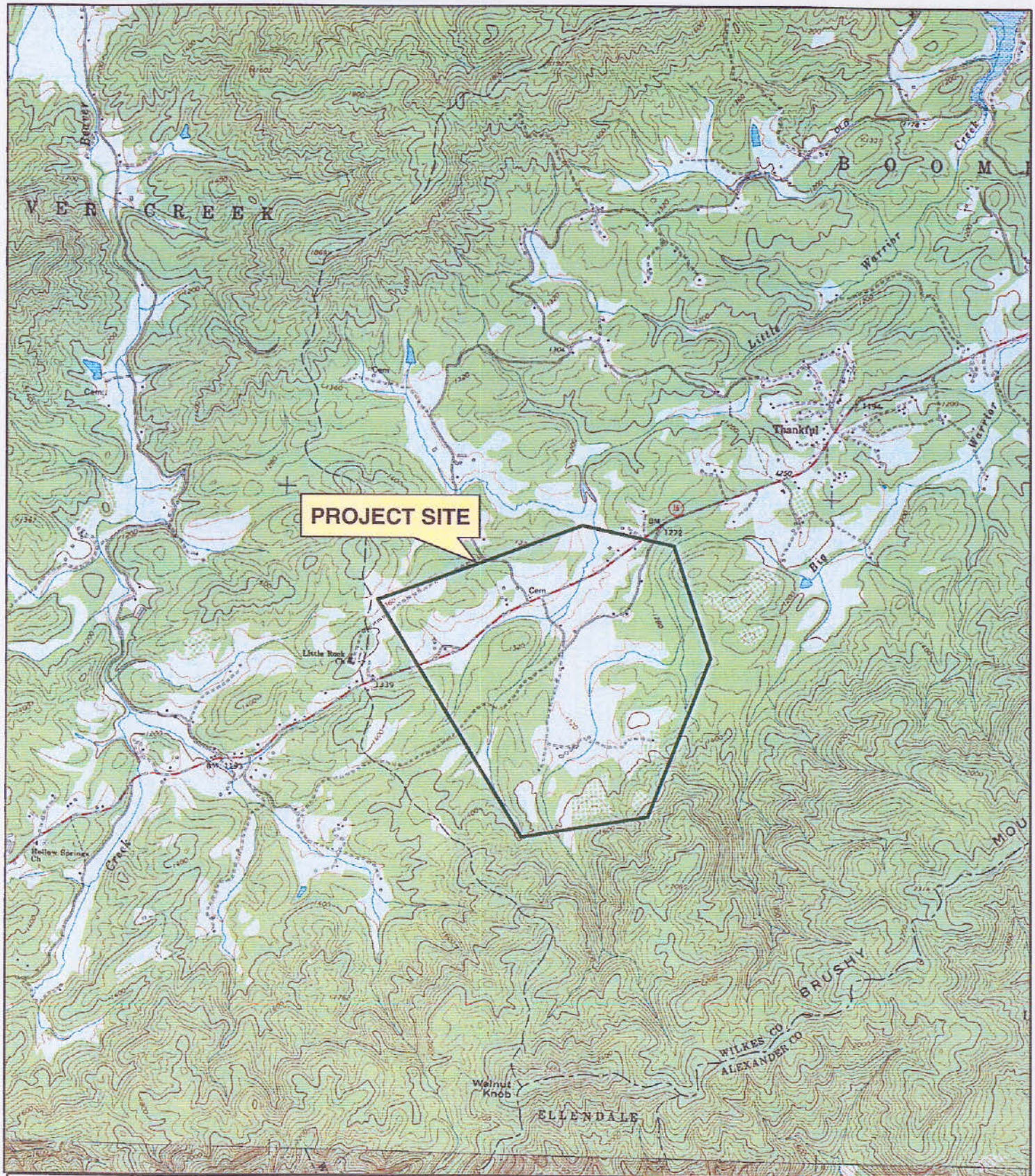
5.0 REFERENCES

North Carolina Wildlife Resources Commission (NCWRC), 2003. As-built Report for the Big Warrior and Little Warrior Creek Site, Wilkes County.

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

US Army Corps of Engineers (USACE), 2003. Stream Mitigation Guidelines. Prepared with cooperation from the US Environmental Protection Agency, NC Wildlife Resources Commission, and the NC Division of Water Quality.

US Geological Survey (USGS), 2004. Real-time Data for USGS 02142000 Lower Little River near All Healing Springs, NC. http://waterdata.usgs.gov/nc/nwis.



MULKEY
ENGINEERS & CONSULTANTS

PROJECT VICINITY
Big Warrior & Little Warrior Creek
Mitigation Site
Wilkes County, North Carolina

Figure No.
1

Prepared For:

1:36,000

0 1,125 2,250 4,500 6,750 9,000 Feet

USGS 7.5- Minute Topographic Quadrangles: Boomer & Ellendale
Contour Interval 40 Feet

Cross-section Information

Approximate location of each as-built cross-section on Big Warrior Creek. Pink areas show where longitudinal profiles were taken. Survey points used as benchmarks are shown with there identification and the elevation used.

	N 39° 15' 21" W	82.37'
	N 48°01'46" W	81.90'
	N 48°25'28" W	140.54'
	S 89°11'20" W	61.27'
	S 45°48'28" W	314.88'

L84	N 14°41'23" E	193.94'
L85	N 08°47'05" E	115.47'
L86	N 21°29'43" W	253.91'
L87	N 16°08'47" W	124.78'
L88	N 82°48'58" E	46.11'

THIS SURVEY IS OF ANOTHER CATEGORY, SUCH AS THE RECOMBINATION OF EXISTING PARCELS, A COURT-ORDERED SURVEY, OR OTHER EXCEPTION TO THE DEFINITION OF SUBDIVISION.

PROFESSIONAL LAND SURVEYOR

Upper Long Profile

Feed Lot Long. Profile

Middle Pasture Long. Profile

Lower Pasture Long. Profile

Vegetation Plot #1

Vegetation Plot #2

Vegetation Plot #3

Vegetation Plot #4

Vegetation Plot #5

Vegetation Plot #6

XS 1 XS 2 XS 3 XS 4 XS 5 XS 6 XS 7 XS 8 XS 9 XS 10 XS 11 XS 12 XS 13 XS 14 XS 15 XS 16 XS 17 XS 18 XS 19 XS 20 XS 21

POINT-1A62 ELEV=128.21

POINT-1A63 ELEV=136.31

POINT-1A64 ELEV=141.62

POINT-1A65 ELEV=146.74

POINT-1A66 ELEV=158.56

POINT-1A67 ELEV=161.37

POINT-1A68 ELEV=167.67

POINT-1A59 ELEV=115.95

POINT-1A61 ELEV=121.84

POINT-1A49 ELEV=104.2

POINT-1A44 ELEV=91.7

POINT-1A43 ELEV=82.4

POINT-1A1 ELEV=88.09

POINT-1B40 ELEV=

POINT-1B39 ELEV=54.27

POINT-1B36 ELEV=

POINT-1B35 ELEV=47.83

POINT-1B34 ELEV= 40.91

POINT-1B32 ELEV= 39.21

POINT-1B26 ELEV=

POINT-1B24 ELEV= 30.96

PARCEL IA
W. CARLYLE WESTON
DB 565 PG 618

PARCEL IB
ARLEE ANDREWS
DB 565 PG 614

W. CARLYLE WESTON
DB 565 PG 613

TRAIL LINE

PIPE

S82°48'58"W 752.09 (CP TO EP)

S38°01'25"W 9.78'

3.80 ACRES BY COORDINATE COMPUTATION

BEING A PORTION OF ARLEE ANDREWS PROPERTY, DEED BOOK 565 PAGE 614 PLAT BOOK 7 PAGE 164

LEGEND

- IRON PIN FOUND
- IRON SET
- COMPUTED POINT
- REBAR AND CAP SET
- PROPERTY LINE
- R/W LINE
- EASEMENT LINE
- TRACT LINE

SCALE 1" = 200'

I RONALD G. MILLER certify that this plat was drawn under my supervision from an actual survey made under my supervision being a portion of deed and description recorded in deed book 565, page 618, and plat book 7 page 164 that the ratio of precision as calculated is 1: 10000+, that the boundaries not surveyed are shown as broken lines plotted from information found in books referenced, that this plat was prepared in accordance with G.S 47-30 as amended. Witness my original signature, registration number and seal this 31st day of JANUARY, A.D., 20 01.

SURVEYOR

REGISTRATION NUMBER

Prepared For:

Map Not to Scale

Source: North Carolina Wildlife Resource Commision
As-Built Report for the AH&W Mitigation Site

Big Warrior Creek

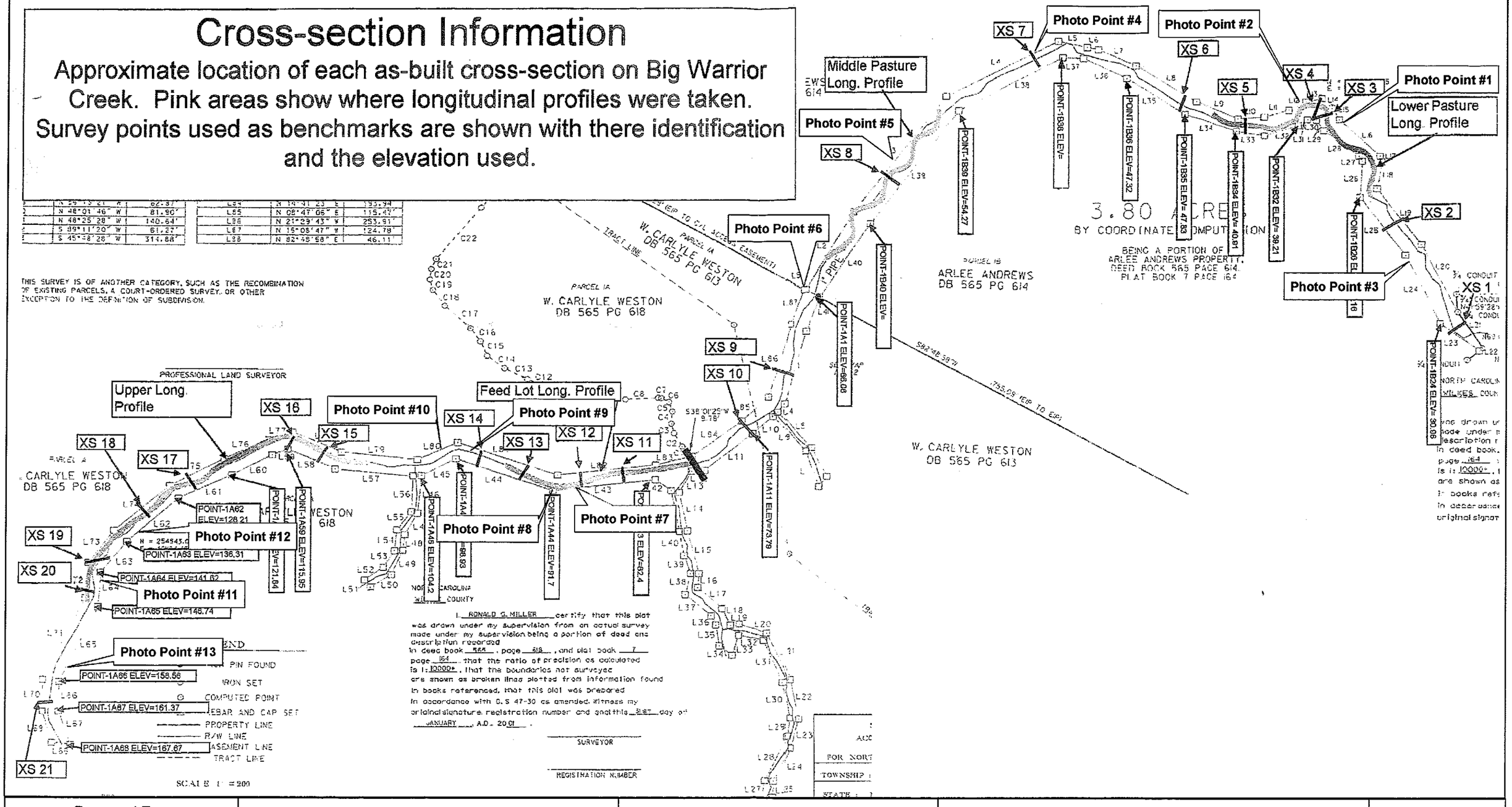
Cross Section and Vegetation Plot Locations

Wilkes County, North Carolina

Figure No. 2

Cross-section Information

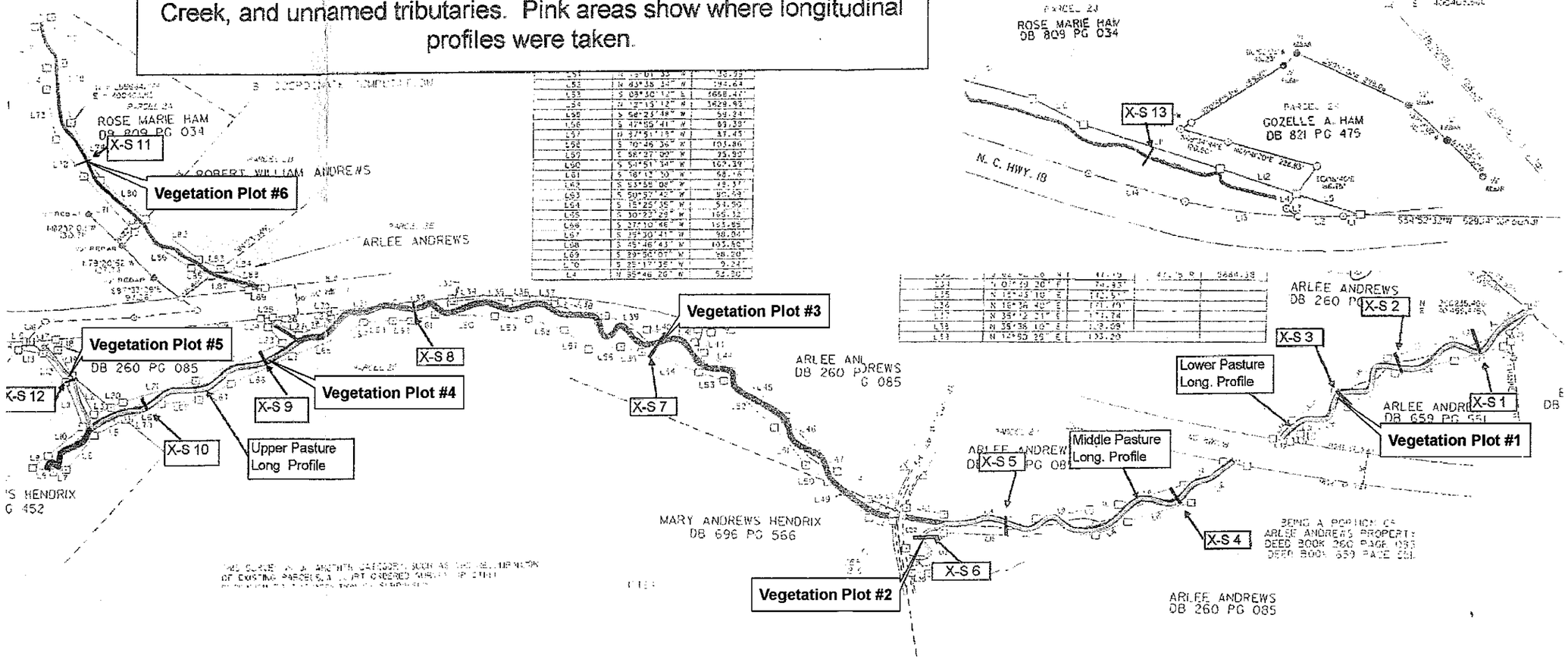
Approximate location of each as-built cross-section on Big Warrior Creek. Pink areas show where longitudinal profiles were taken. Survey points used as benchmarks are shown with there identification and the elevation used.



Prepared For:		Map Not to Scale	**Big Warrior Creek**	**Figure No.**
		Source: North Carolina Wildlife Resource Commision As-Built Report for the AH&W Mitigation Site	**Photo Point Locations** Wilkes County, North Carolina	3

Cross-section Information

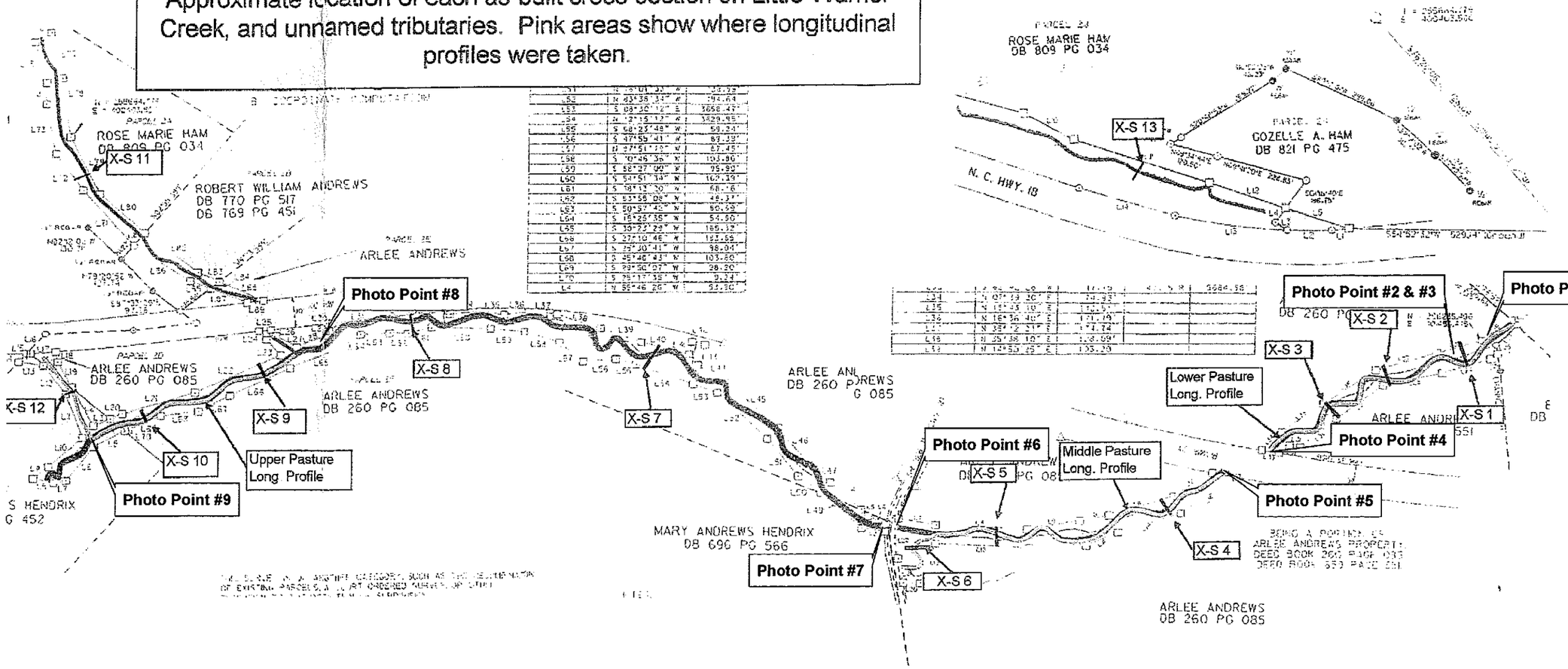
Approximate location of each as-built cross-section on Little Warrior Creek, and unnamed tributaries. Pink areas show where longitudinal profiles were taken.



Prepared For:		N	Map Not to Scale Source: North Carolina Wildlife Resource Commision As-Built Report for the AH&W Mitigation Site	**Little Warrior Creek** **Cross Section and Vegetation Plot Locations** **Wilkes County, North Carolina**	**Figure No.** **4**

Cross-section Information

Approximate location of each as-built cross-section on Little Warrior Creek, and unnamed tributaries. Pink areas show where longitudinal profiles were taken.



Prepared For:			Map Not to Scale	**Little Warrior Creek**	Figure No.
			Source: North Carolina Wildlife Resource Commision As-Built Report for the AH&W Mitigation Site	**Photo Point Locations**	5
				Wilkes County, North Carolina	

APPENDIX A
AS-BUILT DATA

Cross-section Information

Approximate location of each as-built cross-section on Big Warrior Creek. Pink areas show where longitudinal profiles were taken. Survey points used as benchmarks are shown with there identification and the elevation used.

	N 29°13'21" W	92.37'	L84	N 14°41'23" E	193.94'
	N 48°01'46" W	81.90'	L85	N 08°47'06" E	115.47'
	N 48°25'28" W	140.64'	L86	N 21°29'43" W	253.91'
	S 89°11'20" W	61.27'	L87	N 15°08'47" W	124.78'
	S 45°48'28" W	314.88'	L88	N 82°48'58" E	46.11'

THIS SURVEY IS OF ANOTHER CATEGORY, SUCH AS THE RECOMBINATION OF EXISTING PARCELS, A COURT-ORDERED SURVEY, OR OTHER EXCEPTION TO THE DEFINITION OF SUBDIVISION.

PROFESSIONAL LAND SURVEYOR

Upper Long. Profile

Middle Pasture Long. Profile

Lower Pasture Long. Profile

Feed Lot Long. Profile

XS 1 XS 2 XS 3 XS 4 XS 5 XS 6 XS 7 XS 8 XS 9 XS 10 XS 11 XS 12 XS 13 XS 14 XS 15 XS 16 XS 17 XS 18 XS 19 XS 20 XS 21

POINT-1A62 ELEV=128.21
POINT-1A61 ELEV=121.84
POINT-1A59 ELEV=115.95
POINT-1A63 ELEV=136.31
POINT-1A64 ELEV=141.62
POINT-1A65 ELEV=146.74
POINT-1A66 ELEV=158.56
POINT-1A67 ELEV=161.37
POINT-1A68 ELEV=167.67
POINT-1A46 ELEV=104.2
POINT-1A45 ELEV=98.93
POINT-1A44 ELEV=91.7
POINT-1A43 ELEV=82.4
POINT-1A11 ELEV=73.79
POINT-1A1 ELEV=66.08
POINT-1B40 ELEV=
POINT-1B39 ELEV=54.27
POINT-1B38 ELEV=
POINT-1B36 ELEV=47.32
POINT-1B35 ELEV= 47.83
POINT-1B34 ELEV= 40.91
POINT-1B32 ELEV= 39.21
POINT-1B26 ELEV= 36.16
POINT-1B24 ELEV= 30.96

PARCEL 1A
W. CARLYLE WESTON
DB 565 PG 618

PARCEL 1A
W. CARLYLE WESTON
DB 565 PG 613

PARCEL 1B
ARLEE ANDREWS
DB 565 PG 614

3.80 ACRES
BY COORDINATE COMPUTATION
BEING A PORTION OF ARLEE ANDREWS PROPERTY DEED BOOK 565 PAGE 614, PLAT BOOK 7 PAGE 164

W. CARLYLE WESTON
DB 565 PG 613

S82°48'58"W 1755.09' (EIP TO EIP)

25' (EIP TO C/L ACCESS EASEMENT)

TRACT LINE

N = 254543.044

LEGEND

- IRON PIN FOUND
- IRON SET
- COMPUTED POINT
- REBAR AND CAP SET
- PROPERTY LINE
- R/W LINE
- EASEMENT LINE
- TRACT LINE

SCALE 1" = 200'

200 0 200 400

NORTH CAROLINA
WILKES COUNTY

I, RONALD G. MILLER certify that this plat was drawn under my supervision from an actual survey made under my supervision, being a portion of deed and description recorded in deed book 565, page 618, and plat book 7, page 164, that the ratio of precision as calculated is 1: 10000+, that the boundaries not surveyed are shown as broken lines plotted from information found in books referenced, that this plat was prepared in accordance with G. S. 47-30 as amended. Witness my original signature, registration number and seal this 31ST day of JANUARY, A.D., 20 01.

SURVEYOR

REGISTRATION NUMBER

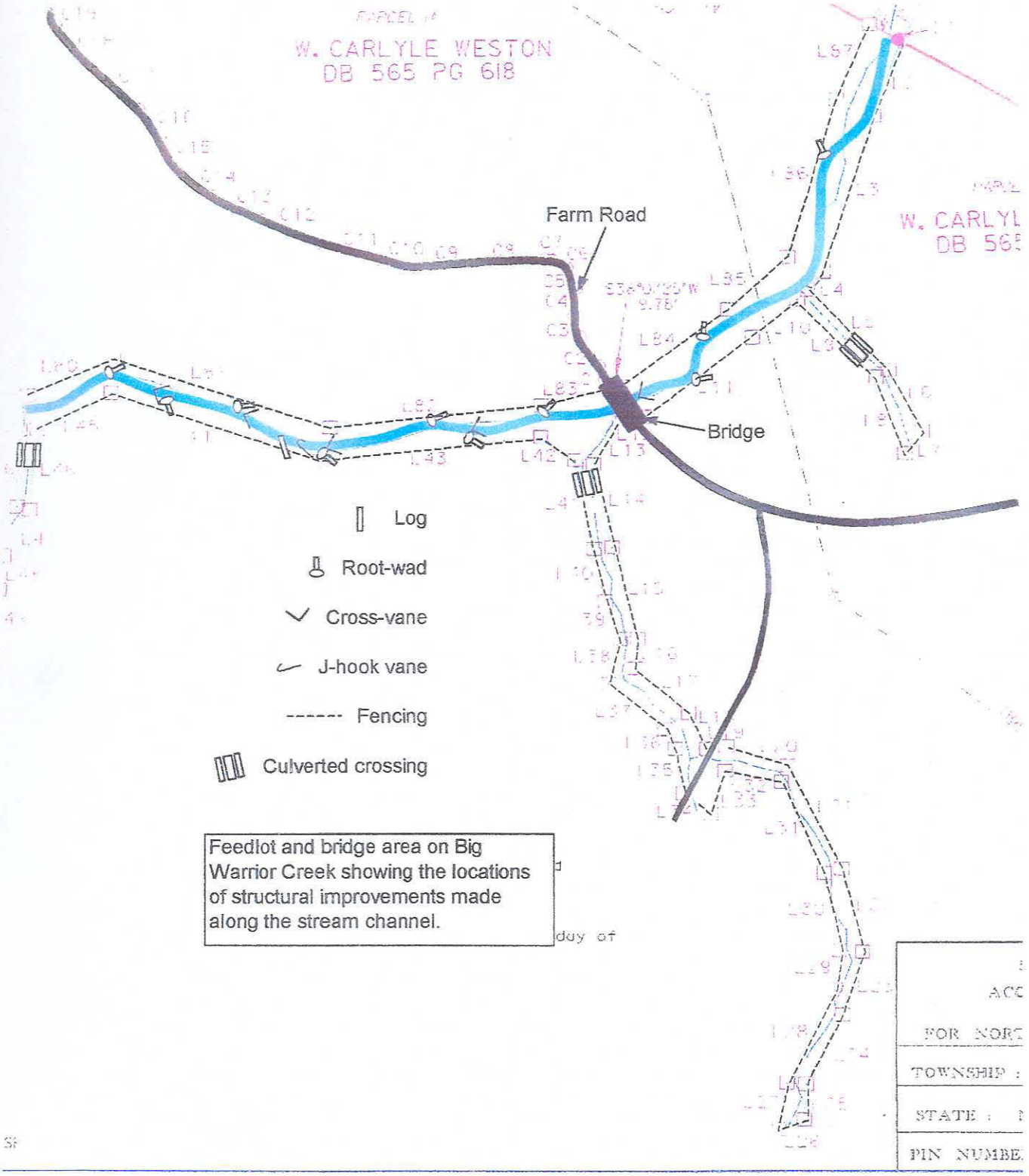
SEAL OR STAMP

FOR NORT

TOWNSHIP :

STATE :

PIN NUMBE



Feedlot and bridge area on Big Warrior Creek showing the locations of structural improvements made along the stream channel.

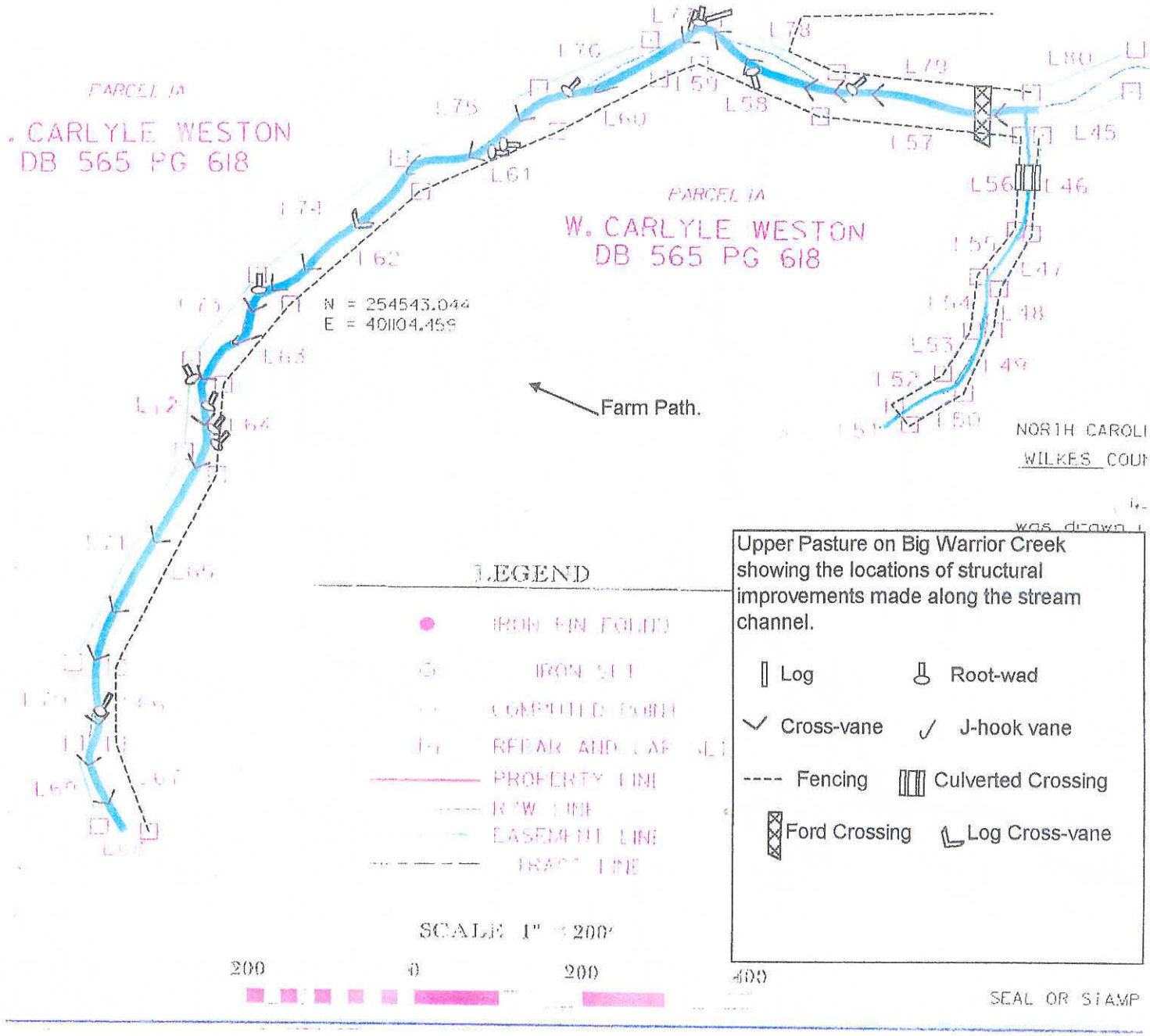
day of

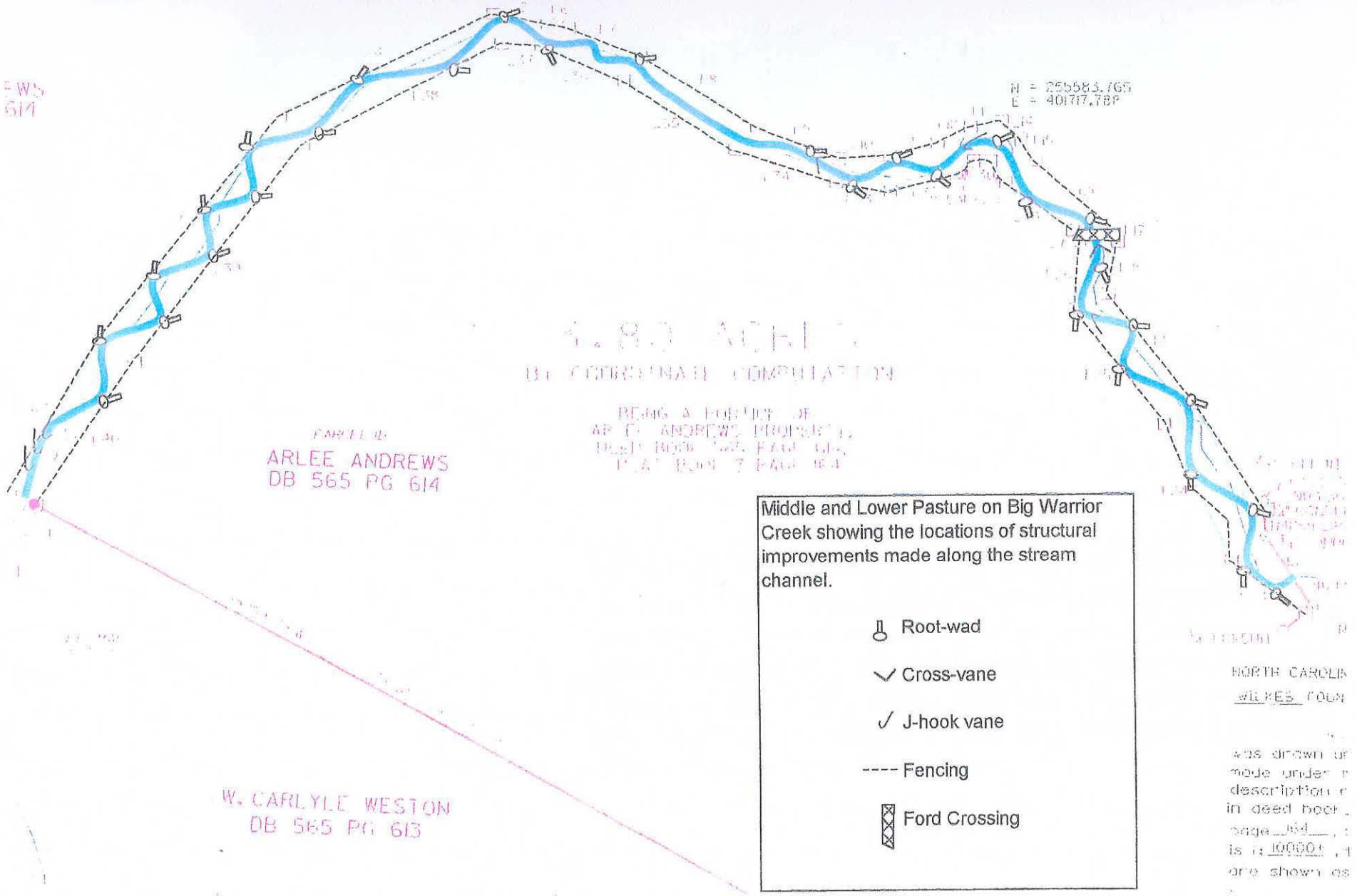
FOR NORT

TOWNSHIP :

STATE :

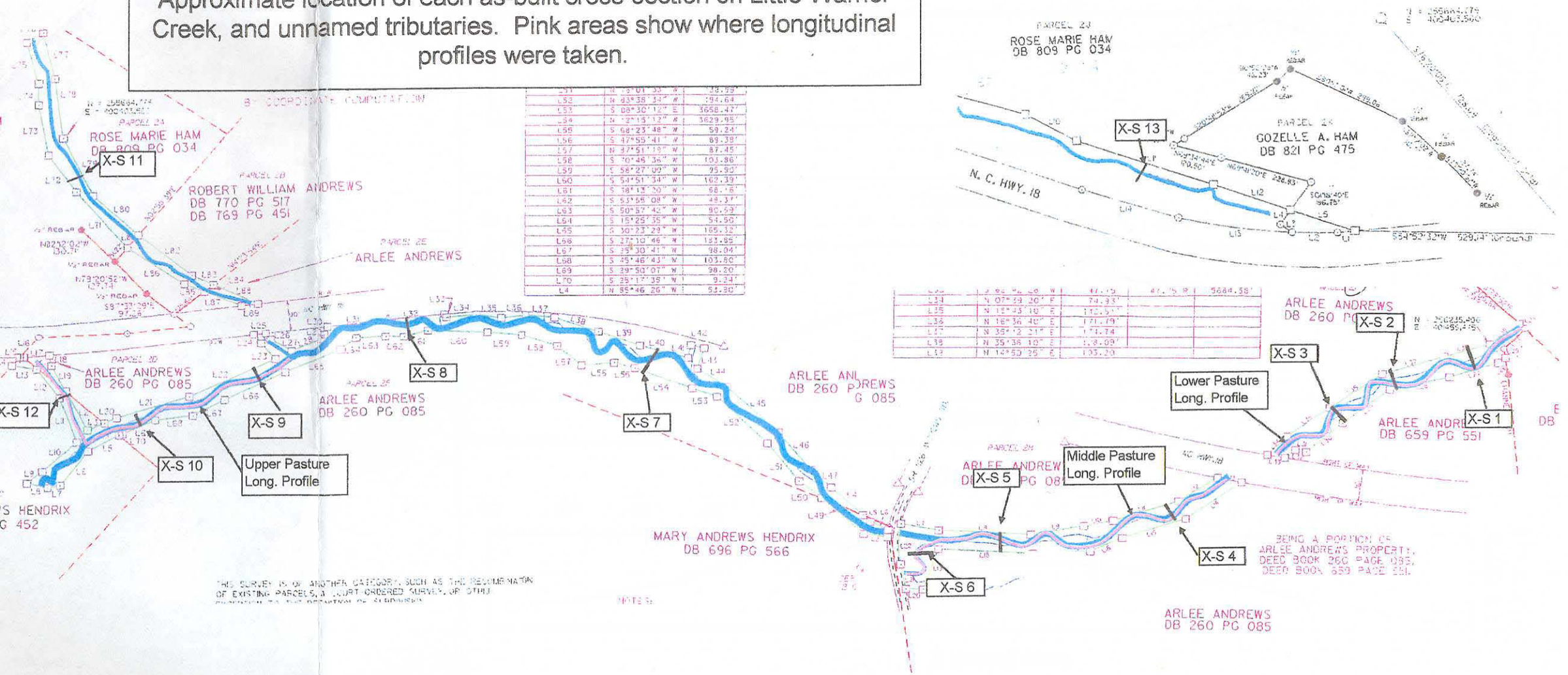
PIN NUMBE

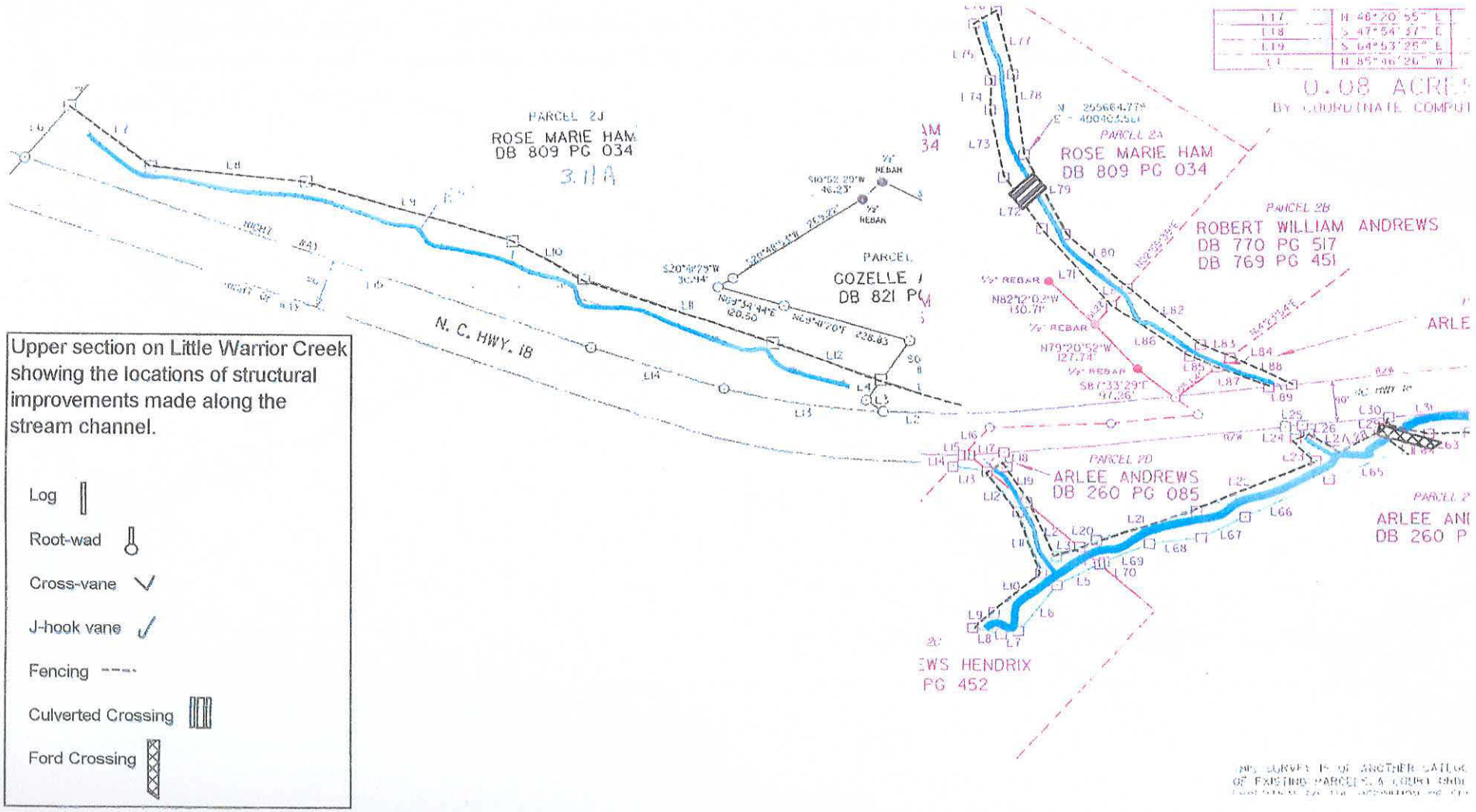

PARCEL 1A
CARLYLE WESTON
DB 565 PG 618
PARCEL 1A
W. CARLYLE WESTON
DB 565 PG 618
N = 254543.044
E = 401104.459
Farm Path.
NORTH CAROLI
WILKES COU
LEGEND
IRON PIN FOUND
IRON SET
COMPUTED POINT
REBAR AND CAP
PROPERTY LINE
R/W LINE
EASEMENT LINE
TRACT LINE
SCALE 1" = 200'
200
0
200
400
Upper Pasture on Big Warrior Creek showing the locations of structural improvements made along the stream channel.
Log
Root-wad
Cross-vane
J-hook vane
Fencing
Culverted Crossing
Ford Crossing
Log Cross-vane
SEAL OR STAMP


N = 255583.765
E = 401717.789
4.83 ACRE
BY COORDINATE COMPUTATION
BEING A PORTION OF
ARLEE ANDREWS
DB 565 PG 614
W. CARLYLE WESTON
DB 565 PG 613
Middle and Lower Pasture on Big Warrior Creek showing the locations of structural improvements made along the stream channel.
Root-wad
Cross-vane
J-hook vane
Fencing
Ford Crossing

Cross-section Information

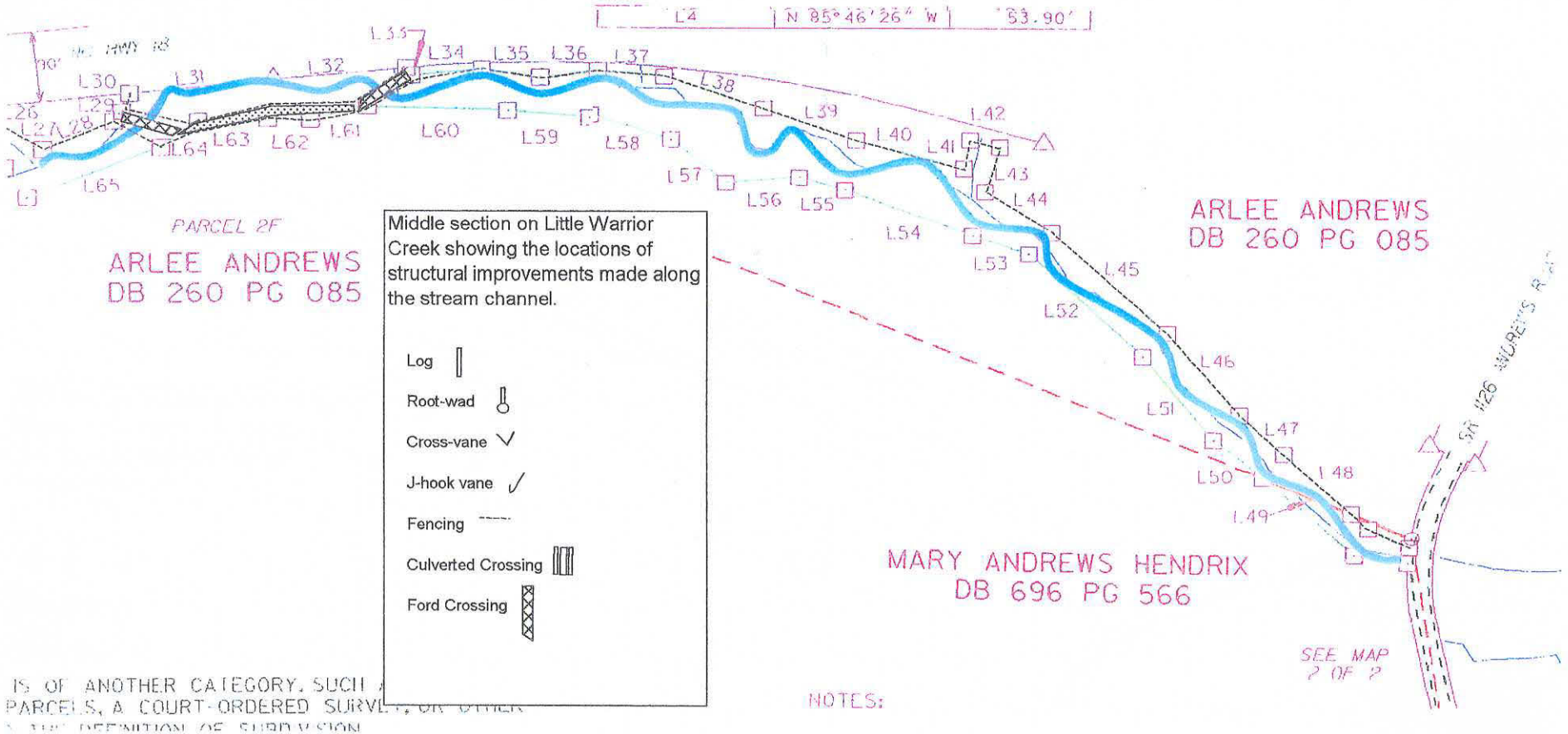
Approximate location of each as-built cross-section on Little Warrior Creek, and unnamed tributaries. Pink areas show where longitudinal profiles were taken.





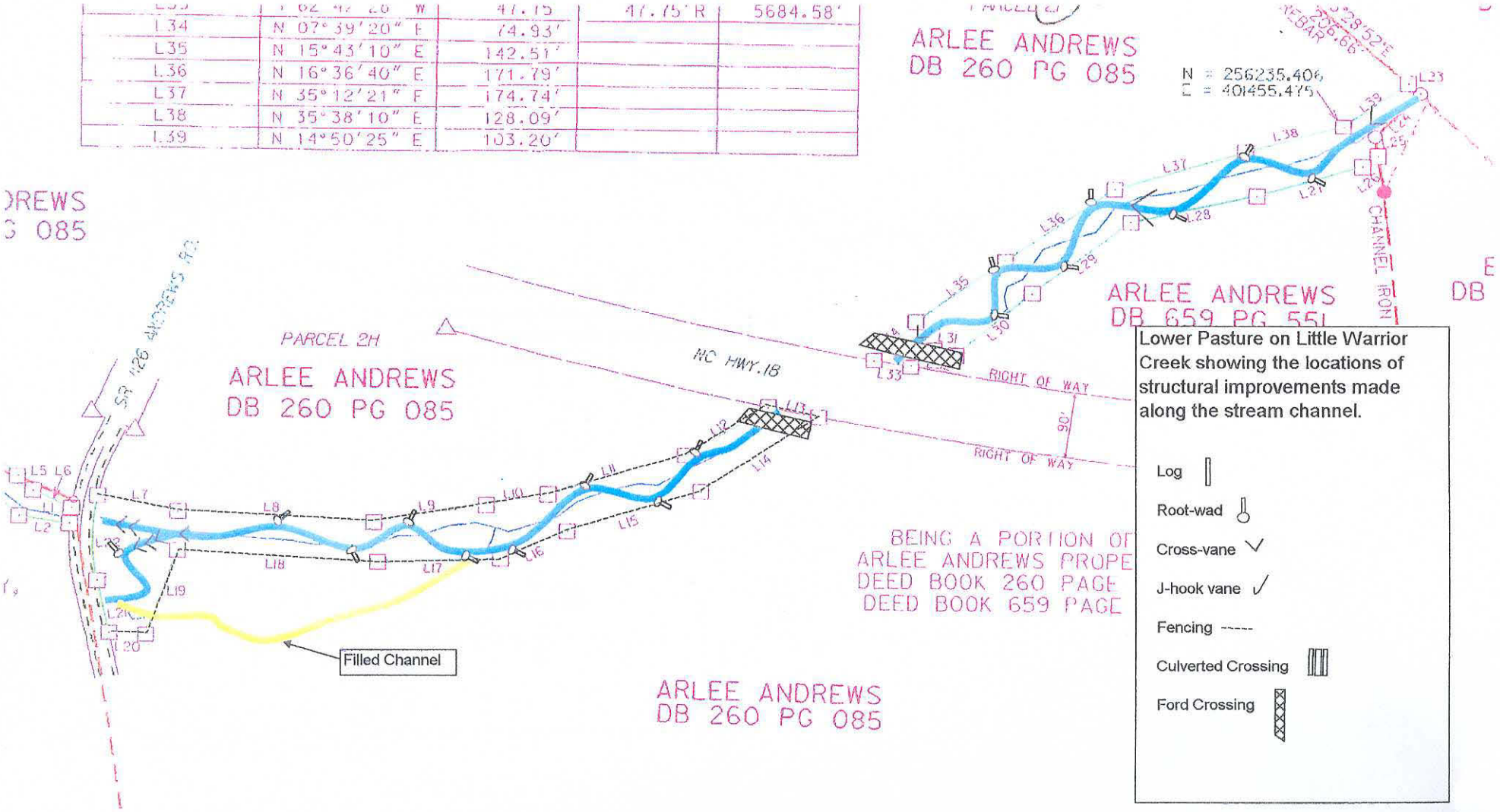
Upper section on Little Warrior Creek showing the locations of structural improvements made along the stream channel.

- Log
- Root-wad
- Cross-vane
- J-hook vane
- Fencing
- Culverted Crossing
- Ford Crossing



IS OF ANOTHER CATEGORY, SUCH
PARCELS, A COURT-ORDERED SURVEY, OR OTHER
DEFINITION OF SUBDIVISION

L34	N 07°39'20" E	74.93'		
L35	N 15°43'10" E	142.51'		
L36	N 16°36'40" E	171.79'		
L37	N 35°12'21" E	174.74'		
L38	N 35°38'10" E	128.09'		
L39	N 14°50'25" E	103.20'		

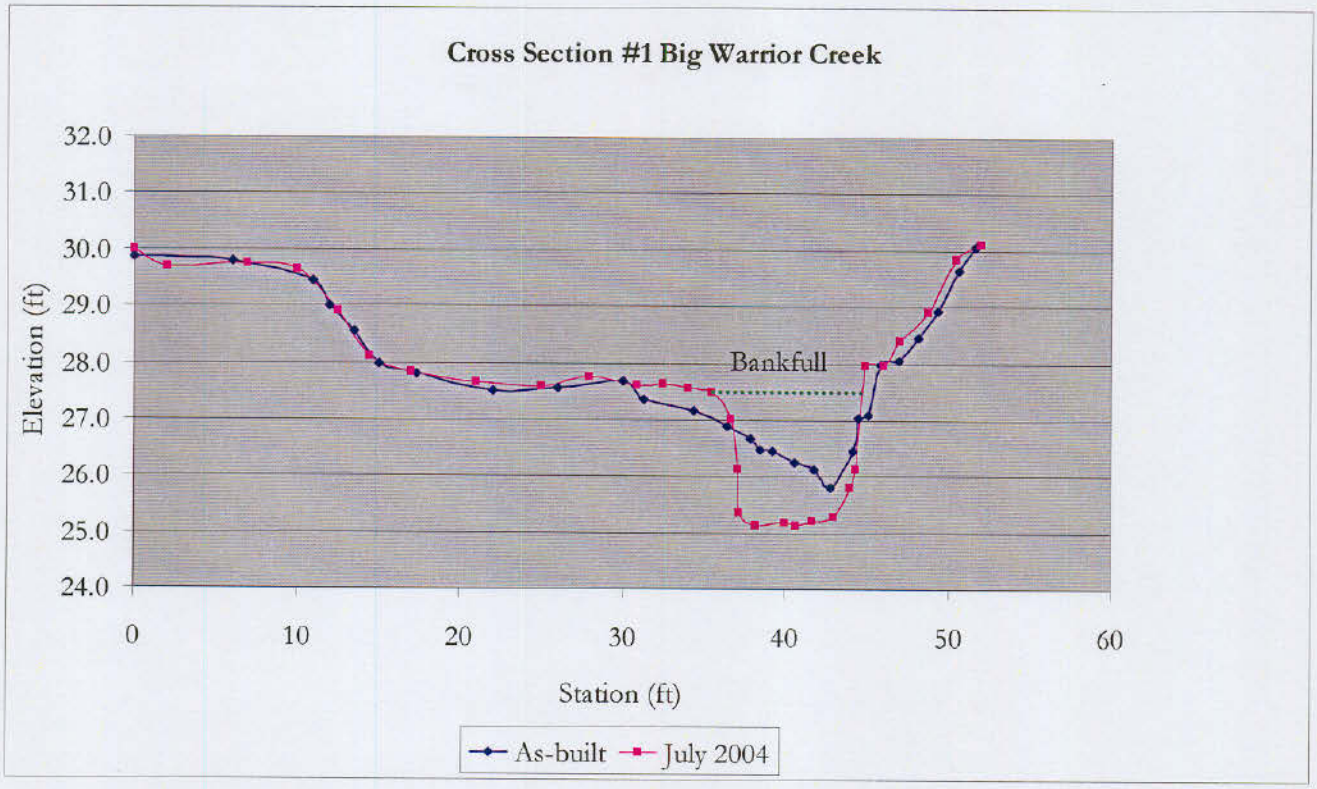


Lower Pasture on Little Warrior Creek showing the locations of structural improvements made along the stream channel.

- Log
- Root-wad
- Cross-vane
- J-hook vane
- Fencing -----
- Culverted Crossing
- Ford Crossing

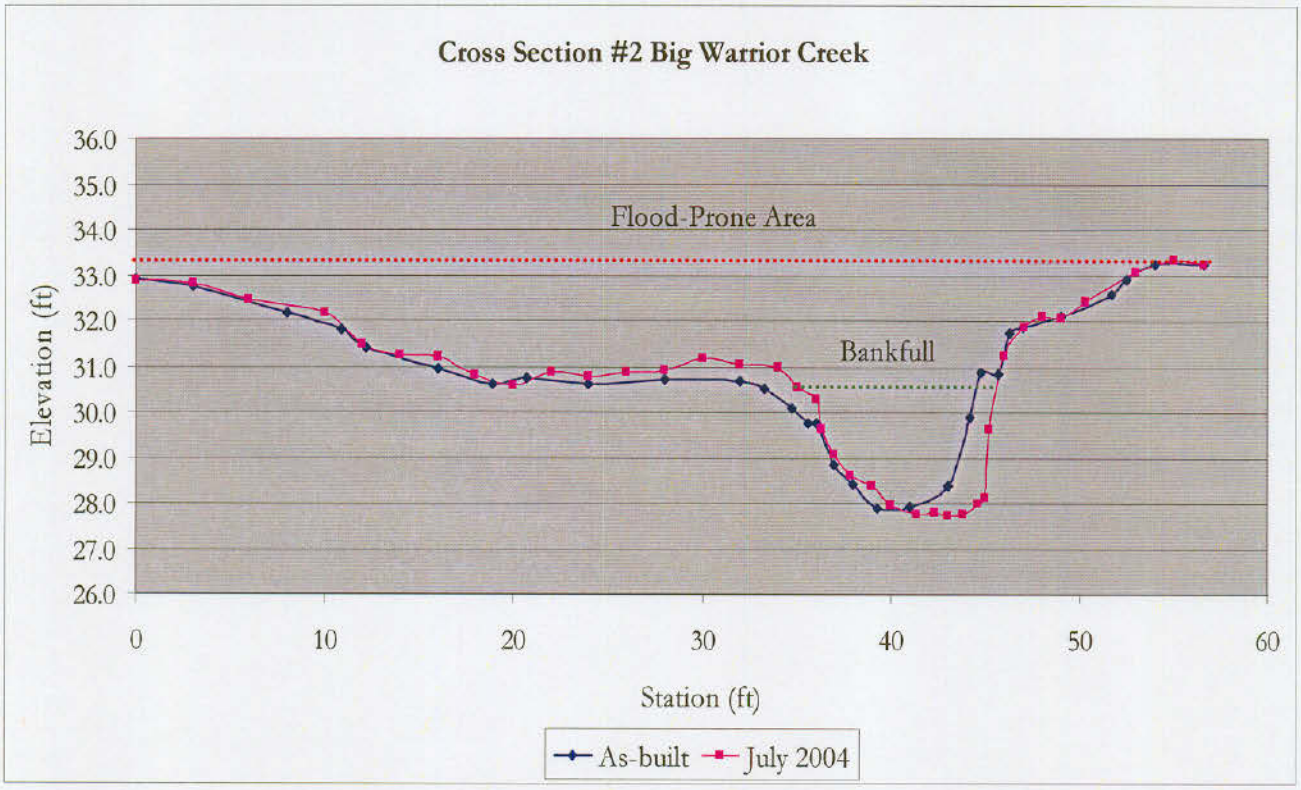
APPENDIX B

CROSS SECTIONS AND THE LONGITUDINAL PROFILE COMPARISON

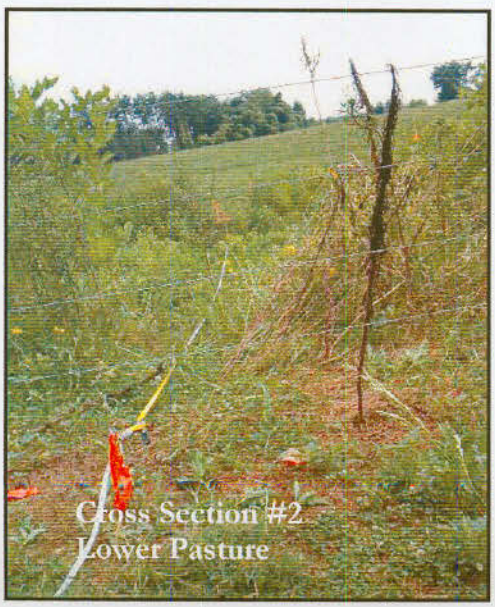


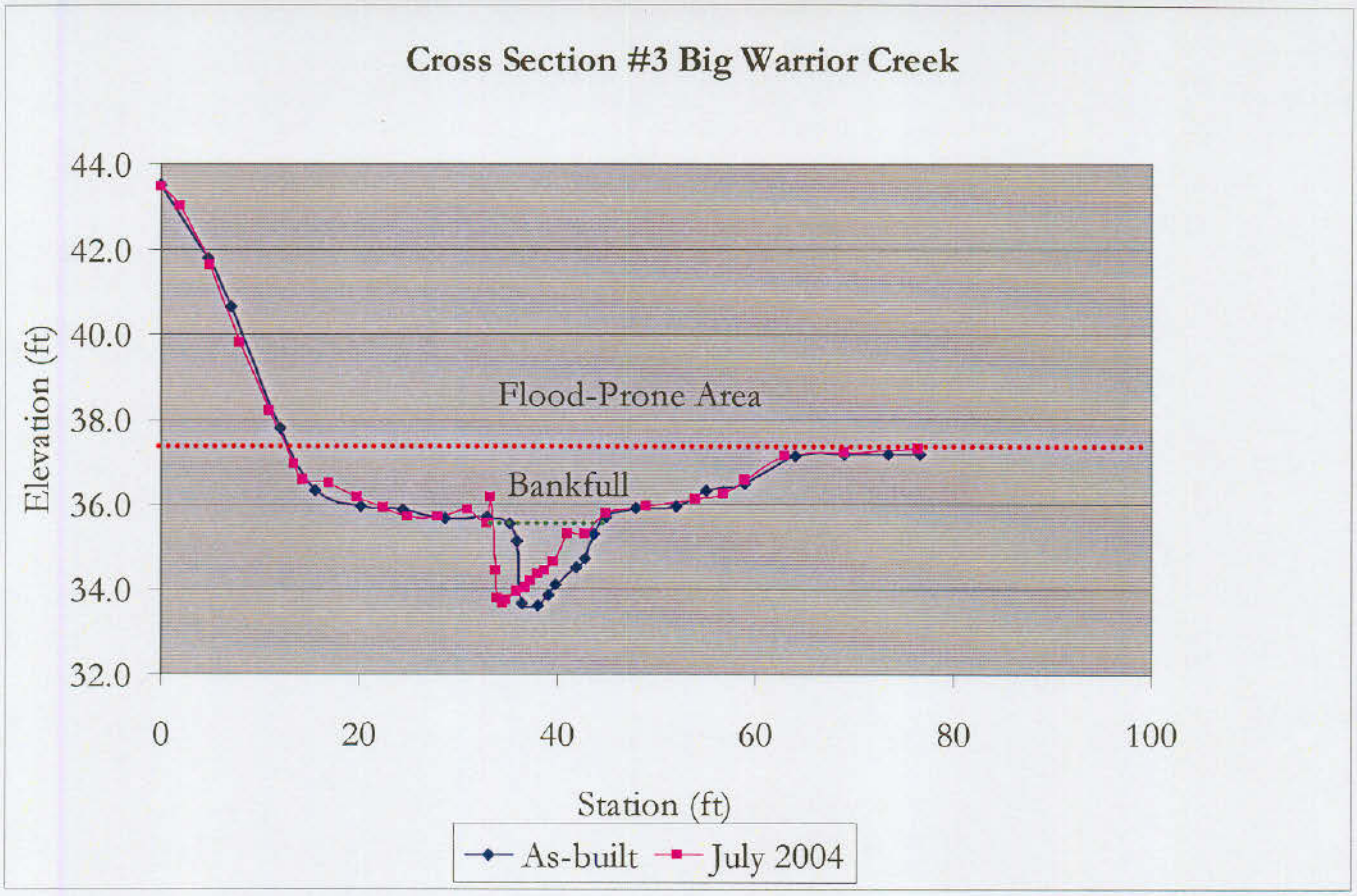
Cross-Section #1 (Glide) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	15.3	16.7
Maximum Bankfull Depth (ft)	1.9	2.3
Bankfull Mean Depth (ft)	1	1.8
Bankfull Width (ft)	15.5	9.2

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.

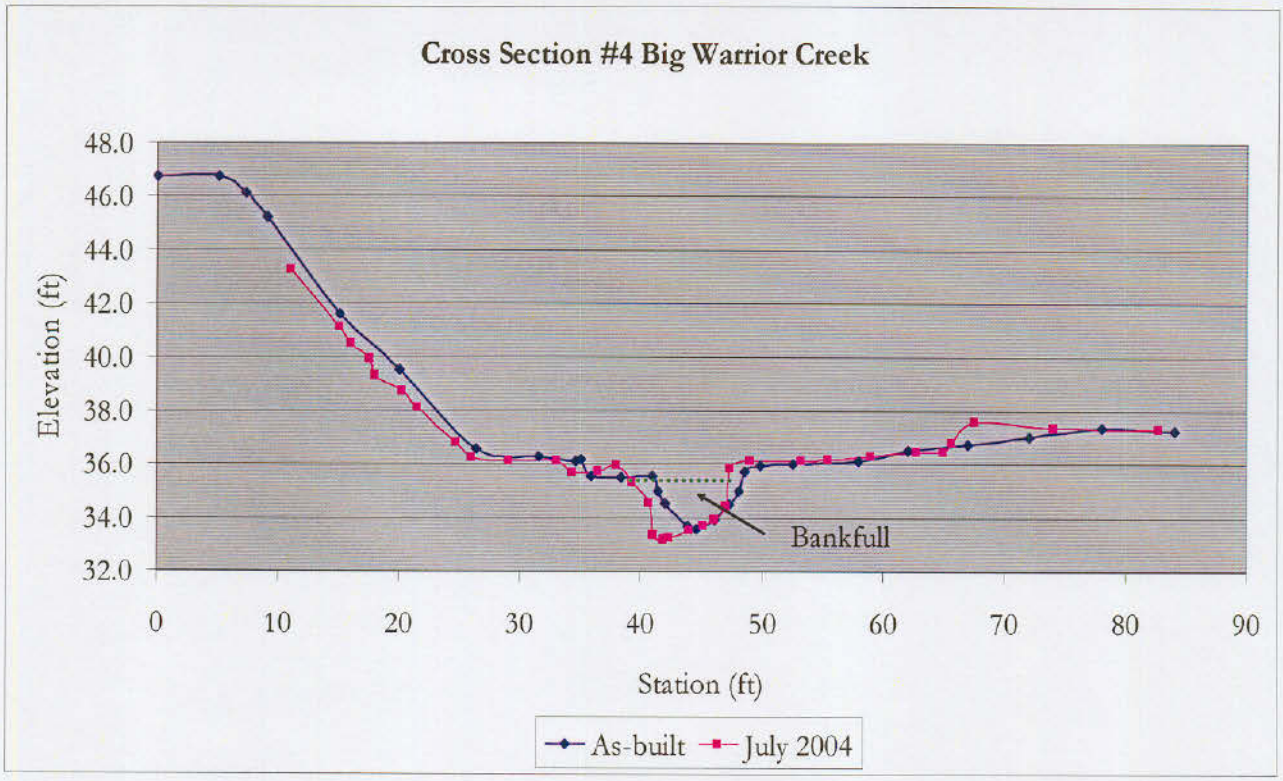


Cross-Section #2 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	20.3	21.5
Maximum Bankfull Depth (ft)	2.8	2.8
Bankfull Mean Depth (ft)	1.6	2
Width/Depth Ratio	7.9	5.3
Entrenchment Ratio	5.3	6.6
Bankfull Width (ft)	12.7	10.7
Width of Flood Prone Area	67	70



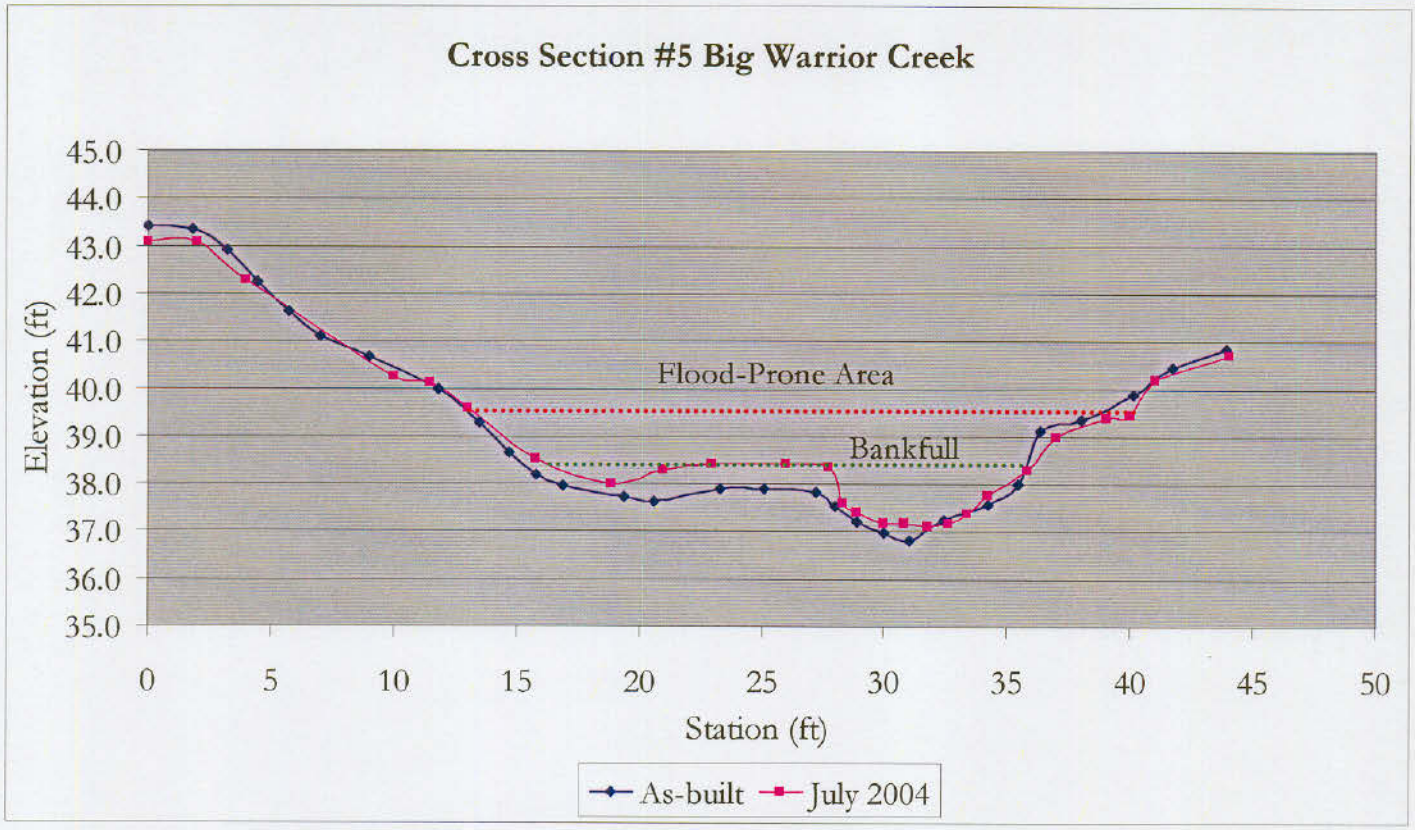


Cross-Section #3 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	12.8	10.1
Maximum Bankfull Depth (ft)	2.1	1.9
Bankfull Mean Depth (ft)	1	1
Width/Depth Ratio	11.6	10.9
Entrenchment Ratio	6.9	6.5
Bankfull Width (ft)	12.2	10.5
Width of Flood Prone Area	84	68

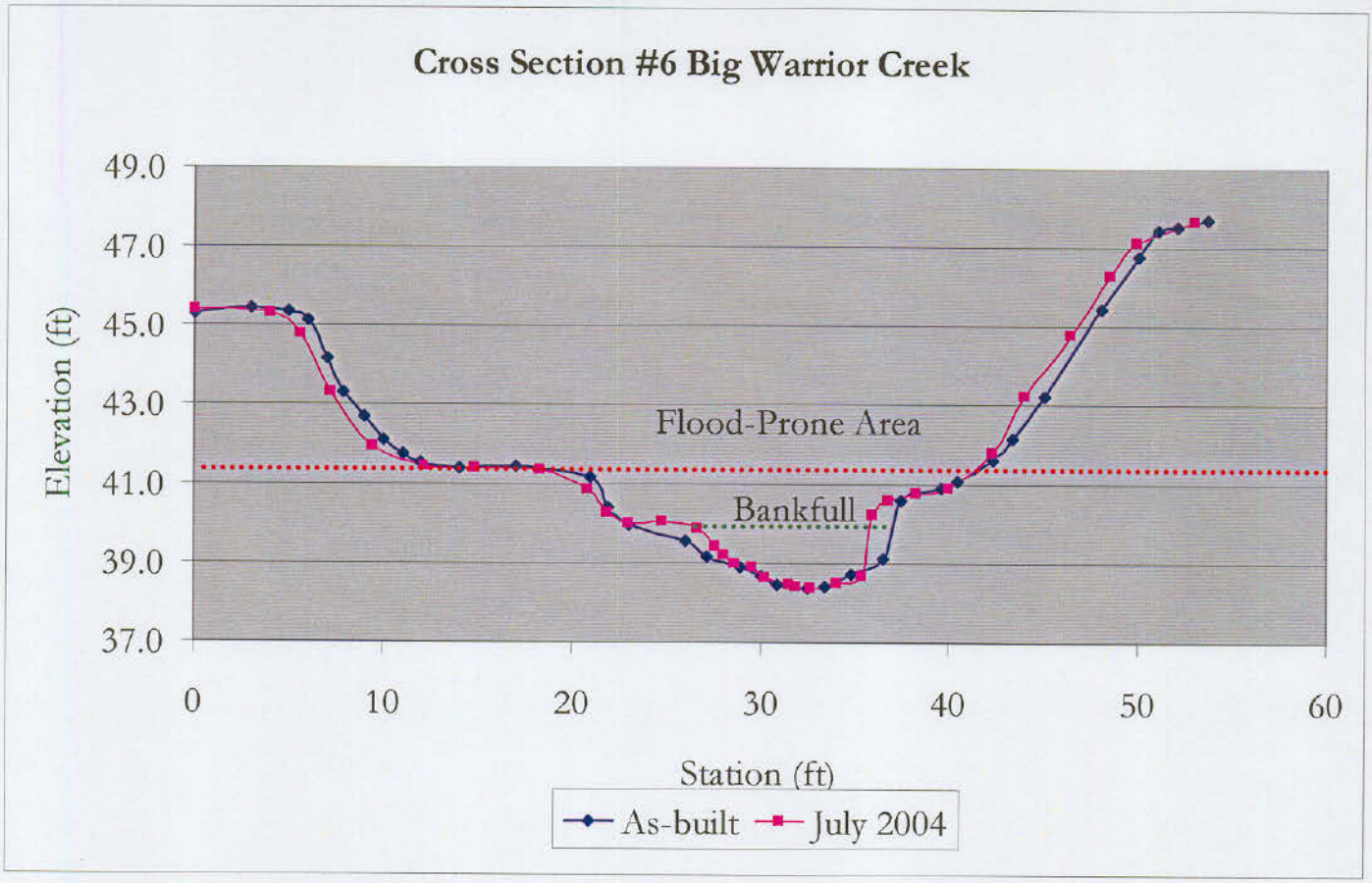


Cross-Section #4 (Pool) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	19.5	11.8
Maximum Bankfull Depth (ft)	2.6	2.2
Bankfull Mean Depth (ft)	1.1	1.5
Bankfull Width (ft)	17.5	8

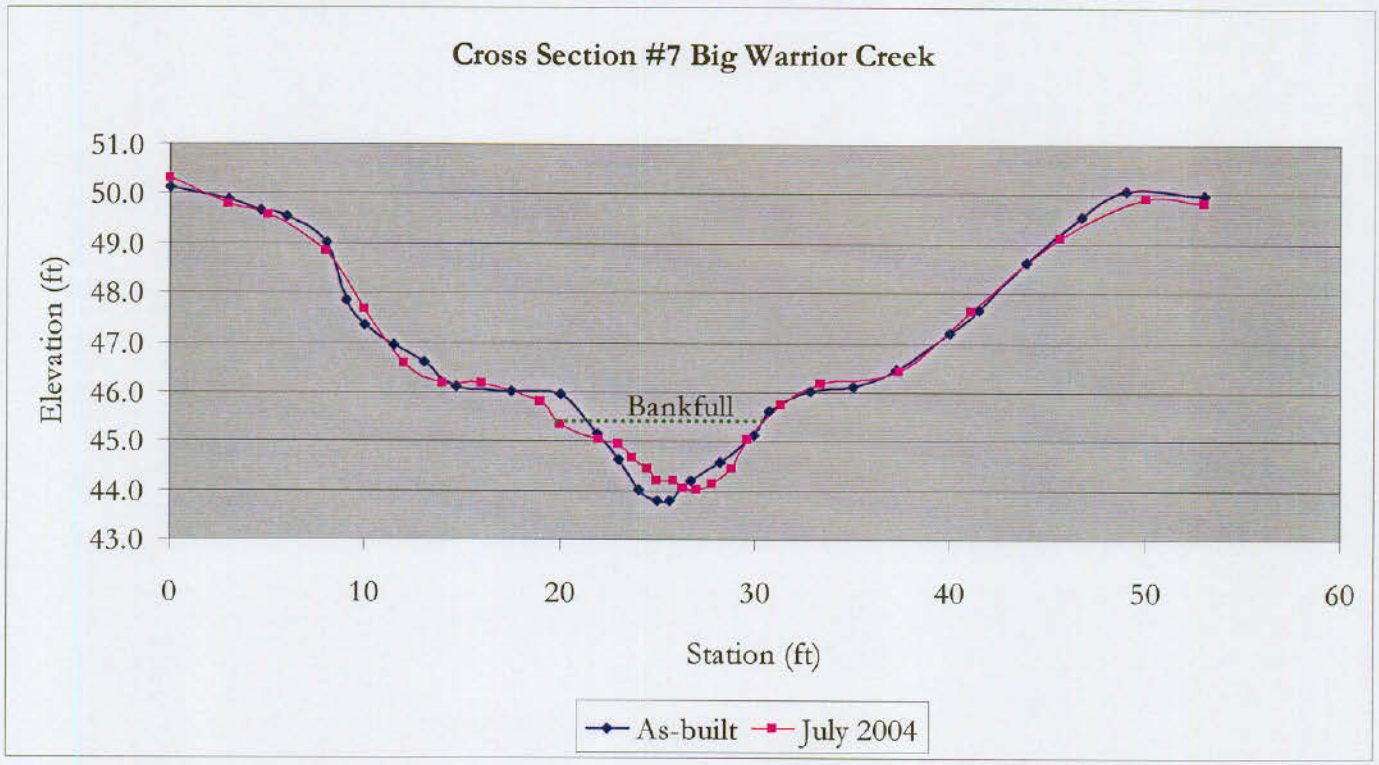
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



Cross-Section #5 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	20.3	7.8
Maximum Bankfull Depth (ft)	1.9	1.2
Bankfull Mean Depth (ft)	1	0.6
Width/Depth Ratio	22.3	22.3
Entrenchment Ratio	1.5	2.1
Bankfull Width (ft)	21.3	13.2
Width of Flood Prone Area	32	28

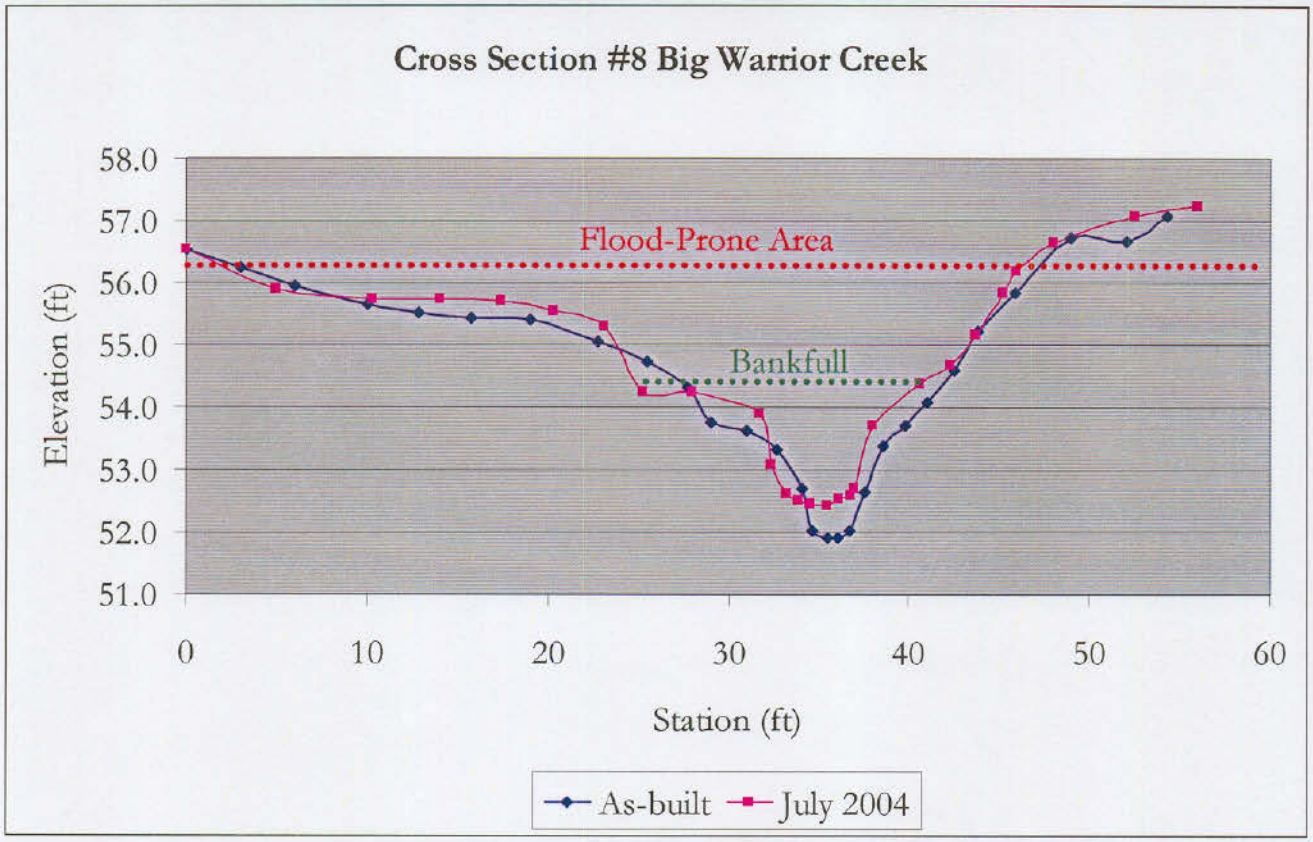


Cross-Section #6 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	22.3	10
Maximum Bankfull Depth (ft)	2.2	1.5
Bankfull Mean Depth (ft)	1.4	1.1
Width/Depth Ratio	10.9	8.3
Entrenchment Ratio	2.3	3.9
Bankfull Width (ft)	15.6	9.1
Width of Flood Prone Area	35	35

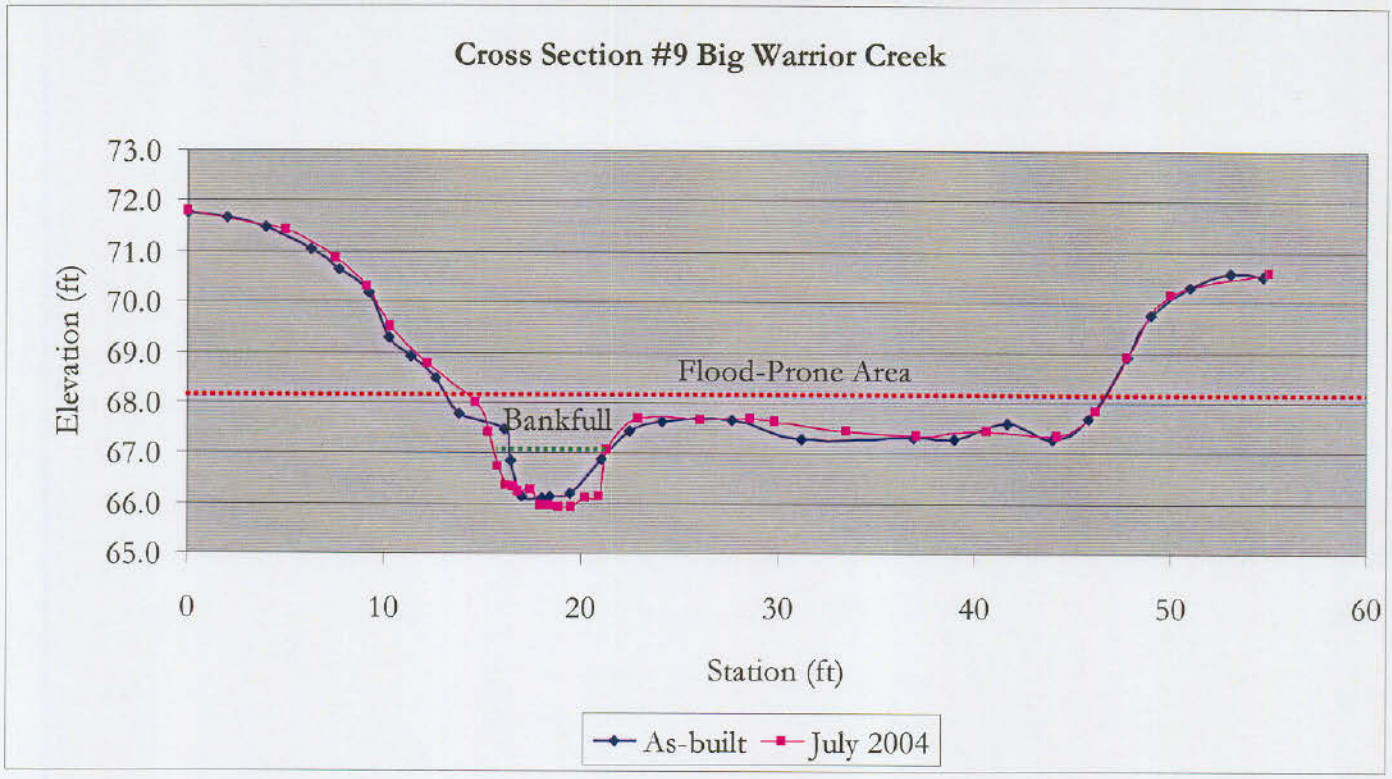


Cross-Section #7 (Run) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	16.4	7.3
Maximum Bankfull Depth (ft)	2.3	1.3
Bankfull Mean Depth (ft)	1.1	0.7
Bankfull Width (ft)	15.2	10.4

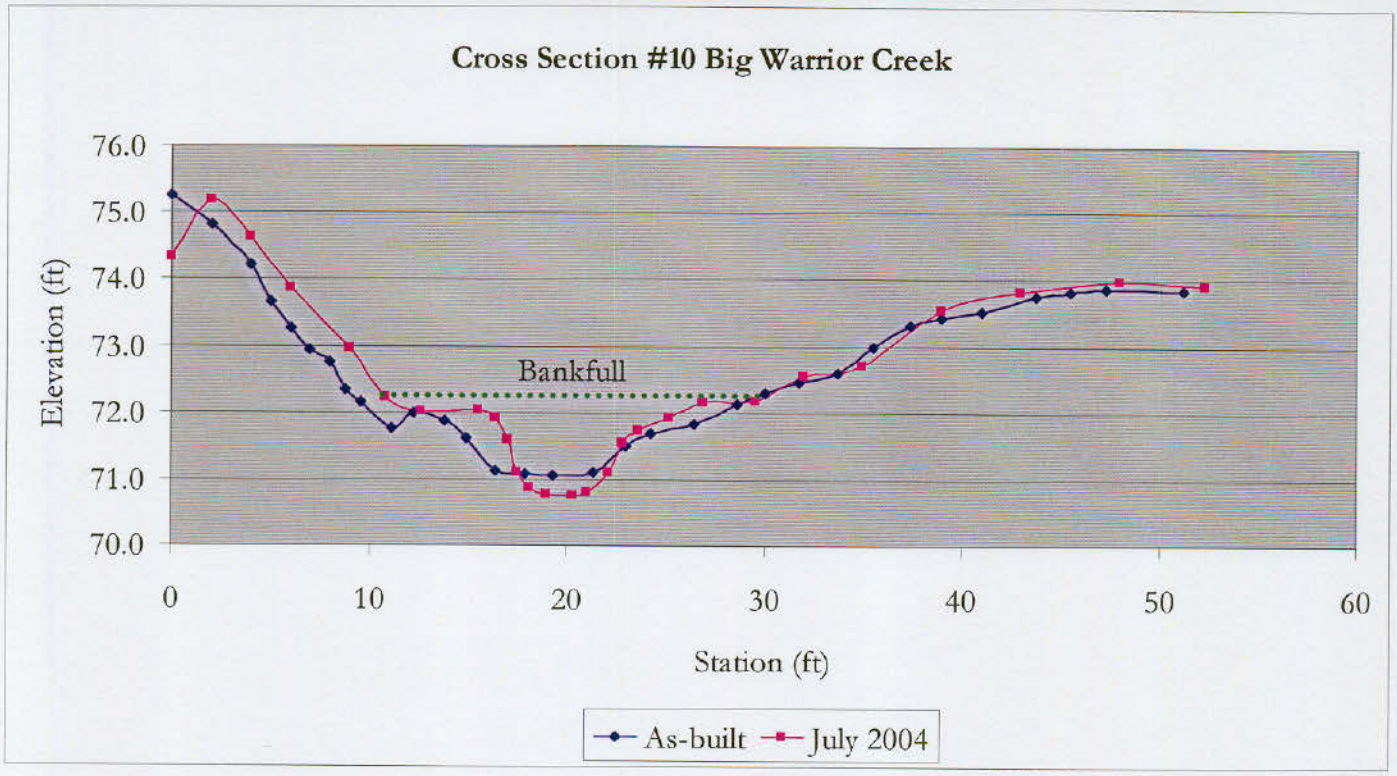
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



Cross-Section #8 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	15.32	5.8
Maximum Bankfull Depth (ft)	2.39	1.3
Bankfull Mean Depth (ft)	1.1	0.9
Width/Depth Ratio	12.8	6.5
Entrenchment Ratio	3.5	3.3
Bankfull Width (ft)	14	6.1
Width of Flood Prone Area	49	20

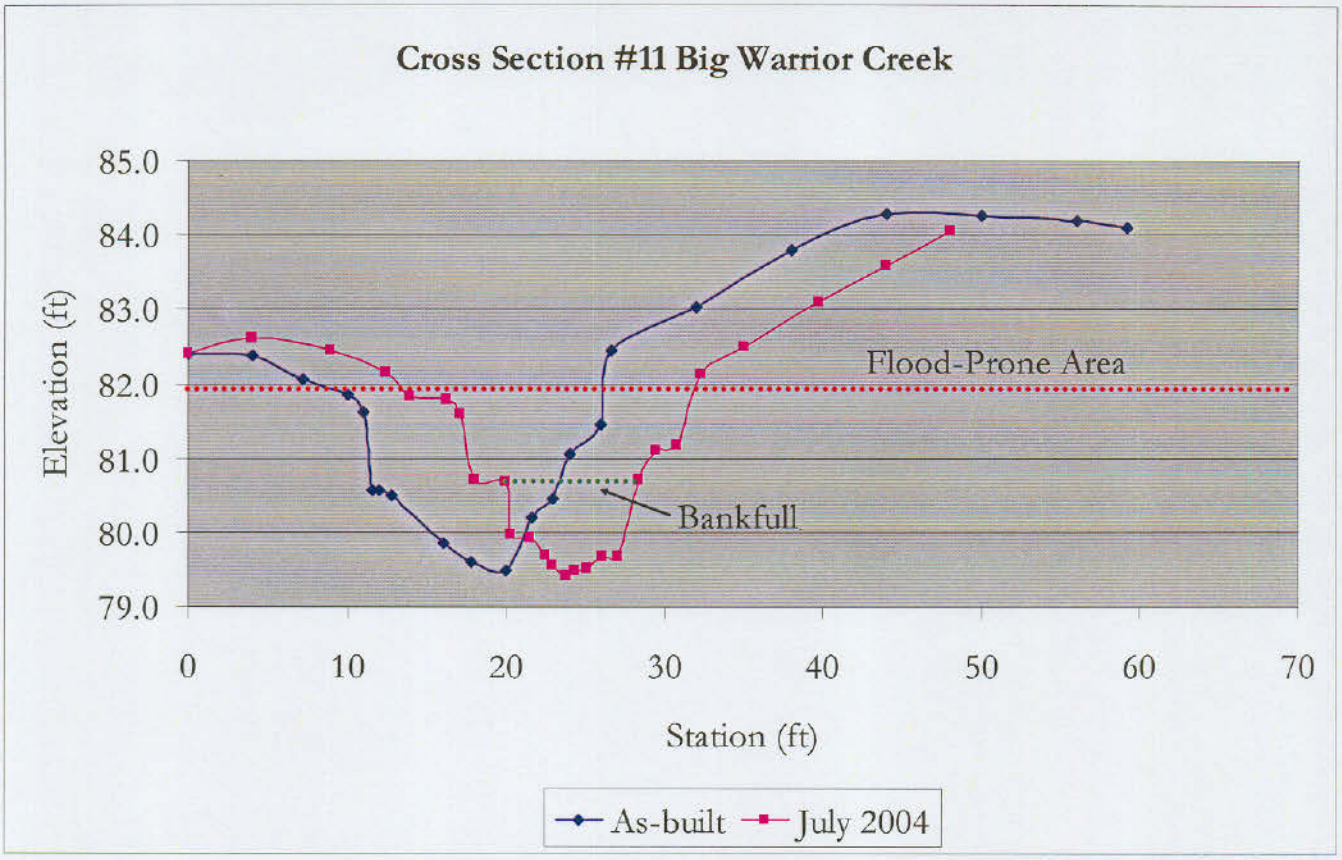


Cross-Section #9 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	16	13.2
Maximum Bankfull Depth (ft)	1.7	1.8
Bankfull Mean Depth (ft)	0.5	0.4
Width/Depth Ratio	64.1	70.7
Entrenchment Ratio	1.2	1.3
Bankfull Width (ft)	32	30.6
Width of Flood Prone Area	38	39

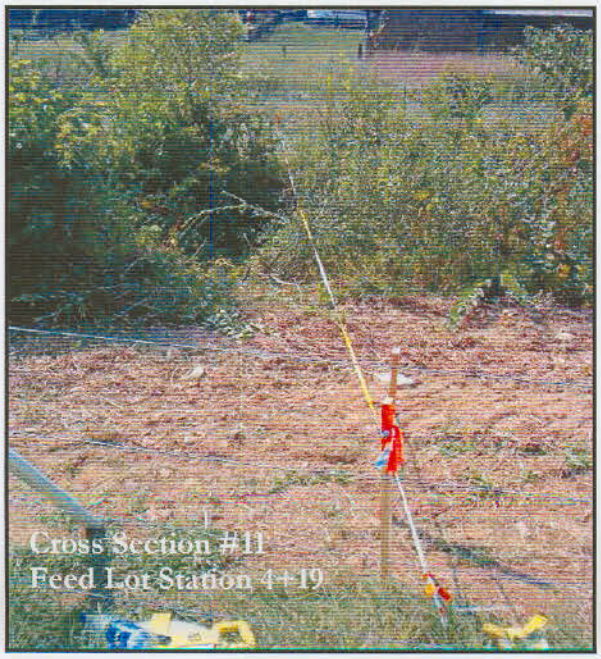


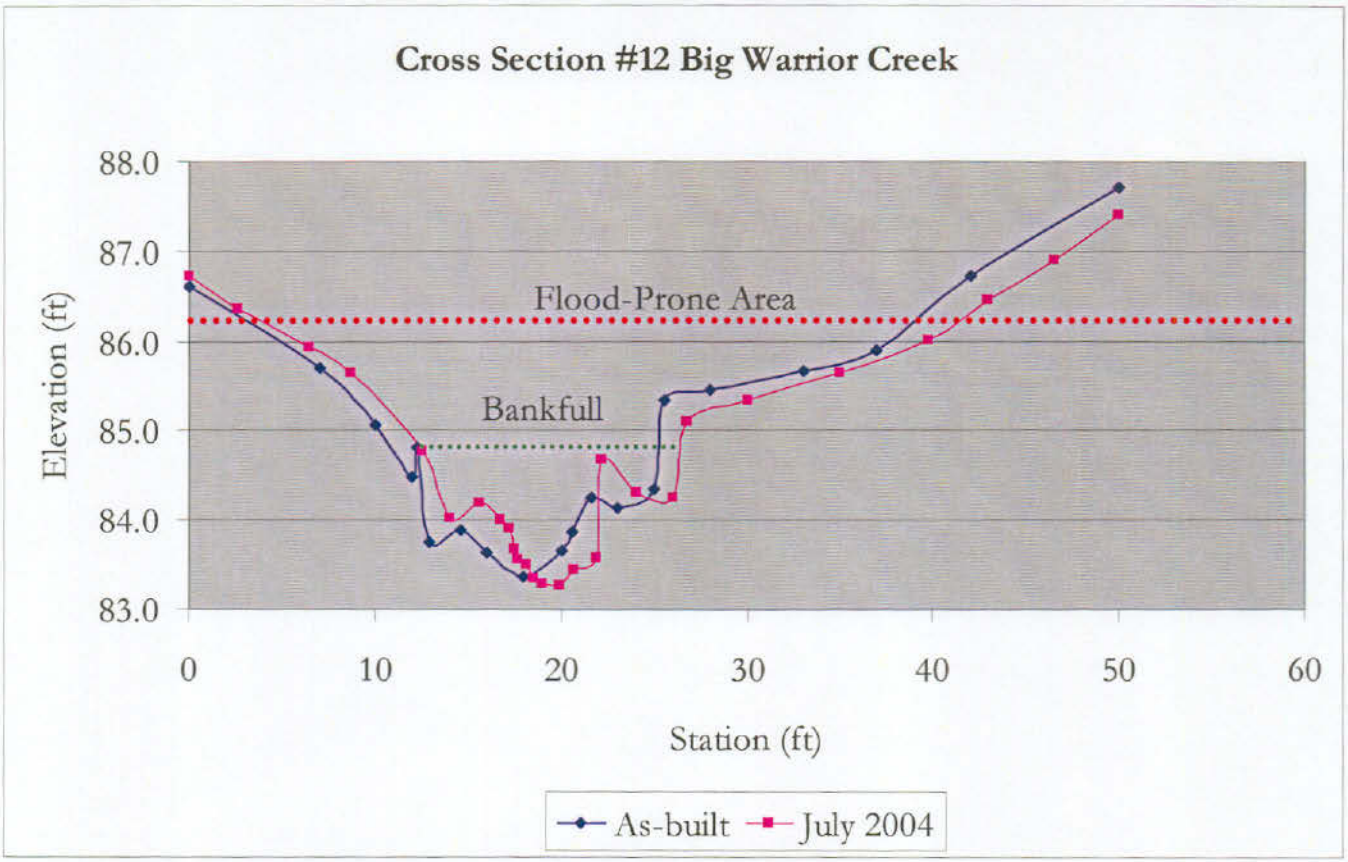
Cross-Section #10 (Pool) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	13.9	10.3
Maximum Bankfull Depth (ft)	1.2	1.5
Bankfull Mean Depth (ft)	0.7	0.5
Bankfull Width (ft)	21.1	19.2

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.

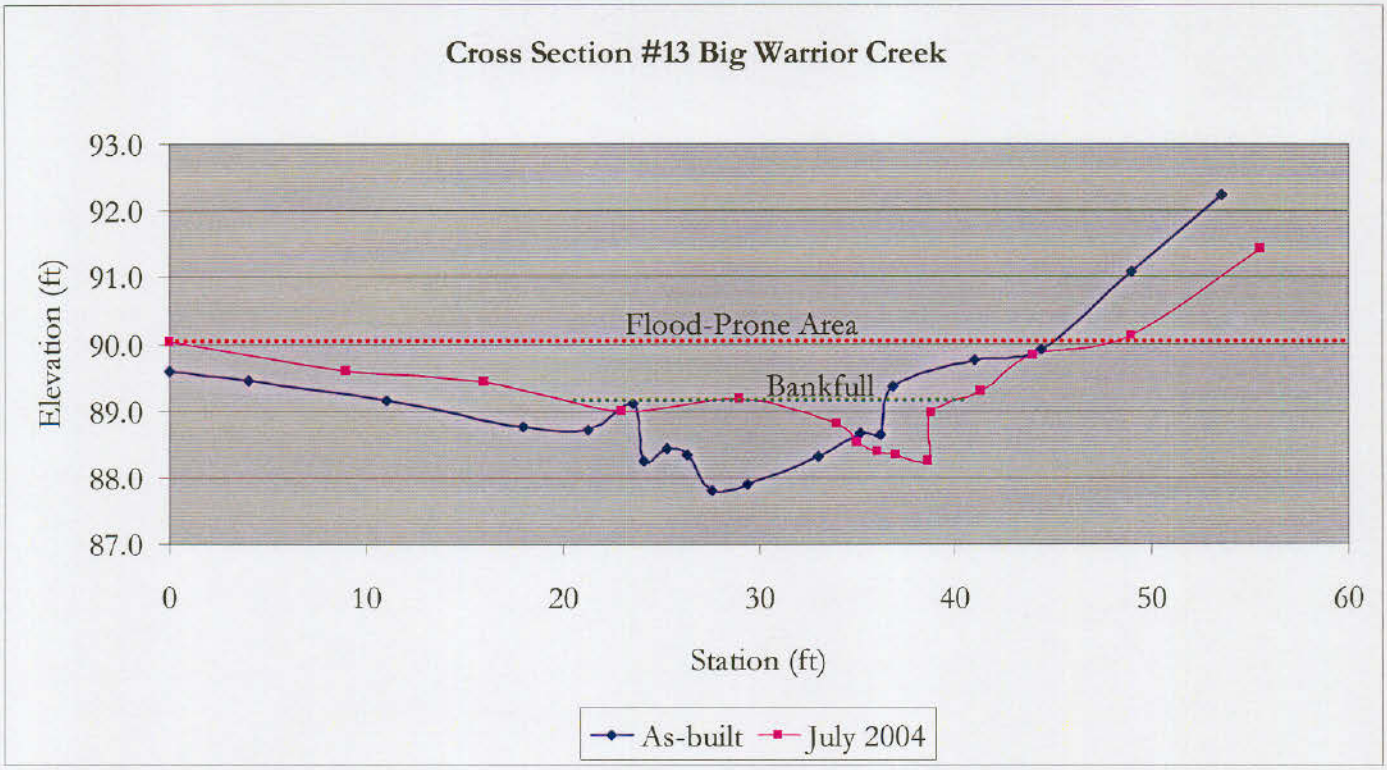


Cross-Section #11(Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	20.2	7.6
Maximum Bankfull Depth (ft)	2.1	1.3
Bankfull Mean Depth (ft)	1.3	0.9
Width/Depth Ratio	11.7	9.2
Entrenchment Ratio	2.5	2.4
Bankfull Width (ft)	15.4	8.4
Width of Flood Prone Area	38	20

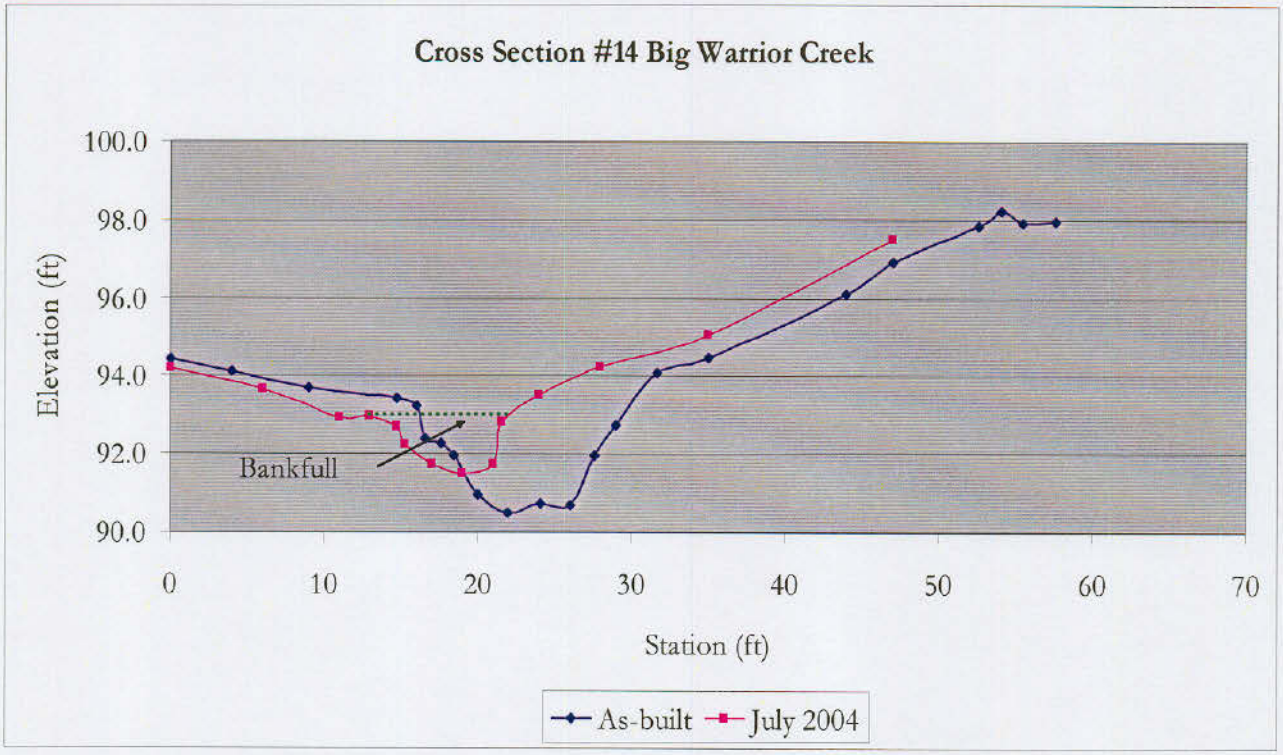




Cross-Section #12 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	20.4	10.8
Maximum Bankfull Depth (ft)	2	1.5
Bankfull Mean Depth (ft)	1.3	0.8
Width/Depth Ratio	11.6	18.1
Entrenchment Ratio	2.7	2.9
Bankfull Width (ft)	15.4	14
Width of Flood Prone Area	42	40

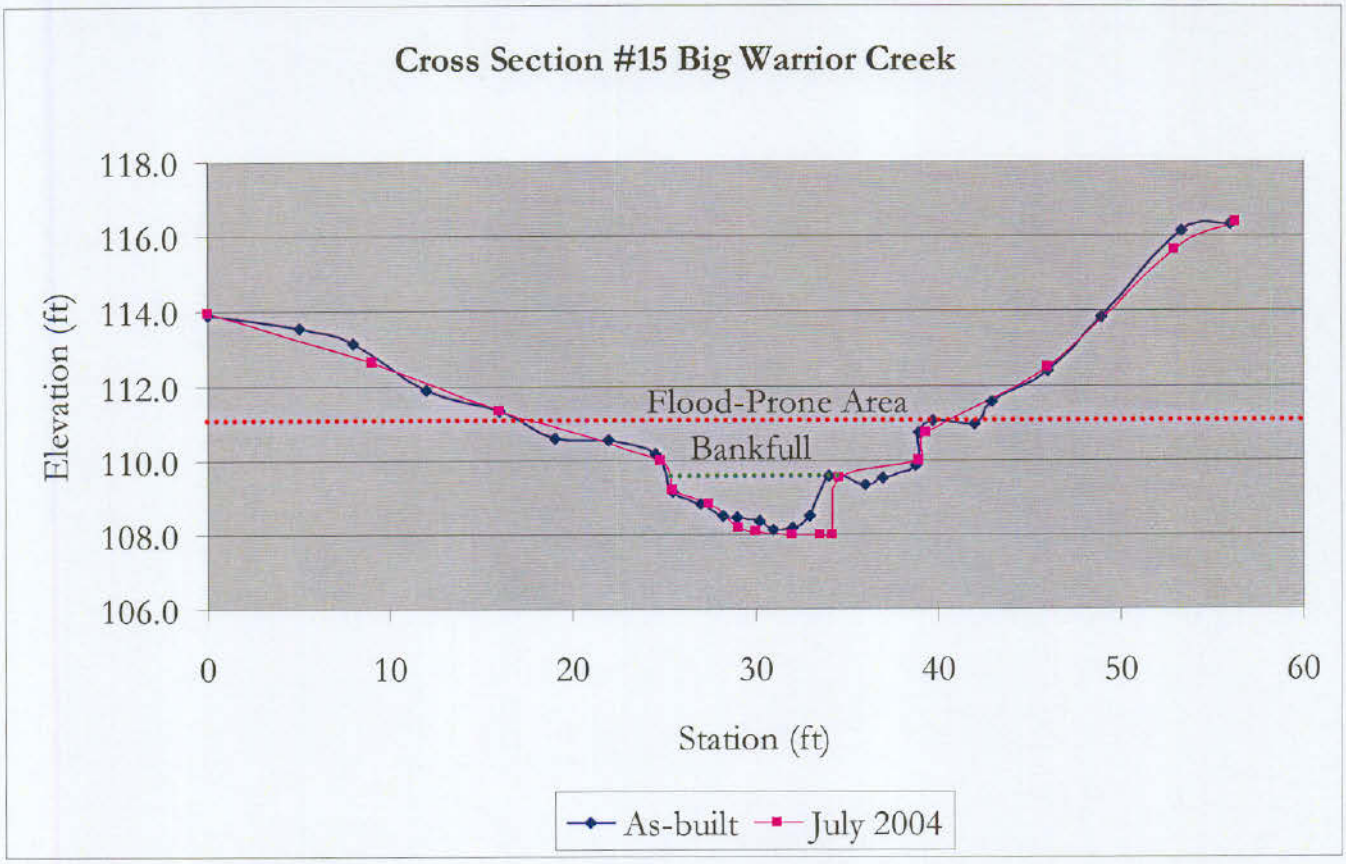


Cross-Section #13 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	20.5	5.4
Maximum Bankfull Depth (ft)	1.6	0.9
Bankfull Mean Depth (ft)	1.6	0.3
Width/Depth Ratio	8.2	75.6
Entrenchment Ratio	3.4	2.4
Bankfull Width (ft)	13	20.2
Width of Flood Prone Area	45	49

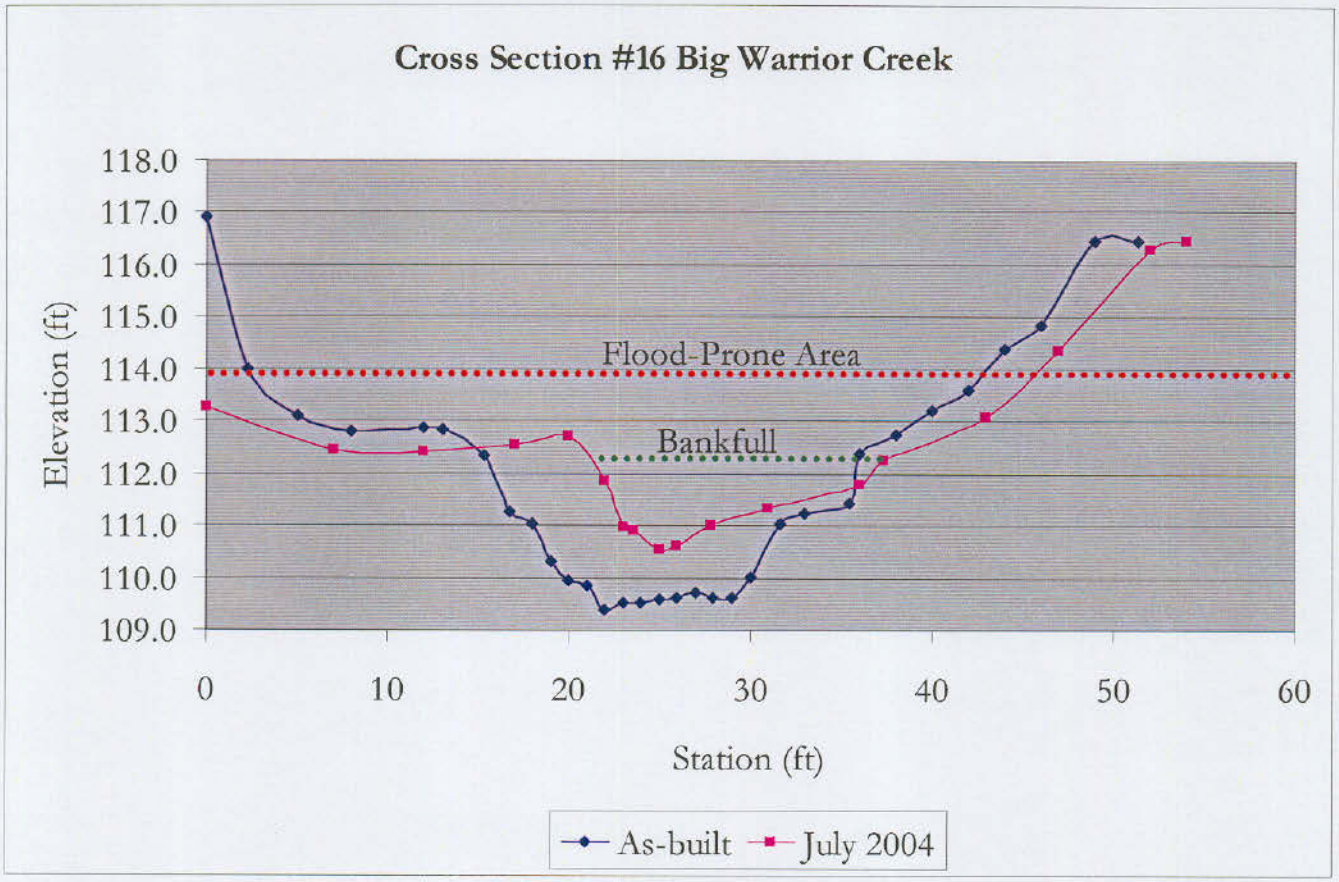


Cross-Section #14 (Pool) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	24.7	8.3
Maximum Bankfull Depth (ft)	2.7	1.5
Bankfull Mean Depth (ft)	1.9	0.7
Bankfull Width (ft)	13.3	11.6

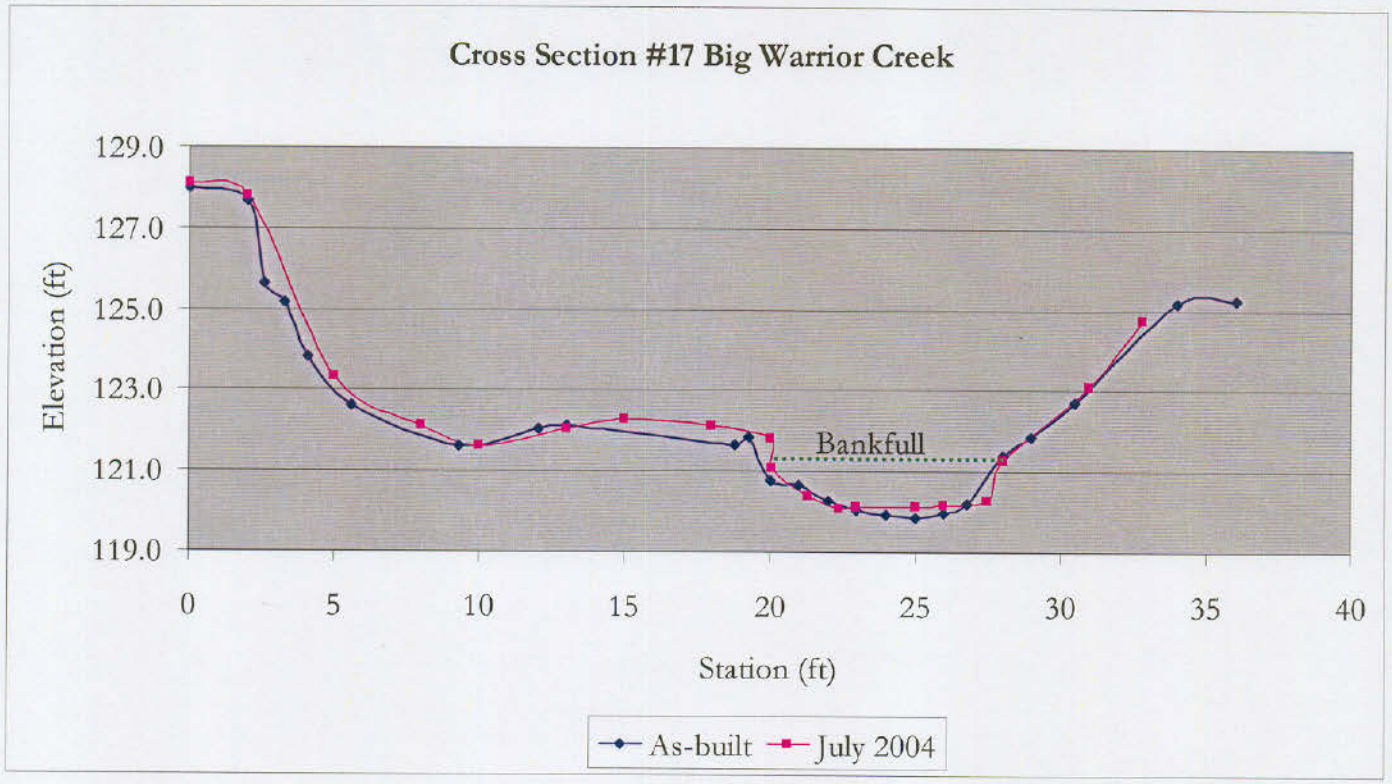
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



Cross-Section #15 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	17.3	10.5
Maximum Bankfull Depth (ft)	2.1	1.5
Bankfull Mean Depth (ft)	1.2	1.1
Width/Depth Ratio	11.4	8.4
Entrenchment Ratio	2.5	2.6
Bankfull Width (ft)	14	9.4
Width of Flood Prone Area	34	24

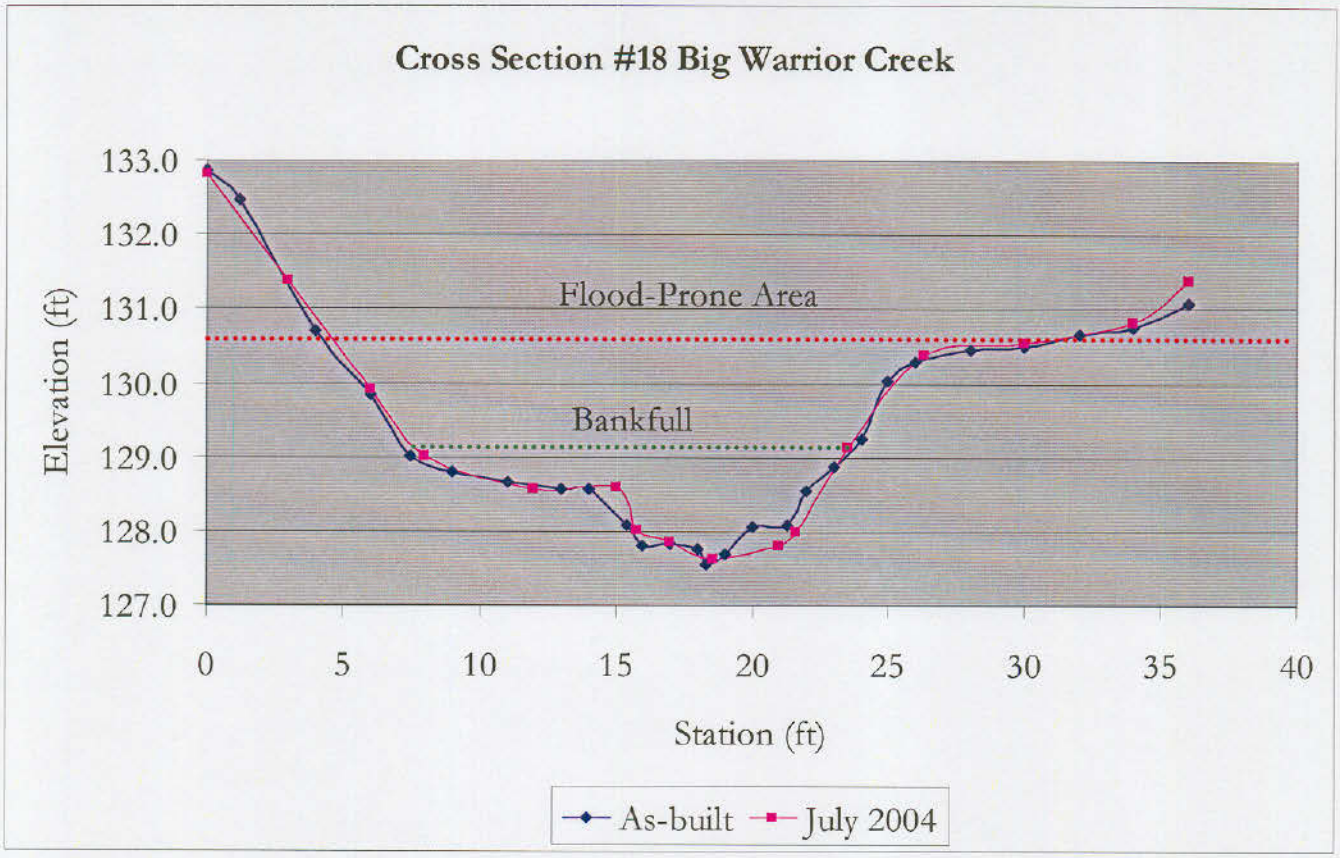


Cross-Section #16 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	40.7	15.3
Maximum Bankfull Depth (ft)	3	1.7
Bankfull Mean Depth (ft)	2.9	0.9
Width/Depth Ratio	72.6	17.3
Entrenchment Ratio	2.5	3.1
Bankfull Width (ft)	14	16.3
Width of Flood Prone Area	46	50

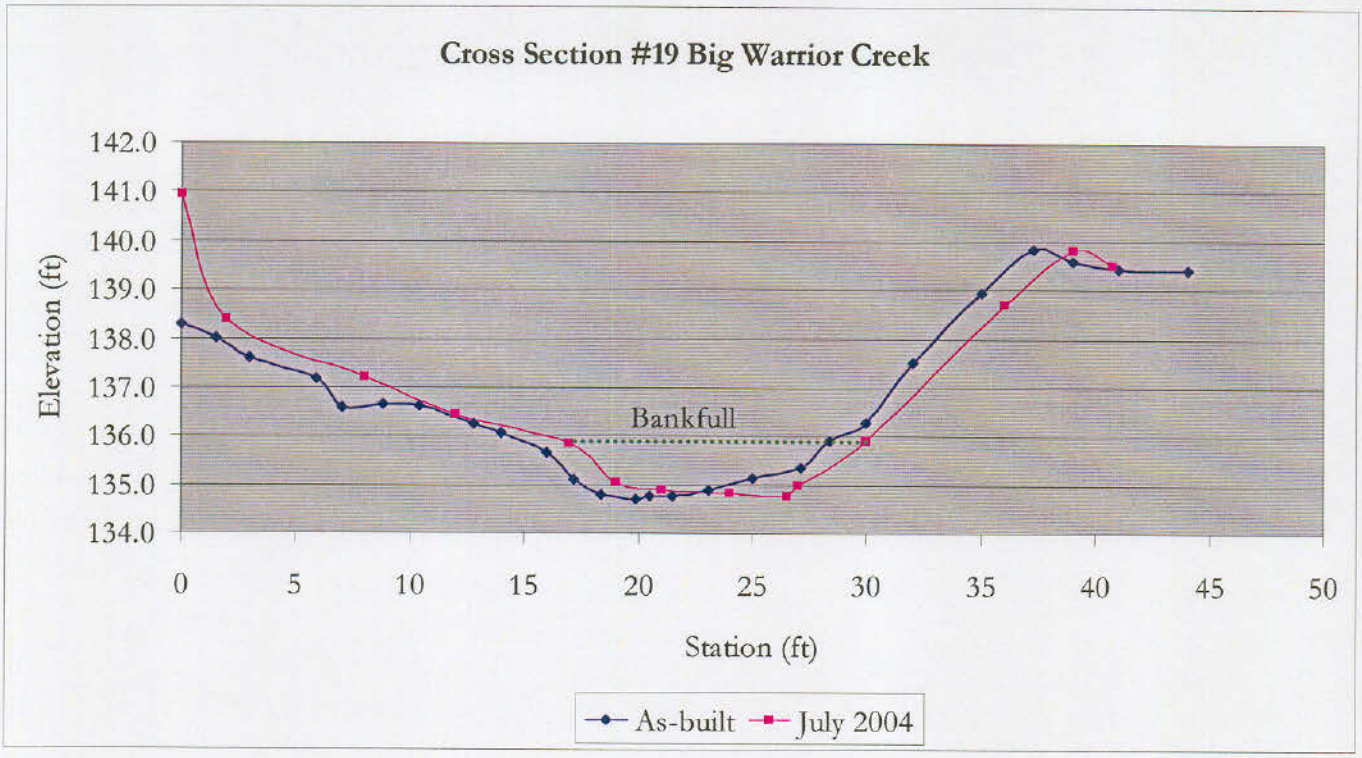


Cross-Section #17 (Pool) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	13.3	7.7
Maximum Bankfull Depth (ft)	2	1.2
Bankfull Mean Depth (ft)	1	1
Bankfull Width (ft)	14	7.9

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.

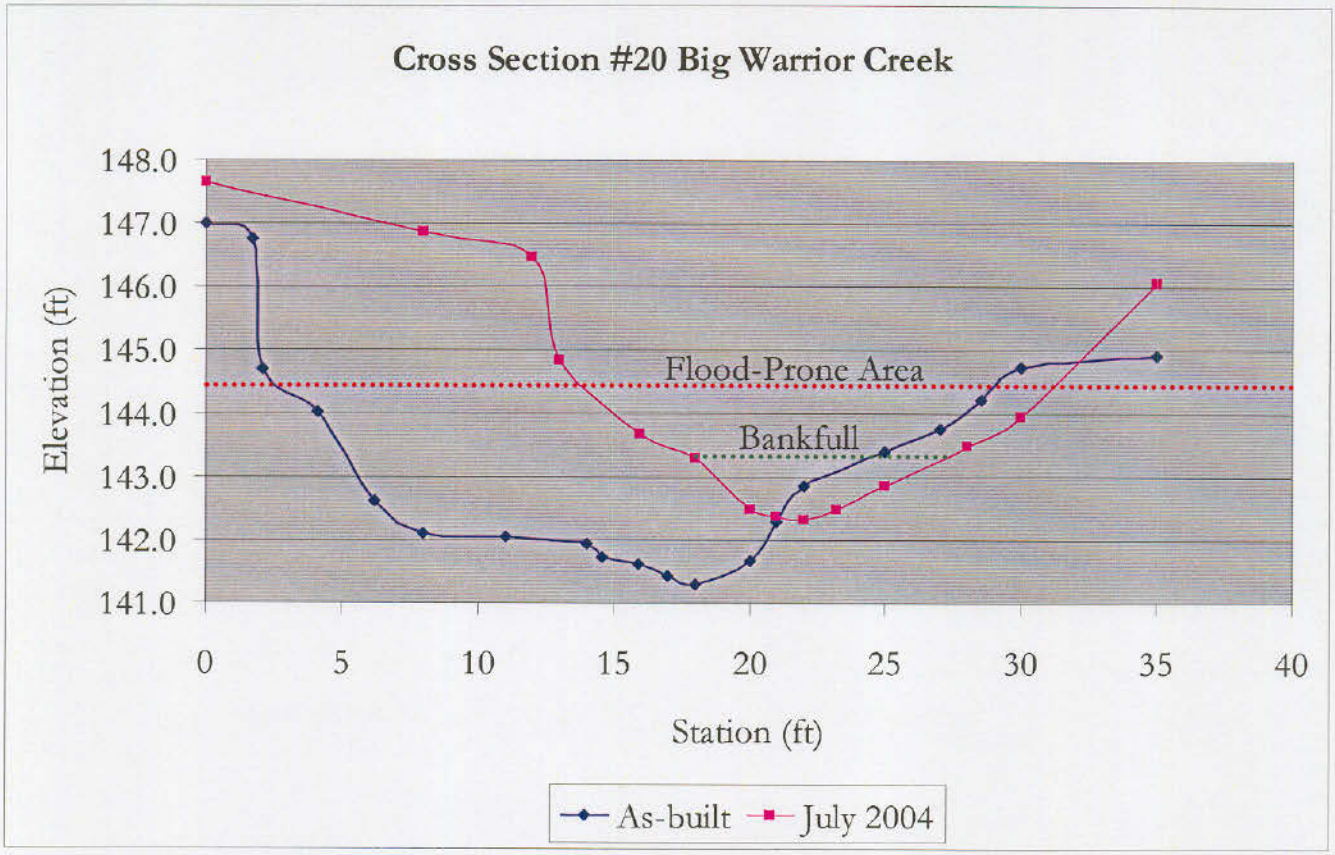


Cross-Section #18 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	10.5	12.5
Maximum Bankfull Depth (ft)	1.5	1.5
Bankfull Mean Depth (ft)	0.8	0.8
Width/Depth Ratio	18.6	19.9
Entrenchment Ratio	2.5	1.9
Bankfull Width (ft)	14	15.7
Width of Flood Prone Area	25	30

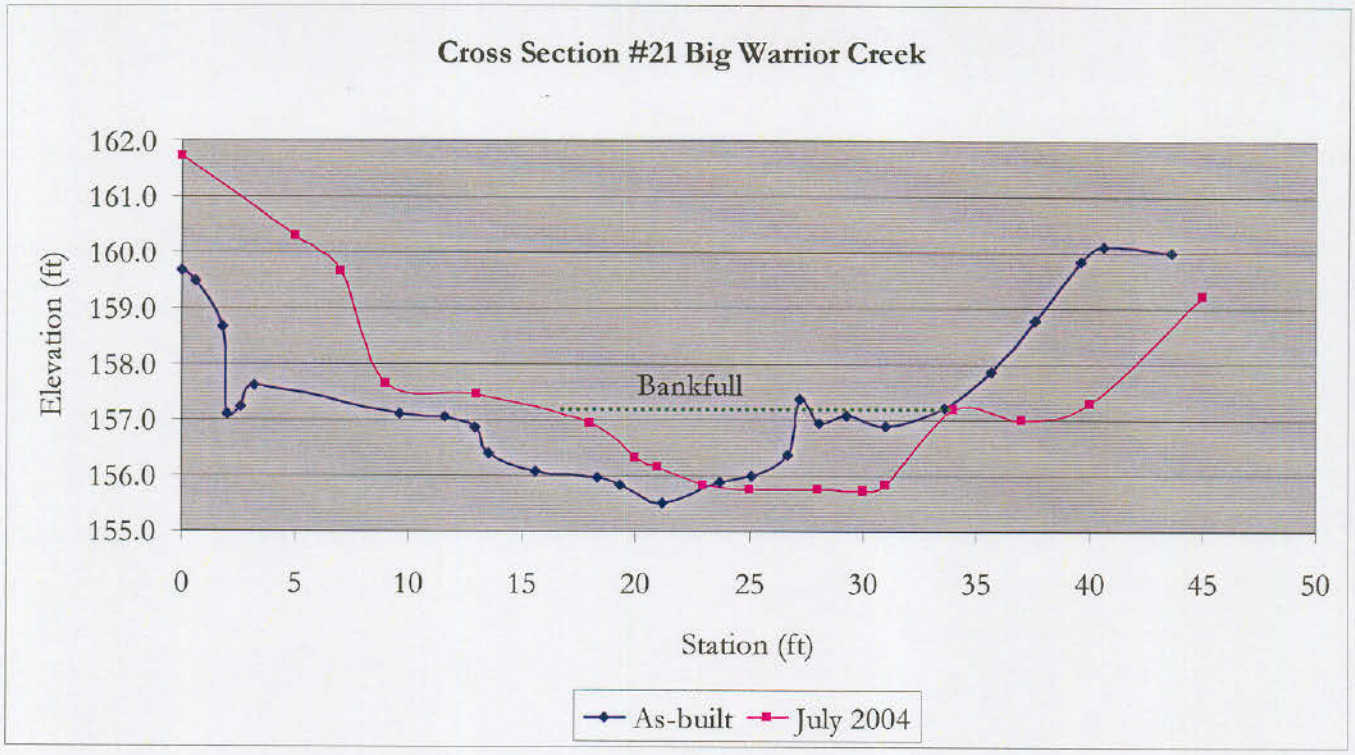


Cross-Section #19 (Run) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	16	9.8
Maximum Bankfull Depth (ft)	1.5	1.1
Entrenchment Ratio	1.7	1.8
Bankfull Width (ft)	17.2	12.8

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.

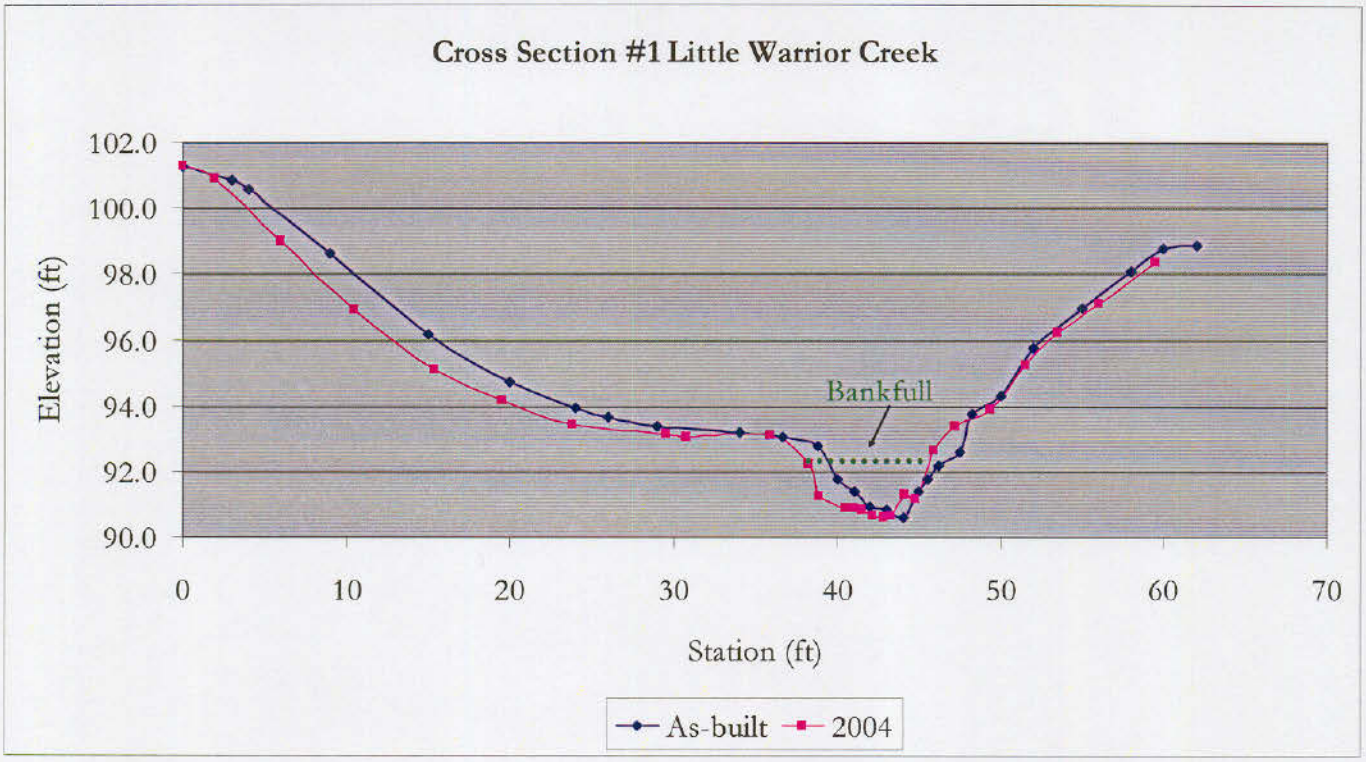


Cross-Section #20 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	14.8	5.4
Maximum Bankfull Depth (ft)	1.6	1
Bankfull Mean Depth (ft)	0.9	0.6
Width/Depth Ratio	17.3	15.5
Entrenchment Ratio	1.6	1.9
Bankfull Width (ft)	16	9.1
Width of Flood Prone Area	26	17



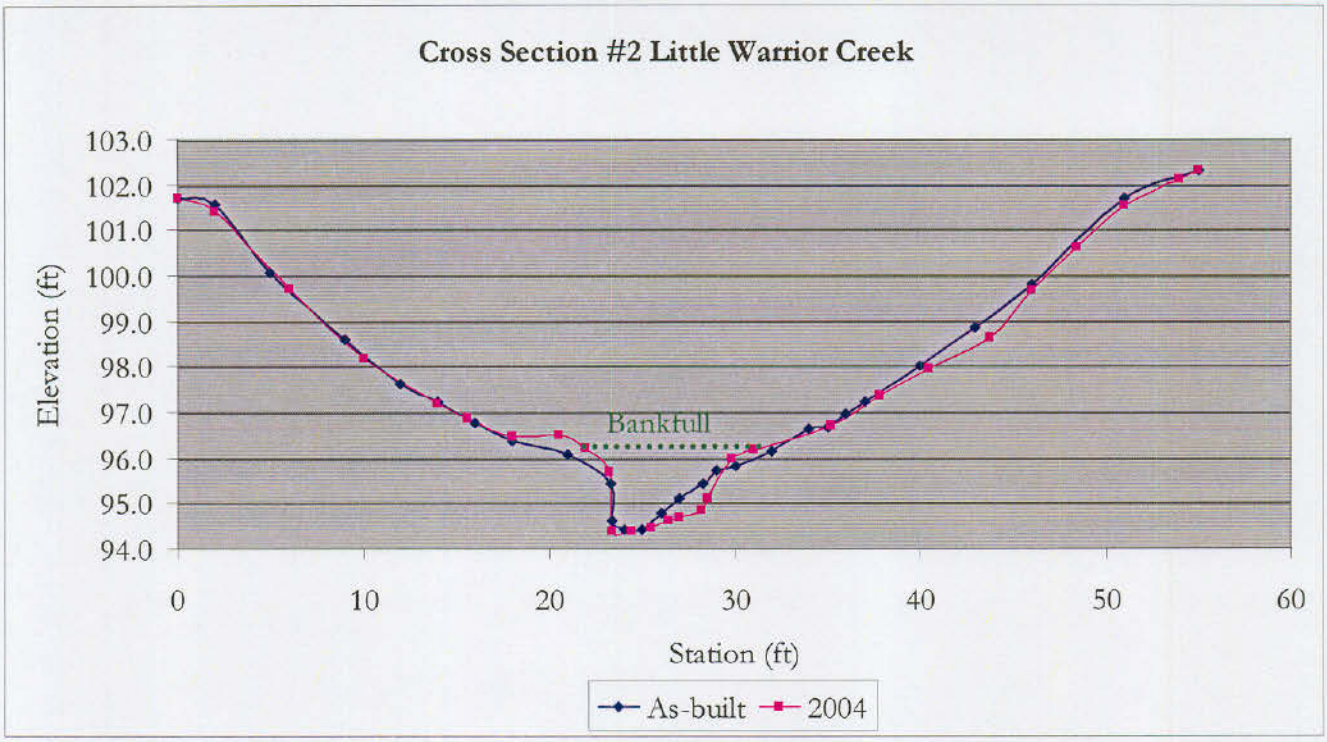
Cross-Section #21 (Pool) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	12.3	18.8
Maximum Bankfull Depth (ft)	1.4	1.5
Bankfull Mean Depth (ft)	0.9	0.8
Bankfull Width (ft)	14	23.6

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



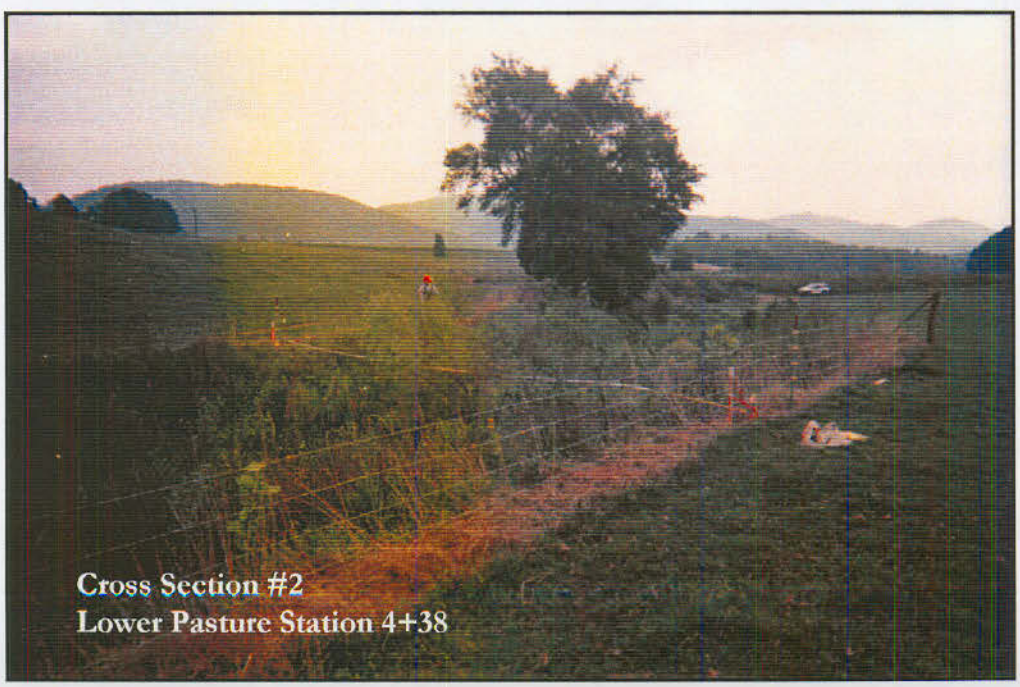
Cross-Section #1 (Pool) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	6.5	12
Maximum Bankfull Depth (ft)	2.2	2
Bankfull Mean Depth (ft)	0.7	1.4
Bankfull Width (ft)	9.1	8.9

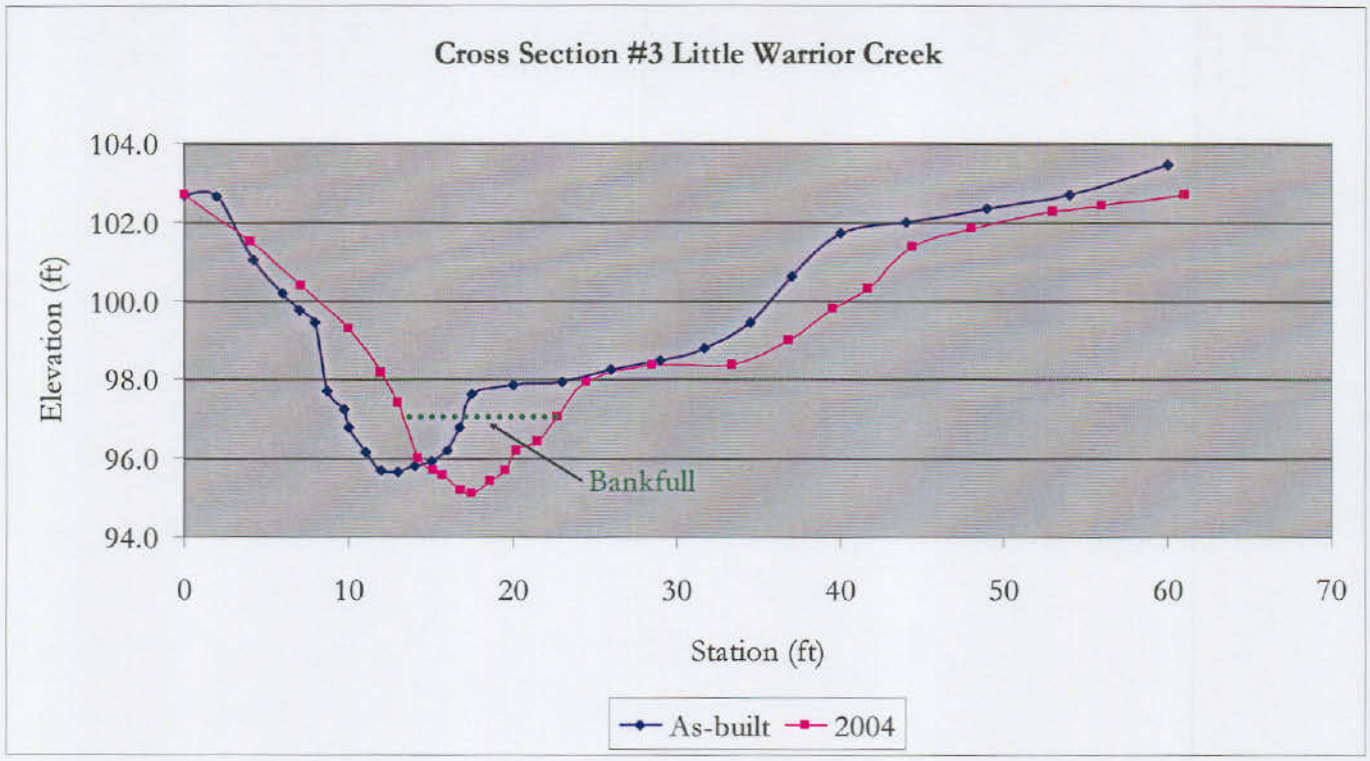
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



Cross-Section #2 (Run) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	16.1	10
Maximum Bankfull Depth (ft)	2.2	1.8
Entrenchment Ratio	2.1	3.3
Bankfull Width (ft)	17	9.4

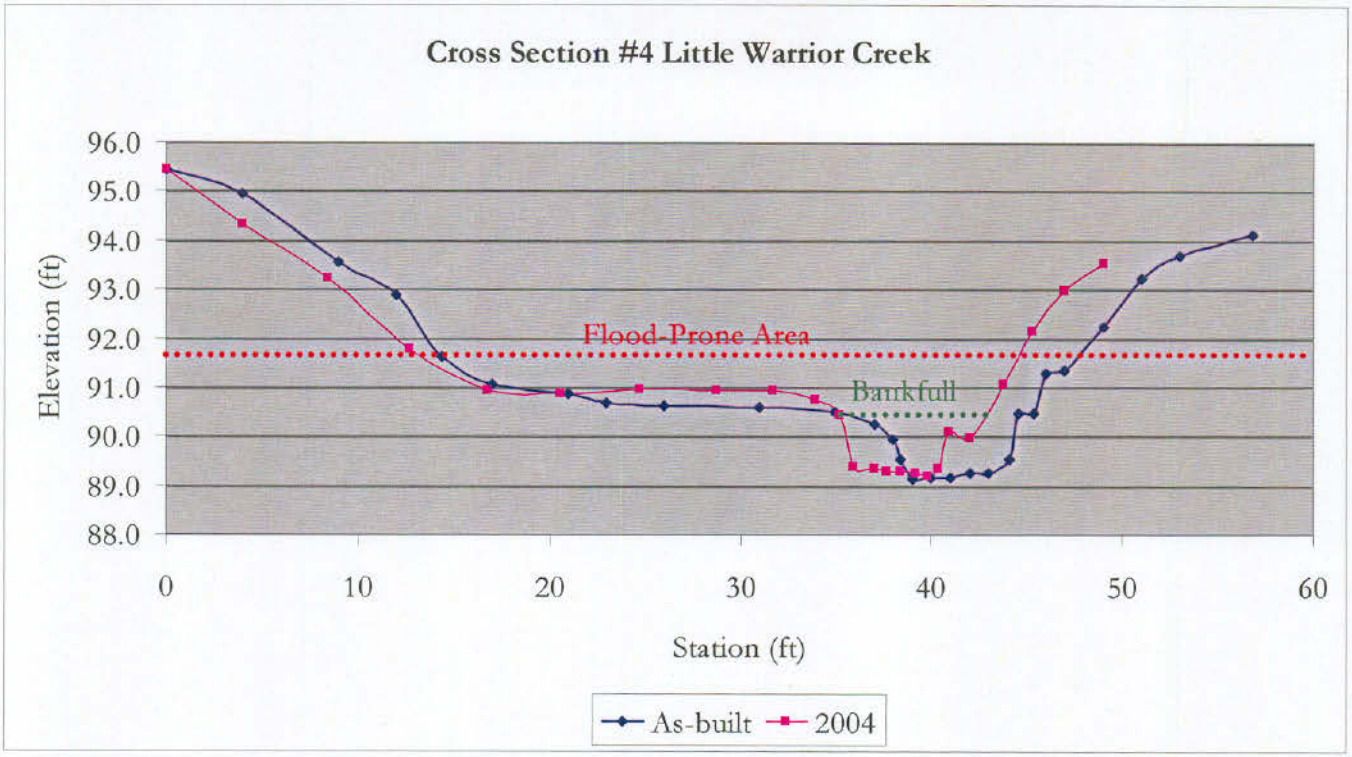
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



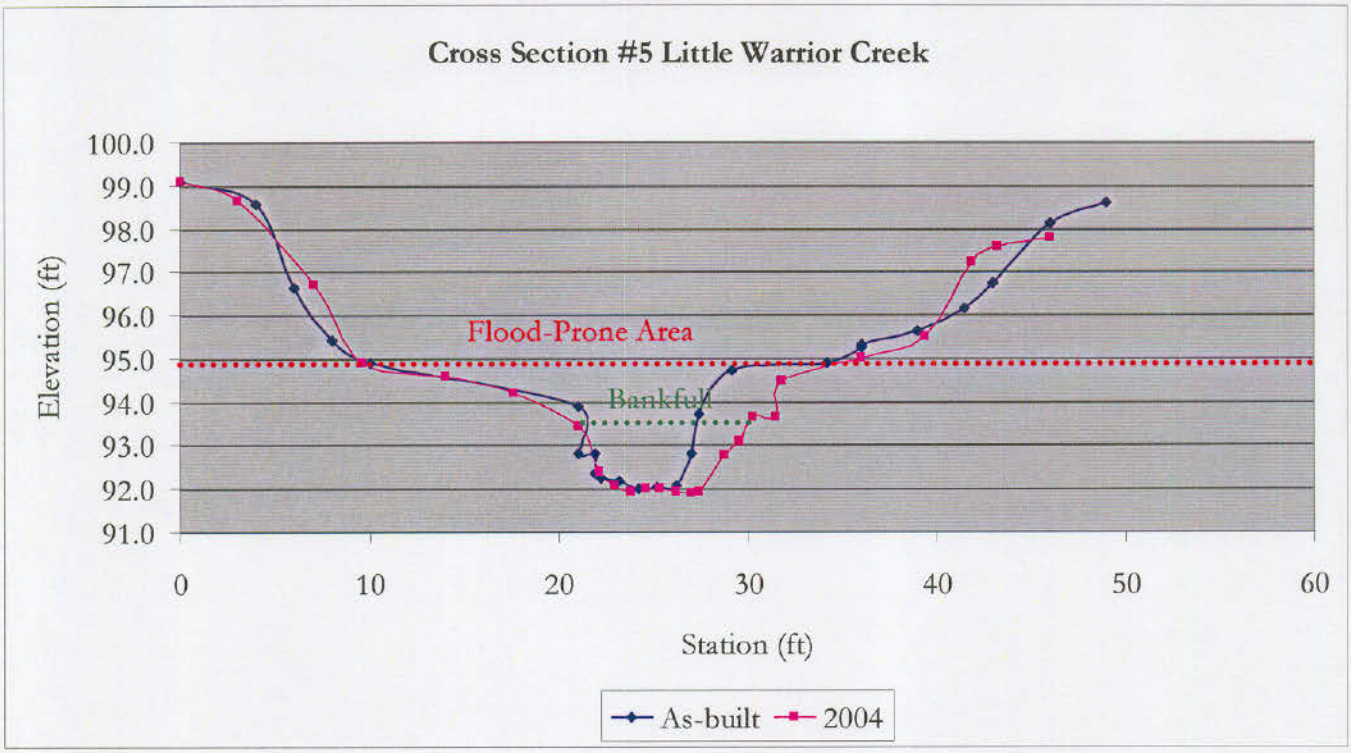


Cross-Section #3 (Pool) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	11.8	10.9
Maximum Bankfull Depth (ft)	2.2	1.9
Bankfull Mean Depth (ft)	1.0	1.2
Bankfull Width (ft)	11.5	9.4

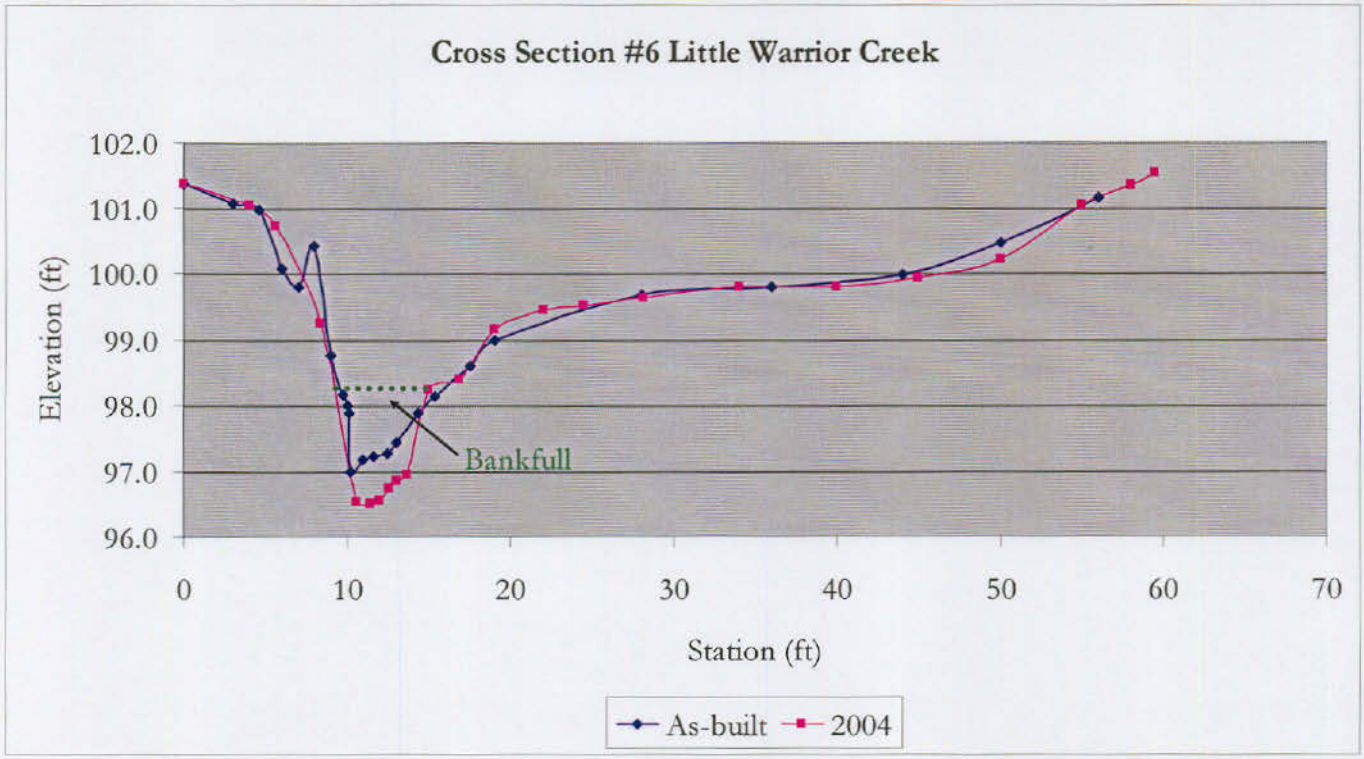
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



Cross-Section #4 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	6.2	6.5
Maximum Bankfull Depth (ft)	1.4	1.2
Bankfull Mean Depth (ft)	0.6	0.9
Width/Depth Ratio	16.1	3.6
Entrenchment Ratio	3.6	8.7
Bankfull Width (ft)	10	7.6
Width of Flood Prone Area	36	40

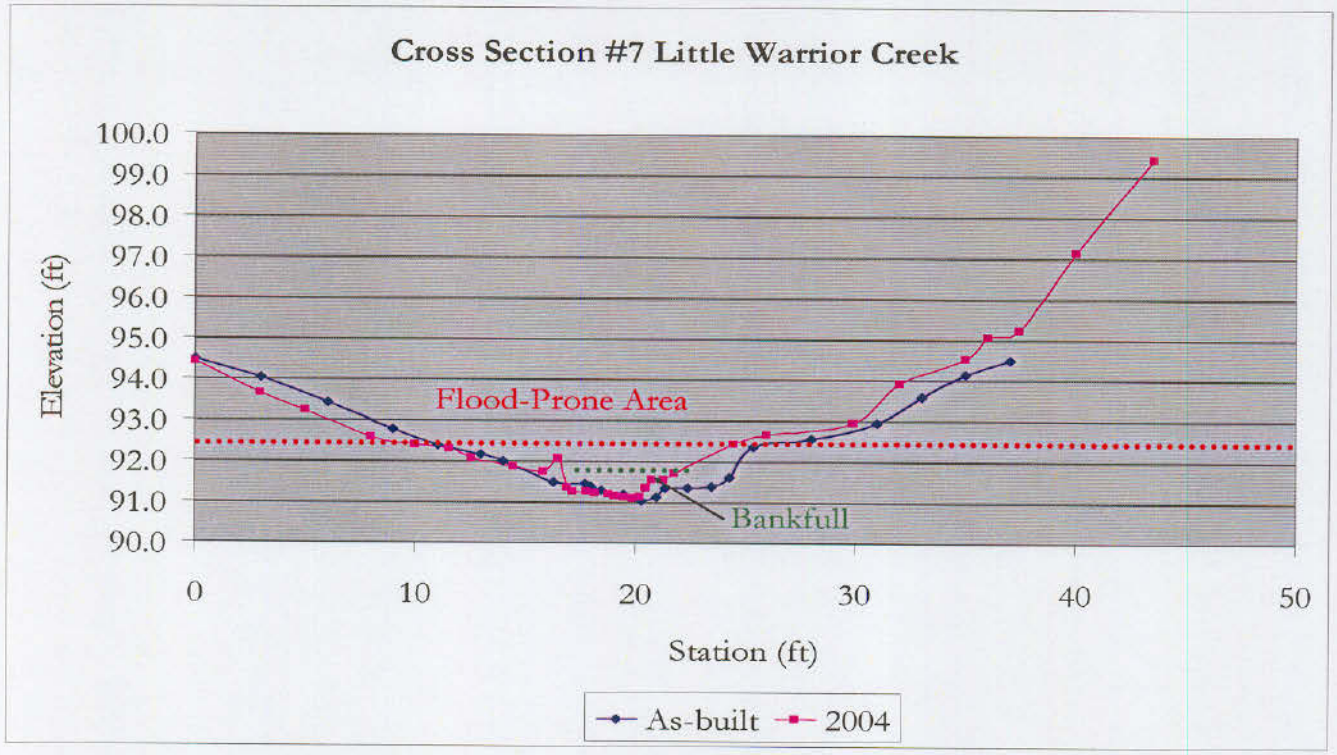


Cross-Section #5 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	8.8	10
Maximum Bankfull Depth (ft)	1.9	1.5
Bankfull Mean Depth (ft)	1.2	1.1
Width/Depth Ratio	5.9	8.1
Entrenchment Ratio	4.6	3
Bankfull Width (ft)	7.2	9
Width of Flood Prone Area	33	27

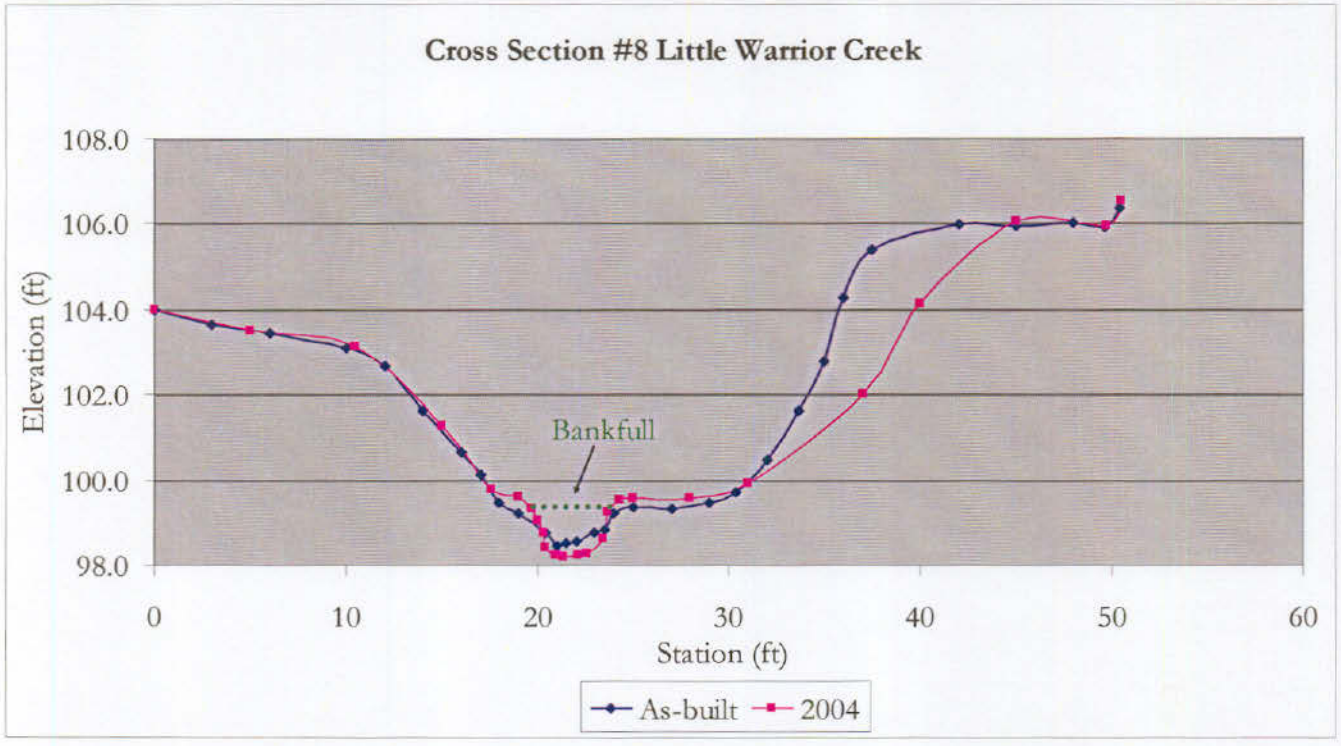


Cross-Section #6 (Run) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	10.2	5.8
Maximum Bankfull Depth (ft)	2	1.7
Bankfull Mean Depth (ft)	1	1.3
Bankfull Width (ft)	10.5	4.6

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.

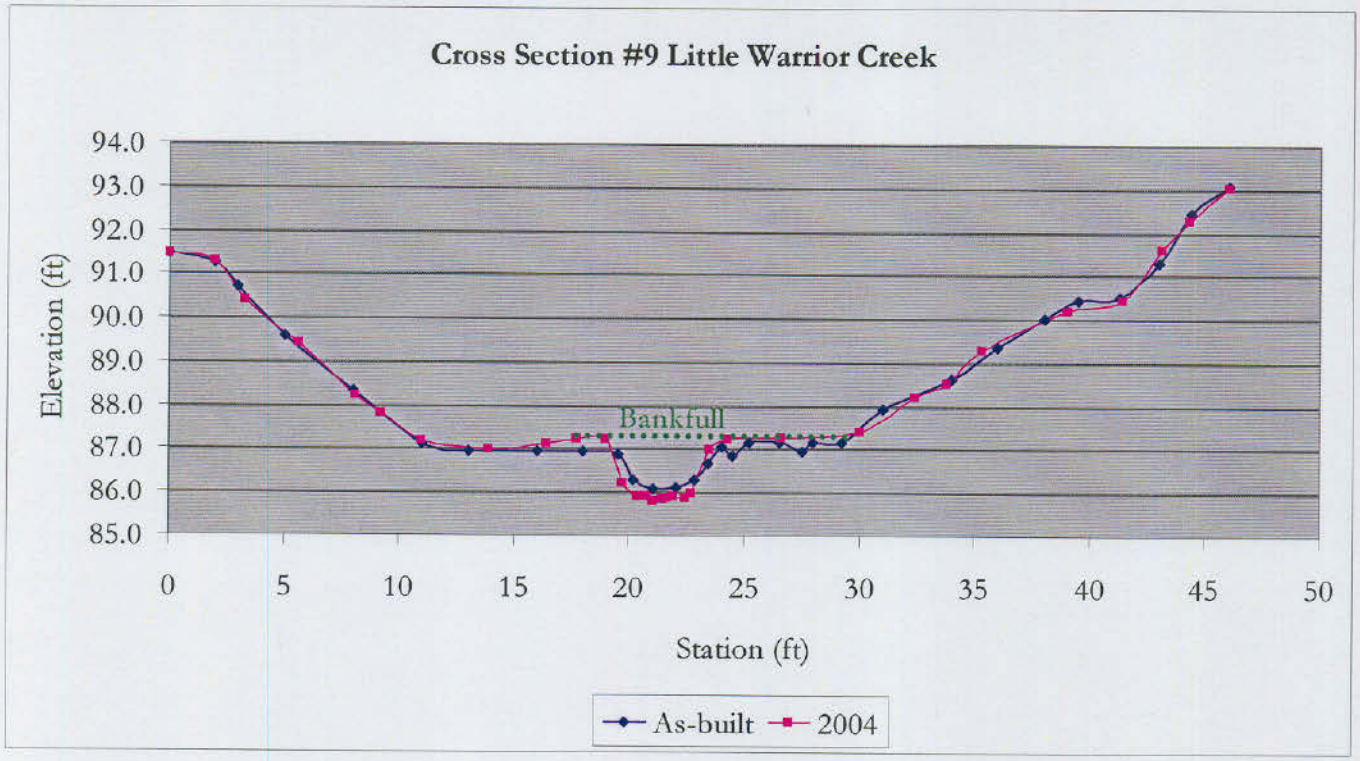


Cross-Section #7 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	10.6	2.2
Maximum Bankfull Depth (ft)	1.3	0.6
Bankfull Mean Depth (ft)	0.8	0.4
Width/Depth Ratio	18.3	12.5
Entrenchment Ratio	2.1	3
Bankfull Width (ft)	13.9	5.3
Width of Flood Prone Area	28	16



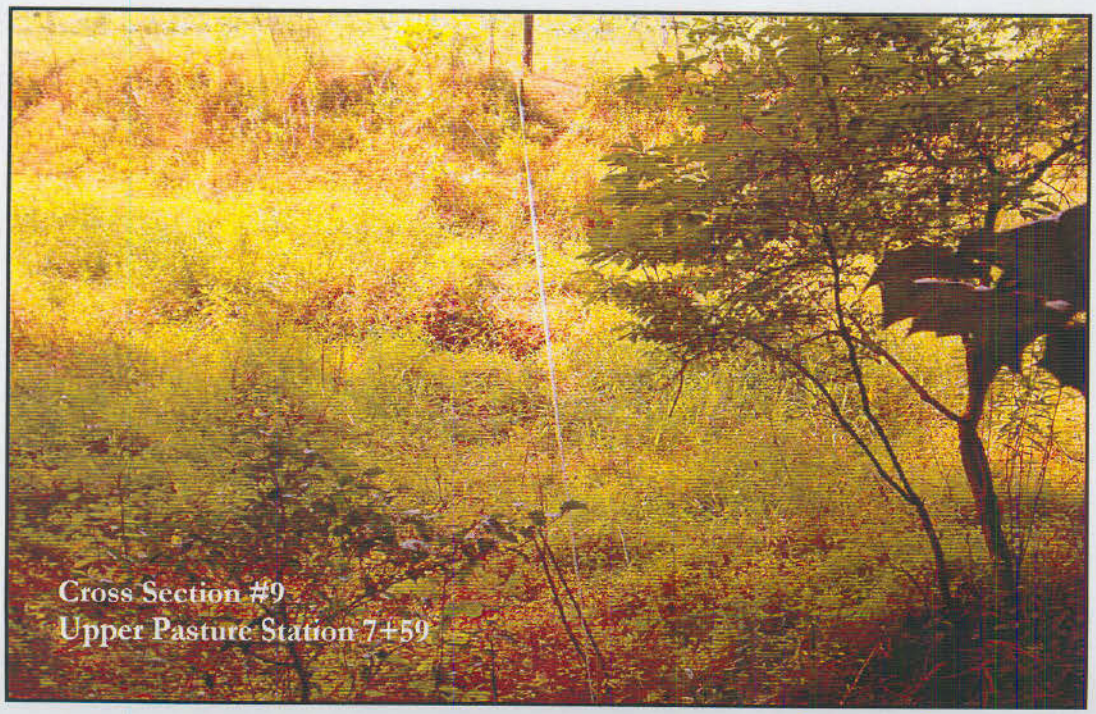
Cross-Section #8 (Glide) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	7	3.5
Maximum Bankfull Depth (ft)	23.7	1.1
Bankfull Mean Depth (ft)	1.4	0.8
Bankfull Width (ft)	12.9	4.2

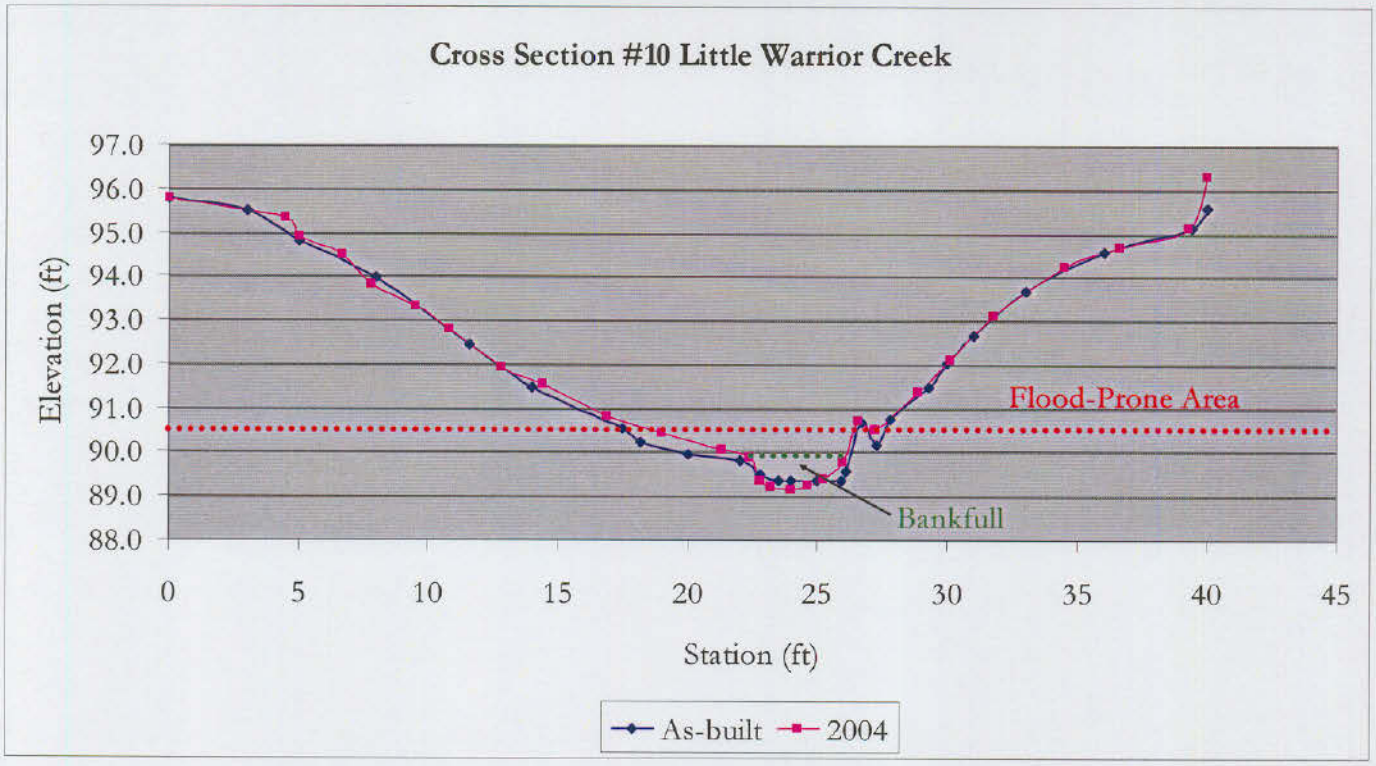
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



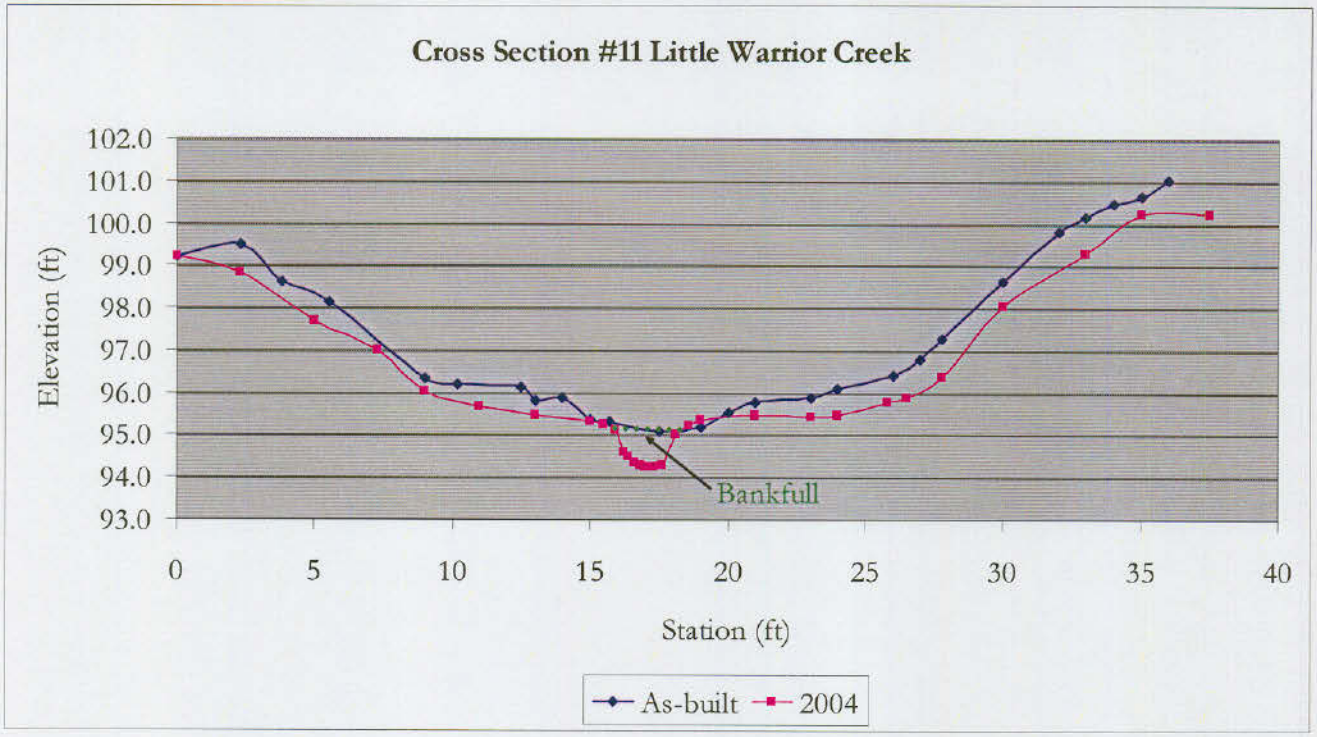
Cross-Section #9 (Glide) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	5.4	5.7
Maximum Bankfull Depth (ft)	1.1	1.4
Bankfull Mean Depth (ft)	0.4	0.5
Bankfull Width (ft)	14.2	12

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.



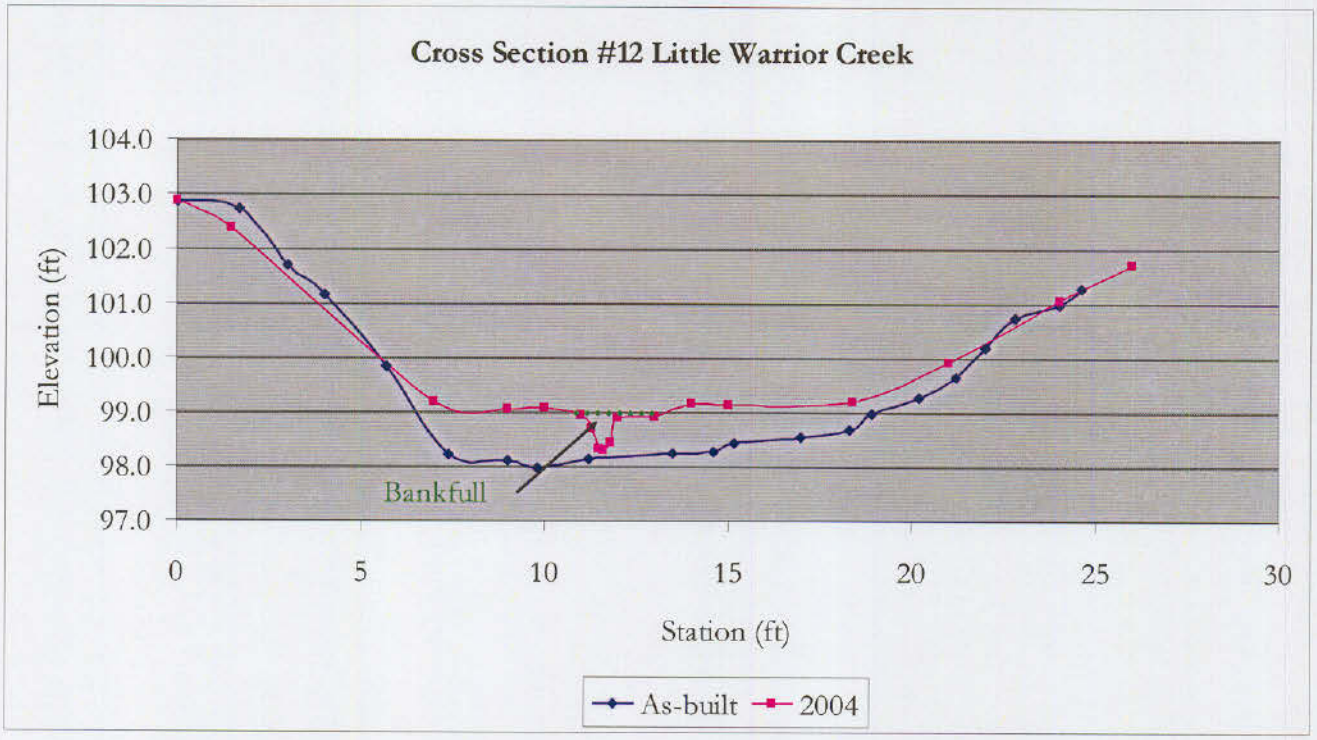


Cross-Section #10 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	7.2	1.8
Maximum Bankfull Depth (ft)	1.2	0.7
Bankfull Mean Depth (ft)	0.7	0.5
Width/Depth Ratio	14	7.3
Entrenchment Ratio	1.7	2.7
Bankfull Width (ft)	10	3.7
Width of Flood Prone Area	16	10



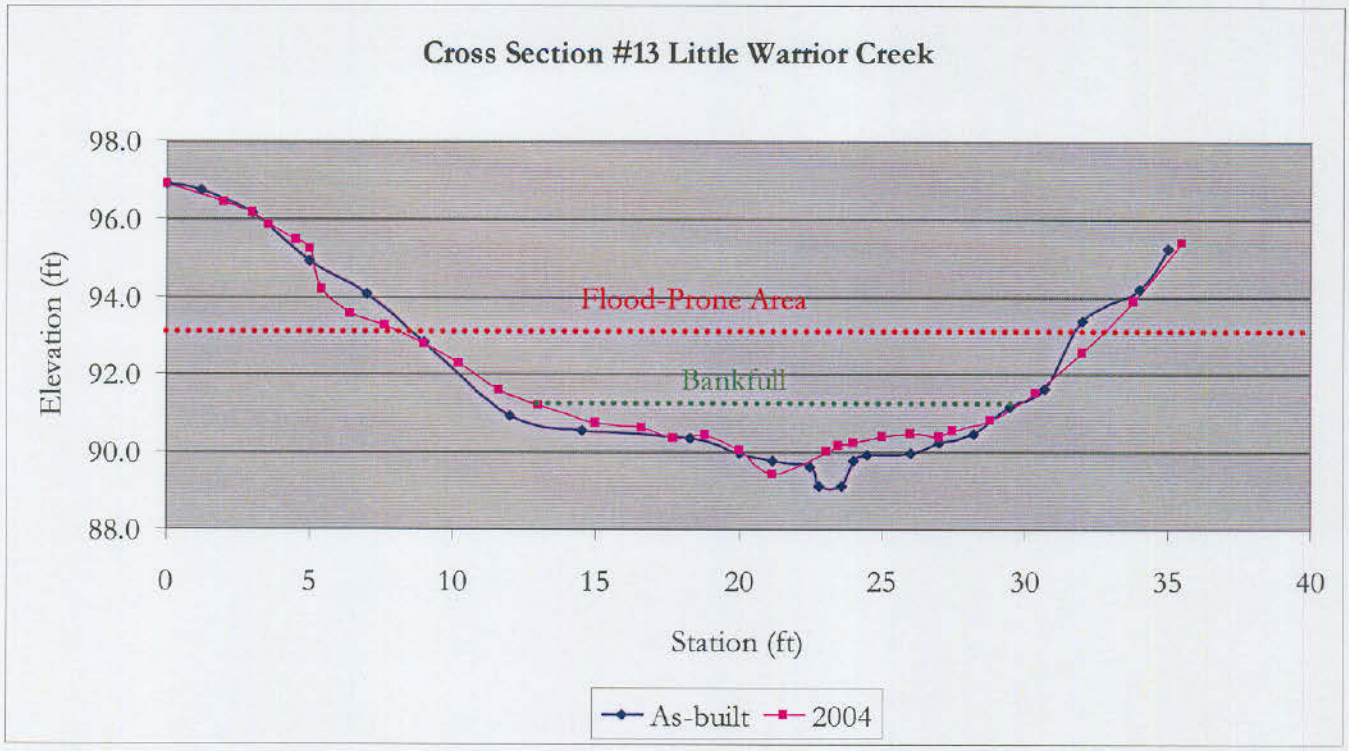
Cross-Section #11 (Run) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	3.8	1.4
Maximum Bankfull Depth (ft)	0.8	0.9
Bankfull Mean Depth (ft)	0.4	0.6
Bankfull Width (ft)	9	2.4

*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.

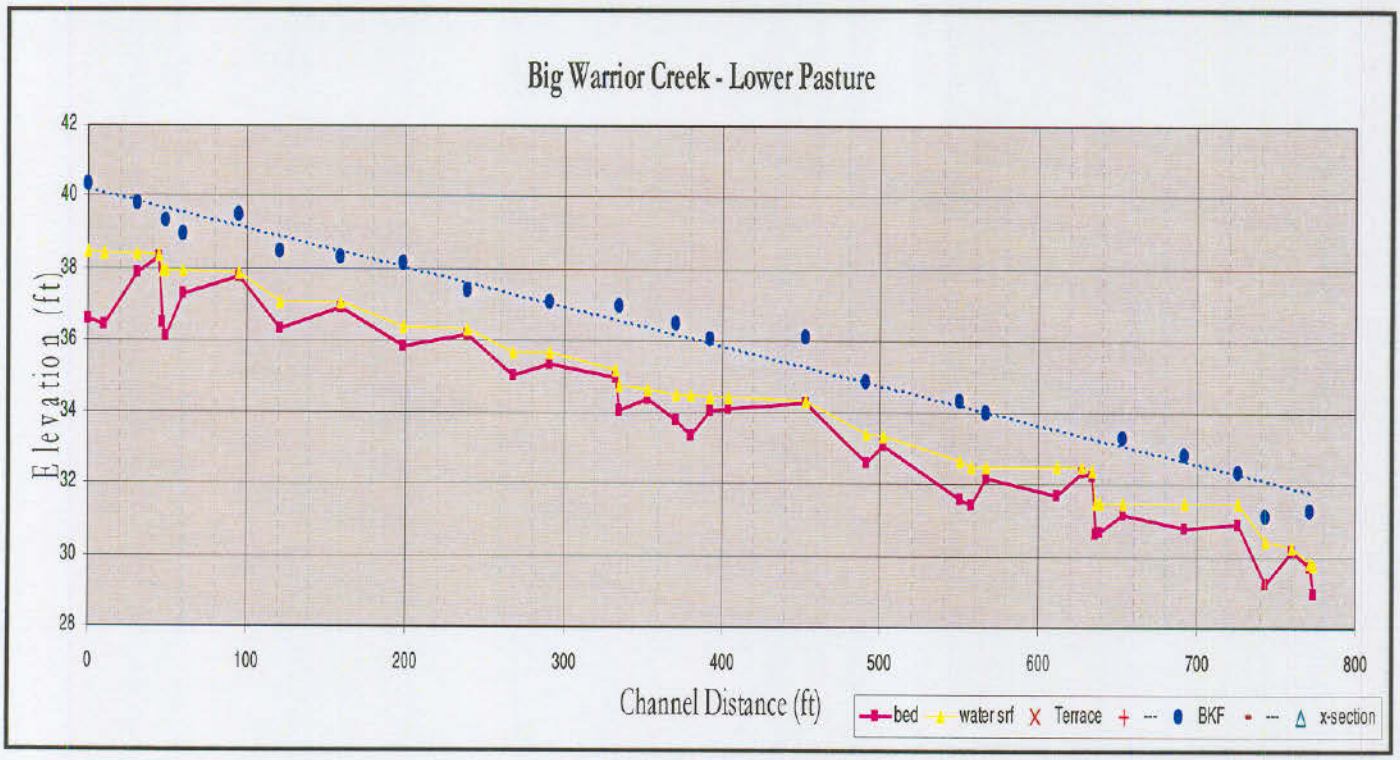


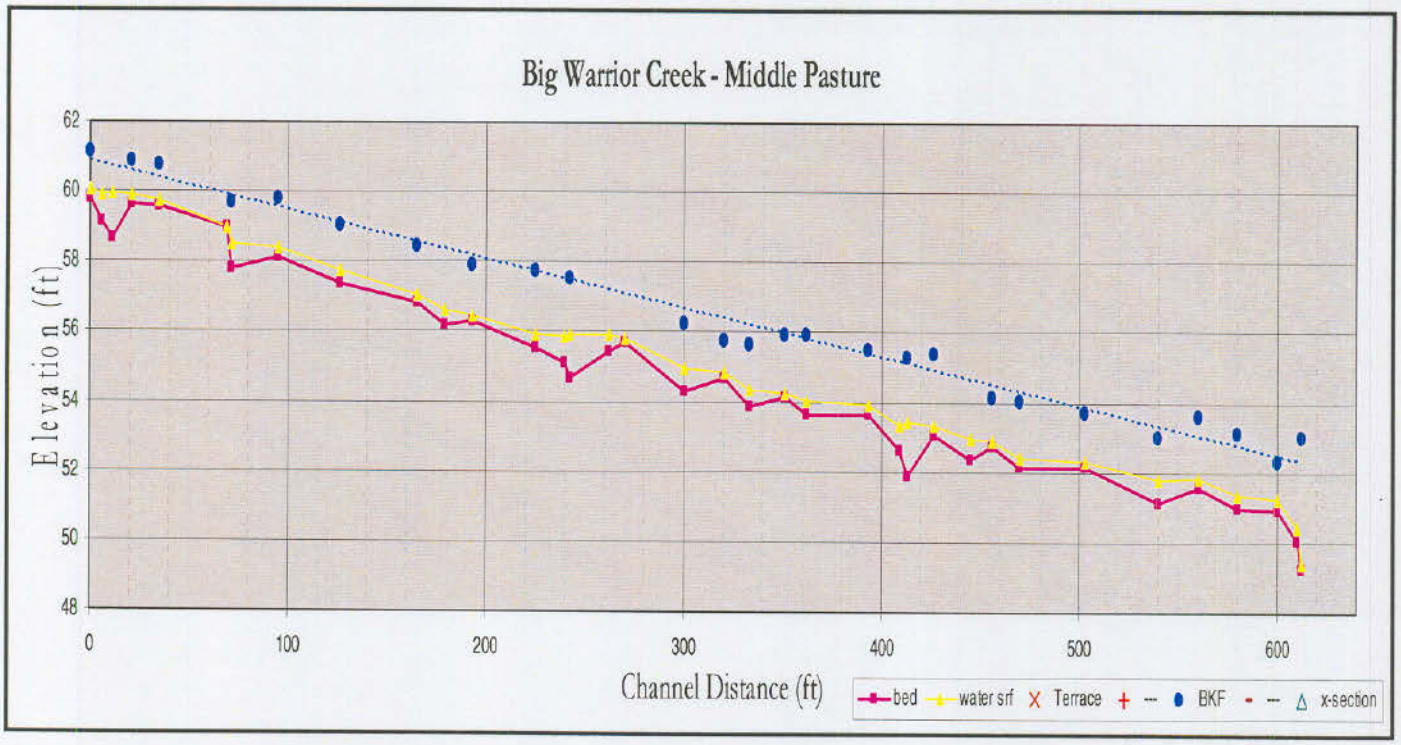
Cross-Section #12 (Run) Abbreviated Morphological Summary*		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	3	0.4
Maximum Bankfull Depth (ft)	0.6	0.7
Bankfull Mean Depth (ft)	0.3	0.2
Bankfull Width (ft)	10	2.1

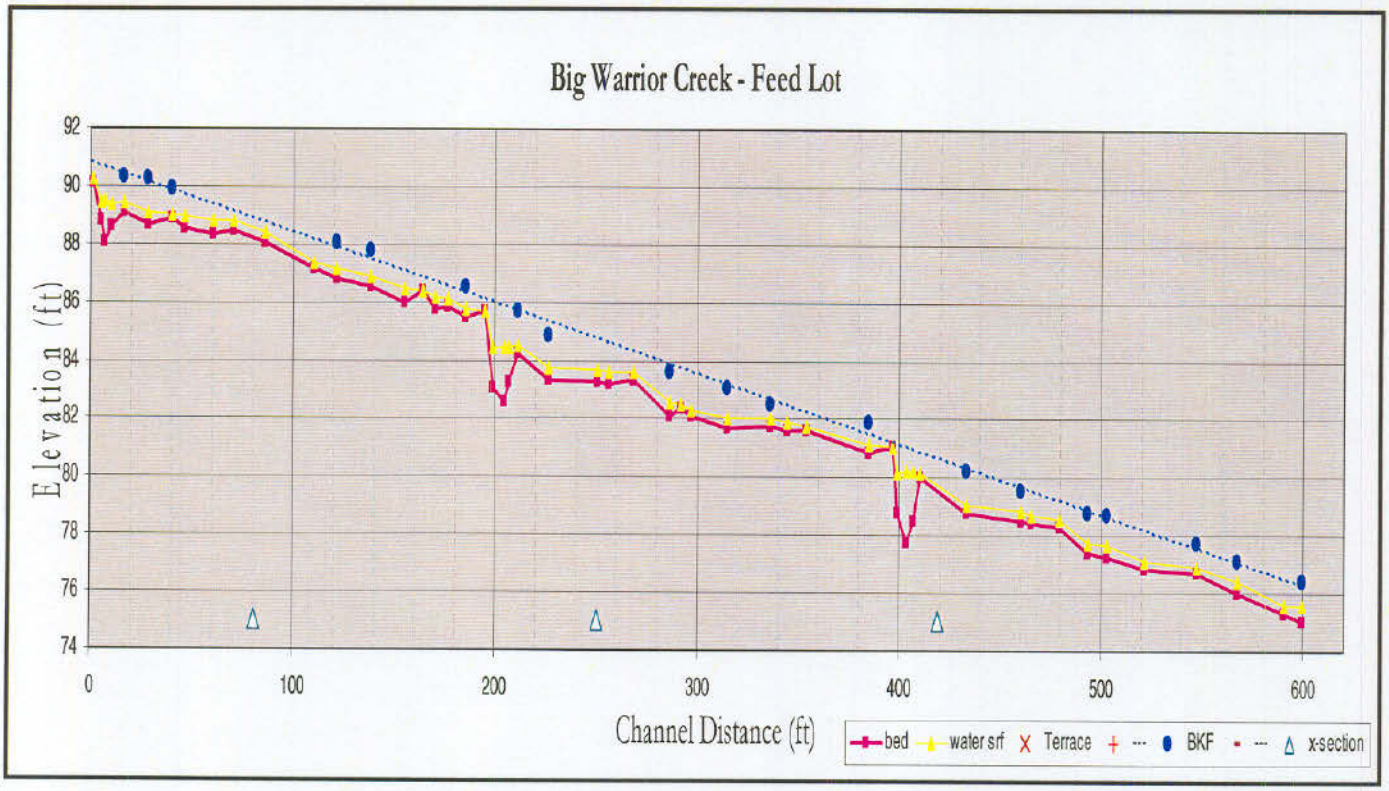
*According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide or run features.

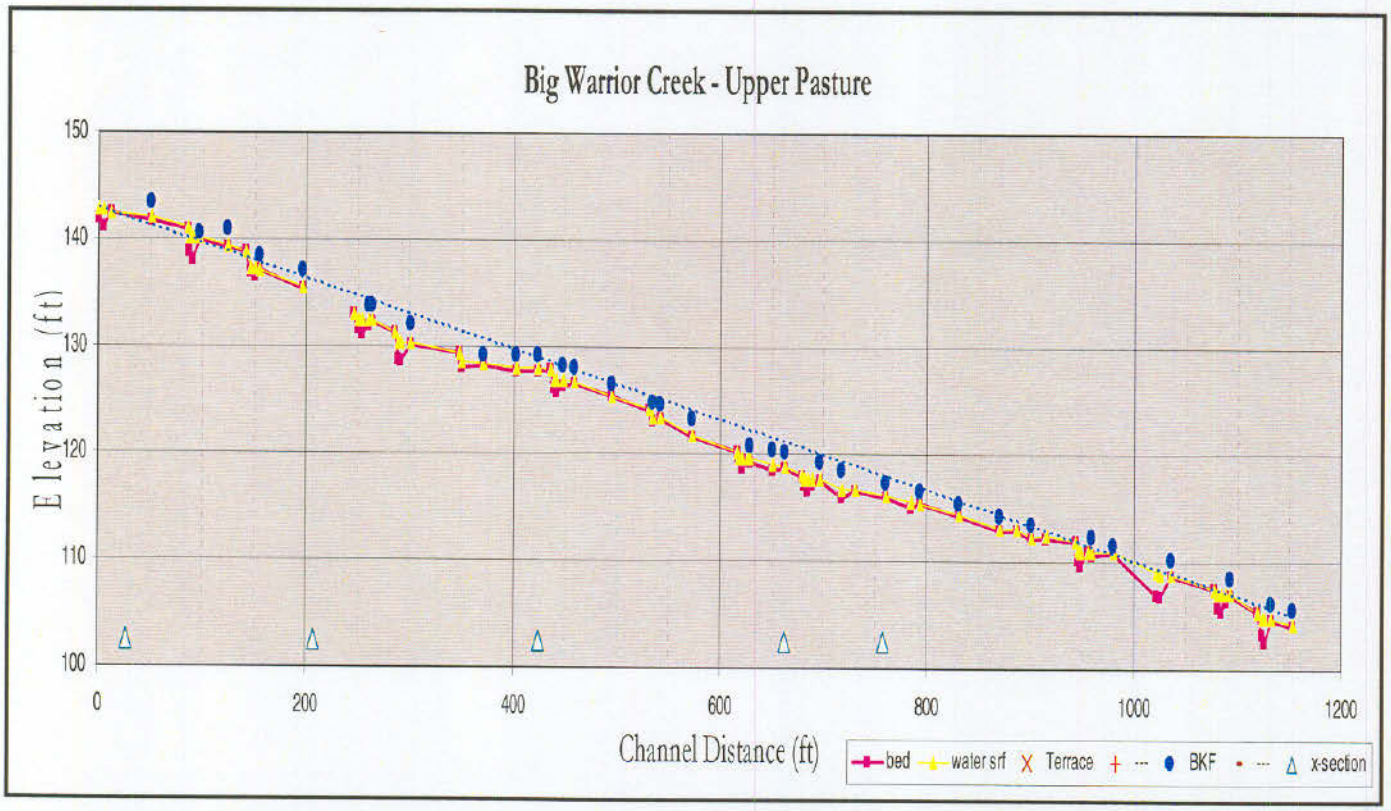


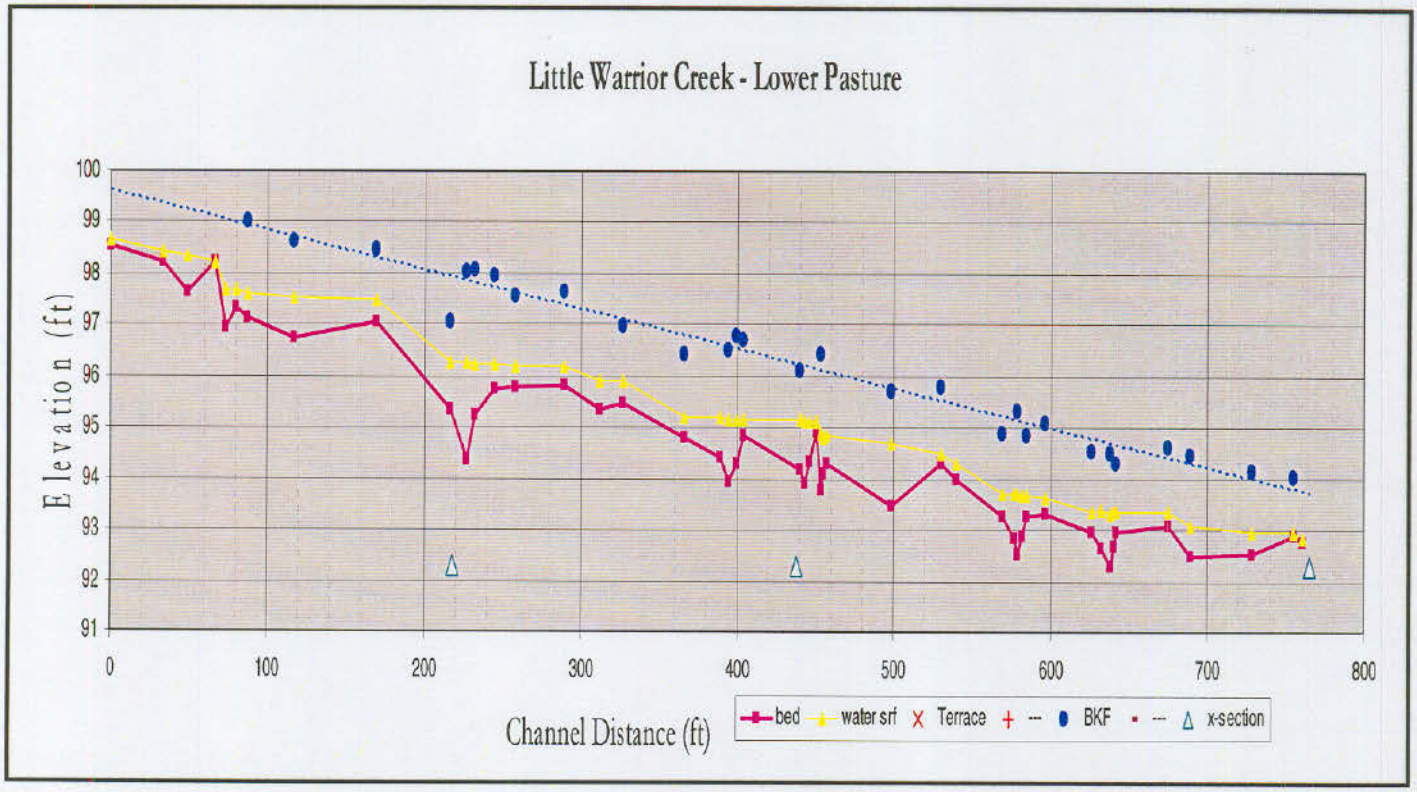
Cross-Section #13 (Riffle) Abbreviated Morphological Summary		
	As-built	2004
Bankfull Cross Sectional Area (ft2)	3.6	13.1
Maximum Bankfull Depth (ft)	1.1	1.8
Bankfull Mean Depth (ft)	0.4	0.8
Width/Depth Ratio	20.3	21.2
Entrenchment Ratio	2.1	1.4
Bankfull Width (ft)	8.5	16.7
Width of Flood Prone Area	18	24

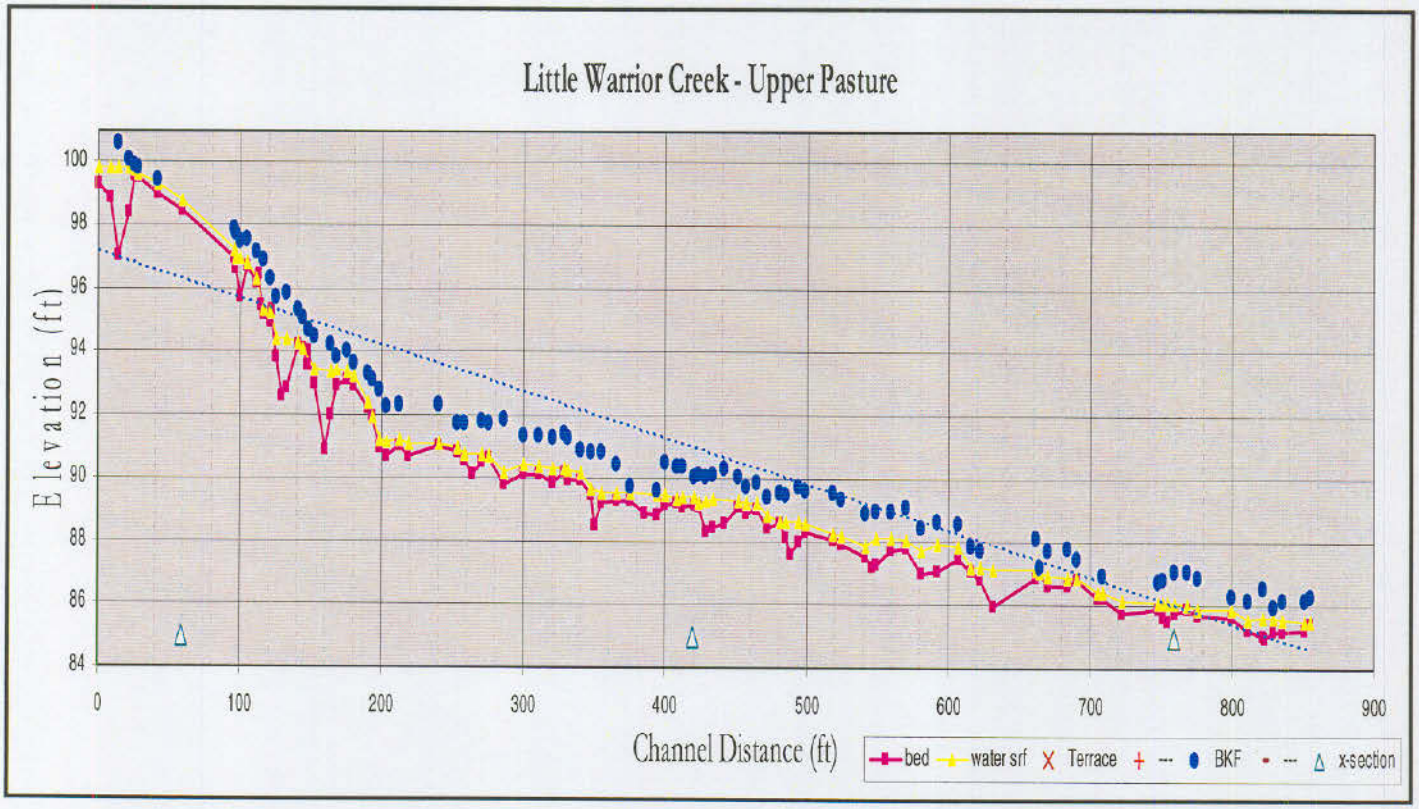

Big Warrior Creek - Lower Pasture
Elevation (ft)
42
40
38
36
34
32
30
28
0
100
200
300
400
500
600
700
800
Channel Distance (ft)
bed
water srf
Terrace
BKF
x-section

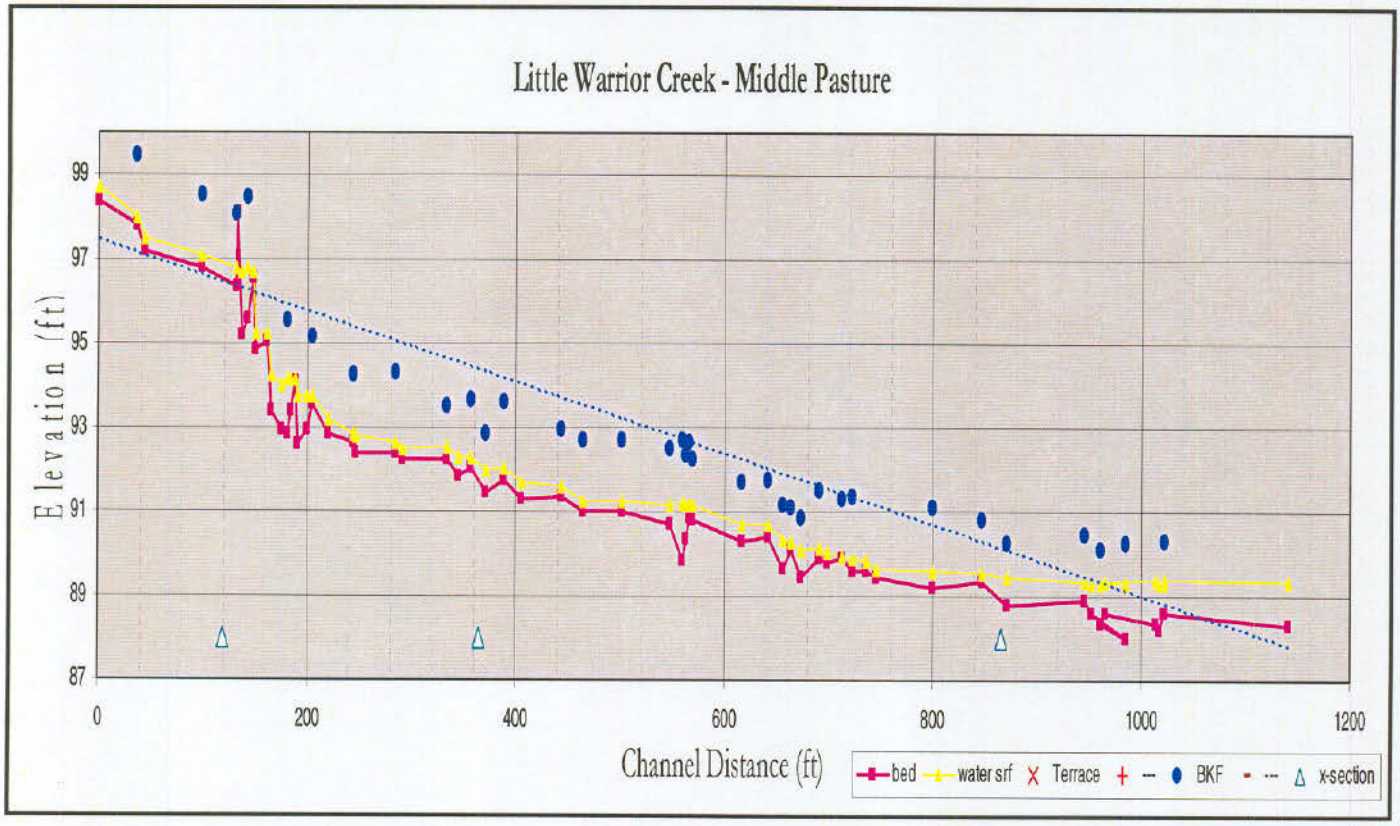

Big Warrior Creek - Middle Pasture
Elevation (ft)
62
60
58
56
54
52
50
48
0
100
200
300
400
500
600
Channel Distance (ft)
bed
water srf
Terrace
BKF
x-section


Big Warrior Creek - Feed Lot
Elevation (ft)
92
90
88
86
84
82
80
78
76
74
0
100
200
300
400
500
600
Channel Distance (ft)
bed
water srf
Terrace
BKF
x-section


Big Warrior Creek - Upper Pasture
Elevation (ft)
150
140
130
120
110
100
0
200
400
600
800
1000
1200
Channel Distance (ft)
bed
water srf
Terrace
BKF
x-section


Little Warrior Creek - Lower Pasture
Elevation (ft)
100
99
98
97
96
95
94
93
92
91
0
100
200
300
400
500
600
700
800
Channel Distance (ft)
bed
water srf
Terrace
BKF
x-section


Little Warrior Creek - Upper Pasture
Elevation (ft)
100
98
96
94
92
90
88
86
84
0
100
200
300
400
500
600
700
800
900
Channel Distance (ft)
bed
water srf
Terrace
BKF
x-section


Little Warrior Creek - Middle Pasture
Elevation (ft)
99
97
95
93
91
89
87
0
200
400
600
800
1000
1200
Channel Distance (ft)
bed
water srf
Terrace
BKF
x-section

APPENDIX C

SITE PHOTOGRAPHS

Photo Points - Big Warrior Creek


Photo Point #2 - 1998


Photo Point #2 - 2003


Photo Point #2 - 2004


Photo Point #3 - 1998


Photo Point #3 - 2003


Photo Point #3 - 2004

Photo Point #4 - 1998

Photo Point #4 - 2003

Photo Point #4 - 2004


Photo Point #5 - 1998


Photo Point #5 - 2003


Photo Point #5 - 2004


Photo Point #6 - 1998


Photo Point #6 - 2003


Photo Point #6 - 2004


Photo Point #7 - 1998


Photo Point #7 - 2003


Photo Point #7 - 2004


Photo Point #8 - 2001


Photo Point #8 - 2003


Photo Point #8 - 2004


Photo Point #9 - 2001


Photo Point #9 - 2003


Photo Point #9 - 2004


Photo Point #10 - 1998


Photo Point #10 - 2003


Photo Point #10 - 2004


Photo Point #11 - 1998


Photo Point #11 - 2003


Photo Point #11 - 2004


Photo Point #12 - 1998


Photo Point #12 - 2003

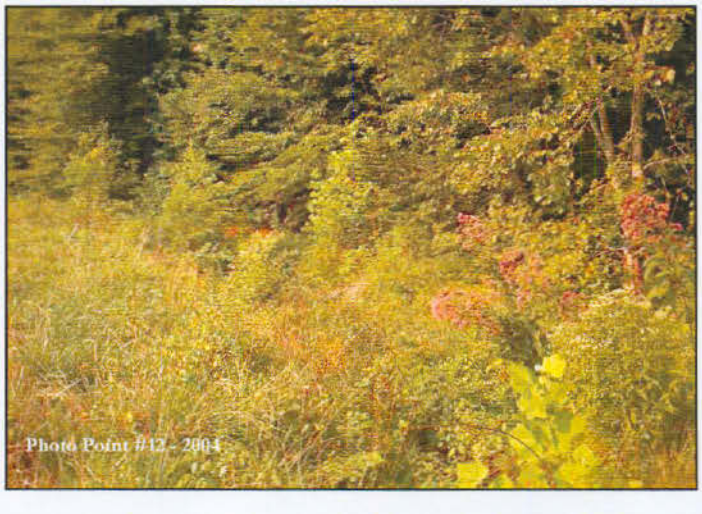


Photo Point #12 - 2004


Photo Point #13 - 1998


Photo Point #13 - 2003

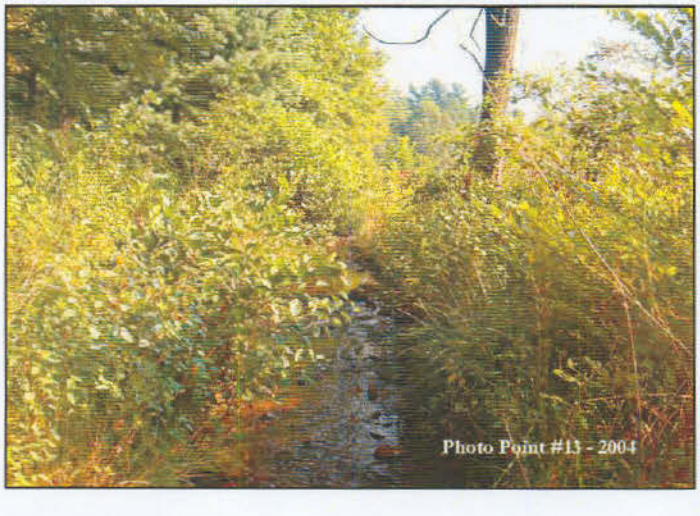
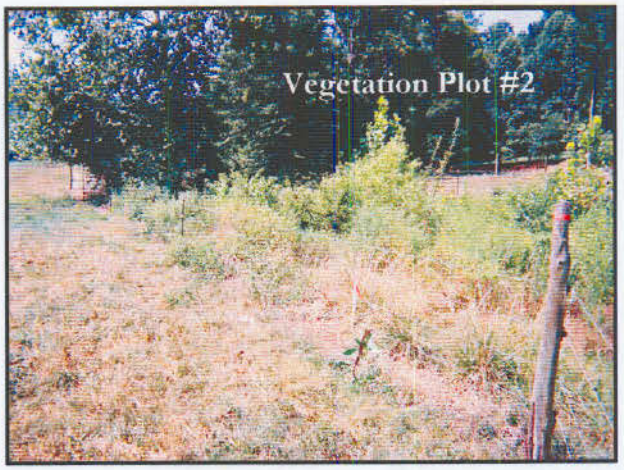
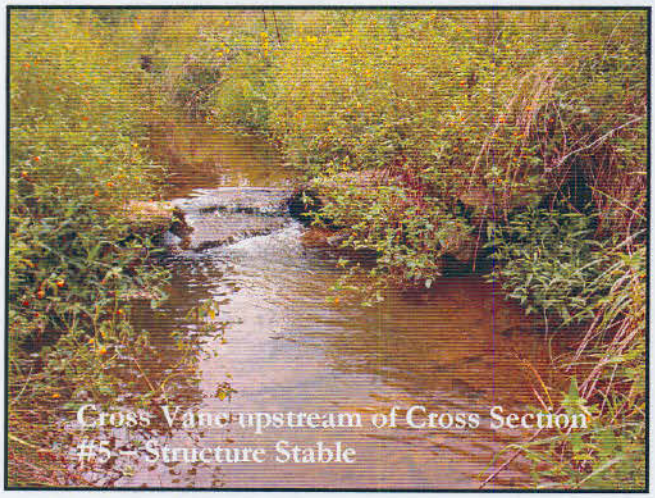


Photo Point #13 - 2004

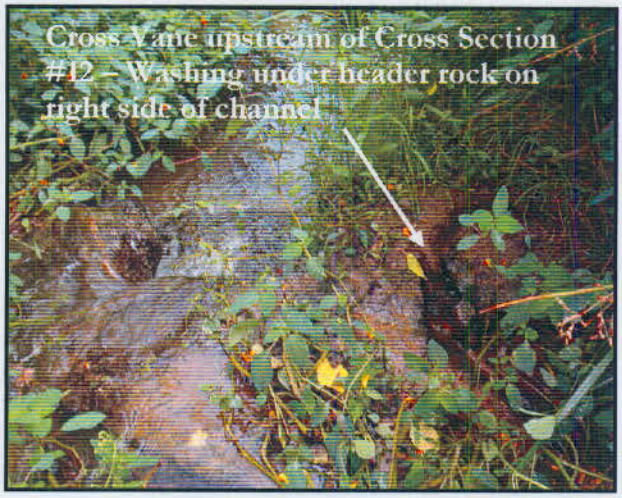
Big Warrior Creek Vegetation Plots



Big Warrior Creek Structures

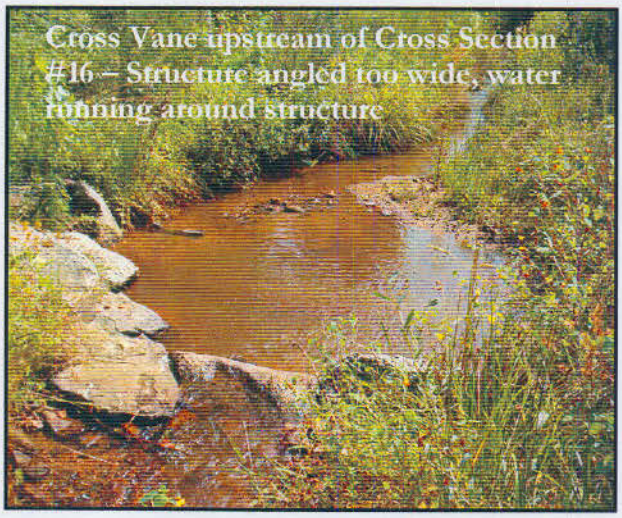


Cross Vane upstream of Cross Section #5 – Structure Stable



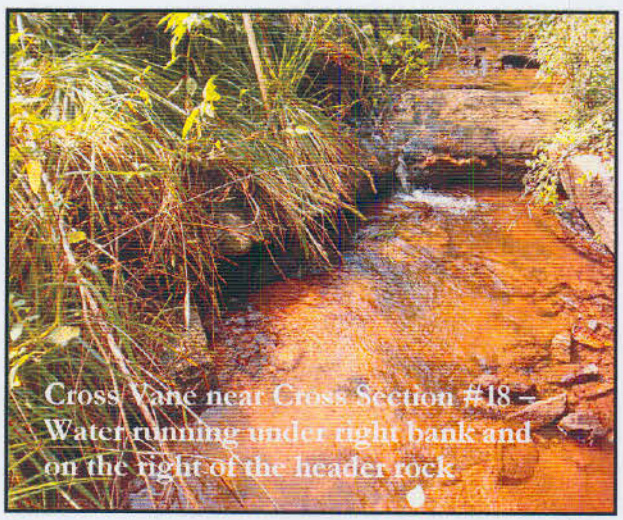
Cross Vane upstream of Cross Section #12 – Washing under header rock on right side of channel

Cross Vane upstream of Cross Section #14 – Structure Stable



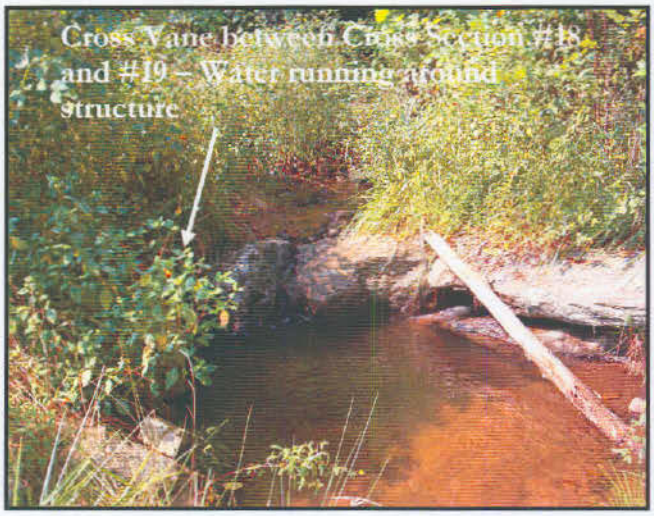
Cross Vane upstream of Cross Section #16 – Structure angled too wide, water running around structure

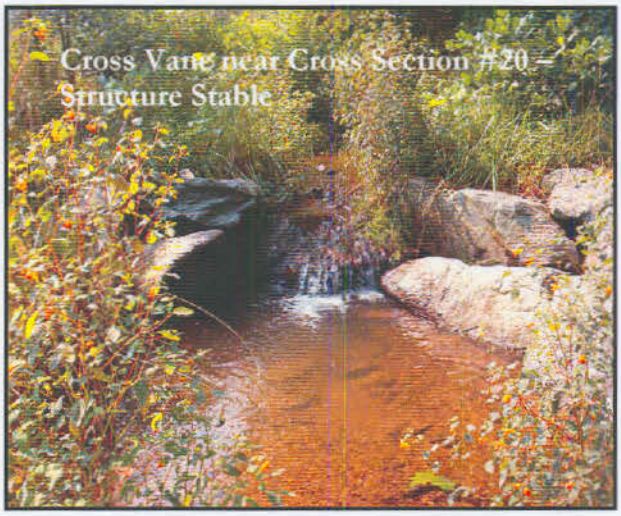
Cross Vane near Bench Mark 121.84 – Structure Stable



Cross Vane near Cross Section #18 – Water running under right bank and on the right of the header rock

Structures (Continued…)


Cross Vane between Cross Section #18 and #19 – Water running around structure


Cross Vane near Cross Section #20 – Structure Stable


Rootwad near Cross Section #10 – Some erosion present behind structure


Rootwad near Cross Section #10 – photo 2


Bank Scour upstream of Lower Pasture Longitudinal Profile Section

Photo Points - Little Warrior Creek


Photo Point #2 - 2001


Photo Point #2 - 2003


Photo Point #2 - 2004


Photo Point #3 - 2001


Photo Point #3 - 2003


Photo Point #3 - 2004


Photo Point #4 - 1998


Photo Point #4 - 2003


Photo Point #4 - 2004


Photo Point #5 - 1998


Photo Point #5 - 2003


Photo Point #5 - 2004


Photo Point #6 - 1998


Photo Point #6 - 2003


Photo Point #6 – 2004


Photo Point #7 - 1998


Photo Point #7 - 2003


Photo Point #7 - 2004


Photo Point #8 - 1998


Photo Point #8 - 2003

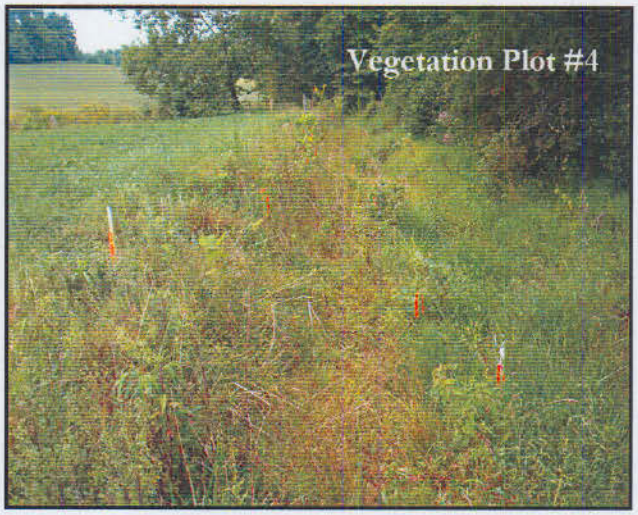

Photo Point #8 - 2004


Photo Point #9 - 1998

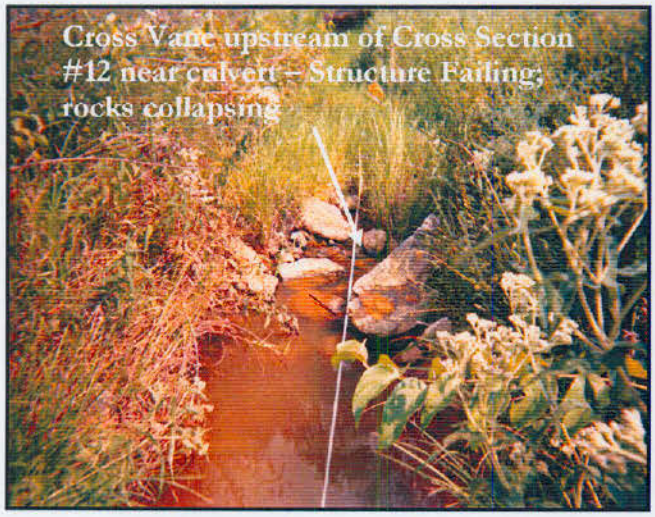

Photo Point #9 - 2003

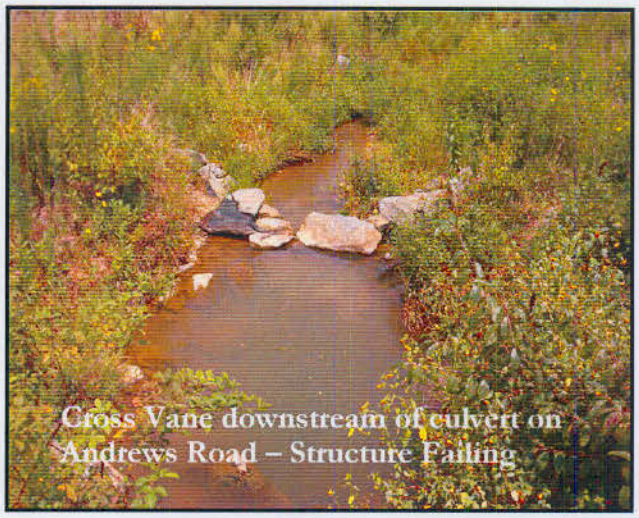

Photo Point #9 - 2004

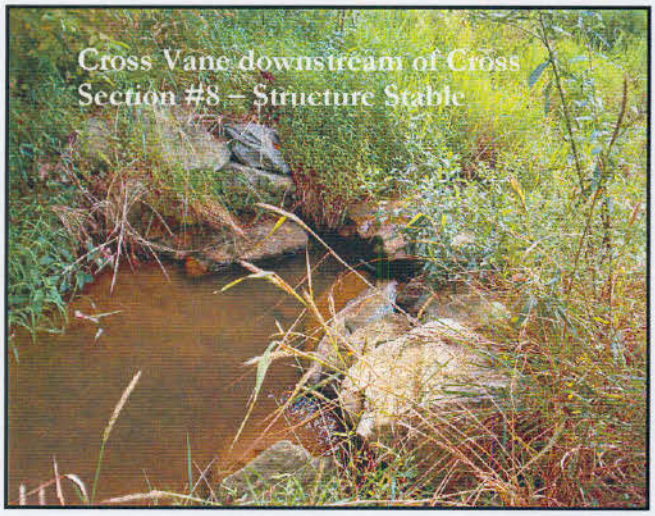
Little Warrior Creek Vegetation Plots

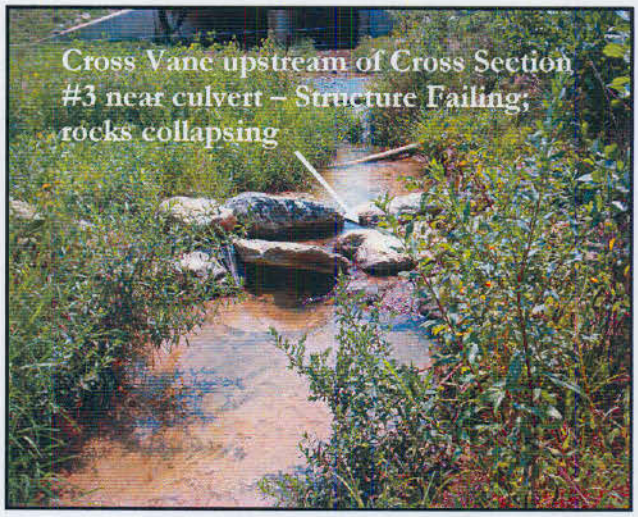


Little Warrior Creek Structures

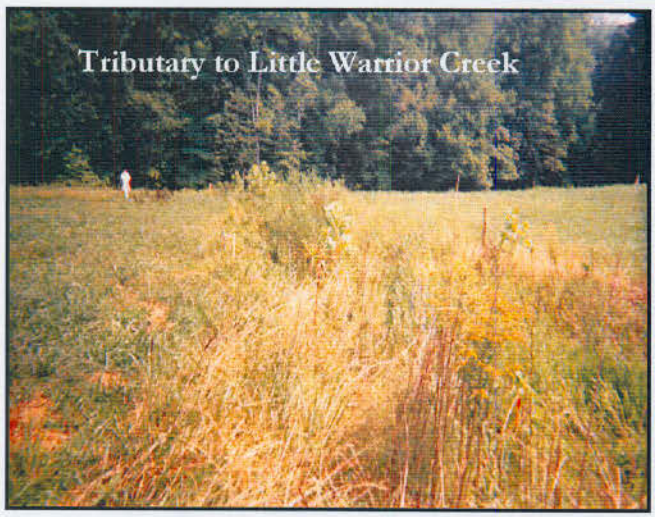

Cross Vane upstream of Cross Section #12 near culvert – Structure Failing; rocks collapsing

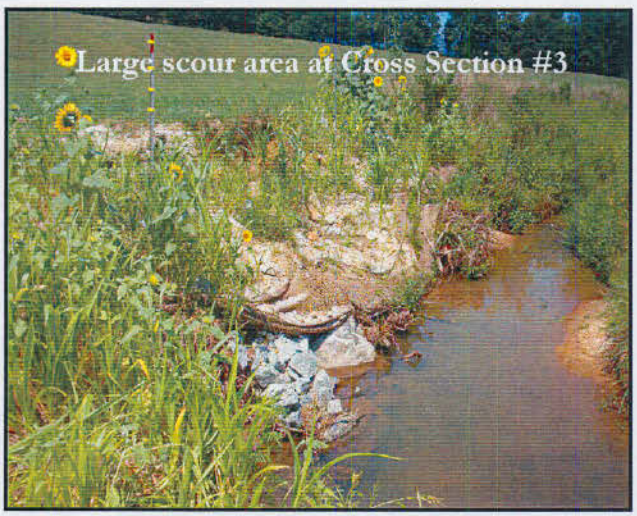

Cross Vane downstream of culvert on Andrews Road – Structure Failing


Cross Vane downstream of Cross Section #8 – Structure Stable


Cross Vane upstream of Cross Section #3 near culvert – Structure Failing; rocks collapsing

Additional Photos – Little Warrior Creek


Tributary to Little Warrior Creek


Large scour area at Cross Section #3