YEAR 3 MONITORING AND CLOSEOUT REPORT

BIG WARRIOR AND LITTLE WARRIOR CREEKS MITIGATION SITE

Wilkes County, North Carolina

FINAL

EEP Project Number: 92715
Contract Number D06082; Task Order Number 07MON01-(6)

Period Covered: October 2007 – October 2008

Submitted: 27 June 2009

Prepared by the North Carolina Wildlife Resources Commission
in Partnership with the
North Carolina Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Table of Contents

List of Figures

List of Tables

1 Executive Summary

The Big Warrior and Little Warrior creeks mitigation site, North Carolina Ecosystem Enhancement Program (EEP) Project Number 92715, Wilkes County was constructed during a 12-month period beginning in August 2001 on the property of the AH&W Farm. As-built (monitoring year 0, MY0), monitoring year 1 (MY1), and monitoring year 2 (MY2) data were collected in 2002, 2004, and 2007. The following report summarizes the year 3 (MY3) stream monitoring data collected during 2008 from Big Warrior and Little Warrior creeks, and compares it with the MY0, MY1, and MY2 data. The MY3 monitoring occurred seven years after construction was completed on Big Warrior Creek and six years after construction was completed on Little Warrior Creek. This report will be considered as the closeout report for this site.

The length of time between the survey events and the fact that three different field teams collected the data resulted in some inconsistencies between data collections. Despite these inconsistencies, it appears both stream channels are stable and functioning properly. Overlay plots of the cross-section and longitudinal data reveal little change in stream channel dimension, pattern, or profile. Due to differences in methods used to collect the longitudinal profile it is difficult to determine the extent of aggradation or degradation of the stream channel. Post-processing to align the data has created enough deviation that a conclusive determination about aggradation or degradation between monitoring years is difficult. However, the general patterns of the various parameters used for stream monitoring suggests stability.

There were 58 structures installed on Big Warrior Creek, all but one are functioning properly. A total of 25 structures were installed in Little Warrior Creek. They were placed in the Lower and Middle pasture sections of the project. Twenty one of the 25 structures are functioning as intended. Mulkey (2005) indicated that there were some structural problems occurring on Little Warrior Creek and that the mitigation review team was supposed to initiate a plan of action to repair the problems. These repairs did not occur.

Although the substrate particle sizes on Big Warrior Creek are fluctuating, they remain in their respective size categories. The D16 is coarse sand, D35 is fine gravel, D50 is medium gravel, and the D84 and D95 are small cobble. Particle sizes for Little Warrior Creek have increased in size from a year ago; however, they are below those found in MY1. The D16 is coarse sand, D35 is very coarse sand, D50 is very fine gravel, D84 is coarse gravel, and the D95 is very coarse gravel. The sediment in Big Warrior Creek appears to be coming from the established stream crossings and the unprotected tributaries entering the stream. The sediment on Little Warrior Creek seems to be coming from upstream sources because the stream channel was stable and riparian vegetation has become well established.

Six vegetation plots were established on each stream during MY1 and resurveyed in MY3. The average density of planted woody vegetation on Big Warrior Creek is 261 per acre, whereas on Little Warrior Creek it is 465 per acre. This exceeds the vegetation success criterion of 260 stems per acre after five growing seasons. This does not include the large number of naturally regenerated woody stems found within the plots. When those stems are included, the average

woody stem density is 1,154 stems per acre for Big Warrior Creek and 1,982 stems per acre for Little Warrior Creek.

Hydrologic monitoring requirements state that at least two bankfull events must occur in two separate years through the five-year monitoring period. There are no surface water gages on Big Warrior Creek or Little Warrior Creek. There is a gage located on the Lower Little River approximately 7 miles south of the mitigation site. Based on the drainage area associated with the gage, the correlated bankfull discharge at the project site according to the North Carolina Rural Mountain Regional Hydraulic Geometry Curves (USACE 2003) is between 800 and 2,000 ft^3/s (Mulkey 2005). A flow of 800 ft^3/s at the gauging station was used to identify bankfull flows at the project site. A review of peak flows at the gage was conducted for the period October 2002-December 2008. According to the graphs, three bankfull events occurred during this period (Table 4, Appendix B.3.), one in April 2003, one in March 2007, and one in December 2008.

All of the agricultural Best Management Practices (BMPs) proposed in the farm management plan and incorporated into the construction plans for both streams are functioning properly. The only issue related to the farm management plan is that gates installed at stream crossings are often left open, allowing cattle to have access to the streams.

In 2005, this site required minor repairs to be in compliance with the North Carolina Department of Environment and Natural Resources, Land Quality Section (NCDENR) sedimentation and erosion control rules. These repairs were conducted by the North Carolina Wildlife Resources Commission (NCWRC). Subsequently, the site was released from compliance monitoring as vegetative ground cover had become established.

The Big Warrior and Little Warrior creeks mitigation site located on the AH&W farm has achieved the required success criteria and is considered eligible for closeout. The as-built data and the three subsequent years of monitoring data substantiate the site's achievement of the monitoring requirements.

2 Introduction

2.1 Project Description

This report summarizes the stream monitoring activities that occurred during 2008 at the Big Warrior Creek and Little Warrior Creek mitigation sites (Figure 1), and serves as the closeout report for the project. These data are compared with as-built data collected in 2002 (MY0) and monitoring data collected in 2004 (MY1) and 2007 (MY2) (NCWRC 2003; Mulkey 2005; NCWRC 2008). The site is situated on the AH&W Farm, which is adjacent to NC 18 in the southwestern portion of Wilkes County. It is approximately 4.0 miles southwest of Boomer and nearly 13.0 miles southwest of Wilkesboro.

The Big Warrior Creek and Little Warrior Creek sites were acquired to provide mitigation for stream impacts associated with the construction of U.S. Highway 421 in Wilkes County (North Carolina Department of Transportation Improvement Program project number R-2239-B). From

2001 to 2005, all reports associated with this mitigation site were prepared for the North Carolina Department of Transportation (NCDOT) stream mitigation program. In 2005, responsibility for this site was transferred from NCDOT to the EEP. The tables and figures were prepared using guidelines previously developed by Mulkey, Inc. (Mulkey 2005). This was done to maintain consistency with earlier reports and to facilitate the comparison of the 2008 data with previous years' data without having to change report formats. Monitoring data were not collected during 2005 and 2006, the transition period of the project from NCDOT to EEP.

The following project description is from the Mulkey 2005 annual report. The mitigation project covers approximately 16,550 linear feet of Big Warrior and Little Warrior creeks 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. A few smaller unnamed tributaries entering Big Warrior Creek were not surveyed as part of this assessment. Design and construction were implemented during 2001 and 2002 by the NCWRC. Priority Level II channel restorations were completed along both streams and their tributaries. Stream restoration involved the installation of root wads and rock vanes, and sloping of the adjacent stream banks to stabilize the channel and reduce erosion. It also included the installation of native vegetation and implementation of a farm management plan that included fencing to protect a 40 to 60 foot wide riparian buffer, installation of cattle watering systems, and stream crossings (Mulkey 2005).

2.2 Purpose

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

- Establish a [permanent] conservation easement along Big Warrior Creek, Little Warrior Creek, and their tributaries to allow for [restoration of] the proper [channel] 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 channel dimension and profile along upper Big Warrior Creek to dissipate energy over this steeper reach and [to] realign the channel where it was eroding into steep slopes;
- Plant native trees, shrubs, and ground cover to stabilize the stream banks, establish shade, and provide wildlife cover and food;
- Enhance fish habitat with [instream] 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.

2.3 Project History

TABLE 1.—Project History.

Summer 1998	USACE issued Section 404 action identification number 199820228; DWQ Section 401 certification included in the USACE permit.
November 2001	NCWRC completed construction on Big Warrior Creek.
November 2001	NCWRC planted Big Warrior Creek with native perennial seed mix.
August 2002	NCWRC completed construction on Little Warrior Creek.
August 2002	NCWRC planted Little Warrior Creek with native perennial seed mix.
Winter 2002	NCWRC planted live stakes and bare rooted trees along Big Warrior Creek.
February 2003	NCWRC completed the as-built report (MY0).
Winter 2003	NCWRC planted live stakes and bare rooted trees along Little Warrior Creek.
July-August 2004	Mulkey, Inc. completed stream channel monitoring (MY1).
July-August 2004	Mulkey, Inc. completed vegetation monitoring (MY1).
January 2005	Mulkey, Inc. completed 2004 monitoring report (MY1).
August-September 2005	NCWRC initiated and completed stream and easement area repairs to comply with a NCDENR Notice of Violation.
September-October 2007	NCWRC completed stream channel monitoring (MY2).
September-October 2007	NCWRC completed vegetation monitoring (MY2).
September-October 2008	NCWRC completed stream channel monitoring (MY3).
September-October 2008	NCWRC completed vegetation monitoring (MY3).
November 2008	NCWRC completed 2007 monitoring report (MY2).
June 2009	NCWRC completed 2008 monitoring/closeout report (MY3).

2.4 Success Criteria

Mulkey (2005) describes the original project success criteria in detail. Essentially, the success criteria address channel stability and improvements to fish habitat. Specifically, the monitoring plan was designed to evaluate the success or failure of all or a combination of the following parameters: channel stability, erosion control, seeding, woody vegetation, and overall response of fish and invertebrate populations to stream restoration (Table 2). Biological monitoring was never conducted at this site, to the best of our knowledge.

TABLE 2.—Standard NCWRC/NCDOT mitigation monitoring criteria as established prior to the USACE (2003) monitoring guidelines.

Measurement	Success (requires no action)	Failure	Action
Photo Reference Sites			
Longitudinal Photographs	No significant* aggradation, degradaton, or erosion	Significant* aggradation, degradation, or erosion	When significant* aggradation, degradation, or erosion occurs, remedial actions will be undertaken.
Lateral Photographs			
Channel Stability			
Cross-Sections	Minimal evidence of instability (down-cutting, deposition, erosion, decrease in particle size)	Significant* evidence of instability	When signicant* evidence of instability occurs, remedial actions will be undertaken.
Longitudinal Profiles			
Pebble Counts			
Plant Survival			
Survival Plots	≥ 75 percent coverage in Photo Points	< 75 percent coverage in Photo Plots	Areas of less than 75 percent coverage will be re-seeded and /or fertilized, live stakes and bare-rooted trees will be replanted to achieve > 80 percent survival.
Stake Counts	≥ 80 percent survival of stakes, 4/m^2	< 80 percent survival of stakes, 4/m^2	
Tree Counts	≥ 80 percent survival of bare-rooted trees	< 80 percent survival of bare-rooted trees	
Biological Indicators (only used for projects with potential to make watershed level changes)			
Invertebrate Populations	Population measures remain the same or improve	Population measures indicate a negative trend	Reasons for the failure will be evaluated and remedial action plans developed and implemented.
Fish Populations			
Overall success or failure will be based on success of 3 of the 4 criteria.			

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

3 Stream Assessment

3.1 Stream Description

3.1.1 Pre-Construction Conditions

The pre-construction conditions at Big Warrior and Little Warrior creeks are well documented and can be found in the construction plans and the as-built report (NCWRC 2001, 2002, 2003).

3.1.2 Post-Construction Conditions

The post-construction conditions at Big Warrior and Little Warrior creeks are well documented and can be found in the as-built, MY1, and MY2 reports (NCWRC 2003, 2008; Mulkey 2005). The MY1 report prepared by Mulkey cited problems with bank erosion and scour due to structure failure on Little Warrior Creek. However, Big Warrior Creek did not experience the same structural failures. Both streams had not yet met the hydrologic requirement of two bankfull events, but they had met the first year woody stem density requirements.

A mitigation review team, established to review mitigation site success, had assessed the problems on Little Warrior Creek and a plan of action was supposed to have been initiated. The repairs to Little Warrior Creek recommended in the monitoring report did not occur. Subsequently, the NCWRC received a non-compliance notice of violation from the NCDENR with regard to the problems on Little Warrior Creek. During September 2005, repairs were made to one rock structure, the approach to one of the stream crossings, and the left bank in the vicinity of cross-section 3 (Figure 3). The project has been in compliance since that time.

3.2 Stream Assessment Results

The cross-section and longitudinal comparisons between the four monitoring surveys was complicated due to the length of time between the surveys. Because of this, some of the benchmarks, cross-section pins, and planted trees and shrubs were difficult to locate or identify. To compound the difficulties in the comparisons, there were two different entities involved in collecting data, NCWRC and Mulkey, and the NCWRC had different teams collect data in 2002, 2007, and 2008. Not all benchmarks set in MY0 for use in calculating elevations could be located in 2004, and none of them could be located in 2007 and 2008. The cross-section and longitudinal survey elevations in 2007 and 2008 were set at 100 ft and 1,000 ft elevations, the data were then post-processed to align the previous year's elevations as closely as possible.

Thirty-four cross-sections were resurveyed in MY3, 21 along Big Warrior Creek (Figure 2; Appendix A.1.) and 13 on Little Warrior Creek (Figure 3; Appendix A.2.); these data are compared with that of MY0, MY1, and MY2. Nineteen of the 21 cross-sections on Big Warrior Creek, and 12 of the 13 cross-sections on Little Warrior Creek were found to be stable in MY3 monitoring period. At some cross-sections the data comparisons between the four monitoring events compare favorably, whereas the comparisons among other cross-sections vary greatly. Plots of the monitoring data from cross-sections 4, 5, 6, 7, 9, 10, 12, 15, 18, and 19 on Big

Warrior Creek and cross-sections 1, 2, 5, 7, 8, and 10 on Little Warrior Creek show that these cross-sections have been relatively stable through the three years of monitoring, seven and six years after construction (Appendices A.1. and A.2.). These cross-section plots revealed minor adjustments in the thalweg and stream banks. These adjustments occurred most often in the bankfull and floodplain areas and were the result of streambed materials being captured by riparian vegetation during flood events. The banks at all cross-sections are stable and well vegetated.

Measurements at cross-sections 1, 2, 3, 8, 11, 13, 14, 16, 17, 20, and 21 on Big Warrior Creek exhibited variations among monitoring events, while measurements at cross-sections 3, 4, 6, 9, 11, 12, and 13 differ on Little Warrior Creek. Mulkey (2005) states that they had problems locating the benchmarks, or the cross-sections did not align properly with the previous surveys. They did not explicitly state that they set new pins, but the data suggests that new pins were installed in locations either upstream, downstream, further away from the channel, or closer to the channel than the original pins. In these instances no attempt was made to align the data, post-processing. Those cross-sections that did not align properly or displayed some type of problem are discussed in greater detail below.

The tables in appendices A.1. and A.2. do not include MY1 data because Mulkey (2005) states that "According to the Rosgen Classification of Natural Rivers flood prone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide, or run features."

Big Warrior Creek

Cross-section 1 (Appendix A.1.): This cross-section transects a pool. The thalweg has degraded by 0.8 ft since MY0. The cross-sectional area and mean bankfull depth have remained stable at 29.1 to 31.0 ft^2 and 0.9 to 1.0 ft since MY1. The right bank is in poor condition due to repeated herbicide application by the landowner. The left bank is stable and vegetated.

Cross-section 2 (Appendix A.1.): This cross-section transects a pool that was armored with a root wad. Since MY0 the right bank has migrated 3.9 ft. This is due to higher flows of water being directed into the bank upstream of the root wad and the scouring of material from behind the root wad and thus creating an overflow channel downstream of this transect. The comparison between MY2 and MY3 suggests stability; however this is not the case. The right bank is eroding and encroaching upon the easement boundary.

Cross-section 3 (Appendix A.1.): This cross-section transects a pool. The left bank migrated considerably between the MY0 and MY1 surveys, but a comparison between the three subsequent years' data shows only minor migration of the left bank occurred. The stream banks are aggrading and the data suggests this cross-section is moving toward an E-type channel. Both banks are stable and well vegetated.

Cross-section 8 (Appendix A.1.): This cross-section transects a riffle. The left end pin could not be located during the MY2 survey. A pin was reset based on best judgment of where the initial pin was set. The data reflects that the pin was set in a different location than the

original pin. A comparison between MY2 and MY3 data suggests that the new cross-section is stable. Both banks are stable and well vegetated.

Cross-section 11 (Appendix A.1.): This cross-section transects a riffle, and appears stable through the three years of monitoring, but the MY1, MY2, and MY3 data plots do not align with the MY0 data. The data plots of the MY1, MY2, and MY3 data are similar in shape to that of the MY0 data. This difference was assumed to be an alignment issue, but the data were graphed in their original form.

Cross-sections 13, 14, 16, 20, and 21 (Appendix A.1.): Based on the differences shown in the cross-section plots these transects appear to have been measured at different locations in MY1. Thus, comparisons between the MY0 and other monitoring data at these locations cannot be made. This is substantiated by the 37-54% differences in bankfull cross-sectional area and 23-104% differences in bankfull width (in both positive and negative directions) when the MY0 and MY3 data are compared. Examination of the MY1, MY2, and MY3 data reveals that cross-sections 13, 14, and 21 demonstrated only minor adjustments to the thalweg or stream banks. Cross-sections 16 and 20 have been impacted by natural occurrences. Cross-section 16 has been impacted by a log debris jamb upstream that is causing the stream bottom to scour. At cross-section 20 a tree top fell into the stream causing a scour hole to be created in the stream bed. The banks at all five of the cross-sections are stable and well vegetated.

Cross-section 17 (Appendix A. 1.): This cross-section transects a riffle. The stream channel and left bank display stability throughout the four years of monitoring. However, the right bank showed considerable erosion in MY3 due to repeated herbicide application by the landowner and monitoring activity impacts during the survey.

Little Warrior Creek

Cross-sections 3, 4, and 11 (Appendix A.2.): These cross-sections transect two pools and a riffle. All three cross-sections appear stable. The MY1, MY2, and MY3 data do not align with the MY0 data, but data from all four years show the same characteristics. It appears the cross-section location was moved in MY1. Comparison among the M1 through MY3 monitoring data show there have been no substantial changes at these three locations since MY1.

Cross-section 6 (Appendix A.2.): This cross-section transects a pool. The left end pin could not be located during the MY2 survey. A new pin was set as close to the original location as could be determined. Because the pin was set in a different location than the original pin, caution should be used in comparing the MY2 and MY3 data with the MY0 and MY1 data. Comparison of the MY2 and MY3 data suggests this cross-section is stable. The banks are stable and well vegetated.

Cross-section 12 (Appendix A.2.): This cross-section transects a pool and is on an unnamed tributary to Little Warrior Creek. It was difficult to make data comparisons at this site because none of the four years of monitoring data appear to be in alignment. It is possible that this cross-section has aggraded and degraded given the number of years between the monitoring events and the sandy composition of the stream bed material. The banks are stable and well vegetated.

Cross-section 13 (Appendix A.2.): This cross-section transects a run and is on the same unnamed tributary to Little Warrior Creek as cross-section 12. The channel has aggraded 1.95 ft. The cross-section now exhibits characteristics of a wetland, more so than that of a stream channel. Wetland grasses are growing in the middle of the stream channel. The stream channel's substrate is composed of silt and clay. The banks are stable and well vegetated.

3.2.1 Longitudinal Profile

Longitudinal profile surveys were completed on seven sections of Big Warrior and Little Warrior creeks (Figures 2 and 3; Appendices B.1.1. and B.2.1.). The longitudinal profiles include the upper pasture (1,169 ft), feedlot (603 ft), middle pasture (622 ft), and lower pasture (830 ft) on Big Warrior Creek, and upper (889 ft), middle (1,062 ft), and lower pastures (873 ft) on Little Warrior Creek. All of the longitudinal profiles exhibit the same characteristics as the as-built surveys through the 3 years of monitoring (seven and six years post-construction). In general, little aggradation or degradation of the channels has occurred. The minor changes that have occurred appear to be natural occurrences and not because of instabilities caused by the stream enhancement activities. Six of the seven longitudinal profiles appear relatively stable through the three years of monitoring. The one exception occurred in the middle pasture of Little Warrior Creek. The MY0 profile differs greatly from the three subsequent monitoring surveys. The benchmark elevation of this section seems to be out of alignment, and no attempt was made to correct the difference in post-processing the subsequent years' data. Most of the head of pool features are located at structures, so the distances the pools appear to have migrated downstream are most likely due to measurement error (the measuring tape, placed in the thalweg, migrated downstream during the survey, or meanders either evolved or devolved creating a difference in the measured distance). The pool lengths on Big Warrior and Little Warrior creeks are generally decreasing, but their depths are increasing.

Big Warrior Creek

Upper Pasture (Appendix B.1.1.): A pool formed at station 5+33 between MY0 and MY1, and increased in length and depth by MY3. Between MY1 and MY2, a second pool formed at station 6+55; although the MY3 data show the pool is aggrading.

Feed Lot (Appendix B.1.1.): It appears that in MY1 the survey starting point was not the same as in MY0, MY2, and MY3. This plot reveals only minor changes occurred in the longitudinal profile.

Middle Pasture (Appendix B.1.1.): There was a pool at station 1+41 in MY0; however, the pool at this location was found to have become a riffle in subsequent monitoring years. A pool present at station 3+18 in MY0 reformed in MY3, and a new pool has formed at station 3+56. The pools along this section of BWC appear to be deeper.

Lower Pasture (Appendix B.1.1.): In MY 3 the starting point of the longitudinal survey was 43 ft downstream from the previous years' surveys. In the vicinity of the starting point for this longitudinal profile there are a number of unmarked stakes that denote the various facets of the

stream survey. There are stakes for cross-sections 5 and 6, and there are three stakes denoting the beginning middle and end of vegetation plot number 5 as well as the starting point for the lower pasture longitudinal profile. As a consequent, the wrong stake was chosen to begin the survey. A small pool was forming at station 3+04 in MY2; this pool appears to have increased in length in MY 3. The pool originally created at station 4+18 was found to be filled in during the MY1, MY2, and MY3 surveys. At station 4+80 a measurement was recorded on top of a naturally occurring log vane in MY2 and MY3. The as-built document does not show a log vane in this vicinity (NCWRC 2003).

Little Warrior Creek

Upper Pasture (Appendix B.2.1.): The survey in MY1 showed pools formed at stations 0+14, 1+29, 1+60, 3+50, 4+28, 4+88, 6+31, and 7+54. The MY3 monitoring data shows that the pools at 0+14, 1+29, 1+60, and 6+31 have degraded since MY2 and are nearly at the same depth as found in MY1. The pools at stations 3+50, 4+28, 4+88, and 7+54 have evolved into runs since MY1. The pools at 0+14, 1+29, and 1+60 are located on an unnamed tributary to Little Warrior Creek and this portion of the longitudinal profile has a steeper gradient than the mainstem of Little Warrior Creek. It is possible that storm events flushed sediment from these pools and deposited it in pools of the lower gradient mainstem portion of this reach.

Middle Pasture (Appendix B.2.1.): The MY3 data reveal a pool is emerging at station 2+81, and that the pools between stations 6+50 and 7+50 have aggraded and become either riffles or runs. In MY1, a pool was present at station 9+55. By MY2, this pool had filled in to become a run, whereas the MY3 data show a pool has formed at station 9+43. A possible explanation is that the cattle have access to the stream at the lower end of this longitudinal profile, and their access to the stream has caused the channel to widen in this area, thereby decreasing the stream's ability to move sediment through the system. The increased stream channel width caused water velocity to slow and allowed sediment to be deposited in the pool upstream of the crossing; however, during storm events these sediments are flushed out of the pool.

Lower Pasture (Appendix B.2.1.): The MY3 survey data reveal a new pool, or a compound pool, has formed at station 1+12, due to natural occurrences. The pool at station 2+33 has decreased in length, and the small pool that formed at station 5+21 in MY2 has increased in length. The MY2 and MY3 longitudinal profile surveys included an additional 100 ft of stream channel that extended them to the downstream end of the project reach.

Longitudinal profile data were collected on seven sections of stream in MY3. Measurement errors are likely the reason that the head of pool features appear to be migrating downstream. The longitudinal profiles also revealed that other minor changes are occurring. These adjustments appear to be natural occurrences and not because of instabilities caused by the stream enhancement activities. Big Warrior Creek had 11 cross-vanes, 40 root wads, six j-hooks, and one log vane installed during construction (NCWRC 2003). All but one of the structures installed on Big Warrior Creek are functioning properly. Little Warrior Creek had nine cross-vanes and 16 root wads installed in the lower and middle pasture sections of the project (NCWRC 2003). No structures were installed on the upper section of Little Warrior Creek. Five of the nine rock cross-vanes are functioning as intended. Three of the four rock vanes that

are exhibiting problems are at the confluence of an unnamed tributary to Little Warrior Creek. The unnamed tributary was relocated to provide more pasture to AH&W farms. The relocation decreased the length of the unnamed tributary, thereby increasing the slope of the stream. The three rock vanes were installed to step-down the channel bed of unnamed tributary to that of Little Warrior Creek. The fourth malfunctioning rock cross-vane is located near cross-section 2 (Figure 3). The thalweg in this portion of the stream makes a sharp turn to the left and water is piping through the left arm of the cross-vane.

3.2.2 Pebble Counts

Pebble counts were conducted at each of the 34 cross-sections on Big Warrior (21) and Little Warrior (13) creeks during MY3. These data were compared to the MY1 results (Figures 2 and 3; Appendices B.1.2. and B.2.2.). Pebble count data for MY0 could not be located and may not have been taken. Only a single pebble count was conducted on each stream as part of the pre-construction survey (NCWRC 2001; 2002). Because the pre-construction data were used for comparisons in the MY1 monitoring report (Mulkey 2005), it is used in this report as well. Reach-wide pebble counts were not conducted during the four years of monitoring, instead the cross-section pebble count data were combined in MY1, MY2, and MY3 for each stream (Appendices B.1.2. and B.2.2.). A particle-size classification analysis of the pooled pebble count data collected from all riffles for each stream is also included (Appendices B.1.2. and B.2.2.).

Sample sizes between MY1, MY2, and MY3 also varied. On average 34 and 44 pebbles were counted at each cross-section on Big Warrior Creek and Little Warrior Creek in MY1, whereas on average 102 and 104 pebbles were counted at each cross section on both streams in MY2 and MY3. The differences in sample sizes need to be considered in the data assessment.

Big Warrior Creek

The combined cross-section substrate data (Appendix B.1.2.) for Big Warrior Creek indicate the D16, D35, and D50 size class index particle sizes were smaller in MY3 than in MY1 and MY2. The MY3 D84 was smaller than MY2, but larger than MY1. The MY3 D95 particle size remained the same as MY2, which was larger than MY1. The D50 for the combined data graphs dropped to the fine gravel category (4 to 8 mm; NCSRI 2003). The combined riffle particle size data reveal that, except for the D16 and D95 particle size classes, the D35, D50, and D84 particle sizes decreased in MY3 (Appendix B.1.2.). The MY3 D16 particle size was larger than that found in the other three years of monitoring, whereas the D95 particle size remained unchanged between MY2 and MY3. Although the values of the combined riffle particle sizes changed in MY3, they remained in the same particle size categories as MY2. The D16 is in the very fine sand category at 0.062 to 0.125 mm, the D35 is in the fine gravel category at 4 to 8 mm, the D50 is in the medium gravel category at 8 to 16 mm, and the D84 and D95 are in the small cobble category at 64 to 128 mm (NCSRI 2003). A review of the combined cross-section data, combined riffle data, and the individual cross-section data (Appendix B.1.2.) suggest that fine sediment is entering the system. The source of this sediment is likely from unvegetated areas adjacent to stream crossings, poorly graveled stream crossings, and unprotected areas on unnamed tributaries. While this sediment is covering the coarse gravels, larger particles are still exposed.

Little Warrior Creek

The combined cross-section substrate analysis (Appendix B.2.2.) for Little Warrior Creek reveals that the particle sizes for all fractions were higher in MY3 than in MY2; however they are not larger than found in MY1. The riffle data comparisons (Appendix B.2.2.) also indicate the same trend except for the D95 particle size, which decreased in size between MY2 and MY3. The riffle data comparisons did not include cross-section 11 because it is located on a tributary to Little Warrior Creek. The sediment appears to be coming from upstream sources as the stream channel and banks in the project reach were, for the most part, stable.

3.2.3 Monitoring Condition

All of the cross-sectional dimension measurements and the riffle pebble count data from Big Warrior Creek were averaged to populate the morphological summary table (Table 3). Cross-sections 11, 12, and 13 and their pebble counts were not incorporated into Little Warrior Creek's table because these cross-sections were located on tributaries. The data reveal minor fluctuations in all of the parameters for both creeks during the three monitoring periods. In general, there does not appear to be any major anomalies with either stream channel. According to Rosgen's Classification of Natural Rivers (Rosgen 1996) both streams key out as C4 stream types. The entrenchment ratios were >2.2 in all surveys except Big Warrior Creek MY2. It was 2.08, but that is still within an acceptable range for it to be a C type stream. The width/depth ratios were >12 except for MY1 on both streams. A plausible explanation for this is that the bankfull elevation that was chosen in MY1 was too low. The average sinuosity for both streams was calculated using the data from the longitudinal profile surveys found in the as-built report (NCWRC 2003). The average sinuosity for Big Warrior Creek was 1.21 and Little Warrior Creek was 1.24. The riffle sections' D50 particle size for both streams was between 2.0 to 64.0 mm (NCSRI 2003), the gravel category, except for MY2 Little Warrior Creek. More fine sediment was found in MY2 than the other monitoring years. Pebble count data could not be located for MY0. These four parameters provide evidence that both streams are C4 stream types with the following characteristics: "slightly entrenched, meandering, gravel dominated, riffle/pool channel with a well developed floodplain" (Rosgen 1996). Streams classified as C4 types are generally considered to be stable.

TABLE 3.—Abbreviated Morphological Summary for Big Warrior and Little Warrior Creeks.

Variable		Big Warrior Creek — Combined Cross-Sections 1 - 21[a]				
		Pre-Const.	MY0	MY1	MY2	MY3
Drainage Area (mi^2)	Range	0.70-1.17	0.70-1.17	0.70-1.17	0.70-1.17	0.70-1.17
N equals		18	21	21	21	21
Bankfull Width (ft)	Mean	18.15	16.30	13.10	18.07	19.00
Bankfull Mean Depth (ft)	Mean	1.41	1.32	1.50	0.87	0.90
Width/Depth Ratio	Mean	12.90	12.30	8.70	24.56	25.70
Bankfull Cross Sectional Area (ft^2)	Mean	25.60	18.20	10.80	15.13	15.80
Maximum Bankfull Depth (ft)	Mean	1.90	2.02	1.55	1.78	1.90
Width of Floodprone Area (ft)	Mean	34.50	41.80	34.40	37.98	34.50
Entrenchment Ratio	Mean	1.90	2.60	2.60	2.08	2.20
Slope	Range	0.034-0.012	0.034-0.010	0.034-0.011	0.034-0.009	0.034-0.010
Particle Sizes (Riffle Sections)						
D_{16} (mm)		0.13		0.51	0.87	0.97
D_{35} (mm)		0.28		6.05	6.80	5.40
D_{50} (mm)		11.30		12.00	12.00	9.90
D_{84} (mm)		50.00		45.00	77.00	72.00
D_{95} (mm)		80.00		89.00	120.00	120.00

[a]Cross-sections 13, 14, 16, 20, and 21 were moved in MY1. Cross-section 8 was moved in MY2.

TABLE 3.—Continued.

Variable		Little Warrior Creek — Combined Cross-Sections 1 - 10[b]				
		Pre-Const.	MY0	MY1	MY2	MY3
Drainage Area (mi^2)	Range	0.43-0.91	0.43-0.91	0.43-0.91	0.43-0.91	0.43-0.91
N equals		10	10	10	10	10
Bankfull Width (ft)	Mean	8.95	11.63	7.41	11.75	11.69
Bankfull Mean Depth (ft)	Mean	1.65	0.78	0.92	0.97	0.96
Width/Depth Ratio	Mean	5.45	14.90	8.05	15.16	15.10
Bankfull Cross Sectional Area (ft^2)	Mean	15.35	8.98	6.84	11.05	11.04
Maximum Bankfull Depth (ft)	Mean	2.40	1.67	1.39	1.94	1.98
Width of Floodprone Area (ft)	Mean	14.50	33.15	26.33	21.61	27.81
Entrenchment Ratio	Mean	1.60	2.85	3.55	2.54	2.62
Slope	Range	0.013-0.005	0.016-0.008	0.017-0.007	0.017-0.007	0.017-0.007
Particle Sizes (Riffle Sections)						
D_{16} (mm)		0.07		0.14	0.11	0.55
D_{35} (mm)		0.17		4.42	0.26	1.30
D_{50} (mm)		0.28		9.30	0.74	3.40
D_{84} (mm)		16.00		26.00	19.00	28.00
D_{95} (mm)		37.00		41.00	52.00	45.00

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

3.2.4 Hydrologic Data and Bankfull Verification

Monitoring requirement criteria mandate that at least two bankfull events must occur in two separate years through the five-year monitoring period. Three bankfull events have occurred, one each in 2003, 2007, and 2008 (Table 4.) 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 located approximately 7 miles south of the mitigation site. This gage is located on the Lower Little River in the Catawba River drainage and has a drainage area of approximately 28 mi^2 (Mulkey 2005). The Lower Little River surface gage (number 02142000) is located in USGS Hydrologic Unit 03050101; the gage is 1,070.00 feet above sea level NGVD29 (USGS 2008).

Based on the drainage area associated with the gage, the correlated bankfull discharge at the project site according to the N.C. Rural Mountain Regional Hydraulic Geometry Curves (USACE 2003) is between 800 and 2,000 ft^3/s (Mulkey 2005). A flow of 800 ft^3/s at the gauging station was used to identify bankfull flows at the project site. A review of peak flows at the gage was conducted for the period October 2002-December 2008. According to the graphs, three bankfull events occurred during this period (Table 4, Appendix B.3.).

TABLE 4.—Monitoring bankfull events at the Big and Little Warrior creeks mitigation sites based on data from the United States Geological Survey Lower Little River gage (gage number 03050101) in the Catawba River drainage near All Healing Springs, Alexander County, North Carolina.

Date	Gage height (ft)	Flows (ft^3/s)	Comments
10 Apr 03	9.0	1,450	Bankfull event
02 Mar 07	8.0	1,240	Bankfull event
11 Dec 08	6.5	867	Bankfull event

3.3 Problem Areas

There were five areas of concern that were documented in the MY2 report and are still in need of attention because of their proximity to the conservation easement boundary (Figures 2 and 3; NCWRC 2008). Two additional problem areas were discovered during the MY3 survey. For purposes of this closeout report all problem areas are described below. One of the two new problem areas is located in the lower pasture of Big Warrior Creek between cross-sections 3 and 4 (Figure 2). The other site is located in the middle pasture of Little Warrior Creek near cross-section 6 (Figure 3). The total lengths of all the stream problem areas comprise only 200 ft of the total 16,550 ft of the stream project.

The two previously identified problem areas on Big Warrior Creek (NCWRC 2008) are located in the lower pasture section. The first problem area is located near longitudinal profile station 4+66, whereas the second problem area is located below cross-section 2 (Figure 2; Appendix C.1.3.). The MY3 survey identified an additional problem area in the lower pasture between cross-sections 3 and 4 (Figure 2; Appendix C.1.3.). A combination of overland flows from the adjacent heavily grazed pasture and the repeated use of herbicide under the fences are causing the high left bank to slough. The easement boundary is located at the top of the high bank and, if left untreated, the bank sloughing will encroach into the adjacent field, outside of the conservation easement.

The three problem areas identified in the MY2 monitoring report on Little Warrior Creek (NCWRC 2008) were located near cross-section 2 in the lower pasture, at station 5+10 along the longitudinal profile of the lower pasture, and on the second unnamed tributary to Little Warrior Creek downstream of cross-section 11 (Figure 3; Appendix C.2.3.). The new problem area discovered in MY3 is located in the middle pasture near the confluence of Little Warrior Creek and an unnamed tributary (Figure 3; Appendix C.2.3.). There are three rock cross-vanes in this area that have water piping through them. In addition to the piping associated with the three rock cross-vanes, the right bank in the vicinity of cross-section 6 also is eroding.

3.4 Photograph stations

There are 13 photograph reference points on Big Warrior Creek (Appendix C.1.1.), and 9 photograph reference points on Little Warrior Creek (Appendix C.2.1.). These photograph reference points were established during the as-built survey. The photographic evidence confirms that the stream channel is stable.

3.5 Repairs

The MY2 monitoring report documents repairs that were made to Little Warrior Creek in 2005 due to a Notice of Violation from NCDENR – Land Quality Section (NCWRC 2008). No other repairs have been initiated.

3.6 Stream Assessment Summary

Stream monitoring data comparisons between years were complicated due to the number of years between the sampling events, the different organizations and teams that collected the data, and the differences in pebble count sample sizes in MY1, MY2, and MY3. In spite of those issues, both streams are stable and have few problem areas.

All four longitudinal profiles on Big Warrior creek show that there are no major channel bed changes other than the pools appeared to be getting smaller, but deeper in MY3. The majority of cross-sections on Big Warrior Creek also show little signs of instability. The pebble counts indicate that fine sediment is present throughout Big Warrior Creek, although visual observations suggest that the sediment is coming from sources outside of the conservation easement. The morphological summary data found in Table 3 also suggest that Big Warrior Creek is stable. It is categorized as a C4 stream type (Rosgen 1996). There are three areas of concern, all located within the lower pasture. These three areas will need remediation to protect the easement boundaries.

The three longitudinal profiles and the majority of the 13 cross-sections on Little Warrior Creek suggest the stream channel is stable. The pebble counts conducted on Little Warrior Creek indicate that sediment is not being transported through the system. The source of the sediment seems to be from outside of the conservation easement because most of the stream channel appears stable. The morphological summary data found in Table 3 provides additional evidence that Little Warrior Creek is stable. It is classified as a C4 stream type (Rosgen 1996). There are four problem areas on Little Warrior Creek. Two in the lower pasture, one in the middle pasture, and one on the second unnamed tributary; these four areas will also need corrective action to protect the easement boundary and stabilize the stream channel. Most of the previous repairs on Little Warrior creek are functioning properly.

Based on information from the USGS gauging station, the Big Warrior Creek and Little Warrior Creek sites have met the hydrologic monitoring requirement of having two bankfull events in separate years within the five-year monitoring time frame. A flow of 800 ft^3/s at the gauging station was used to identify bankfull flows at the project site. The greatest flow was recorded on April 10, 2003, 1,450 ft^3/s, and the smallest was 867 ft^3/s recorded on December 11, 2008.

4 Vegetation

4.1 Success Criteria

The Big Warrior Creek and Little Warrior Creek sites were required to be monitored for vegetation survival during the first five years after construction. A 320 woody stems per acre density criterion for planted seedlings is 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 (290 stems per acre for year 4, and 260 stems per acre for year 5). The number of plants of one species is not to exceed 20 percent of the total number of plants of all species planted (USACE 2003). Although this is the third year of monitoring, Big Warrior Creek was planted in 2002 and Little Warrior Creek was planted in 2003, thus the vegetation densities should meet the USACEs' fifth year criteria at this site.

4.2 Description of Species

The 2003 as-built report lists the herbaceous vegetation seed mixture sown on Big and Little Warrior creeks, but it does not list the woody species that were planted (NCWRC 2003). The MY1 report lists the woody species that were planted on the site, based on visual observations (Mulkey 2005).

4.3 Plot Description

The MY1 report describes the vegetation plots in detail (Mulkey 2005). All plots were successfully located in MY3 (Figures 2 and 3) and a photographic record of the sites obtained (Appendix C.1.2. and C.2.2).

4.4 Vegetation Monitoring

Twelve vegetation plots were successfully monitored in MY3, six on Big Warrior Creek and six on Little Warrior Creek. Aluminum tags and flagging were originally placed on the woody plants in MY1. By MY3 some of the tags and flagging had fallen off of the woody species. Those species that still had tags on them were identified as tagged stems. Those species that did not have a tag on them were identified as untagged. Some of the tags were found on the ground beneath the woody vegetation, but no attempt was made to identify which woody stem the tag came from due to the dense flora found within the vegetation plots. Data were obtained following previously described methodologies (Table 5).

TABLE 5.—Vegetation monitoring plot statistics for Big Warrior Creek, September 2008.

Tagged tree and shrub species		Plot 1 (10' x 100')	Plot 2 (20' x 50')	Plot 3 (20' x 50')	Plot 4 (20' x 50')	Plot 5 (10' x 100')	Plot 6 (20' x 50')
Botanical name	Common name	MY3 Count					
Betula nigra	River birch	1					
Cornus amomum	Silky dogwood	2	5	9	5		
Fraxinus pennsylvanica	Green ash	3			2	1	
Malus sp	Apple		2				
Liriodendron tulipifera	Tulip poplar	1				1	
Platanus occidentalis	Sycamore					1	
Quercus rubra	Red oak					1	
Salix nigra	Black willow			1			
Salix sericea	Silky willow	1					
Untagged tree and shrub species							
Acer rubrum	Red maple					1	14
Alnus serrulata	Tag alder		1	1			
Betula nigra	River birch					1	
Cornus amomum	Silky dogwood	2	9	17	9	1	2
Cornus florida	Flowering dogwood						
Fraxinus pennsylvanica	Green ash	2			3	2	1
Juglans nigra	Black walnut				1		
Lespedeza bicolor	Lespedeza		1				1
Ligustrum sp.	Privet					1	
Liriodendron tulipifera	Tulip poplar	9				4	4
Oxydendrum arboreum	Sourwood	2					
Platanus occidentalis	Sycamore					1	1
Prunus serotina	Black cherry					2	2
Quercus rubra	Red oak				1		
Rhus typhina	Staghorn Sumac						9
Robinia pseudoacacia	Black locust	11					
Salix nigra	Black willow		3				
Salix sericea	Silky willow		1				
Viburnum sp.	Viburnum	3					
MY 1 total tagged[a]		10	10	16	16	8	5
MY3 total tagged		8	7	10	7	4	0
MY3 total untagged		29	15	18	14	13	34
MY3 total tagged & untagged		37	22	28	21	17	34
MY3 density tagged (stems/acre)		348	305	436	305	174	0
MY3 density tagged & untagged (stems/acre)		1,612	958	1,220	915	741	1,481
MY3 average density tagged		261					
MY3 average density tagged & untagged		1,155					

[a]MY1 did not have any untagged stems, because it was the first year of monitoring vegetation at the site.

TABLE 5.—Continued. Vegetation monitoring plot statistics for Little Warrior Creek, September 2008.

Tagged tree and shrub species		Plot 1 (10' x 100')	Plot 2 (20' x 50')	Plot 3 (20' x 50')	Plot 4 (20' x 50')	Plot 5 (10' x 100')	Plot 6 (20' x 50')
Botanical name	Common name	MY3 Count					
Alnus serrulata	Tag alder		3	2	5	7	
Betula nigra	River birch		2				1
Cephalanthus occidentalis	Button bush			1			3
Cornus amomum	Silky dogwood	1	13	5		2	11
Fraxinus pennsylvanica	Green ash		1		3		
Liriodendron tulipifera	Tulip poplar	1					
Platanus occidentalis	Sycamore		1		1	1	
Untagged tree and shrub species							
Acer rubrum	Red maple	67			41	6	3
Alnus serrulata	Tag alder		5				1
Betula nigra	River birch		1				1
Cephalanthus occidentalis	Button bush			1			8
Cornus amomum	Silky dogwood	5	10	2	3	12	15
Diospyros virginiana	Persimmon	1					
Fraxinus pennsylvanica	Green ash				1		
Ilex Opaca	Holly				2		
Liriodendron tulipifera	Tulip poplar	2	1		8	1	
Oxydendrum arboreum	Sourwood		1		5		
Pinus strobes	White pine		1				
Platanus occidentalis	Sycamore		1				
Prunus serotina	Black cherry				1		
Sambucus canadensis	Elderberry		1				
Viburnum sp.	Viburnum	1					1
MY 1 total tagged[a]		2	37	13	22	20	36
MY3 total tagged		2	20	8	9	10	15
MY3 total untagged		76	21	3	61	19	29
MY3 total tagged & untagged		78	41	11	70	29	44
MY3 density tagged (stems/acre)		87	871	348	392	436	653
MY3 density tagged & untagged (stems/acre)		3,398	1,786	479	3,049	1,263	1,917
MY3 average density tagged		465					
MY3 average density tagged & untagged		1,982					

[a]MY1 did not have any untagged stems, because it was the first year of monitoring vegetation at the site.

4.5 Results

A count of tagged and untagged woody stems was conducted in each of the 12 vegetation plots. On average, the density of tagged woody stems for all plots was 363 per acre. Big Warrior Creek had 261 tagged woody stems per acre and Little Warrior Creek had 465 tagged woody stems per acre, which exceeds the 5-year post-construction density requirement (USACE 2003). A comparison between the three years of monitoring vegetation shows that the survivorship of the tagged species appears to be decreasing (Appendices D.1. and D.2.), but this does not take into account the length of time between the monitoring events and the fact that

some tags had fallen off planted stems. When untagged woody plants were included, the MY3 average stem densities at all 12 vegetation plots were much higher. On average, for the 12 sites combined, there were 1,568 woody stems per acre. Big Warrior Creek had 1,154 woody stems per acre and Little Warrior Creek had 1,982. These numbers are below those found in MY2 (Appendices D.1. and D.2.). Competition between plant species could be a reasonable explanation for the decreased densities. The MY3 average density of all plots for tagged and untagged woody stems far exceeds the vegetation requirements after five growing seasons.

Two plant species not native to North Carolina were present in the Big Warrior Creek vegetation monitoring plots. These were privet *Ligustrum sp.* and shrubby lespedza *Lespedeza bicolor*. Two other nonnative species, multiflora rose *Rosa multiflora* and Japanese honeysuckle *Lonicera japonica*, were found growing in scattered patches on both Big Warrior and Little Warrior creeks. While these species were found in limited densities throughout the site, casual monitoring should be considered.

5 Agricultural Best Management Practices

The Natural Resource Conservation Service (NRCS) developed a livestock management plan in consultation with the AH&W farm manager and the North Carolina Wildlife Resources Commission (NCWRC 2003). This plan included 28,000 feet of fencing along the conservation easements and 21 watering tanks for cattle. To move the cattle from one pasture to another, five culverts and six fords were installed and one bridge was improved (NCWRC 2003). All of these improvements are functioning as expected. There are two problems occurring at the AH&W farm stemming from day-to-day management activities. The first problem is that the gates at the stream fords are not being kept closed. This has allowed cattle continued access to the streams and resulting in water quality degradation. The second problem is that in some areas herbicides are being sprayed too far inside the conservation easement boundary fences. This has reduced the vegetative ground cover and, as a result, some erosion is occurring. There are several places where this erosion is approaching the conservation easement boundary and, if left unchecked, will encroach into the adjacent fields.

6 Project Summary

Although data comparisons between monitoring events were difficult, based on those instances where data are aligned and visual observations, both streams' cross-sections and longitudinal profiles show minimal evidence of instability, down-cutting, deposition, or erosion. However, the pebble counts do show a decrease in pebble size. The source of sediment is most likely due to impacts outside of the conservation easement. These sources include stream crossings on both Big and Little Warrior creeks and from unprotected areas on unnamed tributaries (Big Warrior Creek) or upstream sources (Little Warrior Creek). Both streams should be considered for closeout based on the USACEs' mitigation monitoring criteria.

The site has met the requirements of two bankfull events within five years and it has also met the vegetative success criteria. The vegetation plots are exhibiting greater than 80 percent survival. No biological sampling was conducted as part of this monitoring project. There were four non-native exotic species found throughout the site. These species need to be monitored over the next couple of years to ensure they are not having an impact on the native plant species.

Seven problem areas were identified within the project boundaries, three on Big Warrior Creek and four on Little Warrior Creek. However these areas encompass only about 200 feet of the total 16, 550 feet of restored stream channels. Five of the seven problem areas could impact the easement boundaries. We urge EEP to contact AH&W Farm about the gates being left open at the stream crossings and to reduce the number of times they apply herbicide to the fence lines. A number of the stream problem areas are being exacerbated by the continued killing of vegetation along fence lines that are close to the top of the stream banks.

The conservation easements along both streams were fenced and alternative cattle drinking water systems installed as part of the farm management plan. All of these agricultural BMPs are functioning properly. As mentioned above, the gates to the stream fords are not being closed when not in use, allowing cattle unfettered access to the stream. As a result, some of the stream crossings are in poor condition. The cattle continually disturb the substrate in and adjacent to the crossings, causing a low level of chronic sedimentation. Fecal matter is also being deposited in the stream.

According to a letter (dated July 25, 2007) between NCWRC and EEP, referencing task oriented contract number D06082, task order 07MON01-(1-11) Big Warrior and Little Warrior creeks on the AH&W farm site are scheduled for project closeout after the MY3 monitoring report is completed.

7 Acknowledgements

The NCWRC appreciates Mulkey Inc. for providing the 2004 monitoring survey data and 2004 monitoring report. J. Borawa, M. Fowlkes, J. Wasseen, II, Jeff Ferguson, and Todd Ewing of the NCWRC watershed enhancement group collected the field data; J. Wasseen, II analyzed and prepared this report. J. Borawa improved the report with his thorough review and thoughtful suggestions.

8 References

Mulkey (Mulkey, Inc.). 2005. Annual report for 2004. Big Warrior and Little Warrior Creek Mitigation Site, Wilkes County, WBS Element 34404.4.1 TIP No. R-2239. Mulkey Engineers and Consultants, Raleigh, North Carolina.

NCSRI (North Carolina Stream Restoration Institute). 2003. Stream restoration: a natural channel design handbook. North Carolina Stream Restoration Institute, North Carolina State University, Raleigh. Available: www.bae.ncsu.edu/programs/extension/wqg/sri/. (April 2009).

NCWRC (North Carolina Wildlife Resources Commission). 2001. Stream Mitigation Site Construction Plan for AH&W Farm Big Warrior Creek. North Carolina Wildlife Resources Commission, Raleigh.

NCWRC (North Carolina Wildlife Resources Commission). 2002. Stream Mitigation Site Construction Plan for AH&W Farm Little Warrior Creek. North Carolina Wildlife Resources Commission, Raleigh.

NCWRC (North Carolina Wildlife Resources Commission). 2003. As-built Report for the AH&W Mitigation Site Big and Little Warrior Creeks, Wilkes County. North Carolina Wildlife Resources Commission, Raleigh.

NCWRC (North Carolina Wildlife Resources Commission). 2008. Year 2 Monitoring Report for the Big and Little Warrior Creeks Mitigation Site, Wilkes County, North Carolina, Ecosystem Enhancement Program Project Number 92715. North Carolina Wildlife Resources Commission, Raleigh.

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

USACE (United States Army Corps of Engineers). 2003. Stream Mitigation Guidelines. Prepared with cooperation from the U. S. Environmental Protection Agency, North Carolina Wildlife Resources Commission, and the North Carolina Division of Water Quality. U.S. Army Corps of Engineers, Wilmington District, North Carolina. Available: www.sw.usace.army.mil./wetlands/mitigation/stream_mitigation.html. (December 2008)

USGS (United States Geological Survey). 2008. Real time Data for USGS gage 02142000, Lower Little River near All Healing Springs, North Carolina. Available: http://waterdata.usgs.gov/nc/nwis. (March 2009).

FIGURE 1.—Big Warrior and Little Warrior creeks mitigation site vicinity map.

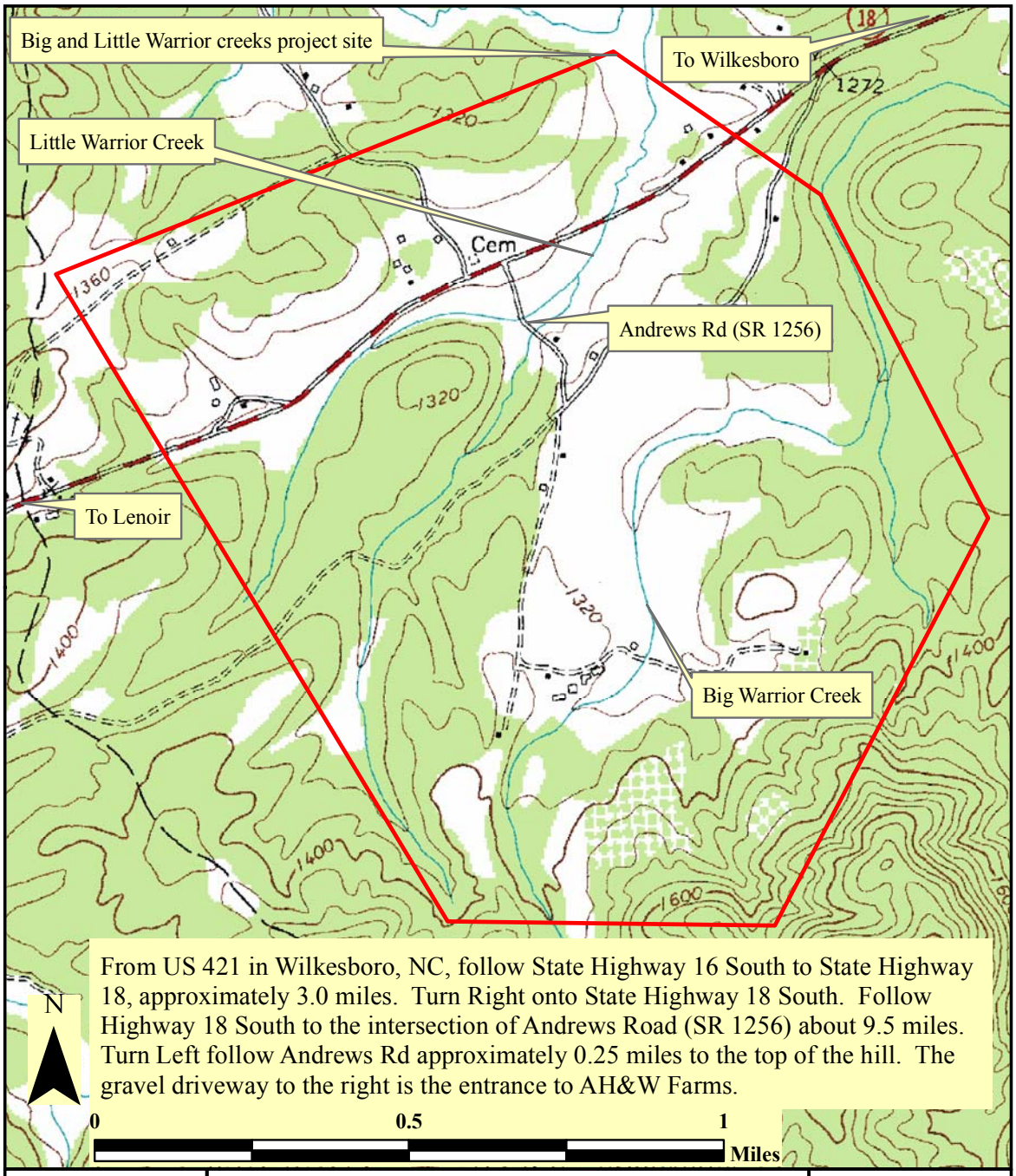
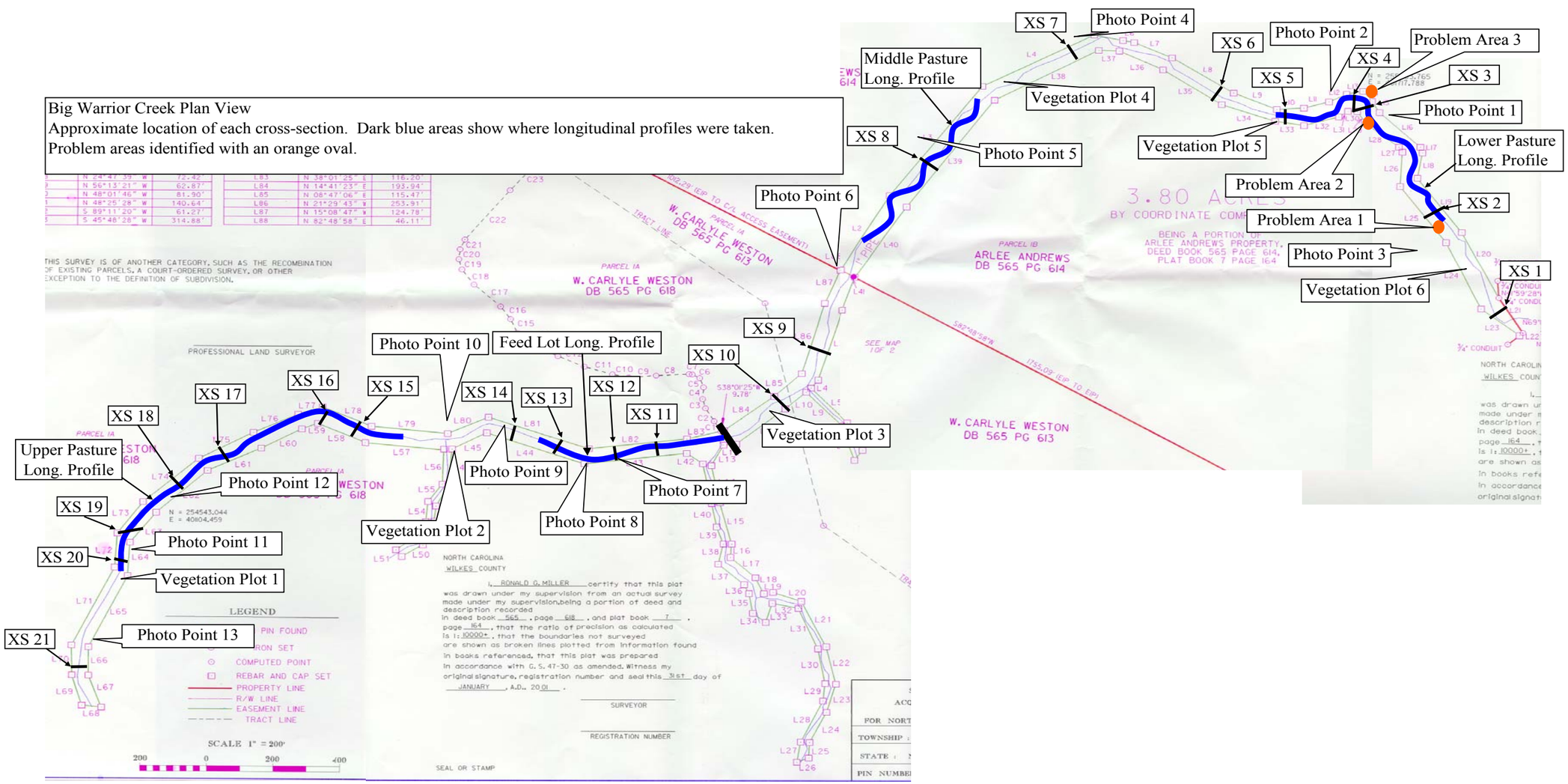


Figure 1. Project site vicinity map
Big Warrior and Little Warrior Creeks Stream Restoration
EEP Project Number 92715, MY3/closeout - 2008
Wilkes County, North Carolina
April 2009

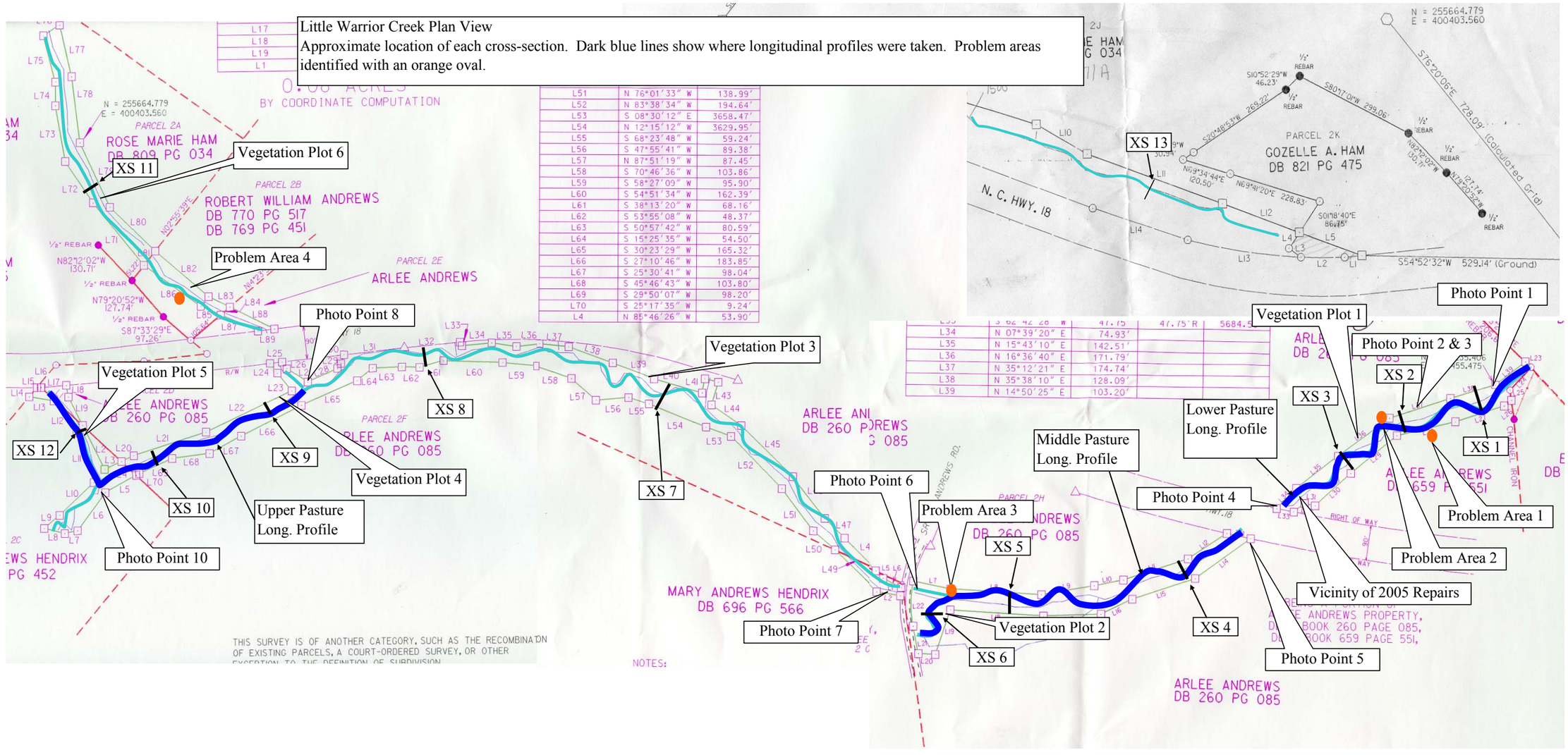
Source:
United States Department of the Interior, Geological Survey
Boomer Quadrangle, 7.5 Minute Series (Topographic).

FIGURE 2.—Big Warrior Creek mitigation site plan view, Yadkin River basin, Wilkes County, North Carolina.



Prepared for: Ecosystem Enhancement Program		Map is not to Scale Source: North Carolina Wildlife Resources Commission, As-built Report for the AH&W Mitigation Site	**Big Warrior Creek** Locations of Cross-sections, Longitudinal Profiles, Vegetation Plots, Photo Points, and Problem Areas Wilkes County, North Carolina	Figure Number 2

FIGURE 3.—Little Warrior Creek mitigation site plan view, Yadkin River basin, Wilkes County, North Carolina.



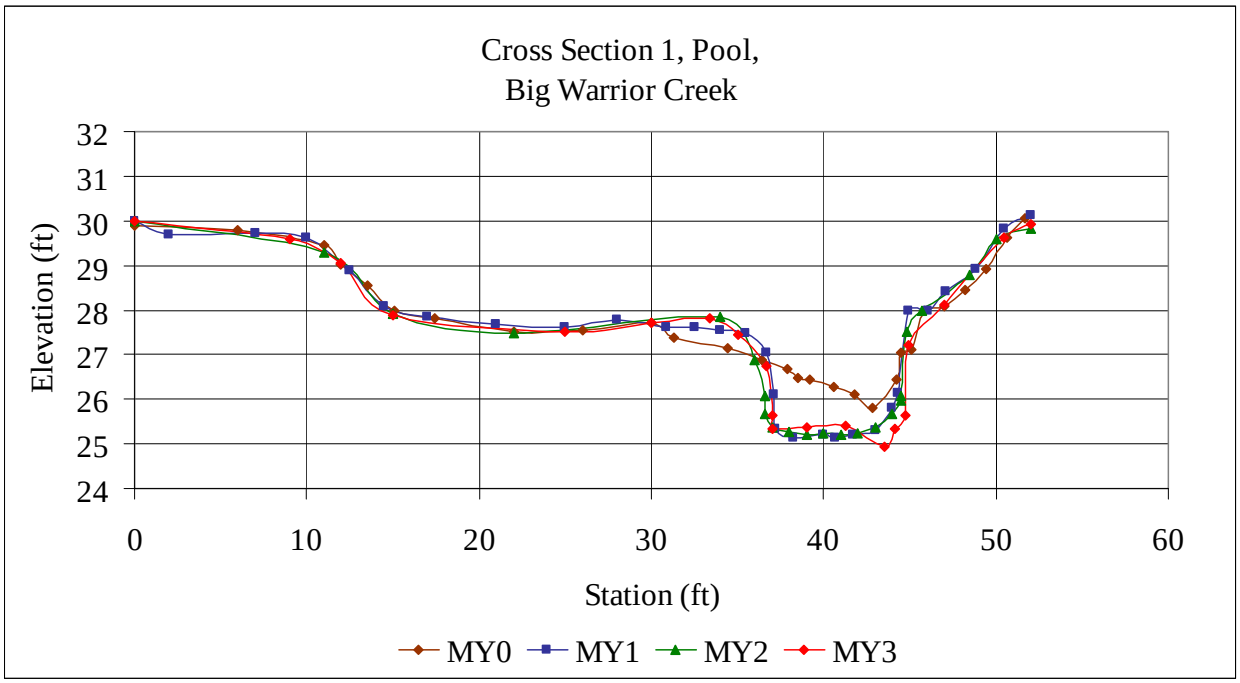
L51	N 76°01'33" W	138.99'
L52	N 83°38'34" W	194.64'
L53	S 08°30'12" E	3658.47'
L54	N 12°15'12" W	3629.95'
L55	S 68°23'48" W	59.24'
L56	S 47°55'41" W	89.38'
L57	N 87°51'19" W	87.45'
L58	S 70°46'36" W	103.86'
L59	S 58°27'09" W	95.90'
L60	S 54°51'34" W	162.39'
L61	S 38°13'20" W	68.16'
L62	S 53°55'08" W	48.37'
L63	S 50°57'42" W	80.59'
L64	S 15°25'35" W	54.50'
L65	S 30°23'29" W	165.32'
L66	S 27°10'46" W	183.85'
L67	S 25°30'41" W	98.04'
L68	S 45°46'43" W	103.80'
L69	S 29°50'07" W	98.20'
L70	S 25°17'35" W	9.24'
L4	N 85°46'26" W	53.90'

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'

Prepared for: Ecosystem Enhancement Program		Map is not to Scale Source: North Carolina Wildlife Resources Commission, As-built Report for the AH&W Mitigation Site	**Little Warrior Creek** Locations of Cross-sections, Longitudinal Profiles, Vegetation Plots, Photo Points, and Problem Areas Wilkes County, North Carolina	Figure Number 3

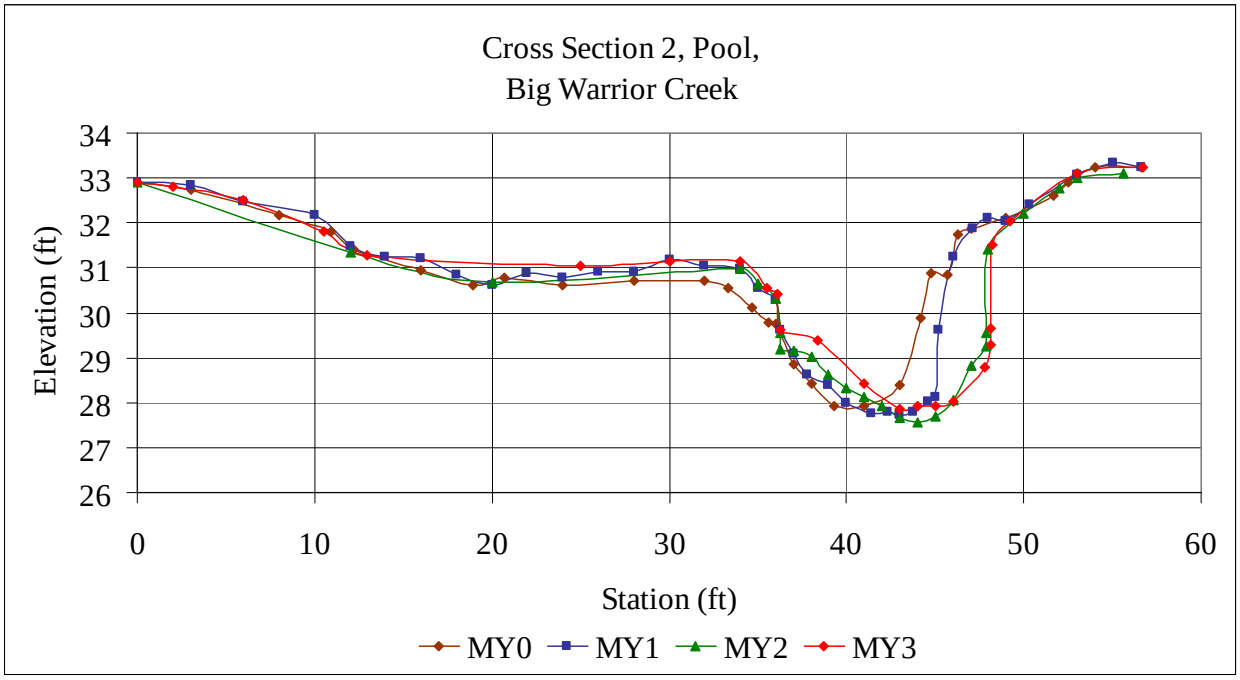
9 Appendix A.—Cross-Section Comparisons

Appendix A.1. Cross-section data comparisons for Big Warrior Creek, MY0-MY3. The orange line in the photographs depicts the cross-section transect location.



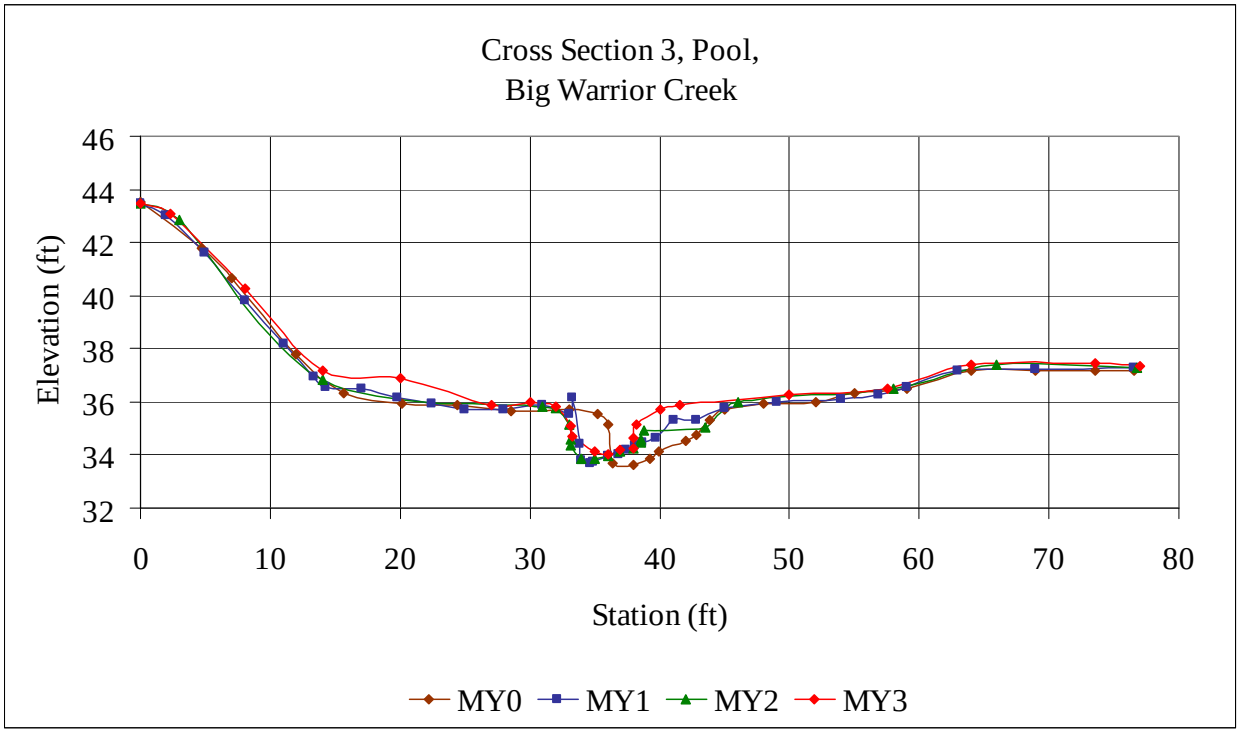
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 1 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	15.3	31.0	29.0	29.1
Maximum Bankfull Depth (ft)	1.9	3.0	2.7	3.0
Bankfull Mean Depth (ft)	1.0	1.0	0.9	0.9
Width/Depth Ratio	15.7		35.1	34.9
Entrenchment Ratio	2.6		1.6	1.6
Bankfull Width (ft)	15.5	31.8	31.9	31.8



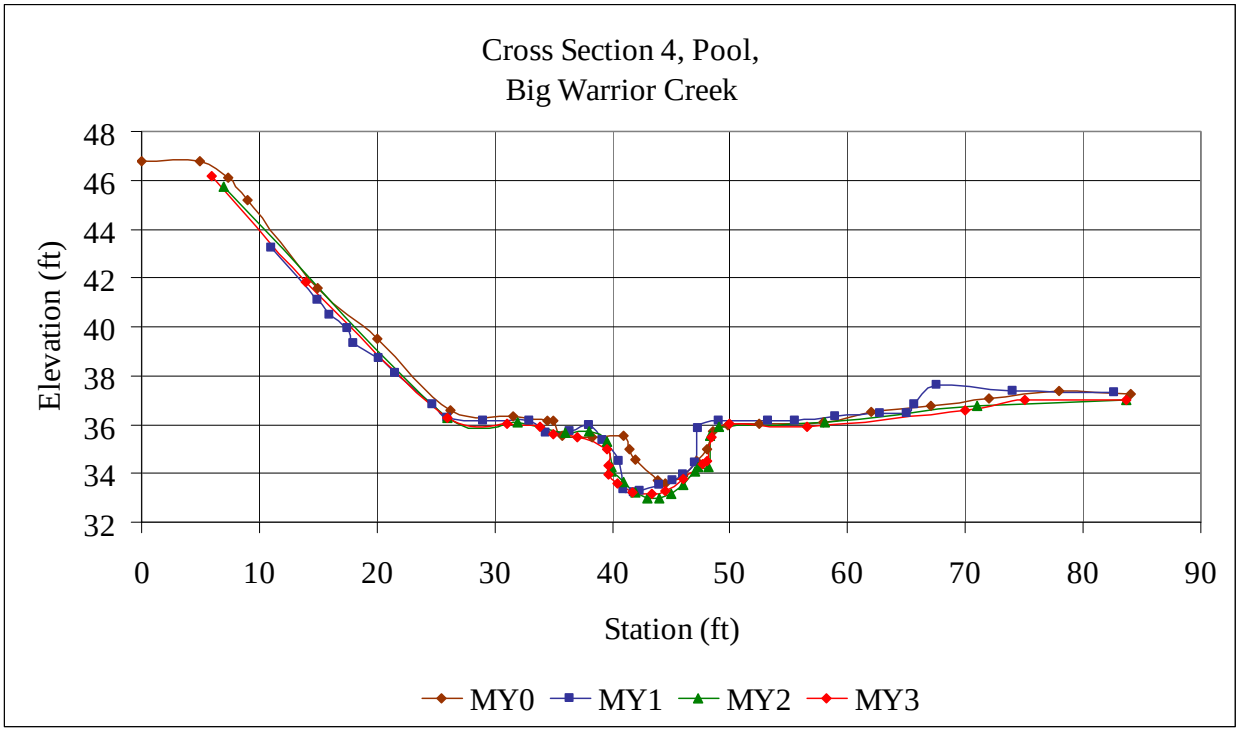
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 2 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	20.3	43.1	34.9	34.8
Maximum Bankfull Depth (ft)	2.8	3.8	3.4	3.4
Bankfull Mean Depth (ft)	1.6	1.3	1.1	1.0
Width/Depth Ratio	7.9	27.4	29.1	31.7
Entrenchment Ratio	5.3	2.9	1.7	1.7
Bankfull Width (ft)	12.7	34.4	31.9	33.2



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

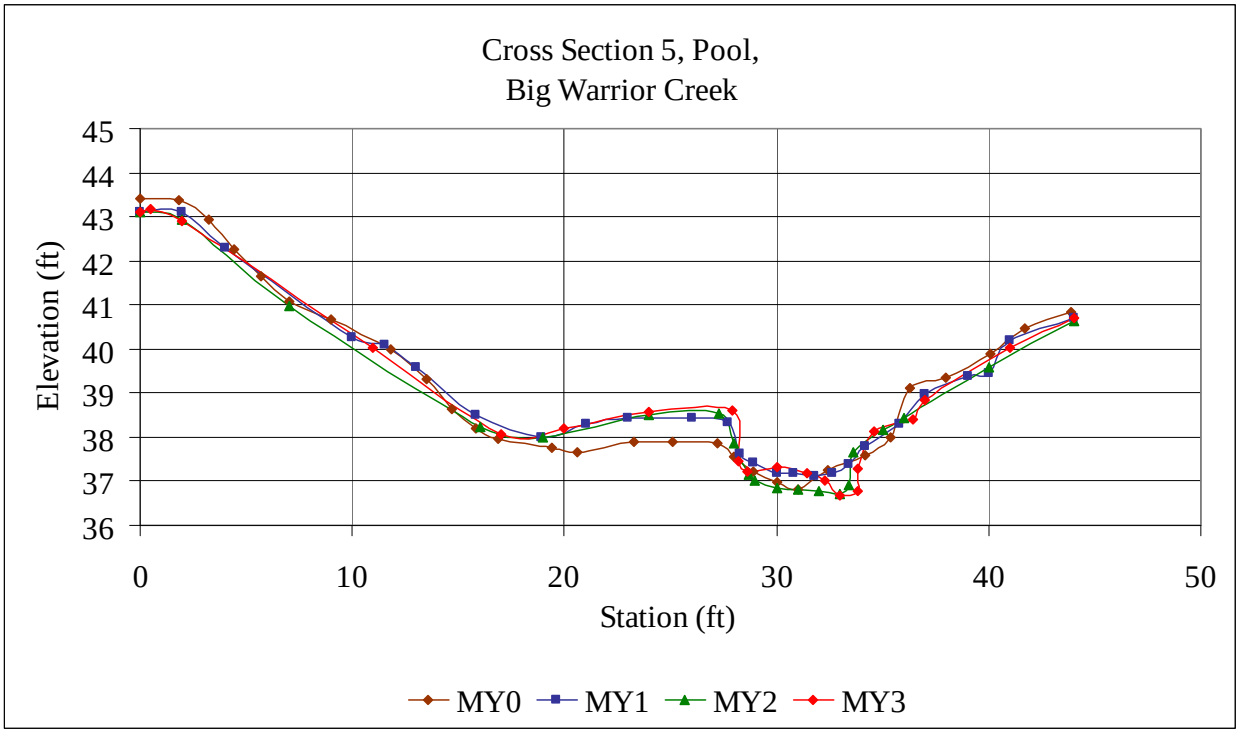
Cross-Section 3 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	12.8	10.1	17.8	8.8
Maximum Bankfull Depth (ft)	2.1	1.9	2.1	1.8
Bankfull Mean Depth (ft)	1.0	1.0	1.0	1.0
Width/Depth Ratio	11.6	10.9	18.0	9.0
Entrenchment Ratio	6.9	6.5	3.7	7.1
Bankfull Width (ft)	12.2	10.5	17.9	8.9



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

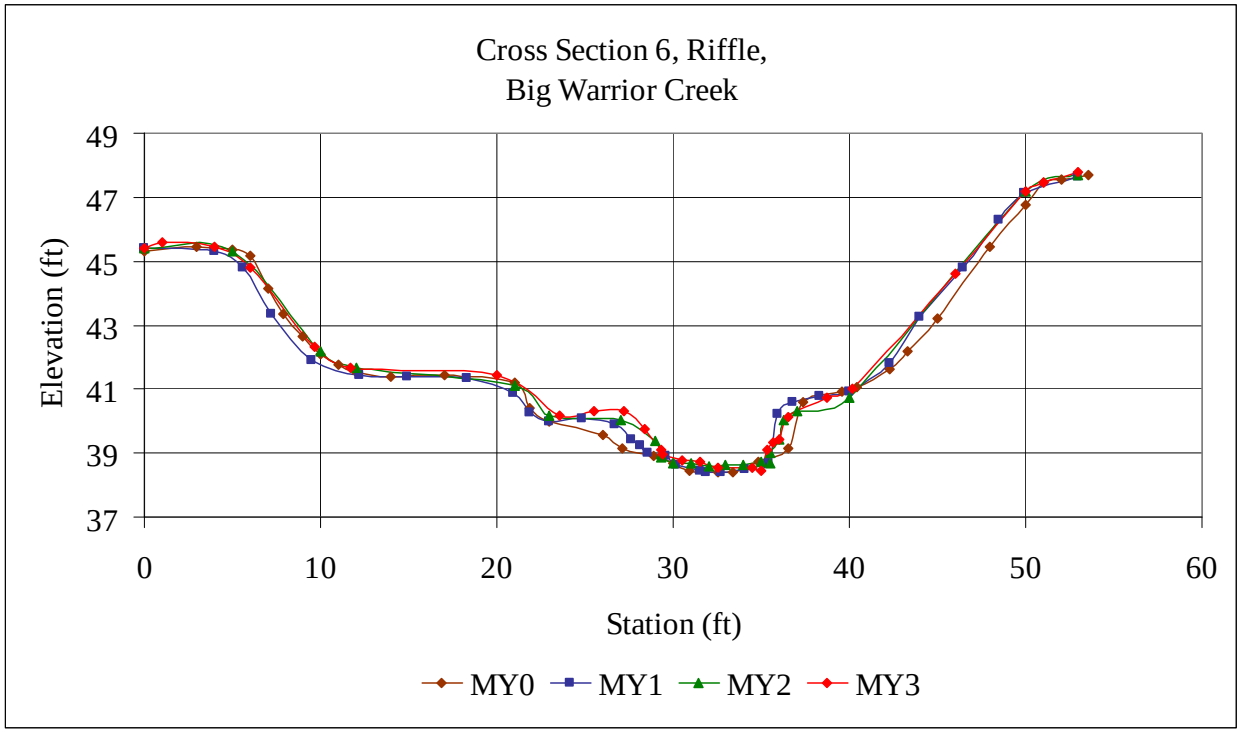
Cross-Section 4 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	19.5	11.8	21.6	21.5
Maximum Bankfull Depth (ft)	2.6	2.2	2.9	2.7
Bankfull Mean Depth (ft)	1.1	1.5	1.4	1.4
Width/Depth Ratio			10.4	10.8
Entrenchment Ratio			4.2	4.0
Bankfull Width (ft)	17.5	8.0	15.0	15.3

Appendix A.1. Continued.



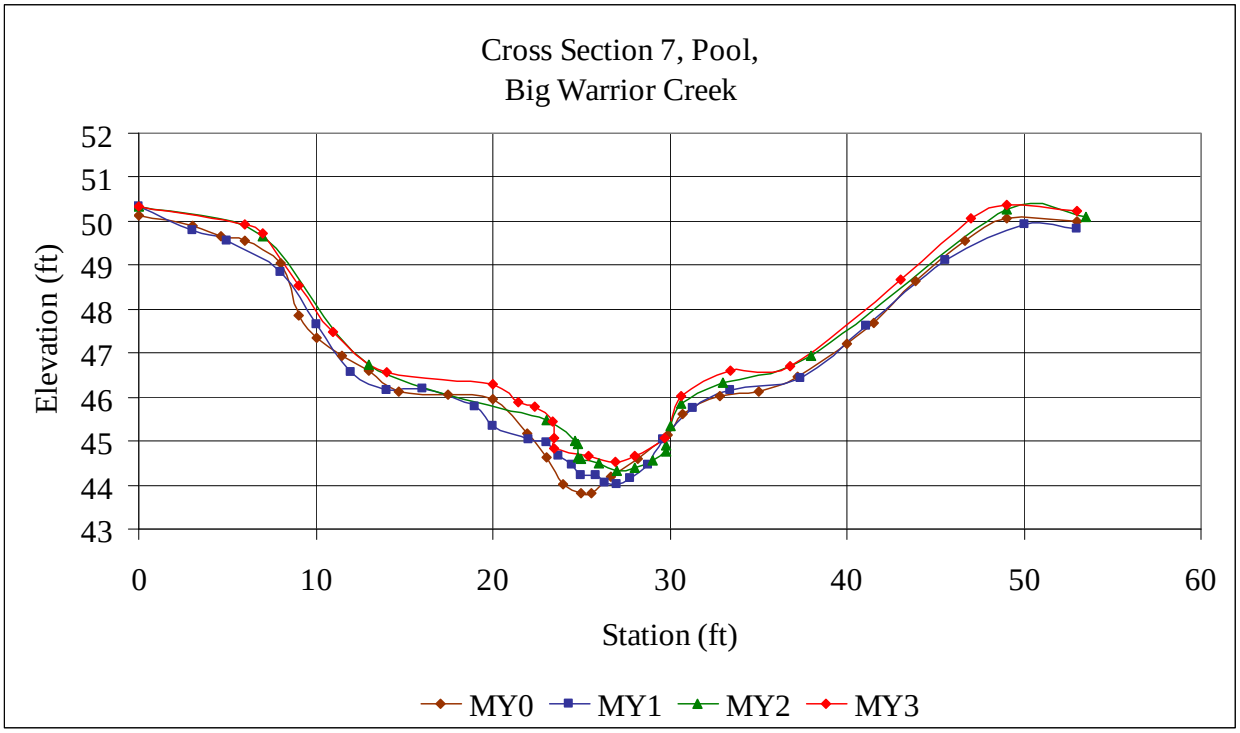
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 5 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	20.3	35.4	19.8	20.0
Maximum Bankfull Depth (ft)	1.9	2.5	2.1	2.3
Bankfull Mean Depth (ft)	1.0	1.3	0.8	0.9
Width/Depth Ratio	22.3	20.8	27.6	26.3
Entrenchment Ratio	1.5	2.4	1.6	1.6
Bankfull Width (ft)	21.3	27.2	23.4	23.0



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 6 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	22.3	10.0	14.3	14.2
Maximum Bankfull Depth (ft)	2.2	1.5	1.8	2.0
Bankfull Mean Depth (ft)	1.4	1.1	1.0	1.0
Width/Depth Ratio	10.9	8.3	15.3	15.7
Entrenchment Ratio	2.3	3.9	2.2	2.2
Bankfull Width (ft)	15.6	9.1	14.8	14.9



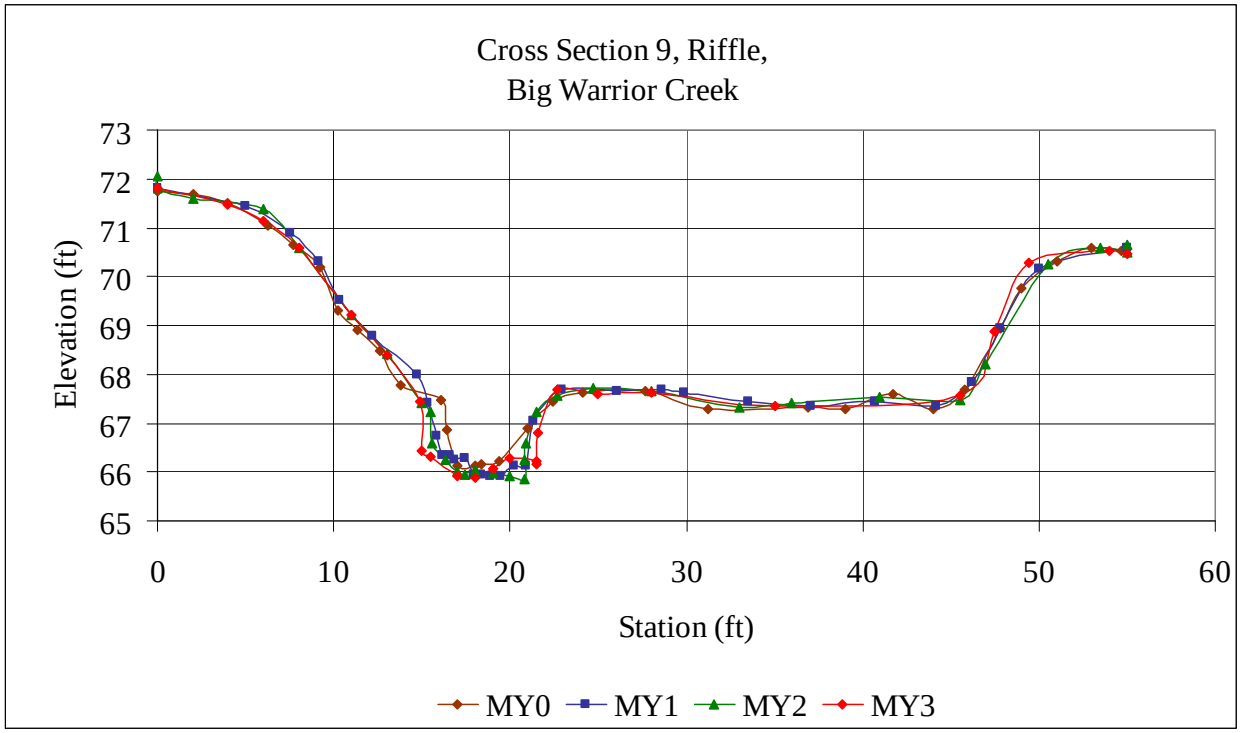
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 7 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	16.4	27.2	23.1	23.2
Maximum Bankfull Depth (ft)	2.3	2.6	2.4	2.3
Bankfull Mean Depth (ft)	1.1	1.1	1.0	1.0
Width/Depth Ratio	14.1	24.6	23.2	25.5
Entrenchment Ratio	2.3	1.5	1.6	1.5
Bankfull Width (ft)	15.2	25.8	23.2	24.3

Appendix A.1. Continued.

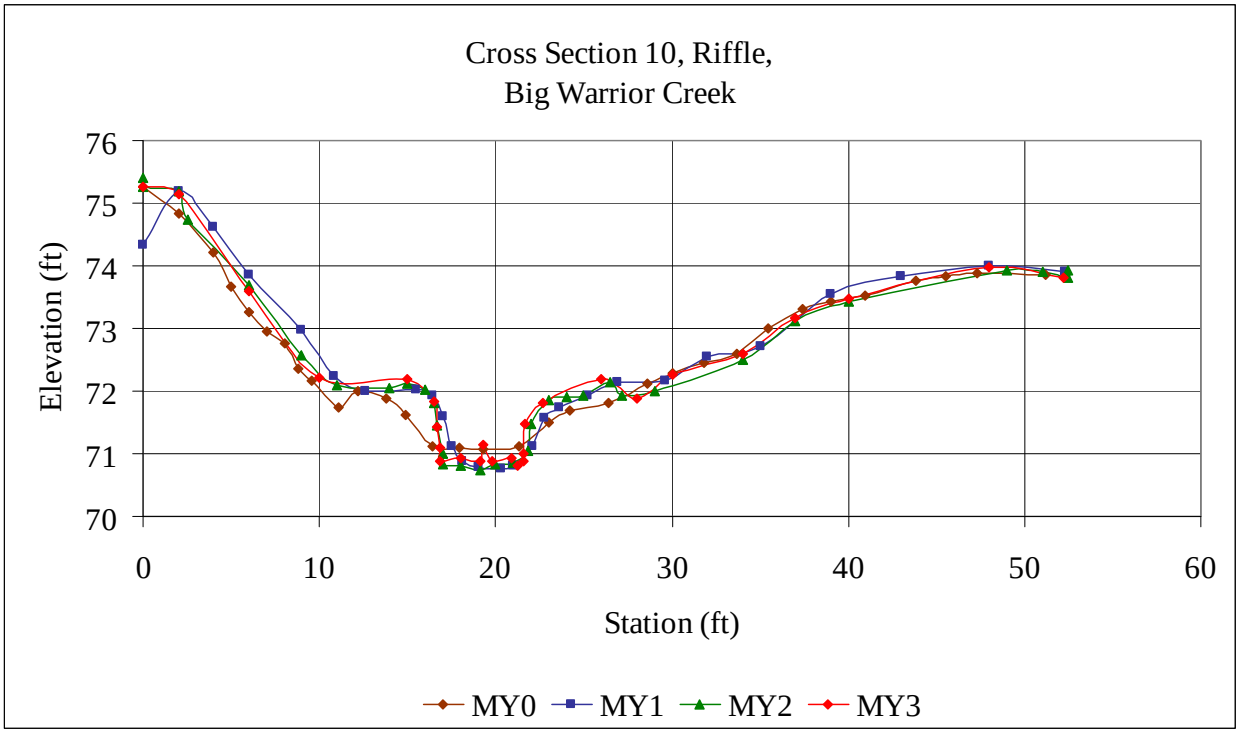
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 8 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	15.3	5.8	11.3	13.9
Maximum Bankfull Depth (ft)	2.4	1.3	1.5	1.7
Bankfull Mean Depth (ft)	1.1	0.9	0.8	0.9
Width/Depth Ratio	12.8	6.5	17.1	16.1
Entrenchment Ratio	3.5	3.3	2.0	1.8
Bankfull Width (ft)	14.0	6.1	13.9	15.0



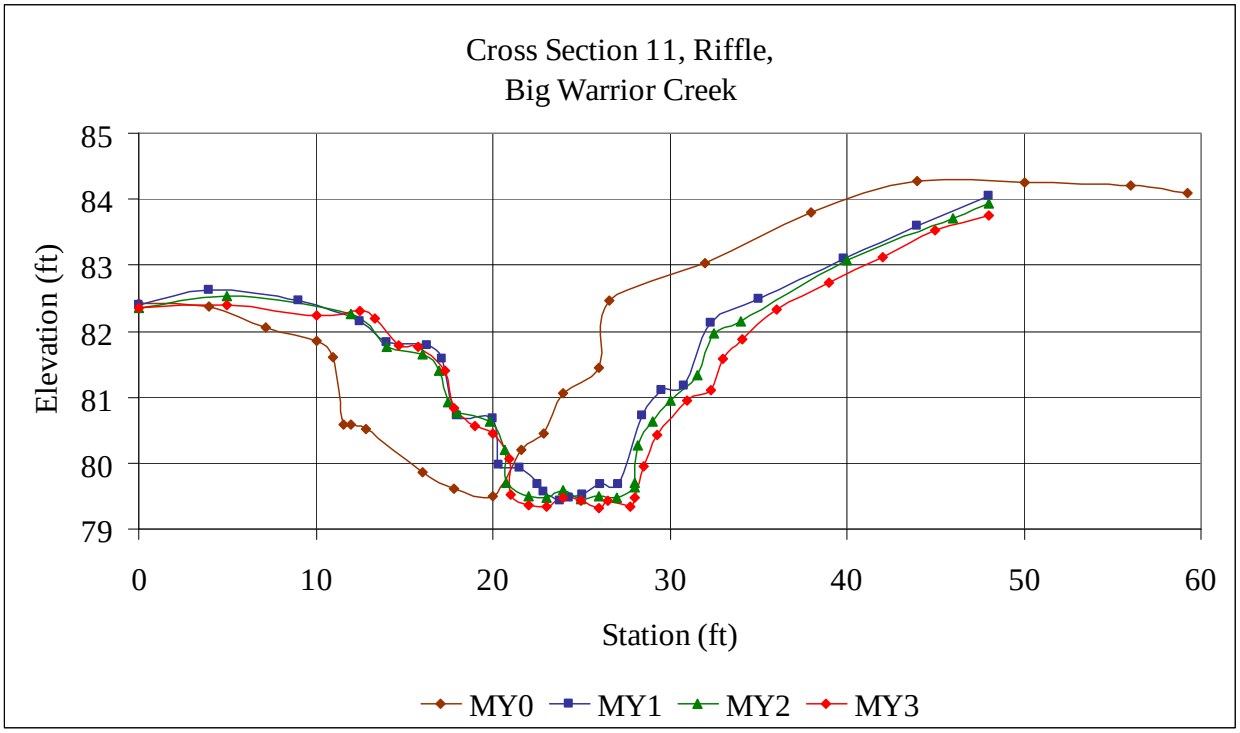
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 9 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	16.0	13.2	14.5	14.5
Maximum Bankfull Depth (ft)	1.7	1.8	1.9	1.8
Bankfull Mean Depth (ft)	0.5	0.4	0.5	0.5
Width/Depth Ratio	64.1	70.7	63.2	65.9
Entrenchment Ratio	1.2	1.3	1.2	1.3
Bankfull Width (ft)	32.0	30.6	31.6	30.9



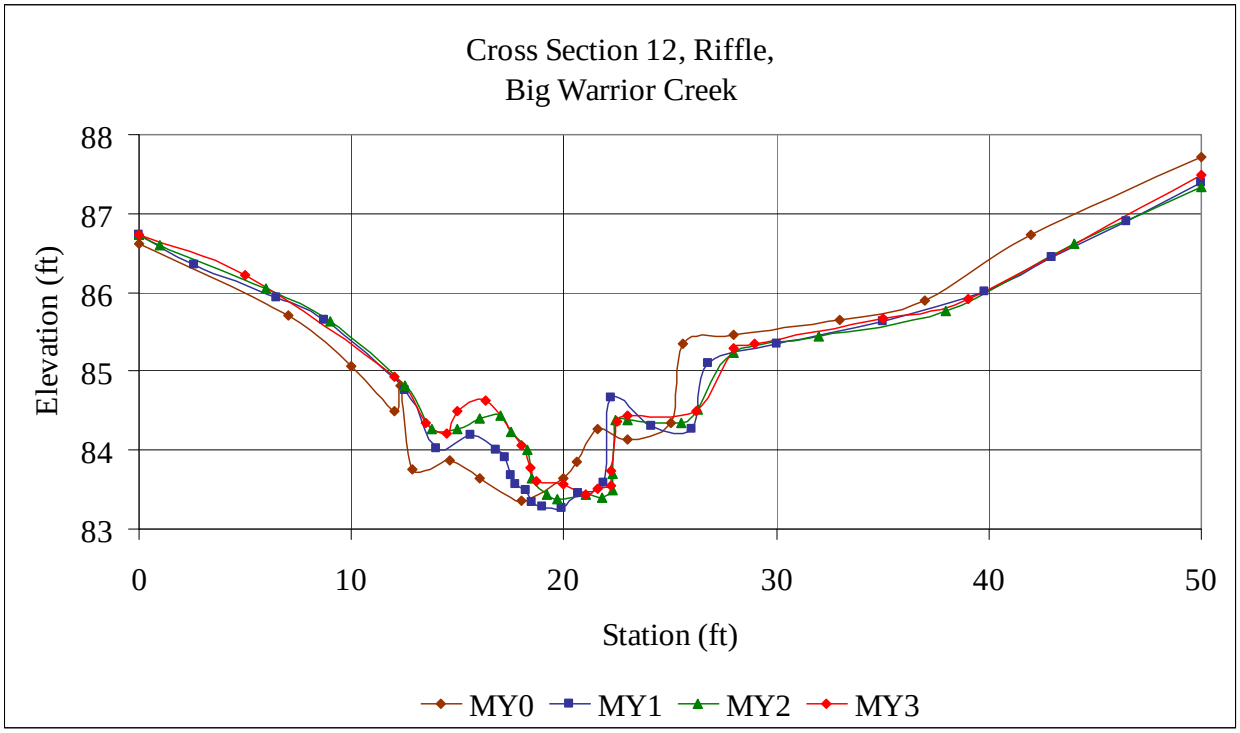
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 10 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	13.9	10.3	9.1	9.7
Maximum Bankfull Depth (ft)	1.2	1.5	1.4	1.5
Bankfull Mean Depth (ft)	0.7	0.5	0.5	0.5
Width/Depth Ratio	32.1	35.7	43.1	41.7
Entrenchment Ratio	1.6	1.7	1.8	1.9
Bankfull Width (ft)	21.1	19.2	19.8	20.1



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

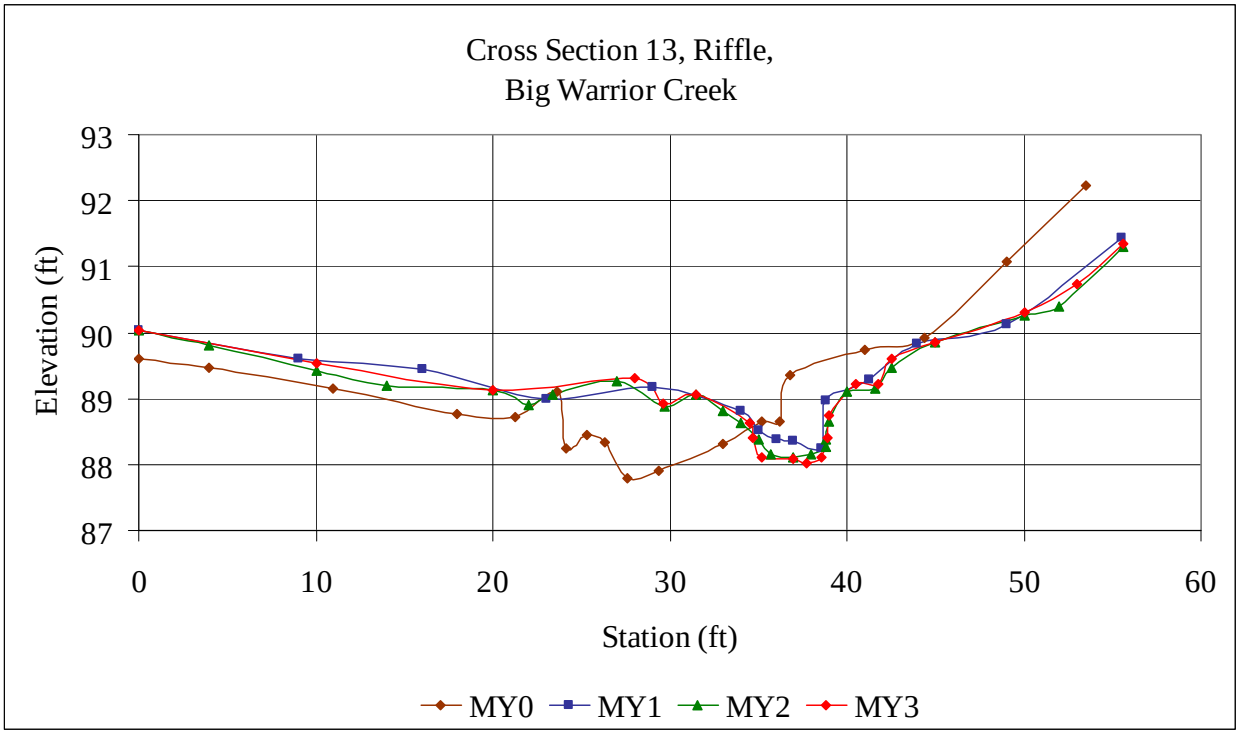
Cross-Section 11 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	20.2	7.6	9.9	10.0
Maximum Bankfull Depth (ft)	2.1	1.3	1.3	1.3
Bankfull Mean Depth (ft)	1.3	0.9	0.9	0.9
Width/Depth Ratio	11.7	9.2	13.1	12.6
Entrenchment Ratio	2.5	2.4	1.8	1.8
Bankfull Width (ft)	15.4	8.4	11.4	11.2



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

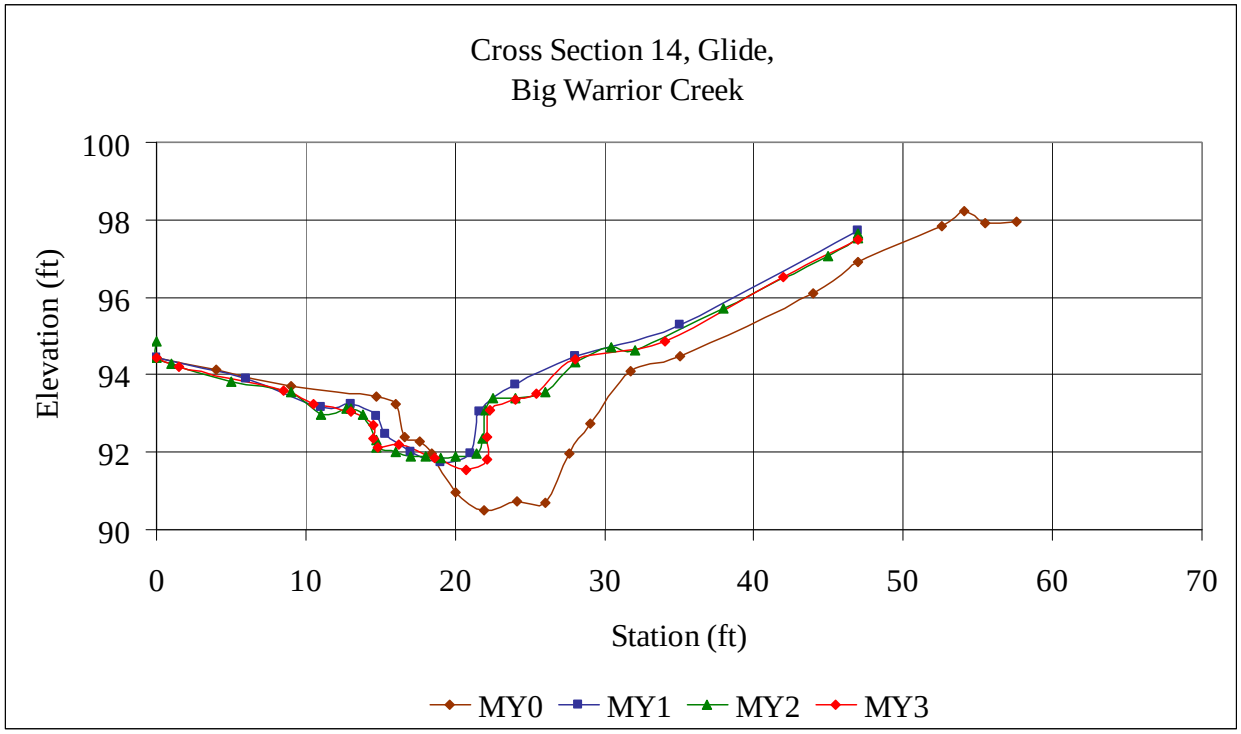
Cross-Section 12 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	20.4	10.8	13.6	13.8
Maximum Bankfull Depth (ft)	2.0	1.5	1.7	1.7
Bankfull Mean Depth (ft)	1.3	0.8	0.8	0.8
Width/Depth Ratio	11.6	18.1	18.9	20.1
Entrenchment Ratio	2.7	2.9	2.8	2.7
Bankfull Width (ft)	15.4	14.0	16.0	16.6

Appendix A.1. Continued.



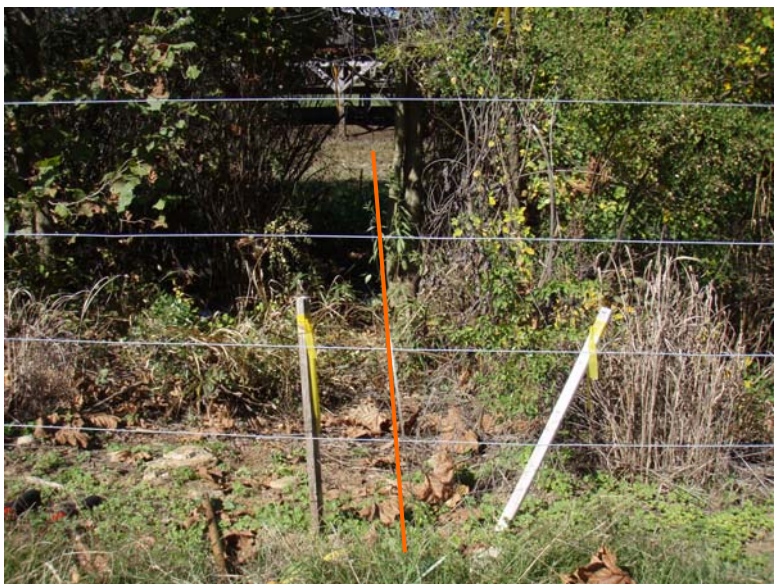
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

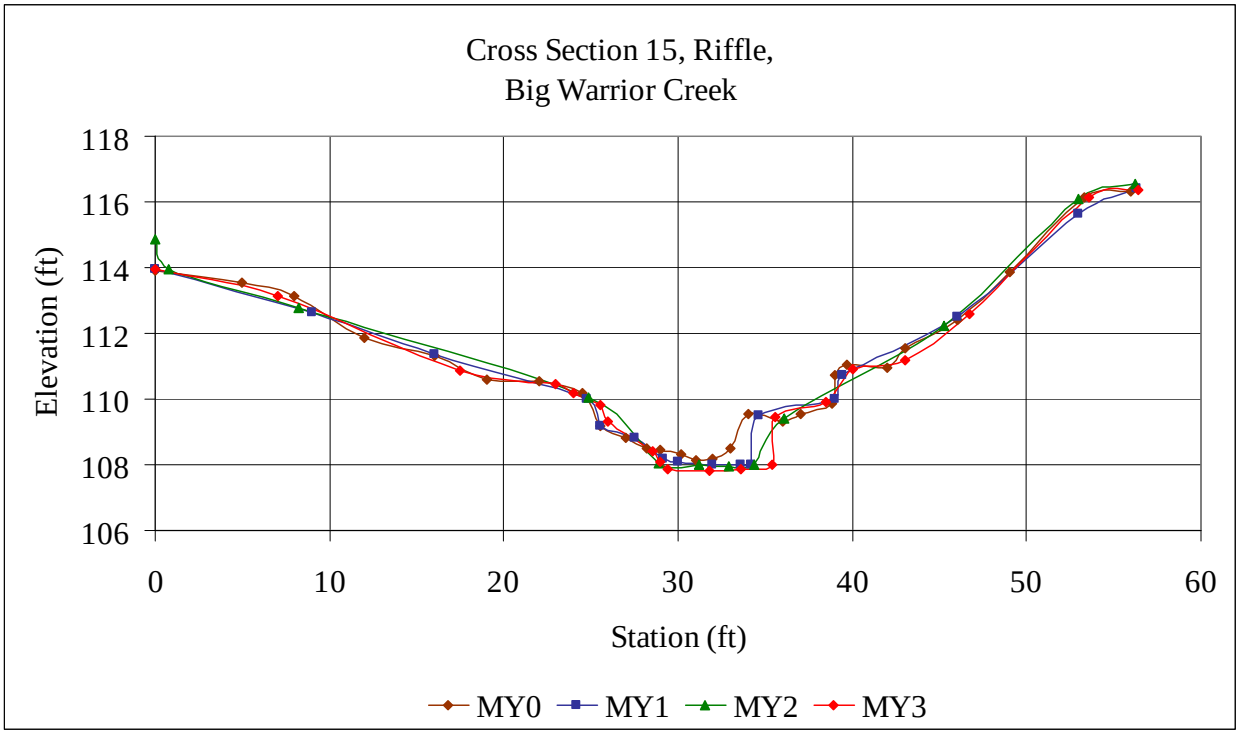
Cross-Section 13 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	20.5	8.0	9.8	9.7
Maximum Bankfull Depth (ft)	1.6	1.0	1.2	1.3
Bankfull Mean Depth (ft)	1.6	0.3	0.3	0.4
Width/Depth Ratio	8.2	66.1	86.8	73.7
Entrenchment Ratio	3.4	2.6	1.8	1.9
Bankfull Width (ft)	13.0	23.0	29.2	26.7



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 14 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	24.7	8.3	14.9	14.9
Maximum Bankfull Depth (ft)	2.7	1.5	1.7	2.0
Bankfull Mean Depth (ft)	1.9	0.7	0.9	0.9
Width/Depth Ratio			18.9	17.9
Entrenchment Ratio			2.0	2.1
Bankfull Width (ft)	13.3	11.6	16.8	16.3

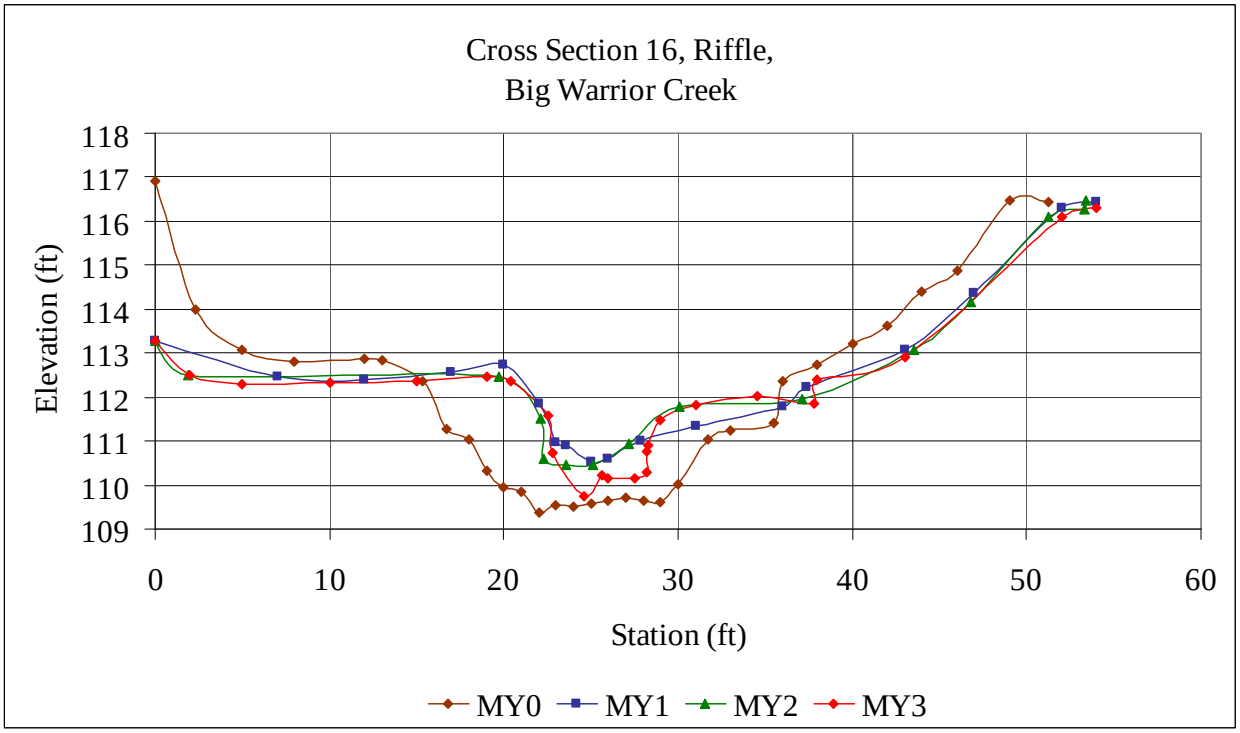




Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

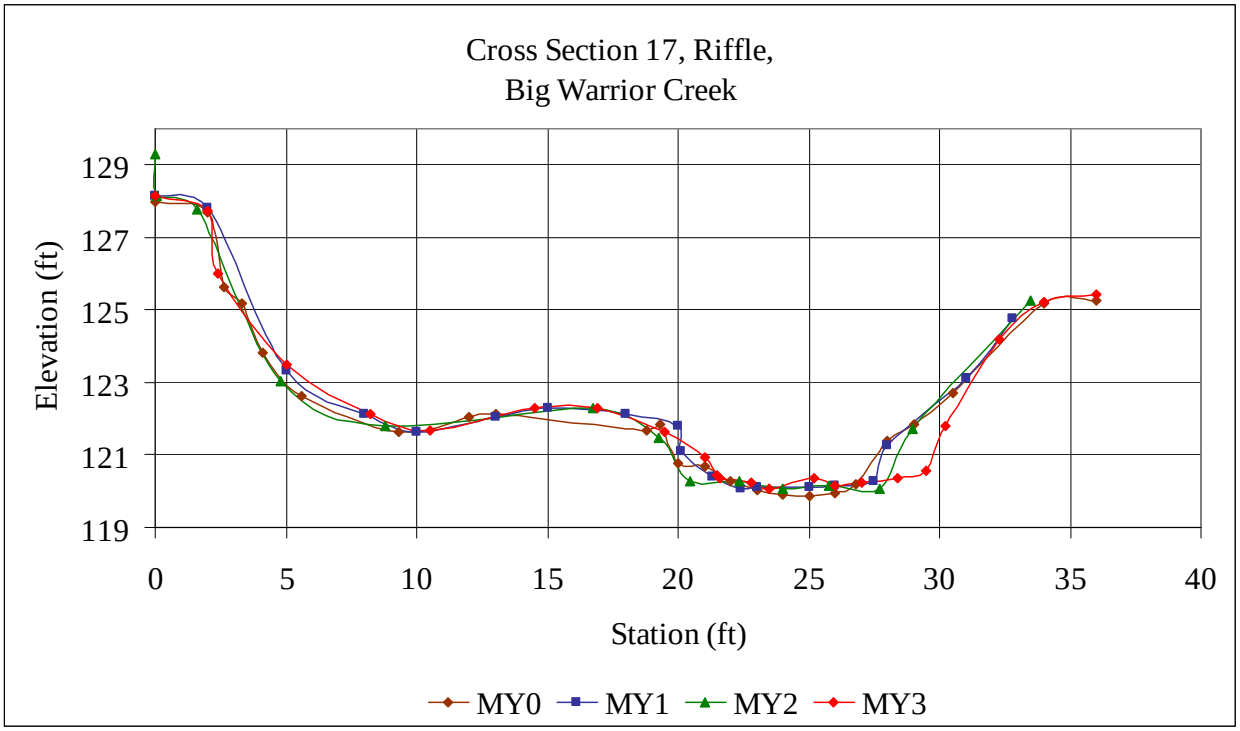
Cross-Section 15 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	17.3	10.5	10.9	11.2
Maximum Bankfull Depth (ft)	2.1	1.5	1.5	1.5
Bankfull Mean Depth (ft)	1.2	1.1	1.1	1.2
Width/Depth Ratio	11.4	8.4	9.1	8.2
Entrenchment Ratio	2.5	2.6	2.1	2.3
Bankfull Width (ft)	14.0	9.4	10.0	9.6

Appendix A.1. Continued.



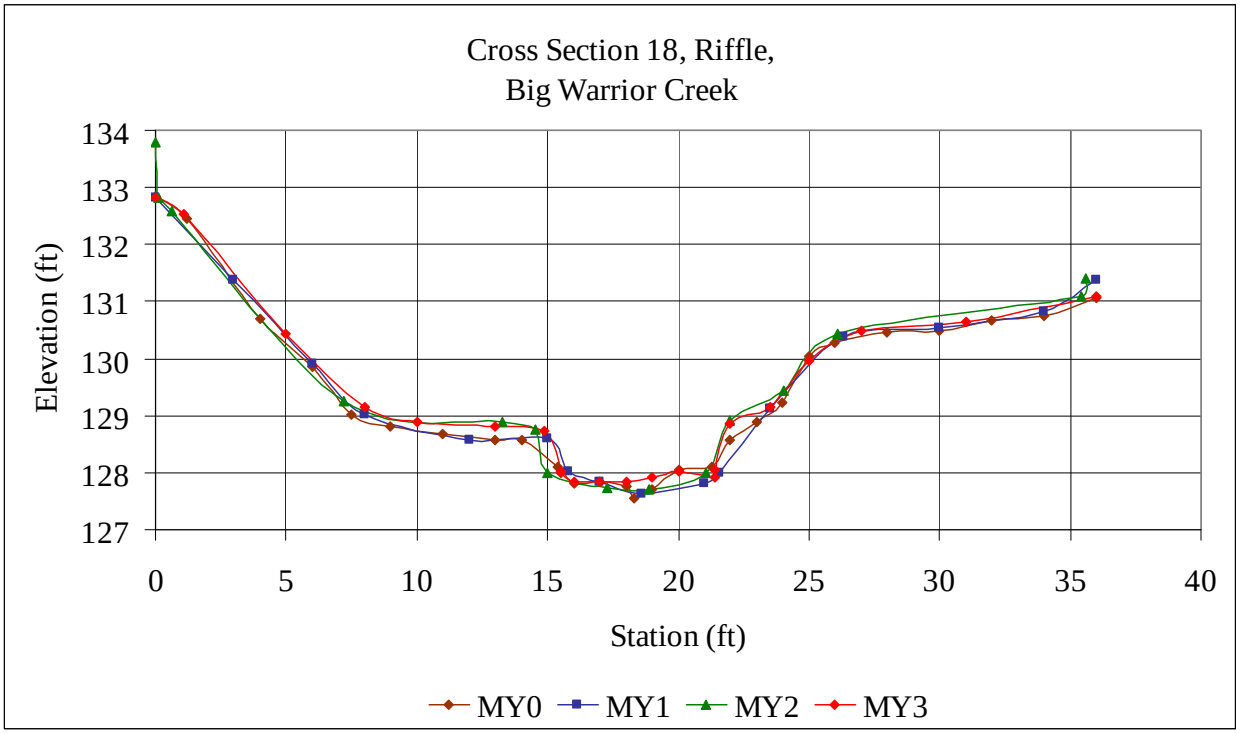
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 16 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	40.7	15.3	18.9	18.8
Maximum Bankfull Depth (ft)	3.0	1.7	2.0	2.6
Bankfull Mean Depth (ft)	2.9	0.9	0.9	0.7
Width/Depth Ratio	72.6	17.3	22.0	43.7
Entrenchment Ratio	2.5	3.4	1.2	1.7
Bankfull Width (ft)	14.0	16.3	20.4	28.6



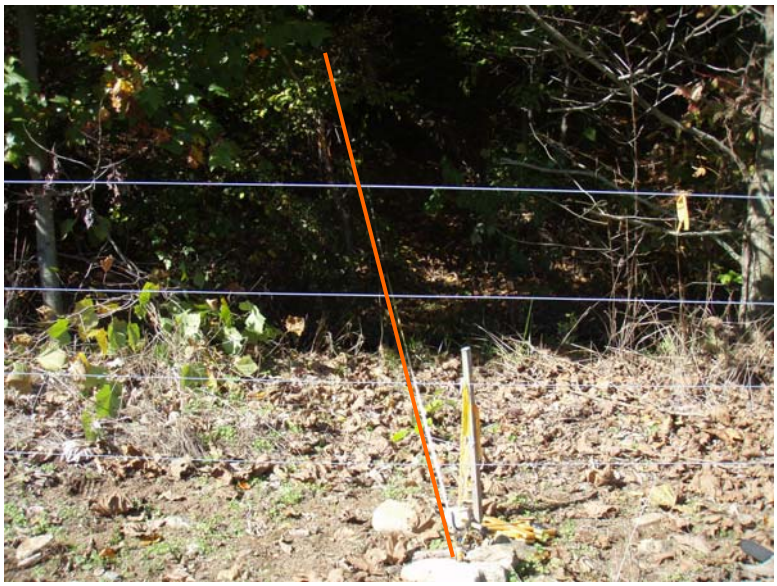
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

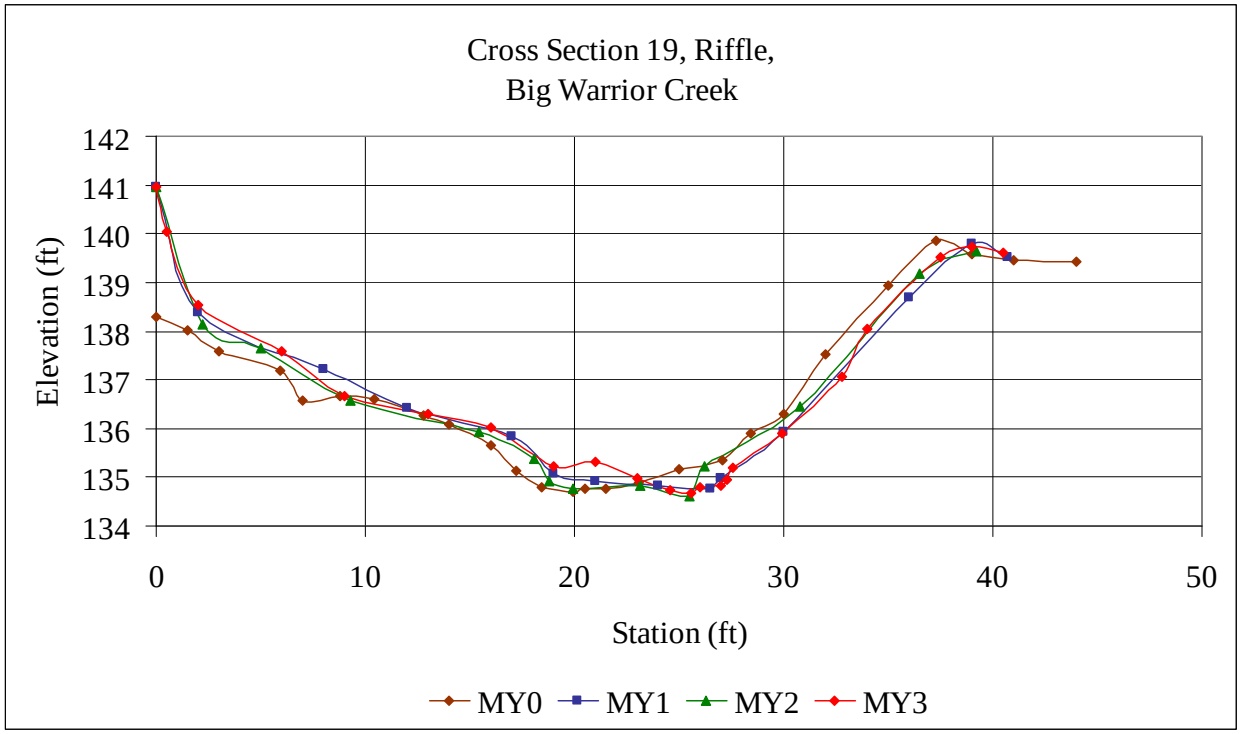
Cross-Section 17 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	13.3	7.7	13.1	14.3
Maximum Bankfull Depth (ft)	2.0	1.2	1.7	1.7
Bankfull Mean Depth (ft)	1.0	1.0	1.3	1.2
Width/Depth Ratio			8.3	9.2
Entrenchment Ratio			2.5	2.3
Bankfull Width (ft)	14.0	7.9	10.4	11.5



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

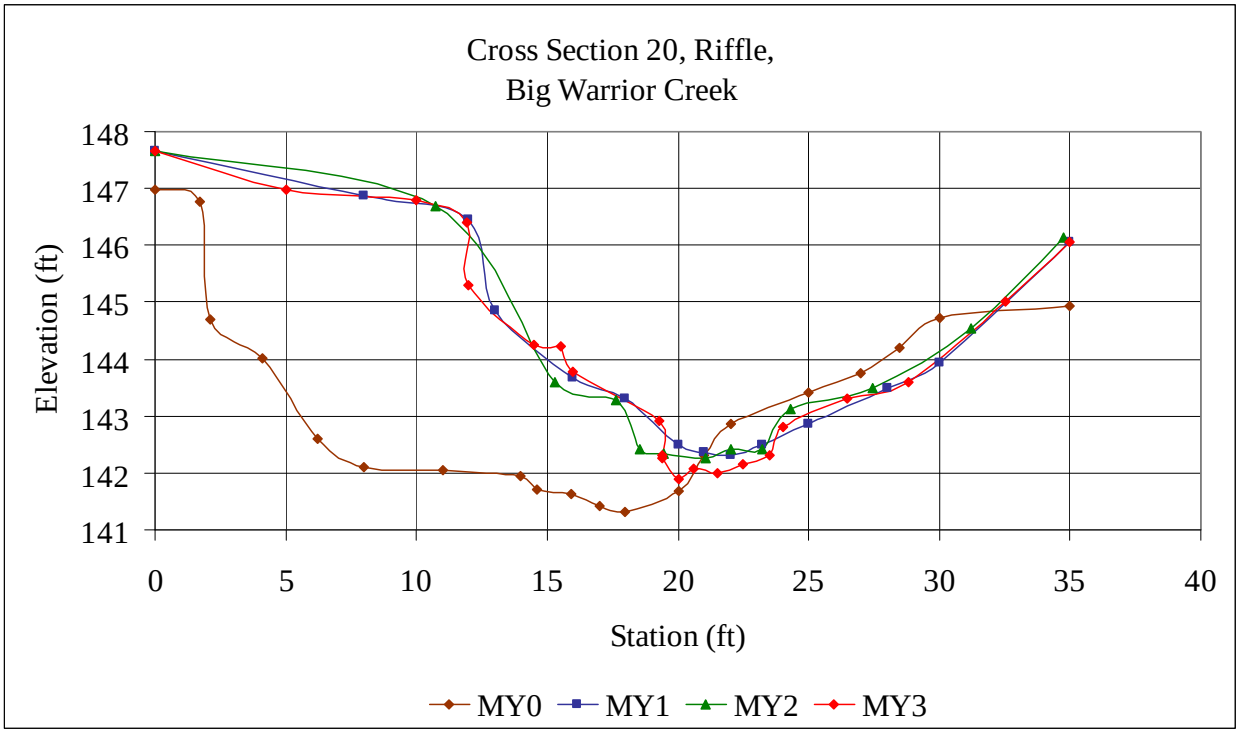
Cross-Section 18 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	10.5	12.5	11.5	10.4
Maximum Bankfull Depth (ft)	1.5	1.5	1.5	1.3
Bankfull Mean Depth (ft)	0.8	0.8	0.7	0.7
Width/Depth Ratio	18.6	19.9	22.3	23.3
Entrenchment Ratio	2.5	1.9	1.7	1.4
Bankfull Width (ft)	14.0	15.7	16.1	15.5





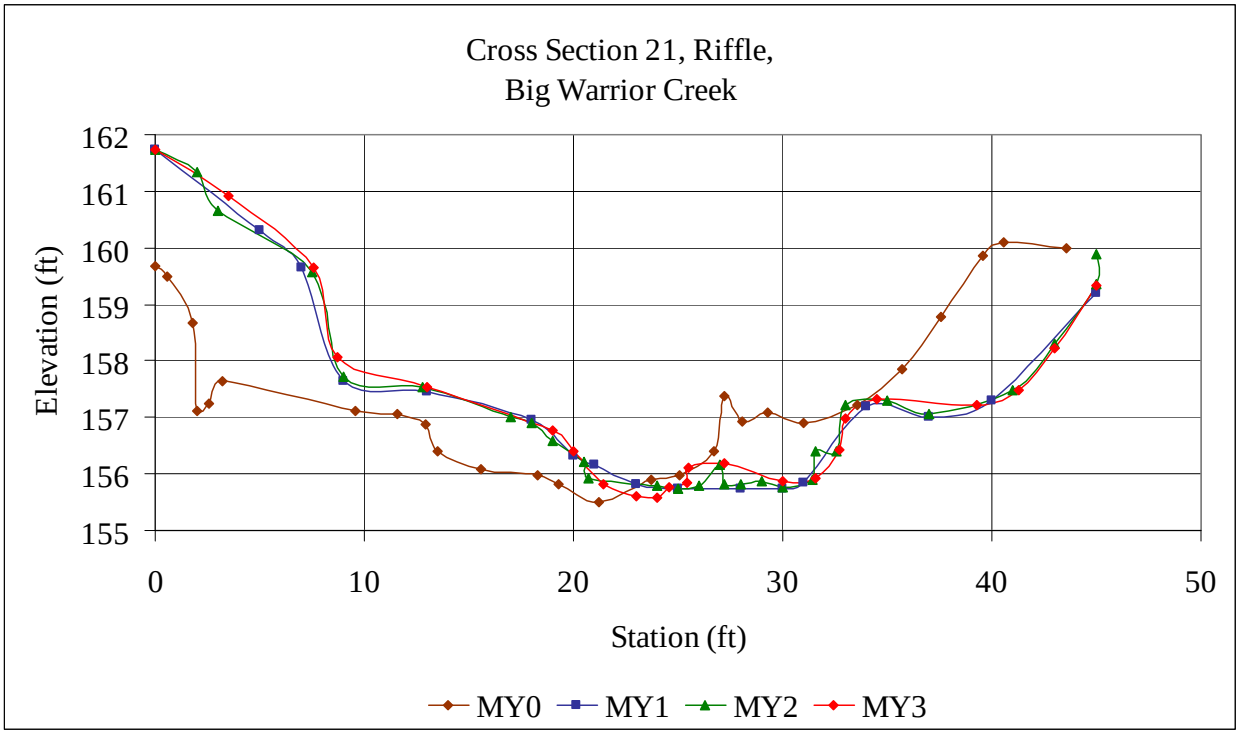
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 19 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	16.0	9.8	10.7	10.9
Maximum Bankfull Depth (ft)	1.5	1.1	1.3	1.3
Bankfull Mean Depth (ft)	0.9	0.8	0.8	0.8
Width/Depth Ratio	18.5	16.7	16.8	18.3
Entrenchment Ratio	1.7	1.8	1.9	1.9
Bankfull Width (ft)	17.2	12.8	13.4	14.2



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

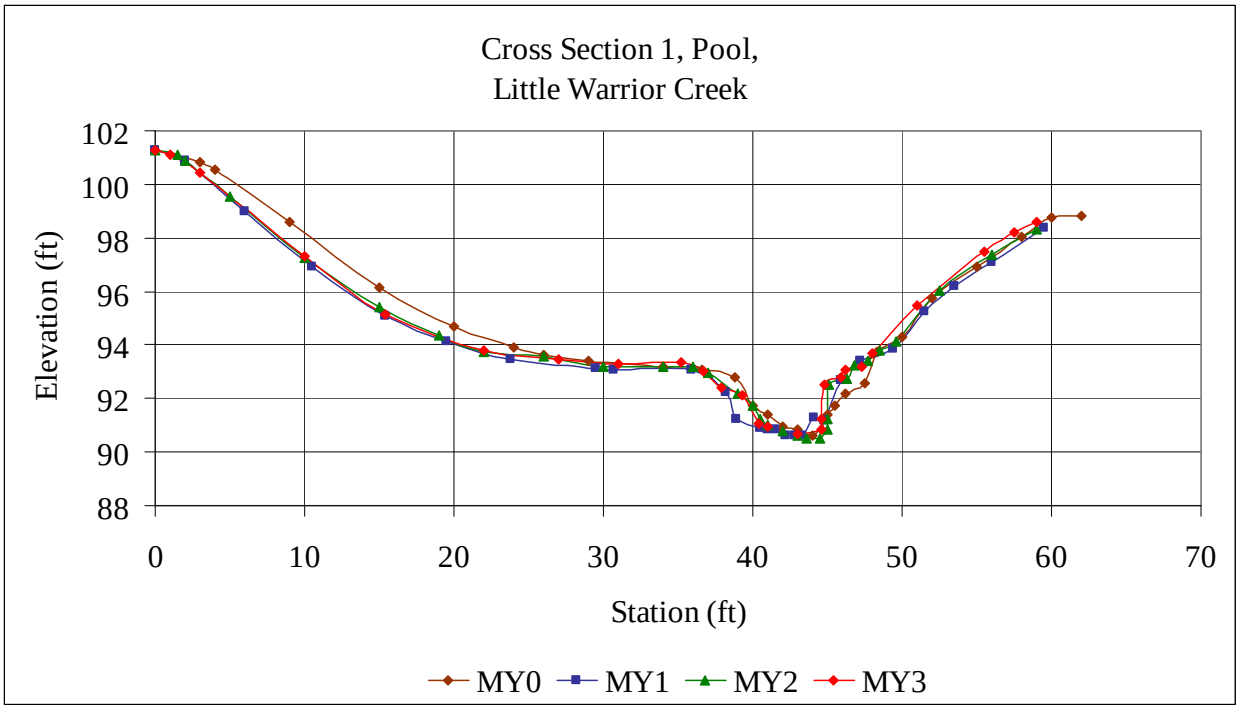
Cross-Section 20 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	14.8	5.4	8.6	9.3
Maximum Bankfull Depth (ft)	1.6	1.0	1.3	1.7
Bankfull Mean Depth (ft)	0.9	0.6	0.7	0.8
Width/Depth Ratio	17.3	15.5	18.1	15.8
Entrenchment Ratio	1.6	1.9	1.5	1.8
Bankfull Width (ft)	16.0	9.1	12.5	12.1



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

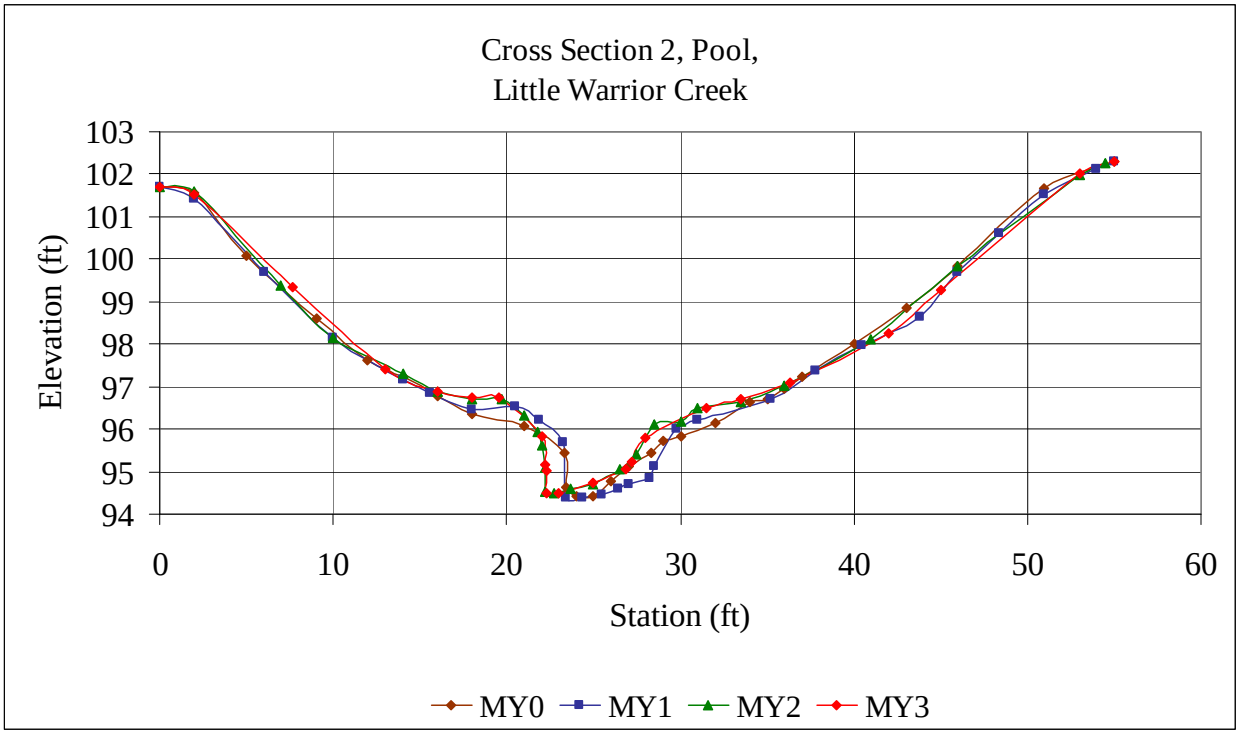
Cross-Section 21 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	12.3	18.8	14.7	18.0
Maximum Bankfull Depth (ft)	1.4	1.5	1.3	1.7
Bankfull Mean Depth (ft)	0.9	0.8	0.9	1.0
Width/Depth Ratio			17.2	19.3
Entrenchment Ratio			2.2	1.9
Bankfull Width (ft)	14.0	23.6	15.9	18.7

Appendix A.2. Cross-section data comparisons for Little Warrior Creek, MY0-MY3. The orange line in the photographs depicts the cross-section transect location.



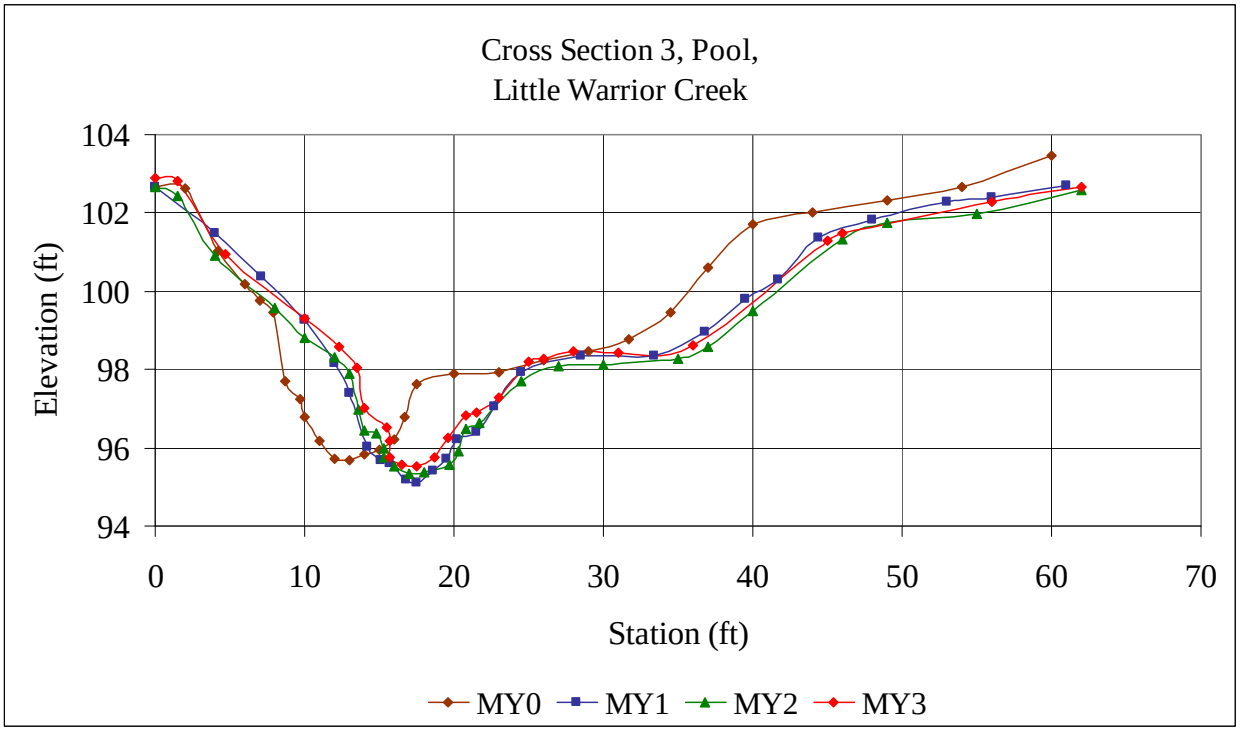
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 1 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	18.7	12.0	15.2	15.6
Maximum Bankfull Depth (ft)	2.8	2.0	2.7	2.6
Bankfull Mean Depth (ft)	1.0	1.4	1.4	13
Width/Depth Ratio	19.8	12.6	7.6	9
Entrenchment Ratio	1.9	1.2	3.6	3.2
Bankfull Width (ft)	19.2	8.9	10.7	11.9



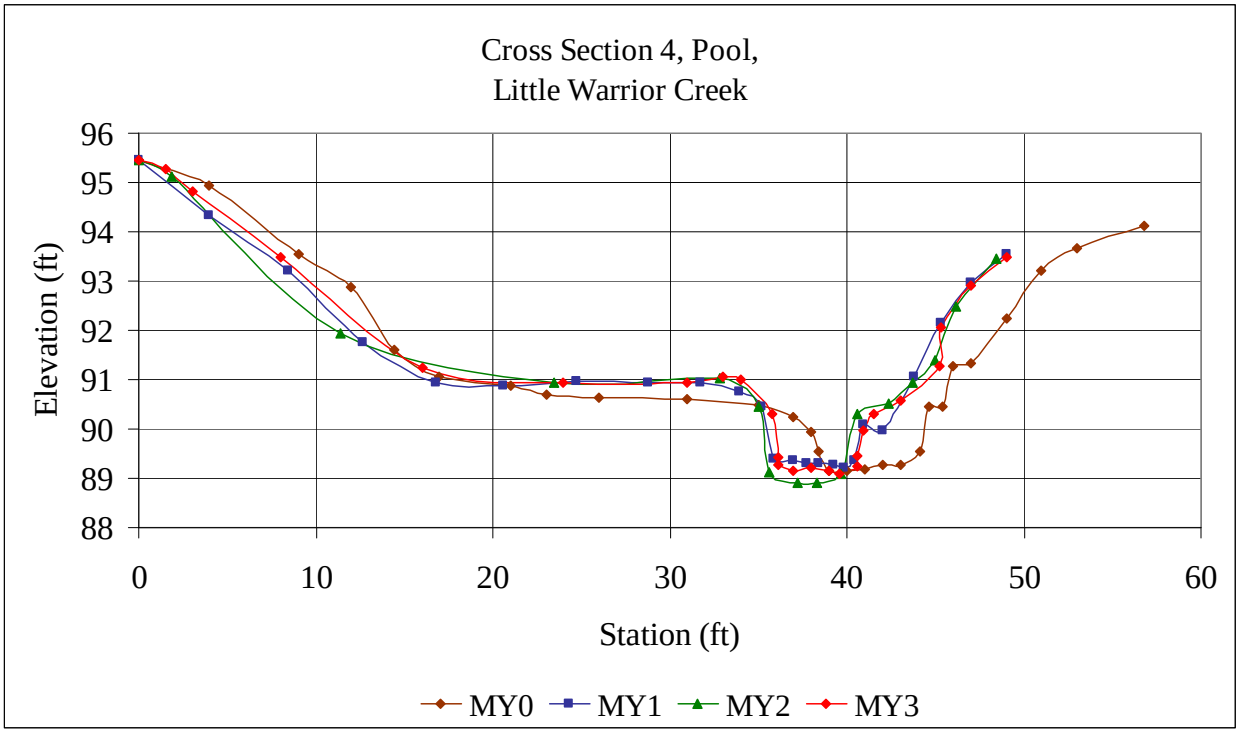
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 2 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	16.1	10.0	13.8	14.8
Maximum Bankfull Depth (ft)	2.2	1.8	2.2	2.3
Bankfull Mean Depth (ft)	1.5	1.1	0.9	1.0
Width/Depth Ratio	7.5	8.7	16.6	13.8
Entrenchment Ratio	1.8	3.3	2.3	2.6
Bankfull Width (ft)	11.0	9.4	15.1	14.3



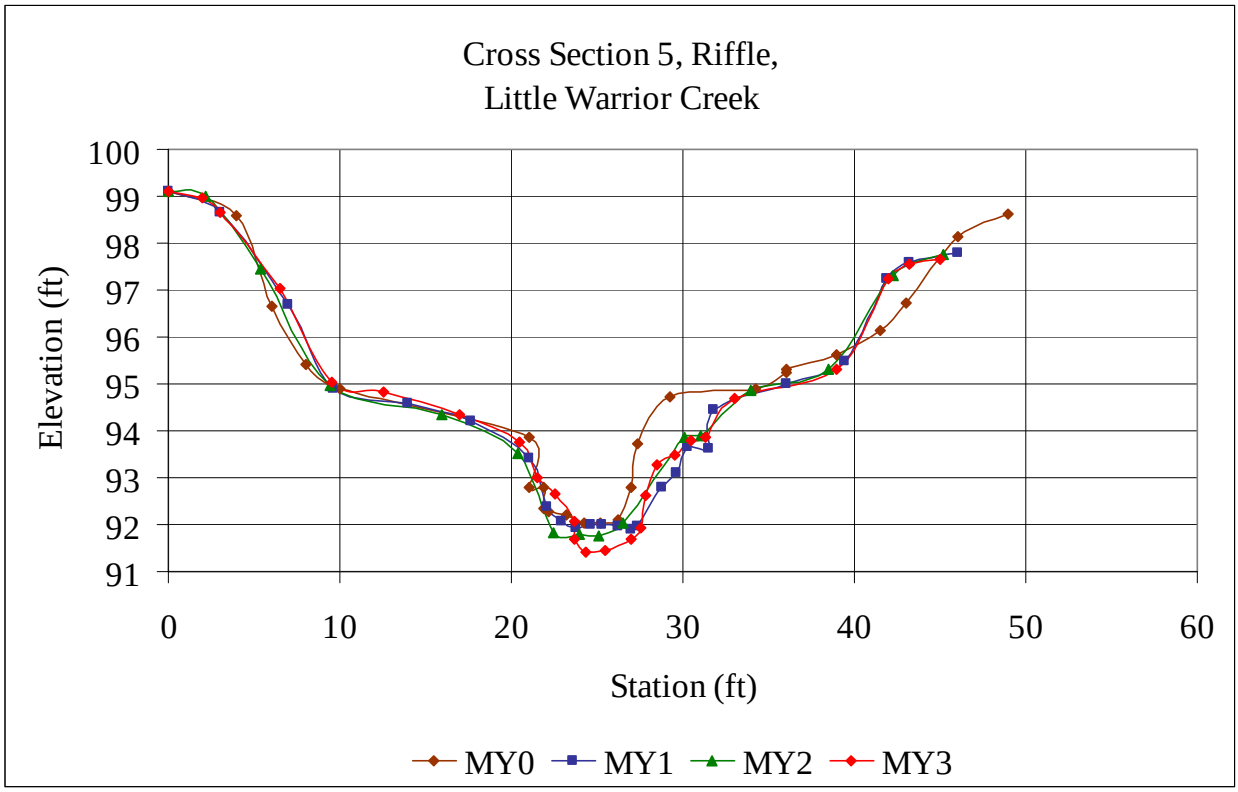
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 3 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	23.8	10.9	20.1	20.1
Maximum Bankfull Depth (ft)	2.8	1.9	2.7	2.8
Bankfull Mean Depth (ft)	2.2	1.2	1.5	1.4
Width/Depth Ratio	5.1		9	9.6
Entrenchment Ratio	1.8		2.9	3
Bankfull Width (ft)	11.0	9.4	13.5	13.9



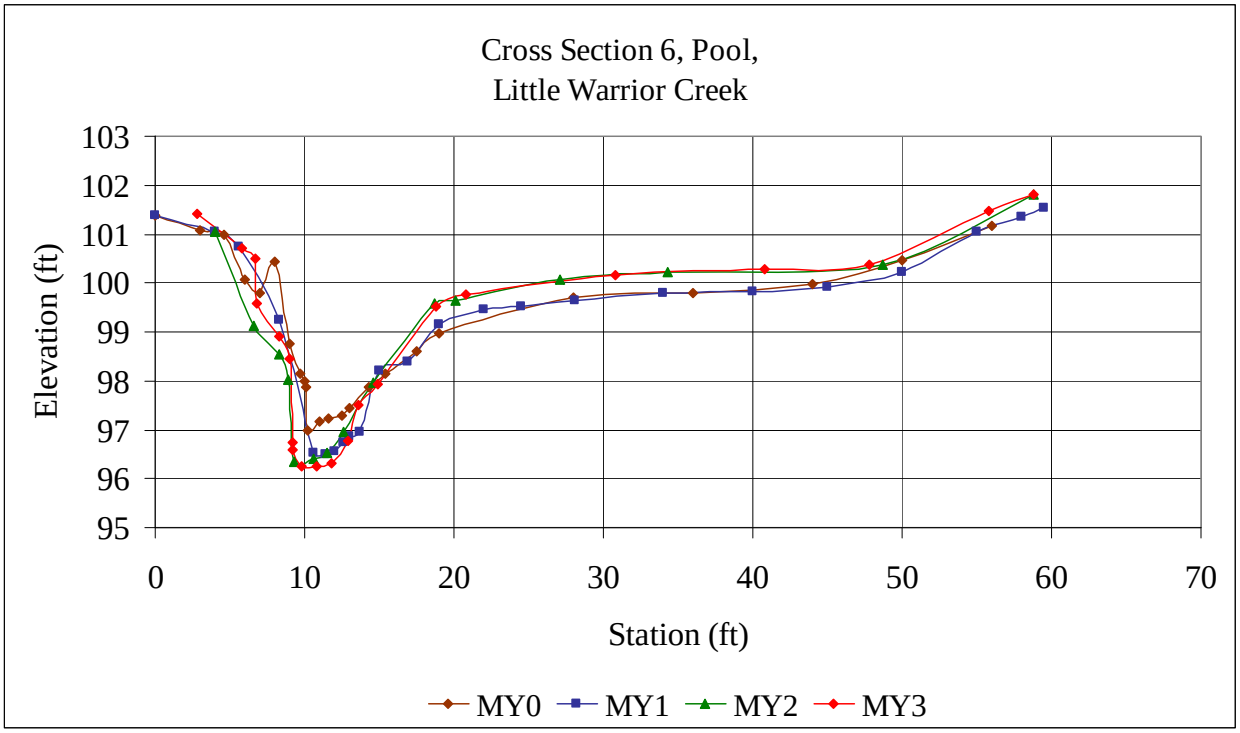
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 4 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	15.5	6.5	11.3	11.8
Maximum Bankfull Depth (ft)	1.7	1.2	2.0	1.9
Bankfull Mean Depth (ft)	1.4	0.9	1.1	0.6
Width/Depth Ratio	7.8	8.9	9.6	35.0
Entrenchment Ratio	1.8	4.5	3.8	1.8
Bankfull Width (ft)	11.0	7.6	10.4	20.3



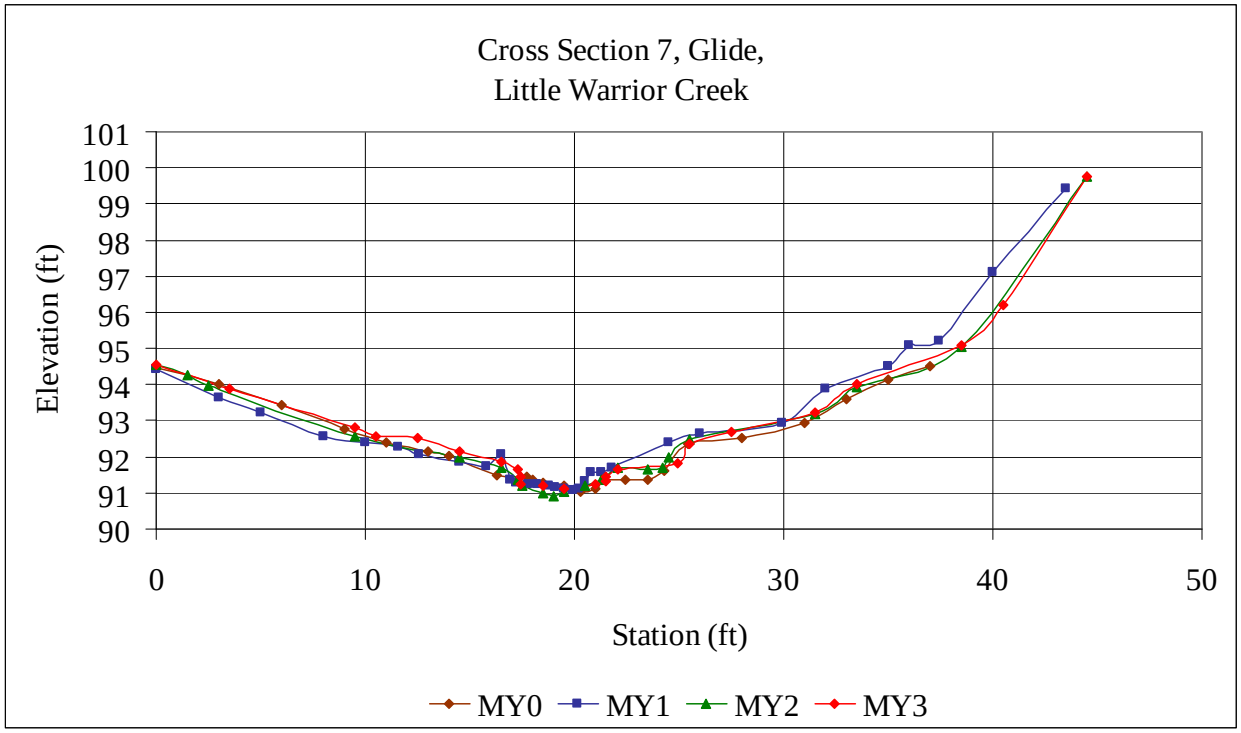
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 5 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	16.5	10.0	14.3	13.0
Maximum Bankfull Depth (ft)	2.7	1.5	2.1	2.4
Bankfull Mean Depth (ft)	1.5	1.1	1.2	1.3
Width/Depth Ratio	7.3	8.1	9.4	7.6
Entrenchment Ratio	1.8	3.0	2.8	3.3
Bankfull Width (ft)	11.0	9.0	11.6	10.0



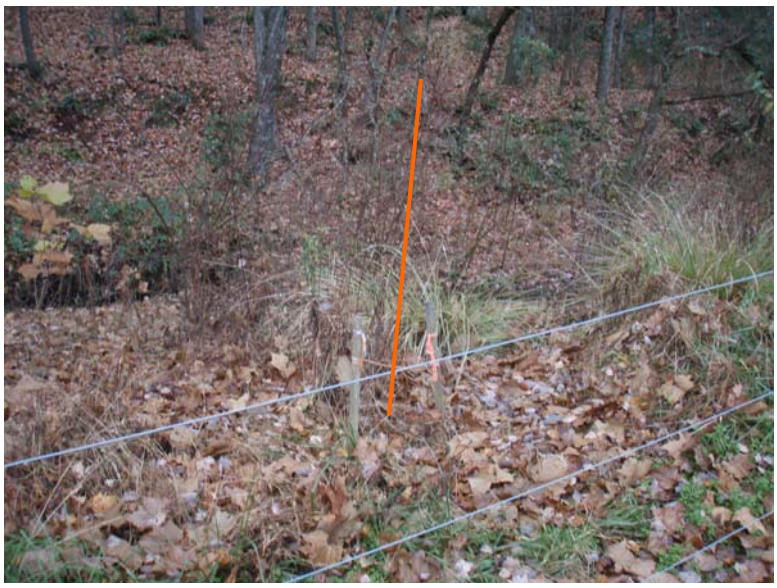
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

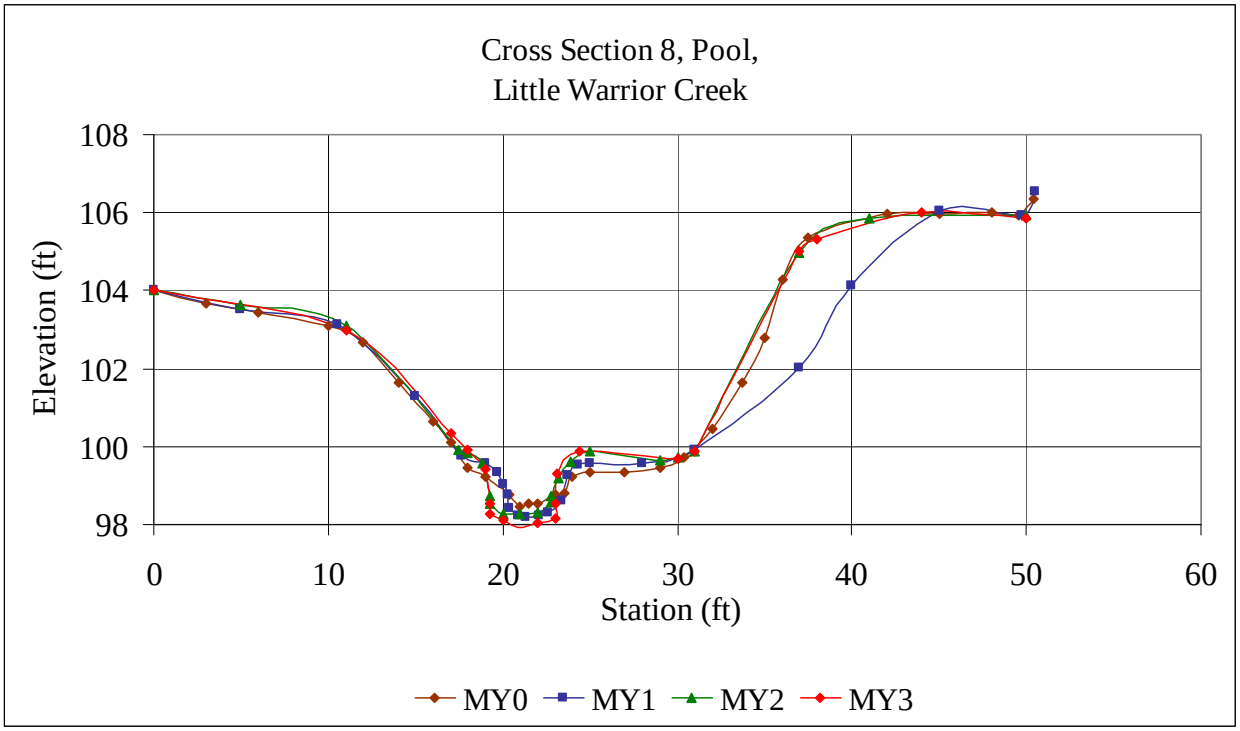
Cross-Section 6 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	10.2	5.8	6.0	6.0
Maximum Bankfull Depth (ft)	2.0	1.7	1.6	1.6
Bankfull Mean Depth (ft)	0.9	1.3	1.1	1.1
Width/Depth Ratio	11.8	3.6	5.3	5.0
Entrenchment Ratio	1.8	8.7	2.2	2.0
Bankfull Width (ft)	11.0	4.6	5.6	5.4



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

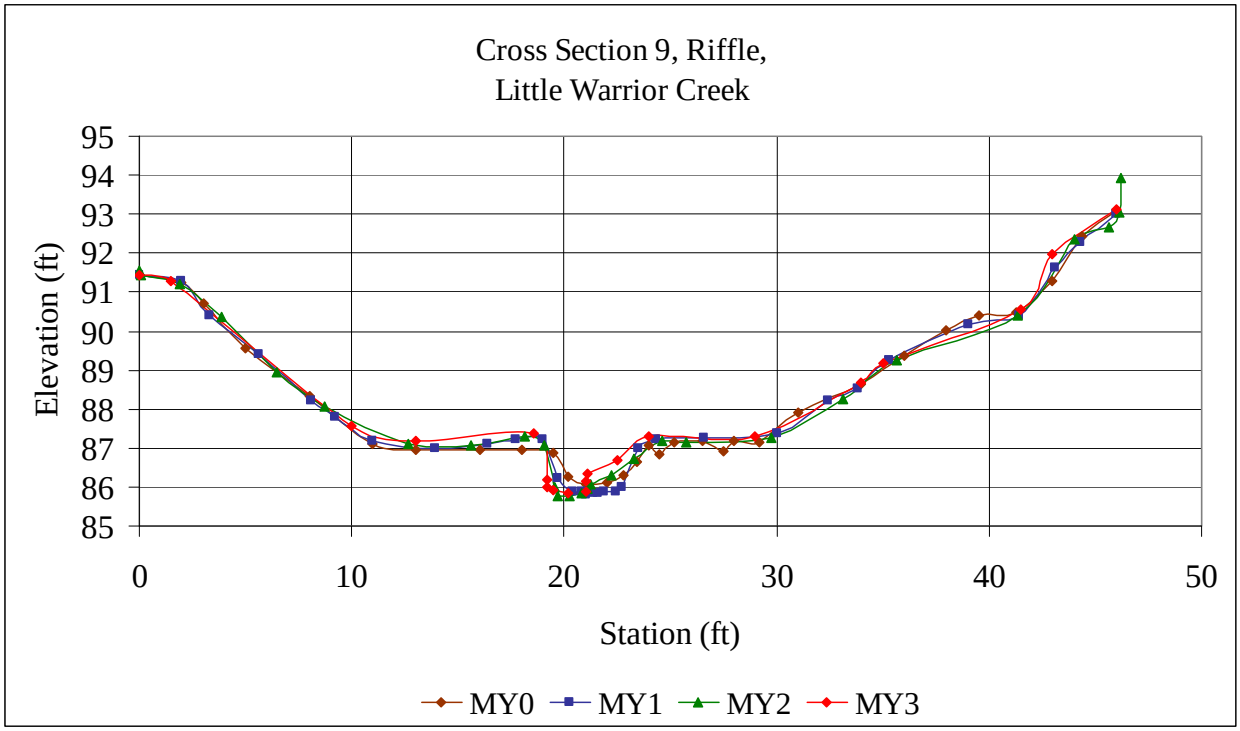
Cross-Section 7 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	10.6	2.2	11.5	11.6
Maximum Bankfull Depth (ft)	1.3	0.6	1.6	1.5
Bankfull Mean Depth (ft)	1.0	0.4	0.8	0.7
Width/Depth Ratio	11.4	12.5	20.4	23.1
Entrenchment Ratio	1.8	3.0	2.1	2.2
Bankfull Width (ft)	11.0	5.3	15.3	16.4





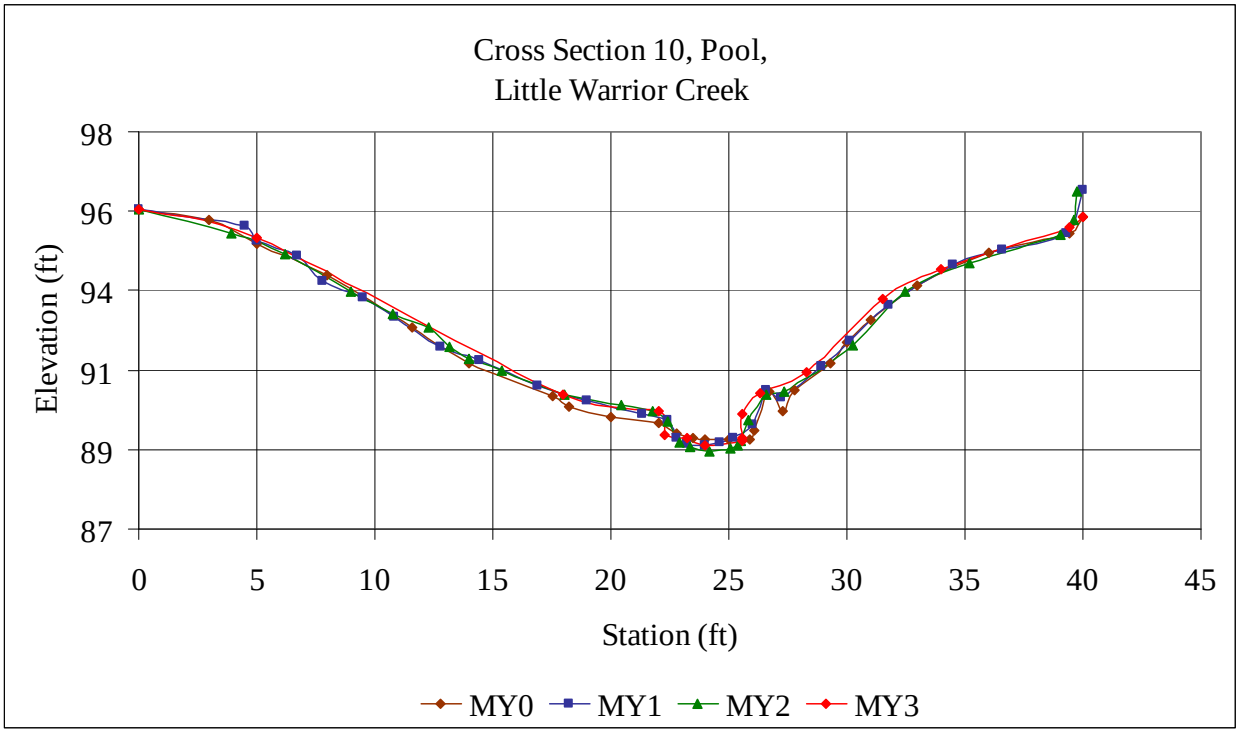
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 8 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	7.0	3.5	8.2	8.6
Maximum Bankfull Depth (ft)	1.2	1.1	1.7	2.0
Bankfull Mean Depth (ft)	0.6	0.8	0.6	0.7
Width/Depth Ratio	17.2		22.6	19.7
Entrenchment Ratio	1.8		1.4	1.5
Bankfull Width (ft)	11.0	4.2	13.6	13.0



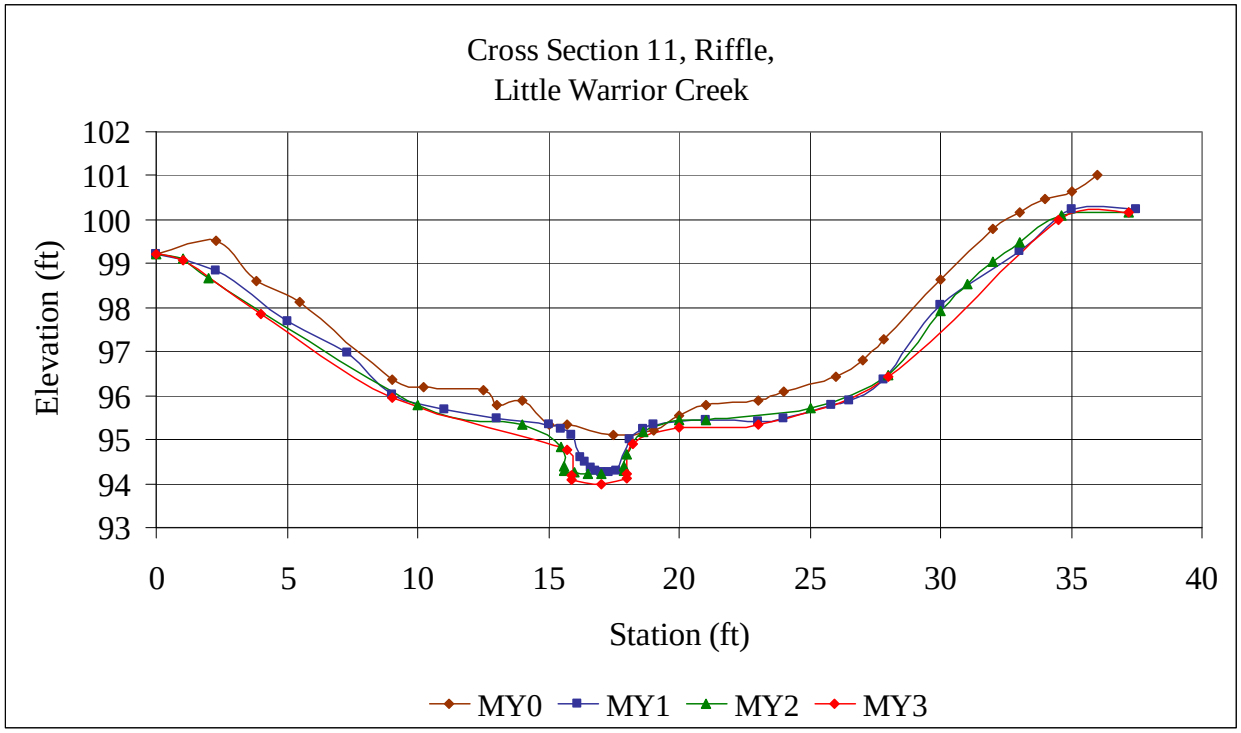
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 9 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	5.4	5.7	5.9	4.9
Maximum Bankfull Depth (ft)	1.1	1.4	1.5	1.5
Bankfull Mean Depth (ft)	0.5	0.5	0.4	0.3
Width/Depth Ratio	22.5		42.8	44.8
Entrenchment Ratio	1.8		1.7	1.8
Bankfull Width (ft)	11.0	12.0	15.8	14.8



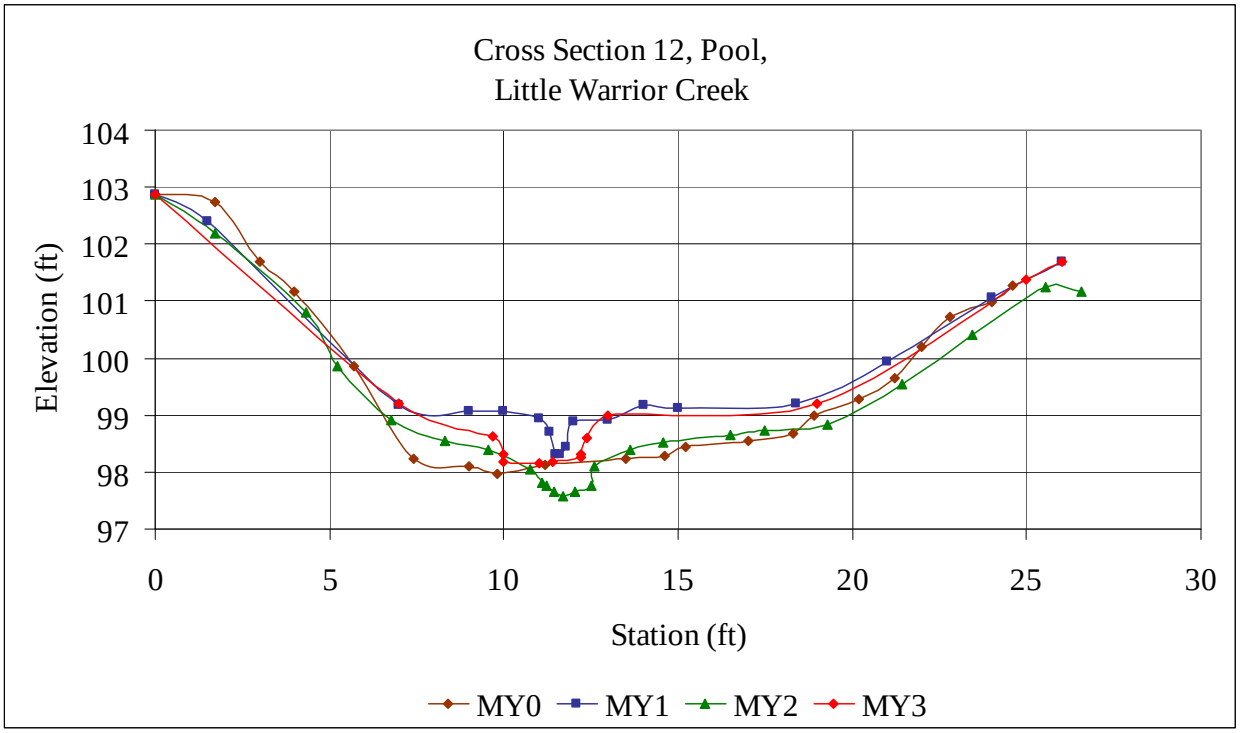
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 10 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	7.2	1.8	4.2	4.0
Maximum Bankfull Depth (ft)	1.2	0.7	1.3	1.2
Bankfull Mean Depth (ft)	0.7	0.5	0.7	0.7
Width/Depth Ratio	16.9	7.3	8.3	9.0
Entrenchment Ratio	1.8	2.7	2.6	3.0
Bankfull Width (ft)	11.0	3.7	5.9	6.0



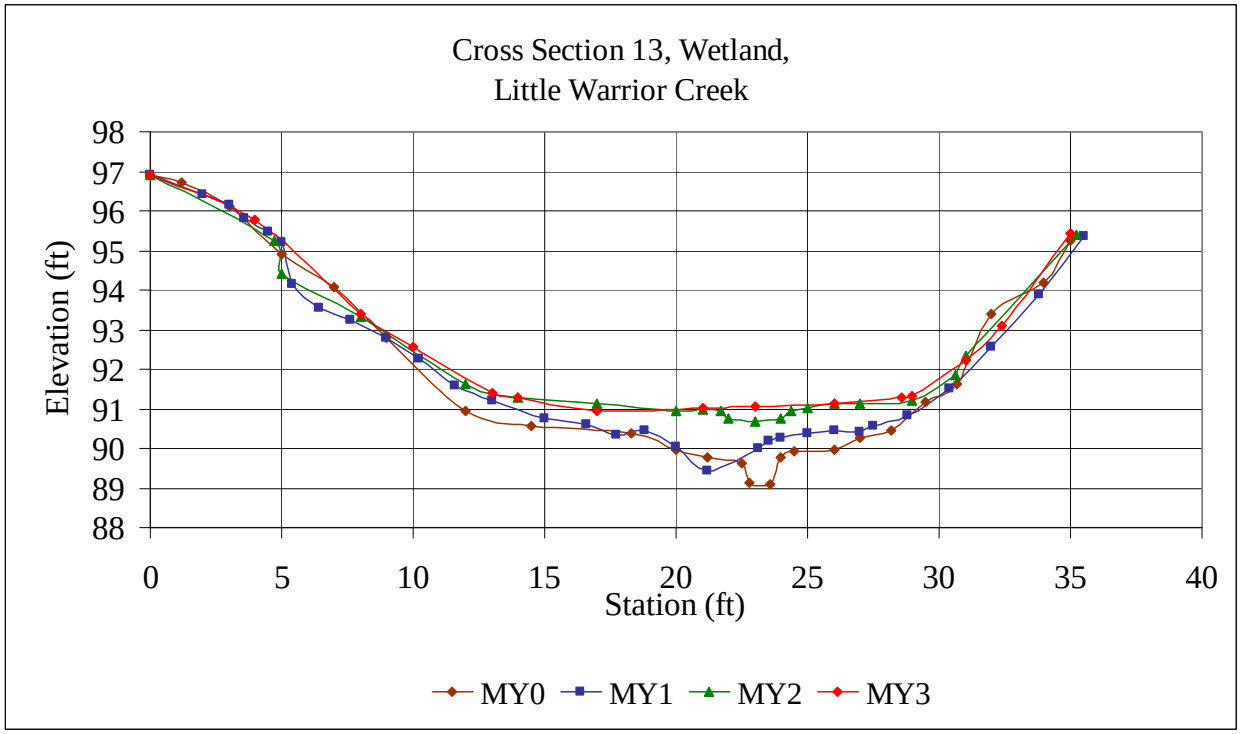
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 11 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	3.8	1.4	4.1	4.2
Maximum Bankfull Depth (ft)	0.8	0.9	1.2	1.3
Bankfull Mean Depth (ft)	0.4	0.6	0.6	0.5
Width/Depth Ratio	21.3	4.2	12.3	18.4
Entrenchment Ratio	1.9	7.0	2.9	2.5
Bankfull Width (ft)	9.0	2.4	7.1	8.8



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 12 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	3.0	0.4	2.4	2.5
Maximum Bankfull Depth (ft)	0.6	0.7	1.0	0.8
Bankfull Mean Depth (ft)	0.3	0.2	0.4	0.5
Width/Depth Ratio	33.2	10.8	18.2	11.3
Entrenchment Ratio	1.4	6.6	2.4	2.8
Bankfull Width (ft)	10.0	2.1	6.6	5.3

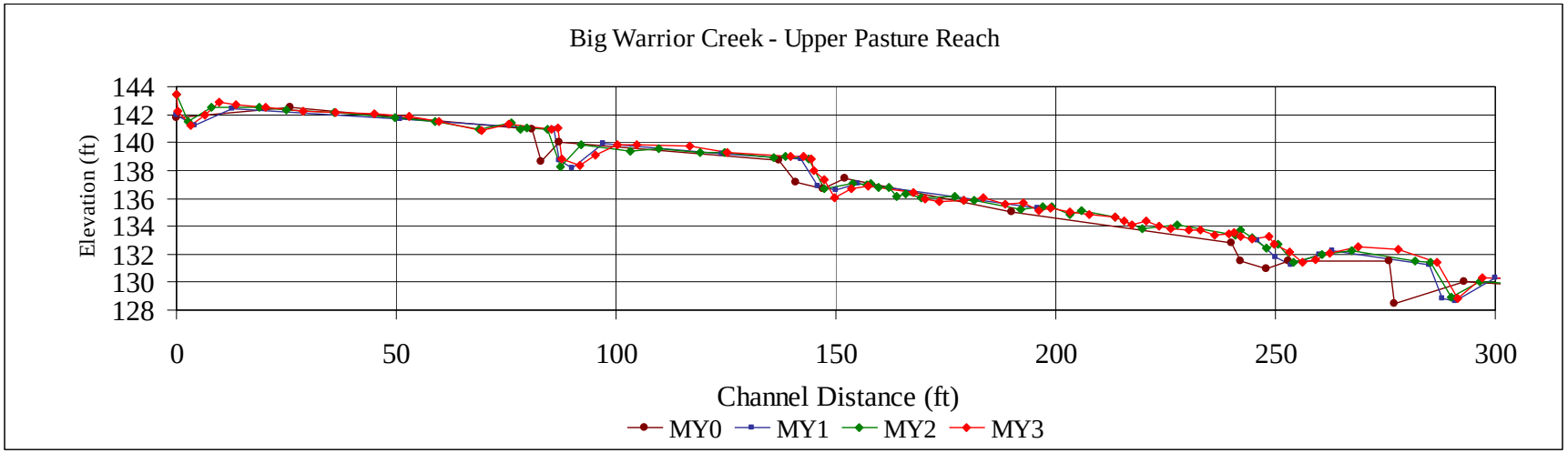


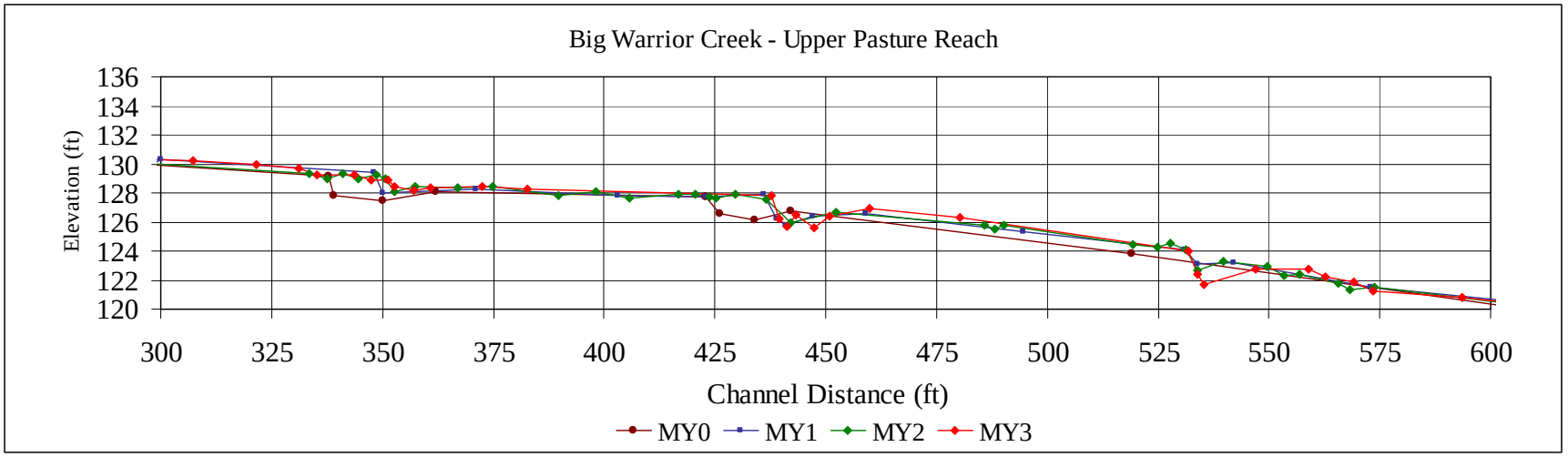
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Cross-Section 13 Abbreviated Morphological Summary				
	MY0	MY1	MY2	MY3
Bankfull Cross Sectional Area (ft^2)	3.6	13.1	1.6	1.0
Maximum Bankfull Depth (ft)	1.1	1.8	0.4	0.2
Bankfull Mean Depth (ft)	0.4	0.8	0.2	0.1
Width/Depth Ratio	20.3	21.2	48.3	112.3
Entrenchment Ratio	2.1	1.4	2.0	2.3
Bankfull Width (ft)	8.5	16.7	8.8	10.7

10 Appendix B.– Longitudinal Profiles, Pebble Count Comparisons, and Hydrography

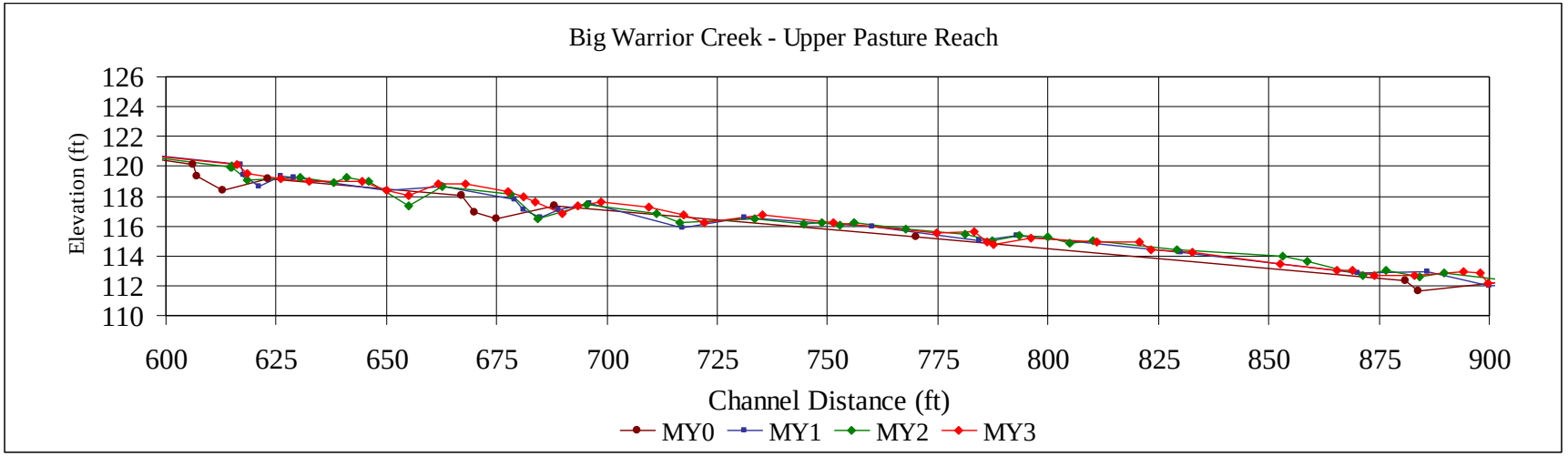
Appendix B.1.1. Longitudinal profile data plot comparisons for Big Warrior Creek, MY0-MY3.

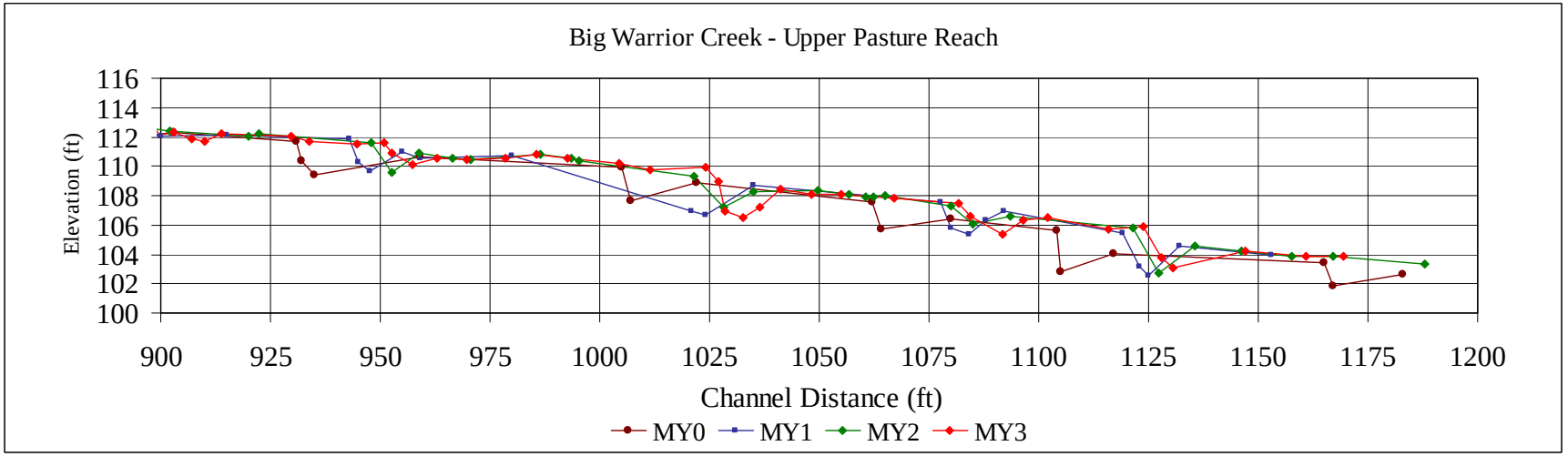




Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

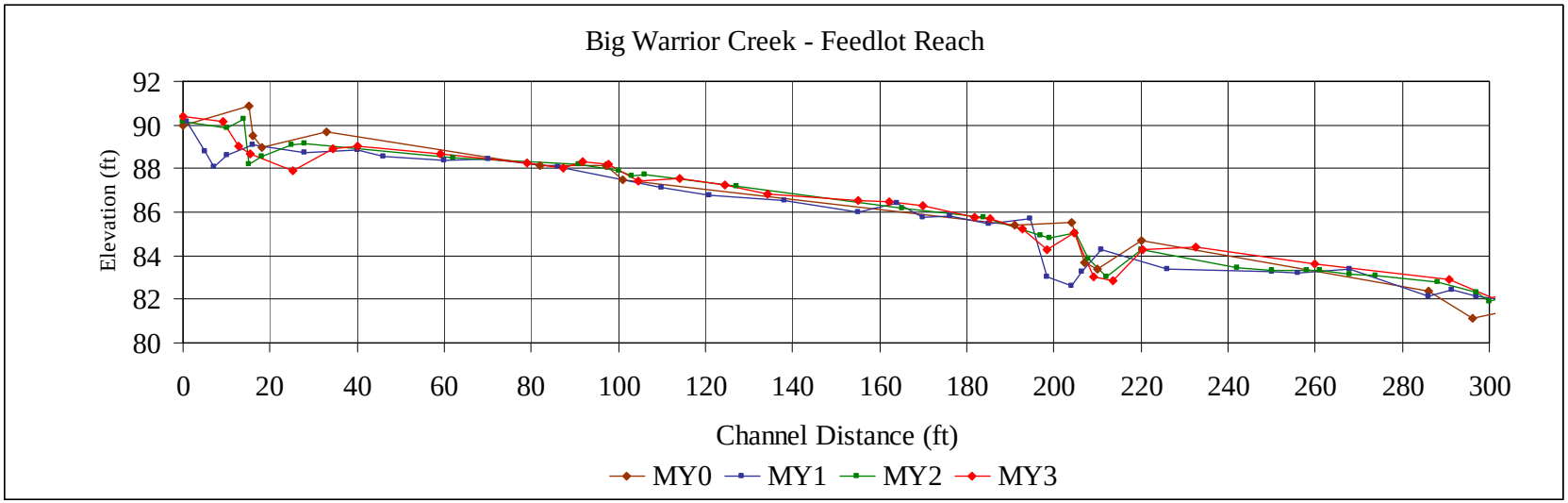
Appendix B.1.1. Continued.

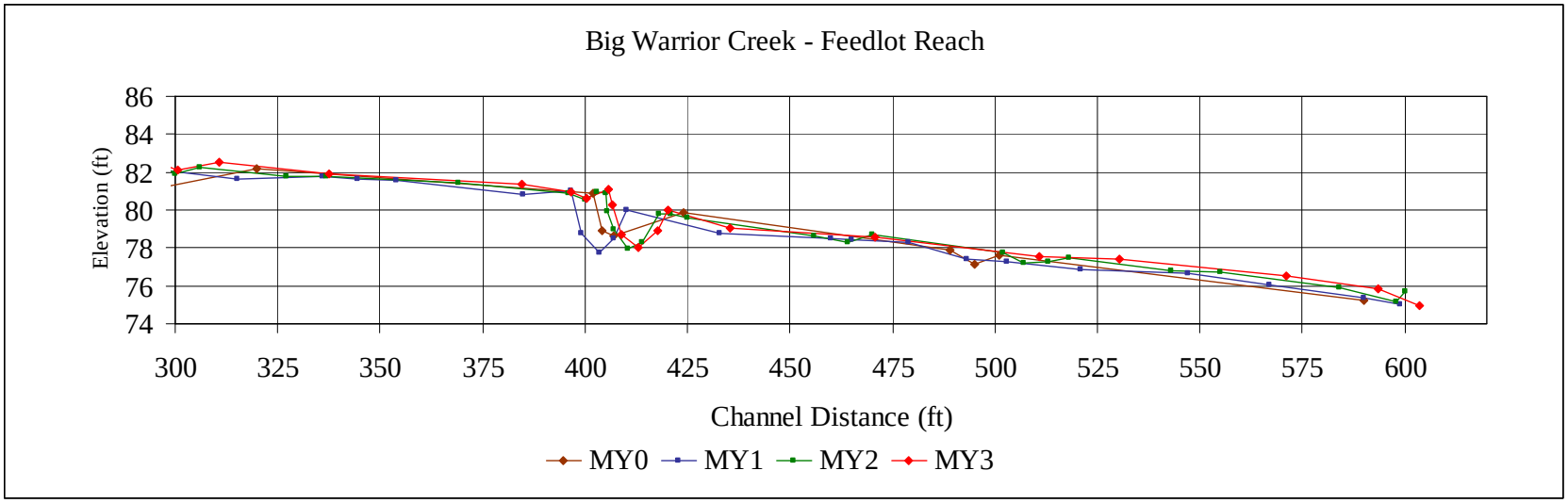




Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

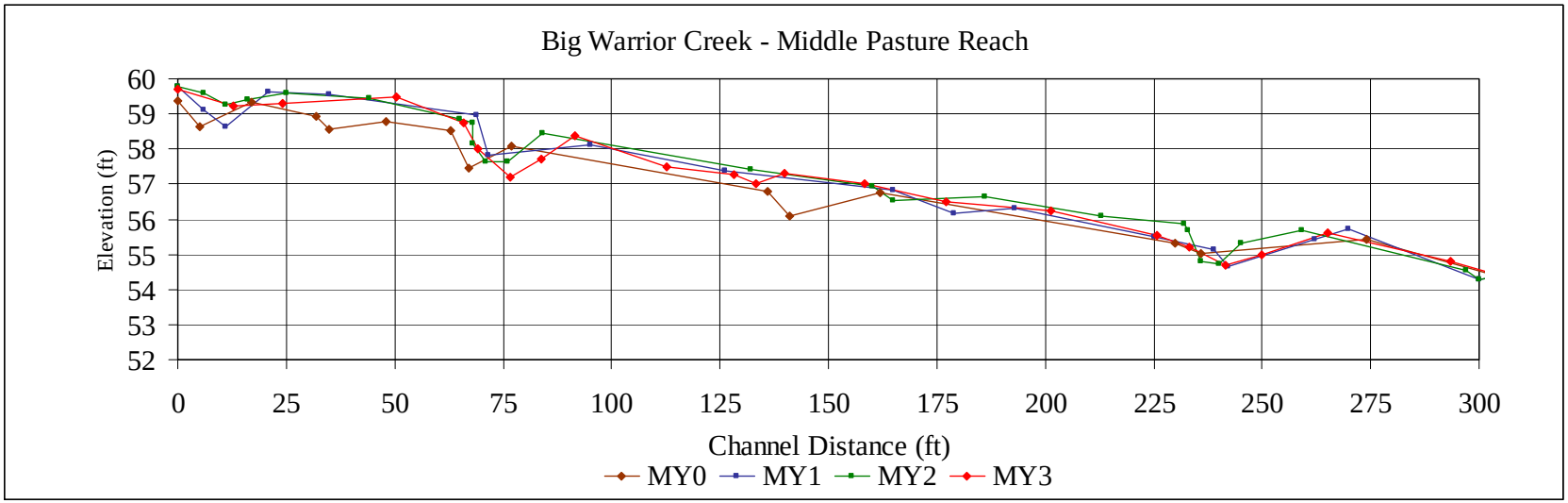
Appendix B.1.1. Continued.

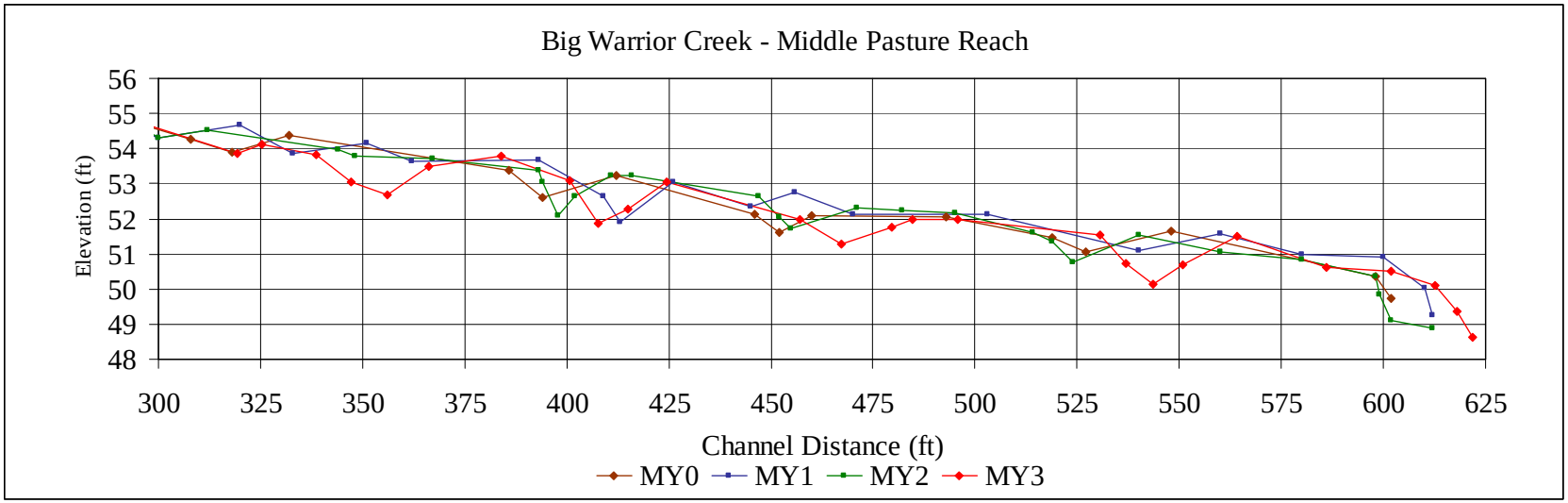




Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

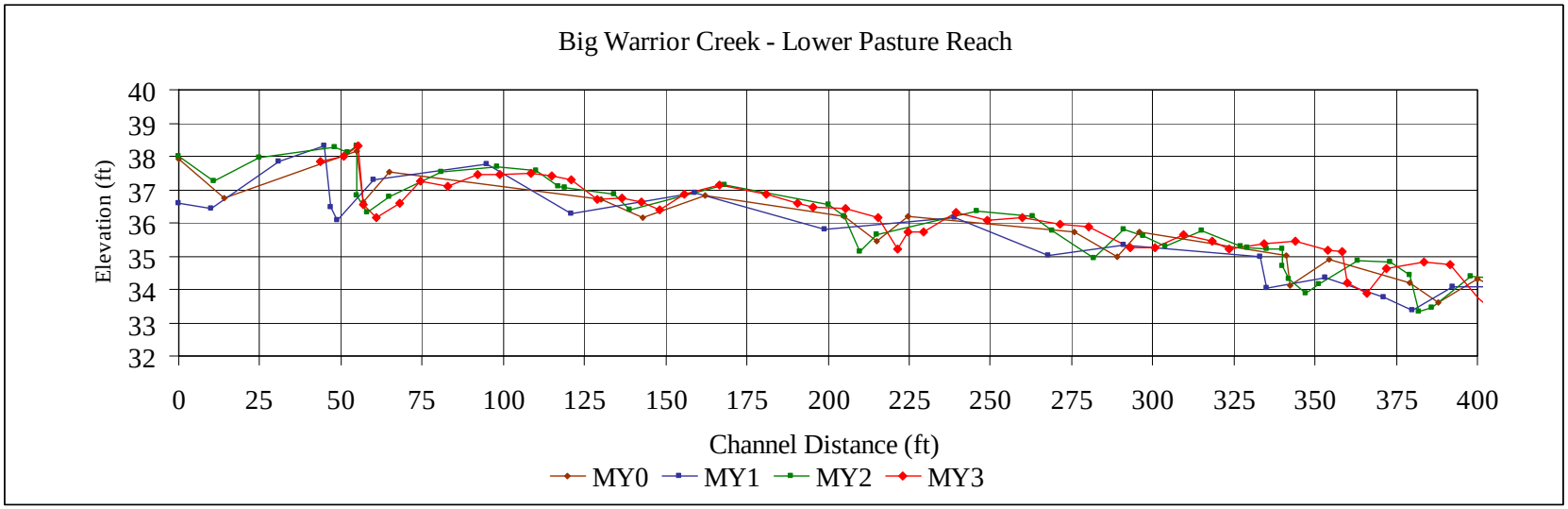
Appendix B.1.1. Continued.

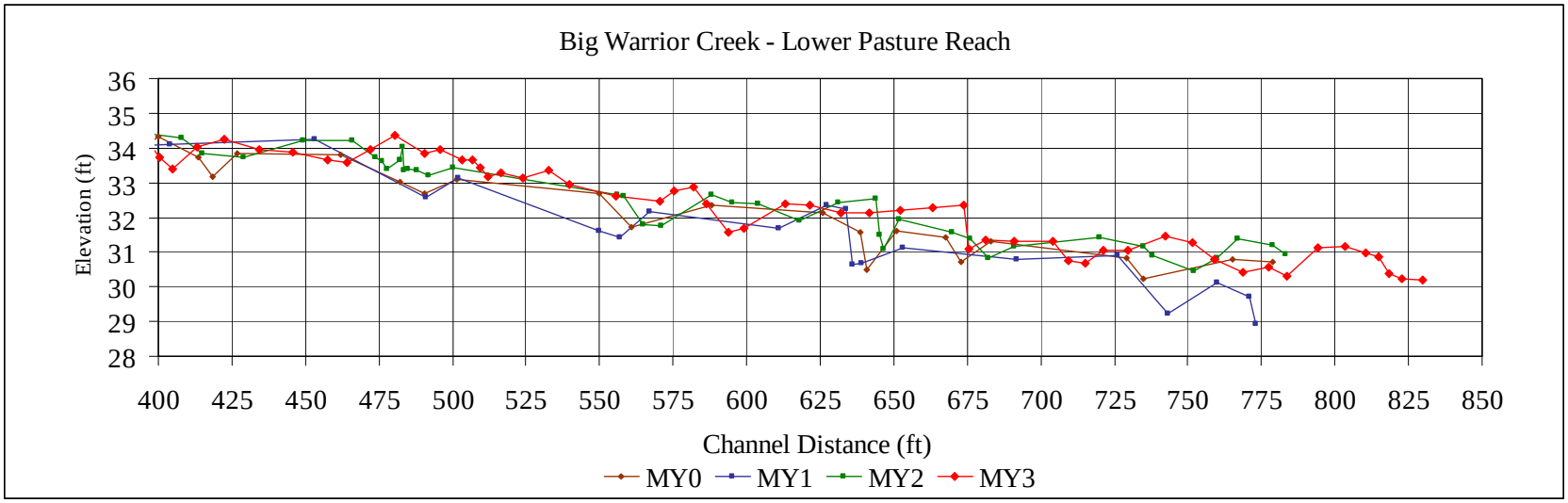




Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

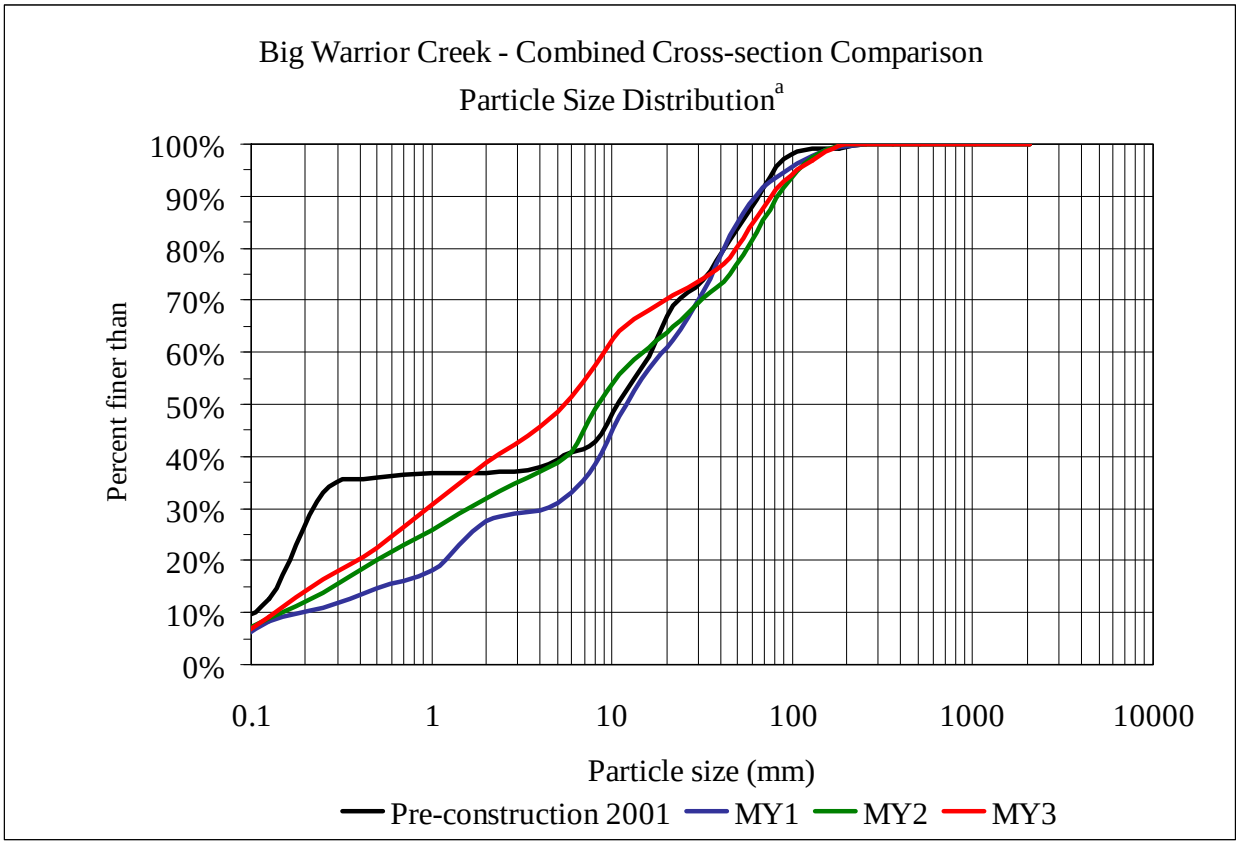
Appendix B.1.1. Continued.





Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Appendix B.1.2. Pebble count data plot comparisons for Big Warrior Creek, MY0-MY3.

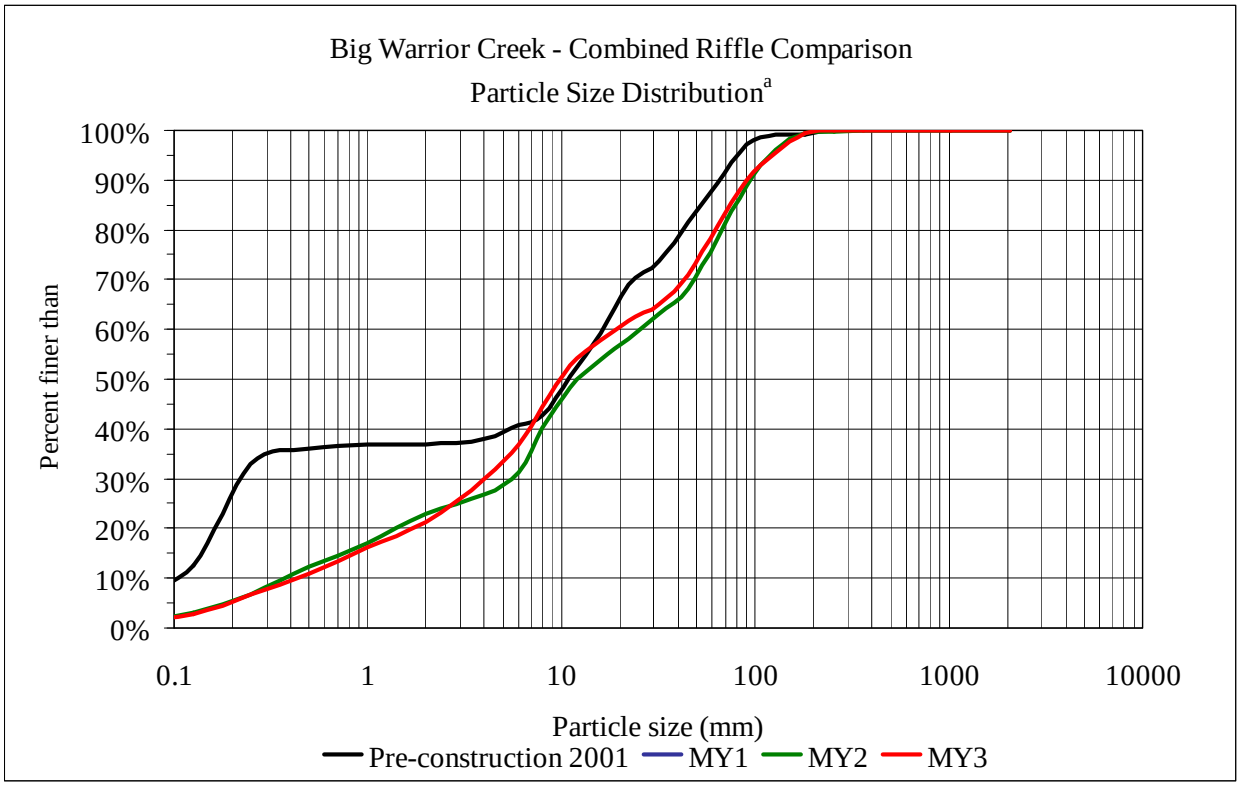


[a]The pre-construction 2001 data were taken at one cross-section on Big Warrior Creek. These data are presented for comparison purposes.

Size class index	Particle size (mm) in year sampled			
	Pre-construction 2001	MY1	MY2	MY3
D_{16}	0.13	0.65	0.32	0.24
D_{35}	0.28	6.60	3.10	1.50
D_{50}	11.30	12.00	8.30	5.50
D_{84}	50.00	48.00	66.00	58.00
D_{95}	80.00	96.00	110.00	110.00

Survey Dates: Pre-construction 17-May01, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Appendix B.1.2. Continued.

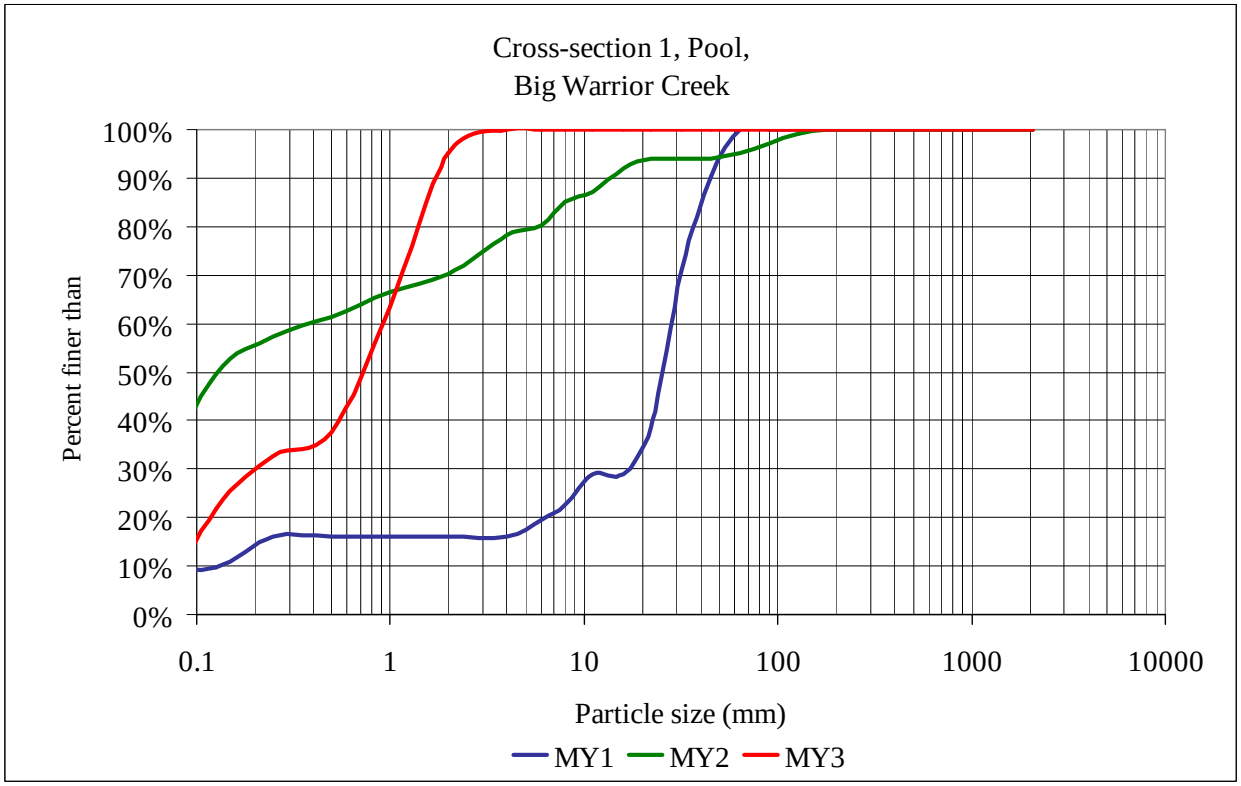


[a]The pre-construction 2001 data were taken at one cross-section on Big Warrior Creek. These data are presented for comparison purposes.

Size class index	Riffle particle size (mm) in year sampled			
	Pre-construction 2001	MY1	MY2	MY3
D_{16}	0.13	0.51	0.87	0.97
D_{35}	0.28	6.00	6.80	5.40
D_{50}	11.30	12.00	12.00	9.90
D_{84}	50.00	45.00	77.00	72.00
D_{95}	80.00	89.00	120.00	120.00

Survey Dates: Pre-construction 17-May01, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

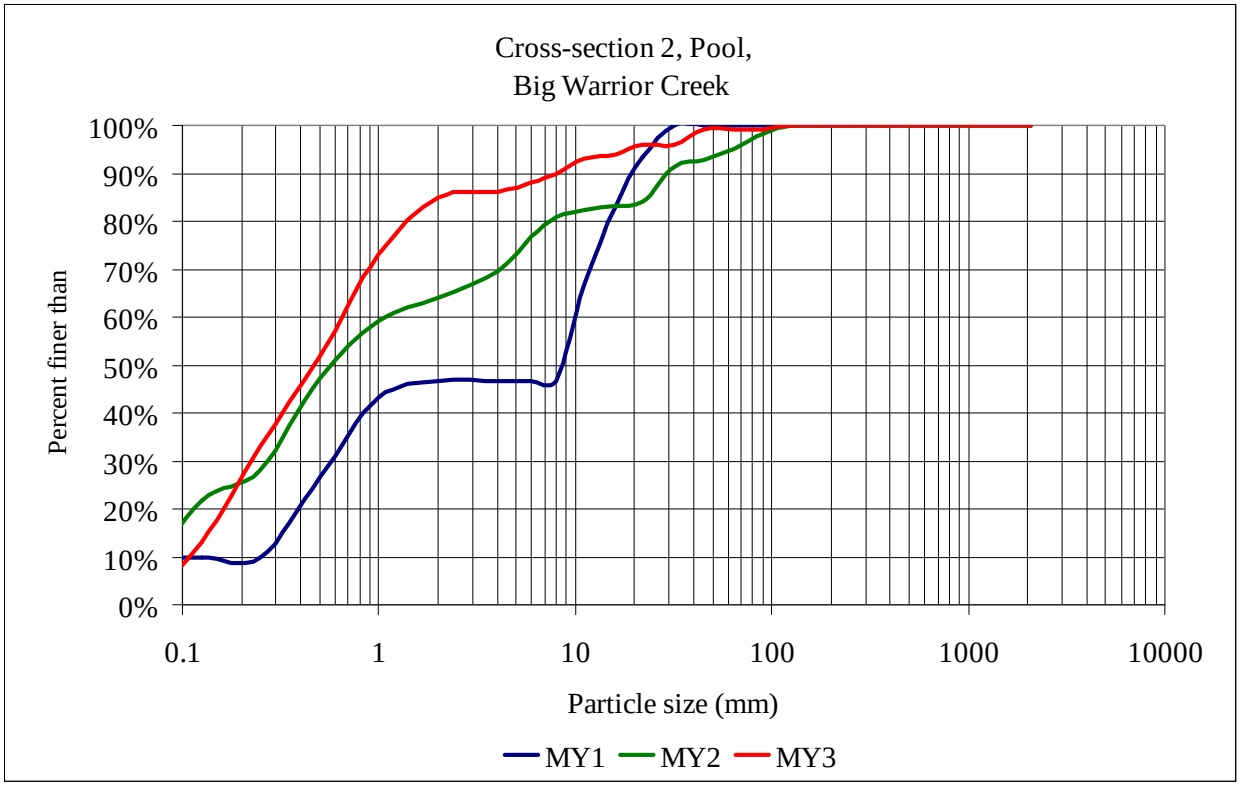
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.25	<0.10	<0.10
D_{35}	19.00	<0.10	0.35
D_{50}	25.00	0.13	0.70
D_{84}	40.00	7.50	1.60
D_{95}	53.00	63.00	2.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

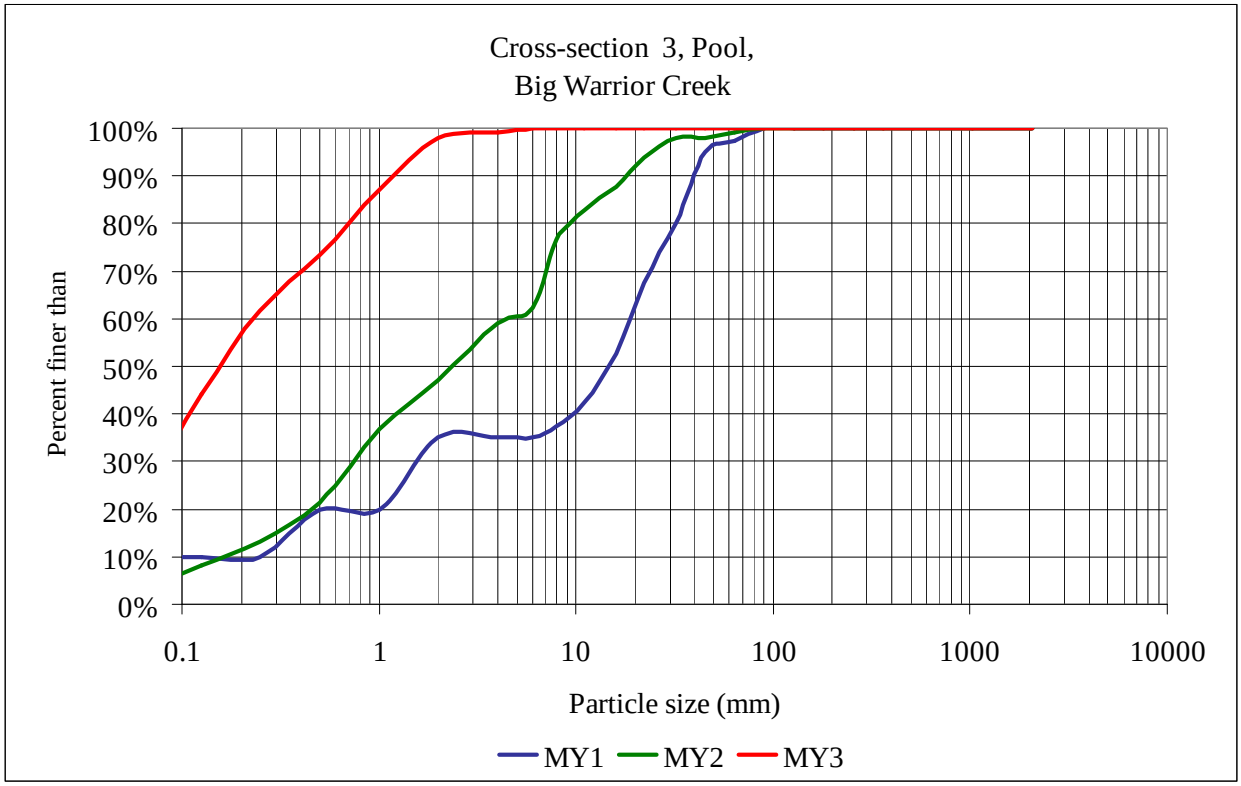
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.32	0.10	0.14
D_{35}	0.71	0.32	0.27
D_{50}	8.40	0.59	0.46
D_{84}	16.00	22.00	1.90
D_{95}	24.00	62.00	19.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

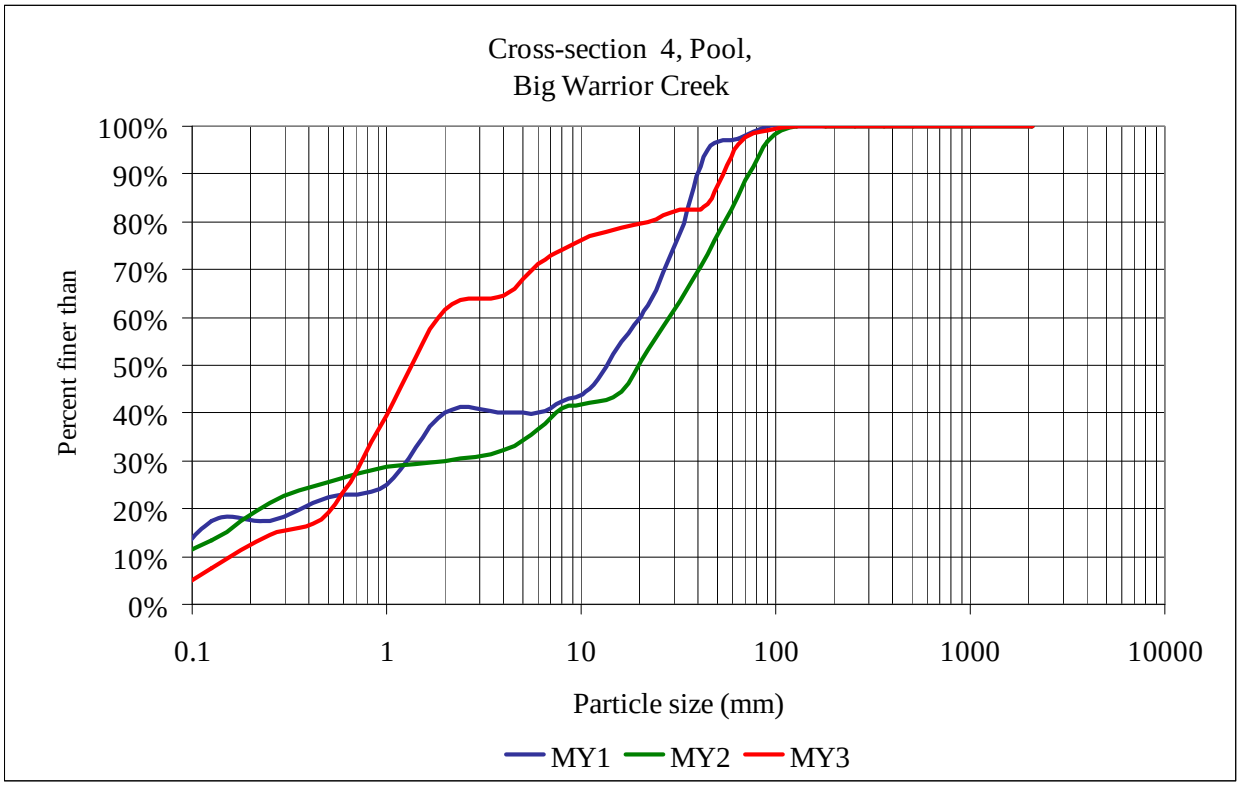
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.38	0.32	<0.10
D_{35}	2.00	0.92	<0.10
D_{50}	15.00	2.40	0.16
D_{84}	35.00	12.00	0.85
D_{95}	45.00	24.00	1.60

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

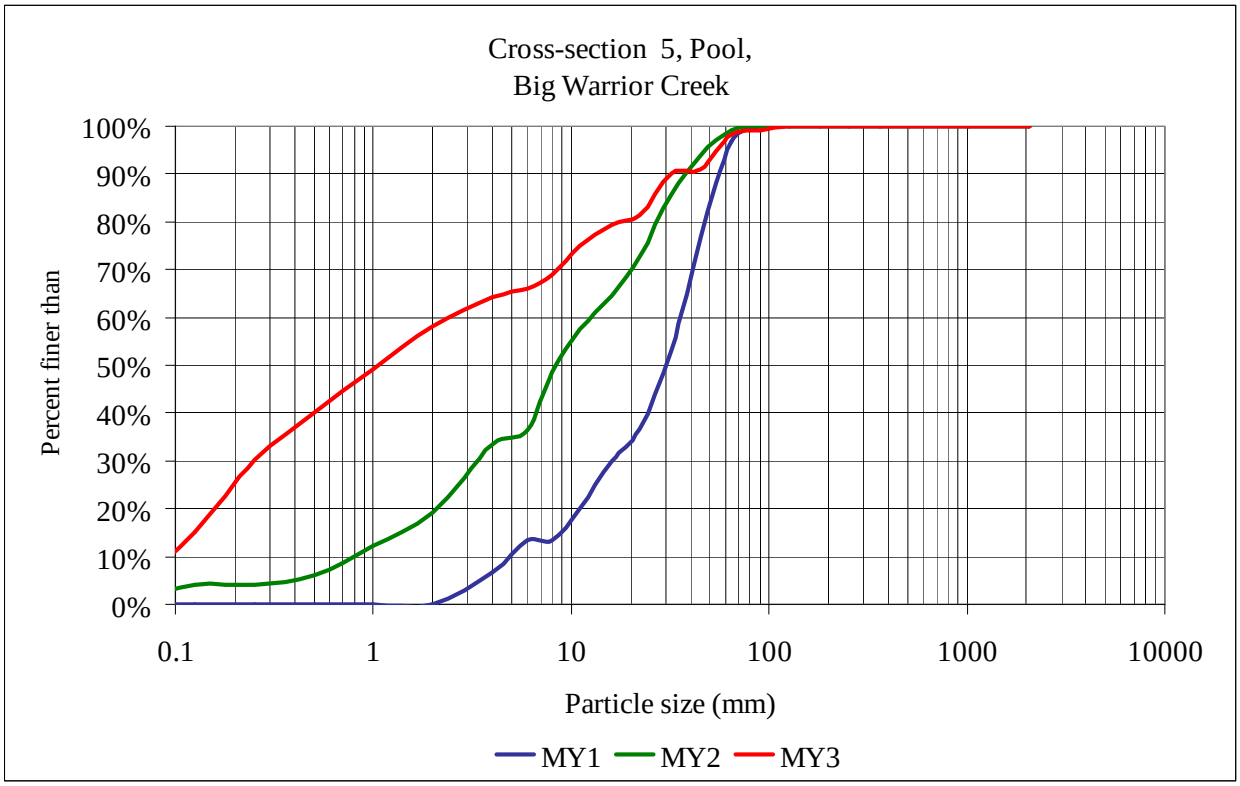
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.12	0.16	0.31
D_{35}	1.60	5.20	0.86
D_{50}	13.00	20.00	1.40
D_{84}	36.00	61.00	45.00
D_{95}	45.00	86.00	62.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

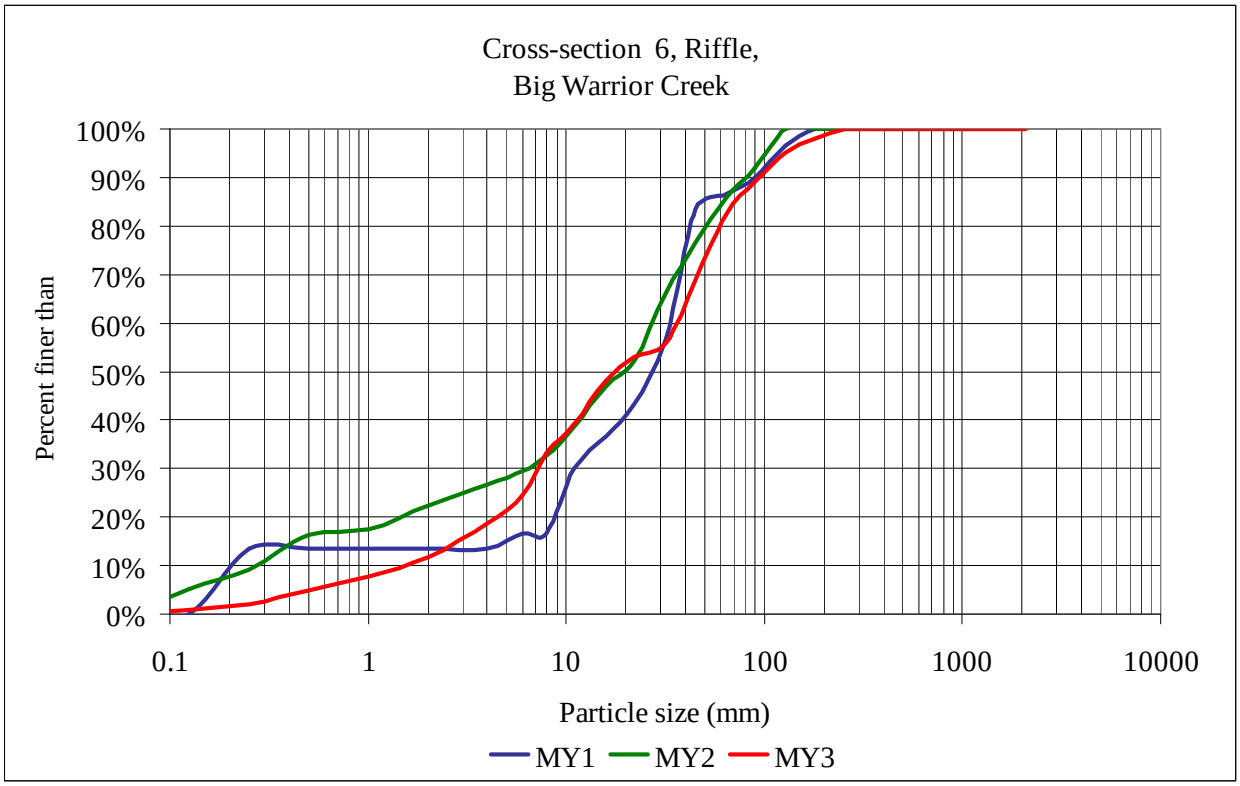
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	9.10	1.50	0.13
D_{35}	20.00	5.00	0.35
D_{50}	30.00	8.40	1.10
D_{84}	51.00	30.00	25.00
D_{95}	62.00	48.00	55.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

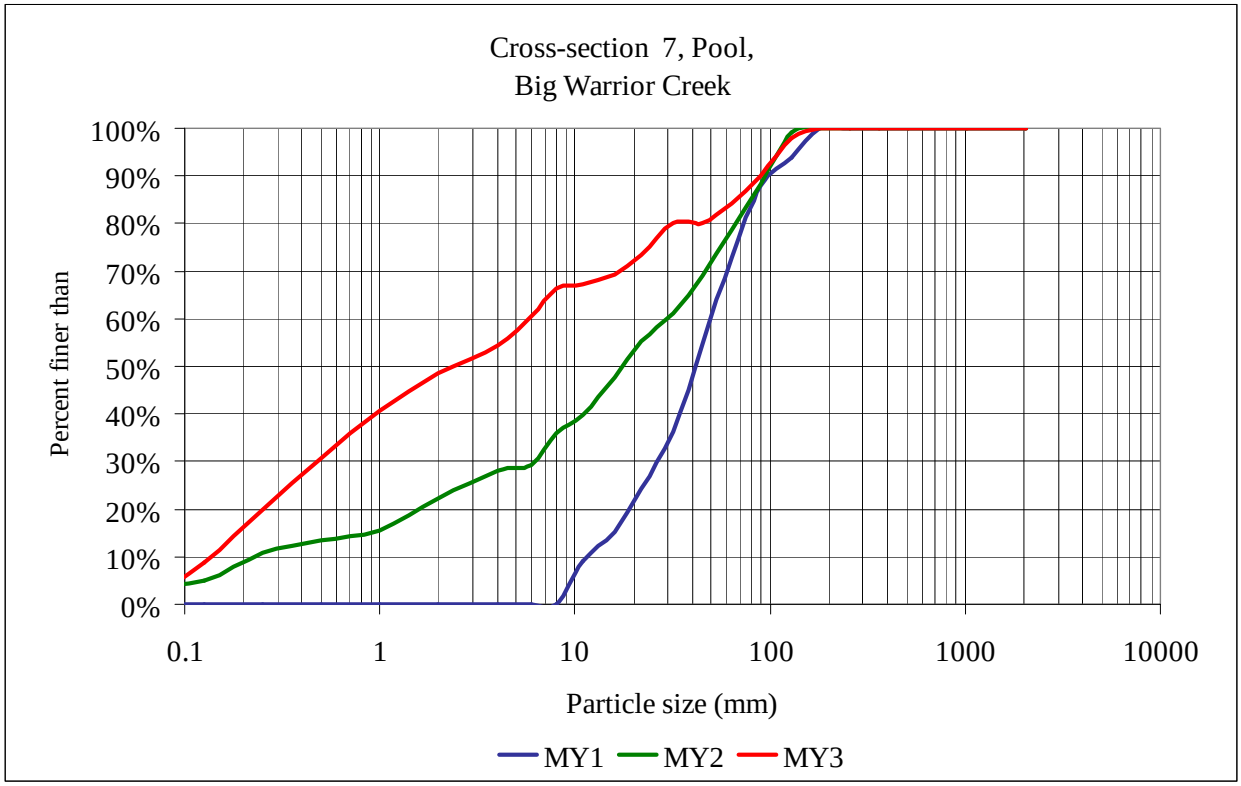
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	5.50	0.48	3.10
D_{35}	15.00	9.00	8.80
D_{50}	27.00	19.00	18.00
D_{84}	48.00	60.00	69.00
D_{95}	120.00	100.00	130.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

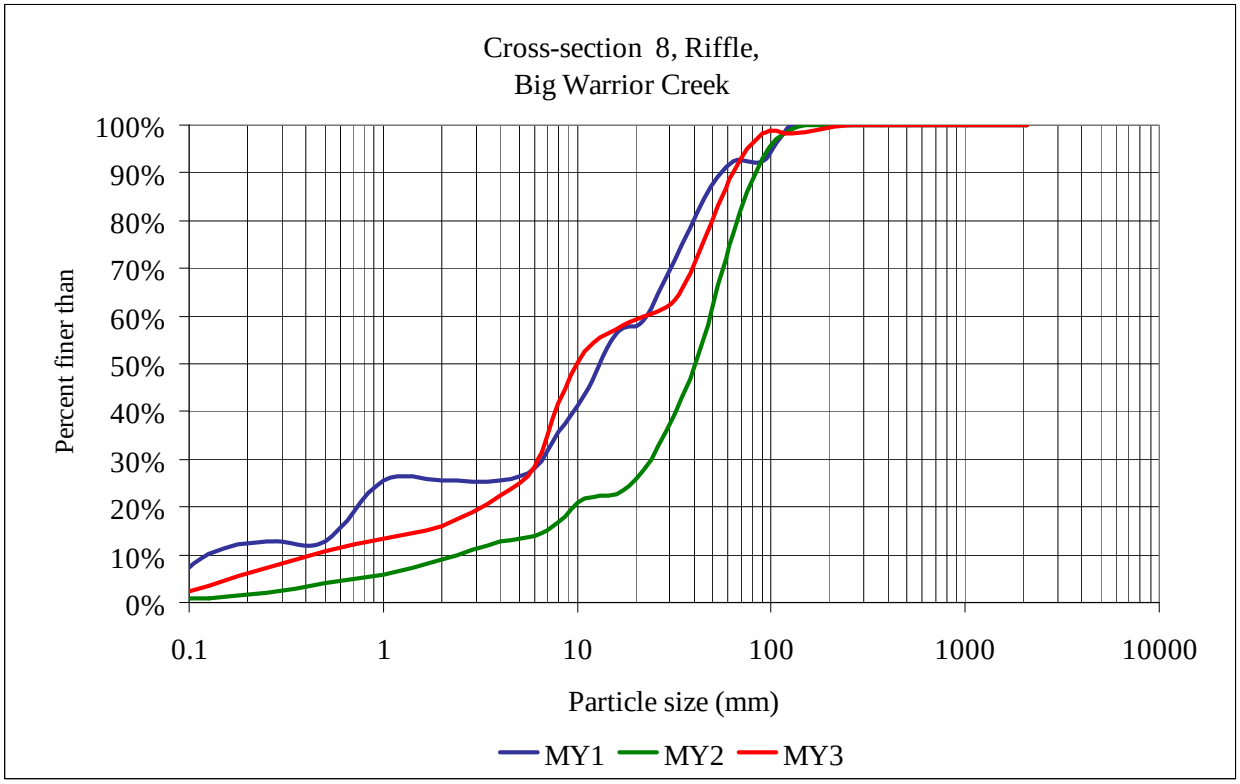
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	16.00	1.00	0.20
D_{35}	31.00	7.70	6.80
D_{50}	41.00	18.00	2.40
D_{84}	82.00	77.00	63.00
D_{95}	140.00	110.00	110.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

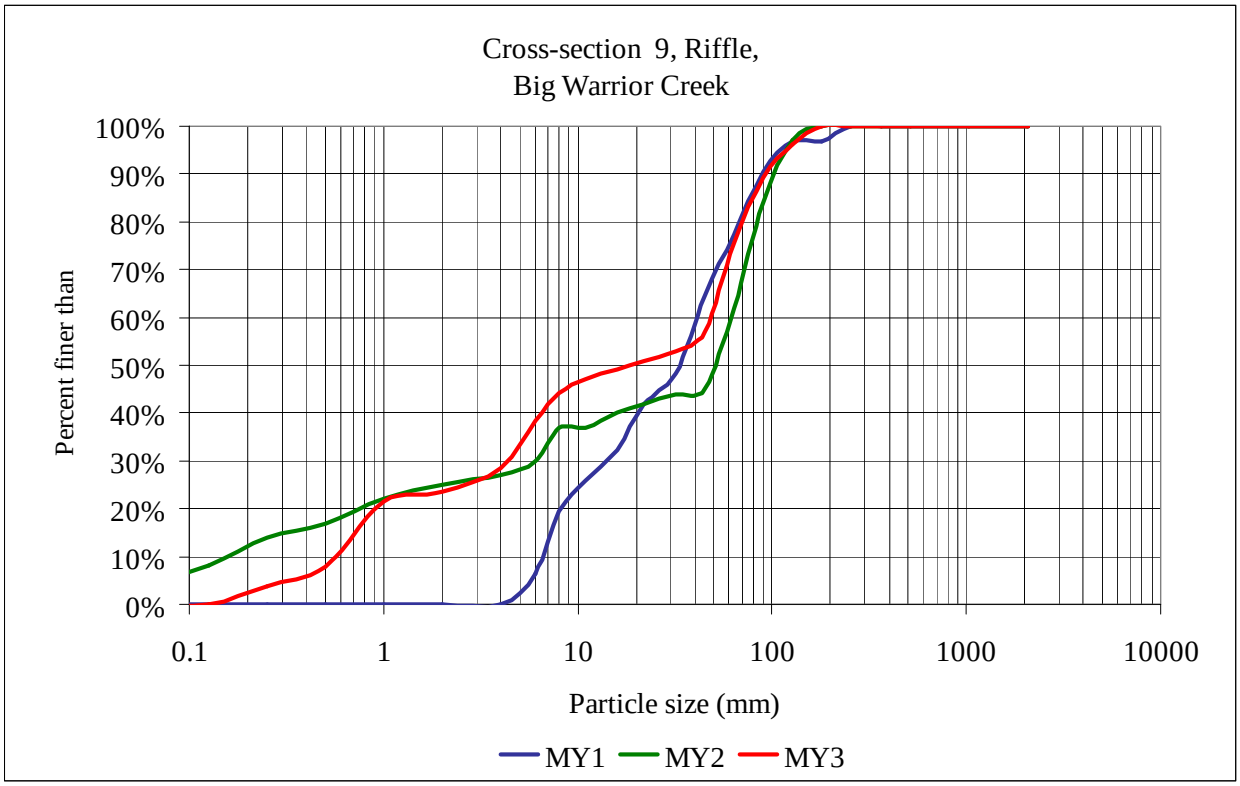
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.59	7.40	2.00
D_{35}	7.70	28.00	6.90
D_{50}	13.00	40.00	10.00
D_{84}	44.00	74.00	55.00
D_{95}	100.00	100.00	79.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

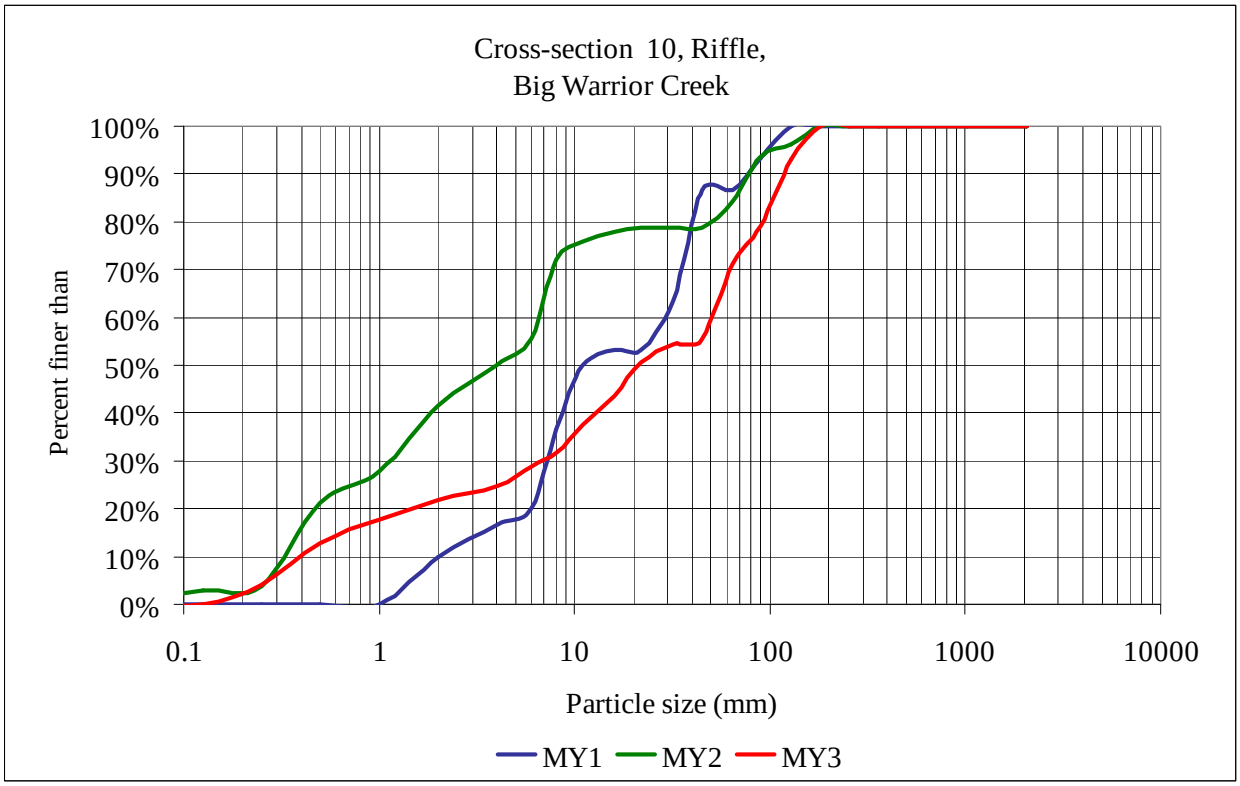
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	7.40	0.40	0.75
D_{35}	18.00	7.40	5.20
D_{50}	33.00	50.00	19.00
D_{84}	76.00	90.00	79.00
D_{95}	120.00	120.00	120.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

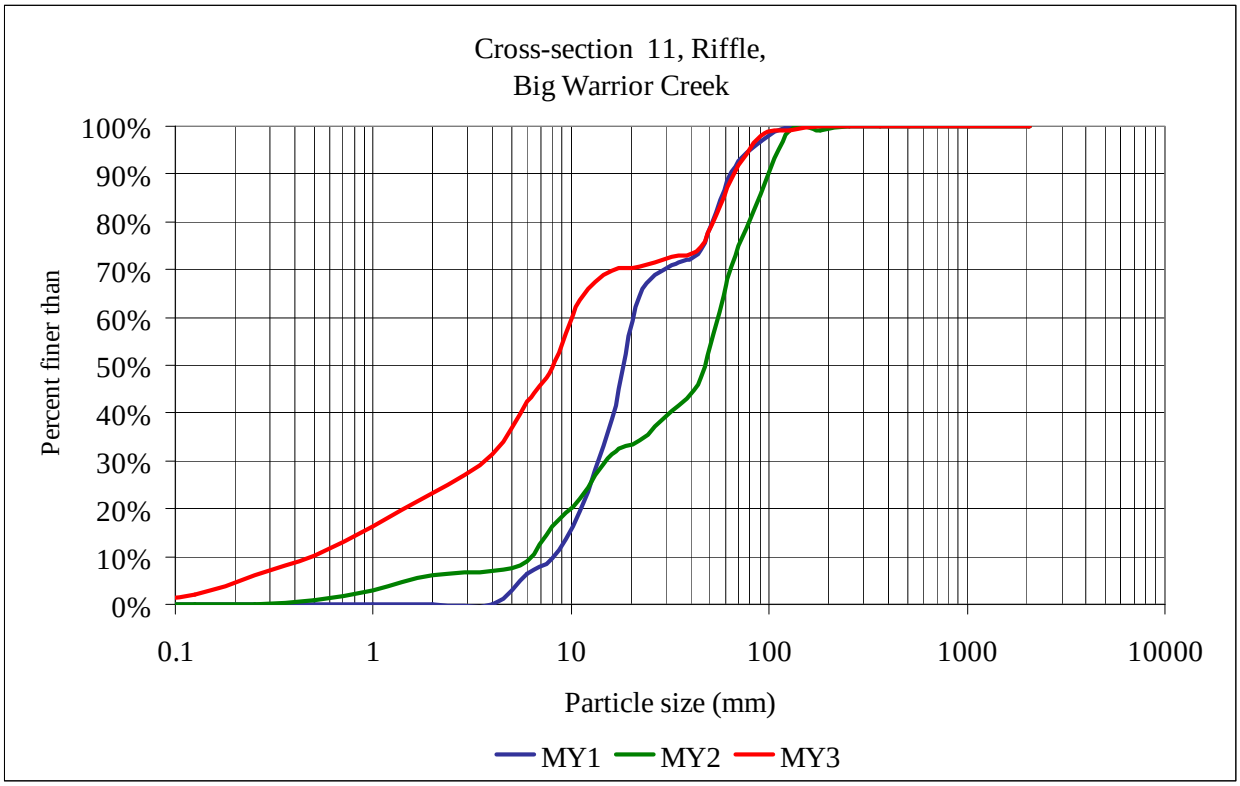
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	3.70	0.41	0.77
D_{35}	7.80	1.40	9.60
D_{50}	11.00	4.00	22.00
D_{84}	43.00	63.00	100.00
D_{95}	98.00	110.00	140.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

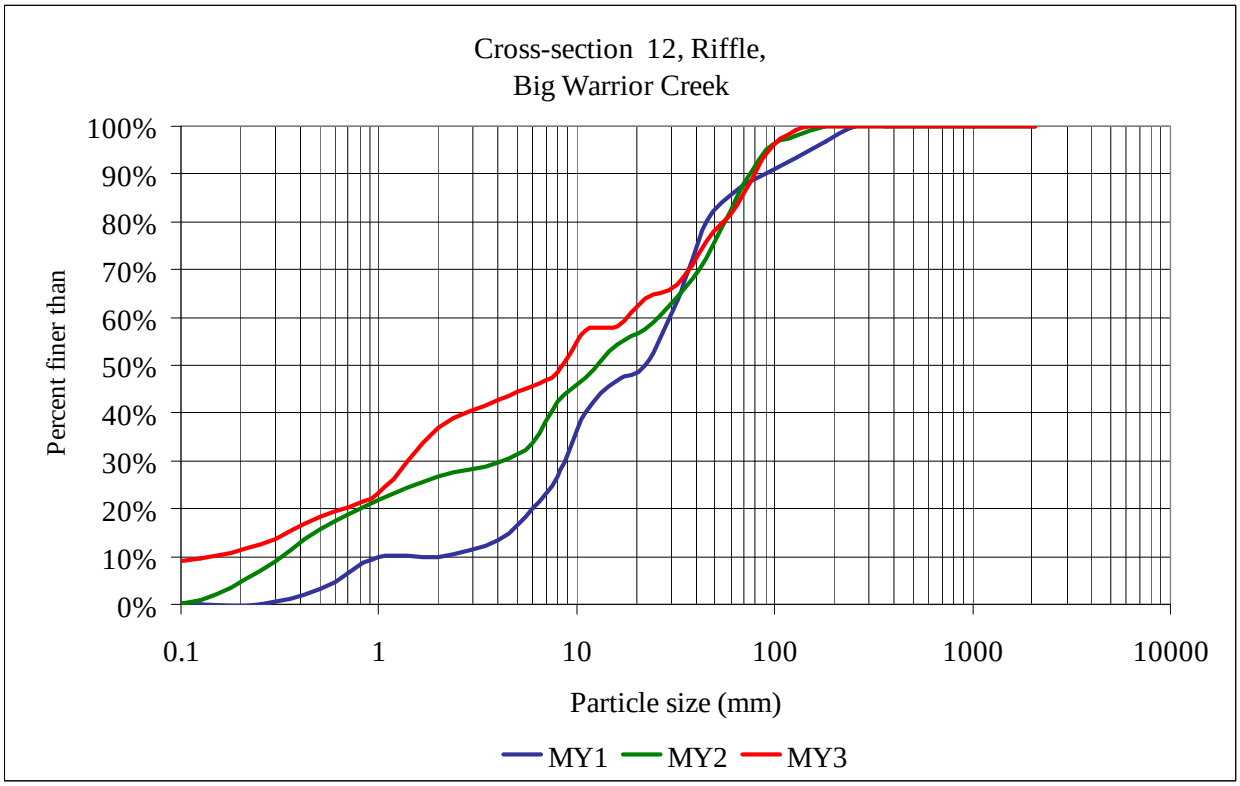
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	9.90	7.90	0.98
D_{35}	15.00	23.00	4.60
D_{50}	18.00	47.00	8.10
D_{84}	56.00	86.00	57.00
D_{95}	82.00	120.00	80.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

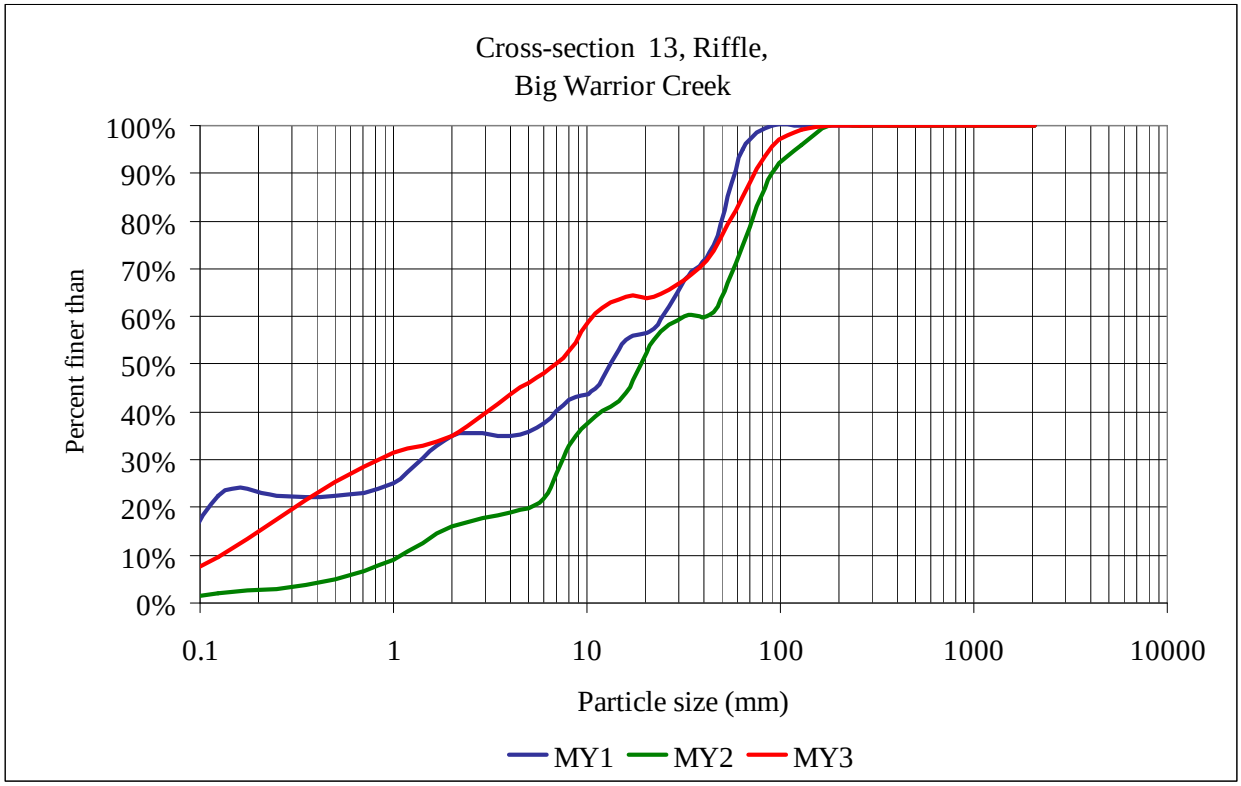
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	4.70	0.51	0.37
D_{35}	9.80	6.30	1.80
D_{50}	22.00	13.00	8.40
D_{84}	56.00	62.00	65.00
D_{95}	150.00	90.00	96.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

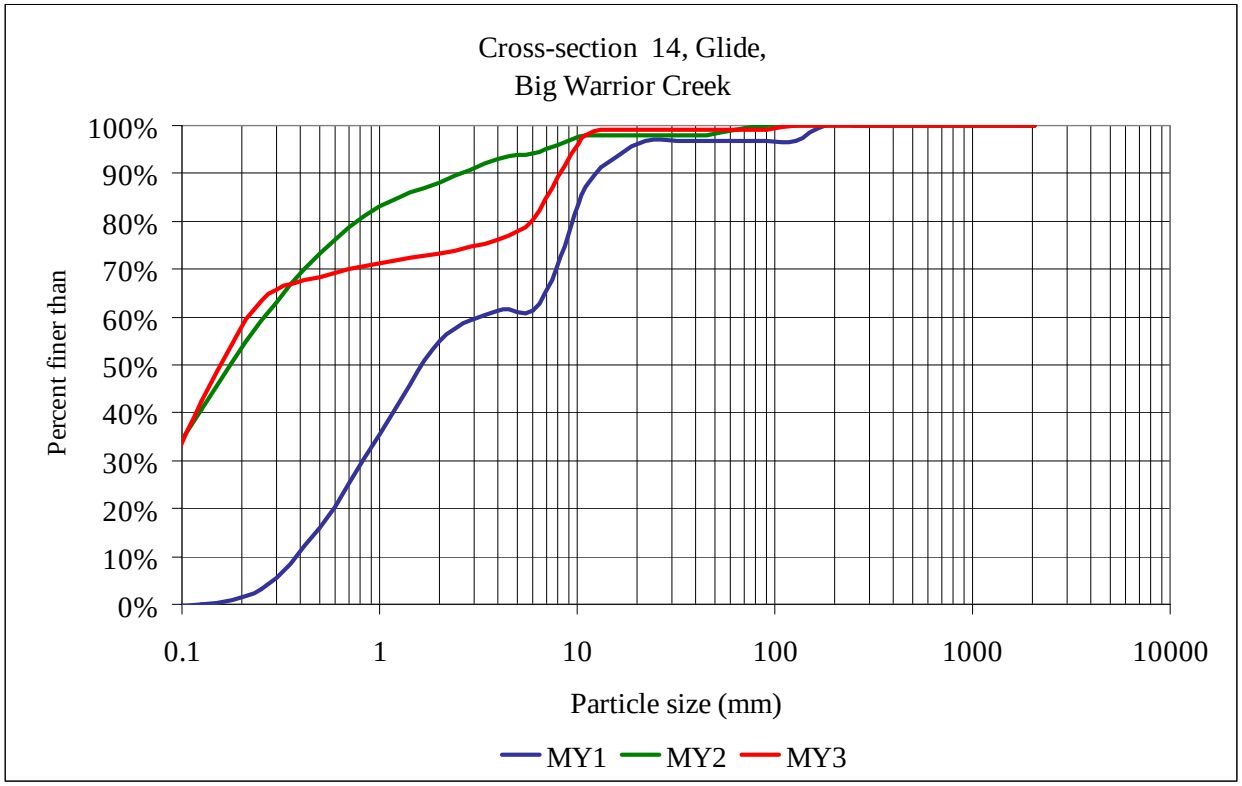
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.10	2.00	0.22
D_{35}	4.00	8.90	2.00
D_{50}	13.00	19.00	6.70
D_{84}	53.00	79.00	62.00
D_{95}	64.00	120.00	88.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

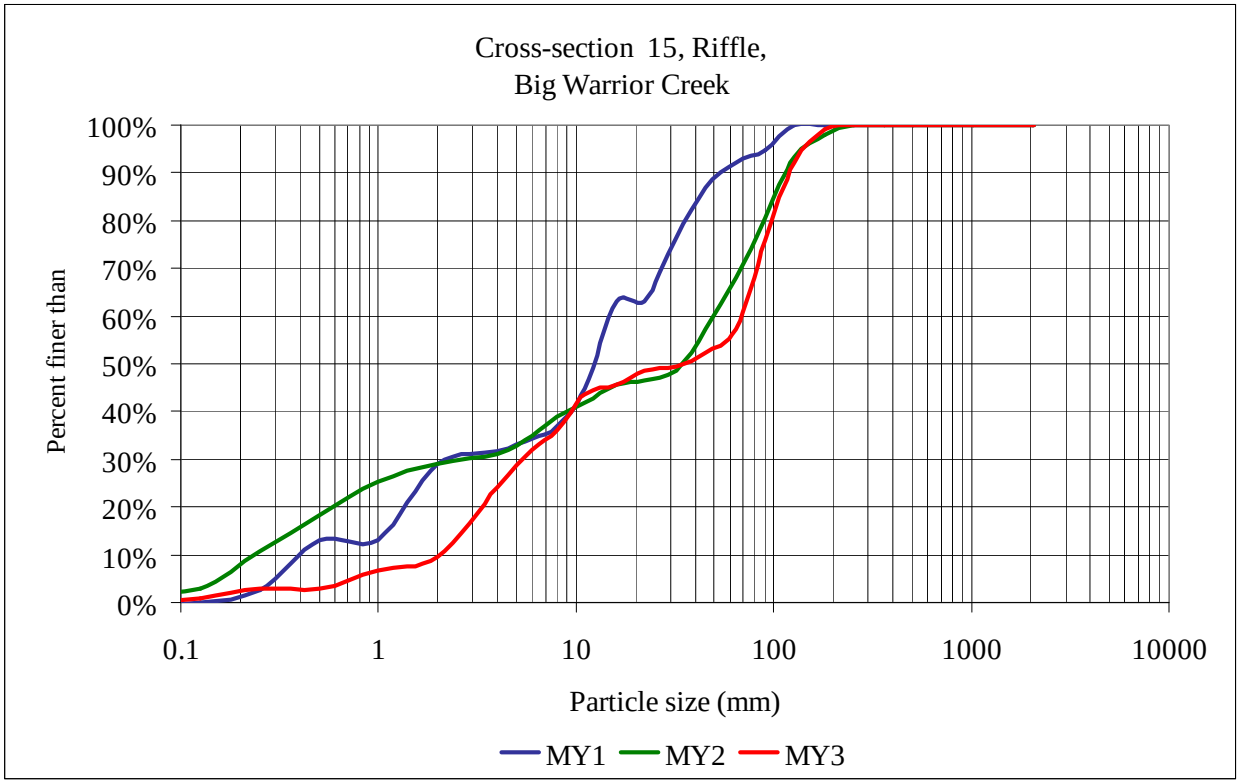
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.50	<0.10	<0.10
D_{35}	0.98	0.10	0.10
D_{50}	1.70	0.18	0.16
D_{84}	10.00	1.10	6.80
D_{95}	18.00	6.90	9.90

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

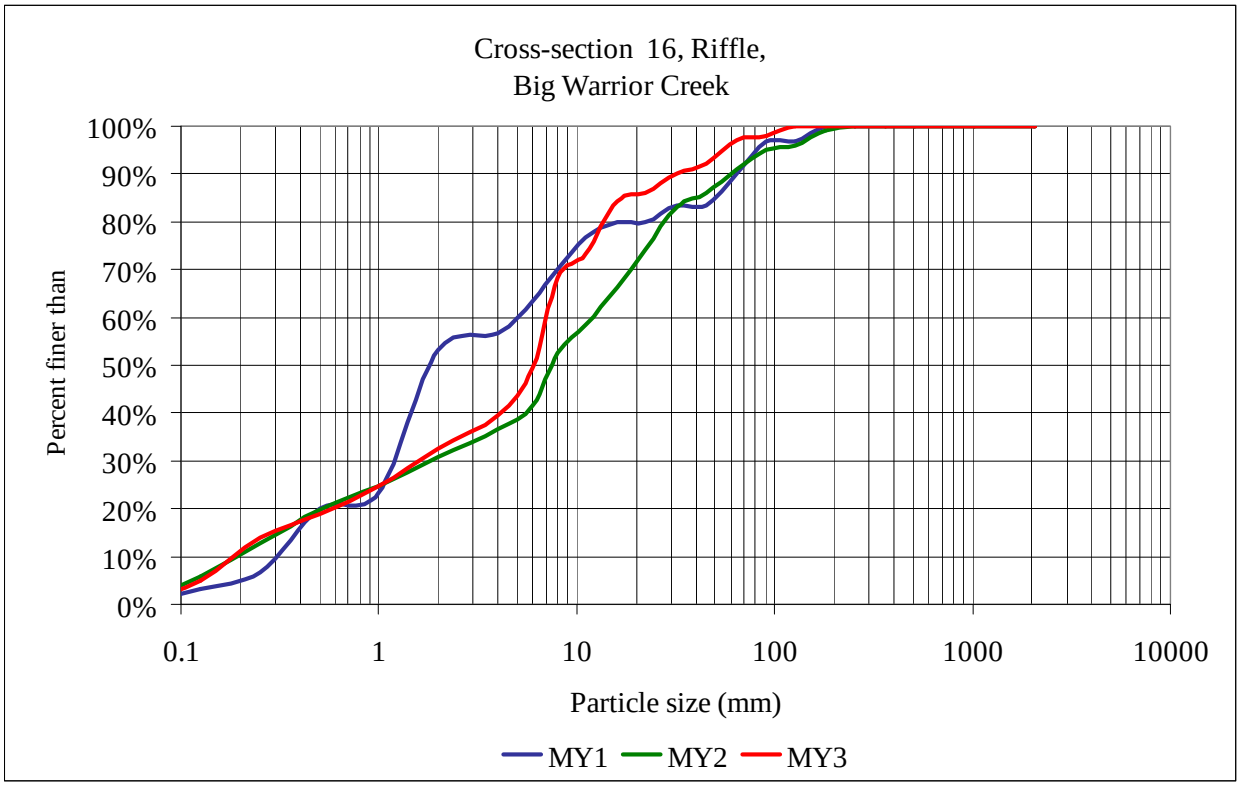
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	1.10	0.40	2.70
D_{35}	6.50	6.00	7.50
D_{50}	12.00	34.00	34.00
D_{84}	41.00	99.00	110.00
D_{95}	92.00	150.00	150.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

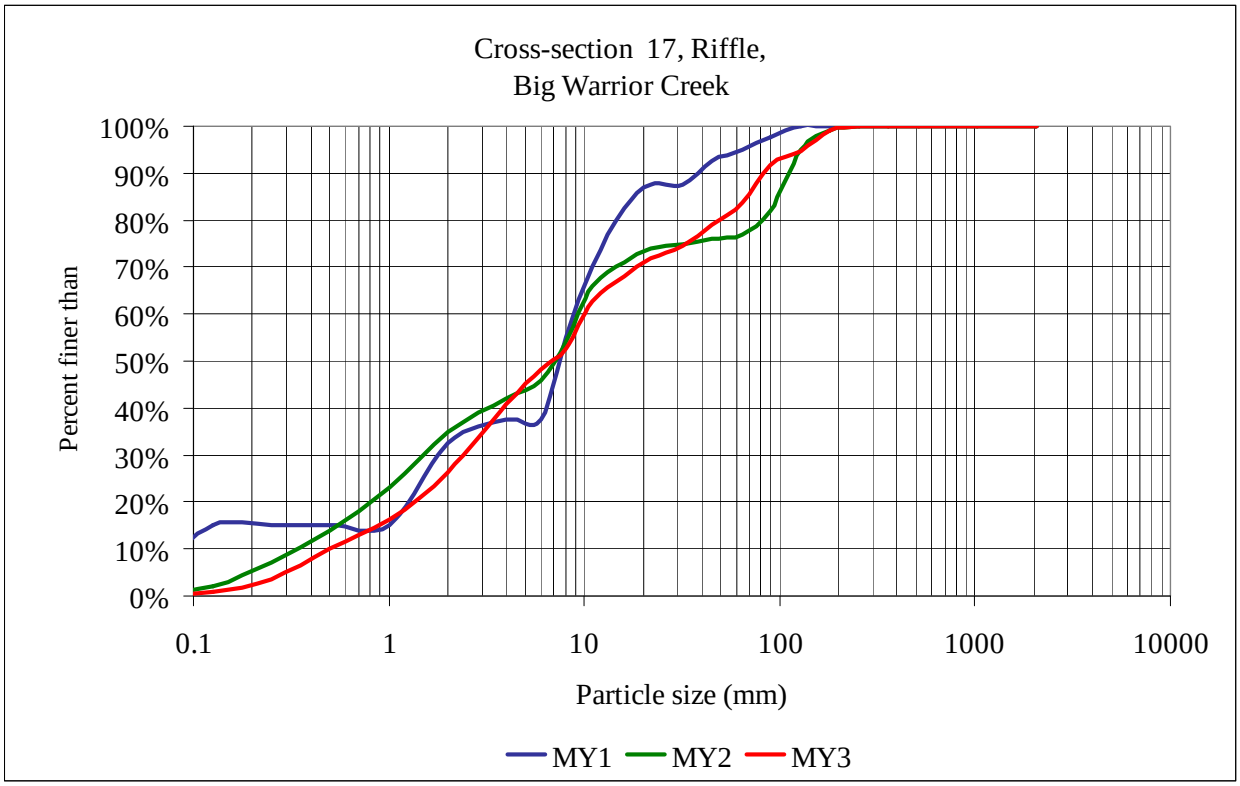
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.41	0.34	0.34
D_{35}	1.30	3.30	2.50
D_{50}	1.90	7.50	6.00
D_{84}	47.00	35.00	16.00
D_{95}	83.00	90.00	55.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

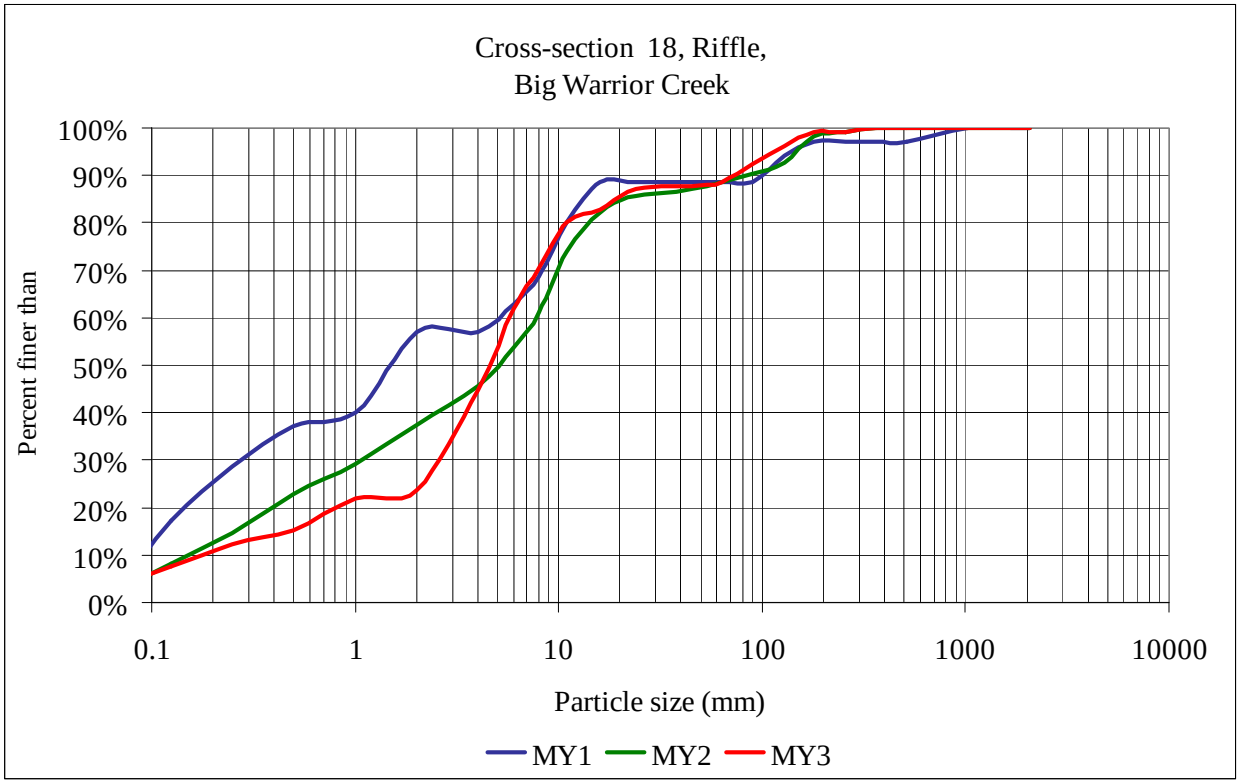
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	1.00	0.58	0.96
D_{35}	2.80	2.00	3.00
D_{50}	7.40	6.90	6.70
D_{84}	18.00	95.00	65.00
D_{95}	64.00	130.00	130.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

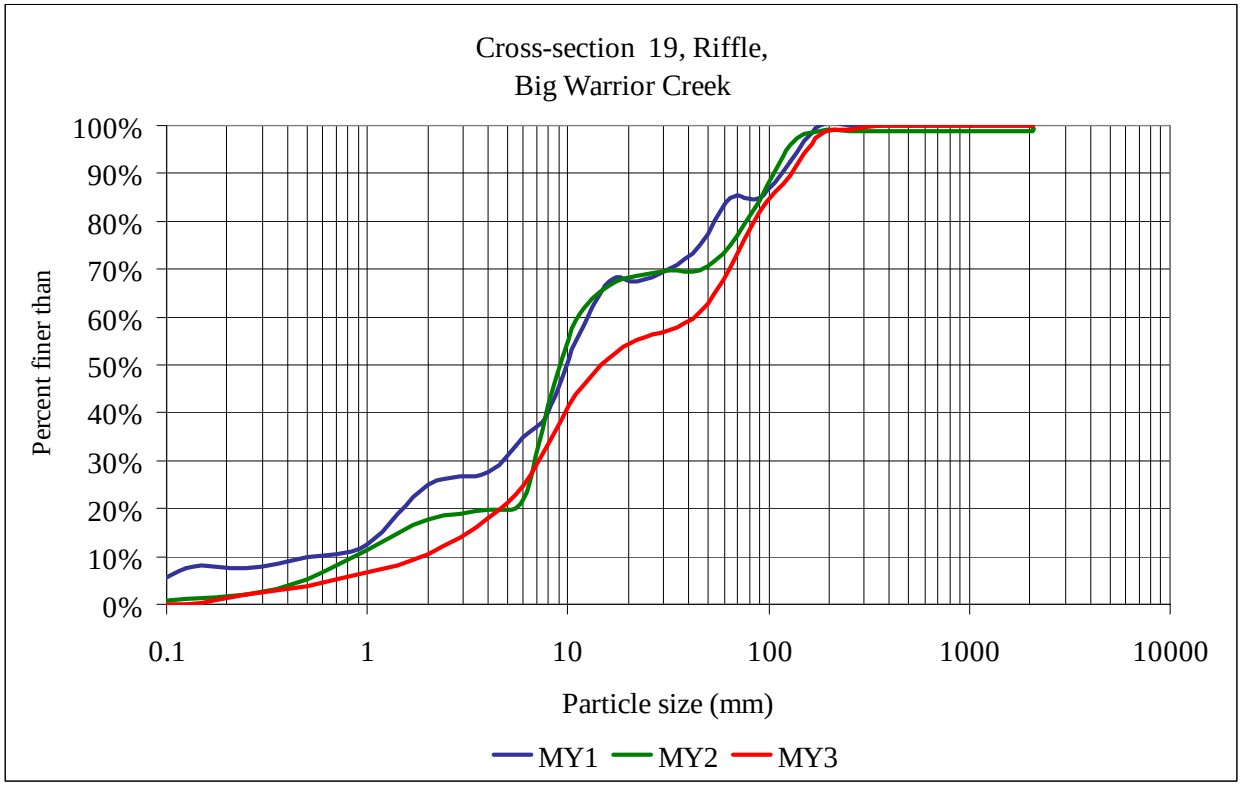
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.12	0.28	0.54
D_{35}	0.42	1.60	2.90
D_{50}	1.50	5.00	4.50
D_{84}	13.00	19.00	18.00
D_{95}	140.00	150.00	110.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

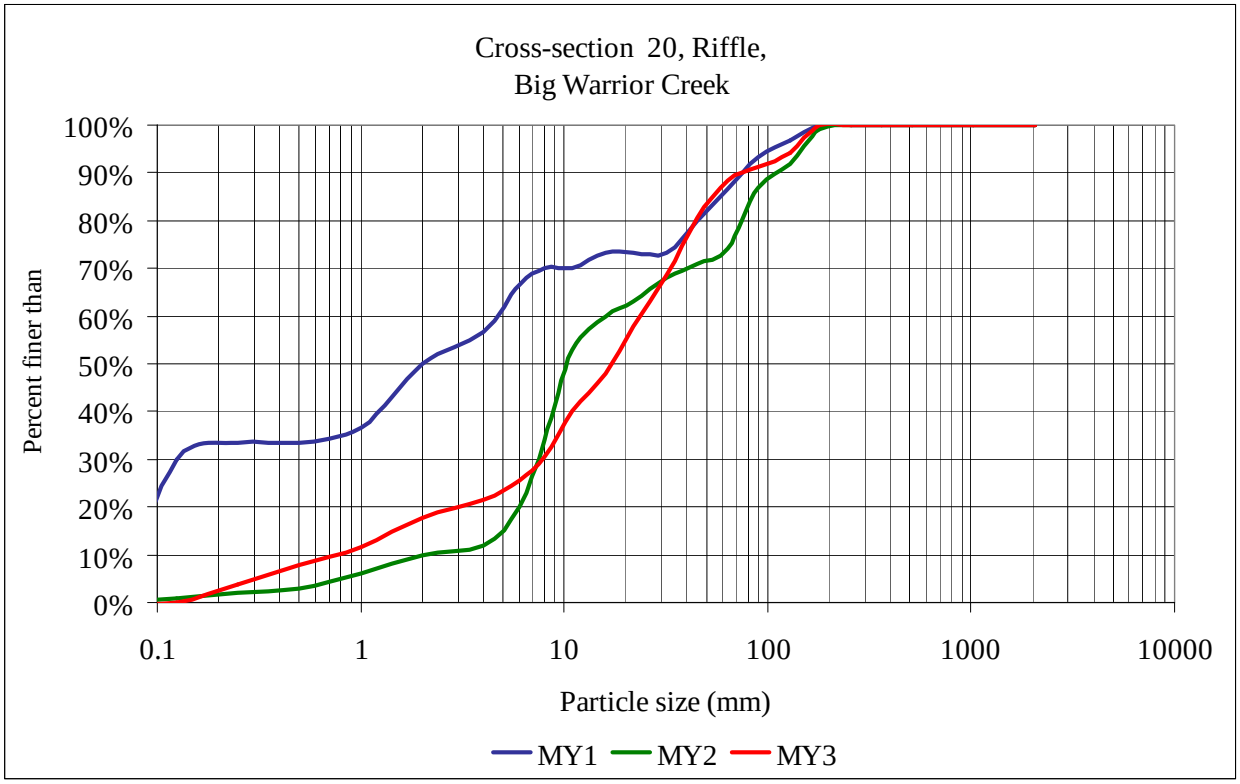
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	1.20	1.60	3.30
D_{35}	6.00	7.20	8.40
D_{50}	9.90	9.20	15.00
D_{84}	62.00	86.00	99.00
D_{95}	140.00	120.00	160.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

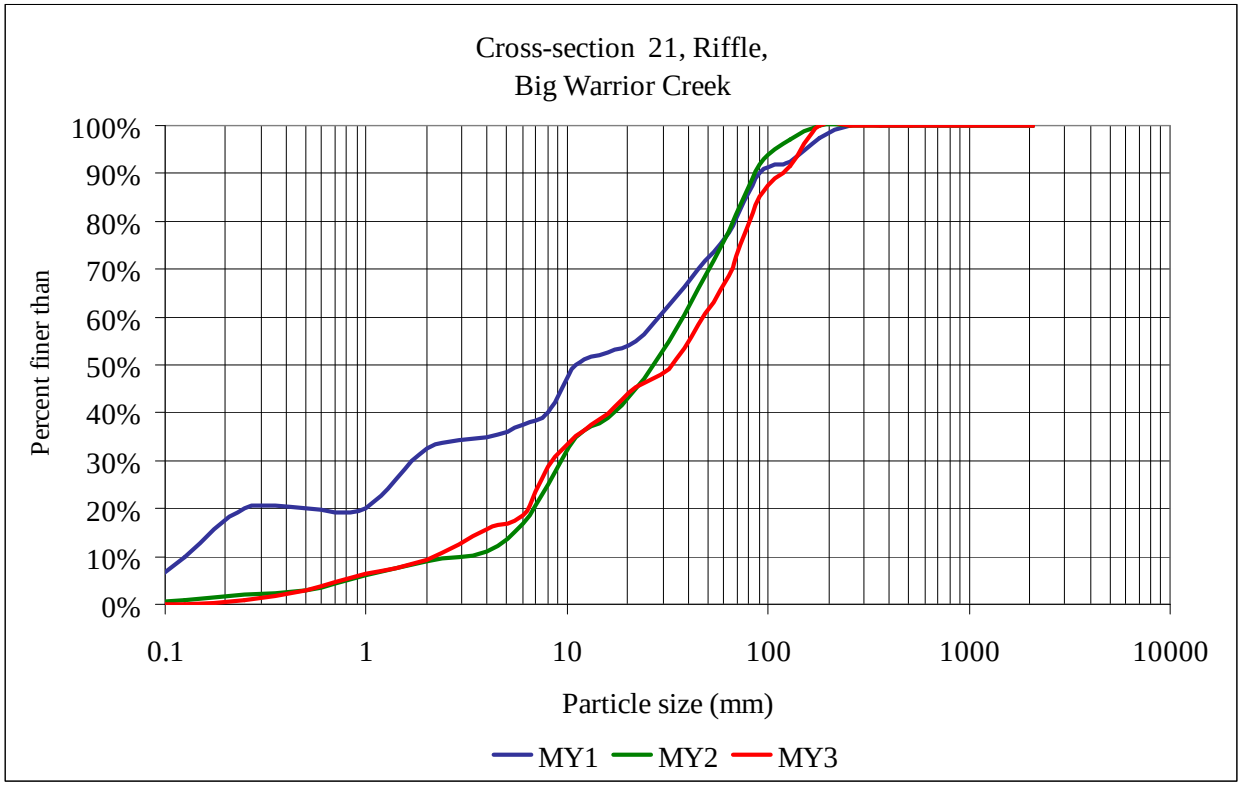
Appendix B.1.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	<0.1	4.90	1.60
D_{35}	0.71	8.10	9.30
D_{50}	2.00	10.00	17.00
D_{84}	56.00	83.00	53.00
D_{95}	110.00	150.00	130.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

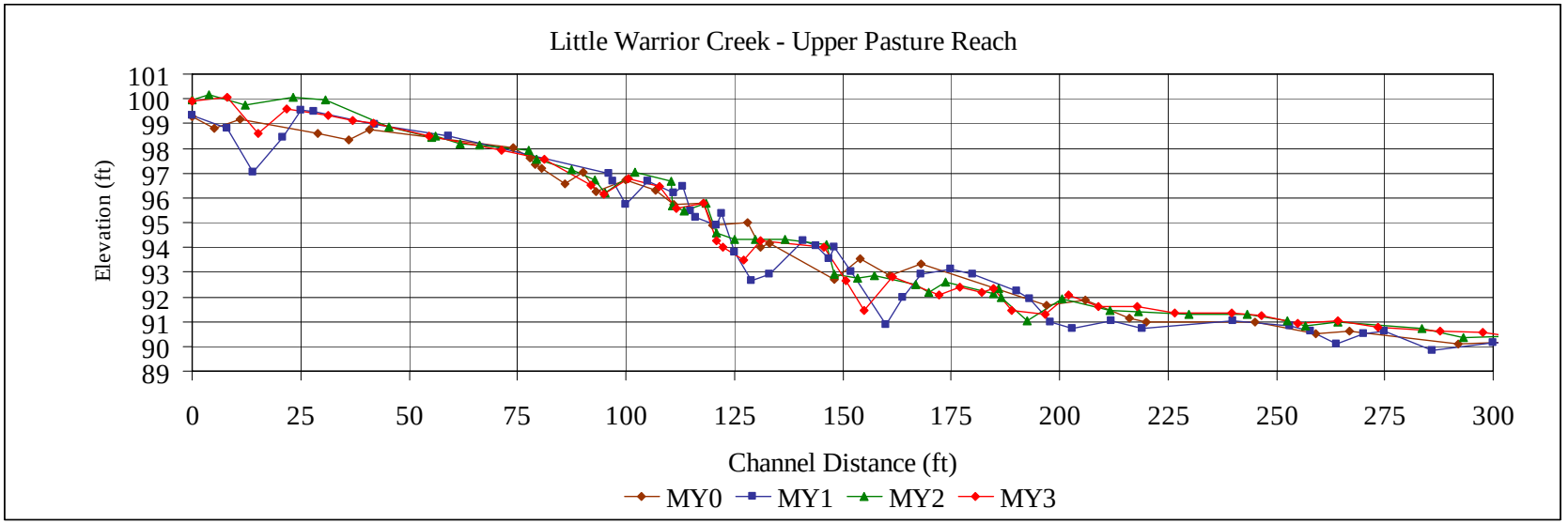
Appendix B.1.2. Continued.

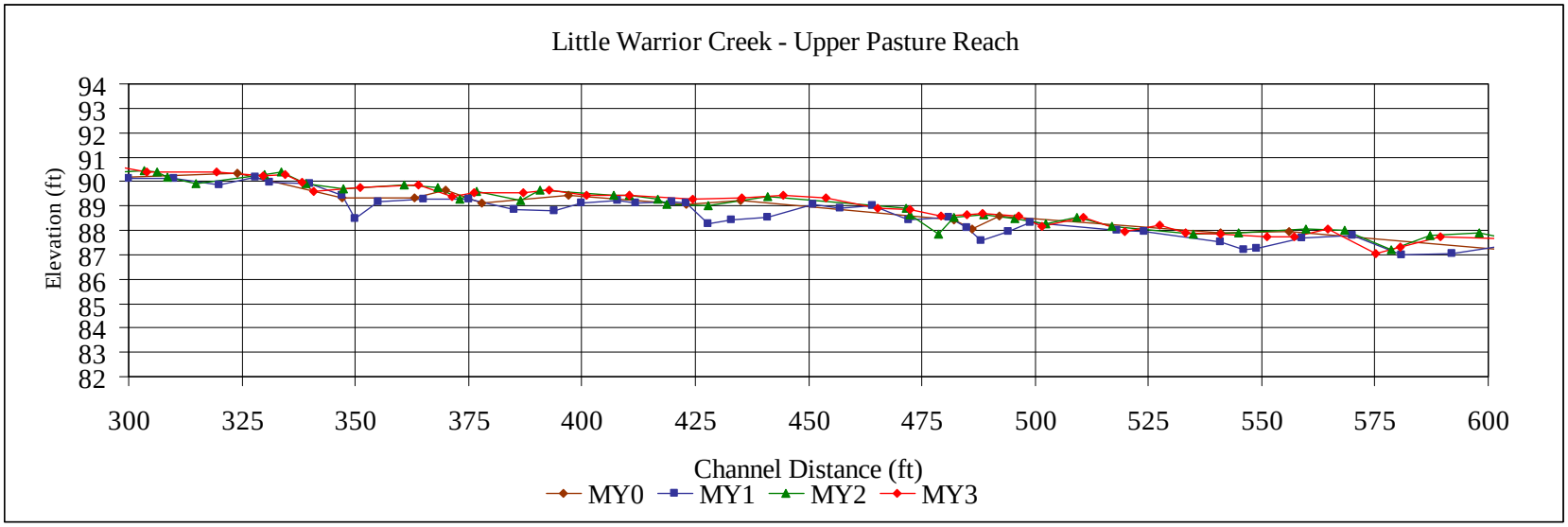


Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.19	5.60	4.20
D_{35}	4.00	11.00	11.00
D_{50}	11.00	27.00	33.00
D_{84}	76.00	74.00	88.00
D_{95}	150.00	110.00	150.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

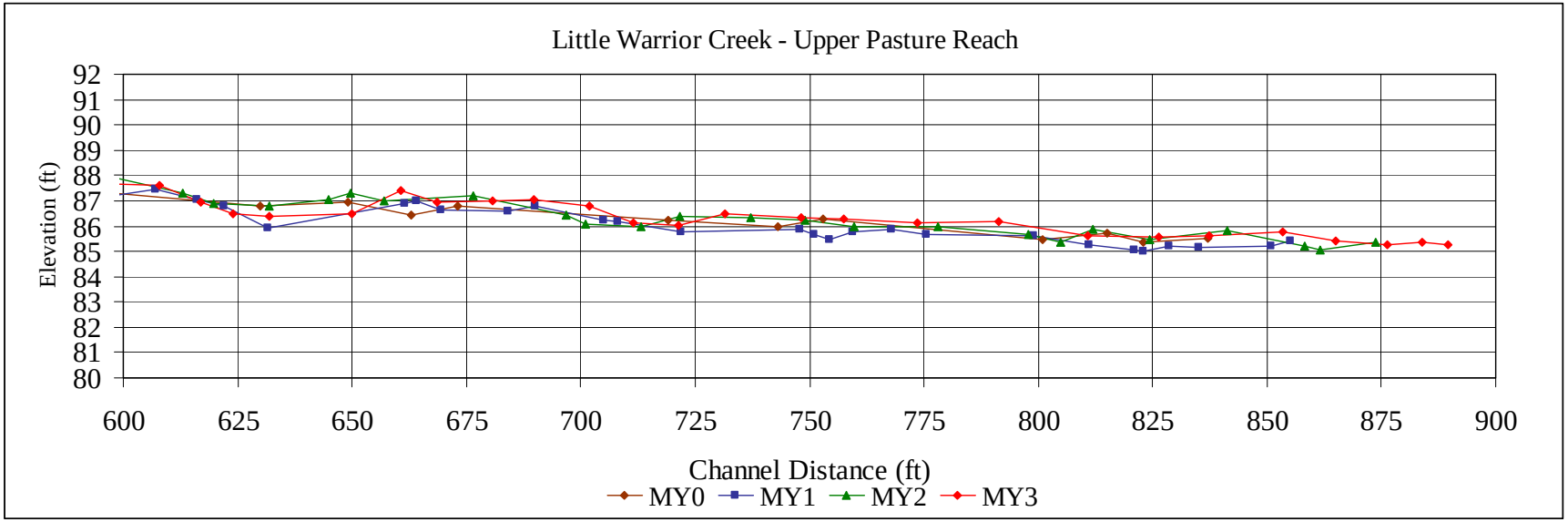
Appendix B.2.1. Longitudinal profile data plot comparisons for Little Warrior Creek, MY0-MY3.





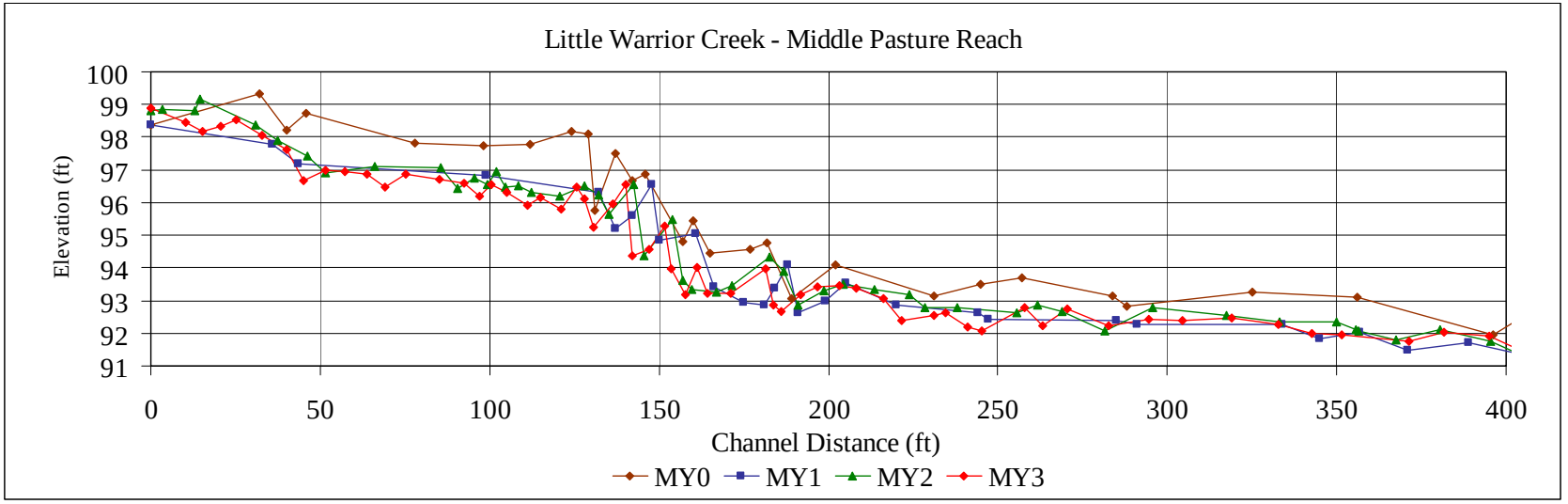
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

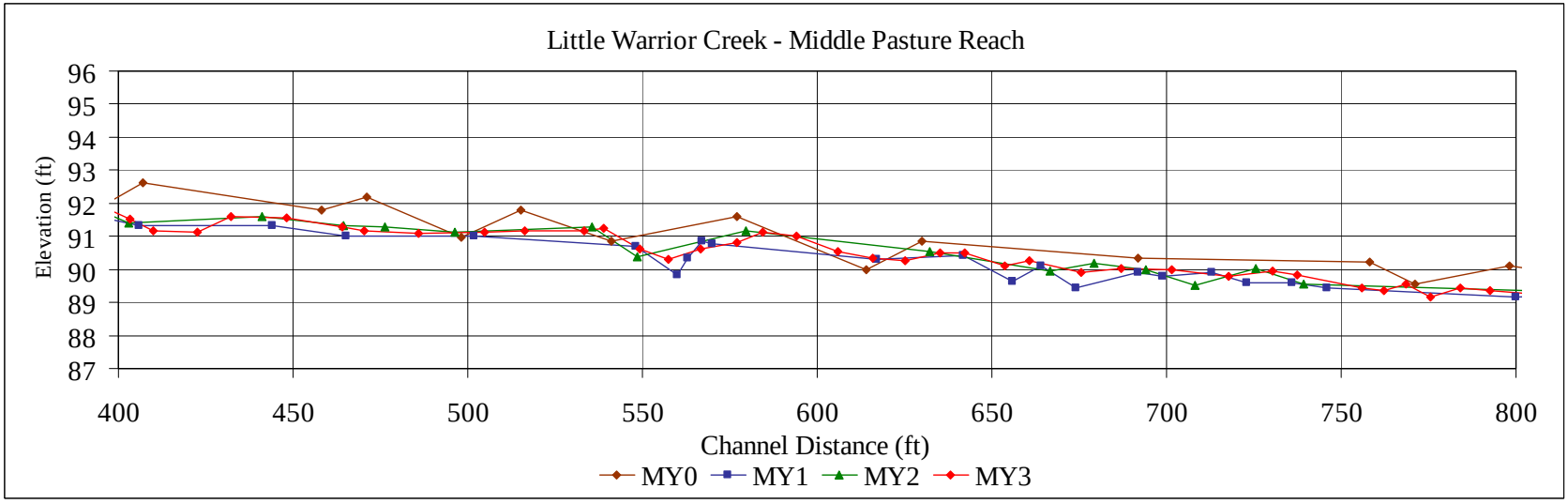
Appendix B.2.1. Continued.



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

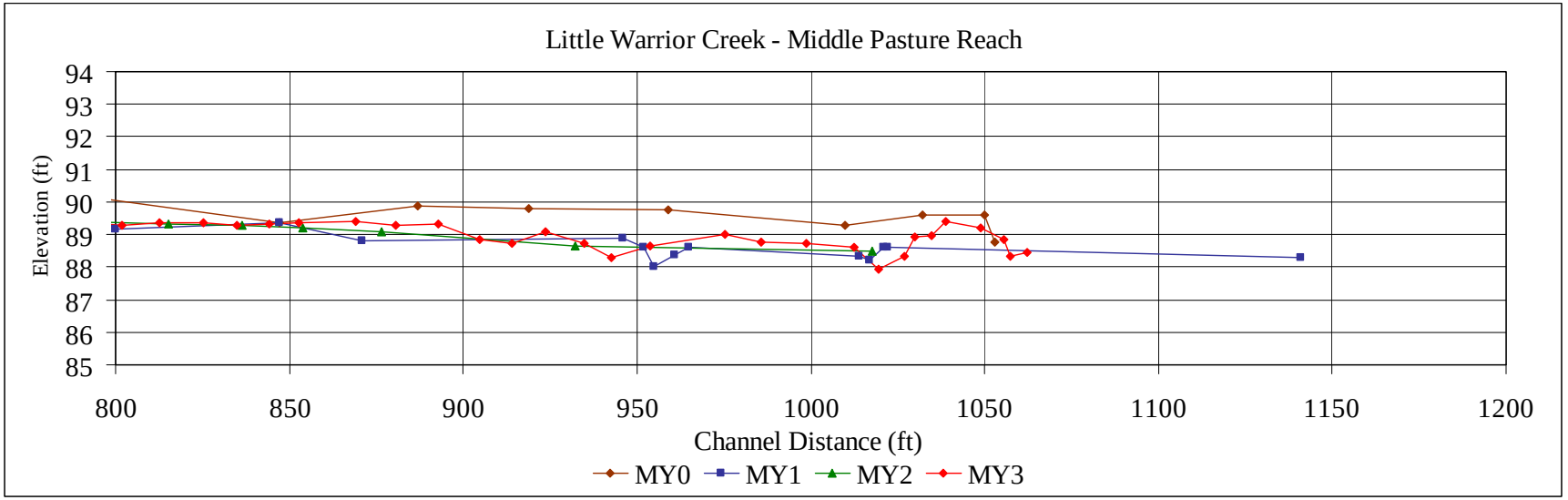
Appendix B.2.1. Continued.





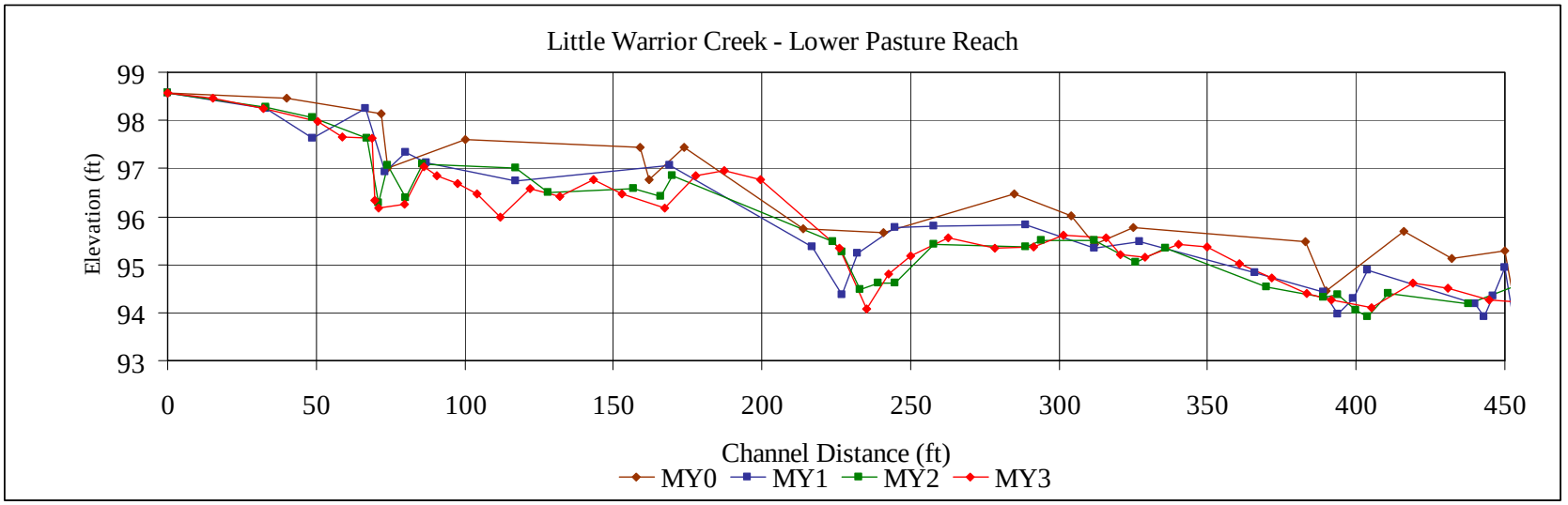
Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

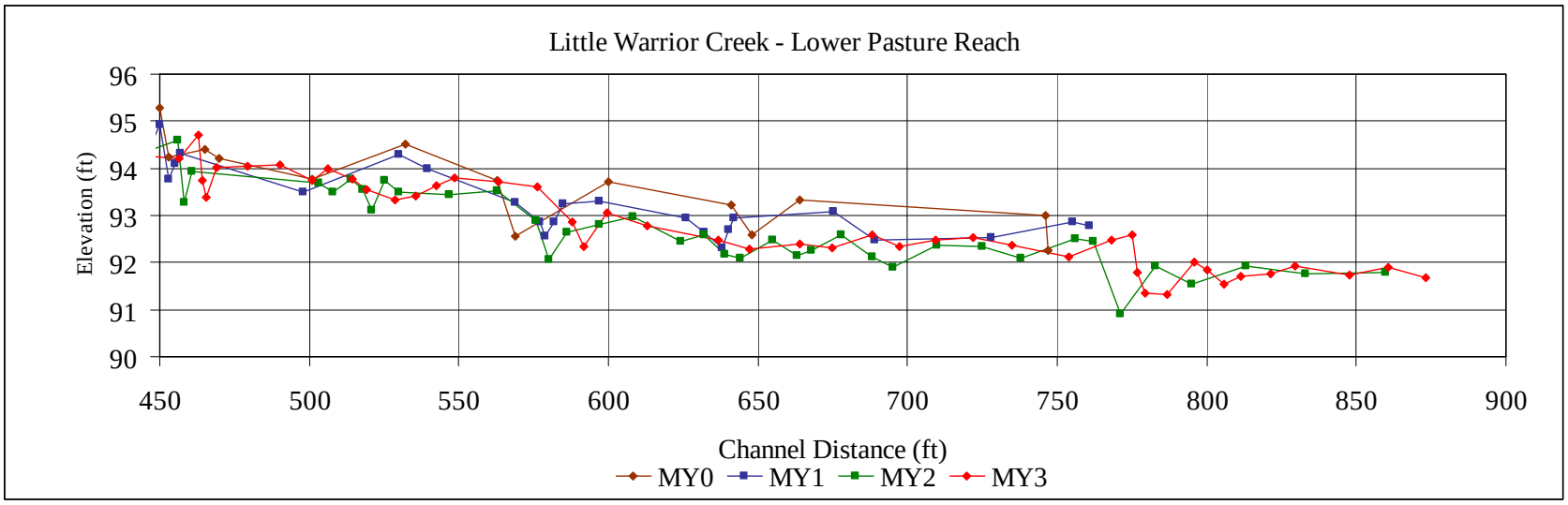
Appendix B.2.1. Continued.



Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

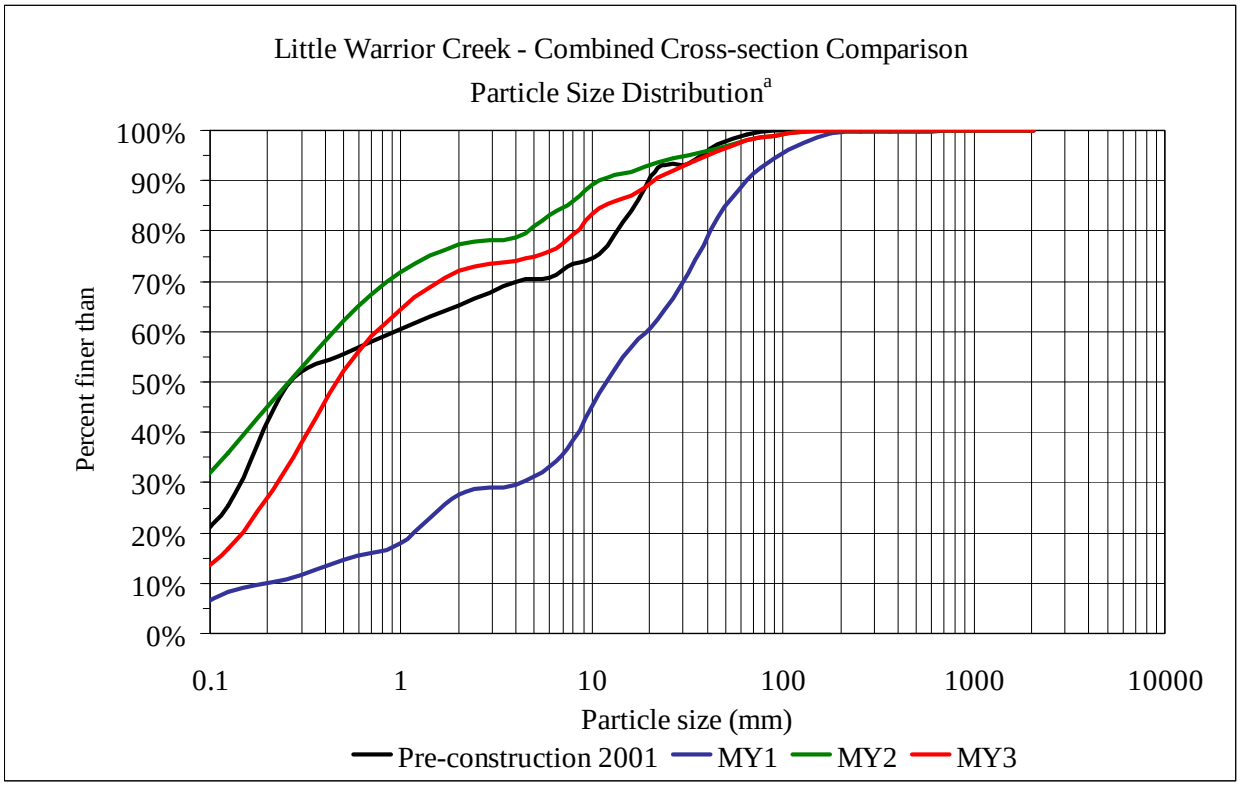
Appendix B.2.1. Continued.





Survey Dates: MY0 18-Dec-02, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Appendix B.2.2. Pebble count data plot comparisons for Big Warrior Creek, MY0-MY3.

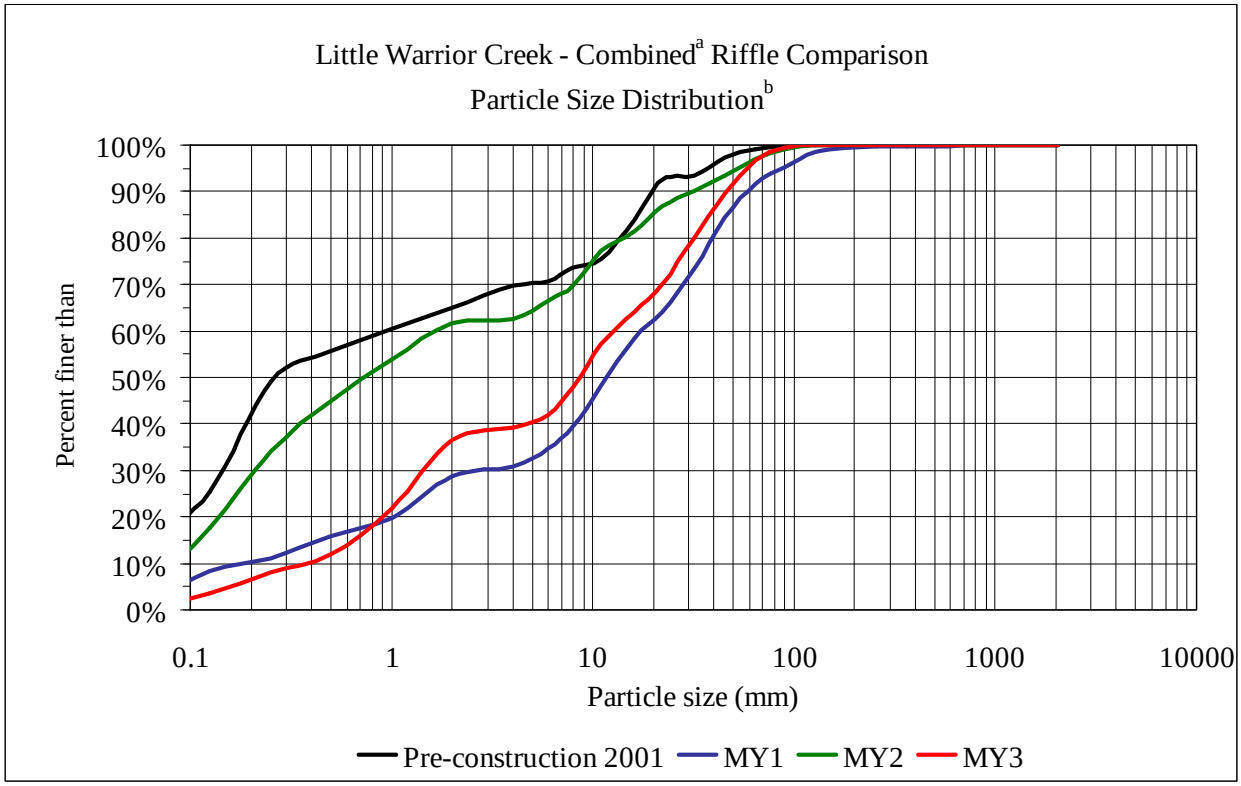


[a]The pre-construction 2001 data were taken at one cross-section on Little Warrior Creek. The data are presented for comparison purposes.

Size class index	Particle size (mm) in year sampled			
	Pre-construction 2001	MY1	MY2	MY3
D_{16}	<0.10	0.65	<0.10	0.12
D_{35}	0.17	6.60	0.12	0.27
D_{50}	0.28	12.00	0.26	0.46
D_{84}	16.00	48.00	6.50	11.00
D_{95}	37.00	96.00	31.00	40.00

Survey Dates: Pre-construction 17-May01, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Appendix B.2.2. Continued.



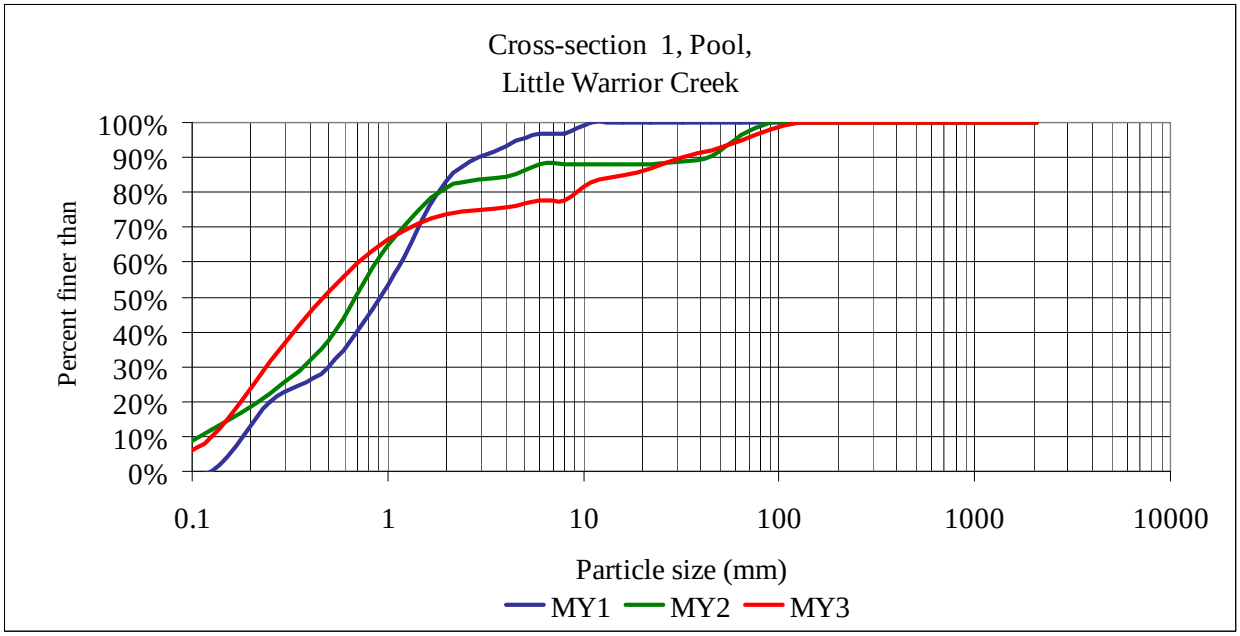
[a]The MY2 riffle comparisons did not include cross-section 11 because it is located on a tributary to Little Warrior Creek.

[b]The Pre-construction 2001 data was taken at one cross-section on Little Warrior Creek. The data is presented for comparison purposes.

Size class index	Particle size (mm) in year sampled			
	Pre-construction 2001	MY1	MY2	MY3
D_{16}	<0.10	0.14	0.11	0.66
D_{35}	0.17	4.40	0.26	1.90
D_{50}	0.28	9.30	0.74	8.60
D_{84}	16.00	26.00	19.00	37.00
D_{95}	37.00	41.00	52.00	59.00

Survey Dates: Pre-construction 17-May01, MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

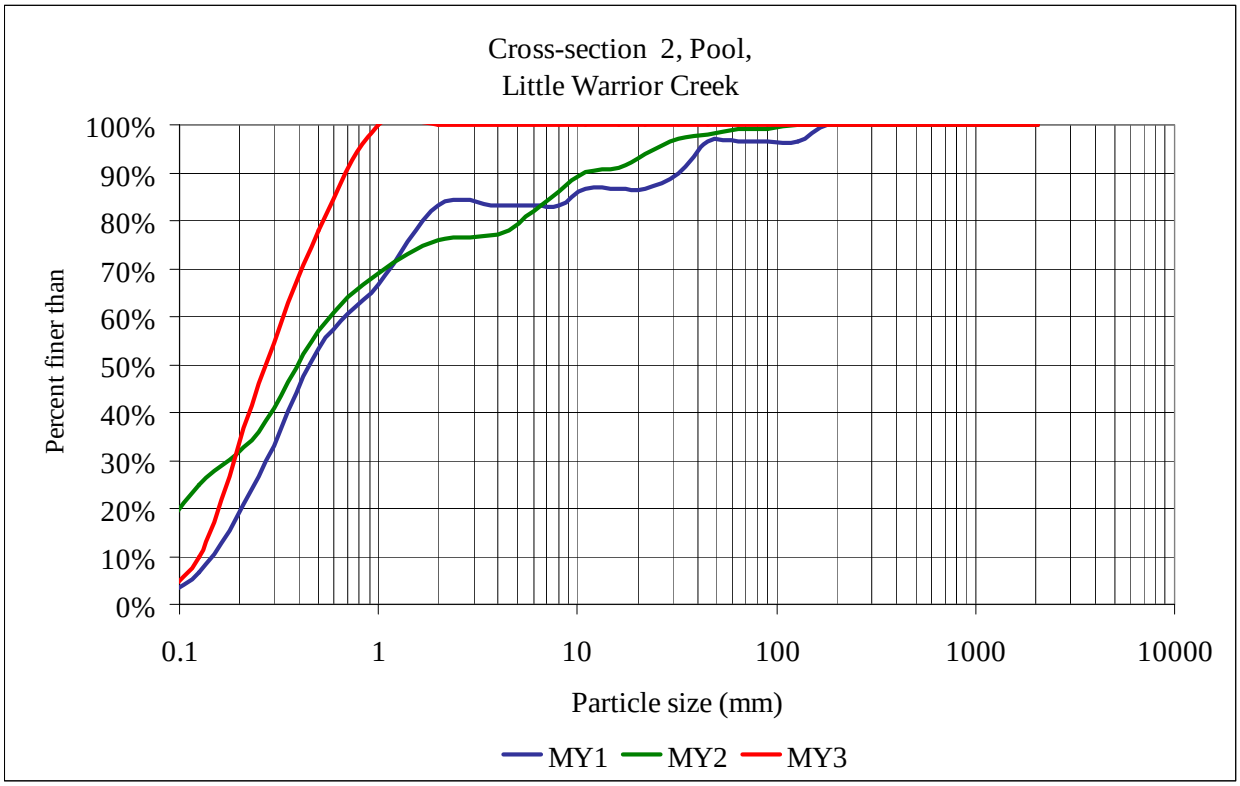
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.22	0.16	0.15
D_{35}	0.58	0.44	0.28
D_{50}	0.91	0.68	0.47
D_{84}	2.10	3.50	14.00
D_{95}	4.90	58.00	64.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

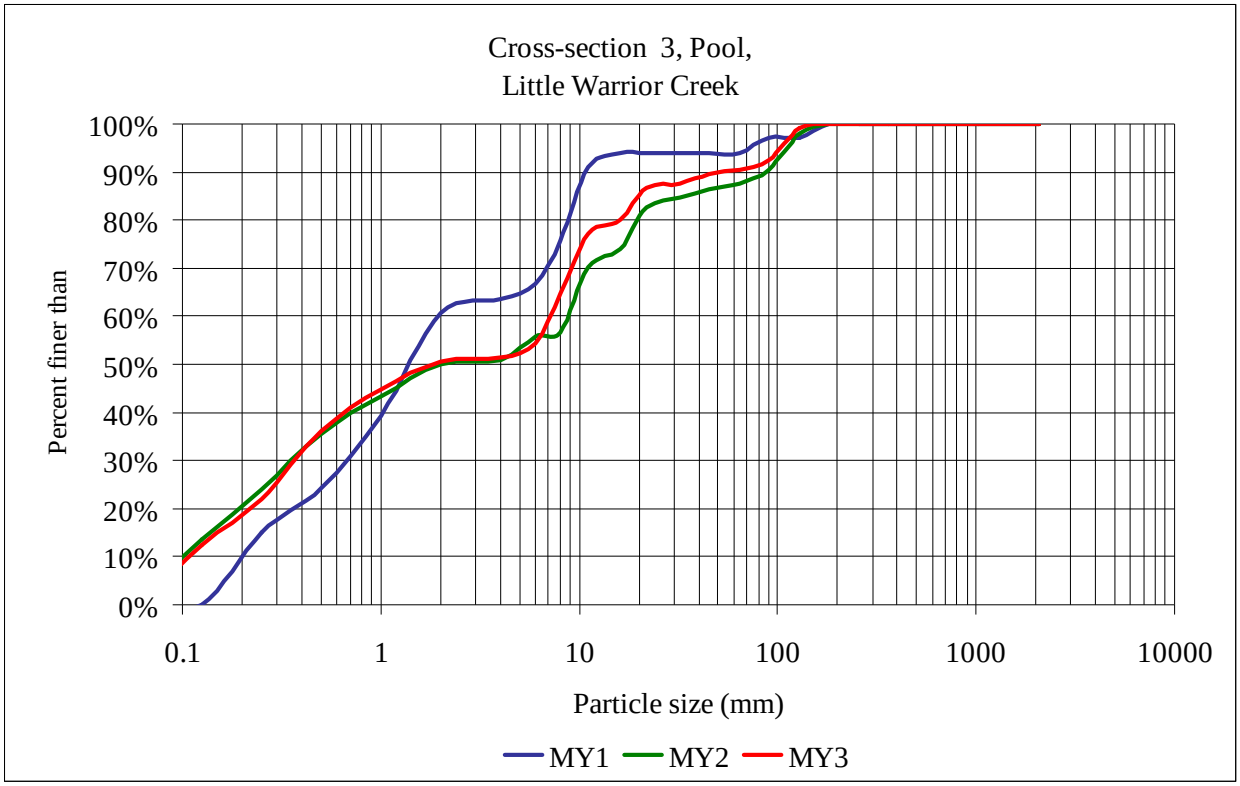
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.17	<0.10	0.14
D_{35}	0.31	0.23	0.20
D_{50}	0.46	0.40	0.27
D_{84}	8.50	6.90	0.60
D_{95}	41.00	25.00	0.85

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

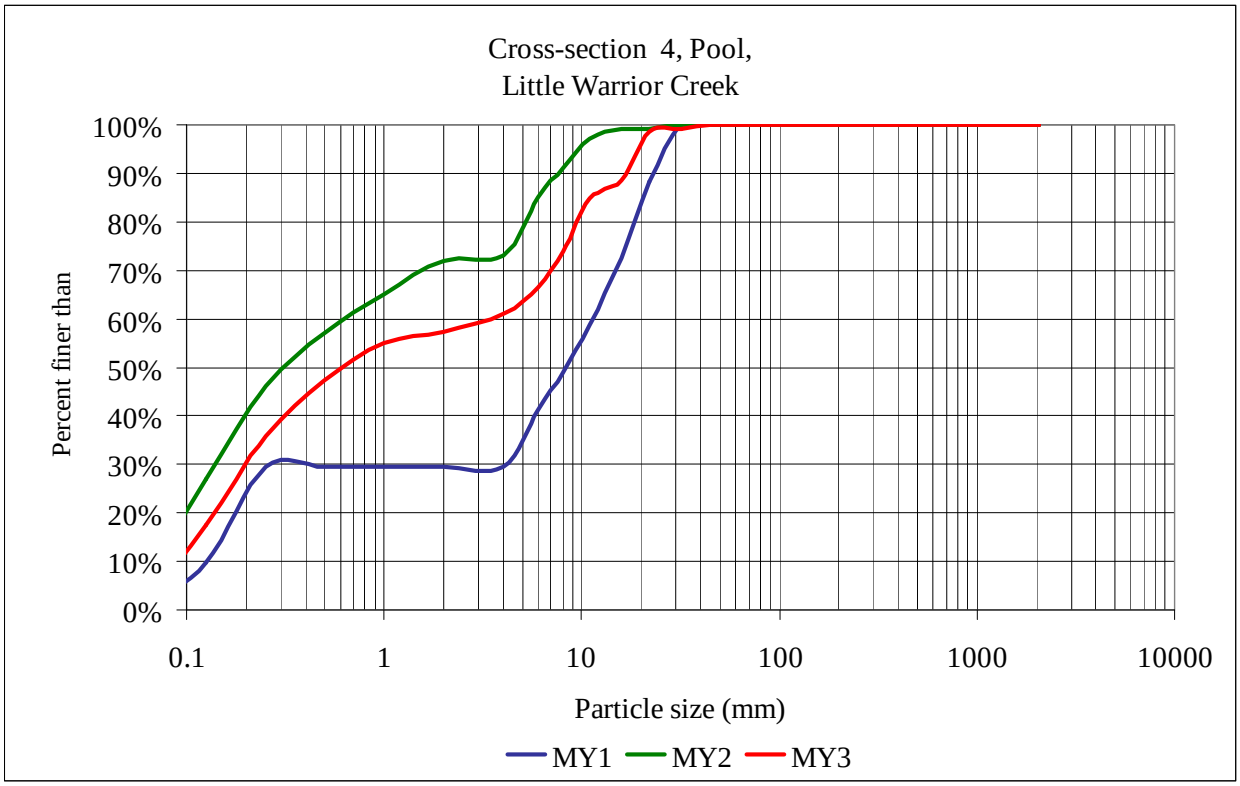
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.27	0.15	0.16
D_{35}	0.82	0.48	0.47
D_{50}	1.40	2.00	1.90
D_{84}	9.50	28.00	19.00
D_{95}	72.00	110.00	100.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

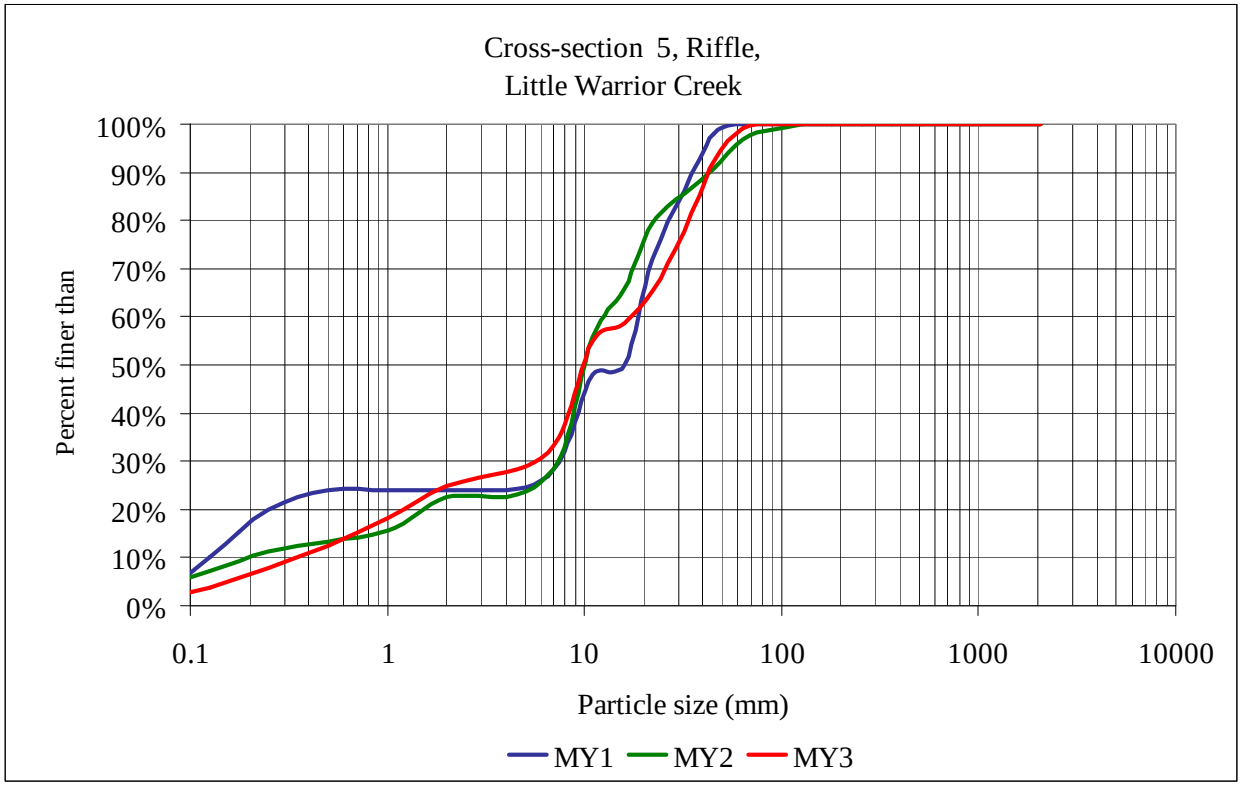
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.16	<0.10	0.12
D_{35}	4.80	0.17	0.24
D_{50}	8.30	0.32	0.64
D_{84}	20.00	5.80	11.00
D_{95}	27.00	9.90	20.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

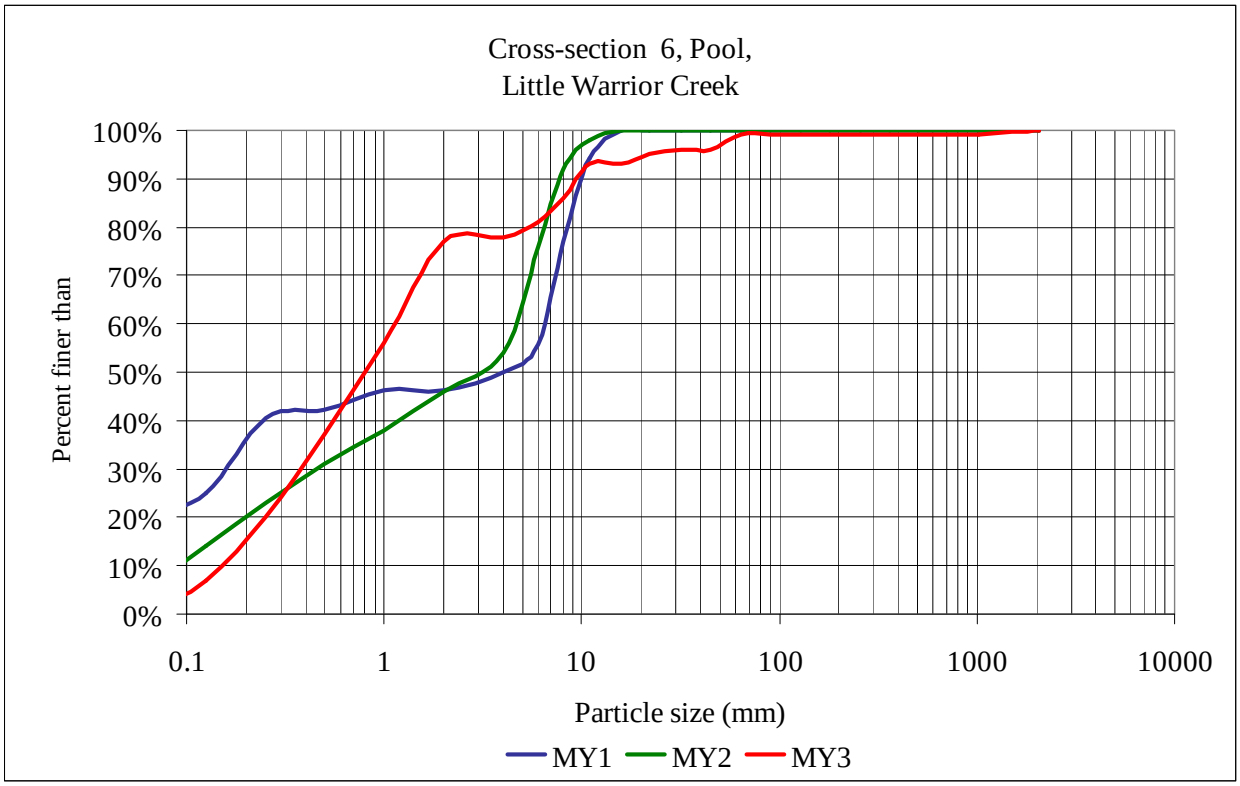
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.19	1.10	0.76
D_{35}	8.50	8.20	7.20
D_{50}	16.00	10.00	10.00
D_{84}	30.00	29.00	37.00
D_{95}	41.00	57.00	52.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

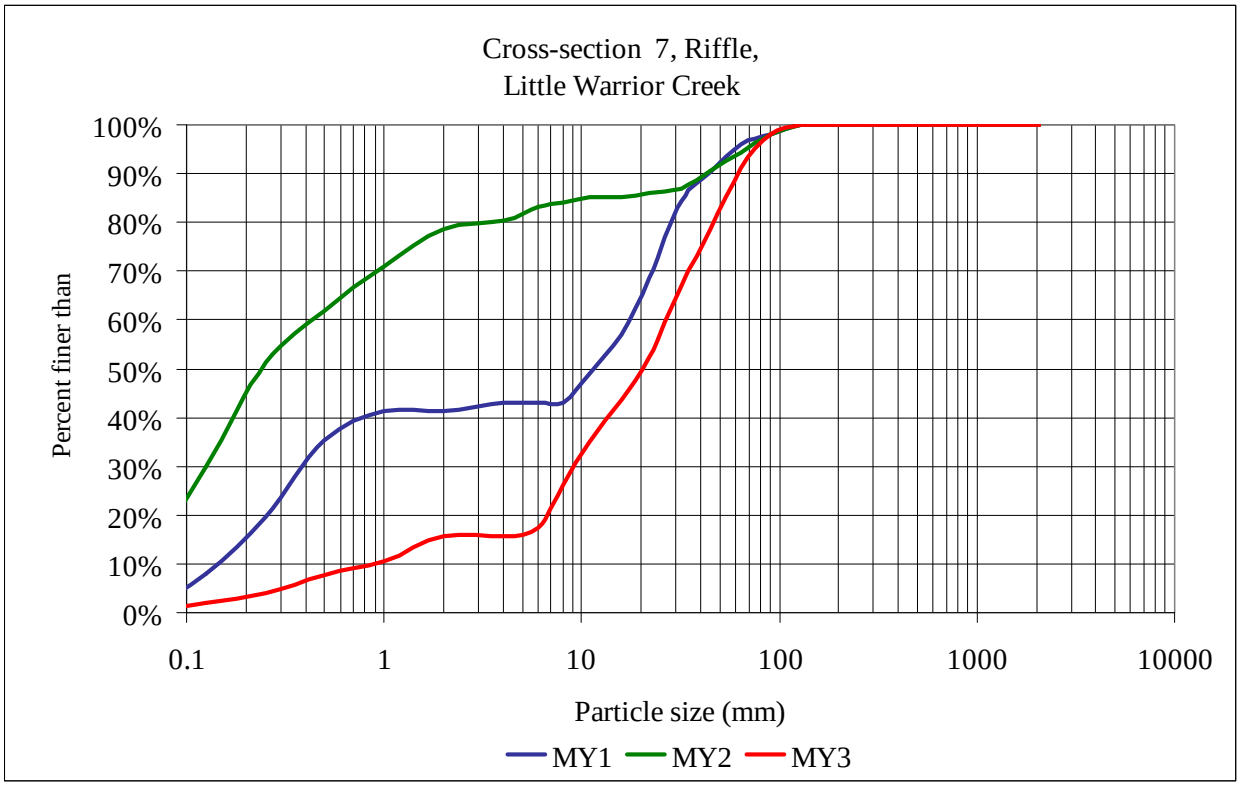
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	<0.10	0.15	0.20
D_{35}	0.20	0.74	0.46
D_{50}	4.00	2.80	0.80
D_{84}	9.10	6.90	7.10
D_{95}	12.00	9.40	22.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

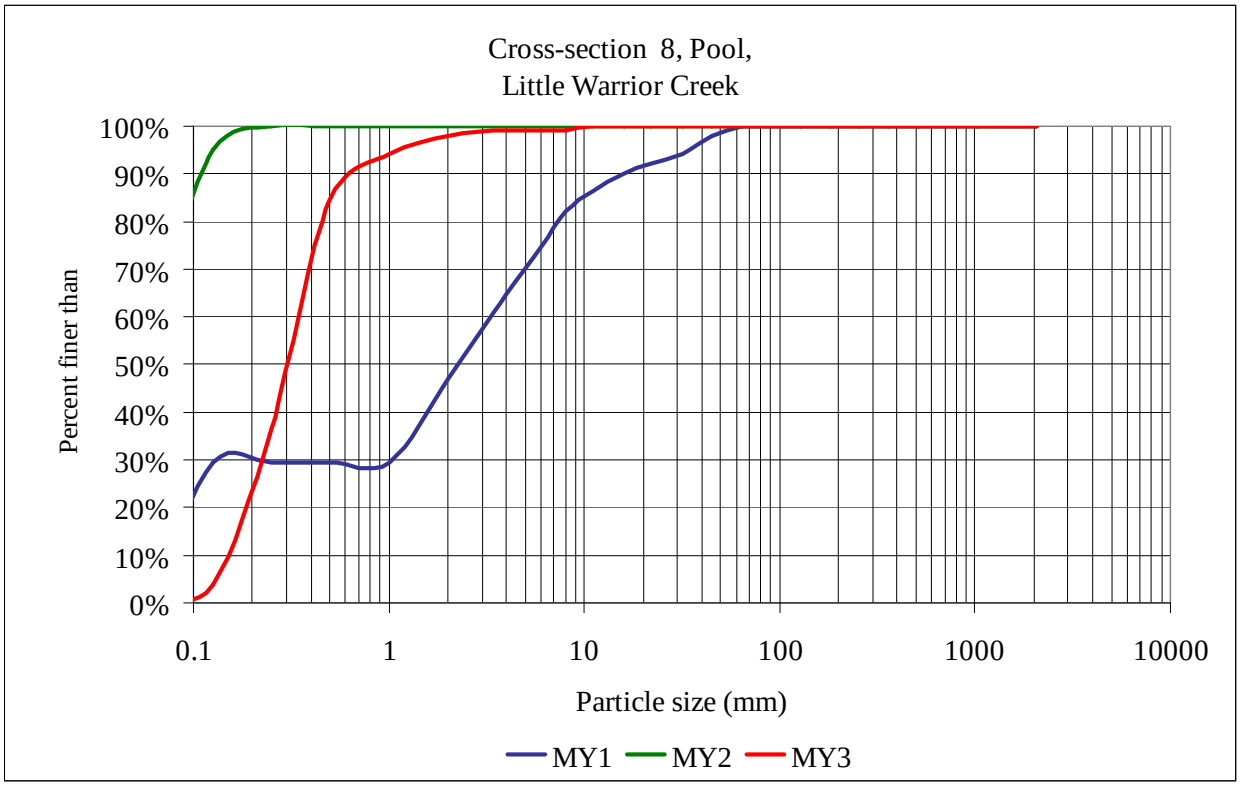
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.20	<0.10	4.40
D_{35}	0.49	0.15	11.00
D_{50}	12.00	0.24	20.00
D_{84}	32.00	7.70	52.00
D_{95}	60.00	68.00	77.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

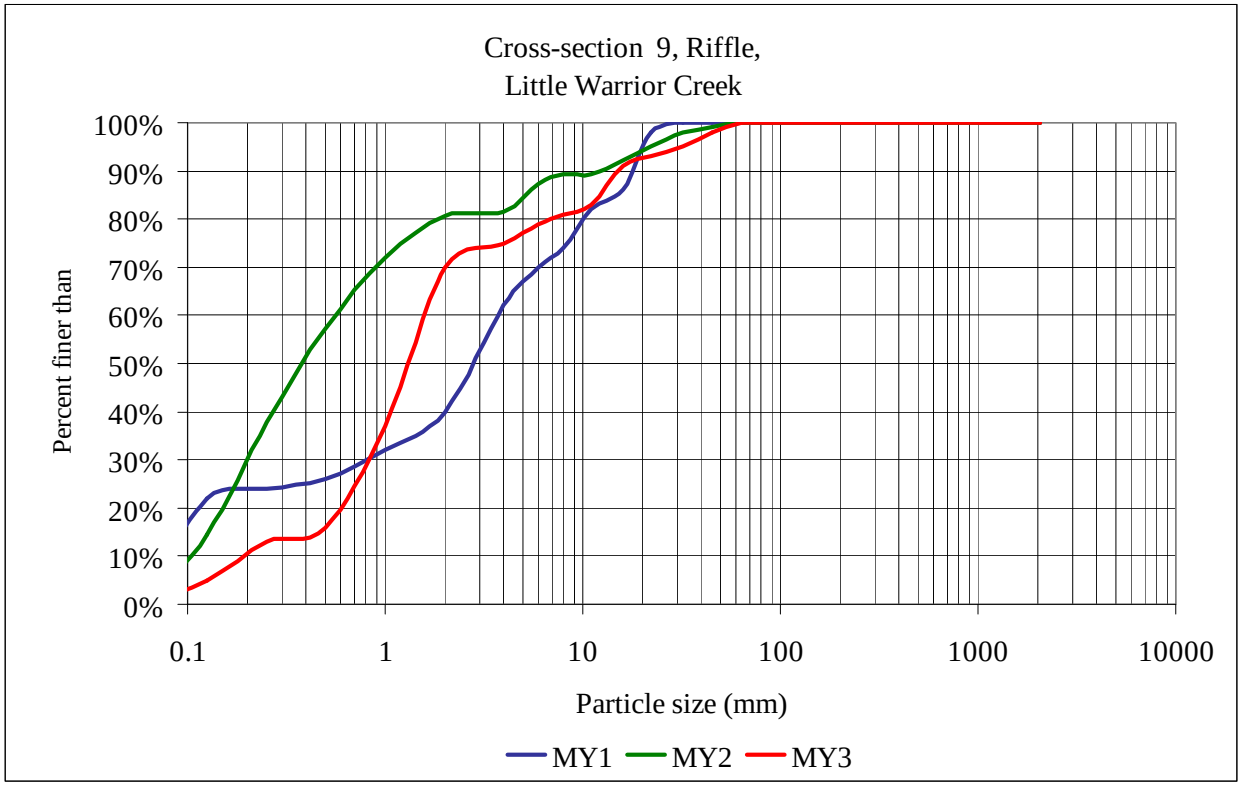
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	<0.10	<0.10	0.16
D_{35}	1.20	<0.10	0.24
D_{50}	2.20	<0.10	0.30
D_{84}	9.10	0.10	0.50
D_{95}	35.00	0.13	1.10

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

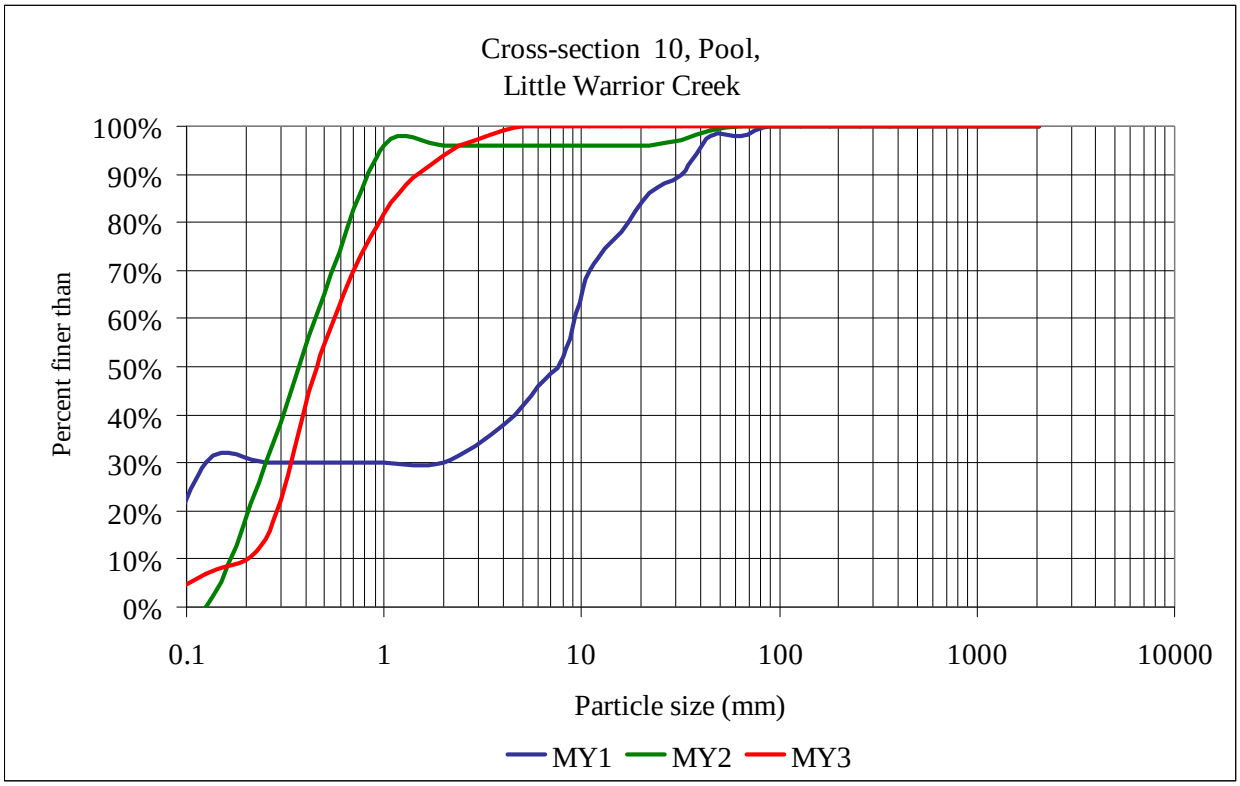
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.10	0.13	0.50
D_{35}	1.30	0.23	0.94
D_{50}	2.70	0.39	1.30
D_{84}	13.00	4.70	12.00
D_{95}	20.00	22.00	32.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

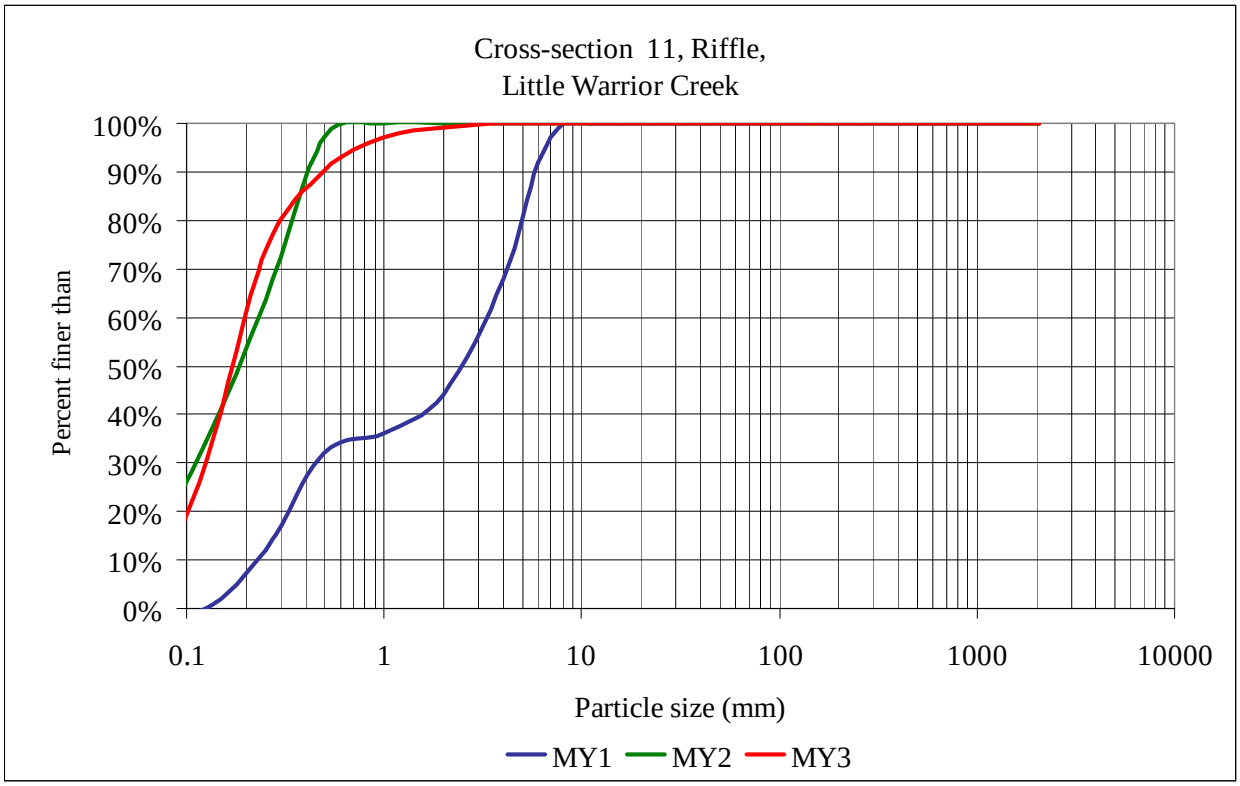
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	<0.10	0.18	0.26
D_{35}	3.10	0.28	0.36
D_{50}	7.30	0.37	0.46
D_{84}	20.00	0.76	1.10
D_{95}	40.00	0.98	2.30

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

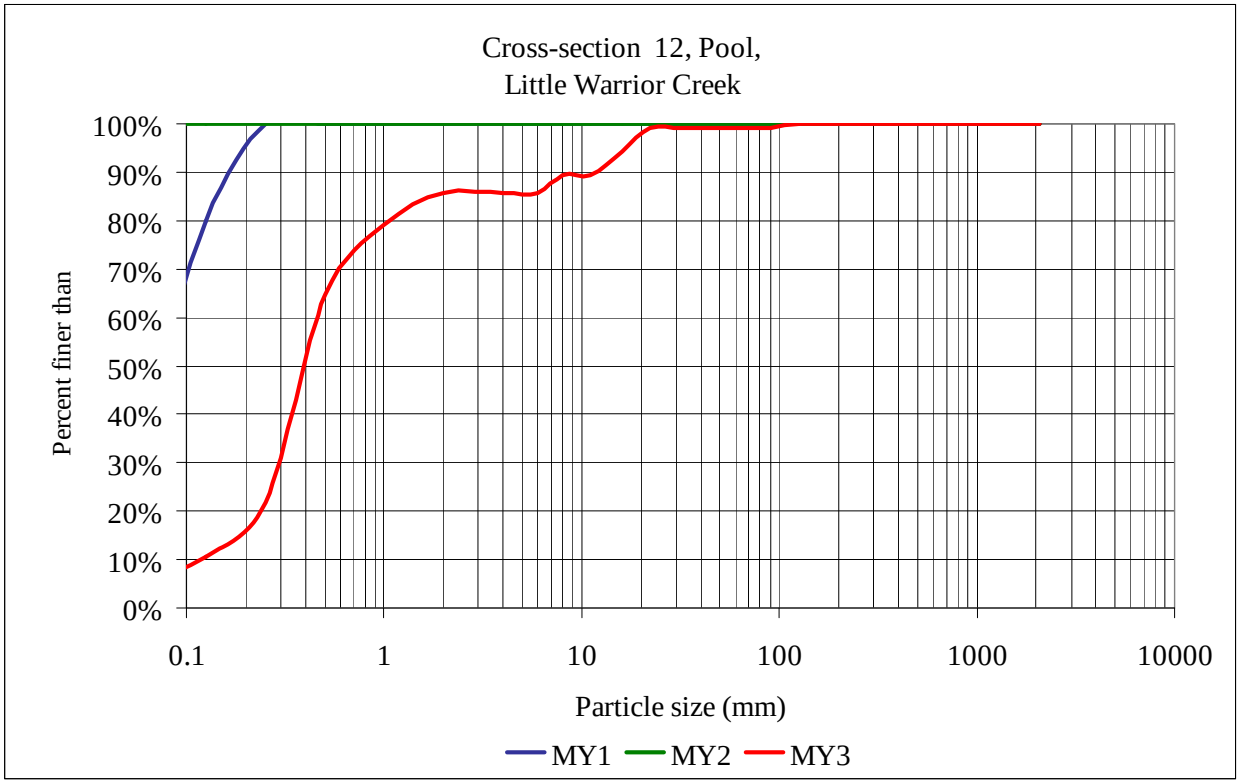
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	0.29	<0.10	<0.10
D_{35}	0.84	0.13	0.14
D_{50}	2.40	0.18	0.17
D_{84}	5.20	0.38	0.38
D_{95}	6.70	0.48	0.81

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

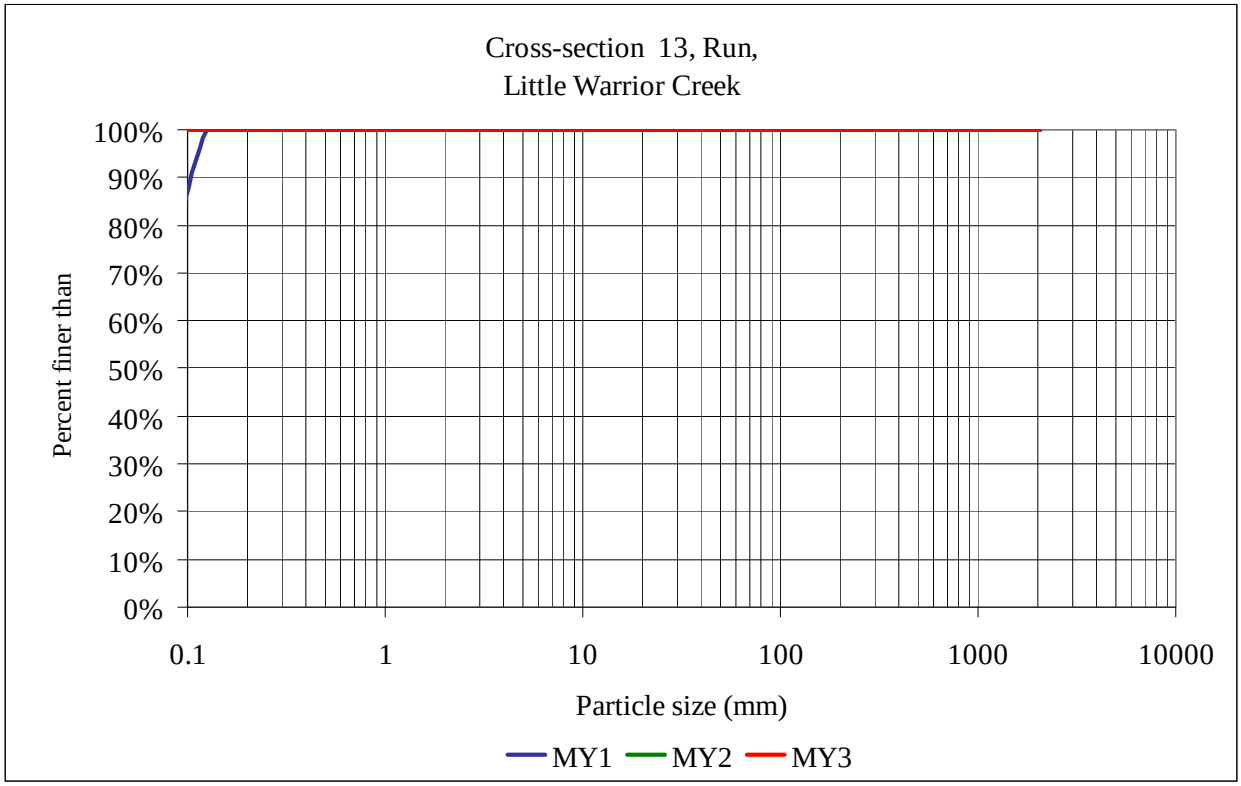
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	<0.10	<0.10	0.17
D_{35}	<0.10	<0.10	0.31
D_{50}	<0.10	<0.10	0.39
D_{84}	0.14	<0.10	1.70
D_{95}	0.21	<0.10	17.00

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

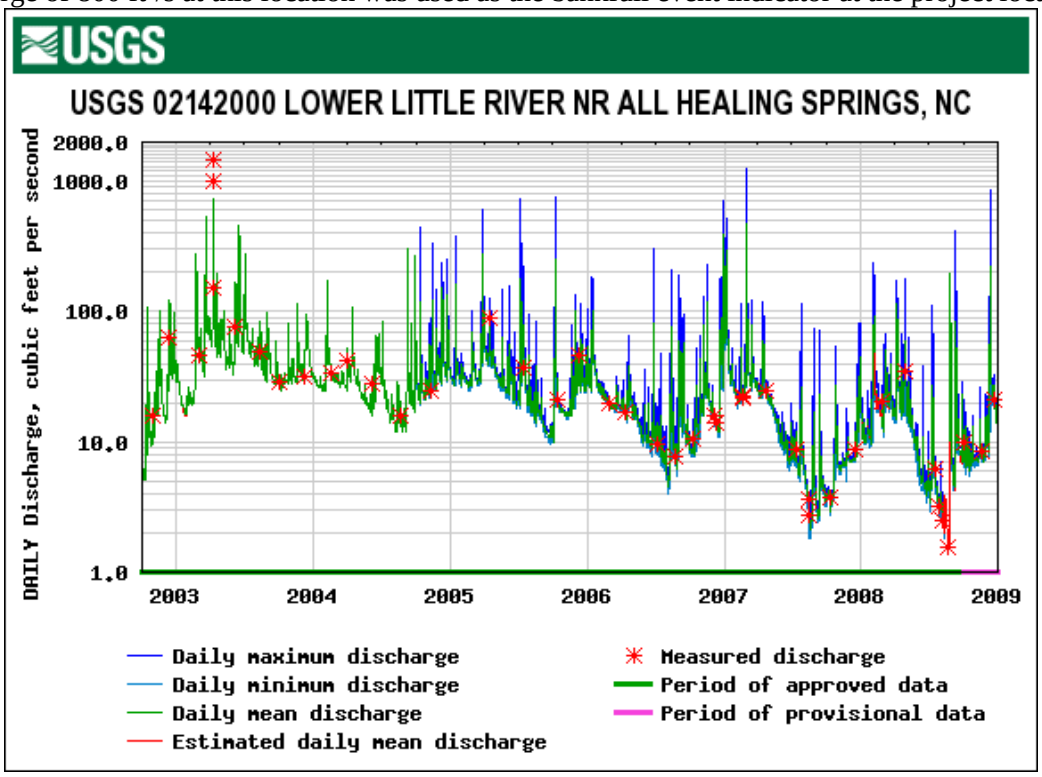
Appendix B.2.2. Continued.

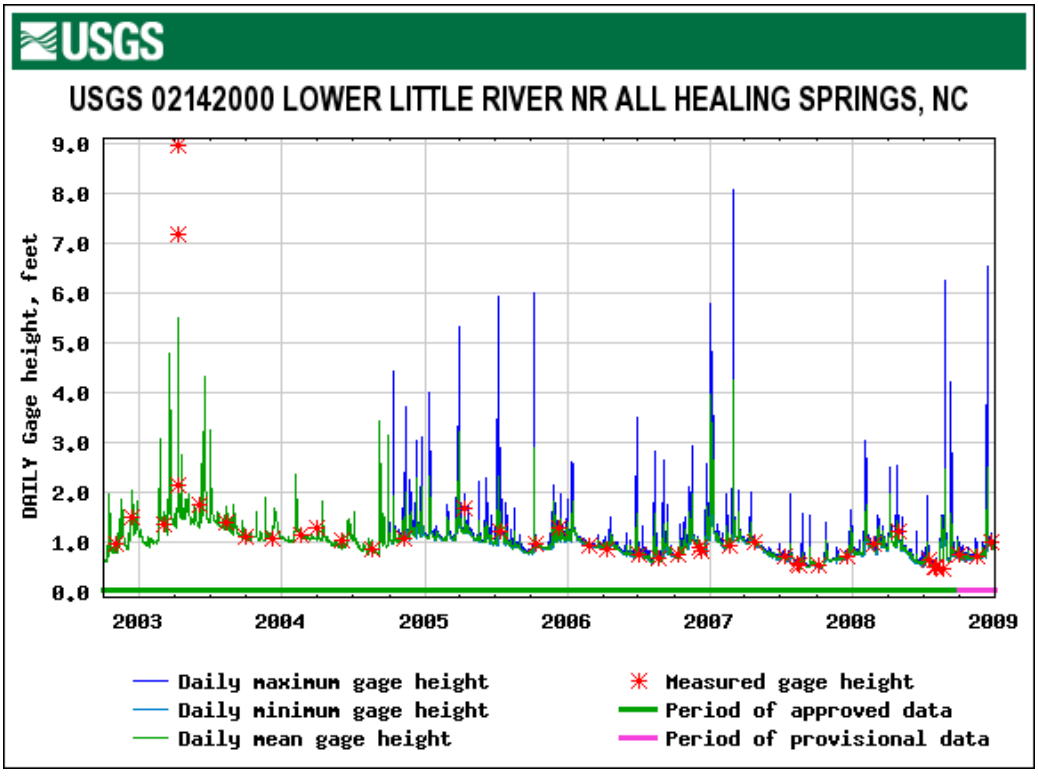


Size class index	Particle size (mm) in year sampled		
	MY1	MY2	MY3
D_{16}	<0.10	<0.10	<0.10
D_{35}	<0.10	<0.10	<0.10
D_{50}	<0.10	<0.10	<0.10
D_{84}	0.10	<0.10	<0.10
D_{95}	0.12	<0.10	<0.10

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Appendix B.3. Surrogate flow data used to determine bankfull flow events at the Big Warrior Creek and Little Warrior Creek stream mitigation sites, Yadkin River basin, Wilkes County North Carolina. Data is from USGS gage 02142000 located on the Little River near All Healing Springs, North Carolina. A discharge of 800 ft^3/s at this location was used as the bankfull event indicator at the project location.



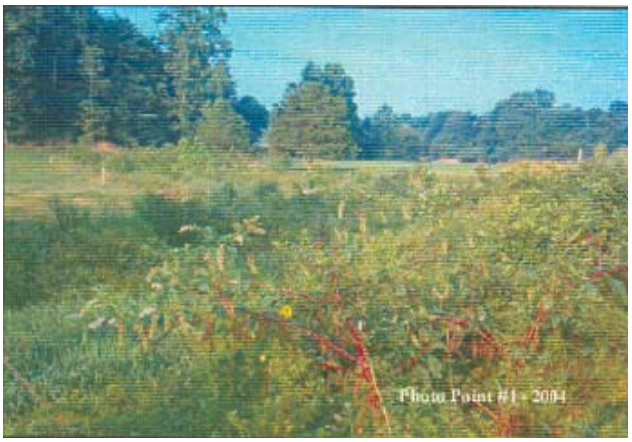


11 Appendix C.– Photograph Reference Points, Vegetation Plot Photographs, and Stream Problem Area Photographs

Appendix C.1.1. Big Warrior Creek photograph reference points. Note: photographs are taken looking upstream (LUS) or looking downstream (LDS).

Photograph station 1, LUS, December 1998.

Photograph station 1, LUS, March 2003.



Photograph station 1, LUS, August 2004.

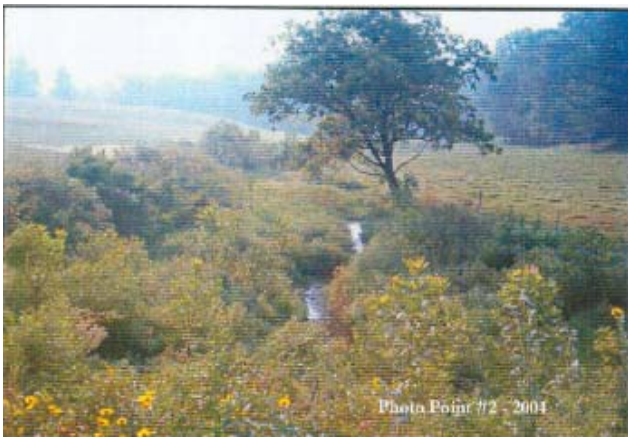
Photograph station 1, LUS, September 2007.

Photograph station 1, LUS, November 2008.

Appendix C.1.1. Continued.

Photograph station 2, LDS, December 1998.

Photograph station 2, LDS, March 2003.



Photograph station 2, LDS, August 2004.

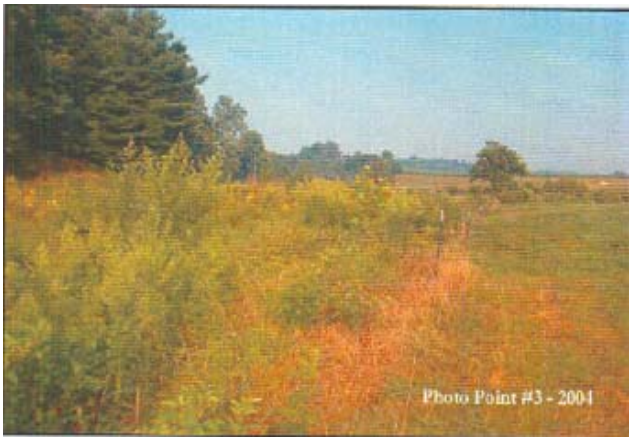
Photograph station 2, LDS, September 2007.

Photograph station 2, LDS, November 2008.

Appendix C.1.1. Continued.

Photograph station 3, LUS, December 1998.

Photograph station 3, LUS, March 2003.



Photograph station 3, LUS, August 2004.

Photograph station 3, LUS, September 2007.

Photograph station 3, LUS, November 2008.

Appendix C.1.1. Continued.

Photograph station 4, LDS, December 1998.

Photograph station 4, LDS, March 2003.

Photograph station 4, LDS, August 2004.

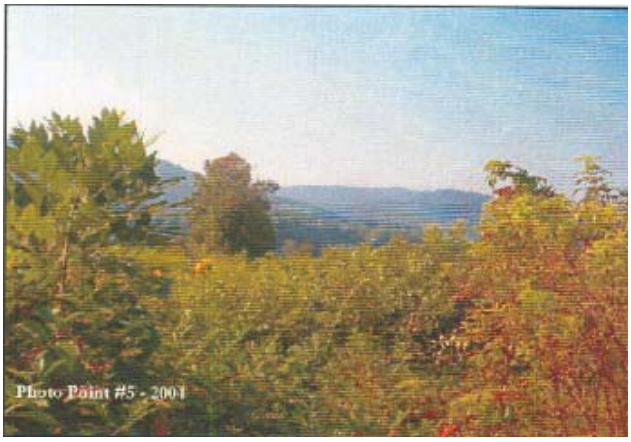
Photograph station 4, LDS, September 2007.

Photograph station 4, LDS, November 2008.

Appendix C.1.1. Continued.

Photograph station 5, LUS, December 1998.

Photograph station 5, LUS, March 2003.



Photograph station 5, LUS, August 2004.

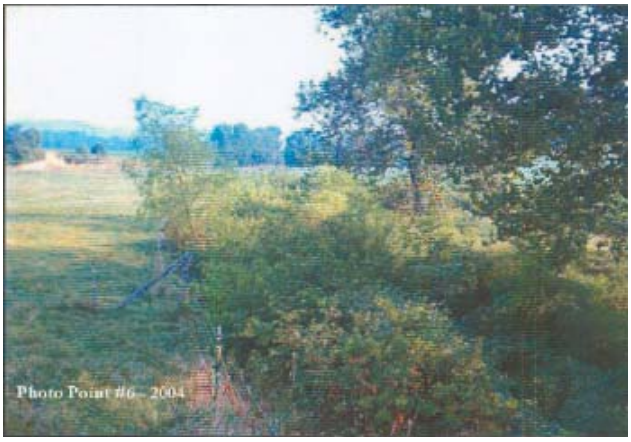
Photograph station 5, LUS, September 2007

Photograph station 5, LUS, November 2008.

Appendix C.1.1. Continued.

Photograph station 6, LDS, December 1998.

Photograph station 6, LDS, March 2003.



Photograph station 6, LDS, August 2004.

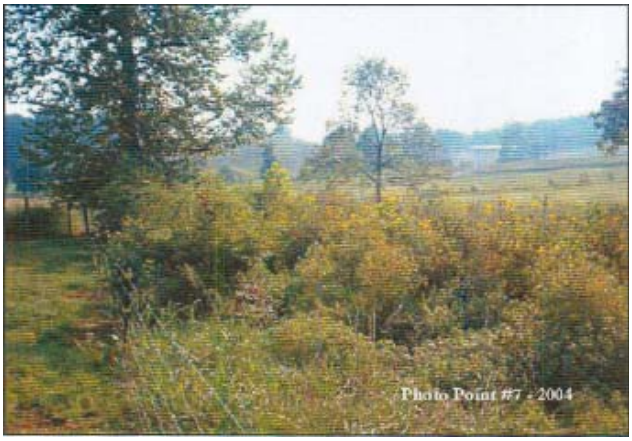
Photograph station 6, LDS, September 2007.

Photograph station 6, LDS, November 2008.

Appendix C.1.1. Continued.

Photograph station 7, LDS, August 2001.

Photograph station 7, LDS, March 2003.



Photograph station 7, LDS, August 2004.

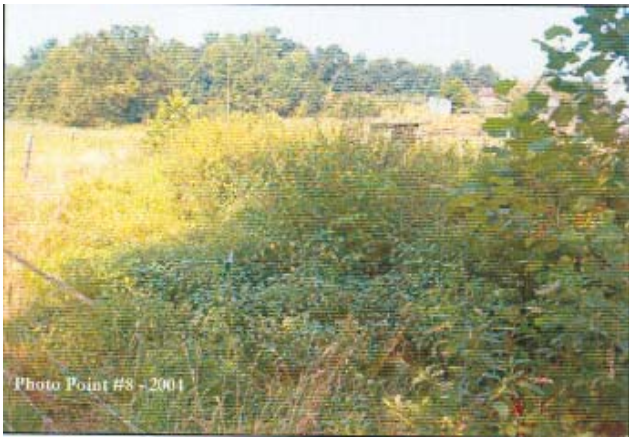
Photograph station 7, LDS, September 2007

Photograph station 7, LDS, November 2008.

Appendix C.1.1. Continued.

Photograph station 8, LUS, August 2001.

Photograph station 8, LUS, March 2003.



Photograph station 8, LUS, August 2004.

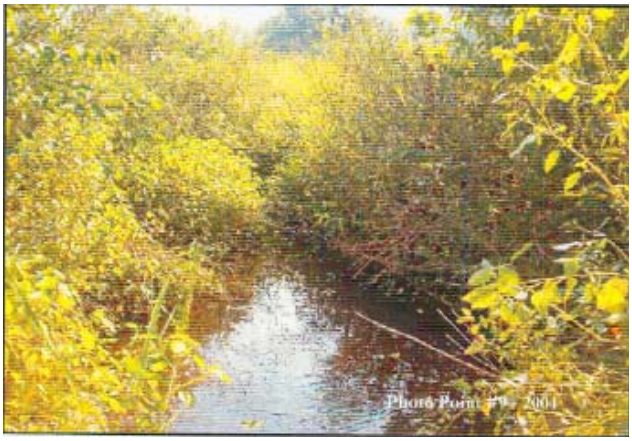
Photograph station 8, LUS, September 2007

Photograph station 8, LUS, November 2008.

Appendix C.1.1. Continued.

Photograph station 9, LDS, August 2001.

Photograph station 9, LDS, March 2003.



Photograph station 9, LDS, August 2004.

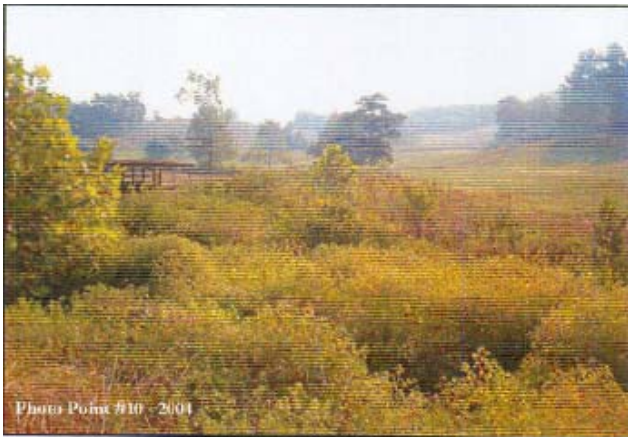
Photograph station 9, LDS, September 2007.

Photograph station 9, LDS, November 2008.

Appendix C.1.1. Continued.

Photograph station 10, LDS, December.1998.

Photograph station 10, LDS, March 2003.



Photograph station 10, LDS, August 2004.

Photograph station 10, LDS, September 2007.

Photograph station 10, LDS, November 2008.

Appendix C.1.1. Continued.

Photograph station 11, LDS, December, 1998.

Photograph station 11, LDS, March 2003.

Photograph station 11, LDS, August 2004.

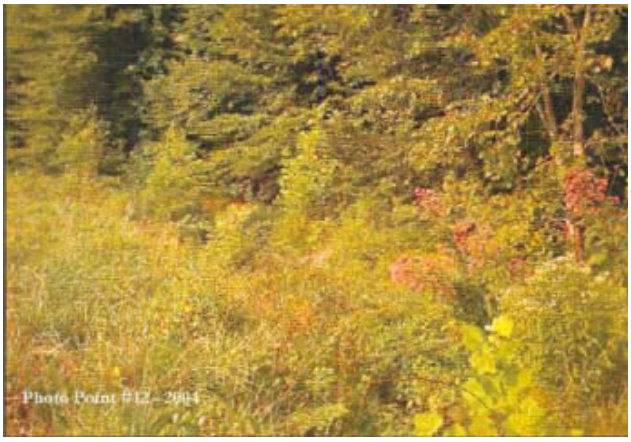
Photograph station 11, LDS, September 2007.

Photograph station 11, LDS, November 2008.

Appendix C.1.1. Continued.

Photograph station 12, LUS, December 1998.

Photograph station 12, LUS, March 2003.



Photograph station 12, LUS, August 2004.

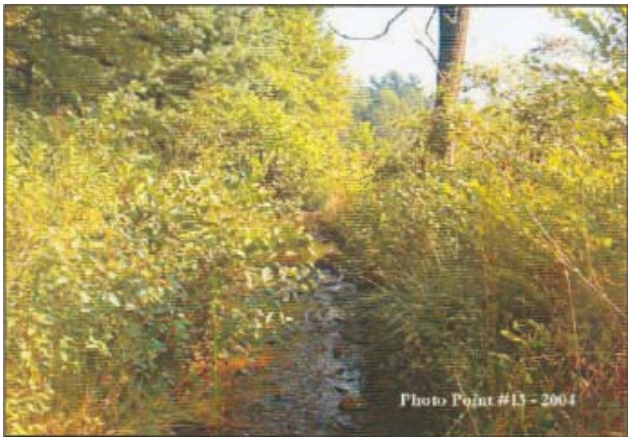
Photograph station 12, LUS, September 2007.

Photograph station 12, LUS, November 2008.

Appendix C.1.1. Continued.

Photograph station 13, LDS, December 1998.

Photograph station 13, LDS, March 2003



Photograph station 13, LDS, August 2004.

Photograph station 13, LDS, September 2007.

Photograph station 13, LDS, November 2008.

Appendix C.1.2. Big Warrior Creek vegetation plot photographs

Vegetation plot 1, September 2004.


Vegetation plot 1, August 2007.


Vegetation plot 1, August 2008.

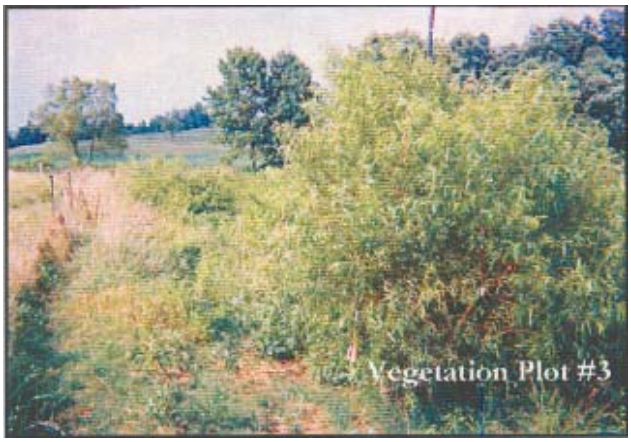
Appendix C.1.2. Continued.

Vegetation plot 2, September 2004.


Vegetation plot 2, August 2007.


Vegetation plot 2, August 2008.

Appendix C.1.2. Continued.



Vegetation plot 3, September 2004.


Vegetation plot 3, August 2007.


Vegetation plot 3, August 2008.

Appendix C.1.2. Continued.

Vegetation plot 4, September 2004.


Vegetation plot 4, August 2007.


Vegetation plot 4, August 2008.

Appendix C.1.2. Continued.

Vegetation plot 5, September 2004.


Vegetation plot 5, August 2007.


Vegetation plot 5, August 2008.

Appendix C.1.2. Continued.

Vegetation plot 6, September 2004.


Vegetation plot 6, August 2007.


Vegetation plot 6, August 2008.

Appendix C.1.3. Big Warrior Creek stream problem area photographs.

Area below cross-section 4, December 2007. Note: large walnut tree leaning.

Area below cross-section 4, November 2008.

Area below cross-section 2, December 2007. Photo taken looking right to left bank.

Area below cross-section 2, November 2008. Photo taken looking downstream.

Area between cross-sections 3 and 4, November 2008. Photo taken at the top of the left bank.

Appendix C.2.1. Little Warrior Creek photograph reference points. Note: photographs are taken looking upstream (LUS) or looking downstream (LDS).

Photograph station 1, LUS, December 1998.

Photograph station 1, LUS, March 2003.

Photograph station 1, LUS, August 2004.

Photograph station 1, LUS, September 2007.

Photograph station, LUS, November 2008.

Appendix C.2.1. Continued.

Photograph station 2, LUS, July 1998.

Photograph station 2, LUS, March 2003.

Photograph station 2, LUS, August 2004.

Photograph station 2, LUS, September 2007.

Photograph station 2, LUS, November 2008.

Appendix C.2.1. Continued.

Photograph station 3, LUS, July 2001.

Photograph station 3, LUS, March 2003.

Photograph station 3, LUS, August 2004.

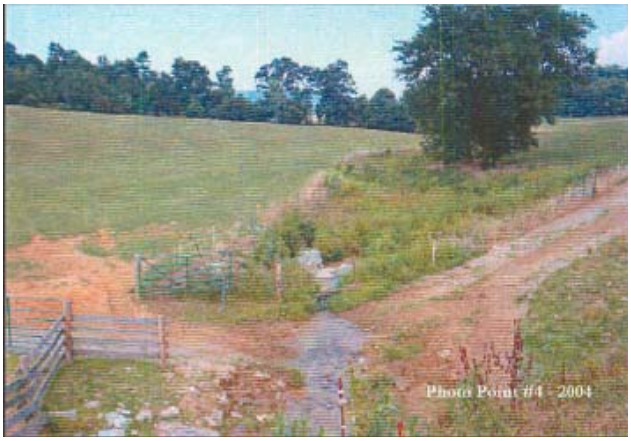
Photograph station 3, LUS, September 2007.

Photograph station 3, LUS, November 2008.

Appendix C.2.1. Continued.

Photograph station 4, LDS, December 1998.

Photograph station 4, LDS, March 2003.



Photograph station 4, LDS, August 2004.

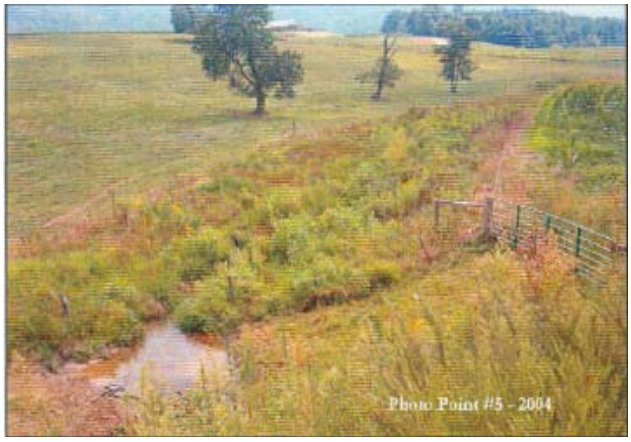
Photograph station 4, LDS, September 2007.

Photograph station 4, LDS, November, 2008.

Appendix C.2.1. Continued.

Photograph station 5, LUS, December 1998.

Photograph station 5, LUS, March 2003.



Photograph station 5, LUS, August 2004.

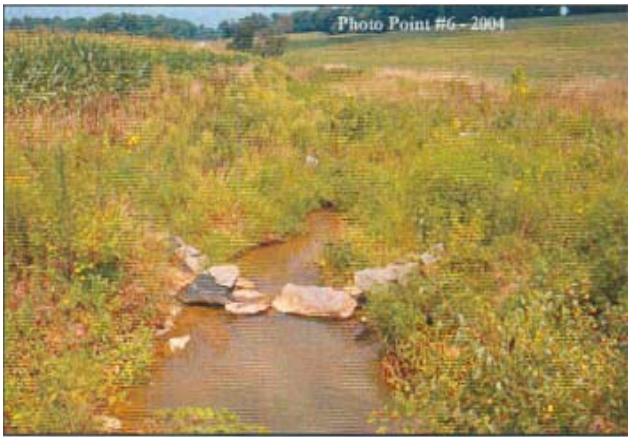
Photograph station 5, LUS, September 2007.

Photograph station 5, LUS, November 2008.

Appendix C.2.1. Continued.

Photograph station 6, LDS, December 1998.

Photograph station 6, LDS, March 2003.



Photograph station 6, LDS, August 2004.

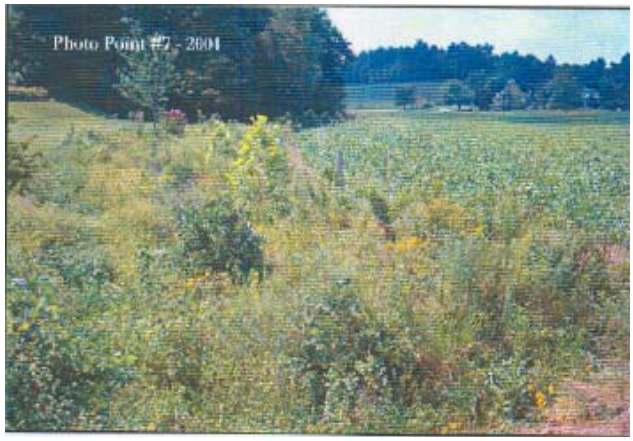
Photograph station 6, LDS, September 2007.

Photograph station 6, LDS, November 2008.

Appendix C.2.1. Continued.

Photograph station 7, LUS, December 1998.

Photograph station 7, LUS, March 2003.



Photograph station 7, LUS, August 2004.

Photograph station 7, LUS, September 2007.

Photograph station 7, LUS, November 2008.

Appendix C.2.1. Continued.

Photograph station 8, LUS, December 1998.

Photograph station 8, LUS, March 2003.

Photograph station 8, LUS, August 2004.

Photograph station 8, LUS, September 2007.

Photograph station 8, LUS, November 2008.

Appendix C.2.1. Continued.

Photograph station 9, LUS, December 1998.

Photograph station 9, LUS, March 2003.

Photograph station 9, LUS, August 2004.

Photograph station 9, LUS, September 2007.

Photograph station 9, LUS, November 2008.

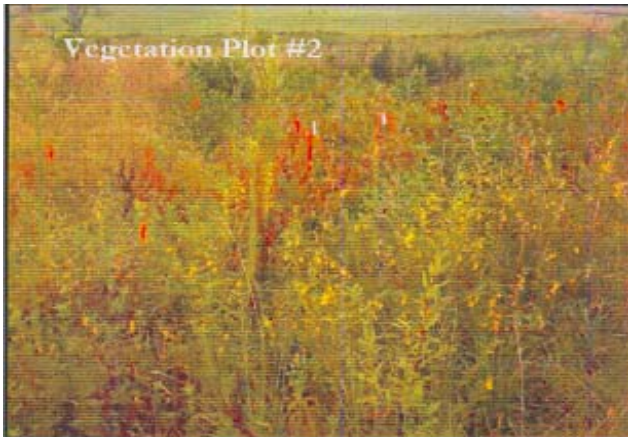
Appendix C.2.2. Little Warrior Creek vegetation plot photographs.

Vegetation Plot 1, September 2004.


Vegetation Plot 1, August 2007.


Vegetation Plot 1, August 2008.

Appendix C.2.2. Continued.

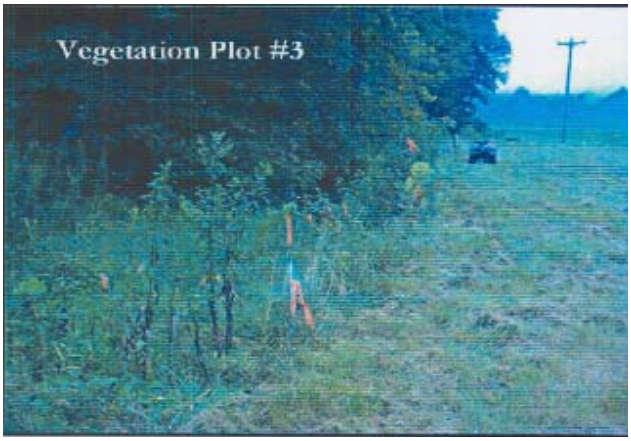


Vegetation Plot 2, September 2004.


Vegetation Plot 2, August 2007.


Vegetation Plot 2, August 2008.

Appendix C.2.2. Continued.

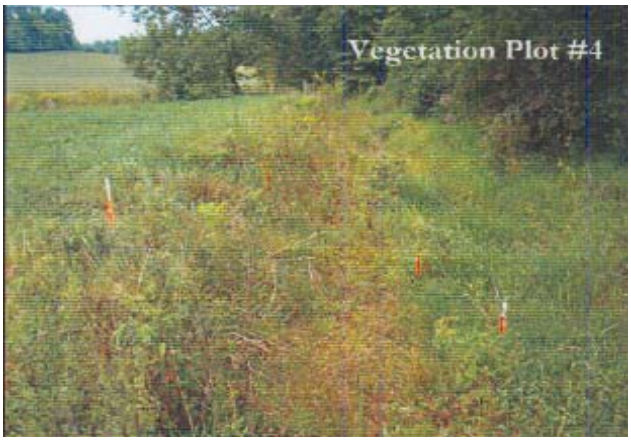


Vegetation Plot 3, September 2004.


Vegetation Plot 3, August 2007.


Vegetation Plot 3, August 2008.

Appendix C.2.2. Continued.



Vegetation Plot 4, September 2004.


Vegetation Plot 4, August 2007.


Vegetation Plot 4, August 2008.

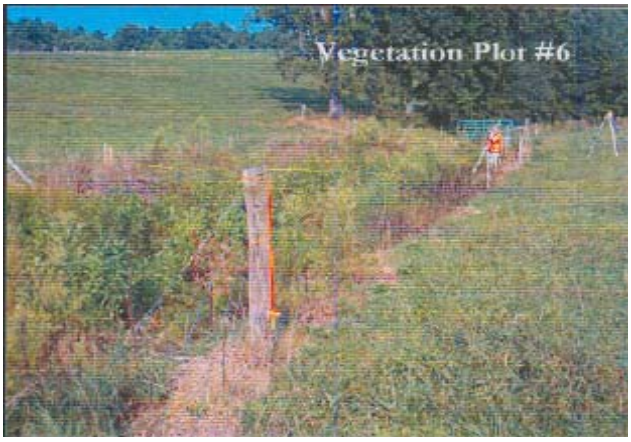
Appendix C.2.2. Continued.

Vegetation Plot 5, September 2004.


Vegetation Plot 5, August 2007.


Vegetation Plot 5, August 2008.

Appendix C.2.2. Continued.



Vegetation Plot 6, September 2004.


Vegetation Plot 6, August 2007.


Vegetation Plot 6, August 2008.

Appendix C.2.3. Little Warrior Creek stream problem area photographs.

Area in the vicinity of cross-section 2. Water is piping through the boulders October 2007.

Area in the vicinity of cross-section 2. Water is piping through the boulders November 2008.

Area between cross-sections 1 and 2, LDS, October 2007.

Area between cross-sections 1 and 2, LDS, November 2008.

Area between cross-sections 1 and 2, LUS. Banks are sloughing due to overland flow, October 2007.

Area between cross-sections 1 and 2, LUS. Banks are sloughing due to overland flow, November 2008.

Appendix C.2.3. Continued.

The four photographs below are in the vicinity of the confluence of an unnamed tributary to LWC and LWC below Andrews road (SR 1256). The stream problem as evidenced in these photographs is piping through the rock structures.

Eroding right bank below cross-section 6, LDS, November 2008.

Appendix C.2.3. Continued.

Area located on an unnamed tributary to LWC below cross-section 11, October 2007.

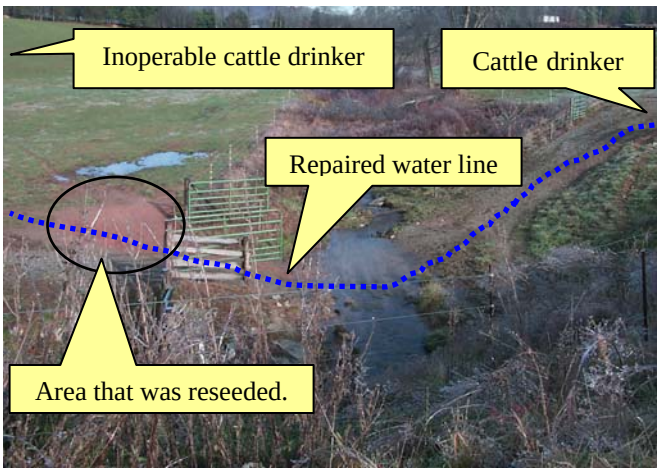
Area located on an unnamed tributary to LWC below cross-section 11, November 2008.

Appendix C.3. 2005 Little Warrior Creek stream repair photographs.

Repositioned boulders and added geotextile fabric to the rock sill in front of the culvert, September 2005.

Photograph looking upstream at the culvert, December 2007.

Photograph looking upstream at the culvert, November 2008.



Repairs to the cattle drinker and reseeding, September 2005.

September 2007.

November 2008

Appendix C.3. Continued.

Before stream bank repairs to the left bank above cross-section 3, LUS, September 2005.

After stream bank repairs to the left bank above cross-section 3, LUS, September 2005.

LDS, November 2008.

Appendix C.3. Continued.

Before stream bank repairs to the left bank around cross-section 3, September 2005.

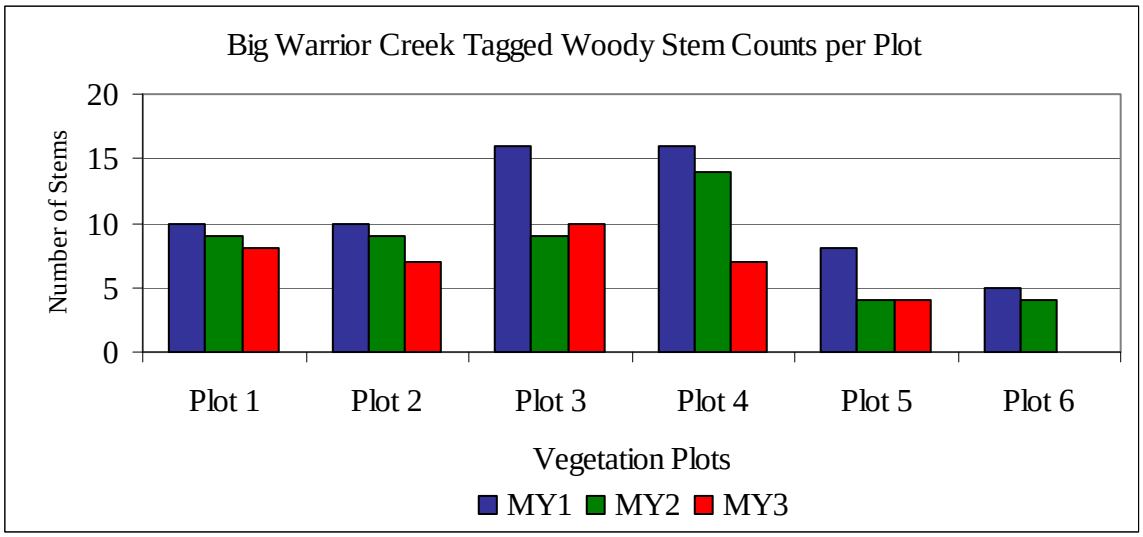
After stream bank repairs to the left bank around cross-section 3, September 2005.

January 2008.

November 2008.

12 Appendix D.—Vegetation Monitoring Comparisons

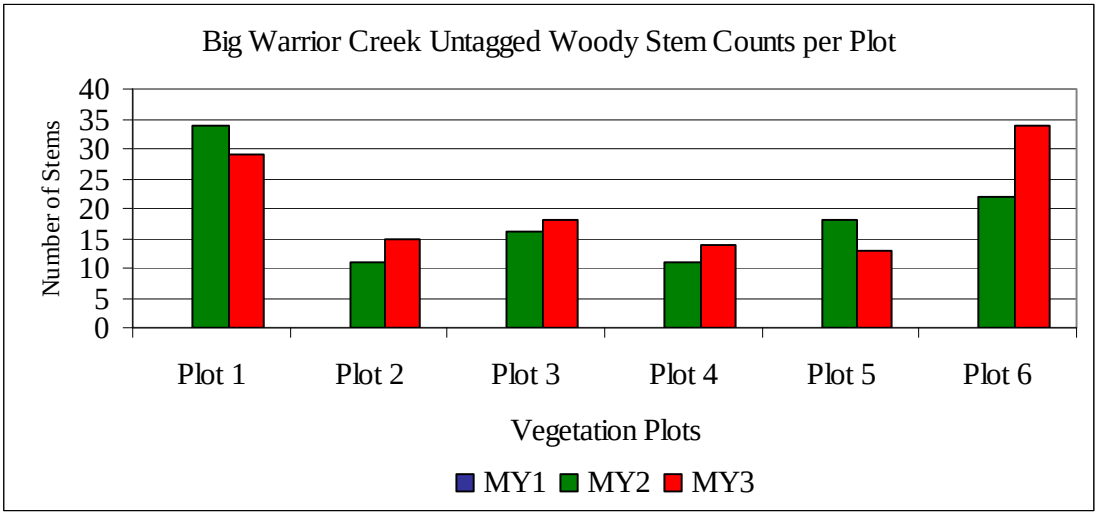
Appendix D.1. Vegetation monitoring data comparisons Big Warrior Creek, MY1-MY3.



Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1	10	10	16	16	8	5
MY2	9	9	9	14	4	4
MY3	8	7	10	7	4	0

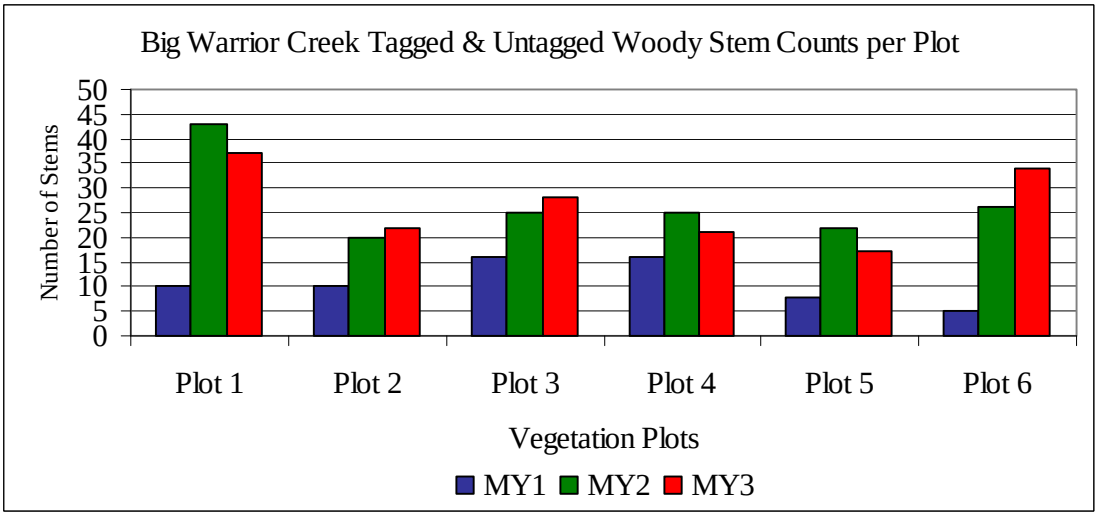
Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Appendix D.1. Continued.



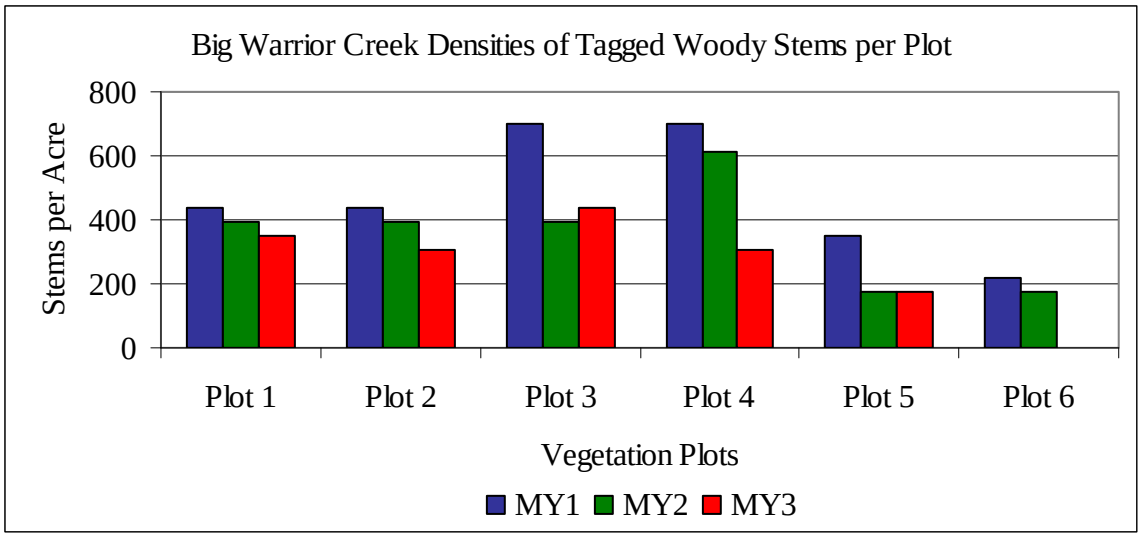
Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1[a]	0	0	0	0	0	0
MY2	34	11	16	11	18	22
MY3	29	15	18	14	13	34

[a]There were no untagged trees in MY1 as that was the year the vegetation plots were established.
Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.



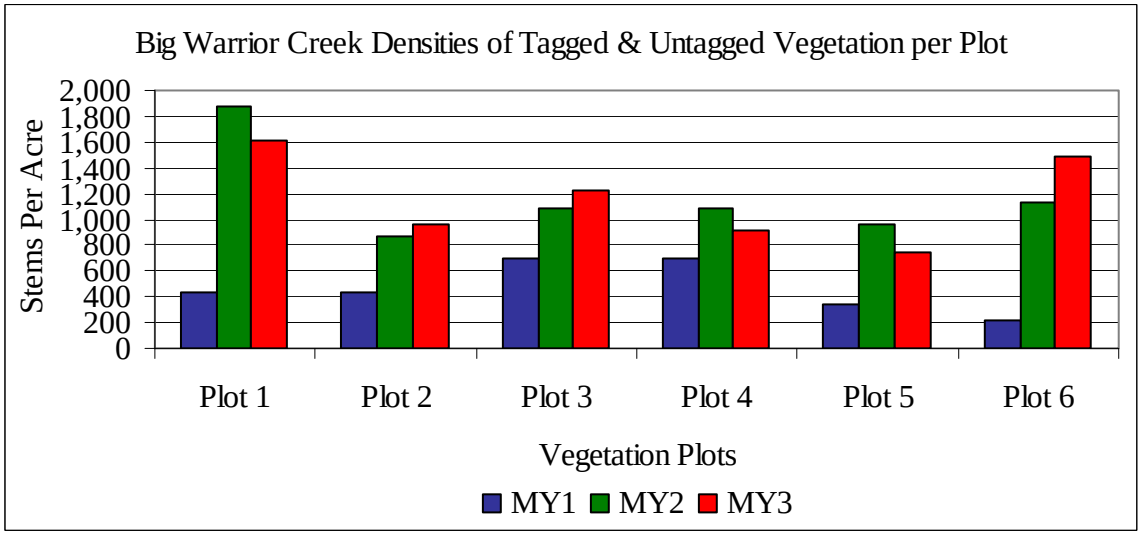
Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1	10	10	16	16	8	5
MY2	43	20	25	25	22	26
MY3	37	22	28	21	17	34

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.
Appendix D.1. Continued.



Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1	436	436	697	697	348	218
MY2	392	392	392	610	174	174
MY3	348	305	436	305	174	0

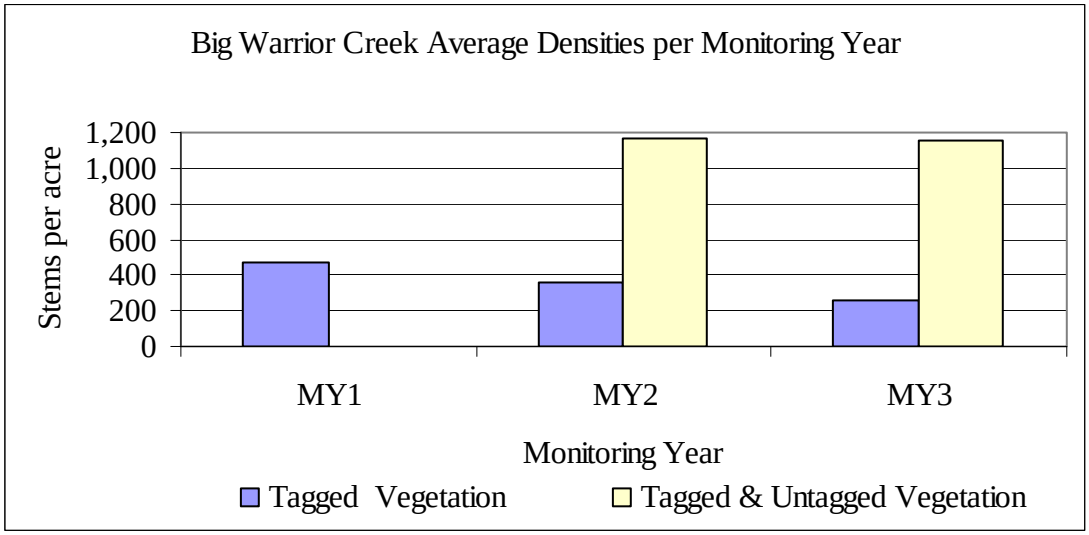
Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.



Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1	436	436	697	697	348	218
MY2	1,873	871	1,089	1,089	958	1,133
MY3	1,612	958	1,220	915	741	1,481

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

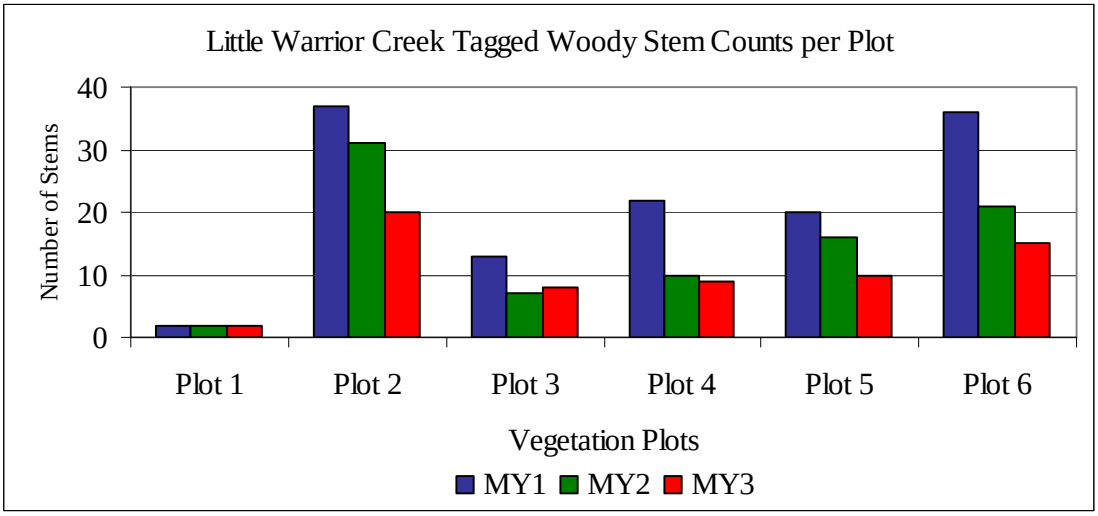
Appendix D.1. Continued.



Monitoring Year	Tagged Vegetation	Tagged & Untagged Vegetation
MY1[a]	472	0
MY2	356	1,169
MY3	261	1,154

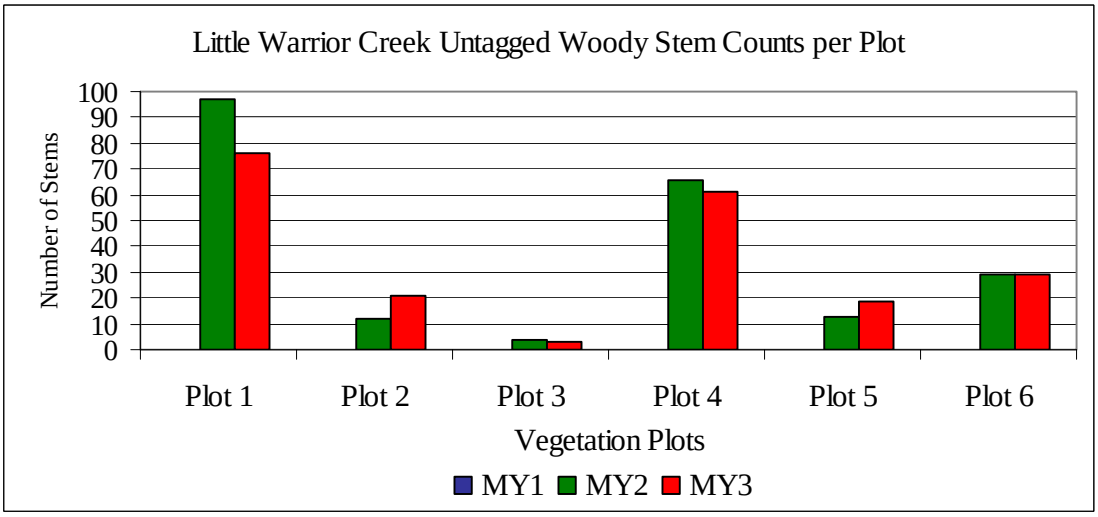
[a]There were no untagged trees in MY1 as that was the year the vegetation plots were established.
Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Appendix D.2. Vegetation monitoring comparisons Little Warrior Creek, MY0-MY3.



Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1	2	37	13	22	20	36
MY2	2	31	7	10	16	21
MY3	2	20	8	9	10	15

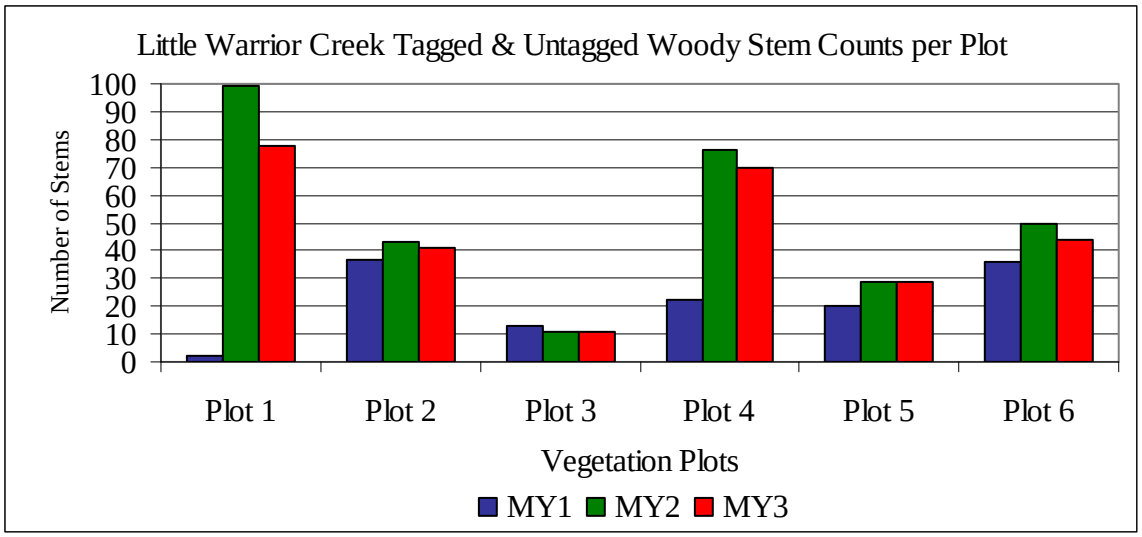
Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.



Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1[a]	0	0	0	0	0	0
MY2	97	12	4	66	13	29
MY3	76	21	3	61	19	29

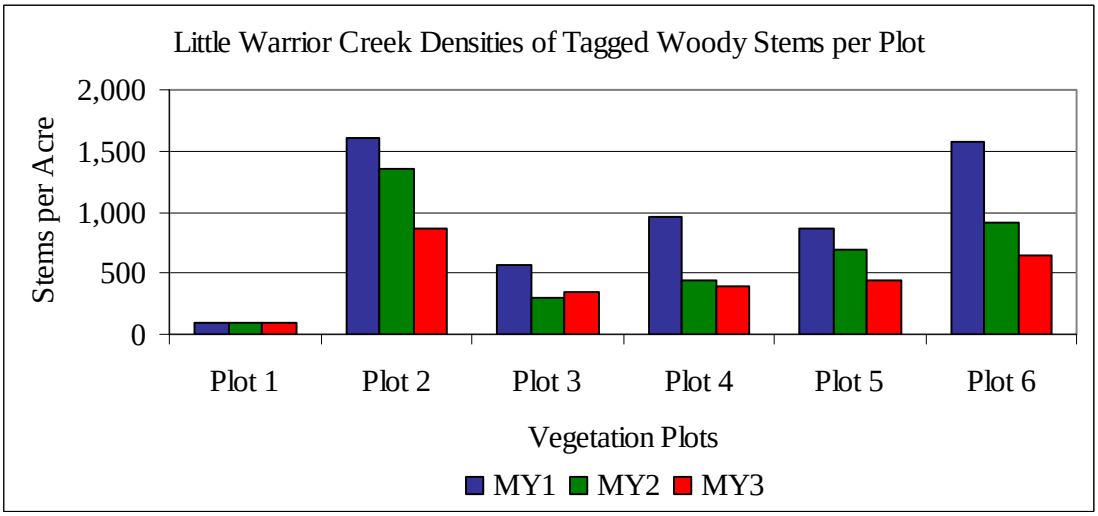
[a]There were no untagged trees in MY1 as that was the year the vegetation plots were established.
Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Appendix D.2. Continued.



Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1	2	37	13	22	20	36
MY2	99	43	11	76	29	50
MY3	78	41	11	70	29	44

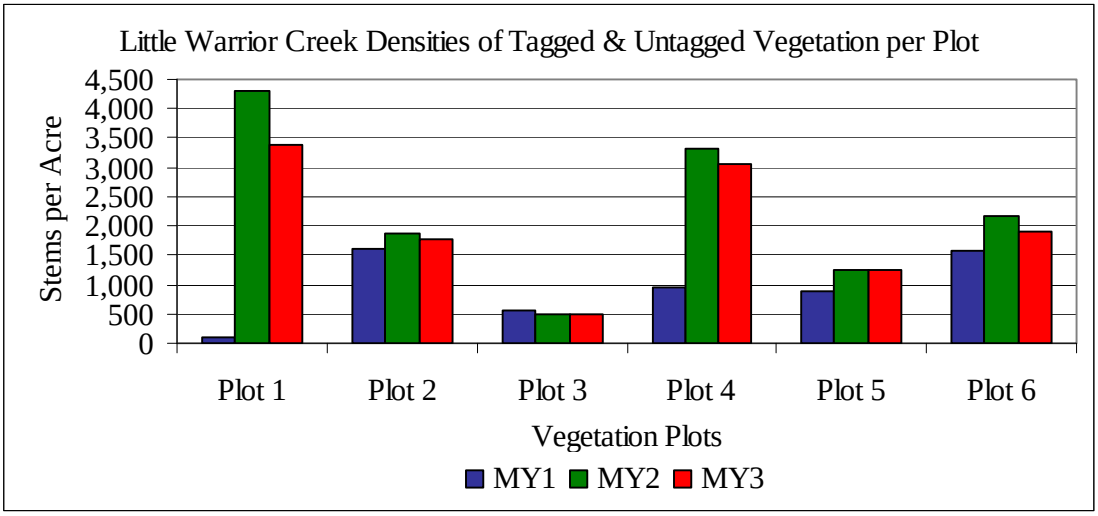
Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.



Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1	87	1,612	566	958	871	1,568
MY2	87	1,350	305	436	697	915
MY3	87	871	348	392	436	653

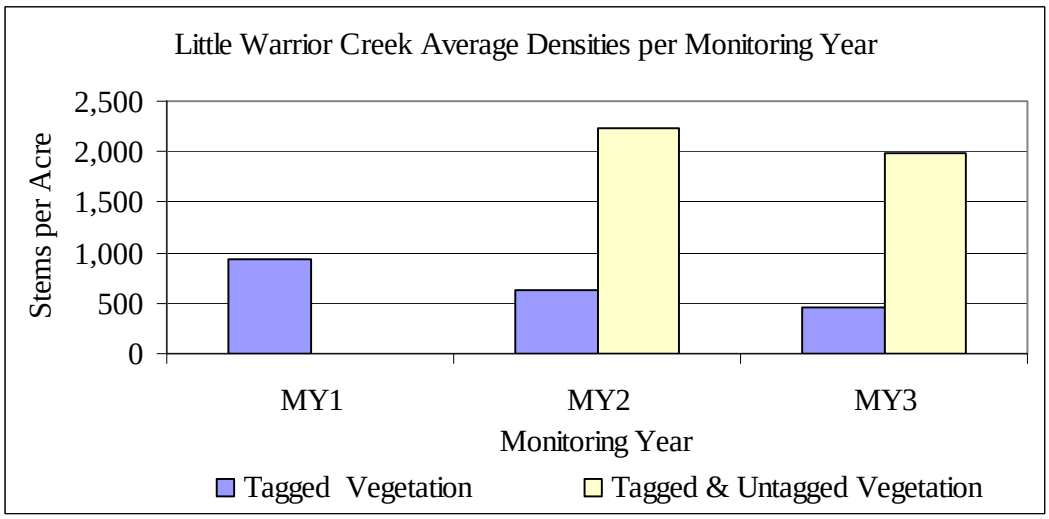
Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.

Appendix D.2. Continued.



Monitoring Year	Vegetation Plots					
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6
MY1	87	1,612	566	958	871	1,568
MY2	4,312	1,873	479	3,311	1,263	2,178
MY3	3,398	1,786	479	3,049	1,263	1,917

Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.



Monitoring Year	Tagged Vegetation	Tagged & Untagged Vegetation
MY1[a]	944	0
MY2	632	2,236
MY3	465	1,982

[a]There were no untagged trees in MY1 as that was the year the vegetation plots were established.
Survey Dates: MY1 Aug-04, MY2 20-Dec-07, MY3 29-Oct-08.