YEAR 2 MONITORING REPORT
for the
BIG WARRIOR AND LITTLE WARRIOR CREEKS MITIGATION SITE

Wilkes County, North Carolina
EEP Project Number: 92715

Final

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

North Carolina Wildlife Resources Commission
Watershed Enhancement Group

November 2008

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 Project Number 92715, Wilkes County was constructed during a 12-month period beginning in August 2001 on the property of AH&W Farm. As-built (monitoring year 0, MY0) and monitoring year 1 (MY1) data were collected in 2002 and 2004. The following report summarizes the year 2 (MY2) stream monitoring data collected during 2007 from Big Warrior and Little Warrior creeks, and compares it with the MY0 and MY1 data. The MY2 monitoring occurred six years after construction was completed on Big Warrior Creek and five years after construction was completed on Little Warrior Creek.

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 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.

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.

The D_{16}, $D_{35,}$ and D_{50} particle sizes for both streams are decreasing; the D_{50} is 12.00 mm for Big Warrior Creek and 0.74 mm for Little Warrior Creek. All of the particle size categories for Little Warrior Creek are at sizes found during pre-construction surveys. The sediment source on Big Warrior Creek appears to be coming from the established stream crossings and the unprotected tributaries entering the stream. The source of 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. The D_{84} and D_{95} particle sizes have increased.

Six vegetation plots were established on both streams during MY1 and resurveyed in MY2. The average density of tagged trees on Big Warrior Creek is 356 per acre, whereas on Little Warrior it is 632 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 is 1,169 per acre for Big Warrior and 2,236 per acre for Little Warrior Creek.

All of the agricultural Best Management Practices (BMPs) proposed in the farm management plan and incorporated in the construction plans for both streams are functioning properly. The only issue related to the farm management plan is that gates installed at stream crossing 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) bringing the site into compliance. Subsequently, the site was released from compliance monitoring as vegetative ground cover has become established.

2 Introduction

2.1 Project Description

The following report summarizes the stream monitoring activities that occurred during 2007 (monitoring year 2; MY2) at the Big Warrior Creek and Little Warrior Creek sites (Figure 1). These data are compared with as-built data collected in 2002 (MY0) and monitoring data collected in 2004 (MY1; NCWRC 2003; Mulkey 2005). 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 constructed to provide mitigation for stream impacts associated with the construction of U.S. Highway 421 in Wilkes County (Transportation Improvement Program number R-2239 B). From 2001 to 2005, all reports associated with this mitigation site were prepared for the NCDOT stream mitigation program. In 2005, responsibility for this site was transferred from NCDOT to the North Carolina Ecosystem Enhancement Program (EEP). This document was 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 2007 data with previous years' data without having to change report formats. Monitoring data was not collected during the transition of the project from NCDOT to EEP (2005 and 2006).

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 (NCSU 2003) were completed along both streams and their tributaries. Stream restoration involved the installation of root wads and rock vanes, and sloping 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 off a 40 to 60 foot 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 quality and stability, and fisheries habitat associated

with Big Warrior and Little Warrior creeks and their tributaries. The following objectives were proposed:

- Establish a 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 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 action identification number 199820228
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 (MY 0).
Winter 2003	NCWRC planted live stakes and bare rooted trees along Little Warrior Creek.
July-August 2004	Mulkey completed stream channel monitoring (MY 1).
July-August 2004	Mulkey completed vegetation monitoring (MY 1).
January 2005	Mulkey completed 2004 monitoring report (MY 1).
August-September 2005	NCWRC initiated and completed stream and easement zone repairs, to comply with NCDENR Notice of Violation.
September-October 2007	NCWRC completed stream channel monitoring (MY 2).
September-October 2007	NCWRC completed vegetation monitoring (MY 2).

2.4 Success Criteria

Mulkey (2005) describes the project success criteria in detail. Essentially, the success criteria address channel stability and improvements to fish habitat. Specifically, this evaluation includes all or a combination of the following parameters: channel stability, erosion control, seeding, woody vegetation, and overall response of fish and invertebrate populations to stream restoration. No biological monitoring was ever conducted at this site, to the best of our knowledge. Table 2 provides further details of the criteria used to evaluate the success or failure at these mitigation sites.

TABLE 2.—NCWRC/NCDOT Mitigation Monitoring Criteria.

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, as-built report, and MY1 report (NCWRC 2001, 2002, 2003; Mulkey 2005).

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 and MY1 reports (NCWRC 2003; Mulkey 2005). The 2005 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.

The 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 that monitoring report did not occur. In 2005, 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 a rock structure, the approach to a stable stream crossing, and the left bank in the vicinity of cross-section 3 (Figure 3).

3.2 Stream Assessment Results

The cross-section and longitudinal comparisons between the three monitoring surveys is complicated due to the length of time between the surveys. Some of the benchmarks, cross-section pins, and planted trees and shrubs were difficult to locate or identify. The as-built data collection (MY0) was completed in 2002. Year 1 monitoring surveys were completed in 2004 (MY1), whereas Year 2 monitoring data were collected in 2007 (MY2). 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 and 2007. One final reason making the data comparisons difficult is that not all benchmarks set in MY0 for use in calculating elevations could be located in 2004. In 2007, the NCWRC could not locate any of the benchmarks; the benchmarks for use in determining elevations by the NCWRC were arbitrarily chosen.

3.2.1 Cross-sections

Thirty-four cross-sections were resurveyed in MY2, 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 and MY1. In general, all cross-sections appeared to be stable. At some cross-sections the data comparisons between MY1 and MY2 compare favorably, whereas the comparisons among all three monitoring events at other cross-sections vary greatly. Plots of the monitoring data at cross-sections 4, 5, 6, 7, 9, 10, 12, 15, 17, 18, and 19 on Big Warrior Creek and cross-sections 1, 2, 5, 8, 9, and 10 on Little Warrior Creek show that these cross-sections are relatively stable through the two years of monitoring, six and five 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, 20, and 21 on Big Warrior Creek exhibit variations among monitoring events, while measurements at cross-sections 3, 4, 6, 7, 11, 12, and 13 differ on Little Warrior Creek. Mulkey (2005) states that they had problems locating the benchmarks or they deemed them to be inconsistent of the overall surveys. They do not explicitly state that they set new pins, but the data does suggest that the pins were replaced either upstream, downstream, further away from the channel, or closer to the channel than the original locations. 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.) are missing MY1 data because Mulkey (2005) states that "According to the Rosgen Classification of Natural Rivers floodprone width, entrenchment ratio, and width/depth ratio are not measured in pool, glide, or run features."

Big Warrior Creek

Cross-section 1 (Appendix A.1.): This cross-section transects a pool. The thalweg has degraded by 0.5 ft since the MY0. However both banks are 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 3.7 ft. This is due to higher flows of water being directed into the bank upstream of the root wad and scouring material from behind the root wad and creating an overflow channel downstream of this transect.

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 MY1 and MY2 data shows only minor migration of the left bank occurred. There is a bench forming at a lower level on the right bank. 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 pin was set in a different location than the original pin. No comparison can be made at this location among any of the monitoring years' data.

Cross-section 11 (Appendix A.1.): This cross-section transects a riffle. This cross-section appears stable through the three years of monitoring, but the MY1 and MY2 data plots do not align with the MY0 data. The data from MY1 and MY2 display similar channel dimensions of the MY0 data. The difference could be attributed to fact that Mulkey had difficulties locating the benchmarks or deemed them to be inconsistent with overall surveys (Mulkey 2005).

Cross-sections 13, 14, 16, 20, and 21 (Appendix A.1.): A comparison can not be made between the as-built data and the monitoring data at these locations. It appears that the data for these cross-sections were taken at different stations than the as-built data. However, a comparison can be made between MY1 and MY2. These five cross-sections demonstrated minor adjustments to the thalweg or stream banks. The banks are stable and well vegetated.

Little Warrior Creek

Cross-sections 3 and 4 (Appendix A.2.): These cross-sections transect pools and appear stable. The MY2 data does not align with the MY0 and MY1 data, but data from all three years show the same characteristics. These differences could be attributed to the fact that three different teams were involved in data collection at this site.

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 data collected to date. The banks are stable and well vegetated.

Cross-section 7 (Appendix A.2.): This cross-section transects a riffle. During post-processing the MY2 data was adjusted 3.5 ft to the left to align the cross-section points with the previous years' data. This adjustment was necessary because the left end pin had been disturbed. This cross-section did not exhibit any signs of instability. The right bank does appear to have degraded somewhat between MY1 and MY2. The channel thalweg and both banks are stable and the banks are well vegetated.

Cross-section 11 (Appendix A.2.): This cross-section transects a riffle and is on an unnamed tributary to Little Warrior Creek. The data of MY0 and MY1 could not be compared because it appears the cross-section location was moved in MY1. A comparison of the MY1 and MY2 data revealed the left bank has migrated 0.7 ft; however 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 three 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 1.5 ft. The cross-section now exhibits characteristics of a wetland, more so than that of a stream channel. Wetland grasses are beginning to grow in the middle of the stream channel. The stream channel's substrate is composed of silt/clay. The banks are stable and well vegetated.

3.2.2 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 (1,188 ft), feedlot (600 ft), middle pasture (612 ft), and lower pasture (783 ft) on Big Warrior Creek, and upper (874 ft), middle (1,017 ft), and lower pastures (860 ft) on Little Warrior Creek (Figures 2 and 3). Six of the seven longitudinal profiles appear relatively stable through the two years of monitoring (six and five years post-construction). In general, little aggradation or degradation of the channel has occurred. The one exception occurred in the middle pasture of Little Warrior Creek. The MY0 profile differs greatly from the two 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 MY1 or MY2 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.

Big Warrior Creek

Upper Pasture (Appendix B.1.1.): A pool at station 5+33 formed at this location between MY0 and MY1, and has maintained itself into MY2. Between MY1 and MY2, a second pool formed at station 6+55.

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

Middle Pasture (Appendix B.1.1.): There were pools at stations 1+41 and 3+18 in MY0; however, the pools at these locations were found to have evolved to riffles in MY1 and MY2.

Lower Pasture (Appendix B.1.1.): A small pool is forming at station 3+04. The pool created at station 4+18 was found to have filled in during the MY1 and MY2 surveys. At station 4+83 a measurement was recorded on top of a log vane in MY2.

Little Warrior Creek

Upper Pasture (Appendix B.2.1.): Monitoring in MY1 showed pools formed at stations 0+14, 1+29, 1+60, 3+50, and 6+31. The MY2 monitoring data shows that the pools at 0+14 and 6+31 have aggraded to shallow pools. The pools at stations 1+29, 1+60, and 3+50 have evolved into runs.

Middle Pasture (Appendix B.2.1.): The MY2 data suggests a pool is emerging at station 2+81 and two pools seem to have migrated downstream at stations 6+66 and 7+07 when compared to the MY1 data. In MY1, there was a pool located at station 9+55, however the MY2 survey revealed this pool has filled in and become a run.

Lower Pasture (Appendix B.2.1.): The MY2 survey revealed a submersed sandbar at station 0+74, the pool at station 2+33 has increased in length, and a small pool has formed at station 5+21 when compared with the MY0 and MY1 longitudinal profiles. This year's survey was extended to the downstream end of the project site. It exceeded the length of stream surveyed in MY0 and MY1.

Longitudinal profiled data were collected on seven sections of stream in MY2. 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.

3.2.3 Pebble Counts

Pebble counts were conducted at each of the 34 cross-sections on Big Warrior (21) and Little Warrior (13) creeks. 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. Because the pre-construction data were used for comparisons in the MY1 monitoring report (Mulkey 2005), it is used in this report as well. There are two combined graphs, one for each stream, which include the pebble count data from all cross-sections; thereby making the data more reflective of the entire reach of each stream (Appendices B.1.2. and B.2.2.). Reach pebble counts were not conducted along any of the seven reaches selected for longitudinal profile surveys on either stream during any monitoring year. Also included in the MY2 report is an analysis of the combined pebble count data collected from all riffles for each stream. These data were used for particle size classification purposes (Appendices B.1.2. and B.2.2.).

Drawing conclusions from the pebble count data is difficult due to the differences in sample sizes between MY1 and MY2. On average 34 and 44 pebbles were counted at each cross-section on Big Warrior Creek and Little Warrior Creek in MY1, whereas 102 pebbles were counted at each cross section on both streams in MY2.

Big Warrior Creek

The combined cross-section substrate analysis (Appendix B.1.2.) for Big Warrior Creek indicates the D_{16}, D_{35}, and D_{50} size class index particle sizes were smaller and the D_{84} and D_{95} particle sizes were larger in MY2 than in MY1. The D_{50} for the combined graphs is in the medium gravel range (8 to 16 mm). However, the combined riffle particle size data reveals that, except for the D_{50} particle size class, all size class categories increased (Appendix B.1.2.). The D_{50} particle size remained unchanged. The analyses of the combined cross-section comparison, riffle comparison, and each individual cross-section comparison (Appendix B.1.2.) suggest that 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 MY2 have dropped to the levels found in the pre-construction survey. The riffle comparisons (Appendix B.2.2.) and the individual cross-section pebble counts (Appendix B.2.2.) also indicate the same trend. The riffle comparisons did not include cross-section 11 because it is located on a tributary to Little Warrior Creek. The increase in sediment appears to be coming from upstream sources as the stream channel and banks in the project reach were, for the most part, stable.

3.2.4 Monitoring Condition

Table three provides summary of the morphological characteristics of Big and Little Warrior creeks. All of the cross-sectional and pebble count data from Big Warrior Creek were averaged to populate the table. 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. It appears that in both of the tables bankfull elevations are lower in MY1 than those of MY2. The decreased elevation causes the cross-sectional area to be smaller. In general, there does not appear to be any major problems with either stream channel. Pebble count data could not be located for MY0.

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

		Big Warrior Creek — Combined Cross-Sections 1 - 21				
Variable		Pre-Const.	MY0	MY1	MY2	MY3
Drainage Area (mi^2)		1.17-0.7	1.17-0.7	1.17-0.7	1.17-0.7	1.17-0.7
Bankfull Width (ft)	Mean	18.15	16.30	13.10	18.07	
Bankfull Mean Depth (ft)	Mean	1.41	1.32	1.50	0.87	
Width/Depth Ratio	Mean	12.90	12.30	8.70	24.56	
Bankfull Cross Sectional Area (ft^2)	Mean	25.60	18.20	10.80	15.13	
Maximum Bankfull Depth (ft)	Mean	1.90	2.02	1.55	1.78	
Width of Floodprone Area (ft)	Mean	34.50	41.80	34.40	37.98	
Entrenchment Ratio	Mean	1.90	2.60	2.60	2.08	
Slope	Range	0.034-0.012	0.034-0.01	0.034-0.011	0.034-0.0093	
Particle Sizes (Riffle Sections)						
D_{16} (mm)		0.13		0.51	0.87	
D_{35} (mm)		0.28		6.05	6.80	
D_{50} (mm)		11.30		12.00	12.00	
D_{84} (mm)		50.00		45.00	77.00	
D_{95} (mm)		80.00		89.00	120.00	

TABLE 3.—Continued.

Variable		Little Warrior Creek — Combined Cross-Sections 1 - 10[a]				
		Pre-Const.	MY0	MY1	MY2	MY3
Drainage Area (mi^2)		0.91-0.43	0.91-0.43	0.91-0.43	0.91-0.43	0.91-0.43
Bankfull Width (ft)	Mean	8.95	11.63	7.41	11.75	
Bankfull Mean Depth (ft)	Mean	1.65	0.78	0.92	0.97	
Width/Depth Ratio	Mean	5.45	14.90	8.05	15.16	
Bankfull Cross Sectional Area (ft^2)	Mean	15.35	8.98	6.84	11.05	
Maximum Bankfull Depth (ft)	Mean	2.40	1.67	1.39	1.94	
Width of Floodprone Area (ft)	Mean	14.50	33.15	26.33	21.61	
Entrenchment Ratio	Mean	1.60	2.85	3.55	2.54	
Slope	Range	0.013-0.005	0.016-0.008	0.017-0.007	0.0017-0.0072	
Particle Sizes (Riffle Sections)						
D_{16} (mm)		0.07		0.14	0.11	
D_{35} (mm)		0.17		4.42	0.26	
D_{50} (mm)		0.28		9.30	0.74	
D_{84} (mm)		16.00		26.00	19.00	
D_{95} (mm)		37.00		41.00	52.00	

[a]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.

3.2.5 Hydrologic Data and Bankfull Verification

Monitoring requirements state that at least two bankfull events must be documented through the five-year monitoring period. No surface water gages exist on Big Warrior Creek or Little Warrior Creek. A review of known U.S. Geological Survey (USGS) surface water gages identified a gage approximately 7 miles south of the mitigation site. This gage site is located along the Lower Little River and has an approximately 28 square-mile drainage area (Mulkey 2005). Lower Little River surface gauge (02142000) is located in USGS Hydrologic Unit 03050101, and the datum of the gauge 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 approximately 800 and 2,000 cubic feet per second (cfs) (Mulkey 2005). A flow of 800 cfs at the gaging 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 2007. According to the graphs, two bankfull events occurred during this period (Appendix B.3.). Table 4 shows the dates, gauge heights, and flow rates for the bankfull events.

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) near All Healing Springs, Alexander County, North Carolina.

Date	Gage height (ft)	Flows (ft^3/s)	Comments
4/10/2003	7.0	1,000	Bankfull event
3/2/2007	8.0	1,240	Bankfull event

3.3 Problem Areas

There are five areas of concern at this site. Two areas are on Big Warrior Creek in the lower pasture (Figure 2) and three on Little Warrior Creek, two areas are located in the lower pasture, and one on the second unnamed tributary (Figure 3). These problem areas will need immediate attention because of their closeness to the conservation easement boundaries. However, the total lengths of the stream problem areas comprise only 60 ft of the total 16,550 ft of the stream project.

The first problem area is near longitudinal profile station 4+66 (lower pasture) on Big Warrior Creek. A large walnut tree, on the right bank, is leaning over the stream and the flow of water is directed toward it (Appendix C.1.3.). The water's flow has scoured under the tree's root system causing the tree and right bank to collapse. The easement boundary fence and stream channel will be compromised should the walnut tree fall. This could cause the stream to encroach into the adjacent pasture.

The second Big Warrior Creek problem area is located below cross-section 2 (lower pasture) (Appendix C.1.3.). The stream has eroded approximately four feet of the right bank upstream of a root wad intended to dissipate energy from the stream flow. The root wad and part of the anchor log is exposed. It also appears that an overflow channel has been cut over top of the log attached to the root wad. The stream is very close to encroaching into the pasture adjacent to the conservation easement.

The third problem area is located on Little Warrior Creek on the lower pasture, near cross-section 2 (Appendix C.2.3.). At that point, the stream makes a sharp right turn where a rock vane appears to have been installed on the left bank. The stream has undercut this vane and is eroding the left bank. The easement boundary is not in jeopardy of being compromised at this location.

The fourth problem is located at station 5+10 on Little Warrior Creek in the lower pasture longitudinal profile area (Appendix C.2.3.). Overland flows from the adjacent heavily grazed pasture are causing the high right 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 final problem is located on the second unnamed tributary to Little Warrior Creek (Figure 3; Appendix C.2.3.) This problem is much like the fourth problem described above, but at a much smaller scale. Overland flows from the adjacent heavily grazed pasture are causing the left bank to slough. There is a bowl, caused by erosion, located outside of the easement boundary at the top of the bank and, if left untreated, the bank sloughing will continue.

3.4 Repairs

In 2005, the NCWRC received a Notice of Violation from NCDENR – Land Quality Section stating that that the Little Warrior Creek was out of compliance with its sediment control plan. The notice indicated that repairs were necessary to the culvert running under Andrews Road (SR 1256), to the enhanced stream crossing north of Highway 18, to the cattle drinking water system, and a portion of the left bank in the vicinity of cross-section 3. Because these were small emergency repairs, no design drawings were prepared. The repairs were completed in September 2005 and were photo documented (Appendix C.3.).

Downstream of the culvert on Andrews Road (SR 1256) water was piping through a constructed rock structure. The NCWRC used a combination of geotextile fabric and repositioned boulders to eliminate the flow of water through this structure. This repair was found to be functioning properly during the MY2 survey.

An area above the enhanced stream crossing, north of NC 18, had become devoid of vegetation because the cattle were allowed to access to this area to drink water from the stream. Discussions with the landowner revealed that the drinking water system on that side of the stream had not worked since the project was completed. The drinking water system was repaired and the bare ground sowed with brown top millet and the area mulched with straw. The landowner continues to leave the gates open to this ford and others around the farm. This area may require reseeding.

A portion of the left bank near cross-section 3 on Little Warrior creek had sloughed due to overland flow. A root wad was positioned in the left bank to protect this area during periods of high flows and to provide a bench. A berm was created at the top of the bank to redirect the overland flow away from this location. This preventive measure has failed because the cattle had access to the berm, which prevented the pasture grass from becoming reestablished.

3.5 Stream Assessment Summary

Stream monitoring data comparisons between years were difficult to make due to a number of issues; however, both streams are stable and have few problem areas. Data comparisons were compromised because of 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 and MY2.

All four longitudinal profiles on Big Warrior creek show that there are no major channel bed issues other than the pools appear to be getting smaller. 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 did not suggest that the sediment is coming from the stream channel or the conservation easement. There are two areas of concern, both located within the lower pasture. These two 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 appeared stable. There are three problem areas on Little Warrior Creek. Two in the lower pasture and one on the second unnamed tributary; these three areas will also need corrective action to protect the easement boundary and stabilize the left bank. Most of the repairs on Little Warrior creek are functioning properly. The two exceptions are the berm at the top of the left bank and the vegetation around the gate at the enhanced stream crossing downstream of NC 18. These two areas will need to be reseeded and cattle access prohibited until the vegetation is reestablished.

Based on information from the USGS, the Big Warrior Creek and Little Warrior Creek sites have met the hydrologic monitoring requirement of having two bankfull events within five years.

4 Vegetation

4.1 Success Criteria

The Big Warrior Creek and Little Warrior Creek sites must be monitored for vegetation survival for the first five years after construction. A 320 stems per acre woody stem 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 second 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' five and four year criteria at this site.

4.2 Description of Species

The 2003 as-built report lists the herbaceous vegetation that was 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 observation (Mulkey 2005).

4.3 Plot Description

The MY1 report describes the vegetation plots in detail (Mulkey 2005). The general locations of the vegetation monitoring plots are shown in Figures 2 and 3; photographs of the vegetation plots are located in Appendix C.1.2. and C.2.2.

4.4 Vegetation Monitoring

Twelve vegetation plots were monitored in MY2, six on Big Warrior Creek and six on Little Warrior Creek. The results of the vegetation survey are located in Table 5, below.

TABLE 5.—Vegetation monitoring plot statistics for Big Warrior Creek, September 2007.

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						
Salix nigra	Black willow						1
Liriodendron tulipifera	Tulip poplar	1					
Cornus amomum	Silky dogwood	3	7	8	10		
Prunus serotina	Black cherry						
Alnus serrulata	Tag alder		2	1			
Betula nigra	River birch	1				1	
Quercus rubra	Red oak				1	1	1
Salix sericea	Silky willow	1					
Fraxinus pennsylvanica	Green ash	3			3	2	1
Platanus occidentalis	Sycamore						1
Untagged tree and shrub species							
Botanical Name	Common Name						
Salix nigra	Black willow			1			
Liriodendron tulipifera	Tulip poplar	11				7	5
Cornus amomum	Silky dogwood	2	9	15	6	1	3
Prunus serotina	Black cherry	2				1	2
Alnus serrulata	Tag alder	2					
Betula nigra	River birch					1	
Quercus rubra	Red oak				2		
Salix sericea	Silky willow	2	1				
Fraxinus pennsylvanica	Green ash	2			1	1	
Platanus occidentalis	Sycamore				1	2	1
Acer rubrum	Red maple					3	6
Rhus typhina	Staghorn sumac						5
Ligustrum sp.	Privet					1	
Cornus florida	Flowering dogwood					1	
Juglans nigra	Black walnut				1		
Lespedeza bicolor	Shrubby lespedeza		1				
Viburnum sp.	Viburnum	2					
Robinia pseudoacacia	Black locust	11					
Total 2004 (MY1)		10	10	16	16	8	5
Total tagged 2007 (MY2)		9	9	9	14	4	4
Total untagged 2007		34	11	16	11	18	22
Total tagged & untagged 2007		43	20	25	25	22	26
Density tagged (Trees/Acre)		392	392	392	610	174	174
Density tagged & untagged (Trees/Acre)		1,873	871	1,089	1,089	958	1,133
Average density tagged		356					
Average density tagged & untagged		1,169					

TABLE 5.—Continued. Vegetation monitoring plot statistics for Little Warrior Creek, September 2007.

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						
Salix nigra	Black willow						
Liriodendron tulipifera	Tulip poplar					1	
Cornus amomum	Silky dogwood	1	20	5		4	17
Prunus serotina	Black cherry			1			
Alnus serrulata	Tag alder	1	5	1	5	8	1
Betula nigra	River birch		2				1
Quercus rubra	Red oak						
Salix sericea	Silky willow						
Fraxinus pennsylvanica	Green ash		1		4		
Platanus occidentalis	Sycamore		1		1	3	
Viburnum sp			2				
Cephalanthus occidentalis	Button bush						2
Untagged tree and shrub species							
Botanical Name	Common Name						
Salix nigra	Black willow						
Liriodendron tulipifera	Tulip poplar	2			11		
Cornus amomum	Silky dogwood	4	5	2	9	11	14
Prunus serotina	Black cherry		1				
Alnus serrulata	Tag alder	2	1		1		
Betula nigra	River birch						
Quercus rubra	Red oak						
Salix sericea	Silky willow						
Fraxinus pennsylvanica	Green ash						
Platanus occidentalis	Sycamore	1		1	1		
Acer rubrum	Red maple	84			33	2	6
Sambucus canadensis	Elderberry		1				
Oxydendrum arboreum	Sourwood		3		9		
Cornus florida	Flowering dogwood	1					2
Pinus strobes	White pine		1				
Diospyros virginiana	Persimmon	2					
Viburnum sp.	Viburnum	1					1
Cephalanthus occidentalis	Button bush				1		6
Juniperus virginiana	Red cedar				1		
Ulmus sp	Elm			1			
Total 2004 (MY1)		2	37	13	22	20	36
Total tagged 2007 (MY2)		2	31	7	10	16	21
Total untagged 2007		97	12	4	66	13	29
Total tagged & untagged 2007		99	43	11	76	29	50
Density tagged (Trees/Acre)		87	1,350	305	436	697	915
Density tagged & untagged (Trees/Acre)		4,312	1,873	479	3,311	1,263	2,178
Average density tagged		632					
Average density tagged & untagged		2,236					

4.5 Results

The period of time between the MY1 and MY2 made it difficult to locate the flagging and tags on the installed woody plants. Some of the flagging and tags had fallen off and could not be located. The vegetation's dense foliage also made locating the tags difficult. An attempt was made to count those tree species with just the tagging; however, the large numbers of volunteer plants and not knowing which trees were originally tagged made this difficult. A count of tagged and untagged trees was conducted in each of the 12 plots. On average, the density of tagged trees was 494/acre. Big Warrior Creek had 356 tagged trees per acre and Little Warrior Creek had 632 tagged trees per acre. These numbers exceed the density requirements for five and four years since a site has been planted (USACE 2003).

The average density of tree species, both tagged and untagged, per acre increases when the number of untagged trees are included. On average, for both sites, there were 1,702 trees per acre. Big Warrior Creek had 1,169 trees per acre and Little Warrior Creek had 2,236. These numbers far exceed the vegetation requirements after five growing seasons. All but two of the species listed in the untagged columns are native to North Carolina. With this said, the numbers of tagged and untagged species should be taken into account when determining if the site has met the required success criterion for vegetation.

There were two plant species present only in the Big Warrior Creek vegetation monitoring plots that are not native to North Carolina, privet *Ligustrum sp.* and shrubby lespedza *Lespedeza bicolor*. Two other species, multiflora rose *Rosa multiflora* and Japanese honeysuckle *Lonicera japonica* were found growing in various places on both Big Warrior and Little Warrior creeks. These plants are exotic invasives and control of them should be considered, so as to allow the native species to mature.

5 Project Summary

Although data comparisons between monitoring events were difficult, based on those instances where data are aligned and visual observations, both Big and Little Warrior Creeks appear stable. A source of sediment on Big and Little Warrior creeks appears to be coming from those areas where there is a stream crossing. Another source of sediment on Big Warrior Creek is the unprotected unnamed tributaries entering the stream. Most of the sediment, on Little Warrior Creek, appears to be coming from upstream sources.

The site has met the requirements of two bankfull events within five years and it has also met the vegetative success criteria. No biological sampling was conducted as part of this monitoring project.

The stream easements are fenced along both streams, and cattle drinking water systems were installed. All of these agricultural BMPs are functioning properly. One item to note is that the landowner is not closing the gates to the stream fords, which is allowing cattle to have access to the streams. Some of these fords are in a poor condition.

There are five stream problem areas that need to be addressed, two on Big Warrior Creek and three on Little Warrior Creek. Four of the five problem areas could impact the easement boundaries. There were four non-native exotic species found throughout the site. These species need to be controlled to minimize their impact on the native plant species.

According to a letter (dated July 25, 2007) between NCWRC and EEP, referencing task oriented contract number D06082 Big Warrior and Little Warrior creeks on the AH&W farm site are scheduled for monitoring in 2008. The project closeout is to be completed after MY3 monitoring report is completed.

6 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.

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.

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

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

7 Acknowledgements

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

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

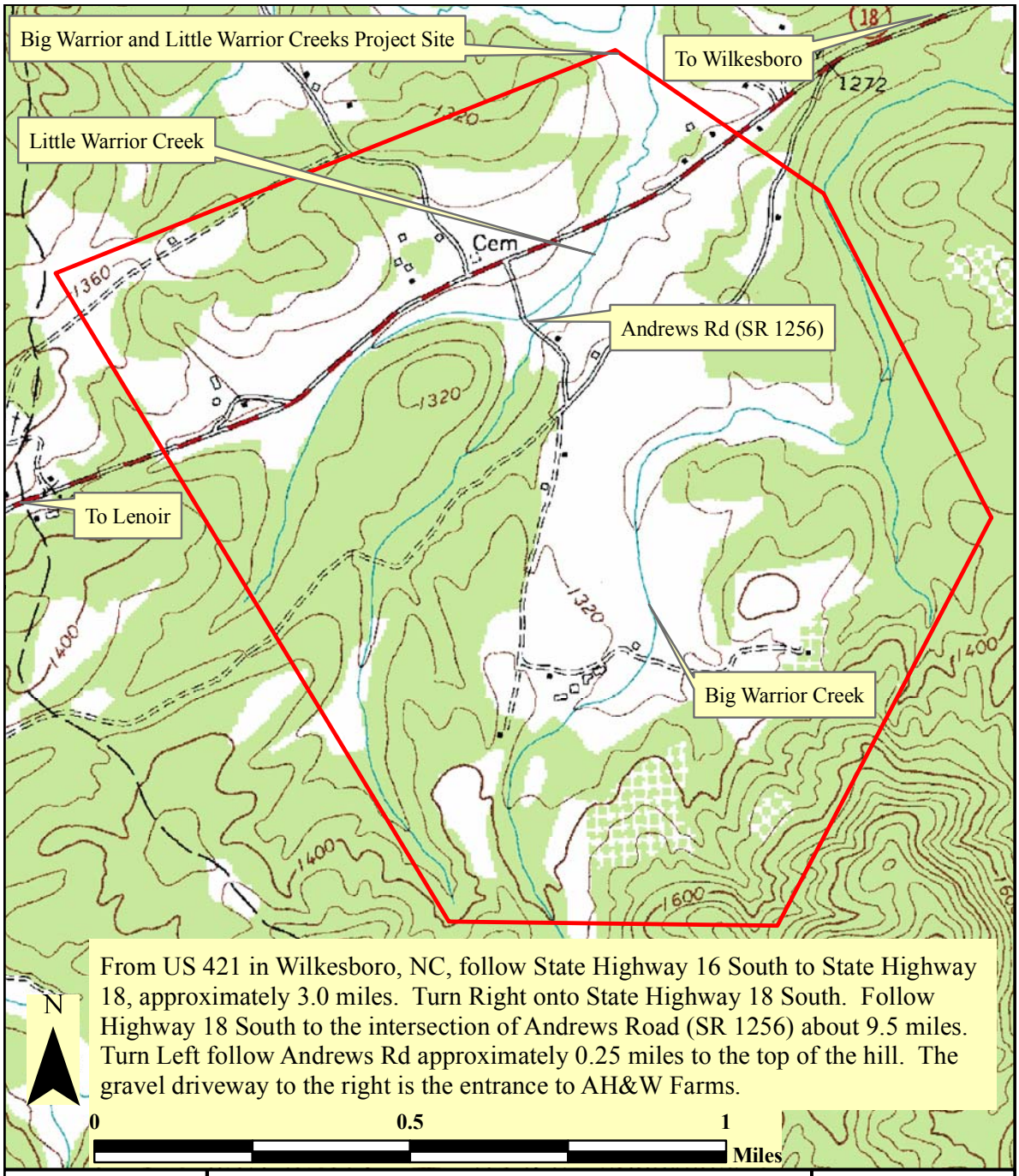
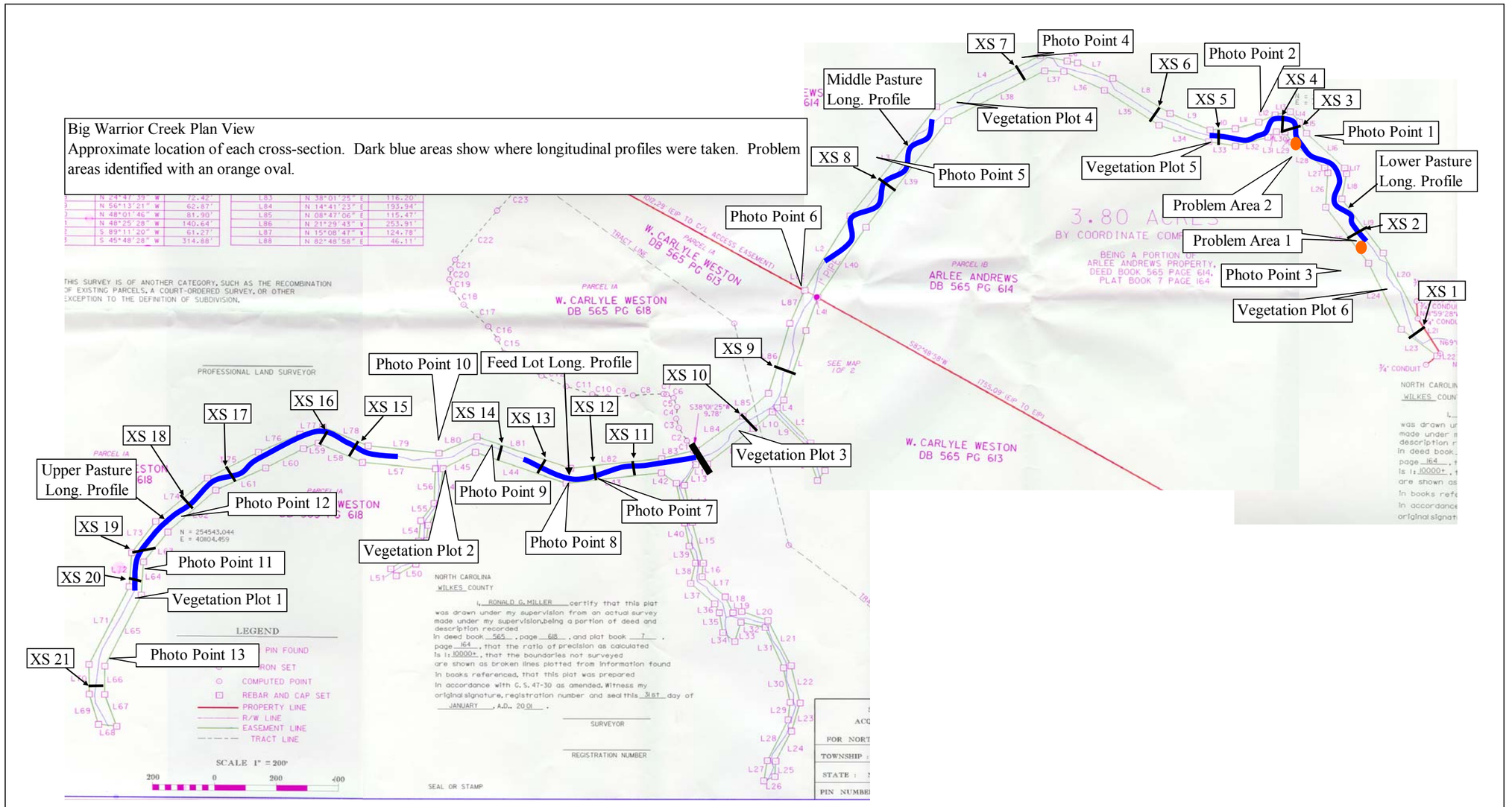


Figure 1. Project site vicinity map
Big Warrior and Little Warrior Creeks Stream Restoration
EEP Project Number 92715, MY2 (2007)
Wilkes County, North Carolina
April 2008

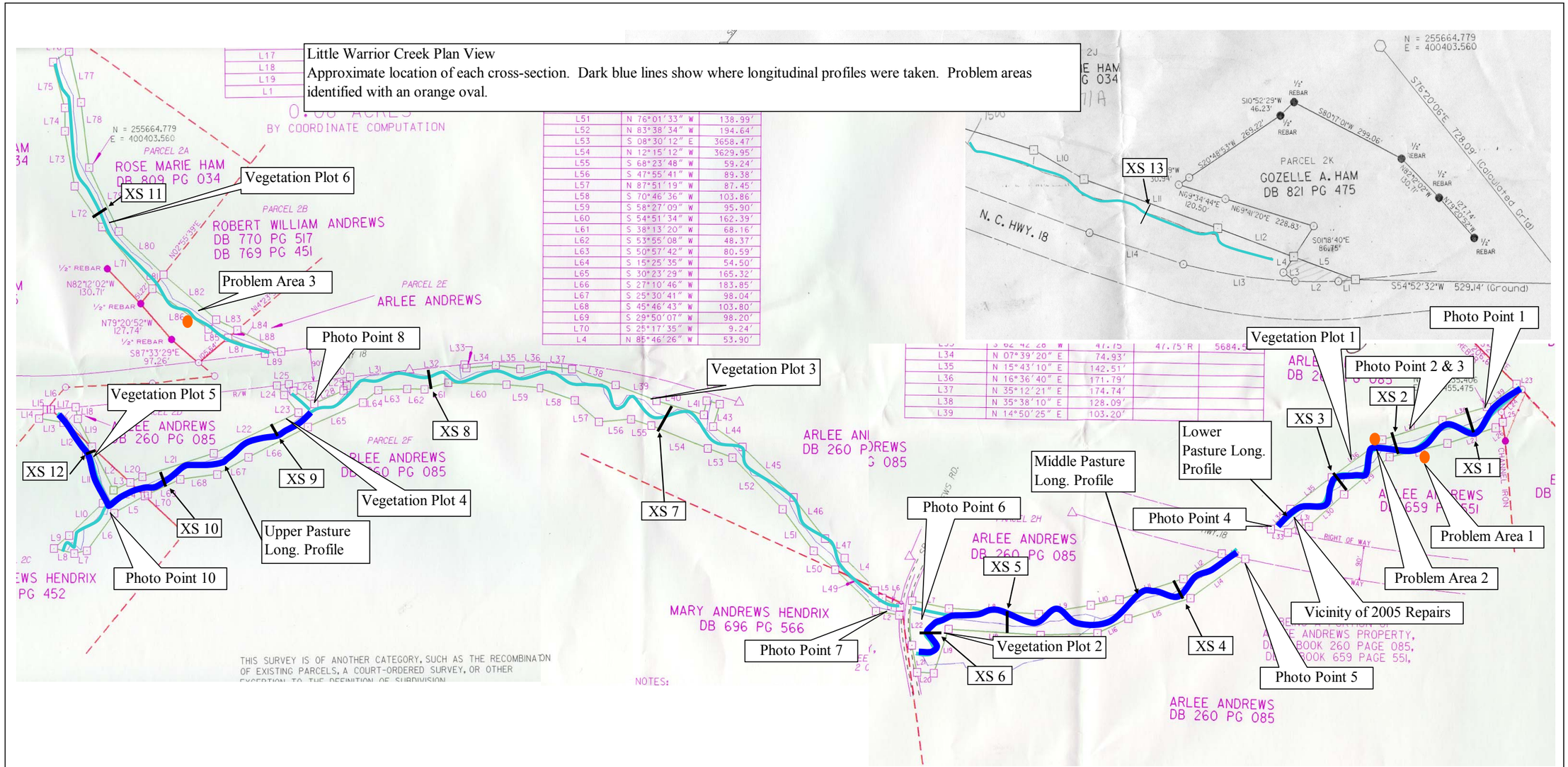
Source:
United States Department of the Interior, Geological Survey
Boomer Quadrangle, 7.5 Minute Series (Topographic).

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



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

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



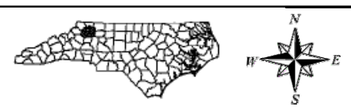
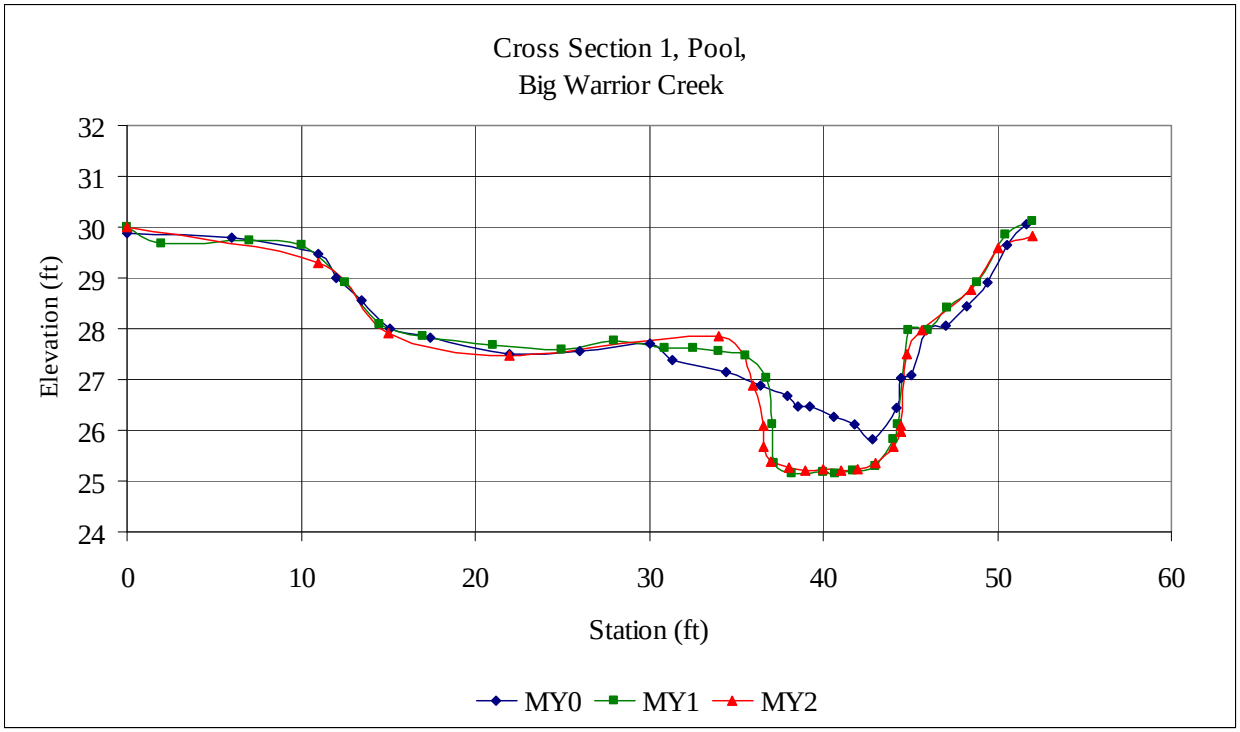
Prepared for: Ecosystem Enhancement Program		Map is not to Scale Source: North Carolina Wildlife Resources Commission, As-built Report for the AH&W Mitigation Site	**Little Warrior Creek** Locations of Cross-sections, Longitudinal Profiles, Vegetation Plots, Photo Points, and Problem Areas Wilkes County,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

Figure Number

3

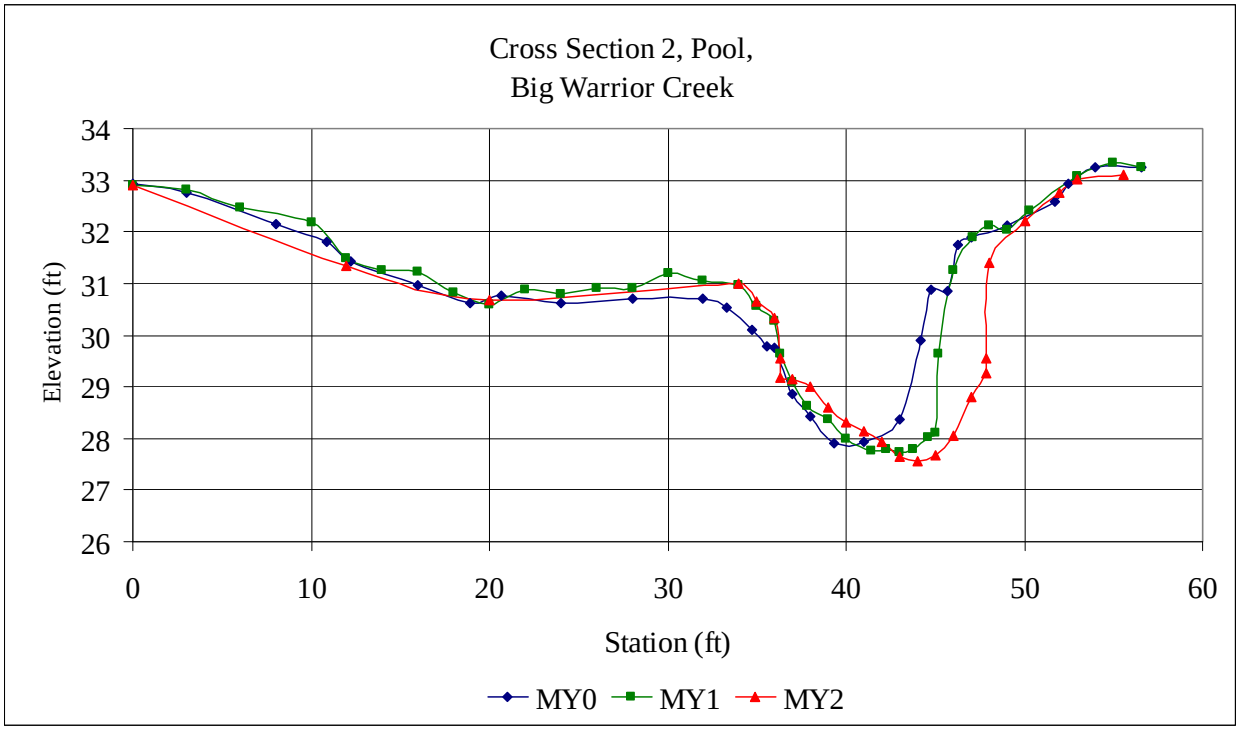
8 Appendix A.—Cross-Section Comparisons

Appendix A.1. Cross-section comparisons Big Warrior Creek, MY0-MY2.



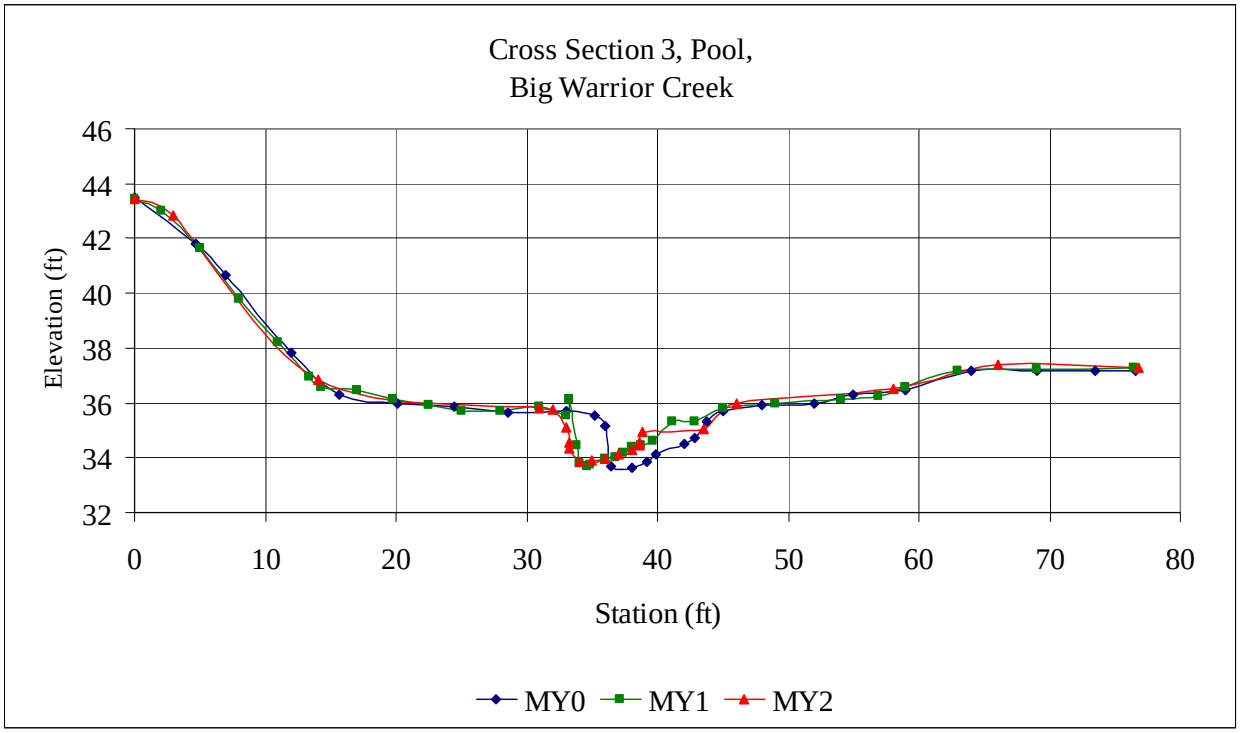
Cross-Section 1 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	15.3	31.0	29.0
Maximum Bankfull Depth (ft)	1.9	3.0	2.7
Bankfull Mean Depth (ft)	1.0	1.0	0.9
Width/Depth Ratio	15.7		35.1
Entrenchment Ratio	2.6		1.6
Bankfull Width (ft)	15.5	31.8	31.9

Appendix A.1. Continued.



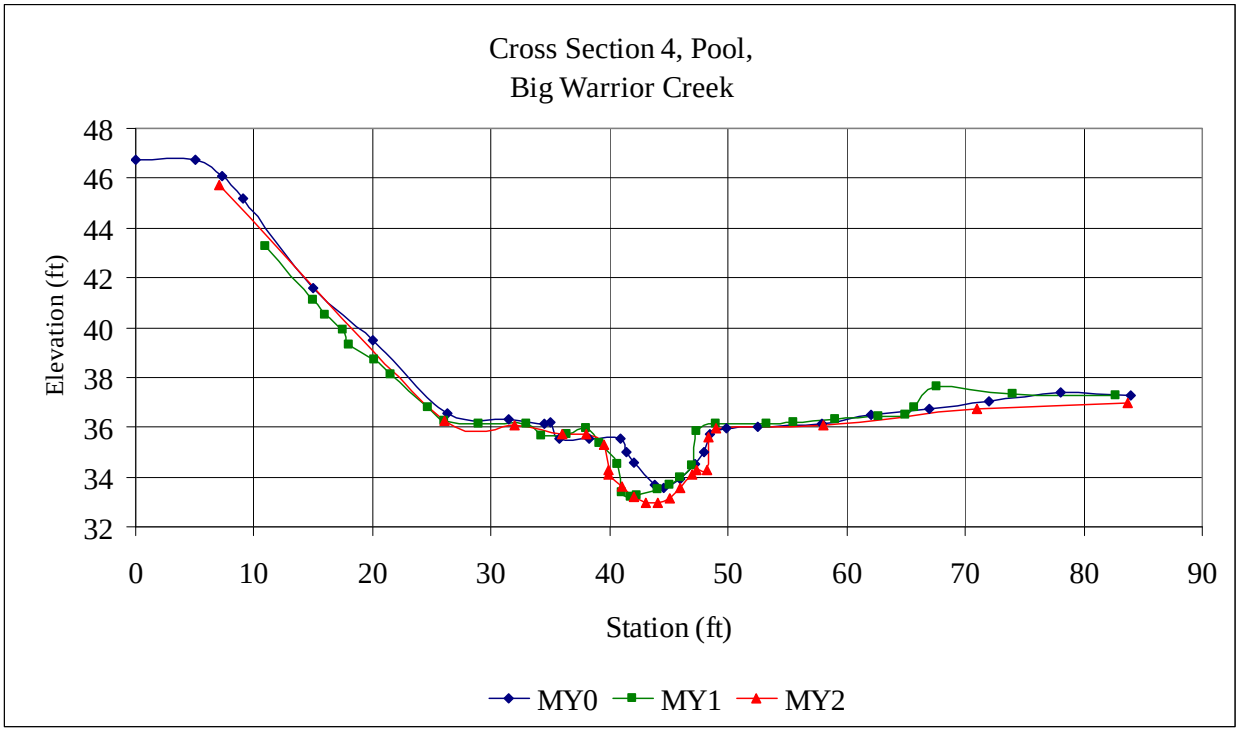
Cross-Section 2 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	20.3	43.1	34.9
Maximum Bankfull Depth (ft)	2.8	3.8	3.4
Bankfull Mean Depth (ft)	1.6	1.3	1.1
Width/Depth Ratio	7.9	27.4	29.1
Entrenchment Ratio	5.3	2.9	1.7
Bankfull Width (ft)	12.7	34.4	31.9

Appendix A.1. Continued.



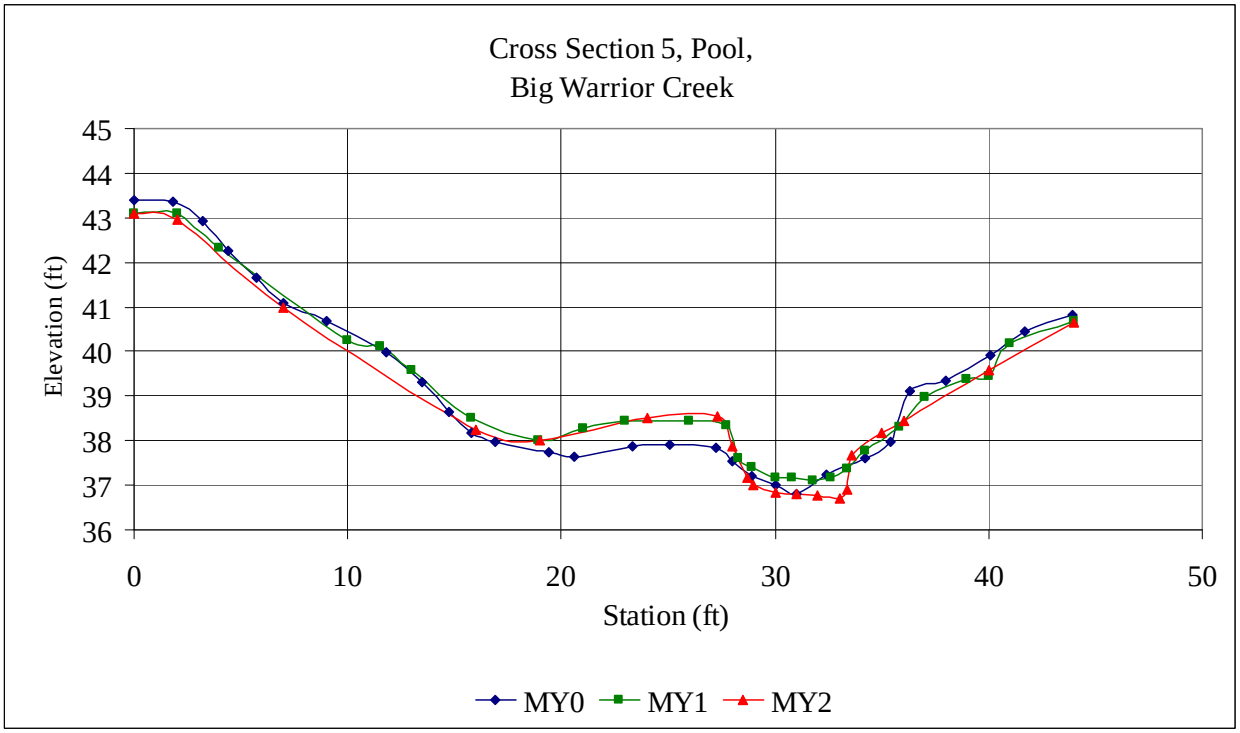
Cross-Section 3 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	12.8	10.1	17.8
Maximum Bankfull Depth (ft)	2.1	1.9	2.1
Bankfull Mean Depth (ft)	1.0	1.0	1.0
Width/Depth Ratio	11.6	10.9	18.0
Entrenchment Ratio	6.9	6.5	3.7
Bankfull Width (ft)	12.2	10.5	17.9

Appendix A.1. Continued.



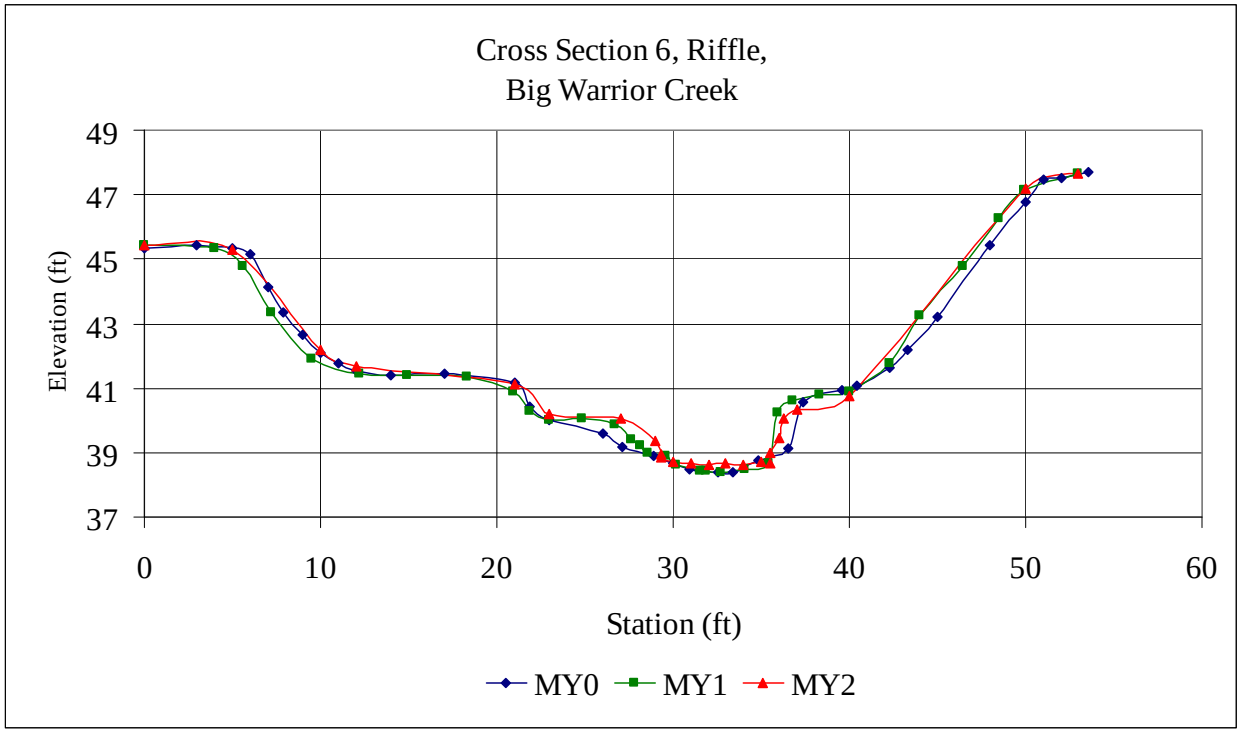
Cross-Section 4 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	19.5	11.8	21.6
Maximum Bankfull Depth (ft)	2.6	2.2	2.9
Bankfull Mean Depth (ft)	1.1	1.5	1.4
Width/Depth Ratio			10.4
Entrenchment Ratio			4.2
Bankfull Width (ft)	17.5	8.0	15.0

Appendix A.1. Continued.



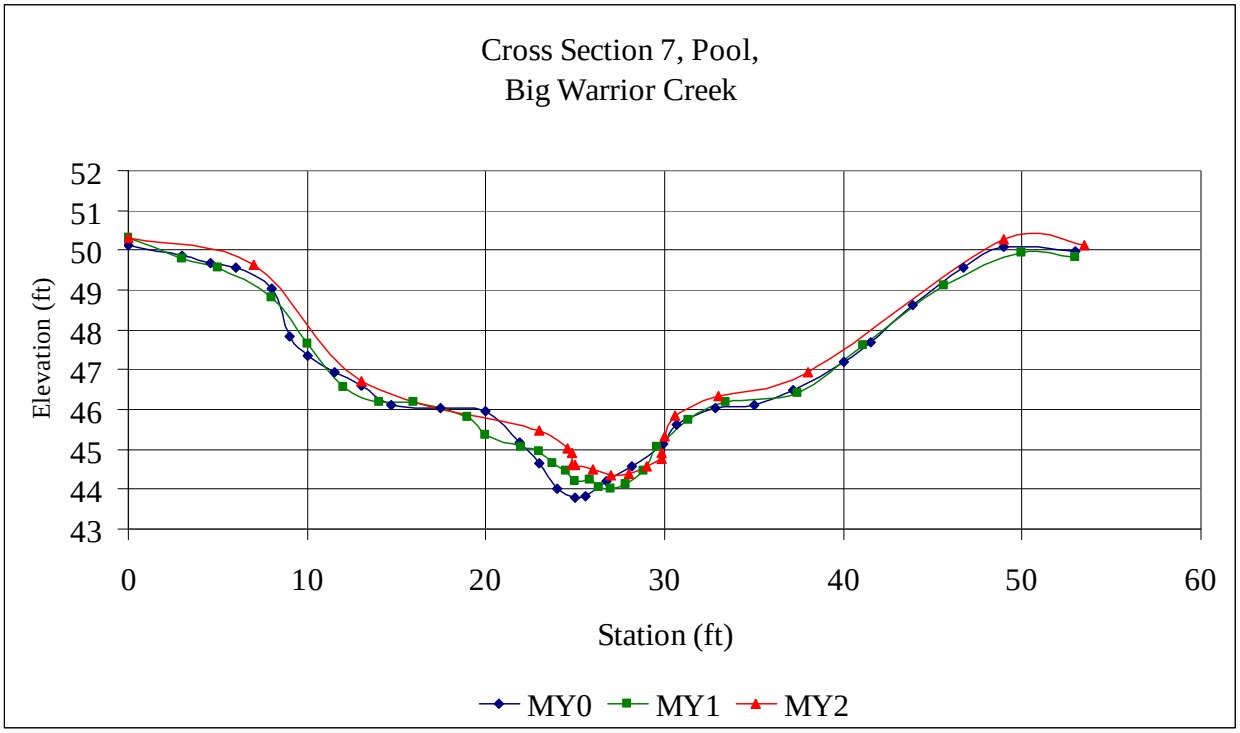
Cross-Section 5 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	20.3	35.4	19.8
Maximum Bankfull Depth (ft)	1.9	2.5	2.1
Bankfull Mean Depth (ft)	1.0	1.3	0.8
Width/Depth Ratio	22.3	20.8	27.6
Entrenchment Ratio	1.5	2.4	1.6
Bankfull Width (ft)	21.3	27.2	23.4

Appendix A.1. Continued.

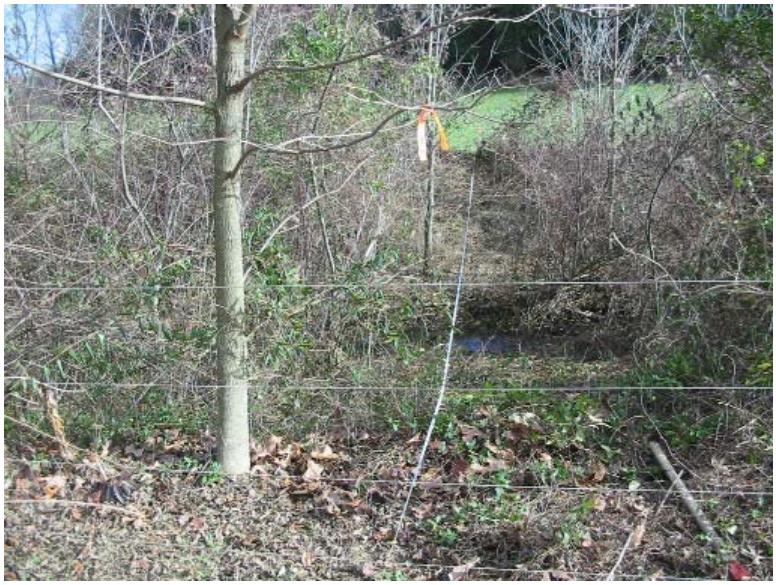


Cross-Section 6 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	22.3	10.0	14.3
Maximum Bankfull Depth (ft)	2.2	1.5	1.8
Bankfull Mean Depth (ft)	1.4	1.1	1.0
Width/Depth Ratio	10.9	8.3	15.3
Entrenchment Ratio	2.3	3.9	2.2
Bankfull Width (ft)	15.6	9.1	14.8

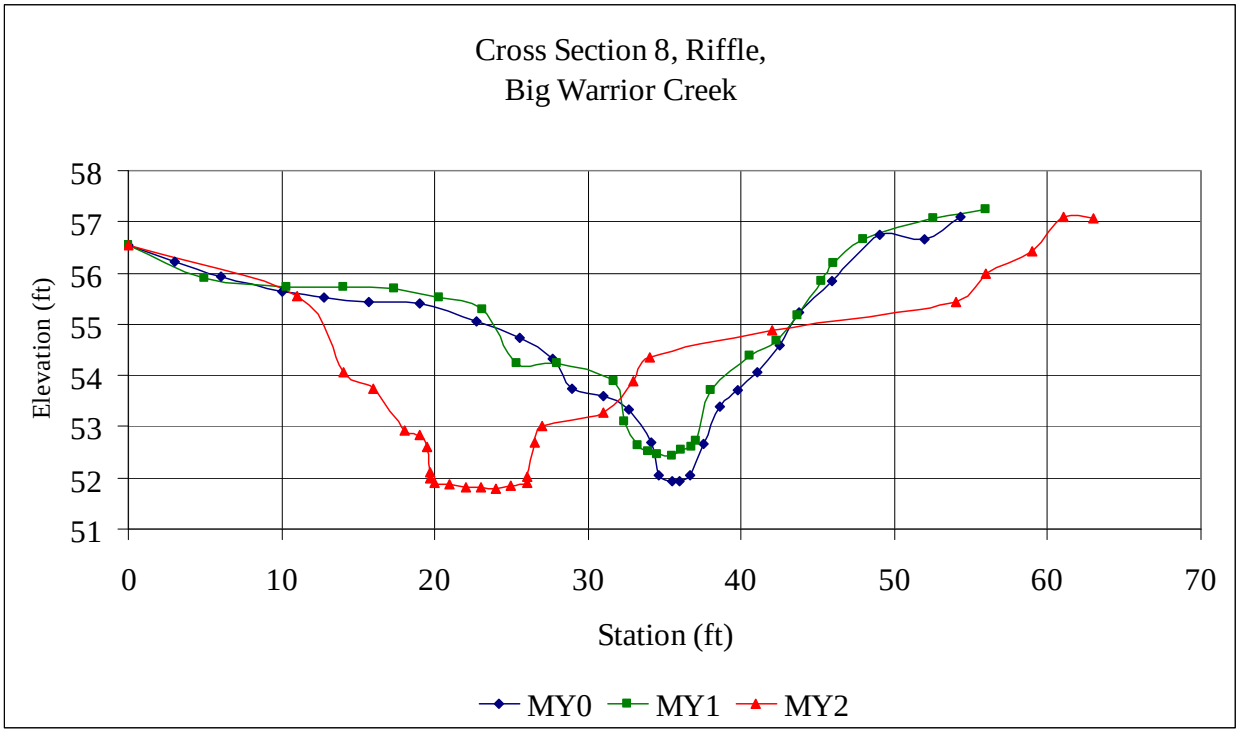
Appendix A.1. Continued.



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

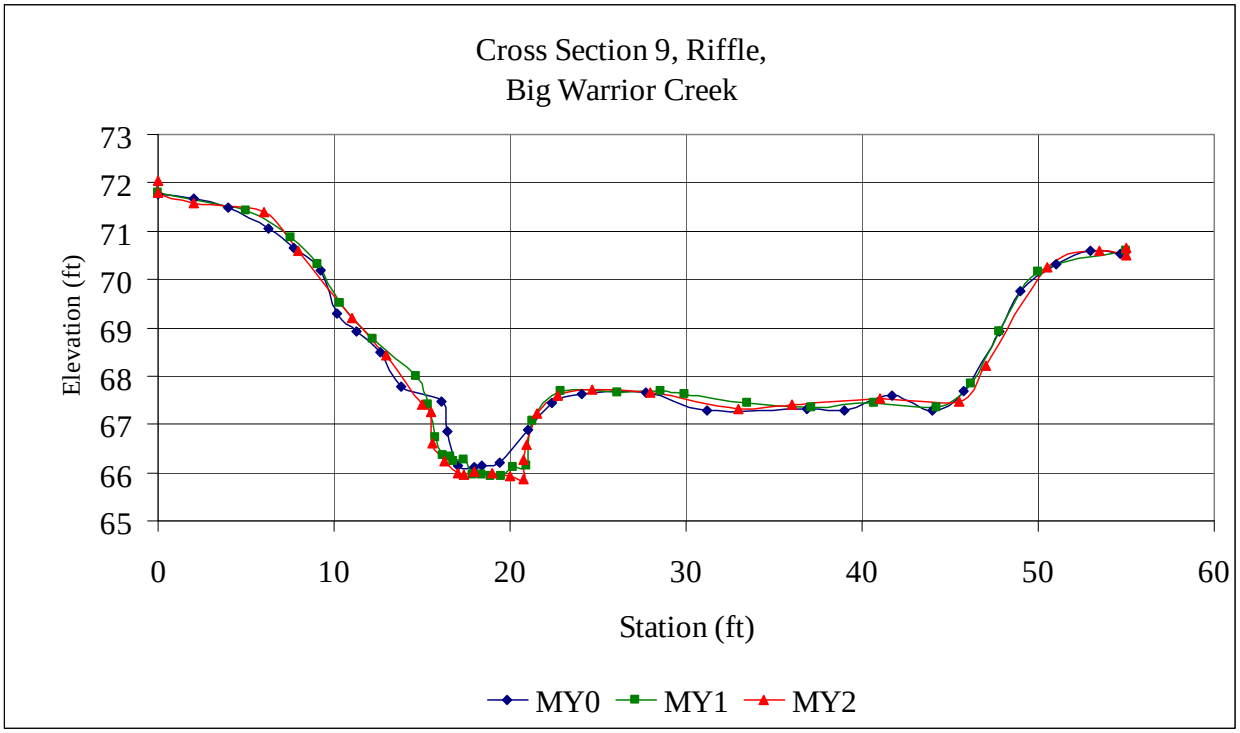


Appendix A.1. Continued.



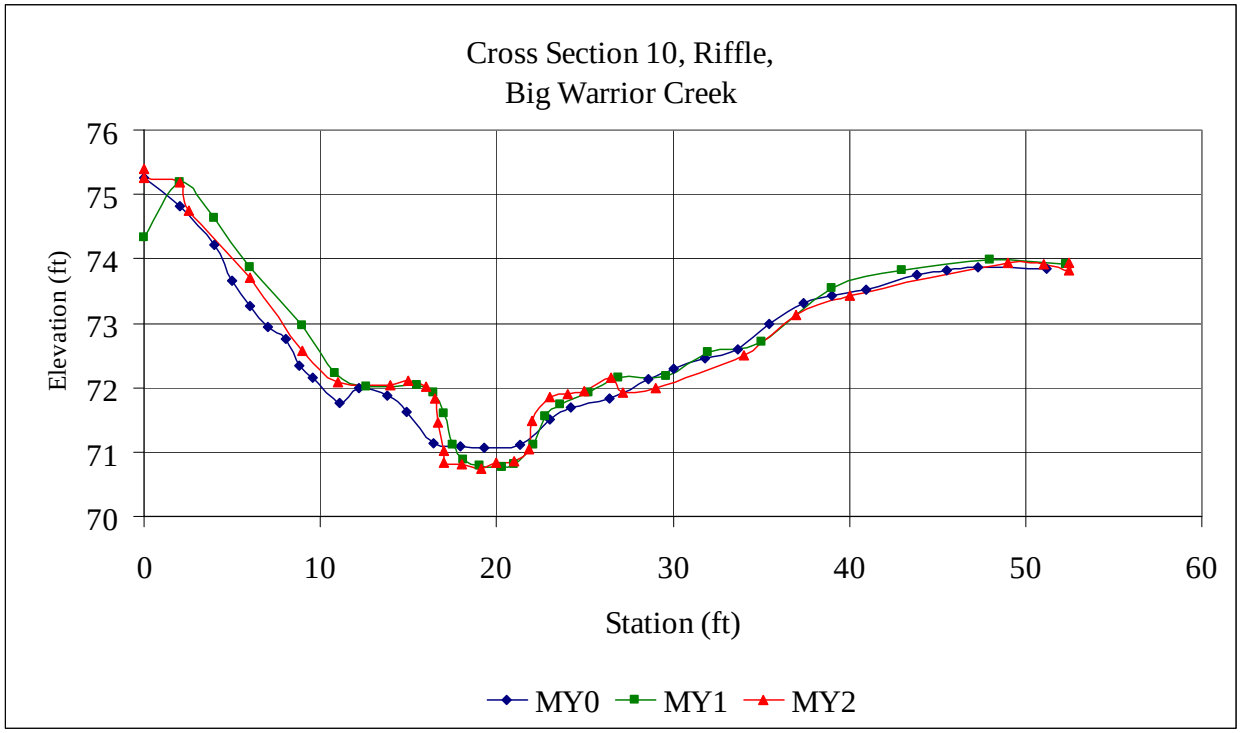
Cross-Section 8 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	15.3	5.8	11.3
Maximum Bankfull Depth (ft)	2.4	1.3	1.5
Bankfull Mean Depth (ft)	1.1	0.9	0.8
Width/Depth Ratio	12.8	6.5	17.1
Entrenchment Ratio	3.5	3.3	2.0
Bankfull Width (ft)	14.0	6.1	13.9

Appendix A.1. Continued.



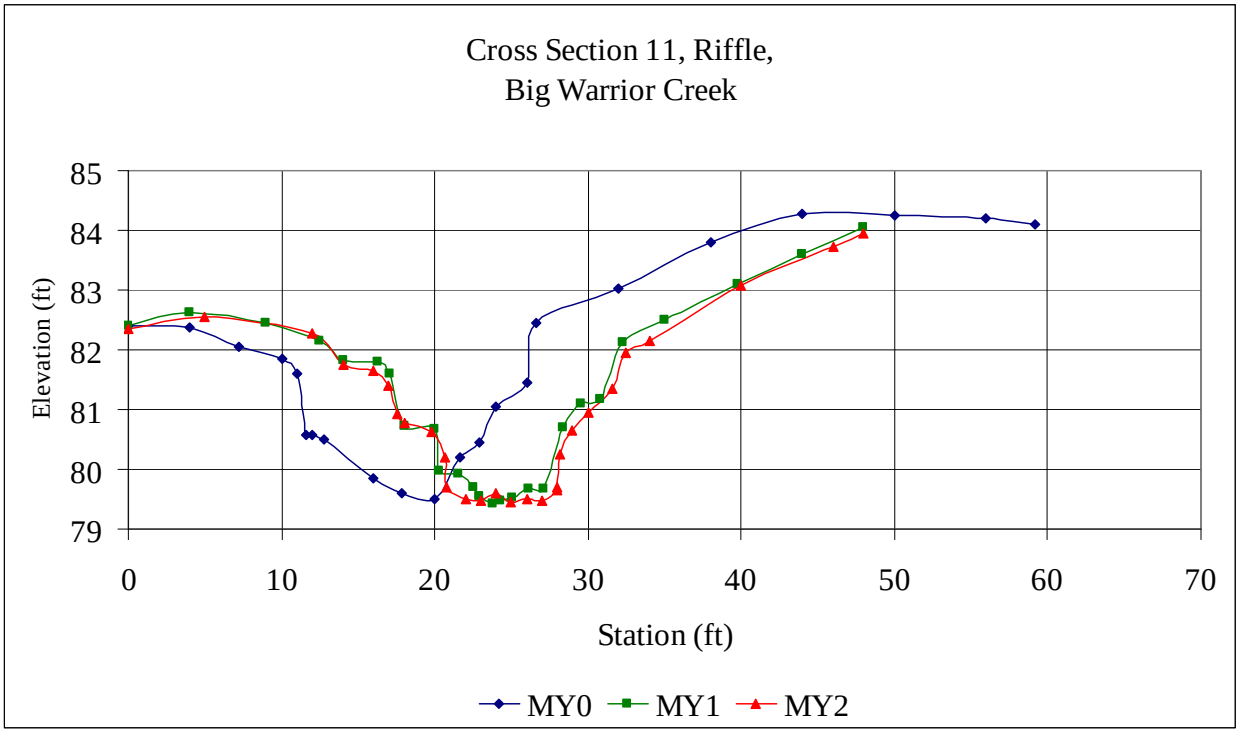
Cross-Section 9 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	16.0	13.2	14.5
Maximum Bankfull Depth (ft)	1.7	1.8	1.9
Bankfull Mean Depth (ft)	0.5	0.4	0.5
Width/Depth Ratio	64.1	70.7	63.2
Entrenchment Ratio	1.2	1.3	1.2
Bankfull Width (ft)	32.0	30.6	31.6

Appendix A.1. Continued.



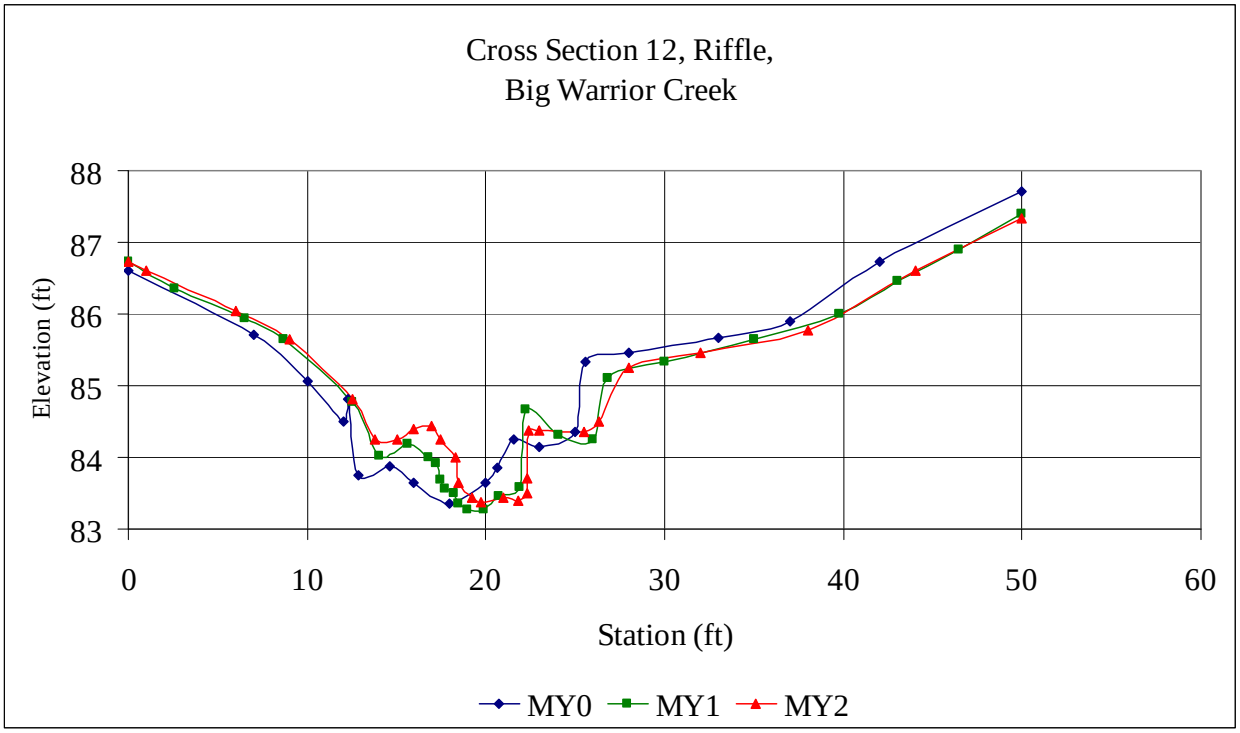
Cross-Section 10 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	13.9	10.3	9.1
Maximum Bankfull Depth (ft)	1.2	1.5	1.4
Bankfull Mean Depth (ft)	0.7	0.5	0.5
Width/Depth Ratio	32.1	35.7	43.1
Entrenchment Ratio	1.6	1.7	1.8
Bankfull Width (ft)	21.1	19.2	19.8

Appendix A.1. Continued.



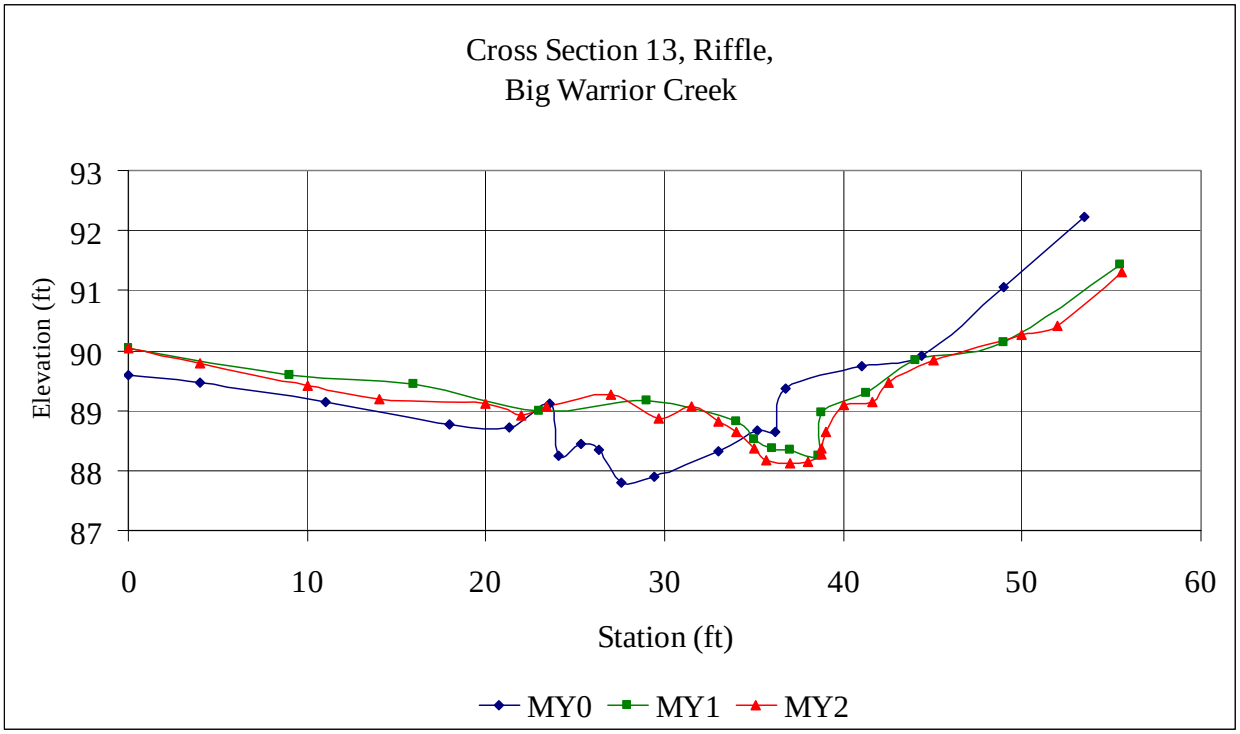
Cross-Section 11 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	20.2	7.6	9.9
Maximum Bankfull Depth (ft)	2.1	1.3	1.3
Bankfull Mean Depth (ft)	1.3	0.9	0.9
Width/Depth Ratio	11.7	9.2	13.1
Entrenchment Ratio	2.5	2.4	1.8
Bankfull Width (ft)	15.4	8.4	11.4

Appendix A.1. Continued.



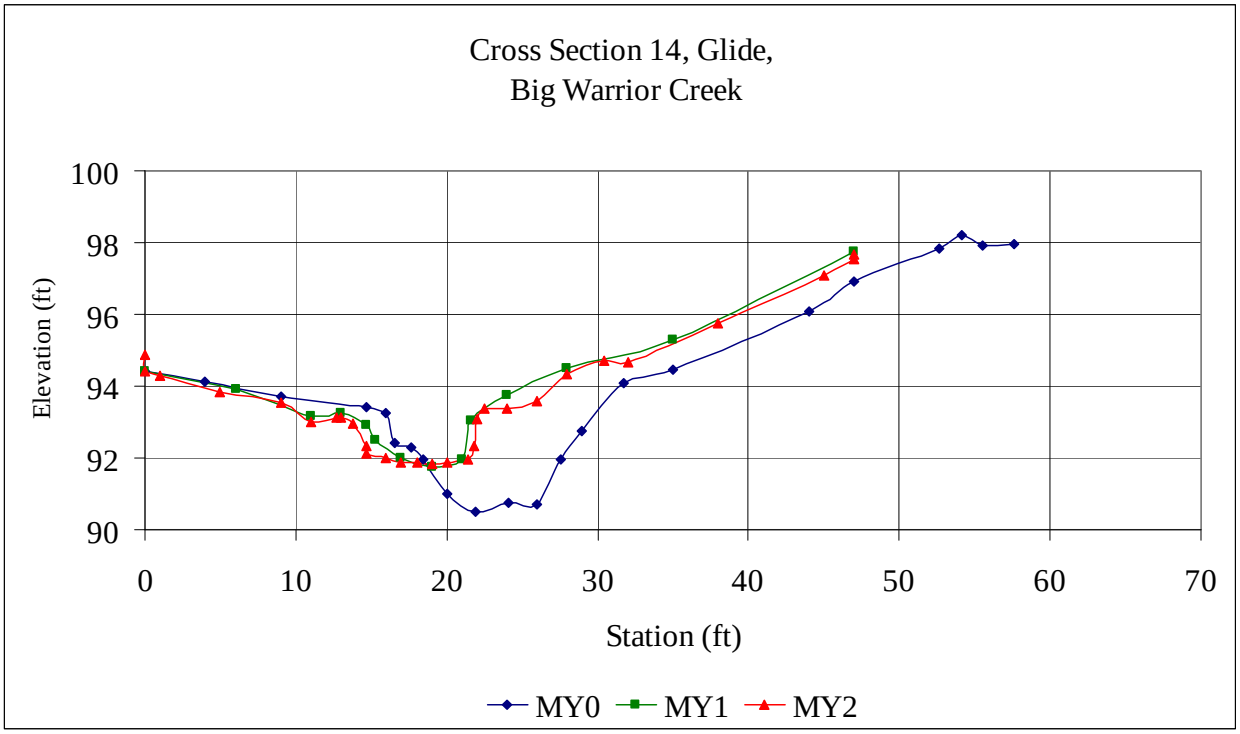
Cross-Section 12 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	20.4	10.8	13.6
Maximum Bankfull Depth (ft)	2.0	1.5	1.7
Bankfull Mean Depth (ft)	1.3	0.8	0.8
Width/Depth Ratio	11.6	18.1	18.9
Entrenchment Ratio	2.7	2.9	2.8
Bankfull Width (ft)	15.4	14.0	16.0

Appendix A.1. Continued.



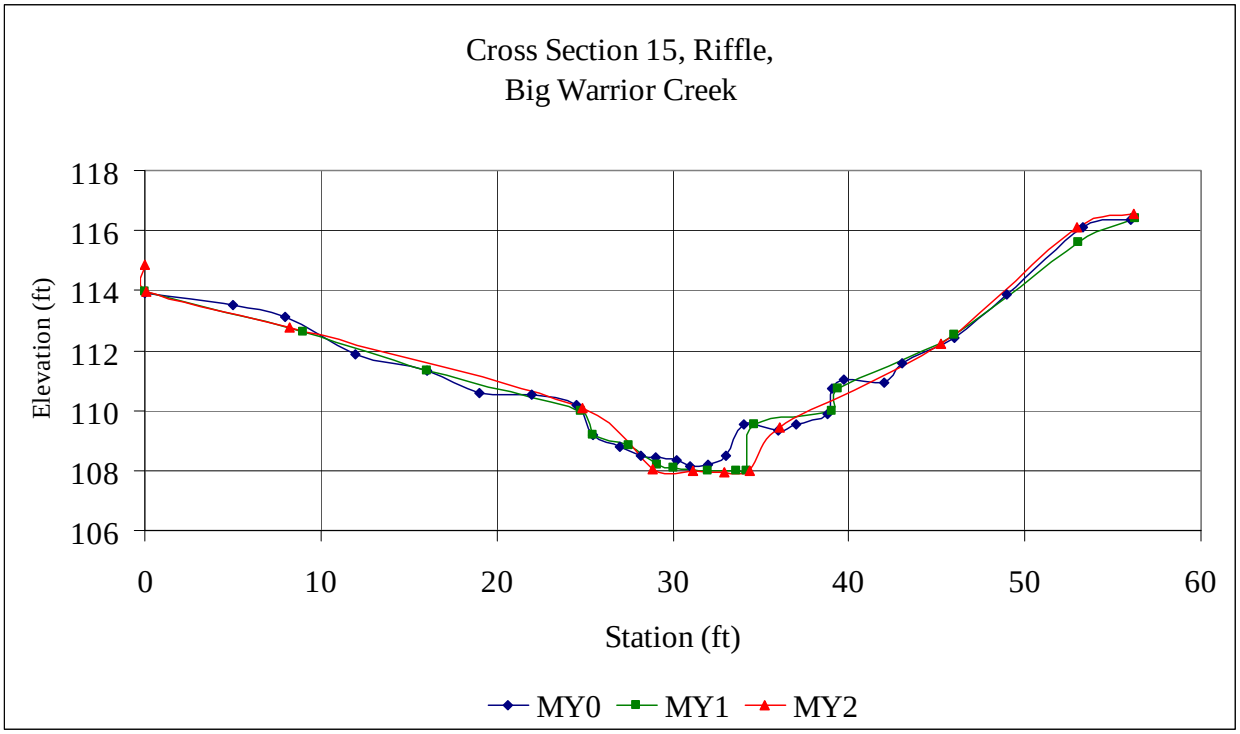
Cross-Section 13 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	20.5	8.0	9.8
Maximum Bankfull Depth (ft)	1.6	1.0	1.2
Bankfull Mean Depth (ft)	1.6	0.3	0.3
Width/Depth Ratio	8.2	66.1	86.8
Entrenchment Ratio	3.4	2.6	1.8
Bankfull Width (ft)	13.0	23.0	29.2

Appendix A.1. Continued.



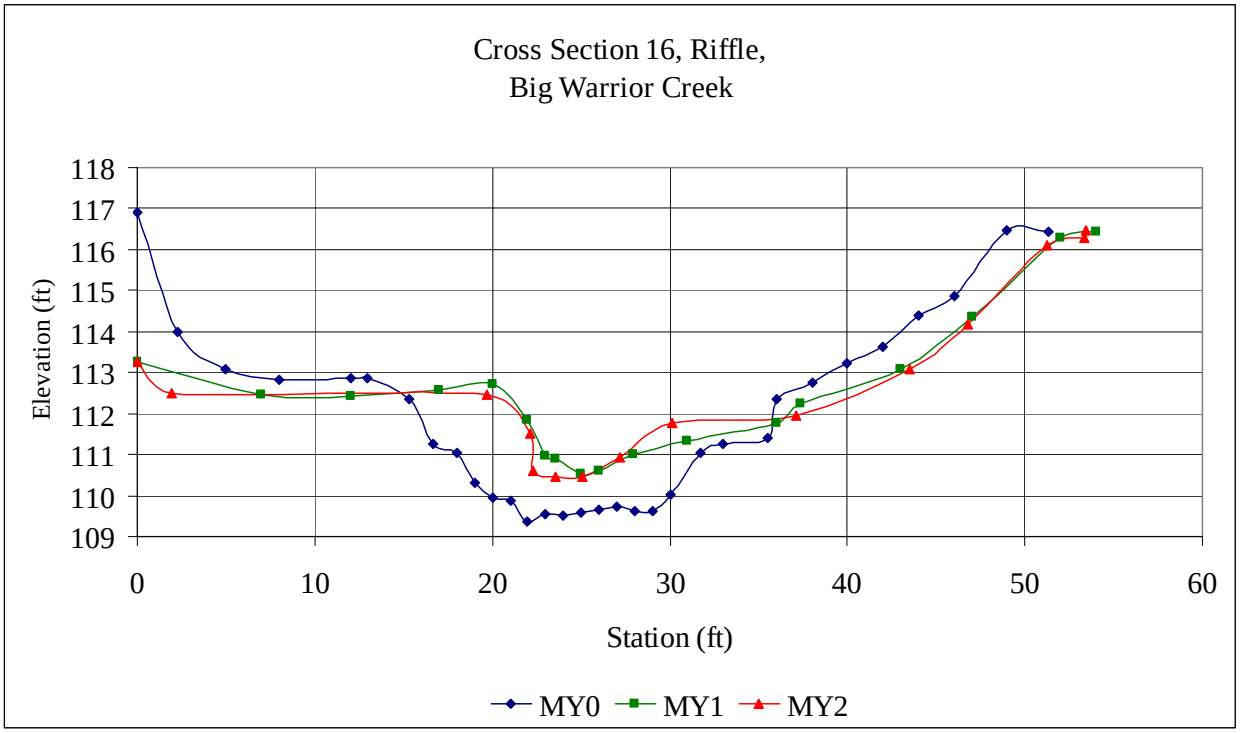
Cross-Section 14 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	24.7	8.3	14.9
Maximum Bankfull Depth (ft)	2.7	1.5	1.7
Bankfull Mean Depth (ft)	1.9	0.7	0.9
Width/Depth Ratio			18.9
Entrenchment Ratio			2.0
Bankfull Width (ft)	13.3	11.6	16.8

Appendix A.1. Continued.



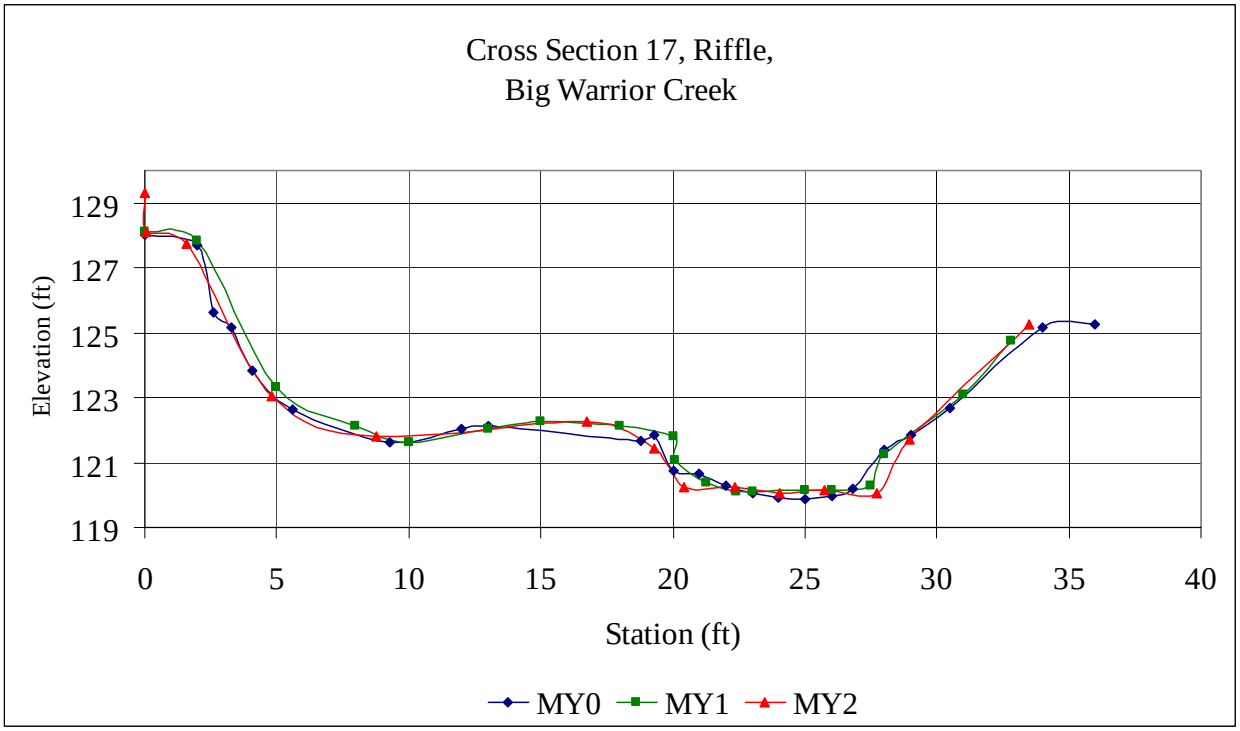
Cross-Section 15 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	17.3	10.5	10.9
Maximum Bankfull Depth (ft)	2.1	1.5	1.5
Bankfull Mean Depth (ft)	1.2	1.1	1.1
Width/Depth Ratio	11.4	8.4	9.1
Entrenchment Ratio	2.5	2.6	2.1
Bankfull Width (ft)	14.0	9.4	10.0

Appendix A.1. Continued.



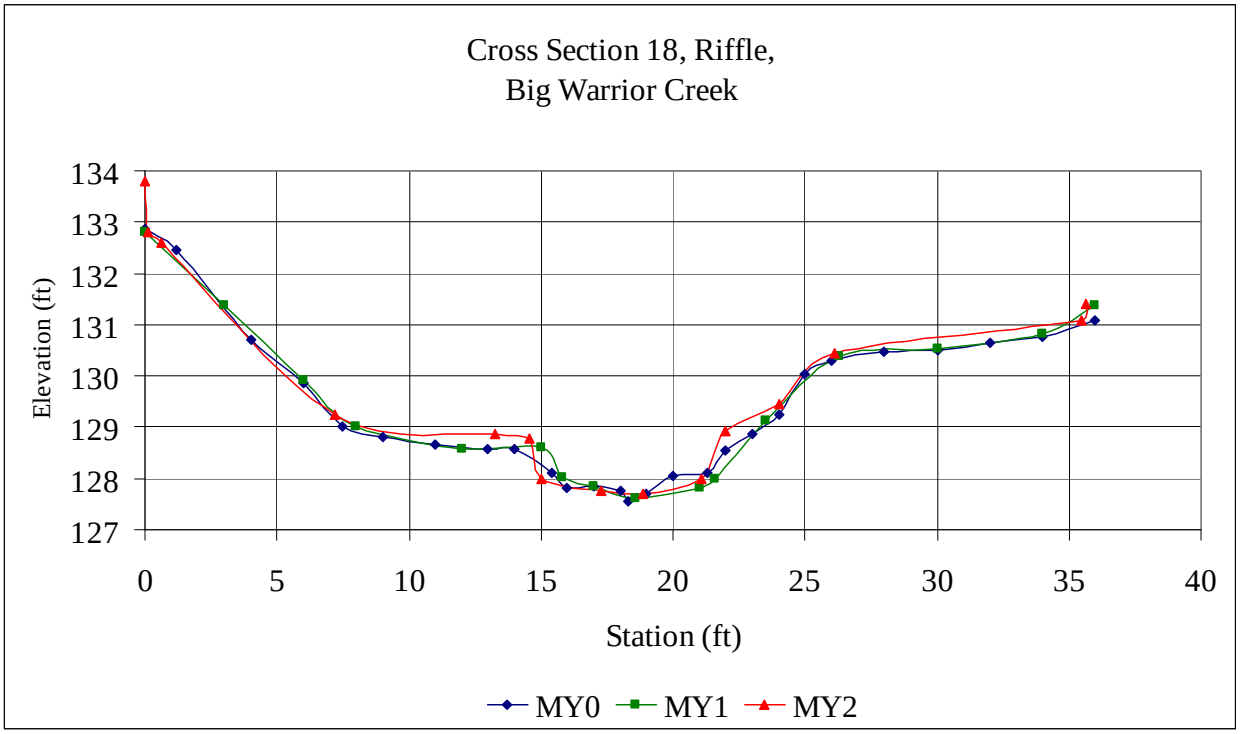
Cross-Section 16 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	40.7	15.3	18.9
Maximum Bankfull Depth (ft)	3.0	1.7	2.0
Bankfull Mean Depth (ft)	2.9	0.9	0.9
Width/Depth Ratio	72.6	17.3	22.0
Entrenchment Ratio	2.5	3.4	1.2
Bankfull Width (ft)	14.0	16.3	20.4

Appendix A.1. Continued.



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

Appendix A.1. Continued.

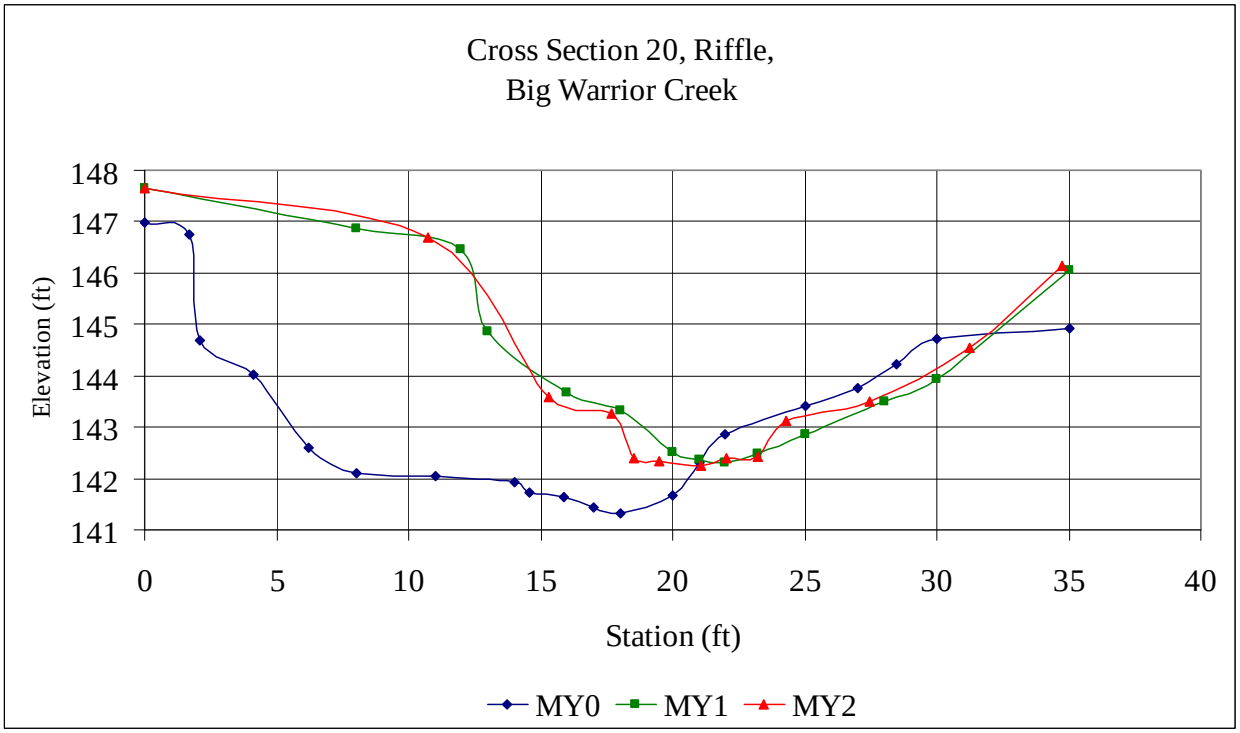


Cross-Section 18 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	10.5	12.5	11.5
Maximum Bankfull Depth (ft)	1.5	1.5	1.5
Bankfull Mean Depth (ft)	0.8	0.8	0.7
Width/Depth Ratio	18.6	19.9	22.3
Entrenchment Ratio	2.5	1.9	1.7
Bankfull Width (ft)	14.0	15.7	16.1

Appendix A.1. Continued.

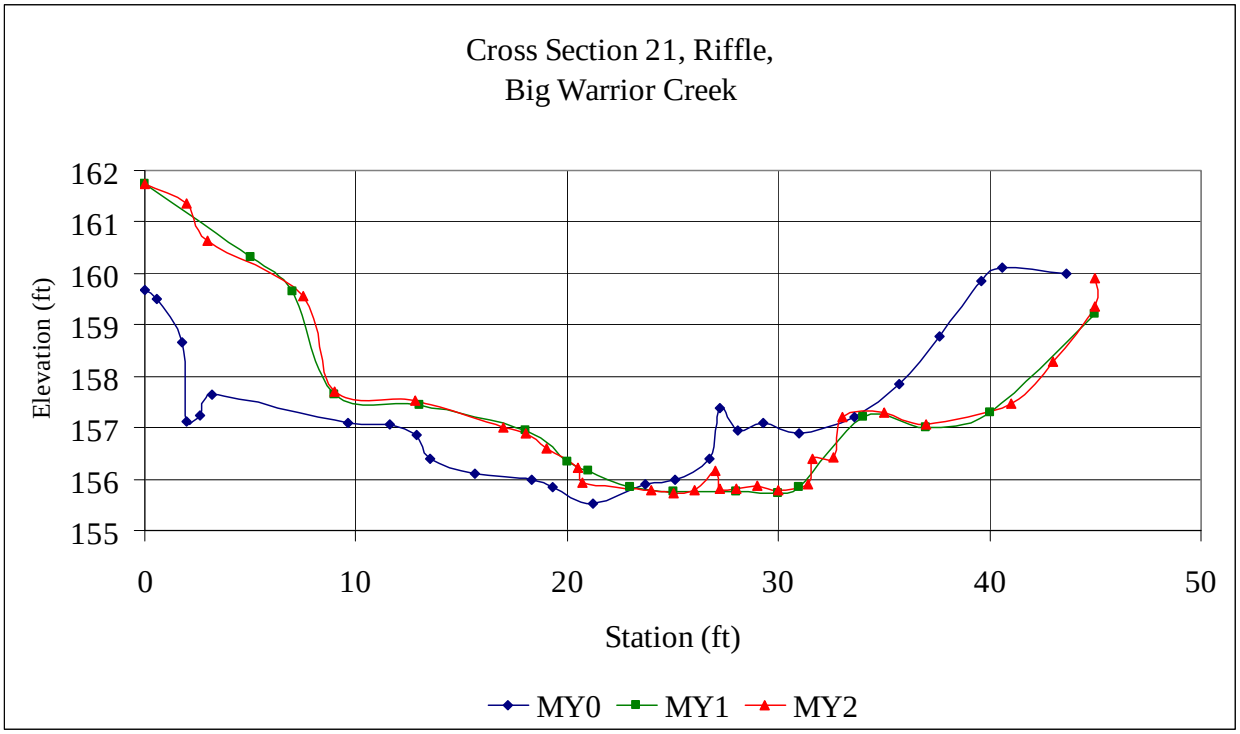
Cross-Section 19 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	16.0	9.8	10.7
Maximum Bankfull Depth (ft)	1.5	1.1	1.3
Bankfull Mean Depth (ft)	0.9	0.8	0.8
Width/Depth Ratio	18.5	16.7	16.8
Entrenchment Ratio	1.7	1.8	1.9
Bankfull Width (ft)	17.2	12.8	13.4

Appendix A.1. Continued.



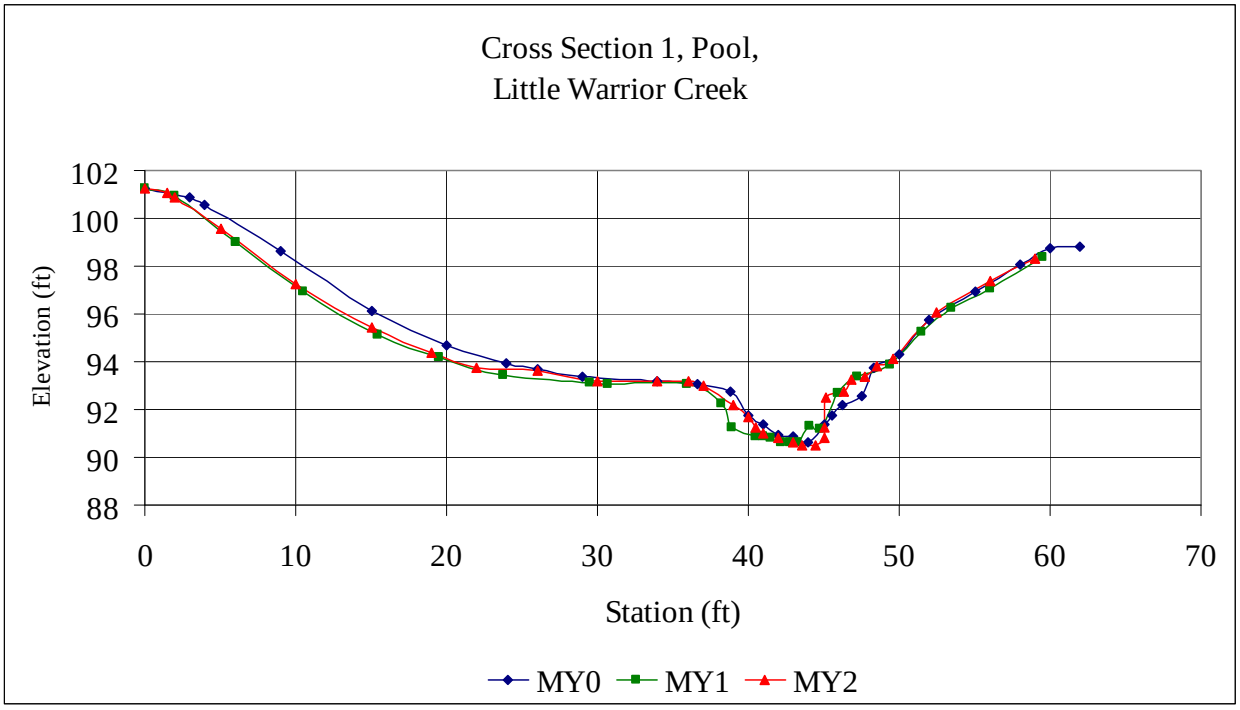
Cross-Section 20 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	14.8	5.4	8.6
Maximum Bankfull Depth (ft)	1.6	1.0	1.3
Bankfull Mean Depth (ft)	0.9	0.6	0.7
Width/Depth Ratio	17.3	15.5	18.1
Entrenchment Ratio	1.6	1.9	1.5
Bankfull Width (ft)	16.0	9.1	12.5

Appendix A.1. Continued.



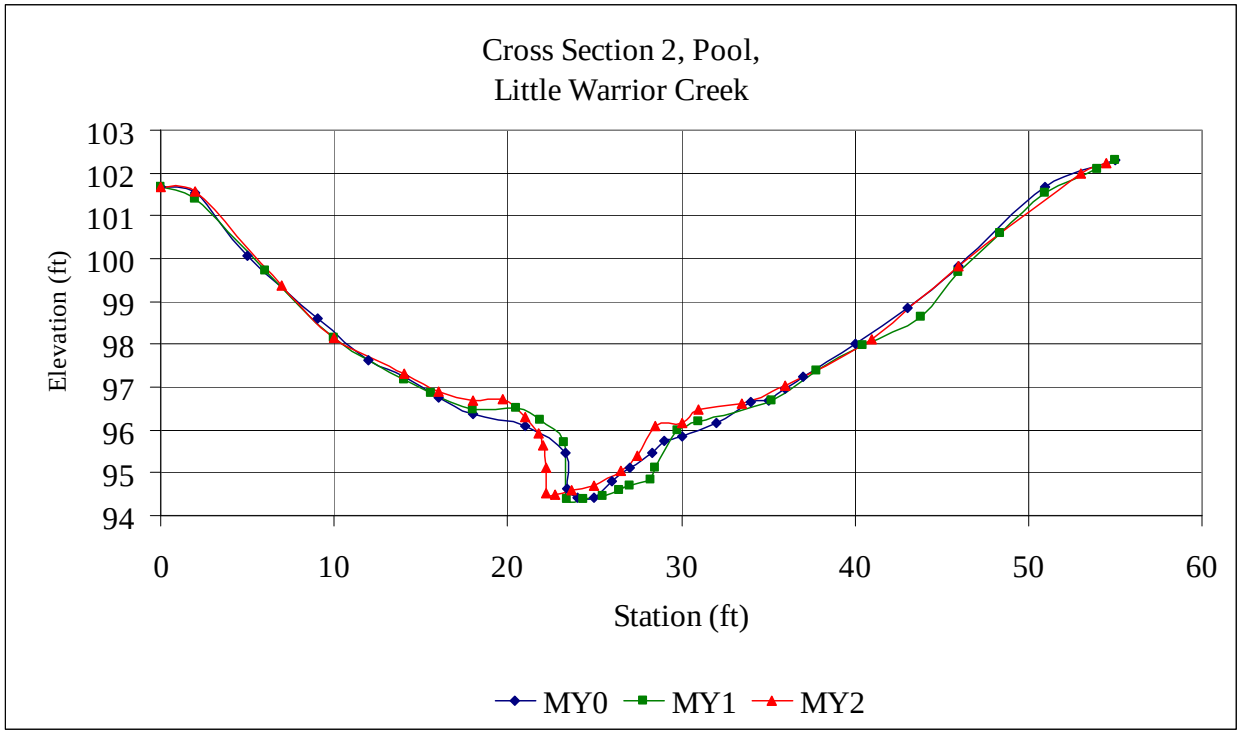
Cross-Section 21 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	12.3	18.8	14.7
Maximum Bankfull Depth (ft)	1.4	1.5	1.3
Bankfull Mean Depth (ft)	0.9	0.8	0.9
Width/Depth Ratio			17.2
Entrenchment Ratio			2.2
Bankfull Width (ft)	14.0	23.6	15.9

Appendix A.2. Cross-section comparisons Little Warrior Creek, MY0-MY2.



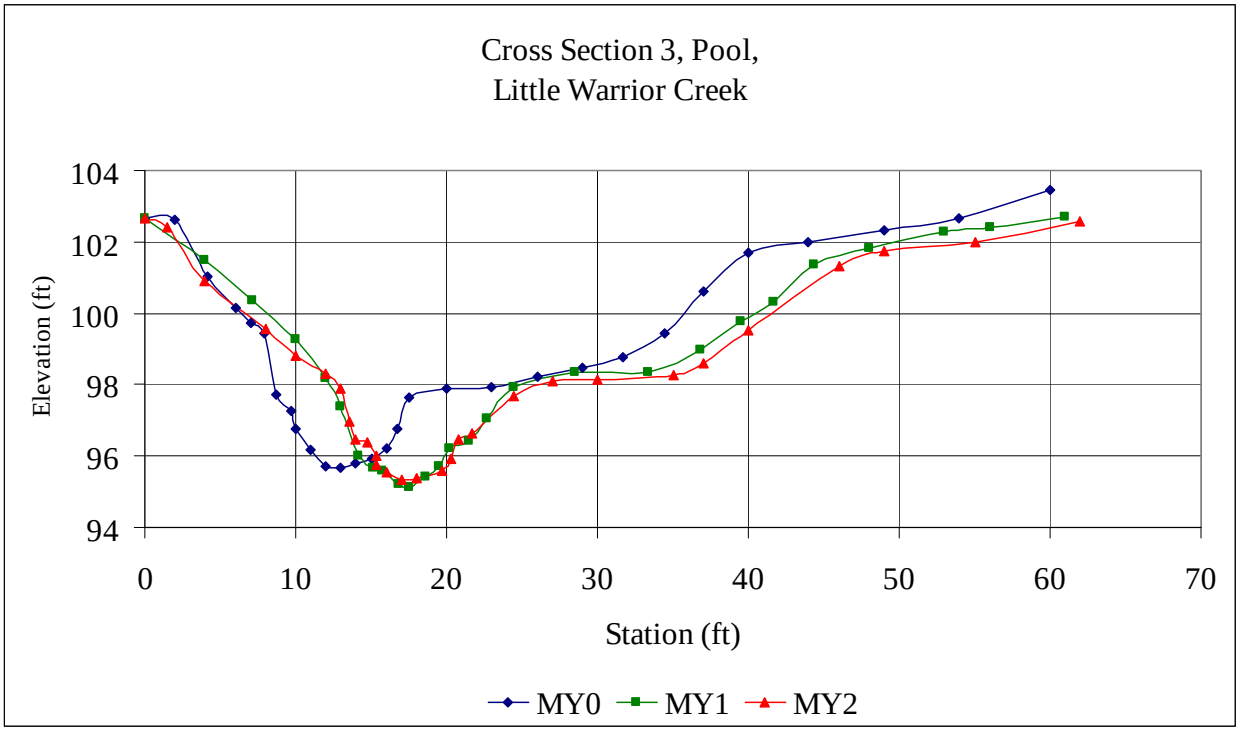
Cross-Section 1 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	18.7	12.0	15.2
Maximum Bankfull Depth (ft)	2.8	2.0	2.7
Bankfull Mean Depth (ft)	1.0	1.4	1.4
Width/Depth Ratio	19.8		7.6
Entrenchment Ratio	1.9		3.6
Bankfull Width (ft)	19.2	8.9	10.7

Appendix A.2. Continued.



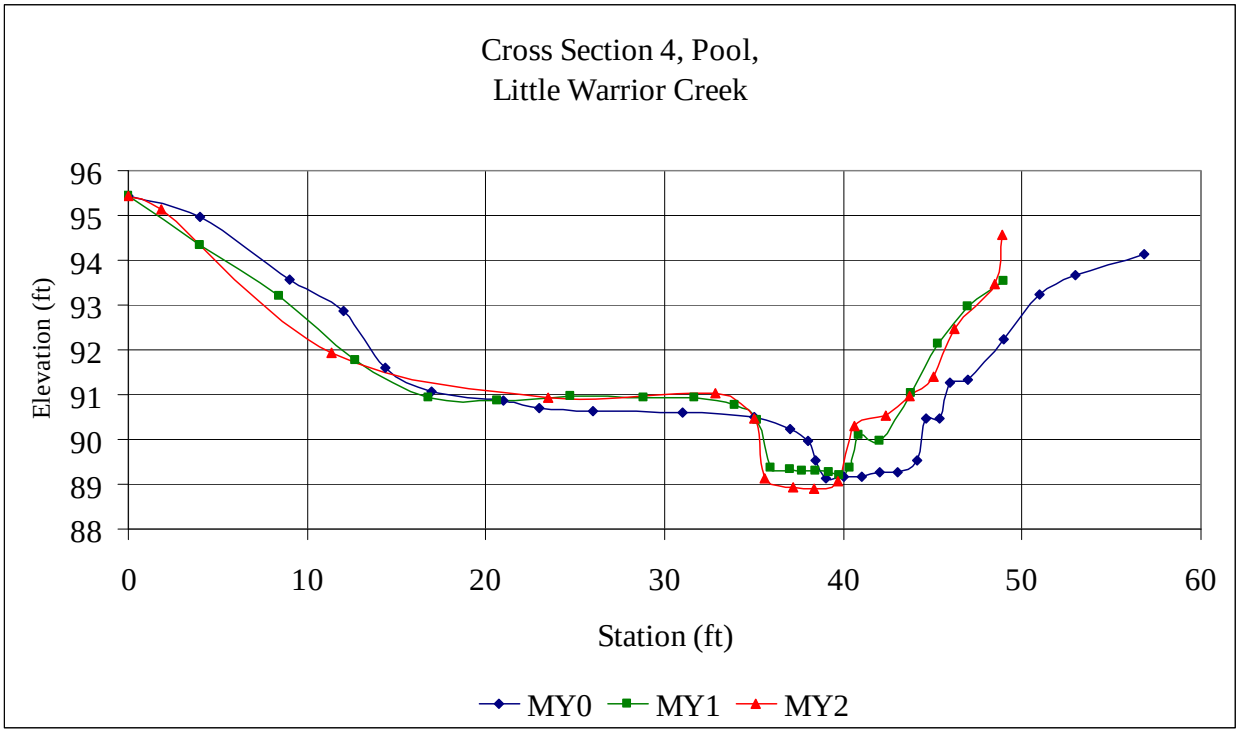
Cross-Section 2 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	16.1	10.0	13.8
Maximum Bankfull Depth (ft)	2.2	1.8	2.2
Bankfull Mean Depth (ft)	1.5	1.1	0.9
Width/Depth Ratio	7.5	8.7	16.6
Entrenchment Ratio	1.8	3.3	2.3
Bankfull Width (ft)	11.0	9.4	15.1

Appendix A.2. Continued.



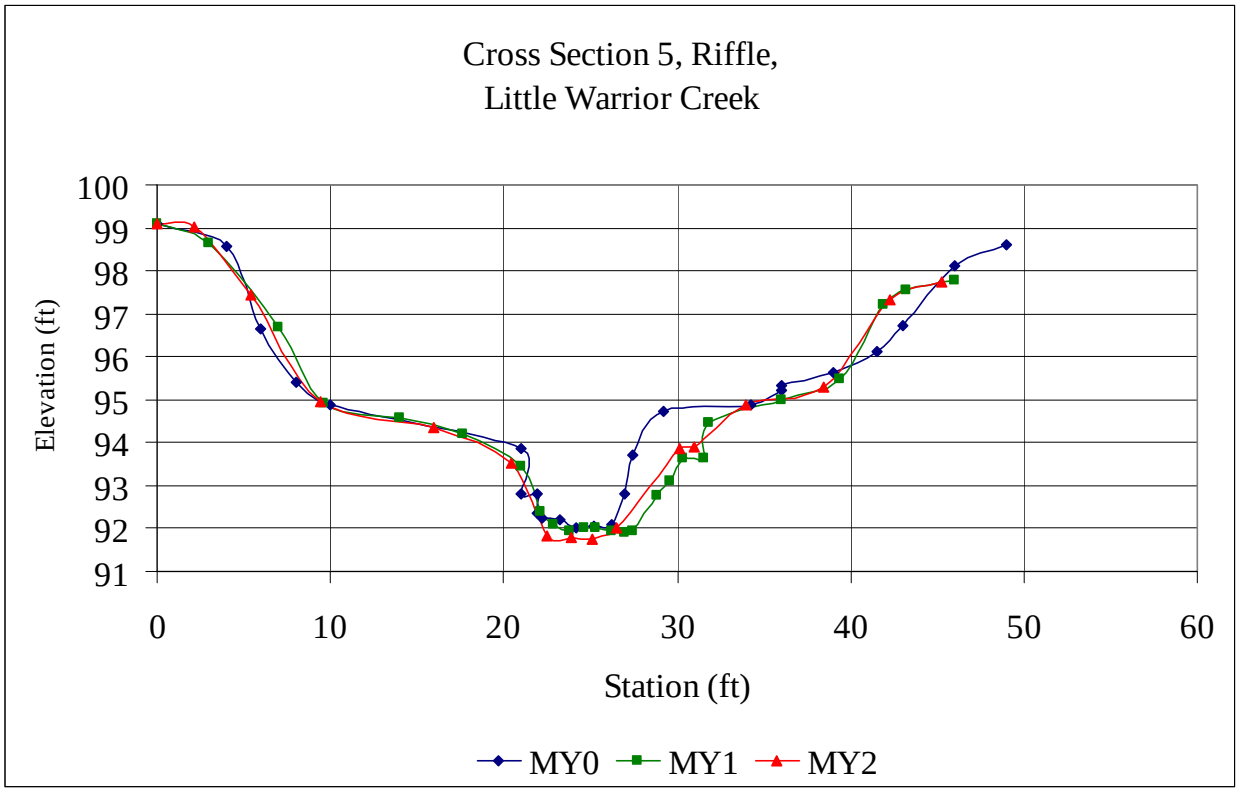
Cross-Section 3 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	23.8	10.9	20.1
Maximum Bankfull Depth (ft)	2.8	1.9	2.7
Bankfull Mean Depth (ft)	2.2	1.2	1.5
Width/Depth Ratio	5.1		9
Entrenchment Ratio	1.8		2.9
Bankfull Width (ft)	11.0	9.4	13.5

Appendix A.2. Continued.



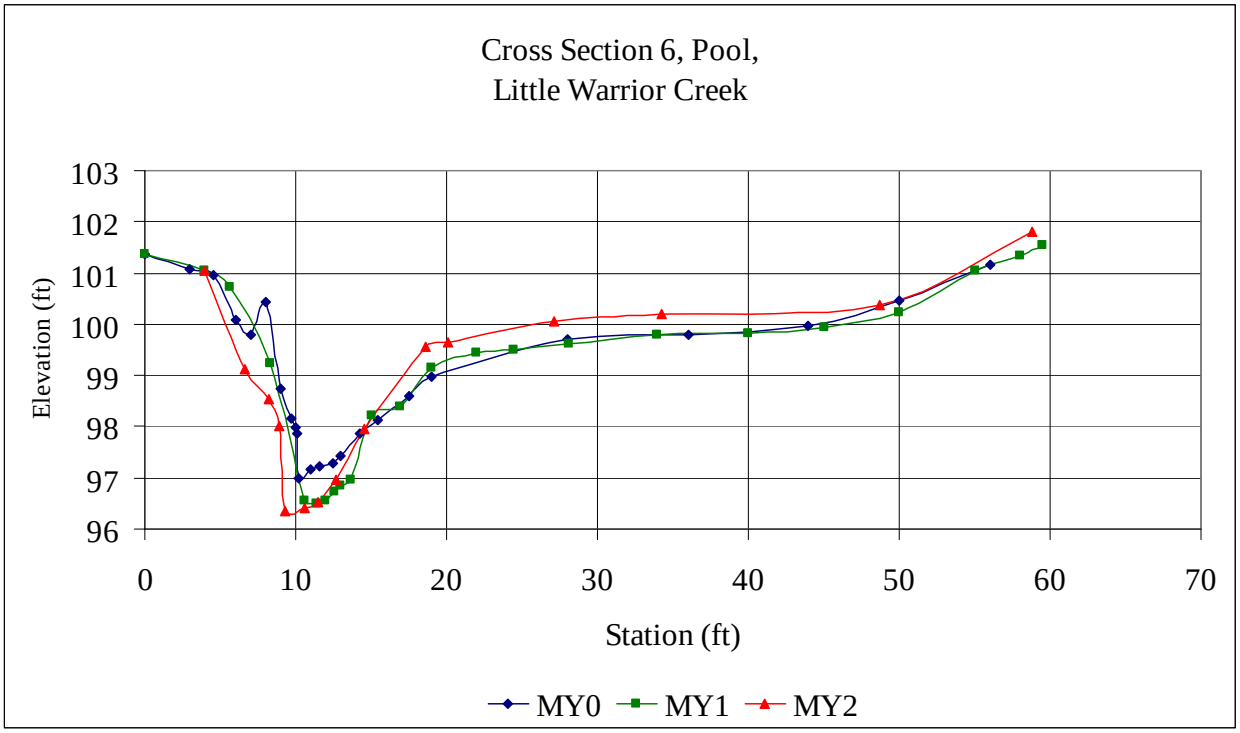
Cross-Section 4 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	15.5	6.5	11.3
Maximum Bankfull Depth (ft)	1.7	1.2	2.0
Bankfull Mean Depth (ft)	1.4	0.9	1.1
Width/Depth Ratio	7.8	8.9	9.6
Entrenchment Ratio	1.8	4.5	3.8
Bankfull Width (ft)	11.0	7.6	10.4

Appendix A.2. Continued.



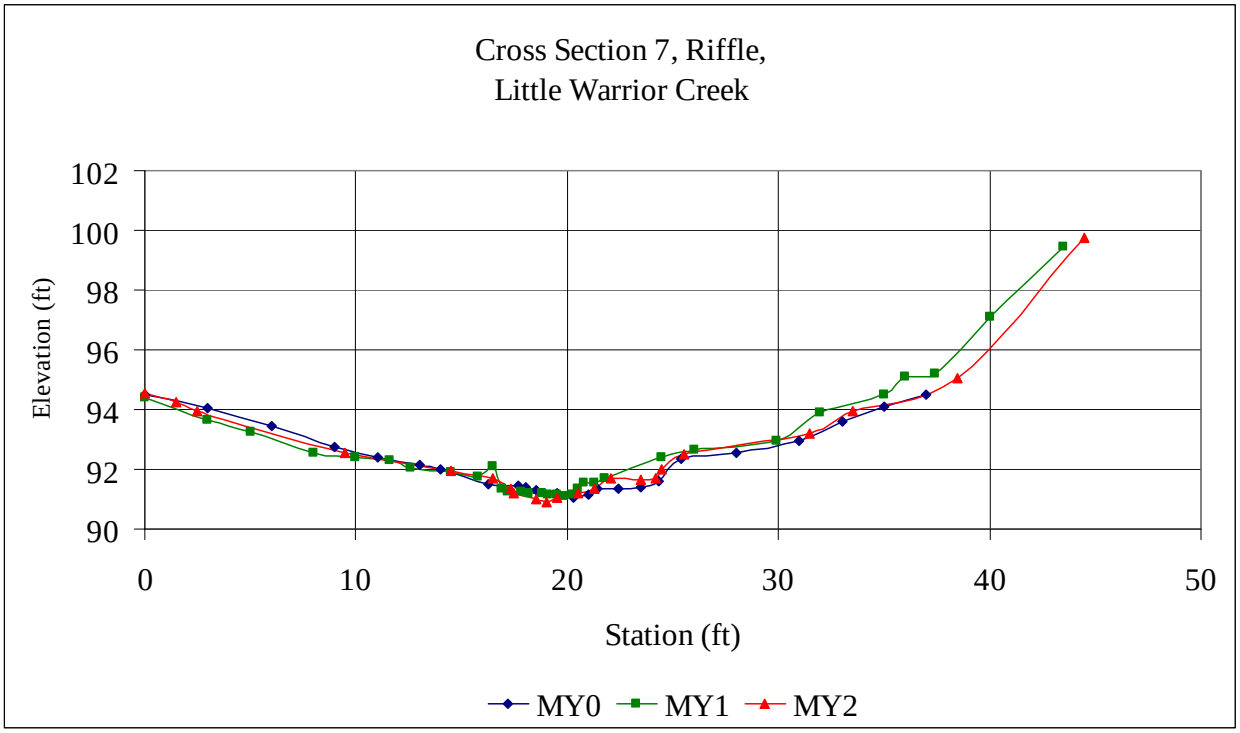
Cross-Section 5 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	16.5	10.0	14.3
Maximum Bankfull Depth (ft)	2.7	1.5	2.1
Bankfull Mean Depth (ft)	1.5	1.1	1.2
Width/Depth Ratio	7.3	8.1	9.4
Entrenchment Ratio	1.8	3.0	2.8
Bankfull Width (ft)	11.0	9.0	11.6

Appendix A.2. Continued.



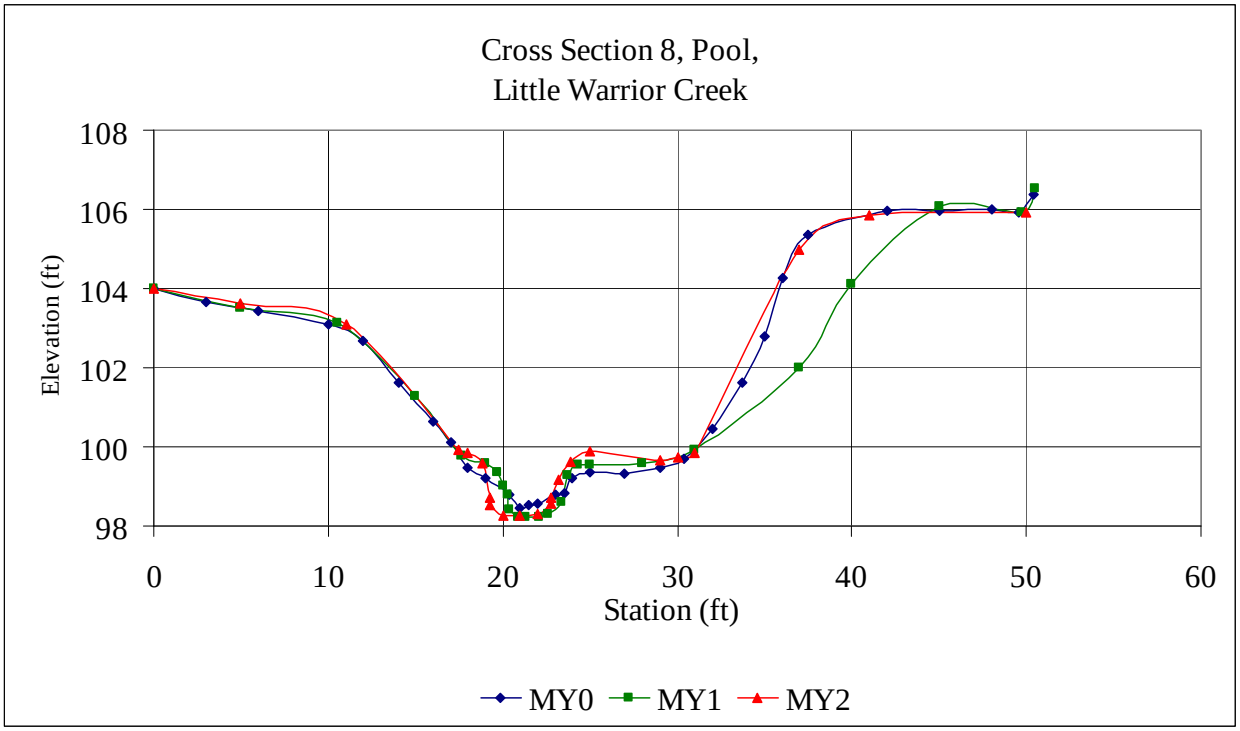
Cross-Section 6 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	10.2	5.8	6.0
Maximum Bankfull Depth (ft)	2.0	1.7	1.6
Bankfull Mean Depth (ft)	0.9	1.3	1.1
Width/Depth Ratio	11.8	3.6	5.3
Entrenchment Ratio	1.8	8.7	2.2
Bankfull Width (ft)	11.0	4.6	5.6

Appendix A.2. Continued.



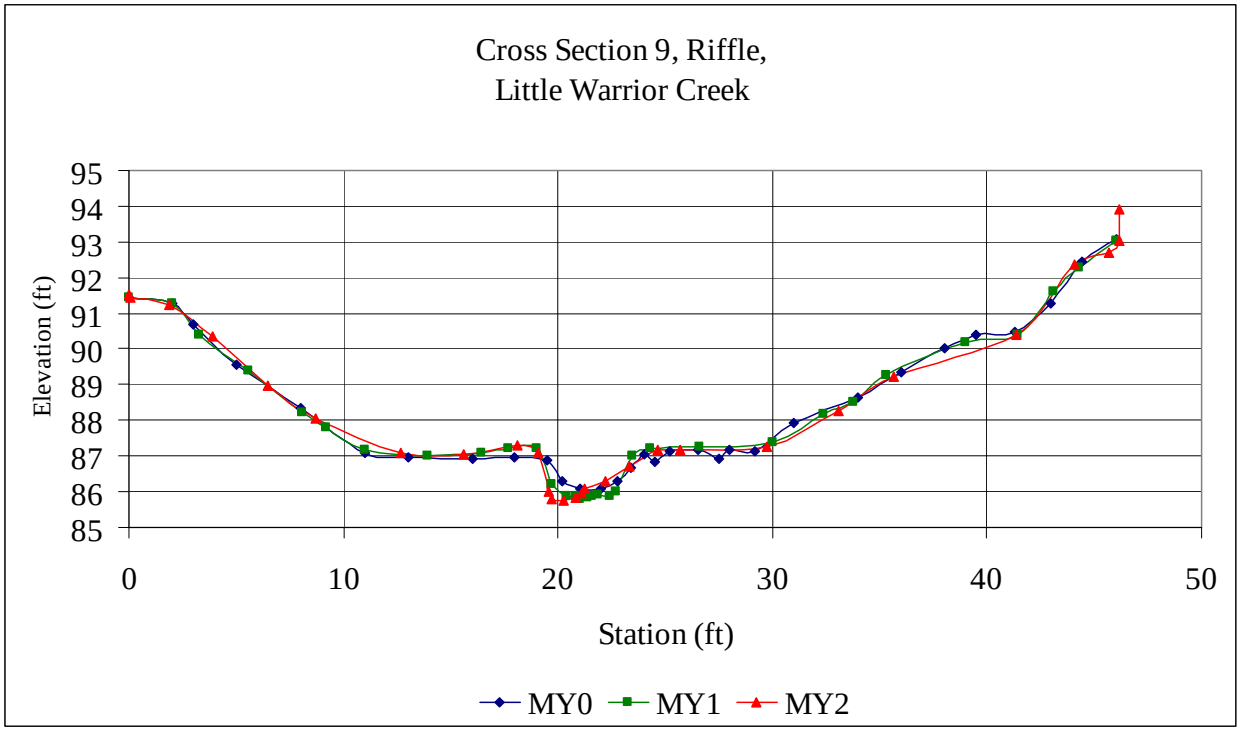
Cross-Section 7 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	10.6	2.2	11.5
Maximum Bankfull Depth (ft)	1.3	0.6	1.6
Bankfull Mean Depth (ft)	1.0	0.4	0.8
Width/Depth Ratio	11.4	12.5	20.4
Entrenchment Ratio	1.8	3.0	2.1
Bankfull Width (ft)	11.0	5.3	15.3

Appendix A.2. Continued.



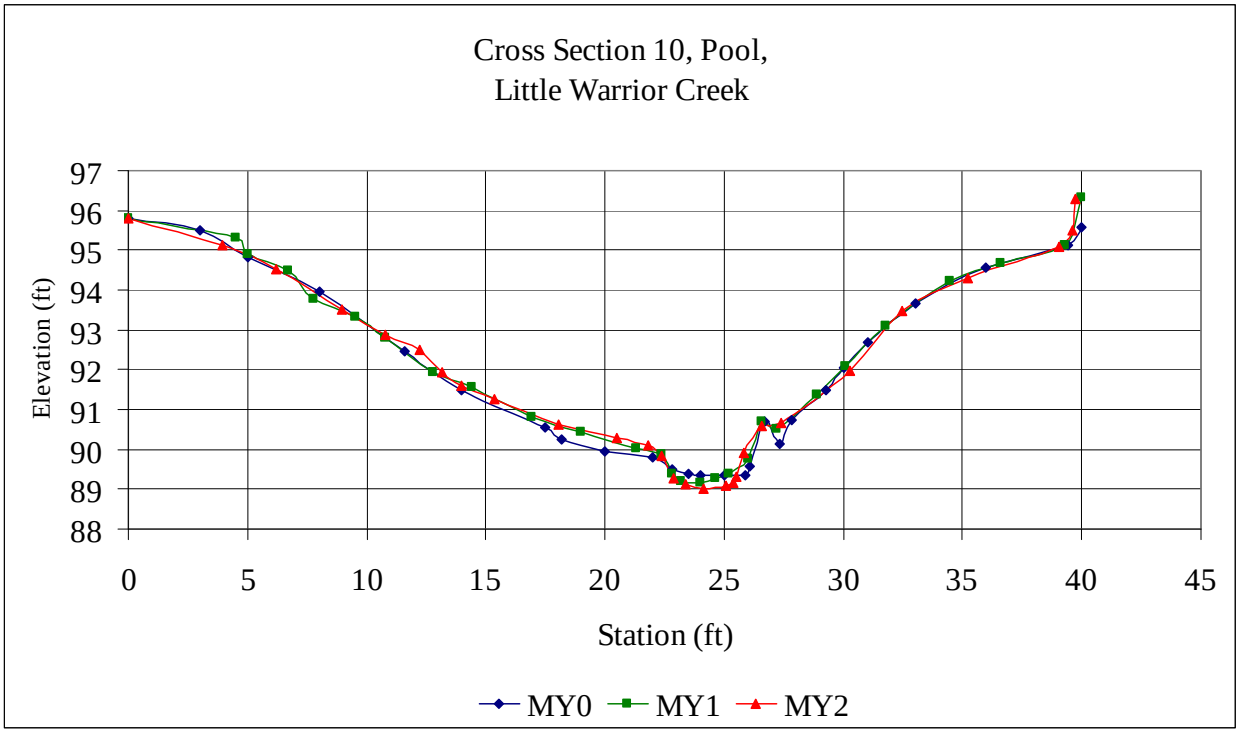
Cross-Section 8 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	7.0	3.5	8.2
Maximum Bankfull Depth (ft)	1.2	1.1	1.7
Bankfull Mean Depth (ft)	0.6	0.8	0.6
Width/Depth Ratio	17.2		22.6
Entrenchment Ratio	1.8		1.4
Width/Depth Ratio	11.0	4.2	13.6

Appendix A.2. Continued.



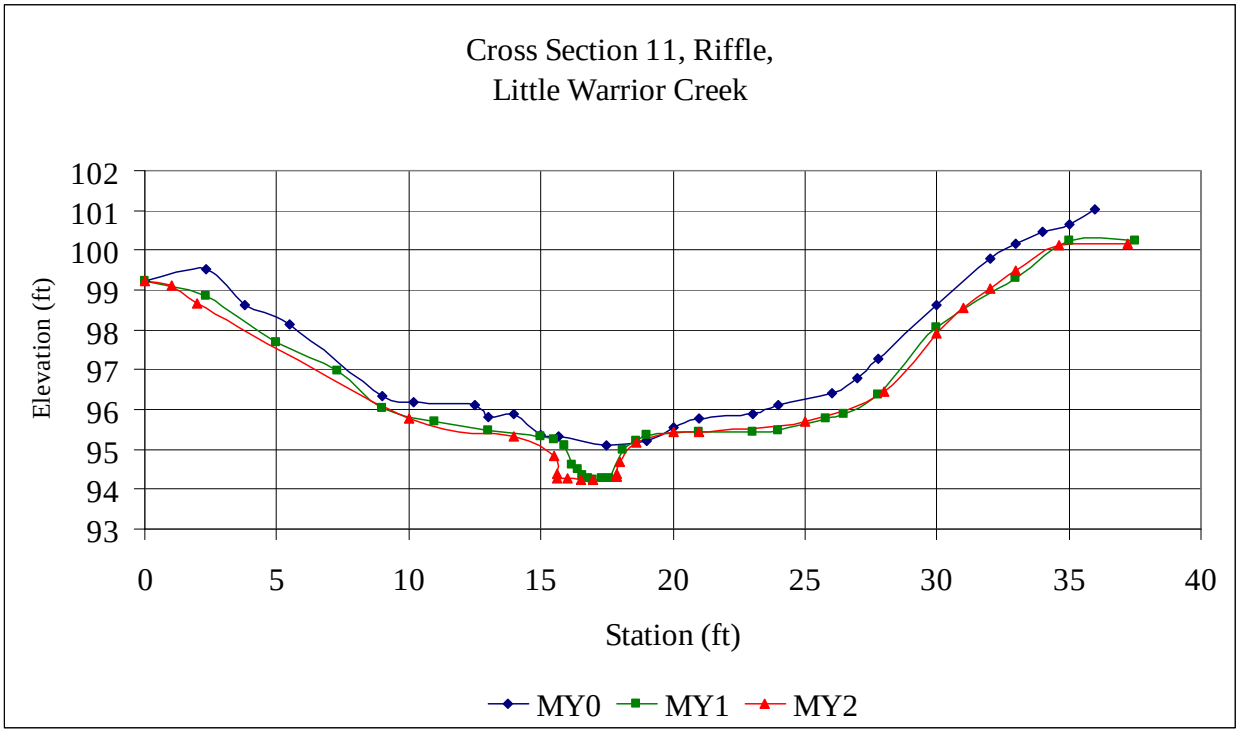
Cross-Section 9 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	5.4	5.7	5.9
Maximum Bankfull Depth (ft)	1.1	1.4	1.5
Bankfull Mean Depth (ft)	0.5	0.5	0.4
Width/Depth Ratio	22.5		42.8
Entrenchment Ratio	1.8		1.7
Bankfull Width (ft)	11.0	12.0	15.8

Appendix A.2. Continued.



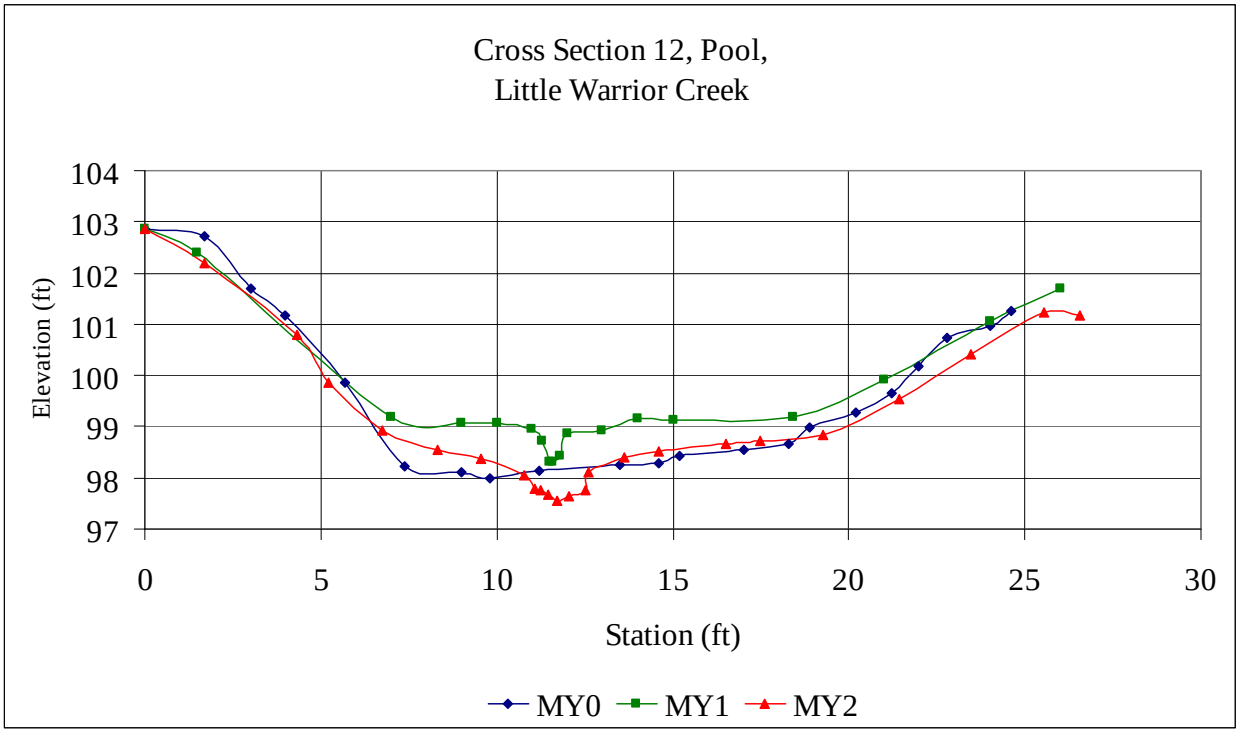
Cross-Section 10 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	7.2	1.8	4.2
Maximum Bankfull Depth (ft)	1.2	0.7	1.3
Bankfull Mean Depth (ft)	0.7	0.5	0.7
Width/Depth Ratio	16.9	7.3	8.3
Entrenchment Ratio	1.8	2.7	2.6
Bankfull Width (ft)	11.0	3.7	5.9

Appendix A.2. Continued.



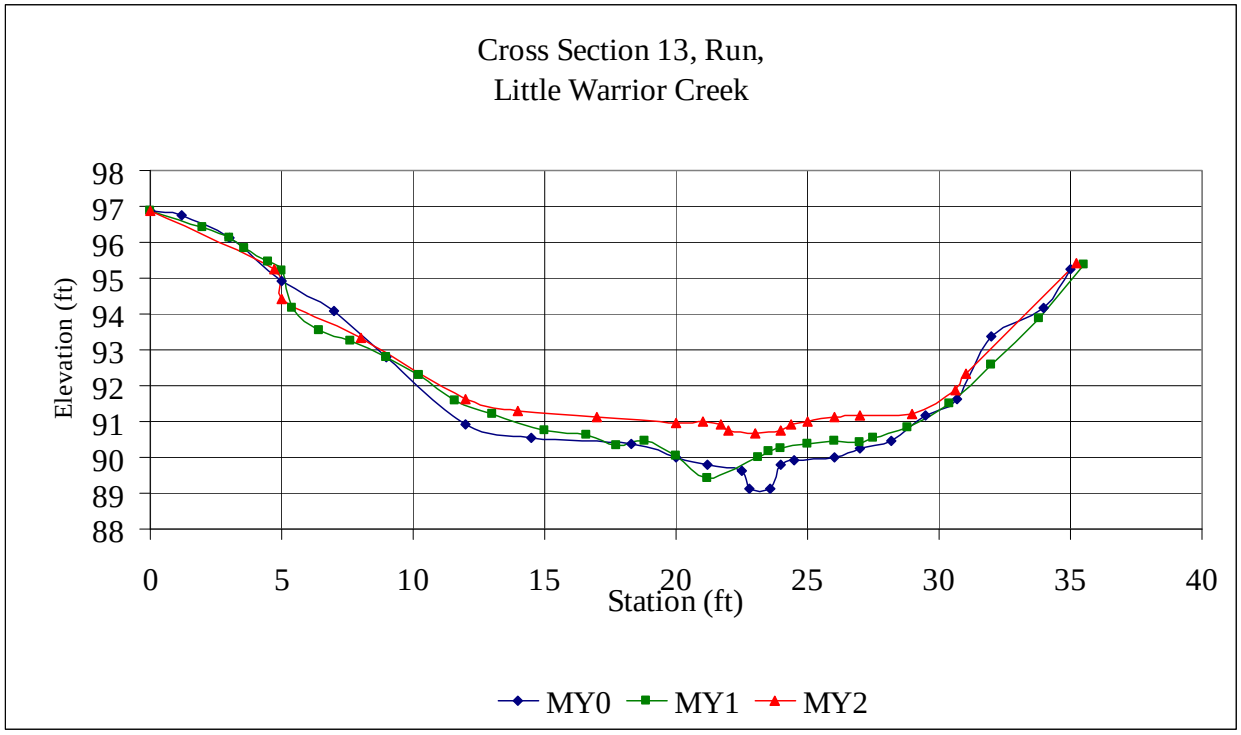
Cross-Section 11 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	3.8	1.4	4.1
Maximum Bankfull Depth (ft)	0.8	0.9	1.2
Bankfull Mean Depth (ft)	0.4	0.6	0.6
Width/Depth Ratio	21.3	4.2	12.3
Entrenchment Ratio	1.9	7.0	2.9
Bankfull Width (ft)	9.0	2.4	7.1

Appendix A.2. Continued.



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

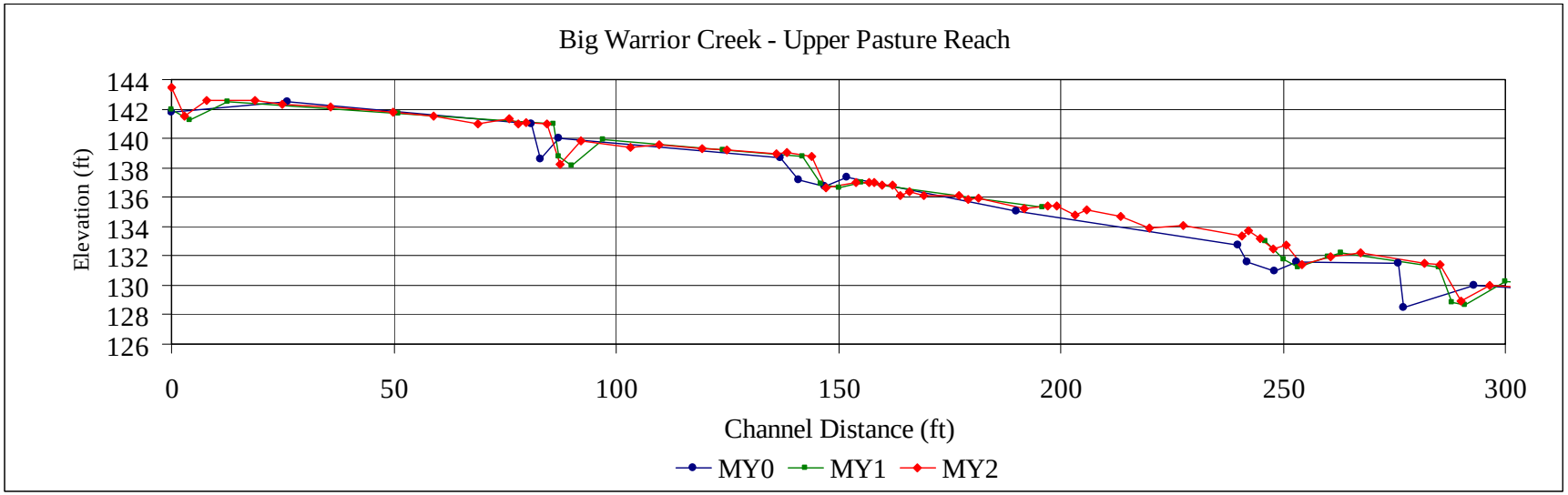
Appendix A.2. Continued.

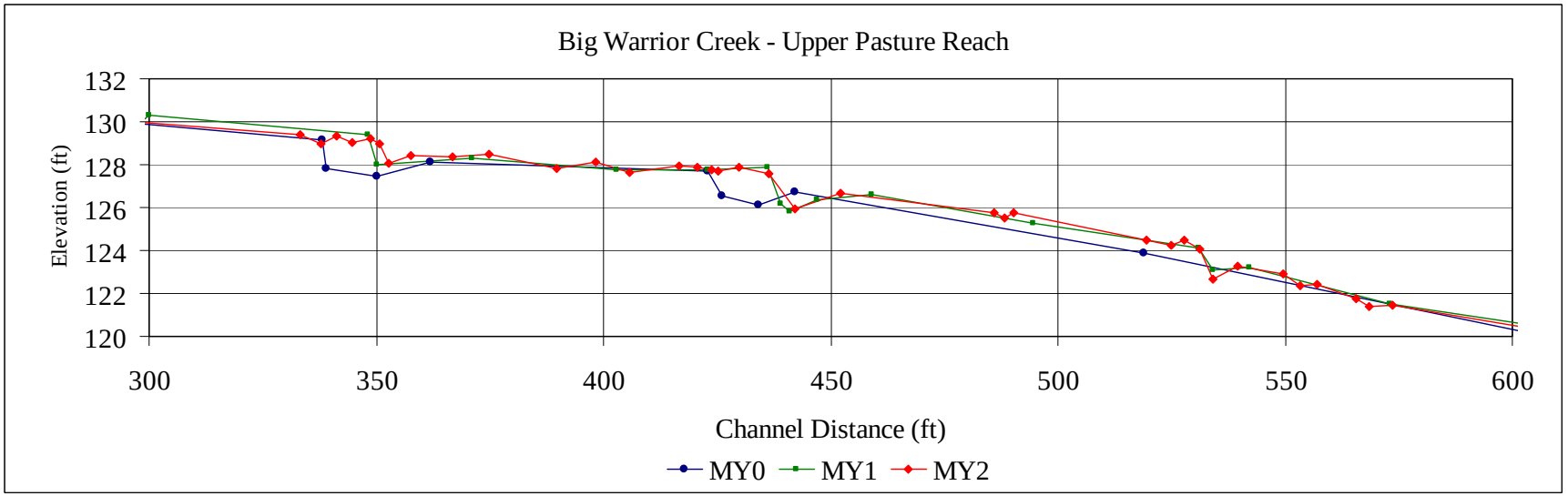


Cross-Section 13 Abbreviated Morphological Summary			
	MY0	MY1	MY2
Bankfull Cross Sectional Area (ft^2)	3.6	13.1	1.6
Maximum Bankfull Depth (ft)	1.1	1.8	0.4
Bankfull Mean Depth (ft)	0.4	0.8	0.2
Width/Depth Ratio	20.3	21.2	48.3
Entrenchment Ratio	2.1	1.4	2.0
Bankfull Width (ft)	8.5	16.7	8.8

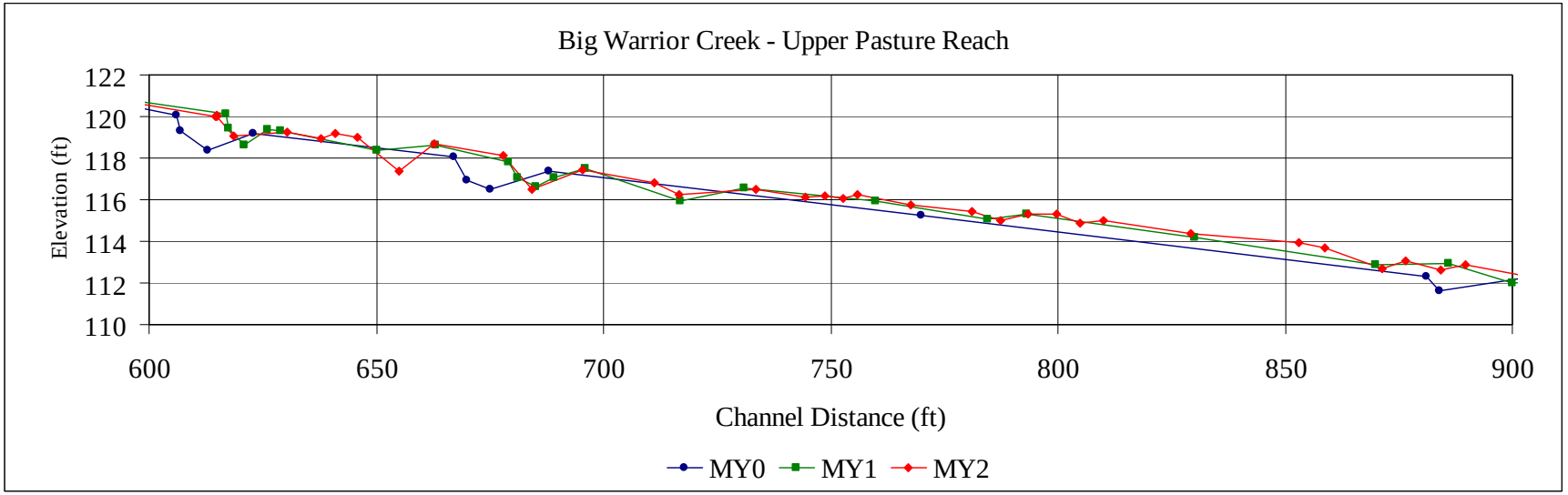
9 Appendix B.– Longitudinal Profile and Pebble Count Comparisons, and Hydrograph

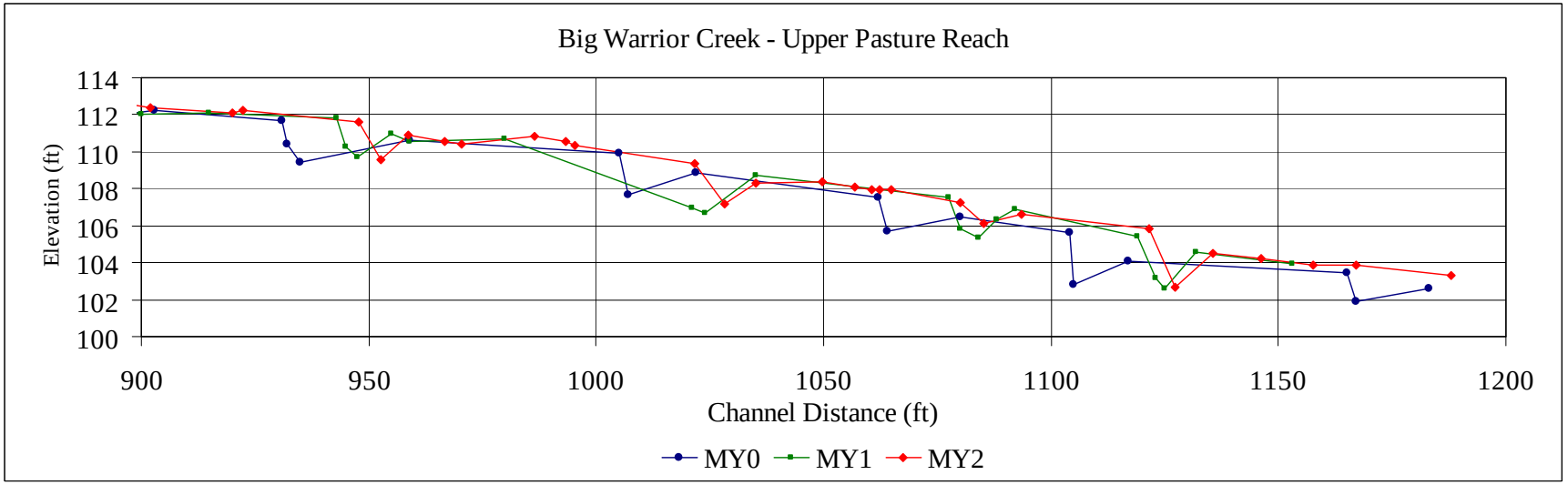
Appendix B.1.1. Longitudinal profile comparisons, Big Warrior Creek, MY0-MY2.



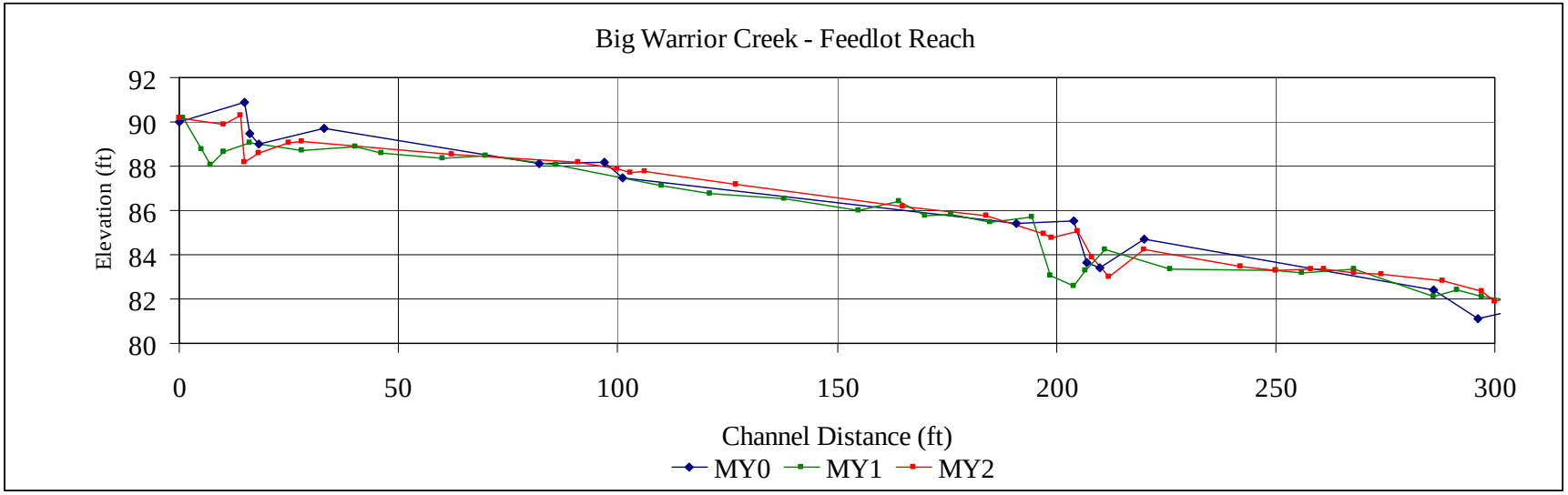


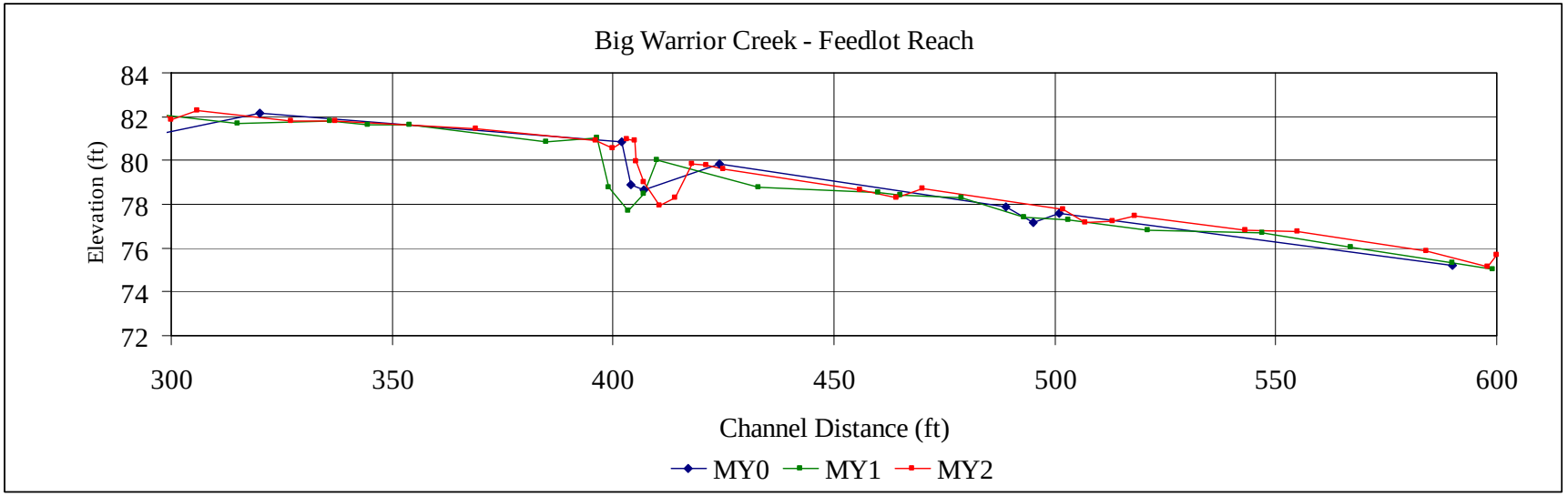
Appendix B.1.1. Continued.



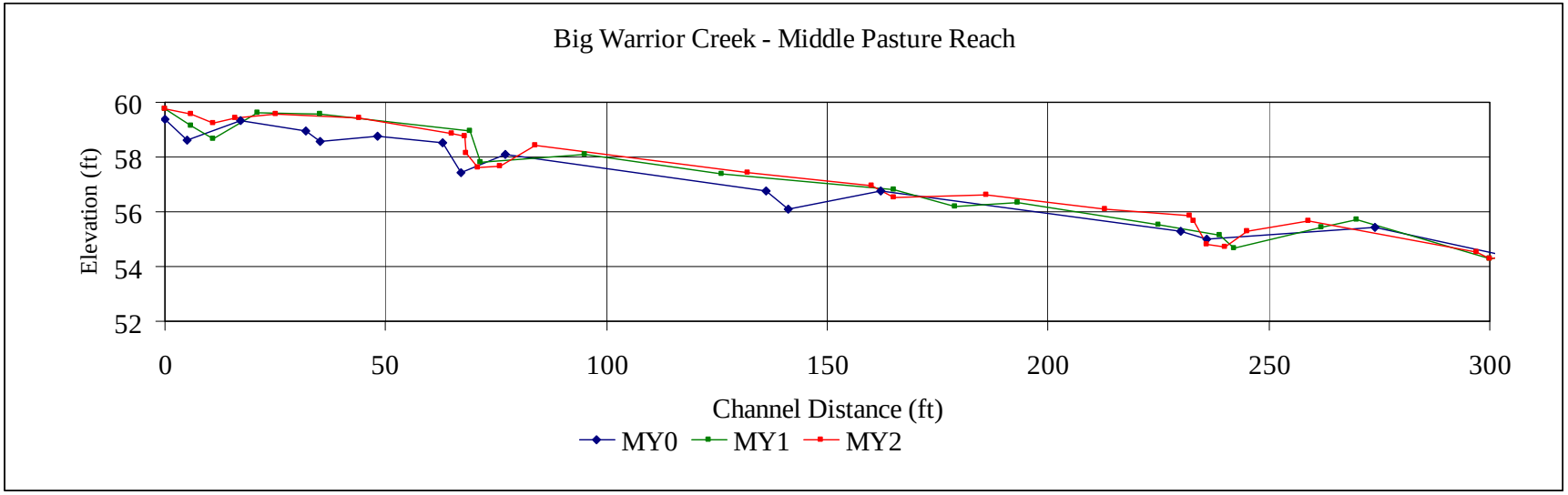


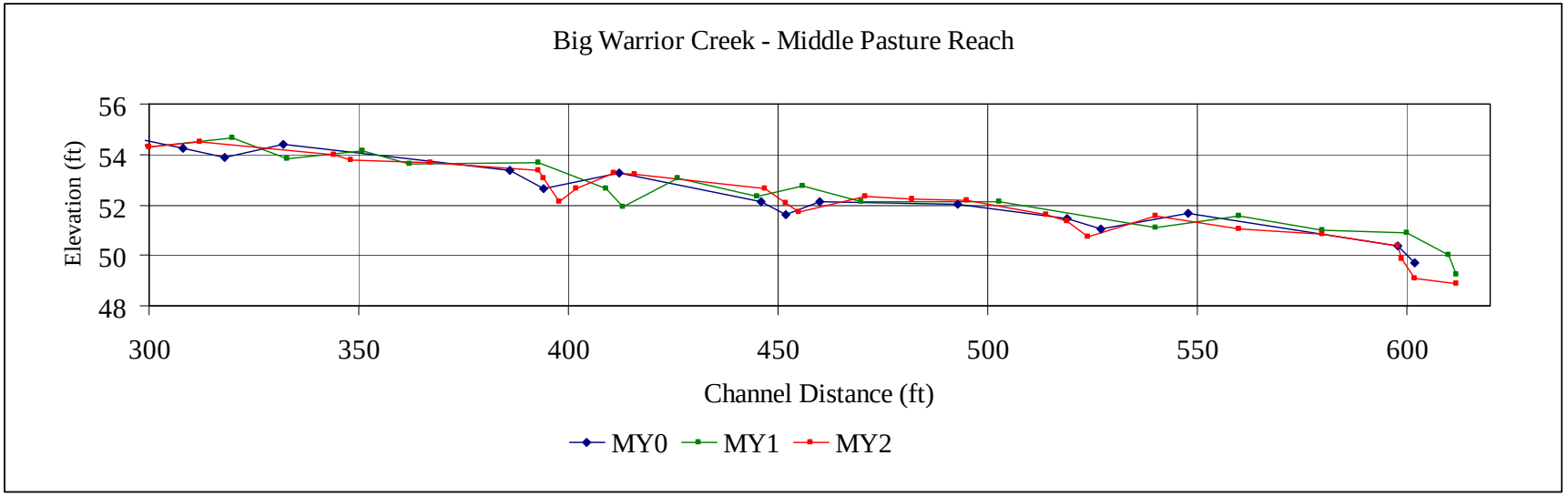
Appendix B.1.1. Continued.



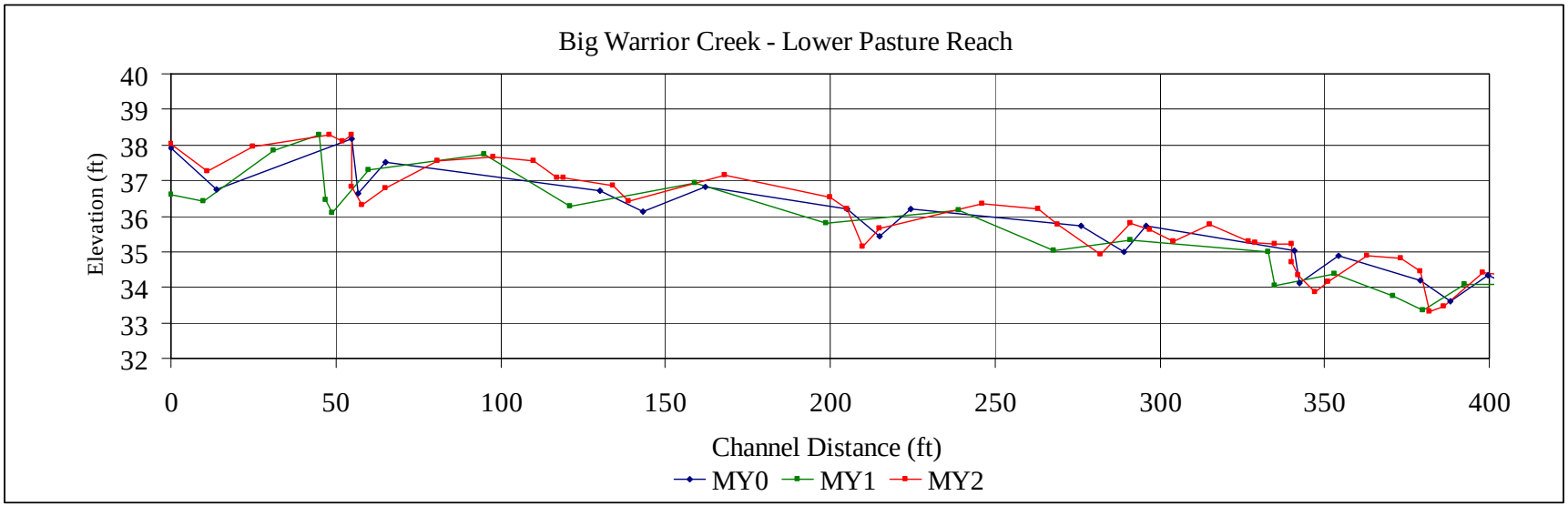


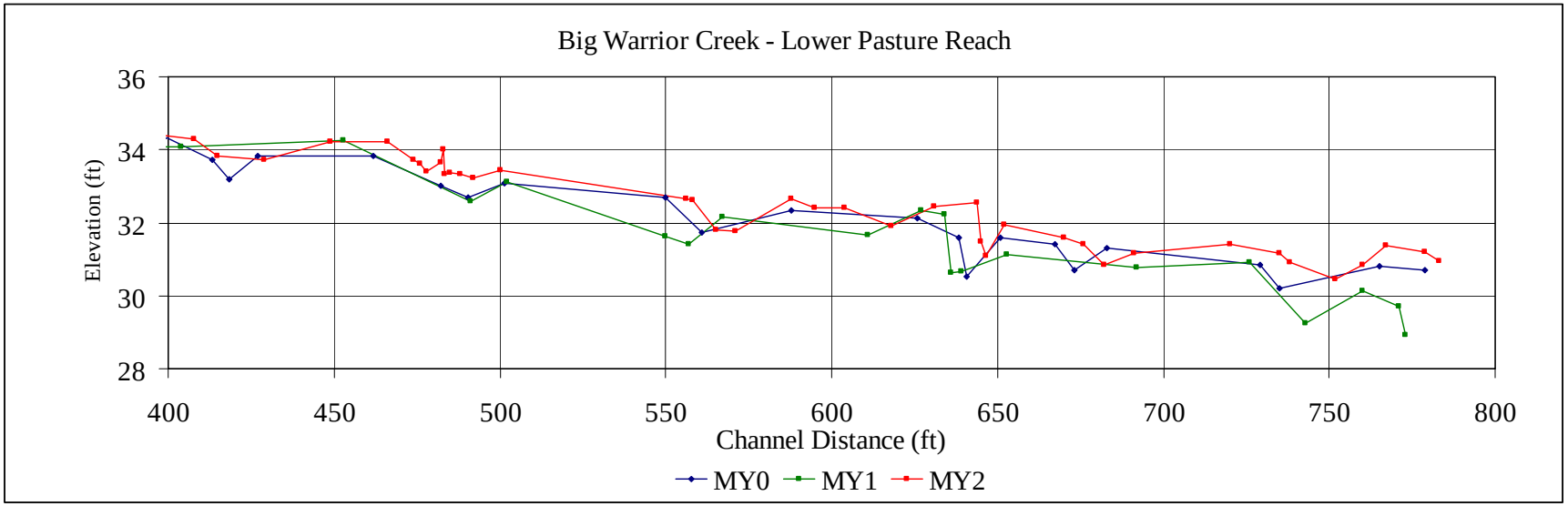
Appendix B.1.1. Continued.



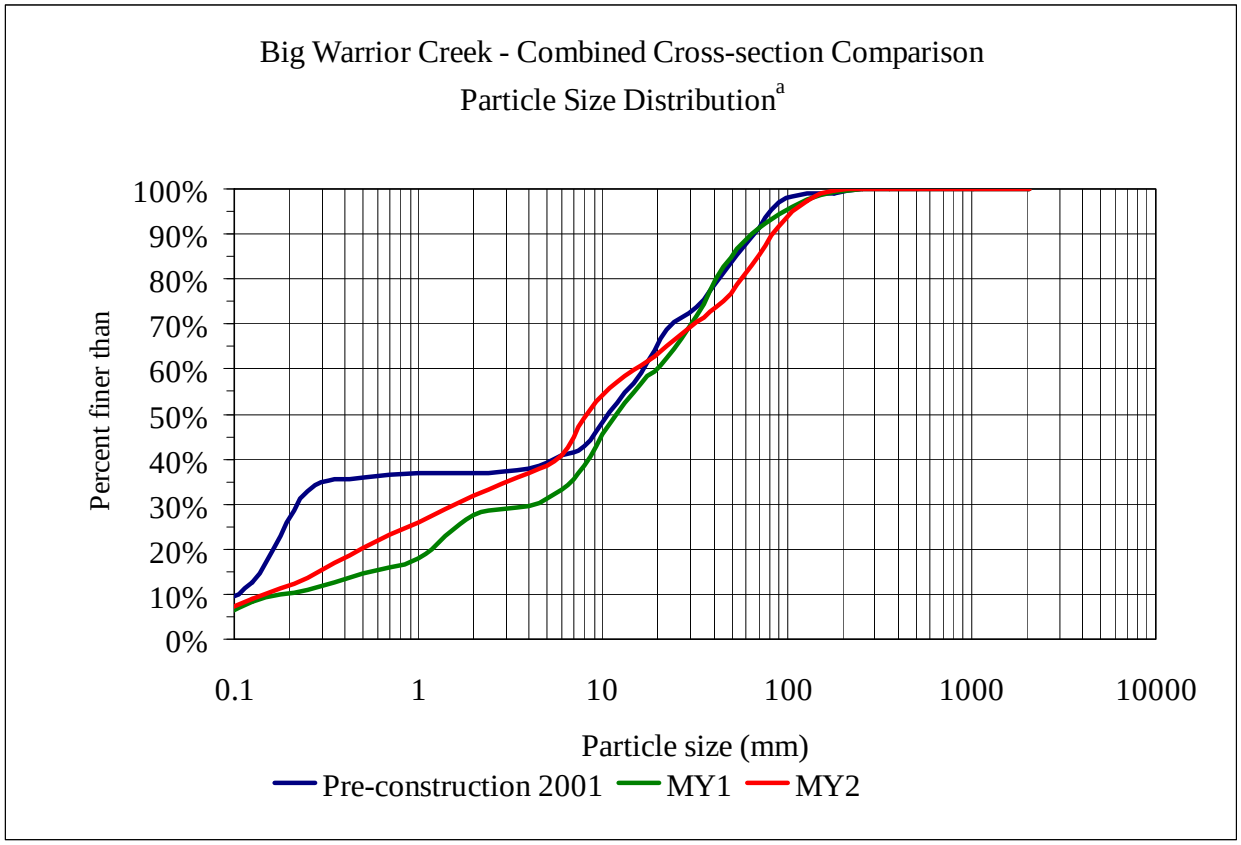


Appendix B.1.1. Continued.





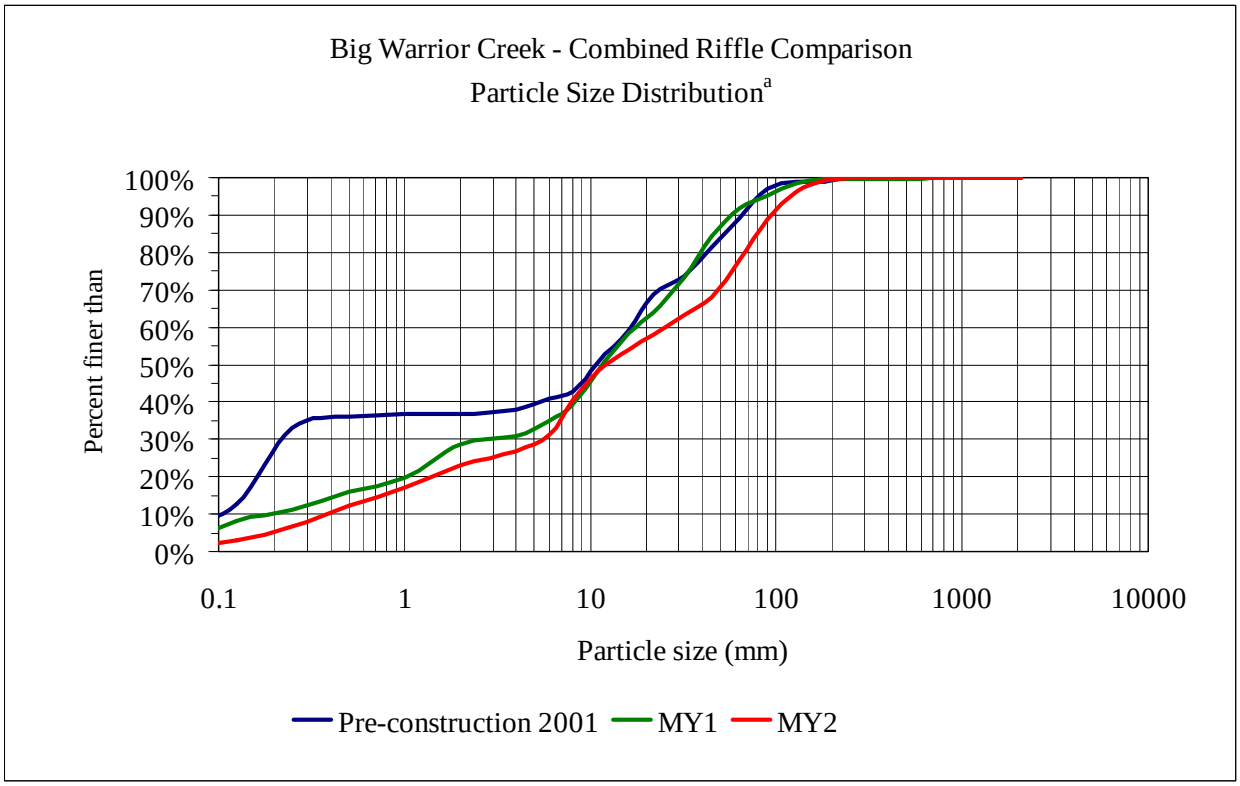
Appendix B.1.2. Pebble Count Comparisons, Big Warrior Creek, MY0-MY2.



[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
D_{16}	0.13	0.65	0.32
D_{35}	0.28	6.60	3.10
D_{50}	11.30	12.00	8.30
D_{84}	50.00	48.00	66.00
D_{95}	80.00	96.00	110.00

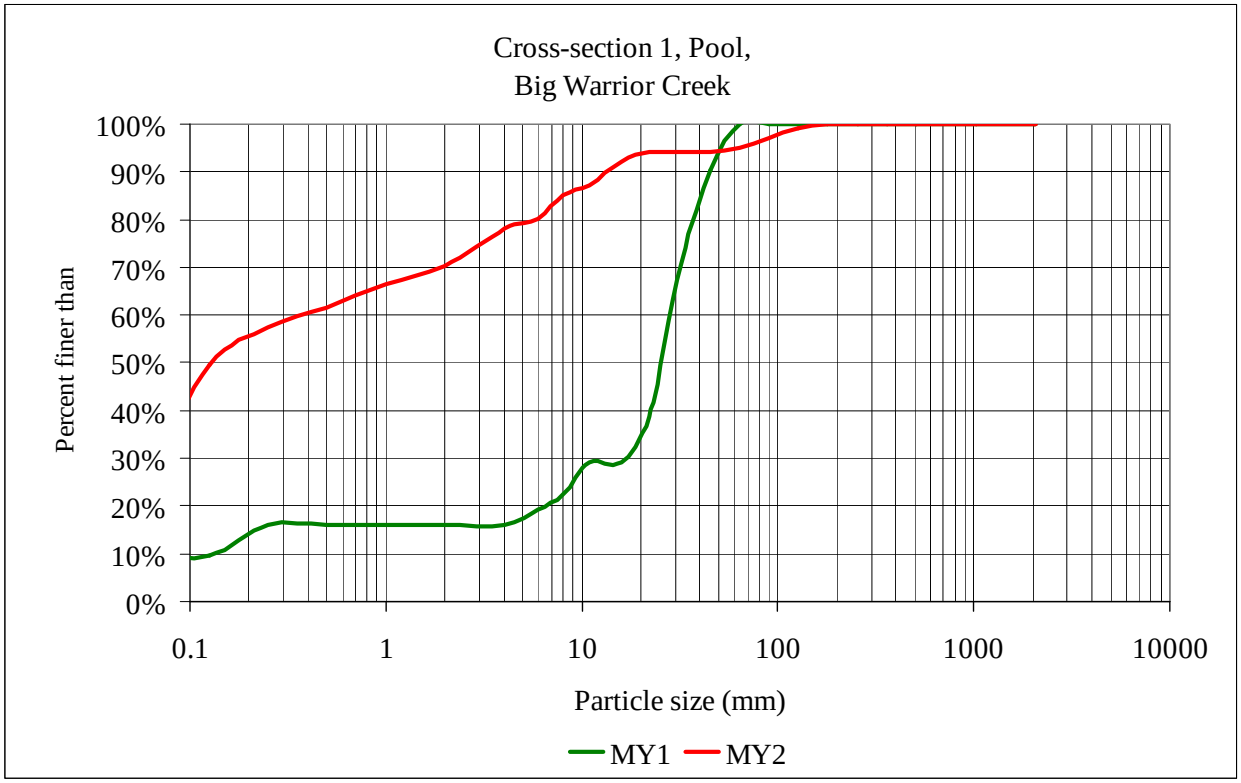
Appendix B.1.2. Continued.



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

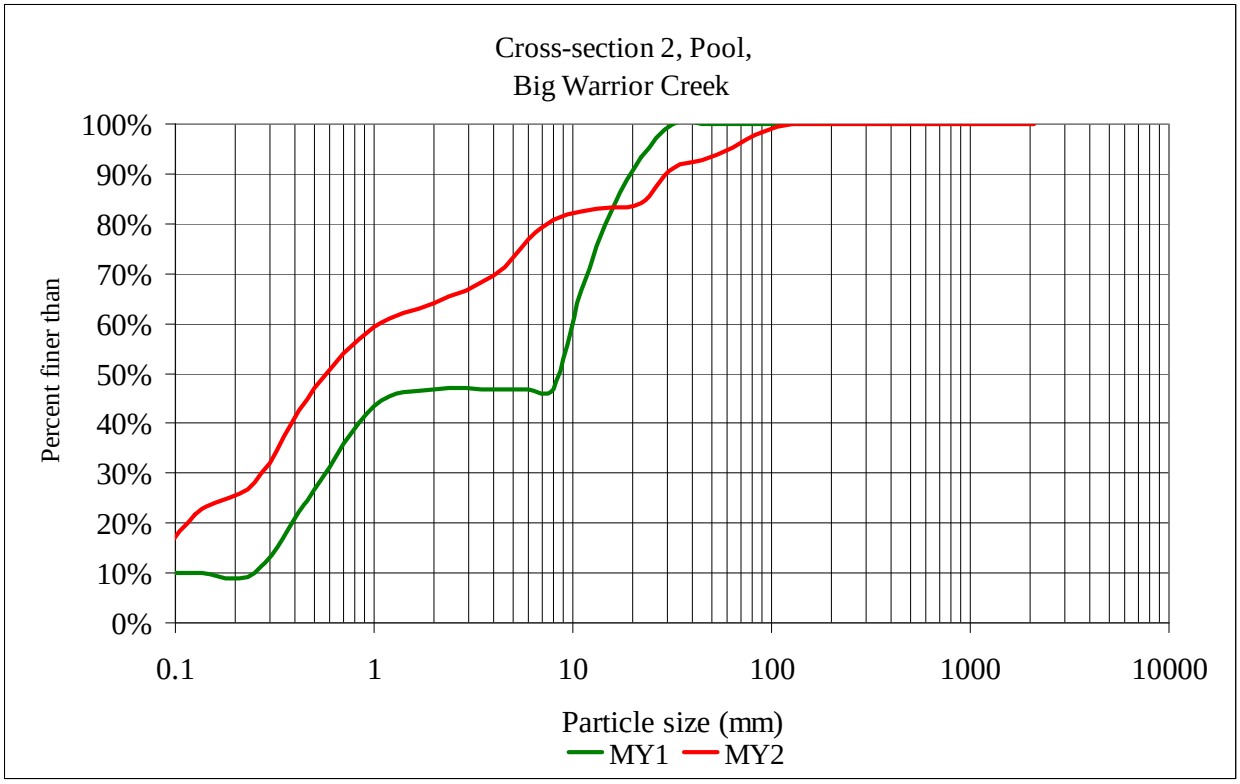
Size class index	Riffle particle size (mm) in year sampled		
	Pre-construction 2001	MY1	MY2
D_{16}	0.13	0.51	0.87
D_{35}	0.28	6.00	6.80
D_{50}	11.30	12.00	12.00
D_{84}	50.00	45.00	77.00
D_{95}	80.00	89.00	120.00

Appendix B.1.2. Continued.



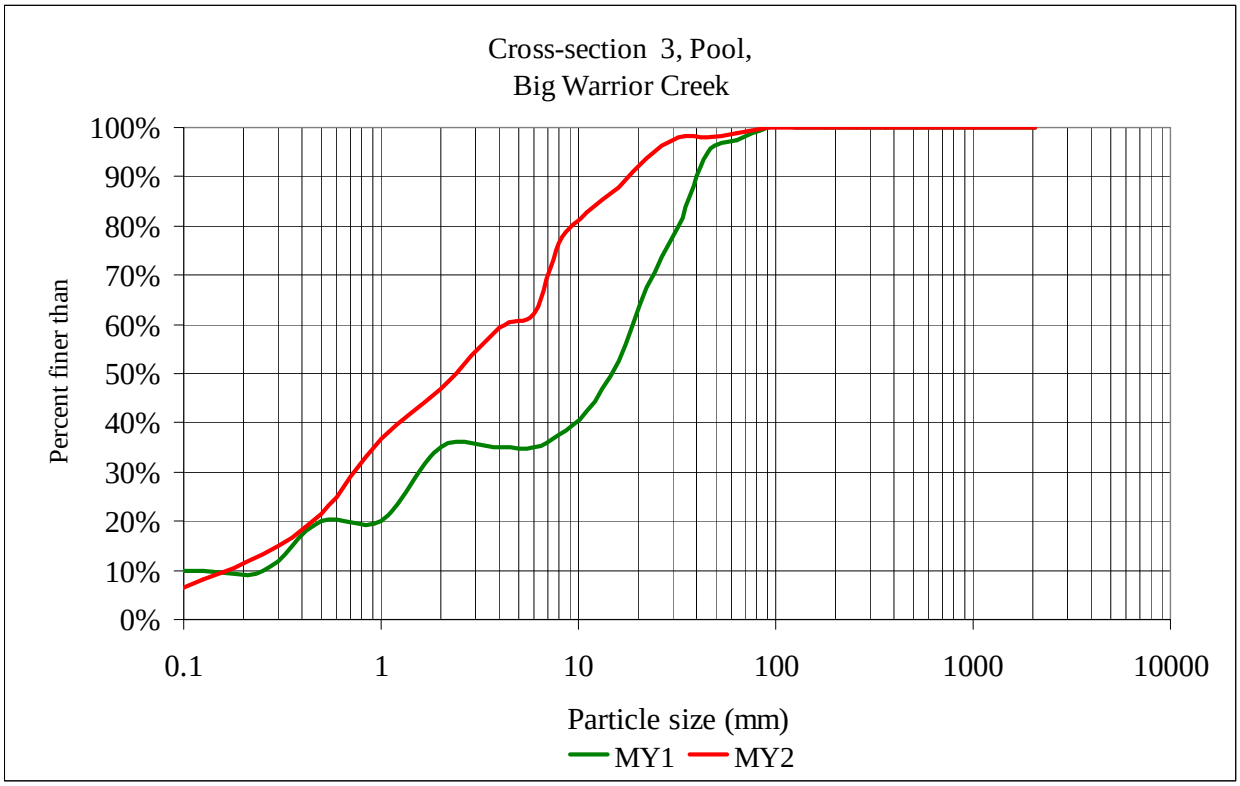
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.25	<0.1
D_{35}	19.00	<0.1
D_{50}	25.00	0.13
D_{84}	40.00	7.50
D_{95}	53.00	63.00

Appendix B.1.2. Continued.



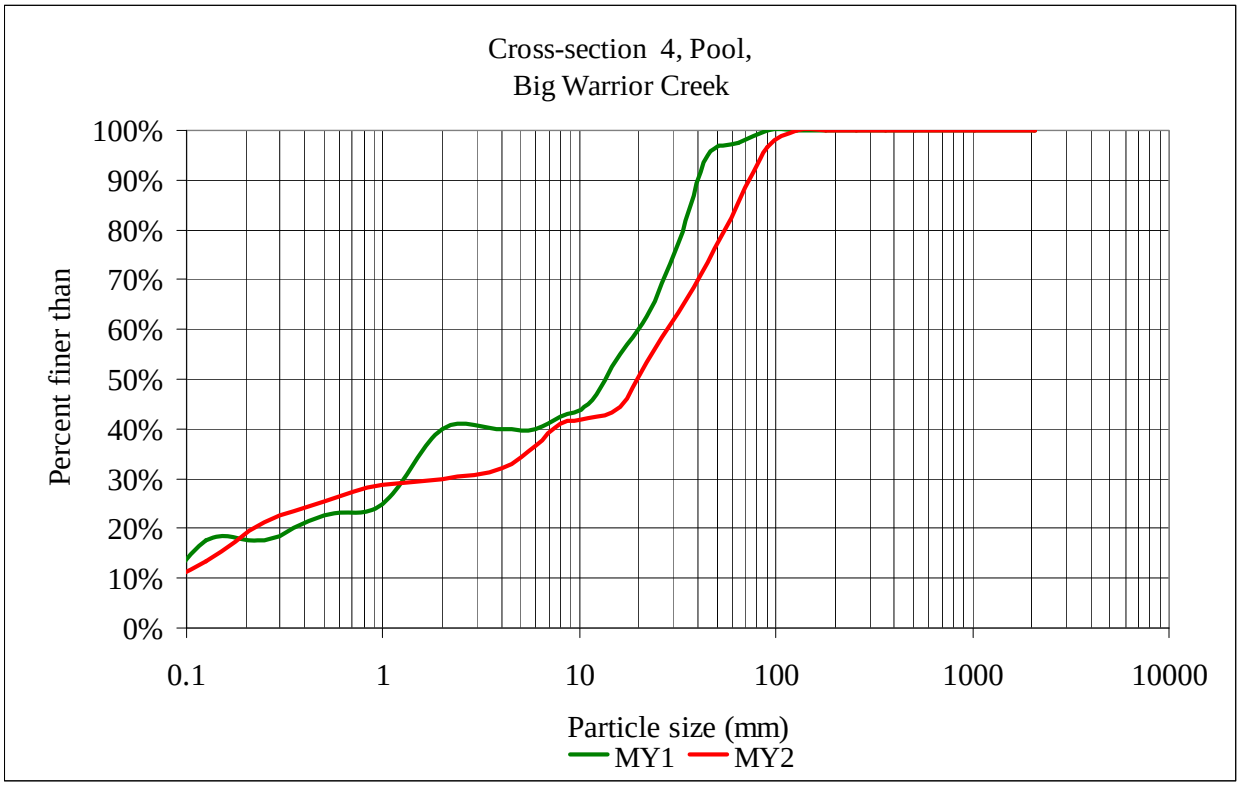
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.32	0.10
D_{35}	0.71	0.32
D_{50}	8.40	0.59
D_{84}	16.00	22.00
D_{95}	24.00	62.00

Appendix B.1.2. Continued.



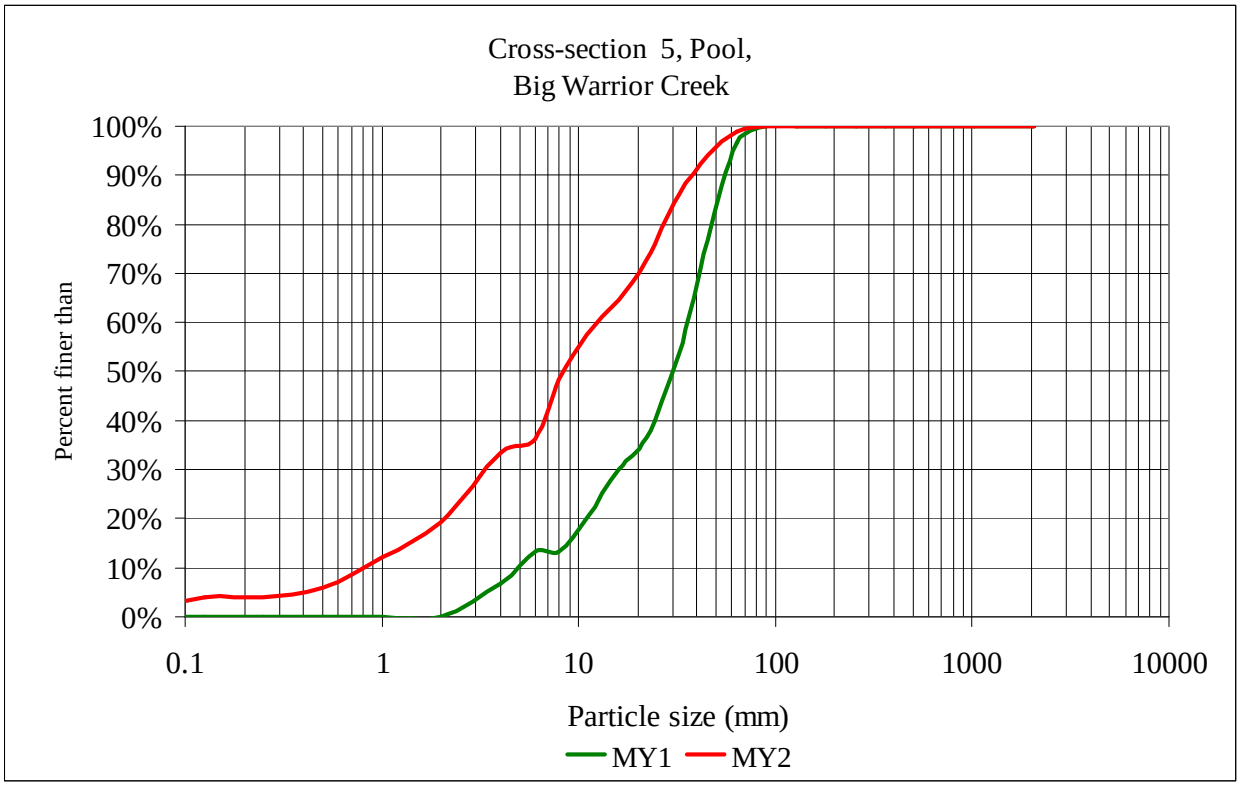
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.38	0.32
D_{35}	2.00	0.92
D_{50}	15.00	2.40
D_{84}	35.00	12.00
D_{95}	45.00	24.00

Appendix B.1.2. Continued.



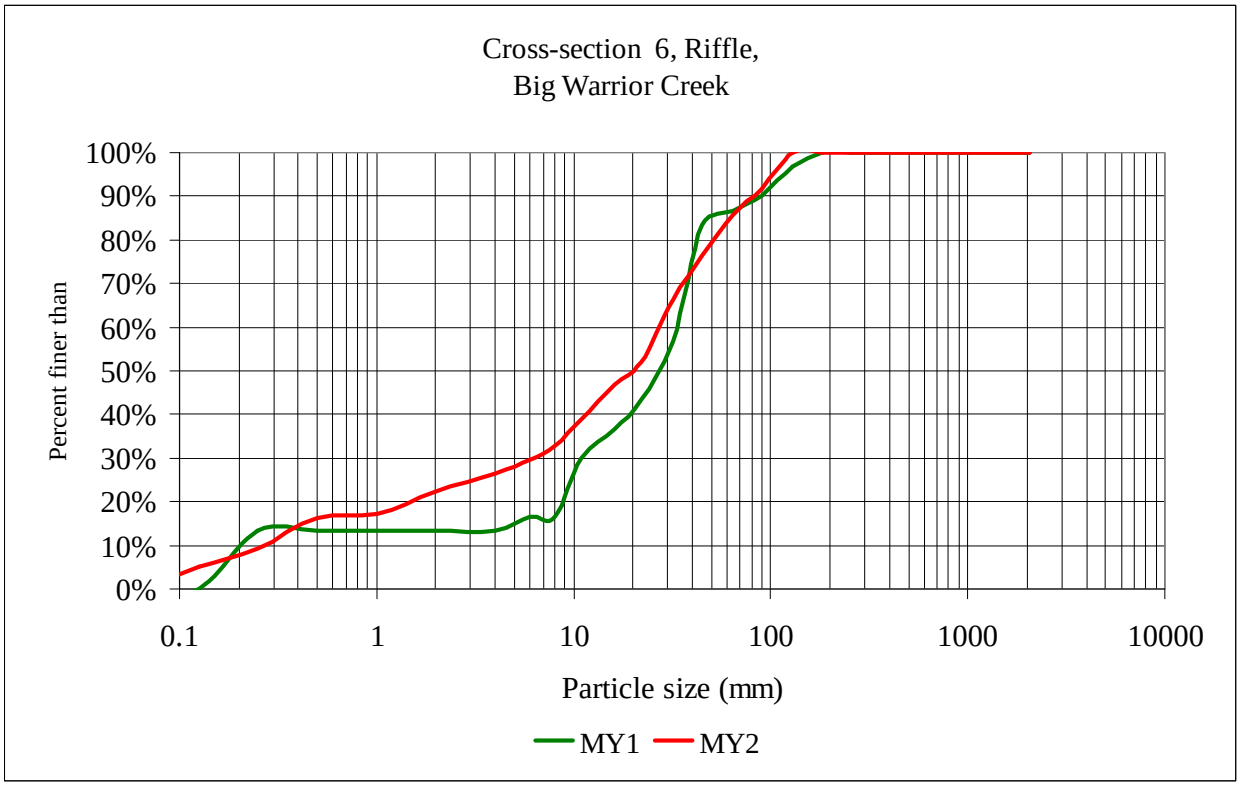
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.12	0.16
D_{35}	1.60	5.20
D_{50}	13.00	20.00
D_{84}	36.00	61.00
D_{95}	45.00	86.00

Appendix B.1.2. Continued.



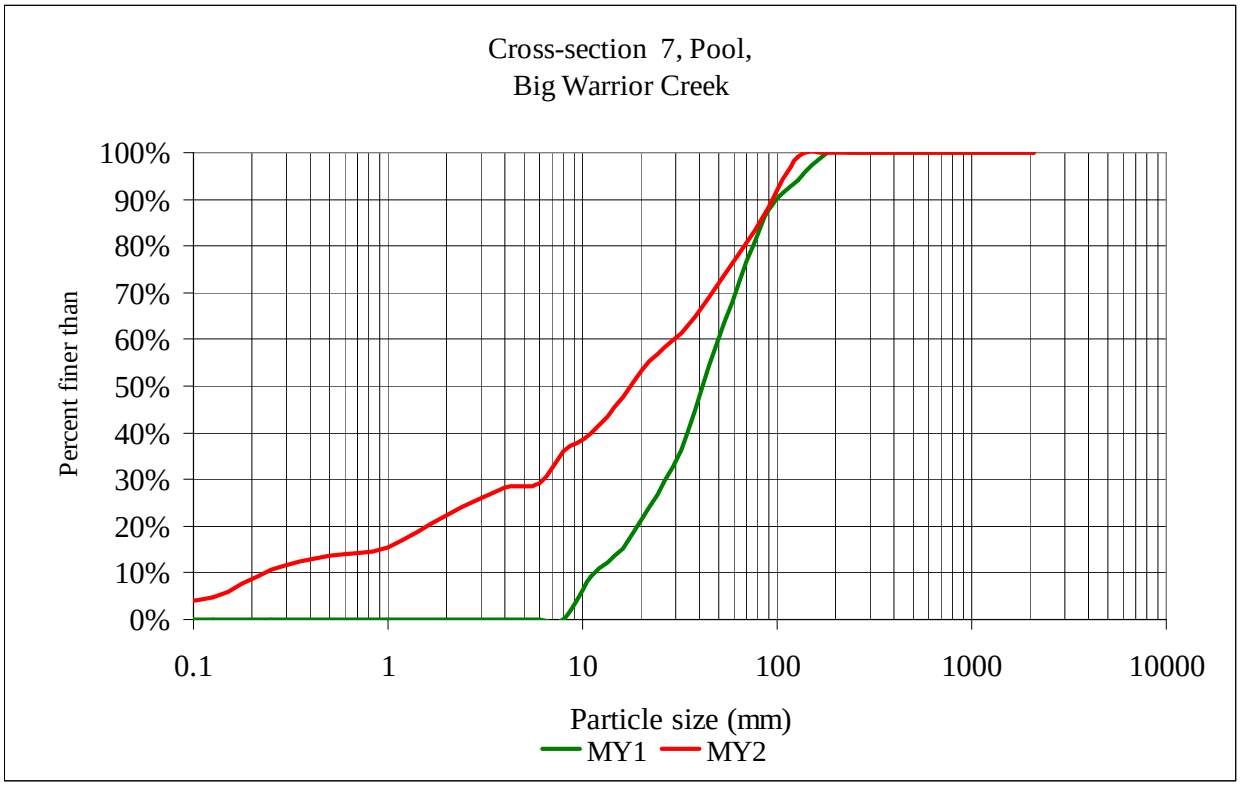
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	9.10	1.50
D_{35}	20.00	5.00
D_{50}	30.00	8.40
D_{84}	51.00	30.00
D_{95}	62.00	48.00

Appendix B.1.2. Continued.



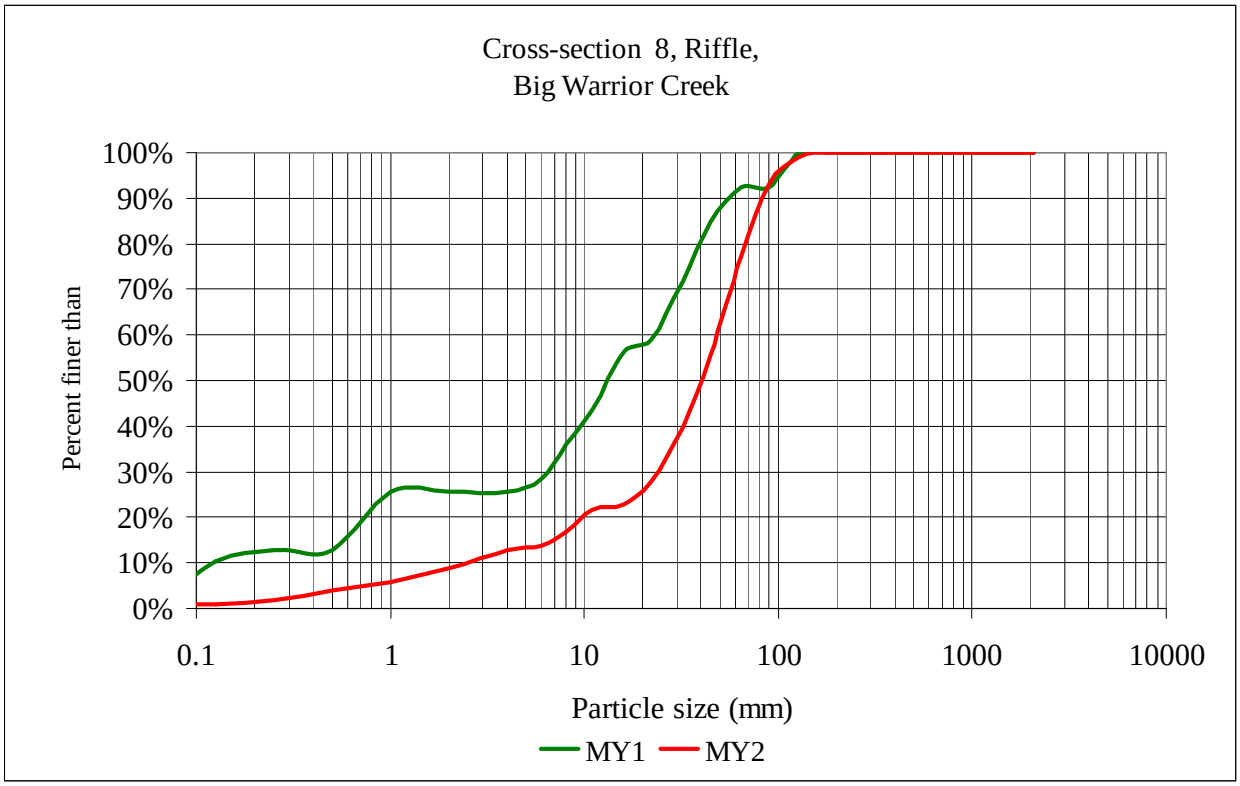
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	5.50	0.48
D_{35}	15.00	9.00
D_{50}	27.00	19.00
D_{84}	48.00	60.00
D_{95}	120.00	100.00

Appendix B.1.2. Continued.



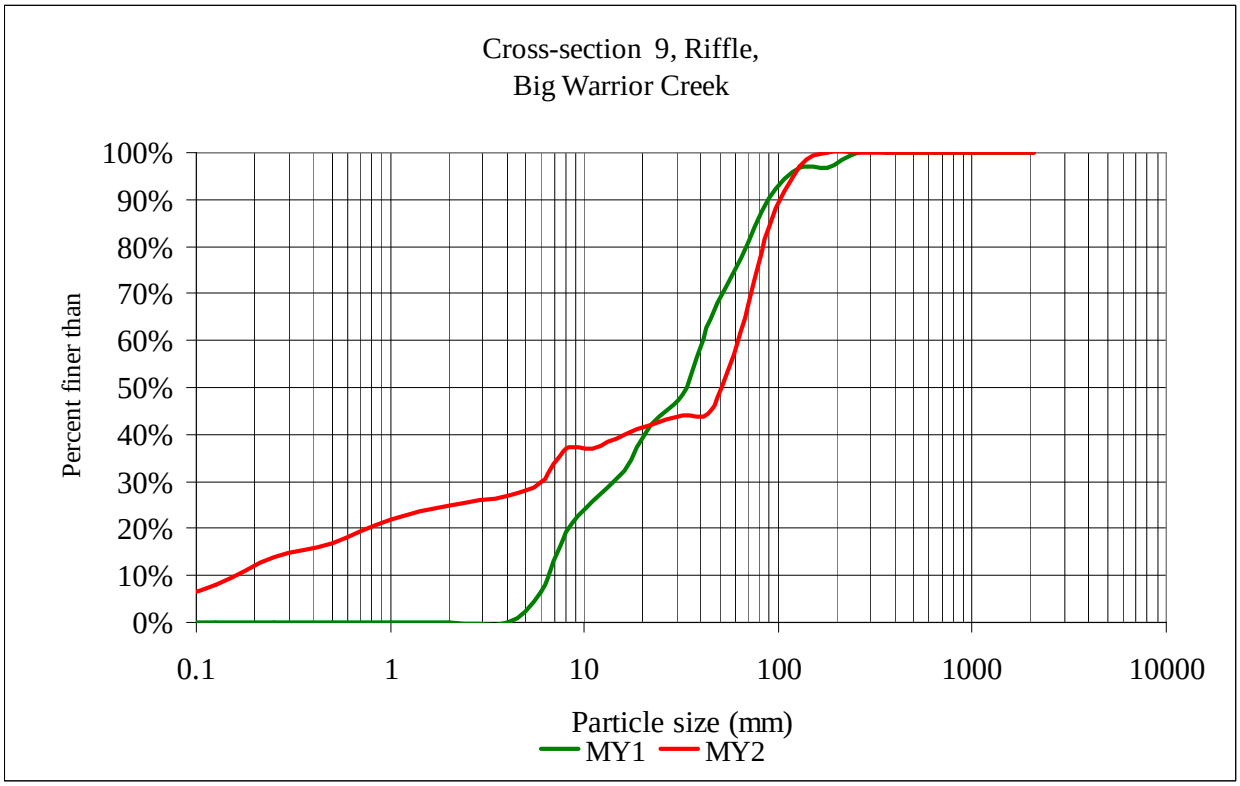
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	16.00	1.00
D_{35}	31.00	7.70
D_{50}	41.00	18.00
D_{84}	82.00	77.00
D_{95}	140.00	110.00

Appendix B.1.2. Continued.



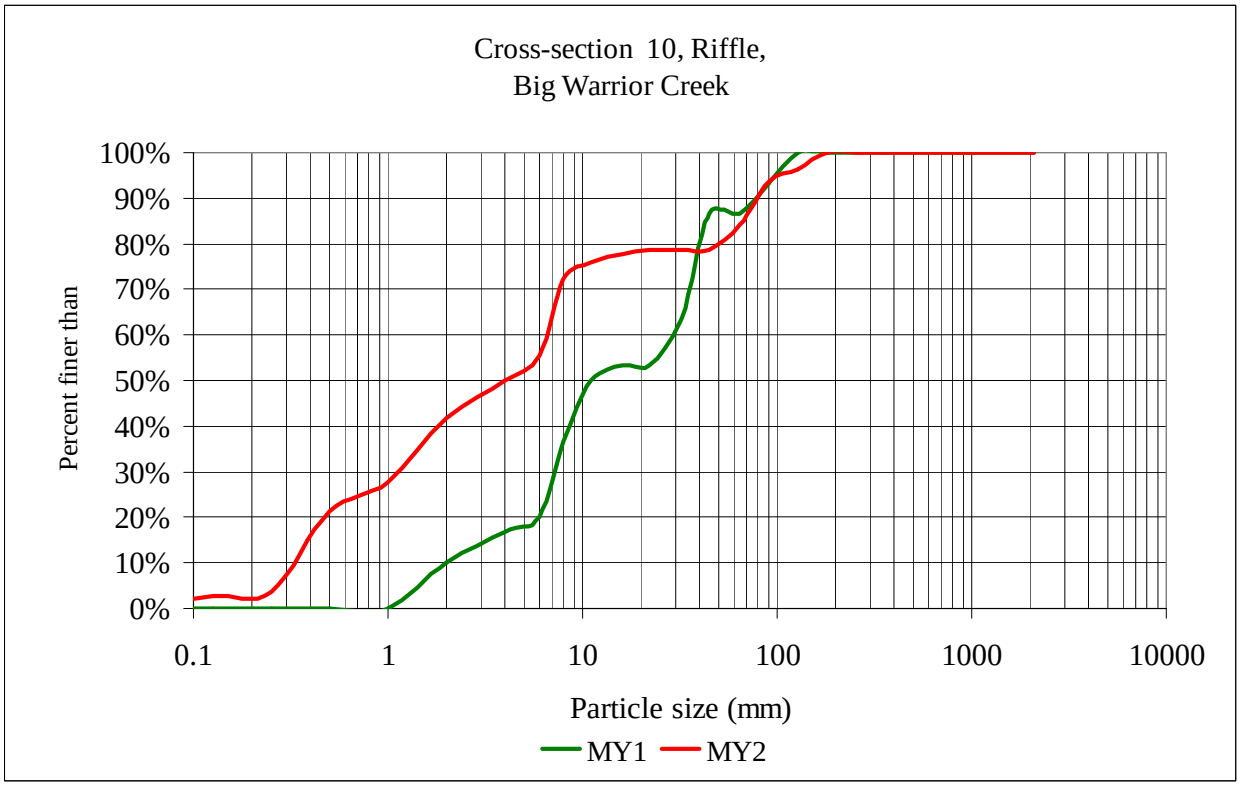
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.59	7.40
D_{35}	7.70	28.00
D_{50}	13.00	40.00
D_{84}	44.00	74.00
D_{95}	100.00	100.00

Appendix B.1.2. Continued.



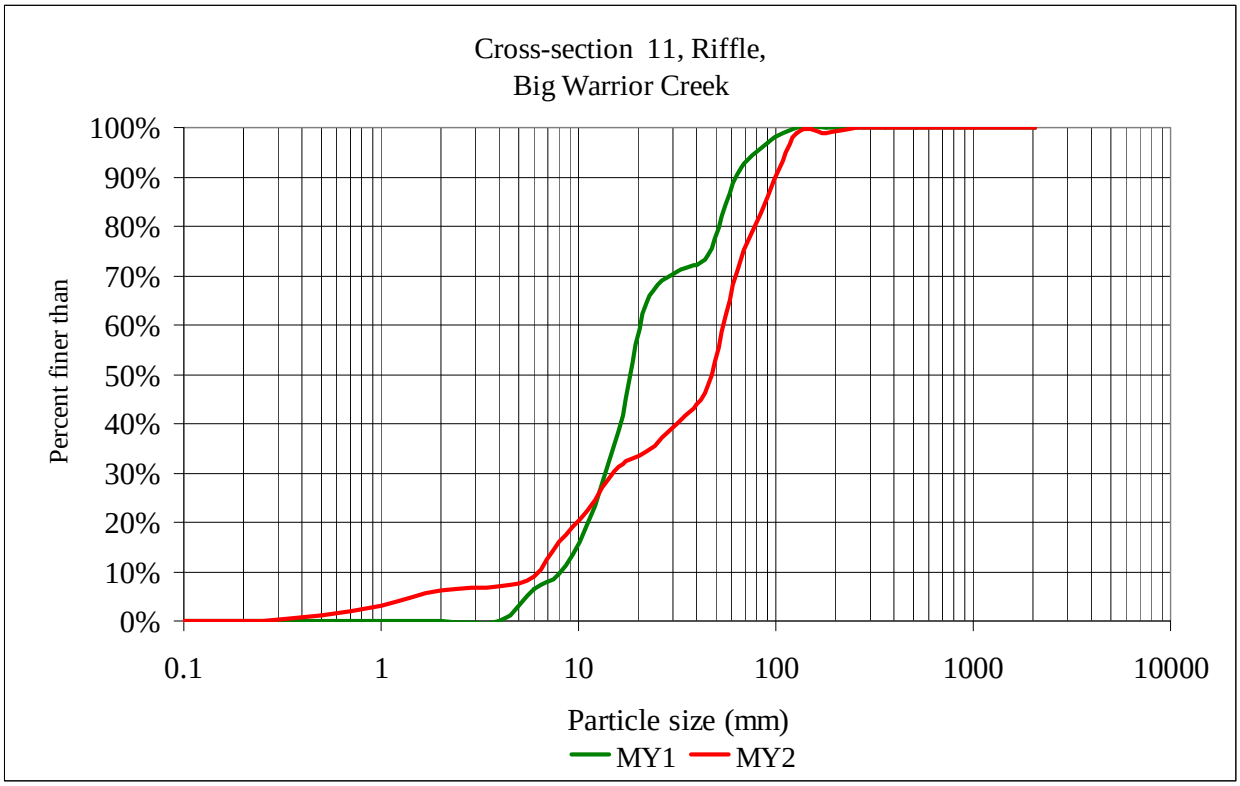
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	7.40	0.40
D_{35}	18.00	7.40
D_{50}	33.00	50.00
D_{84}	76.00	90.00
D_{95}	120.00	120.00

Appendix B.1.2. Continued.



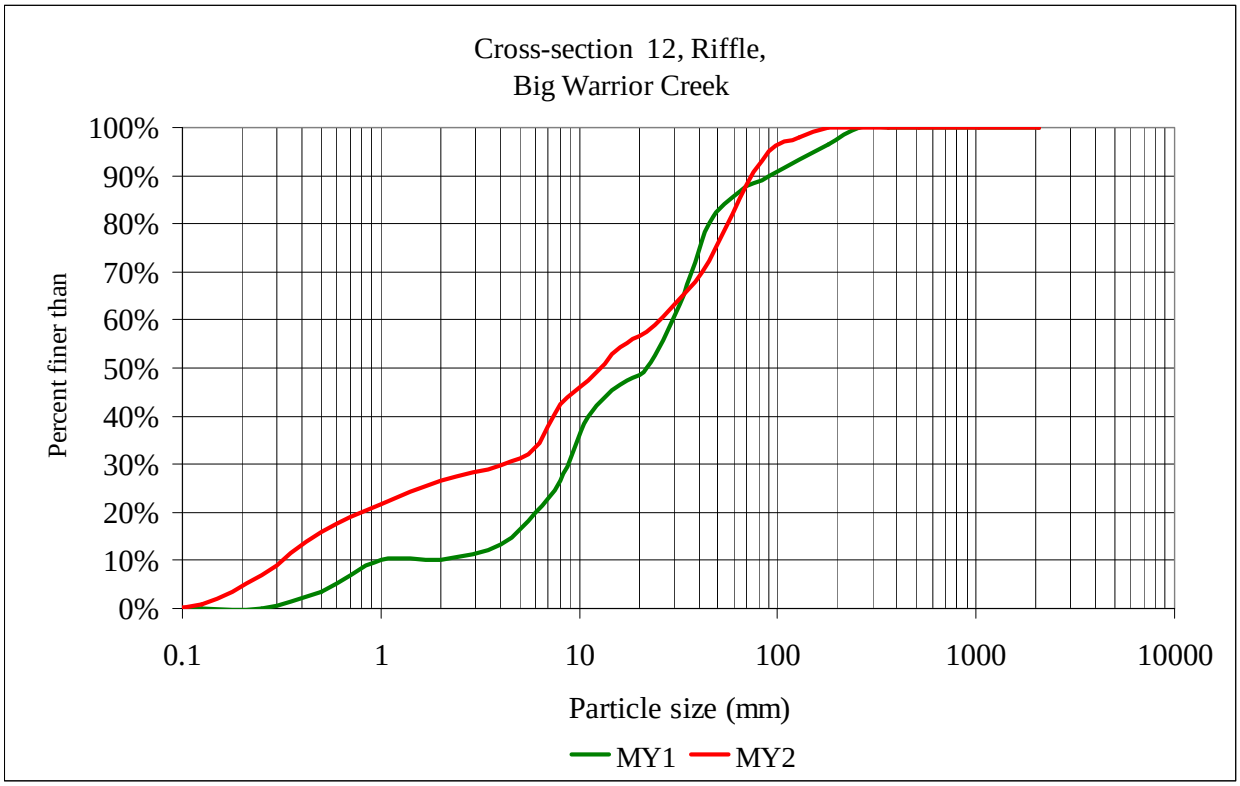
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	3.70	0.41
D_{35}	7.80	1.40
D_{50}	11.00	4.00
D_{84}	43.00	63.00
D_{95}	98.00	110.00

Appendix B.1.2. Continued.



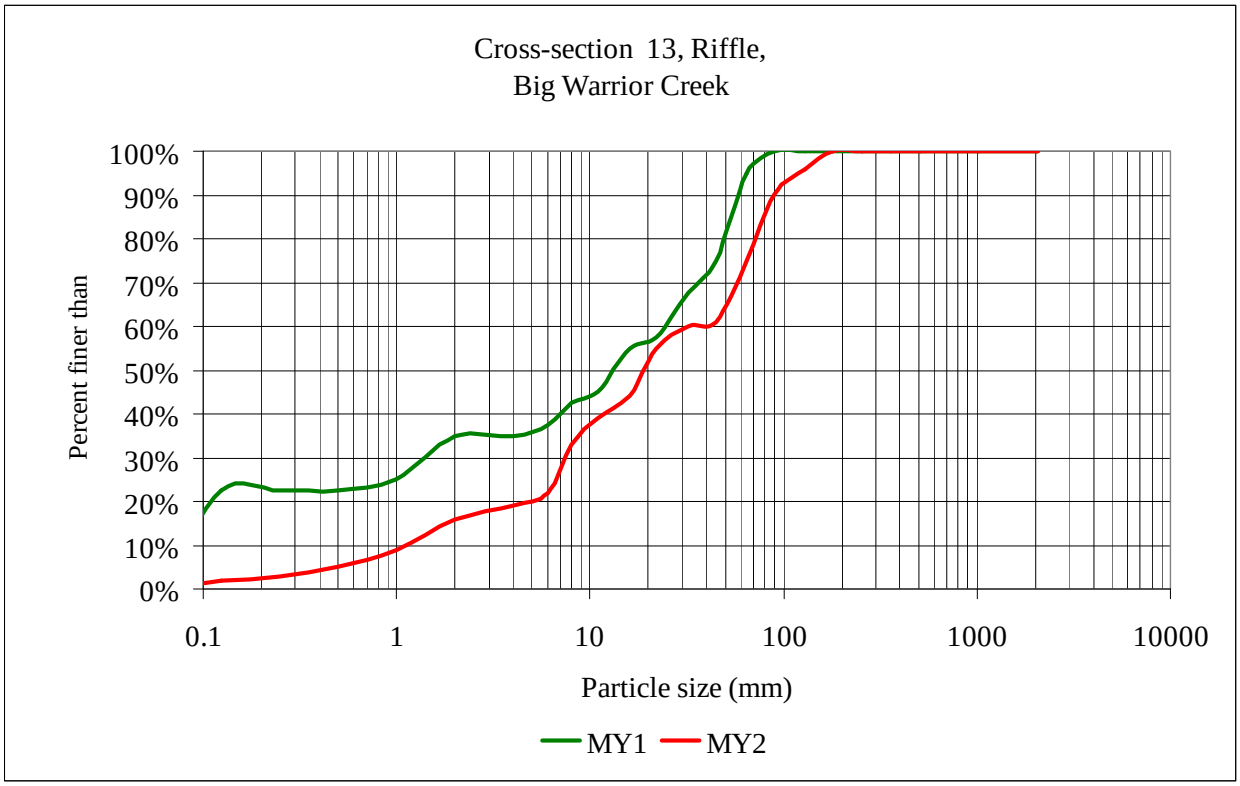
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	9.90	7.90
D_{35}	15.00	23.00
D_{50}	18.00	47.00
D_{84}	56.00	86.00
D_{95}	82.00	120.00

Appendix B.1.2. Continued.



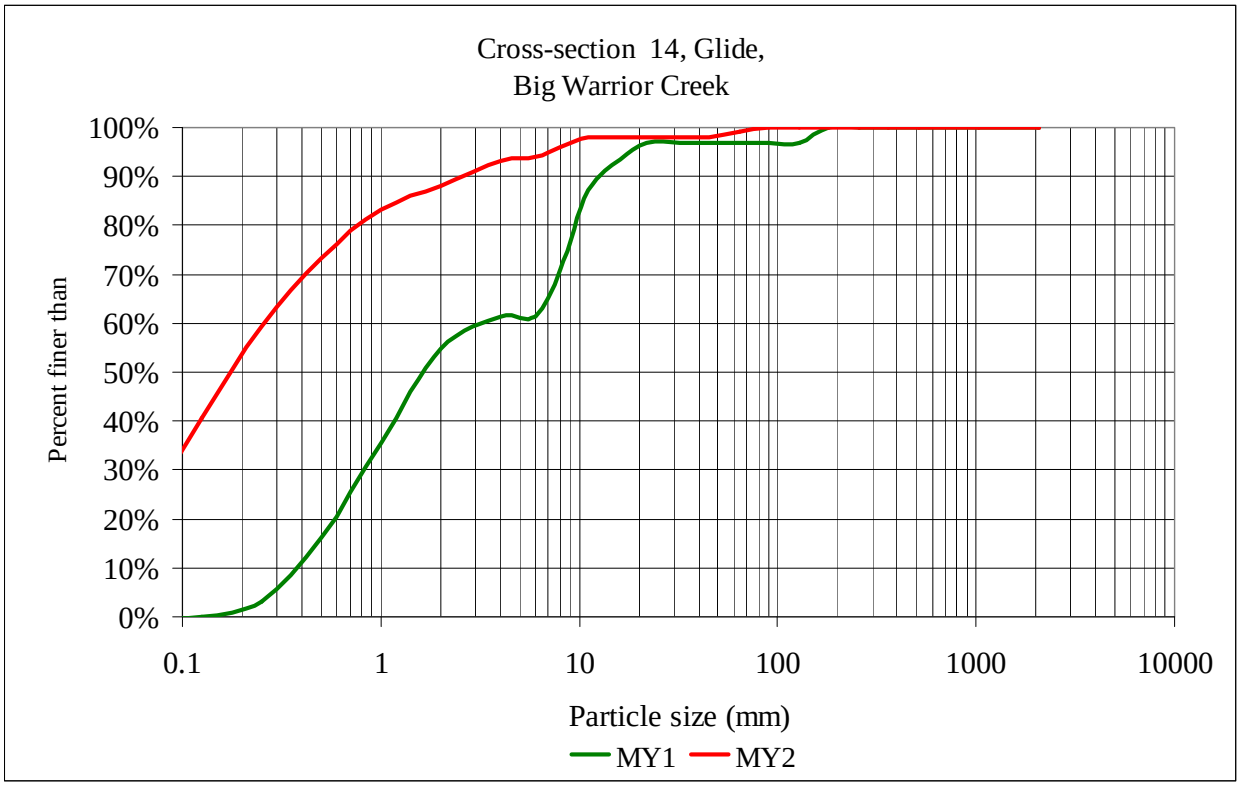
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	4.70	0.51
D_{35}	9.80	6.30
D_{50}	22.00	13.00
D_{84}	56.00	62.00
D_{95}	150.00	90.00

Appendix B.1.2. Continued.



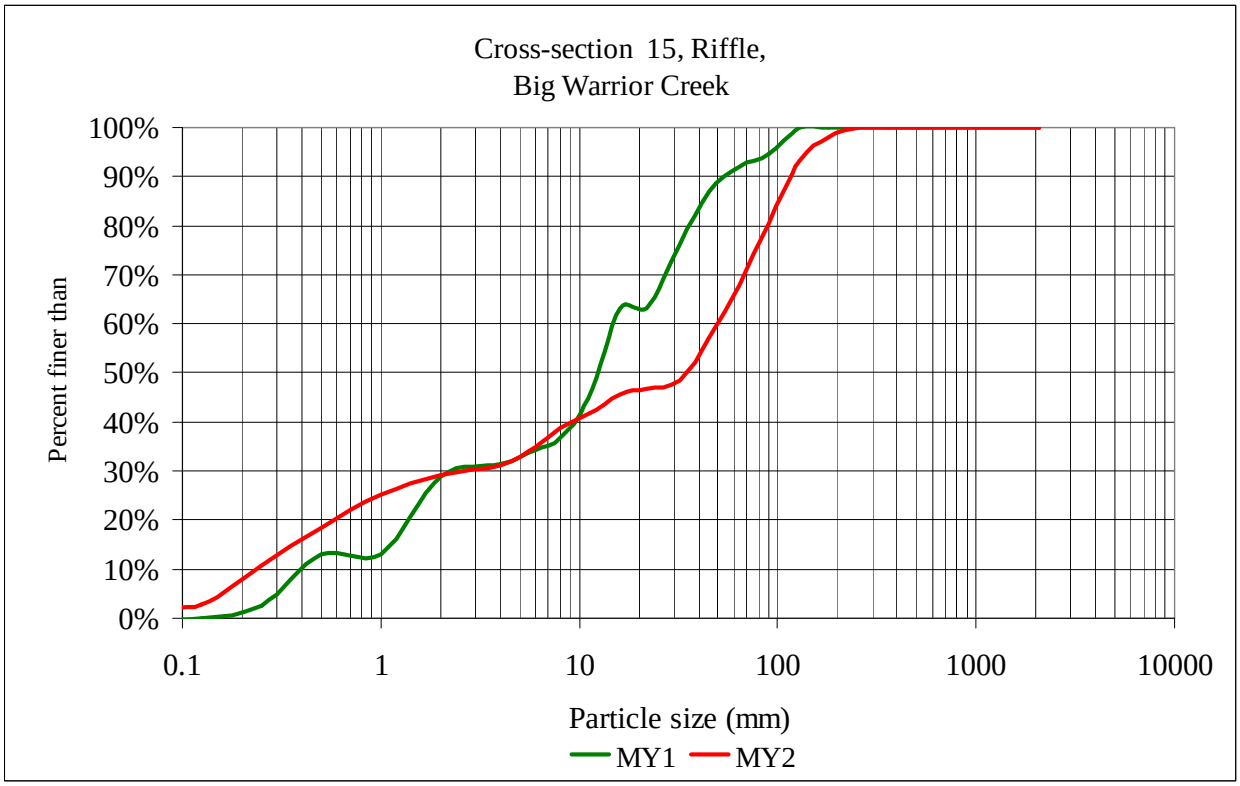
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.10	2.00
D_{35}	4.00	8.90
D_{50}	13.00	19.00
D_{84}	53.00	79.00
D_{95}	64.00	120.00

Appendix B.1.2. Continued.



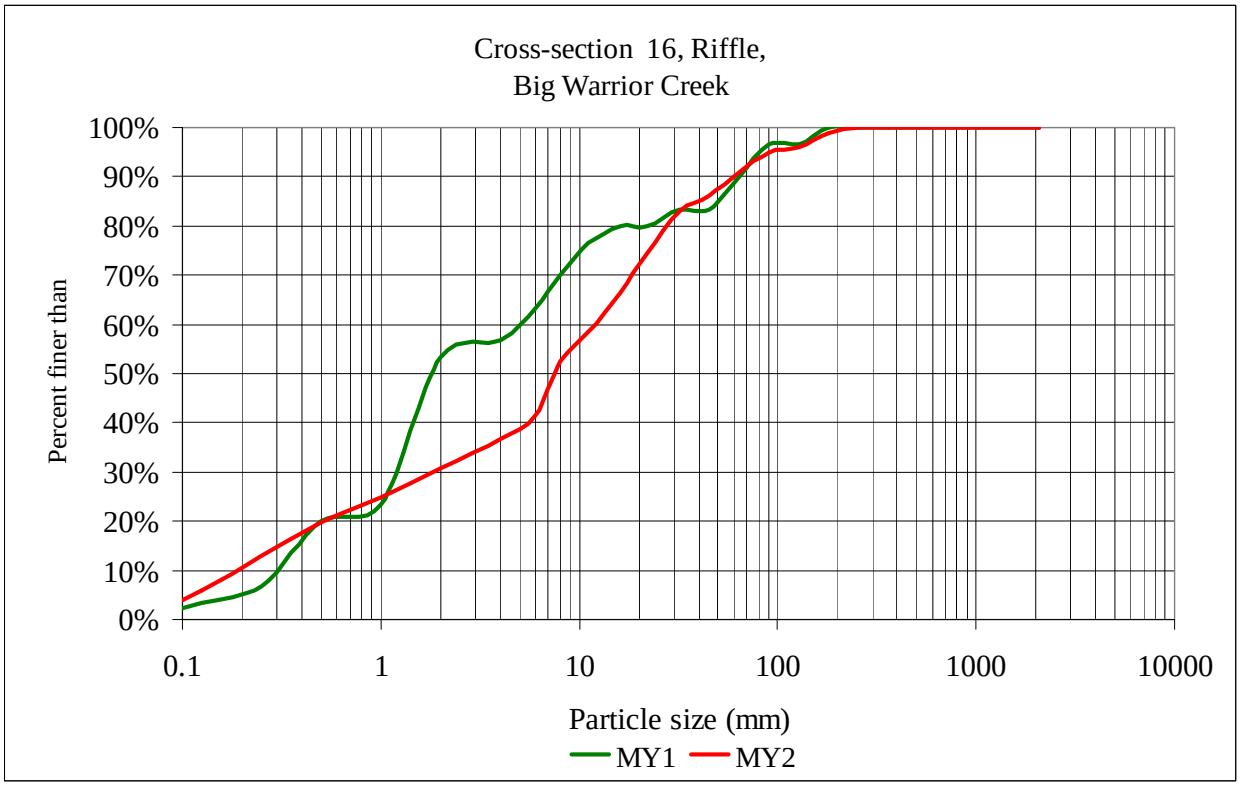
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.50	<0.10
D_{35}	0.98	0.10
D_{50}	1.70	0.18
D_{84}	10.00	1.10
D_{95}	18.00	6.90

Appendix B.1.2. Continued.



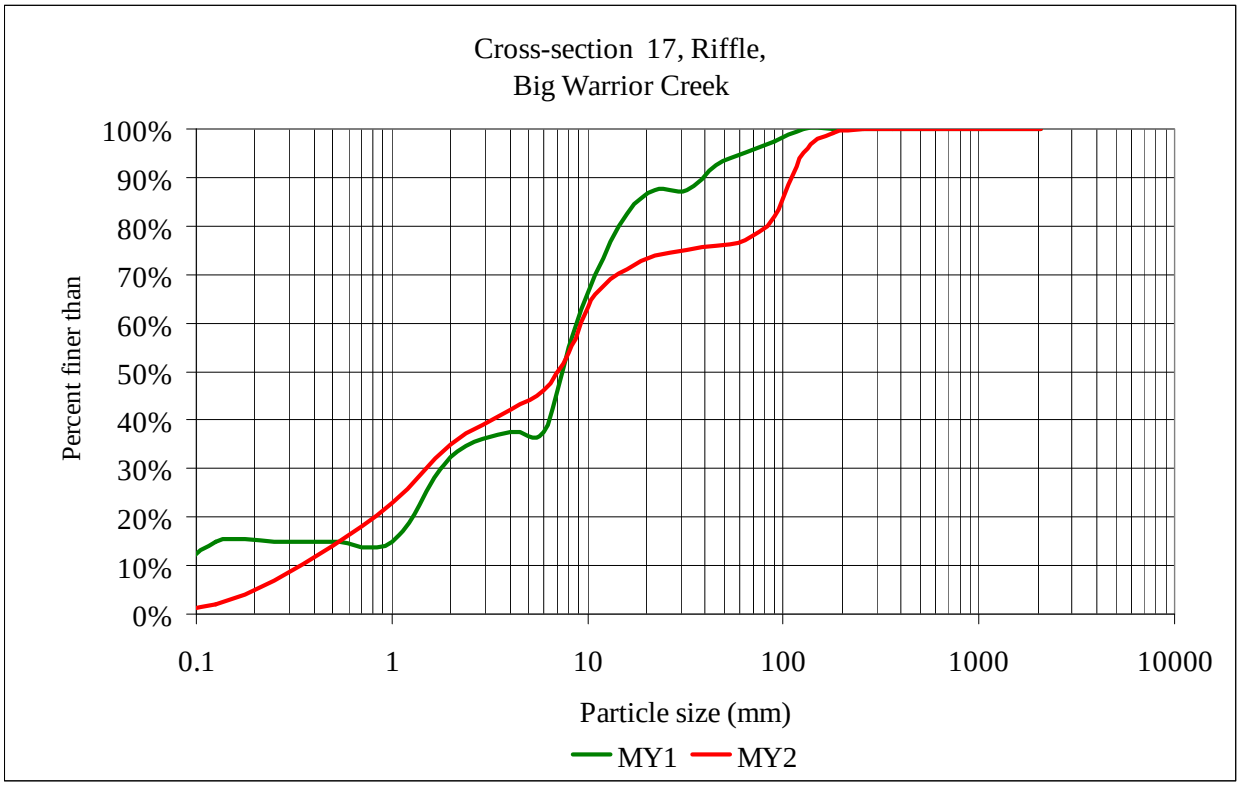
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	1.10	0.40
D_{35}	6.50	6.00
D_{50}	12.00	34.00
D_{84}	41.00	99.00
D_{95}	92.00	150.00

Appendix B.1.2. Continued.



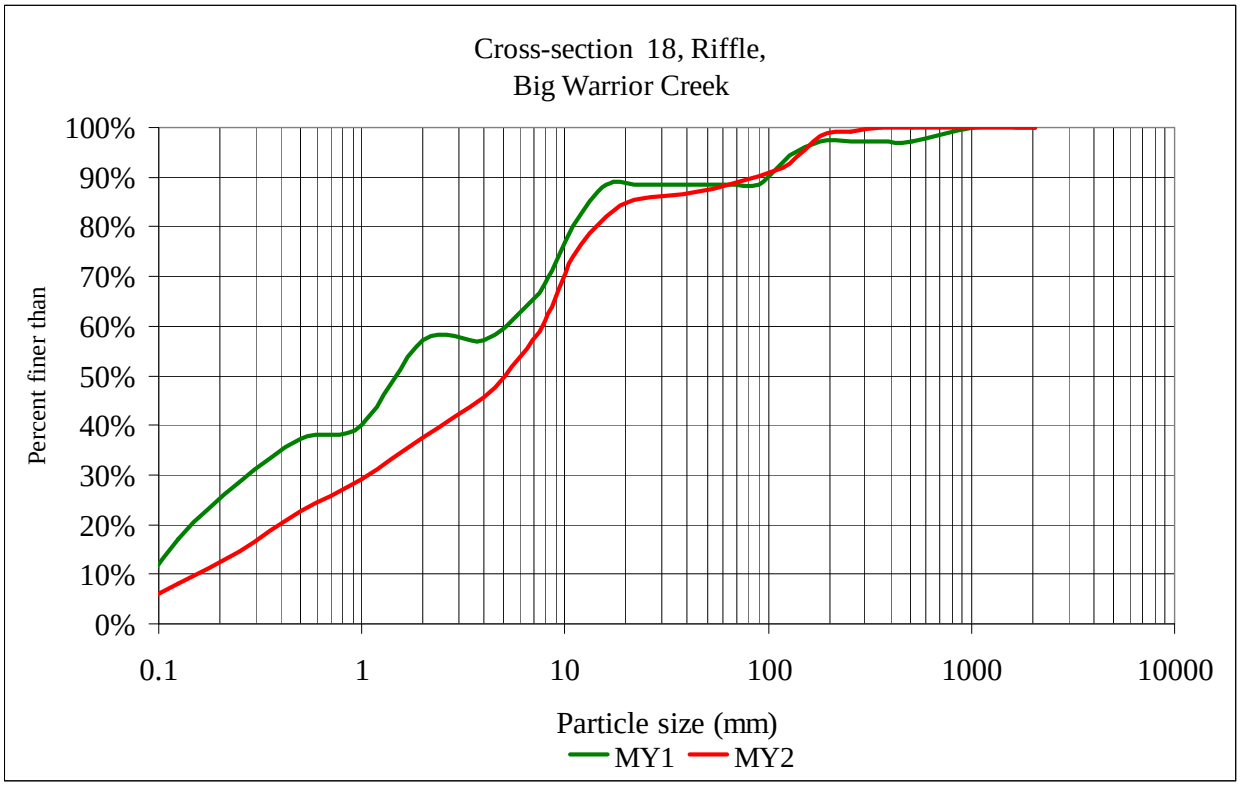
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.41	0.34
D_{35}	1.30	3.30
D_{50}	1.90	7.50
D_{84}	47.00	35.00
D_{95}	83.00	90.00

Appendix B.1.2. Continued.



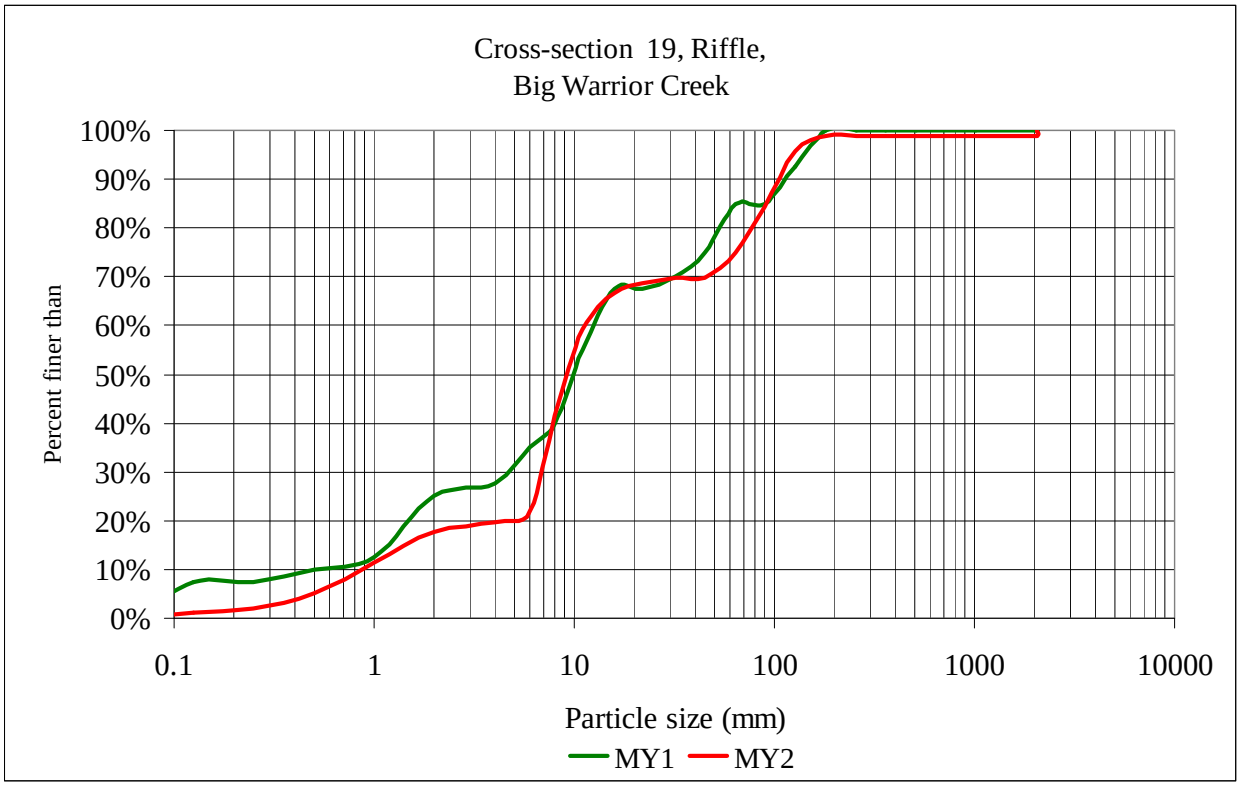
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	1.00	0.58
D_{35}	2.80	2.00
D_{50}	7.40	6.90
D_{84}	18.00	95.00
D_{95}	64.00	130.00

Appendix B.1.2. Continued.



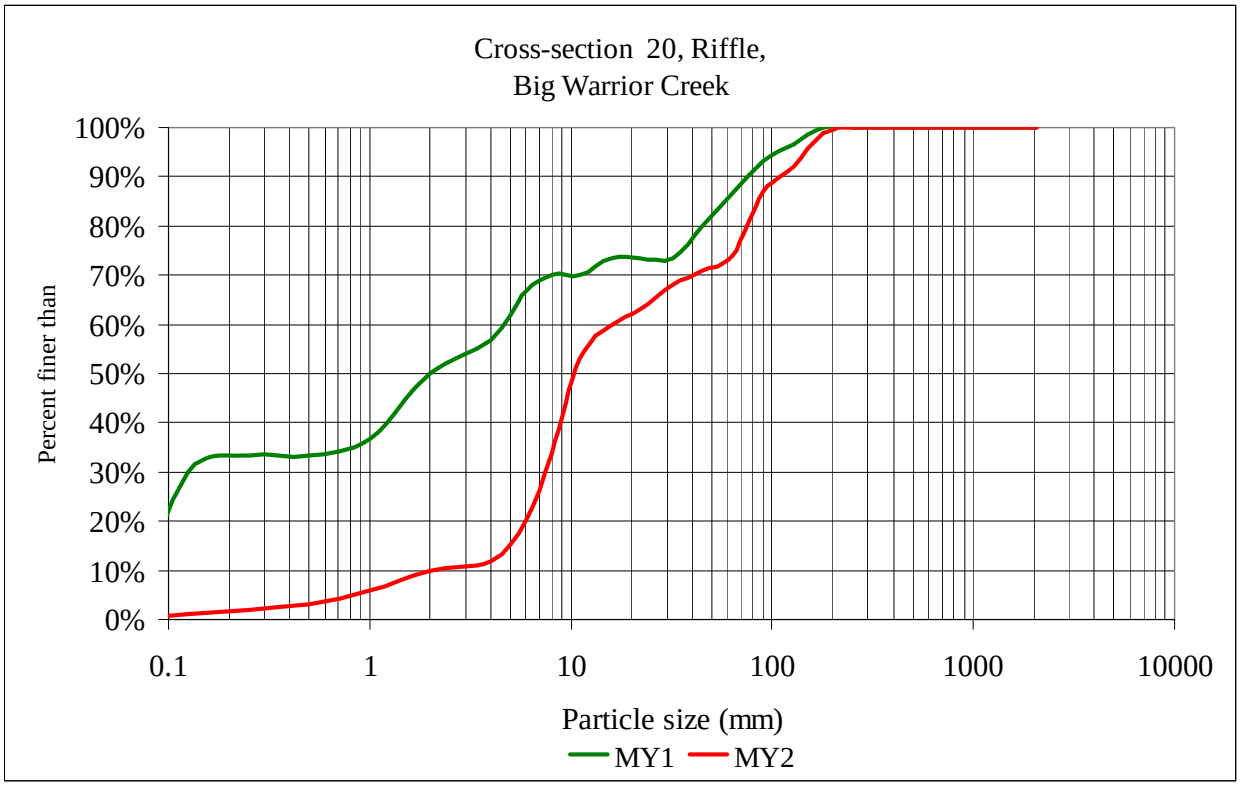
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.12	0.28
D_{35}	0.42	1.60
D_{50}	1.50	5.00
D_{84}	13.00	19.00
D_{95}	140.00	150.00

Appendix B.1.2. Continued.



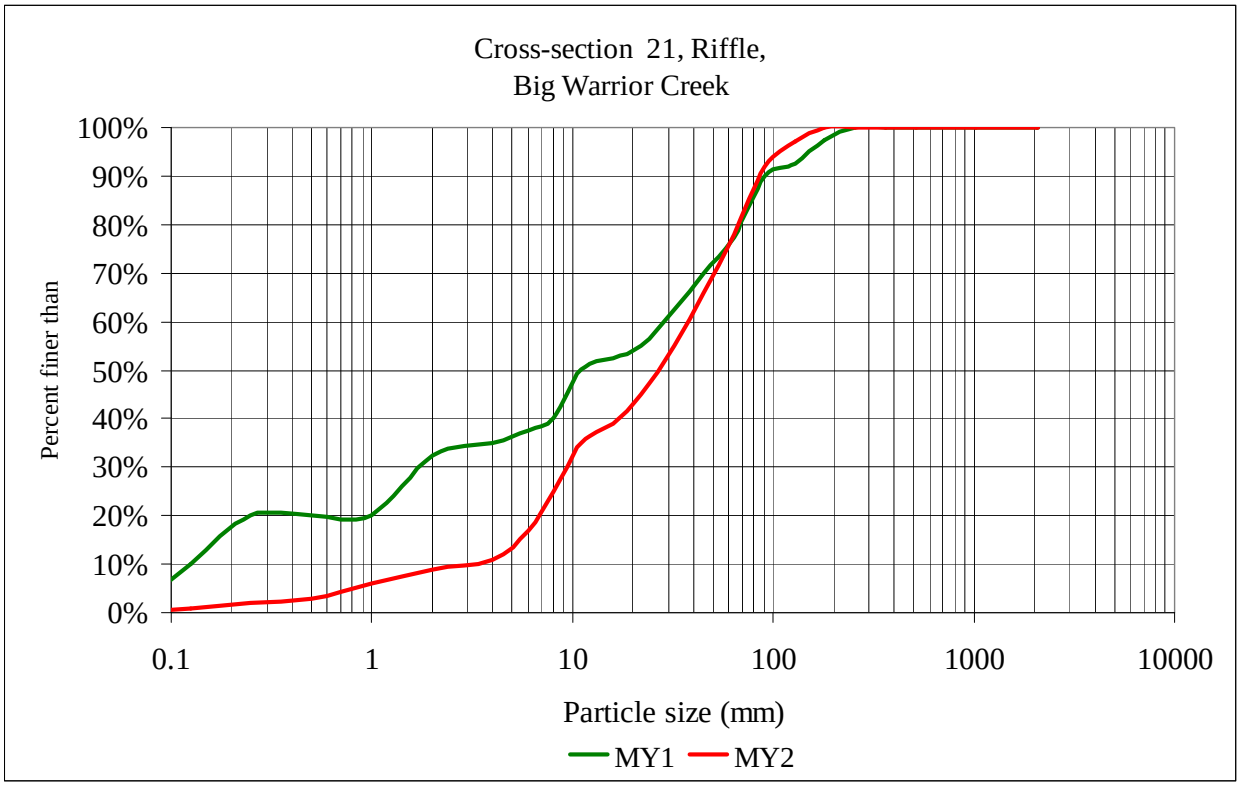
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	1.20	1.60
D_{35}	6.00	7.20
D_{50}	9.90	9.20
D_{84}	62.00	86.00
D_{95}	140.00	120.00

Appendix B.1.2. Continued.



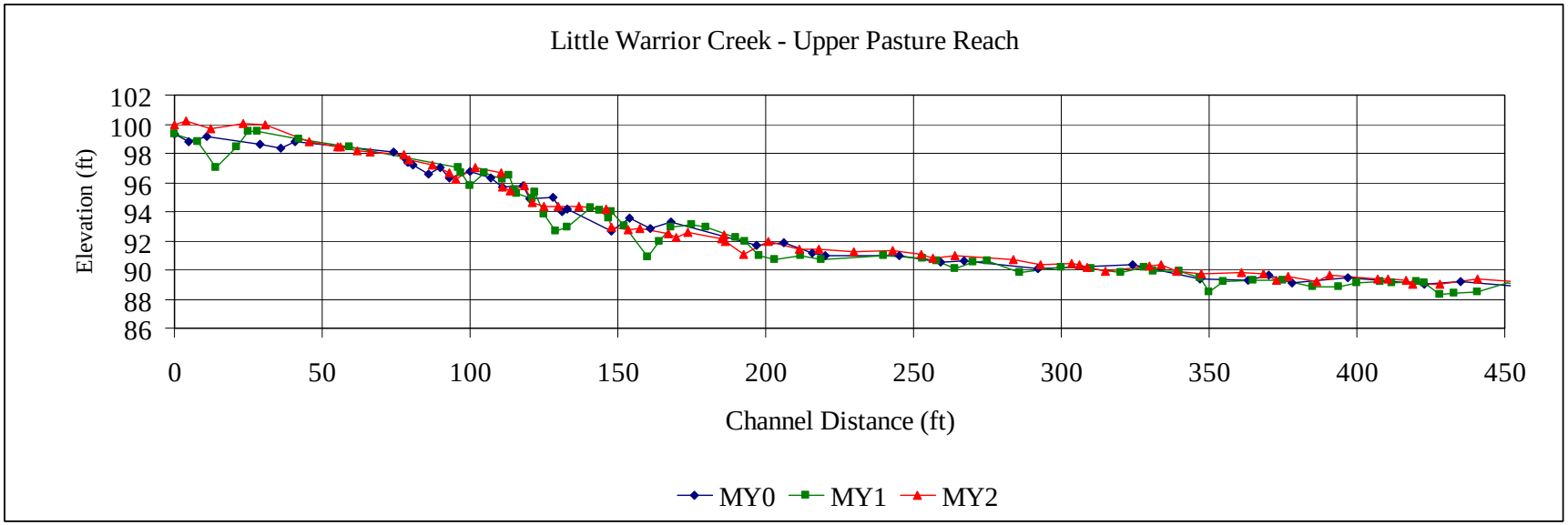
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	<0.1	4.90
D_{35}	0.71	8.10
D_{50}	2.00	10.00
D_{84}	56.00	83.00
D_{95}	110.00	150.00

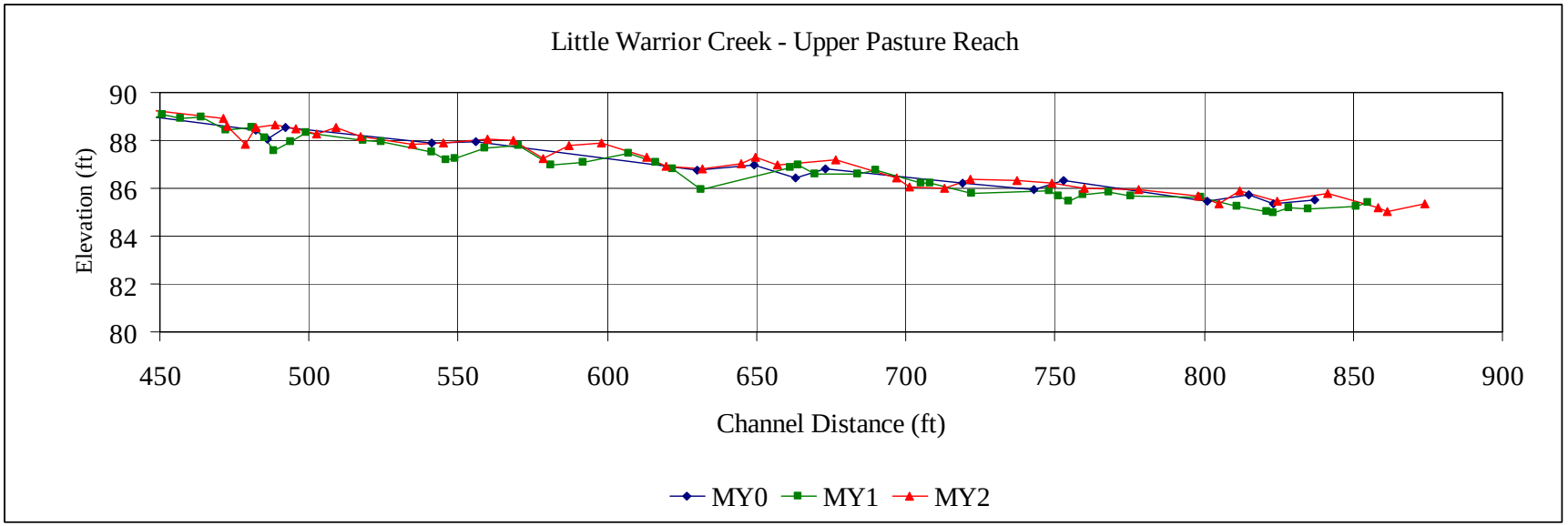
Appendix B.1.2. Continued.



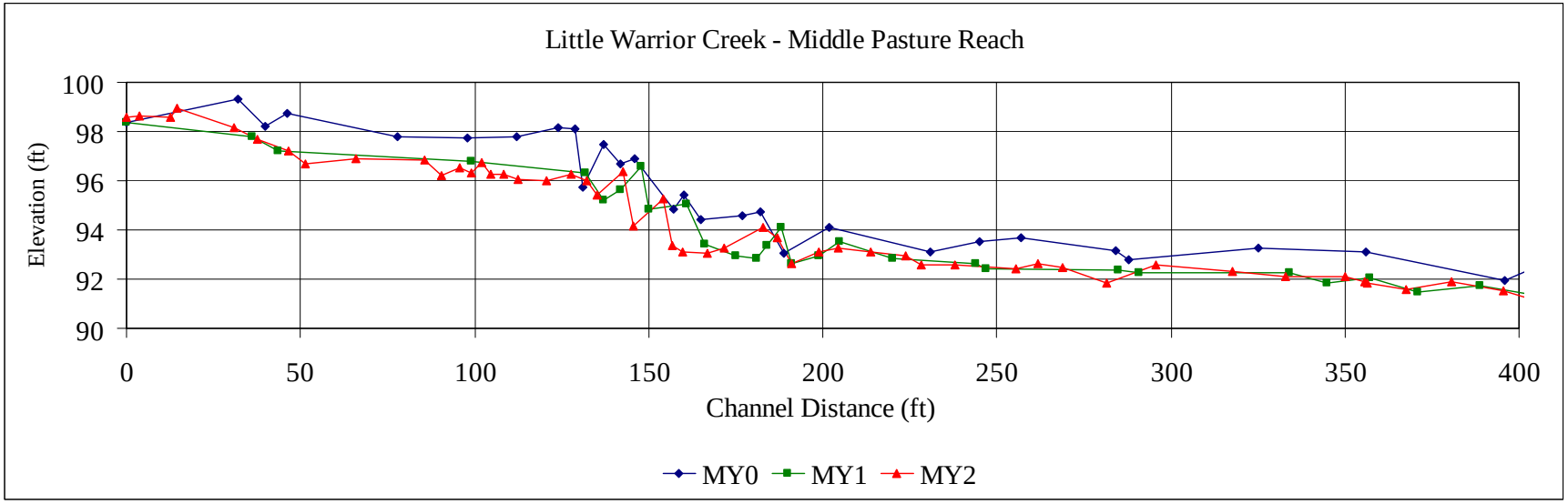
Size class index	Particle size (mm) in year sampled	
	MY1	MY2
D_{16}	0.19	5.60
D_{35}	4.00	11.00
D_{50}	11.00	27.00
D_{84}	76.00	74.00
D_{95}	150.00	110.00

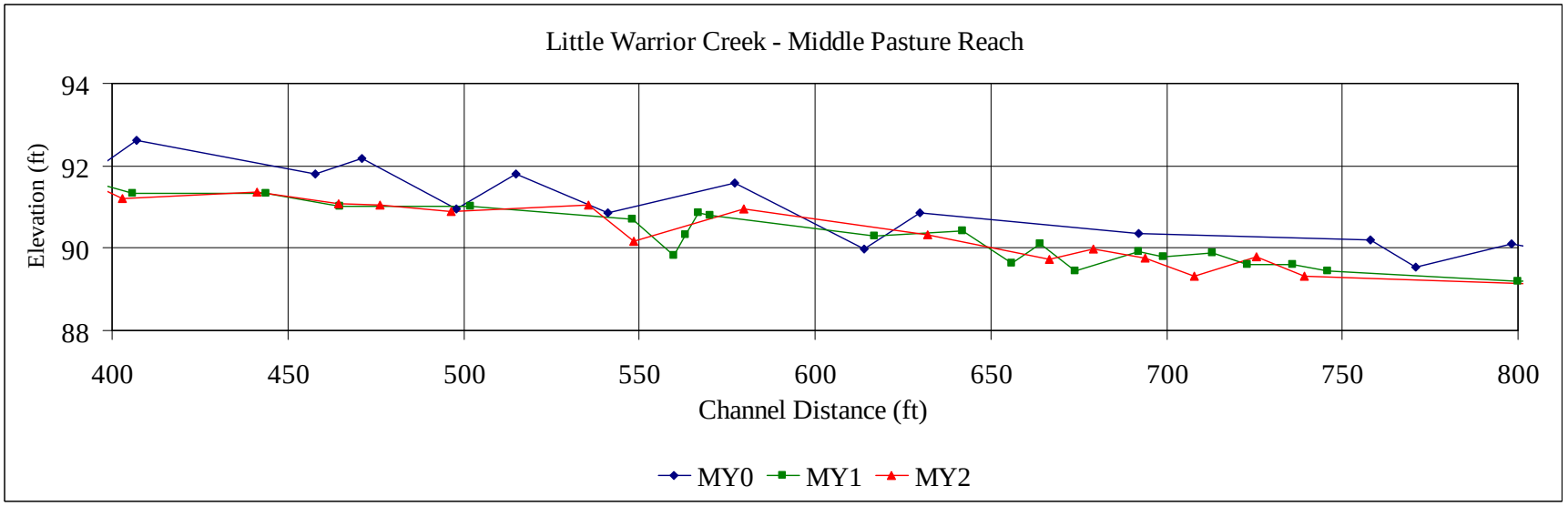
Appendix B.2.1. Longitudinal profile comparisons, Little Warrior Creek, MY0-MY2.



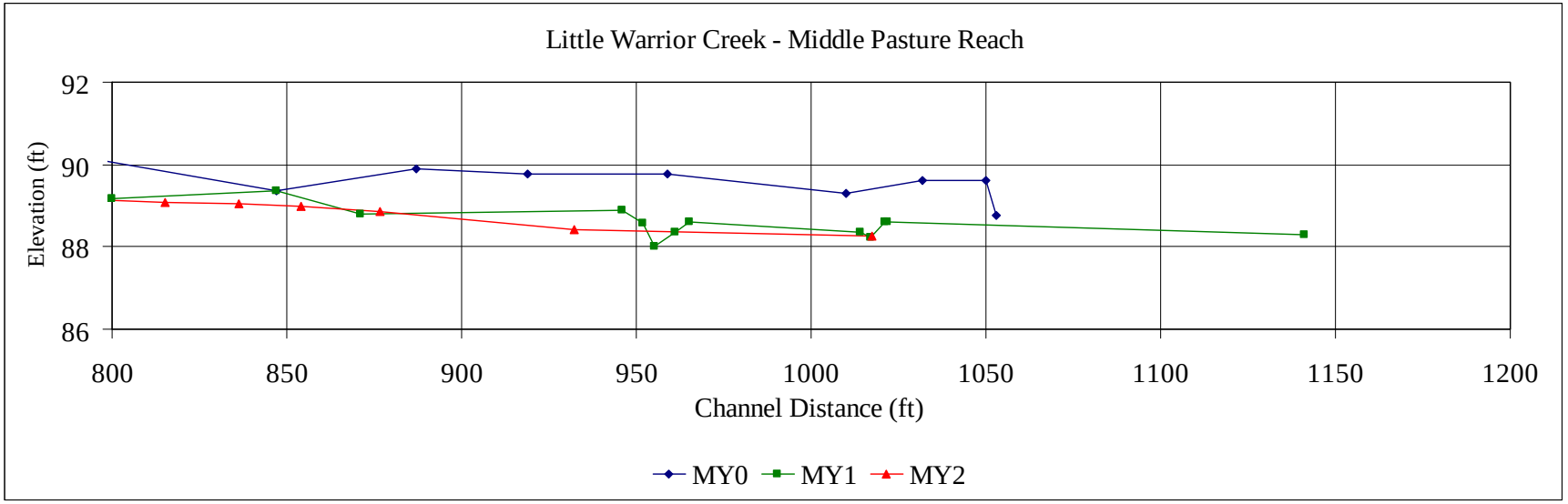


Appendix B.2.1. Continued.

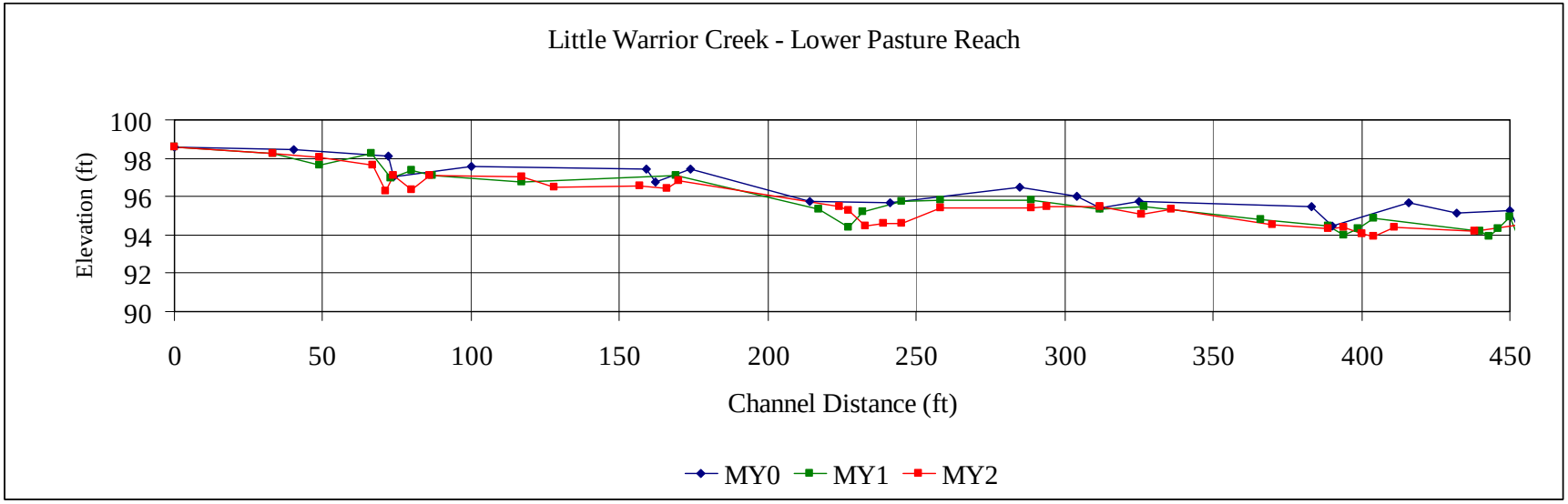


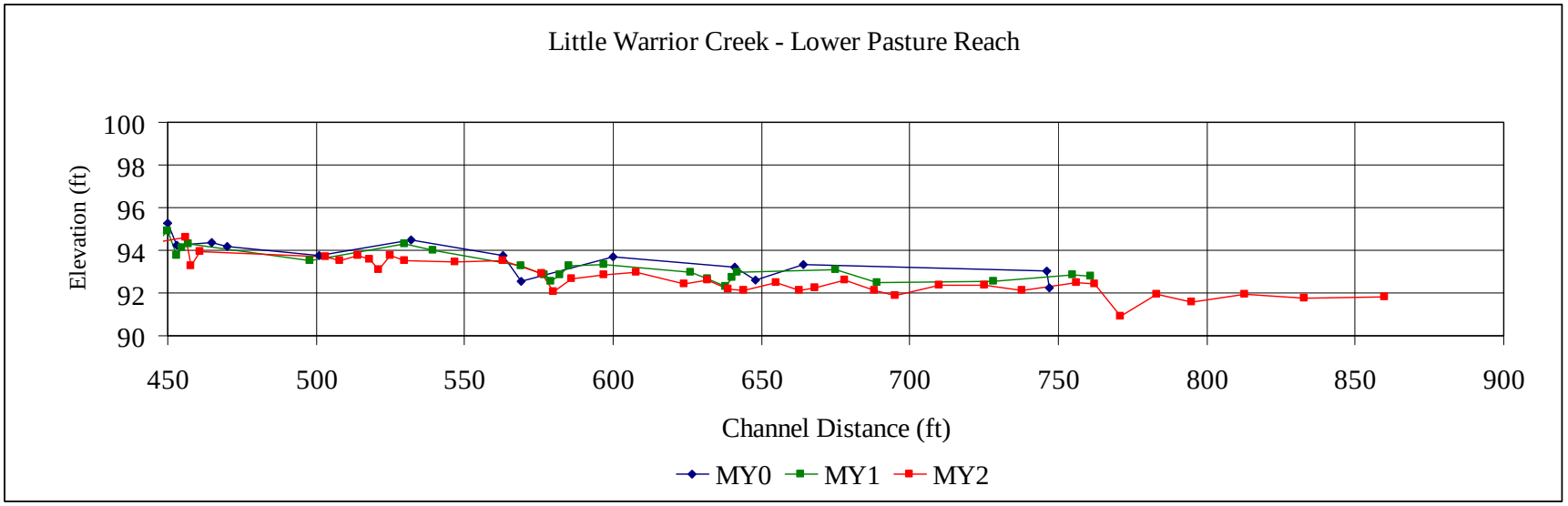


Appendix B.2.1. Continued.

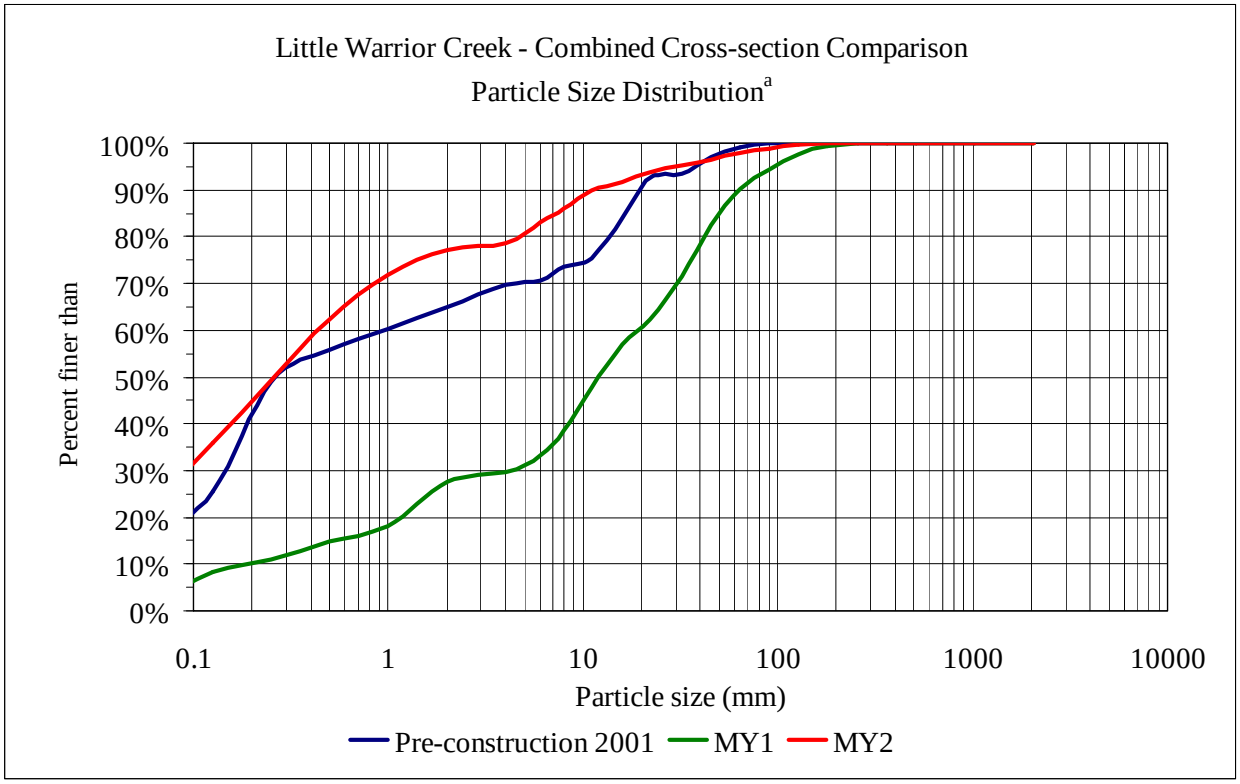


Appendix B.2.1. Continued.





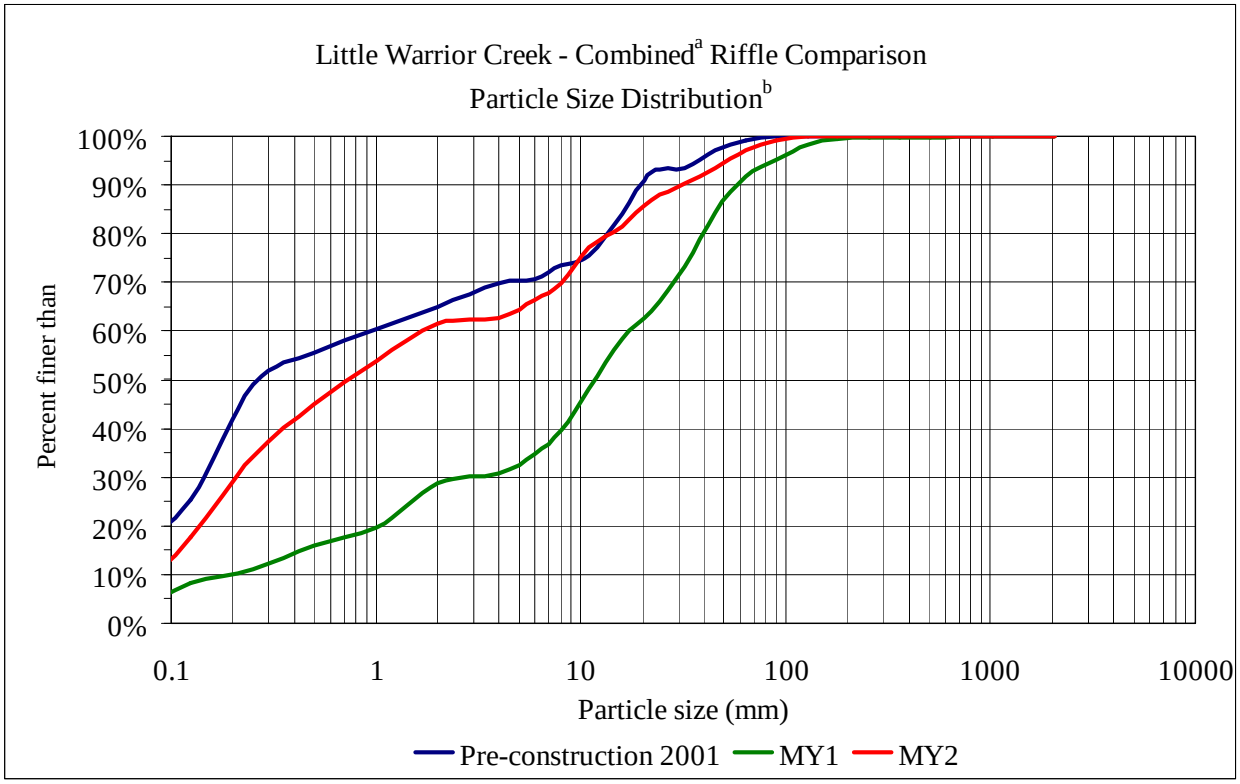
Appendix B.2.2. Pebble Count Comparisons, Big Warrior Creek, MY0-MY2.



[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	MY 1	MY 2
D_{16}	<0.10	0.65	<0.10
D_{35}	0.17	6.60	0.12
D_{50}	0.28	12.00	0.26
D_{84}	16.00	48.00	6.50
D_{95}	37.00	96.00	31.00

Appendix B.2.2. Continued.

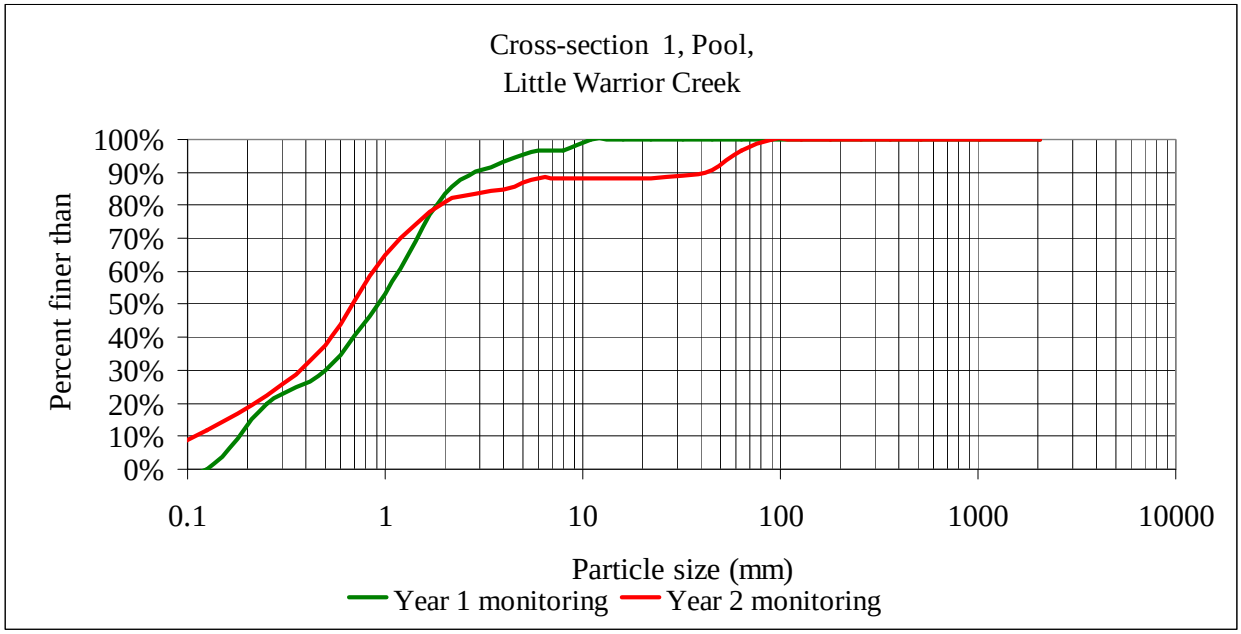


[a]The MY2 riffle comparisons did not include cross-section 11 because it is located on a tributary to Little Warrior Creek.

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

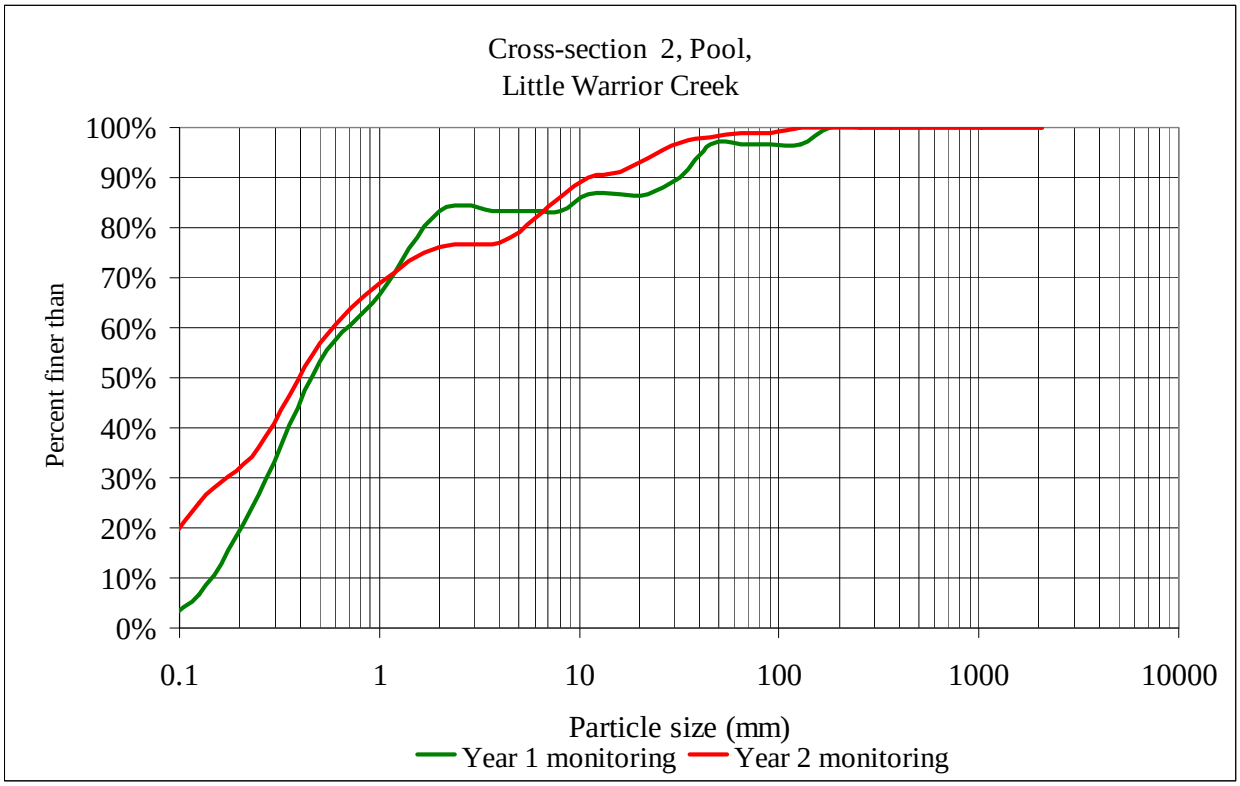
Size class index	Particle size (mm) in year sampled		
	Pre-construction 2001	MY 1	MY 2
D_{16}	<0.10	0.14	0.11
D_{35}	0.17	4.40	0.26
D_{50}	0.28	9.30	0.74
D_{84}	16.00	26.00	19.00
D_{95}	37.00	41.00	52.00

Appendix B.2.2. Continued.



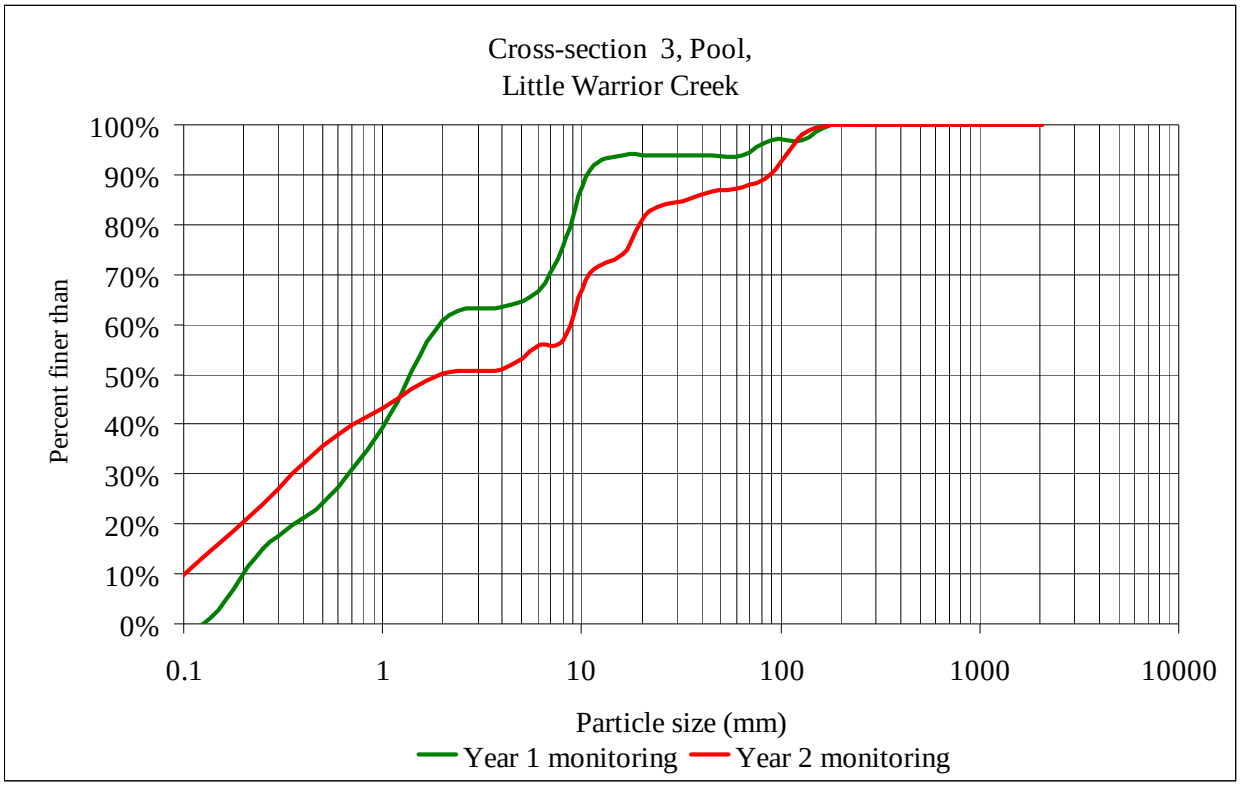
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	0.22	0.16
D_{35}	0.58	0.44
D_{50}	0.91	0.68
D_{84}	2.10	3.50
D_{95}	4.90	58.00

Appendix B.2.2. Continued.



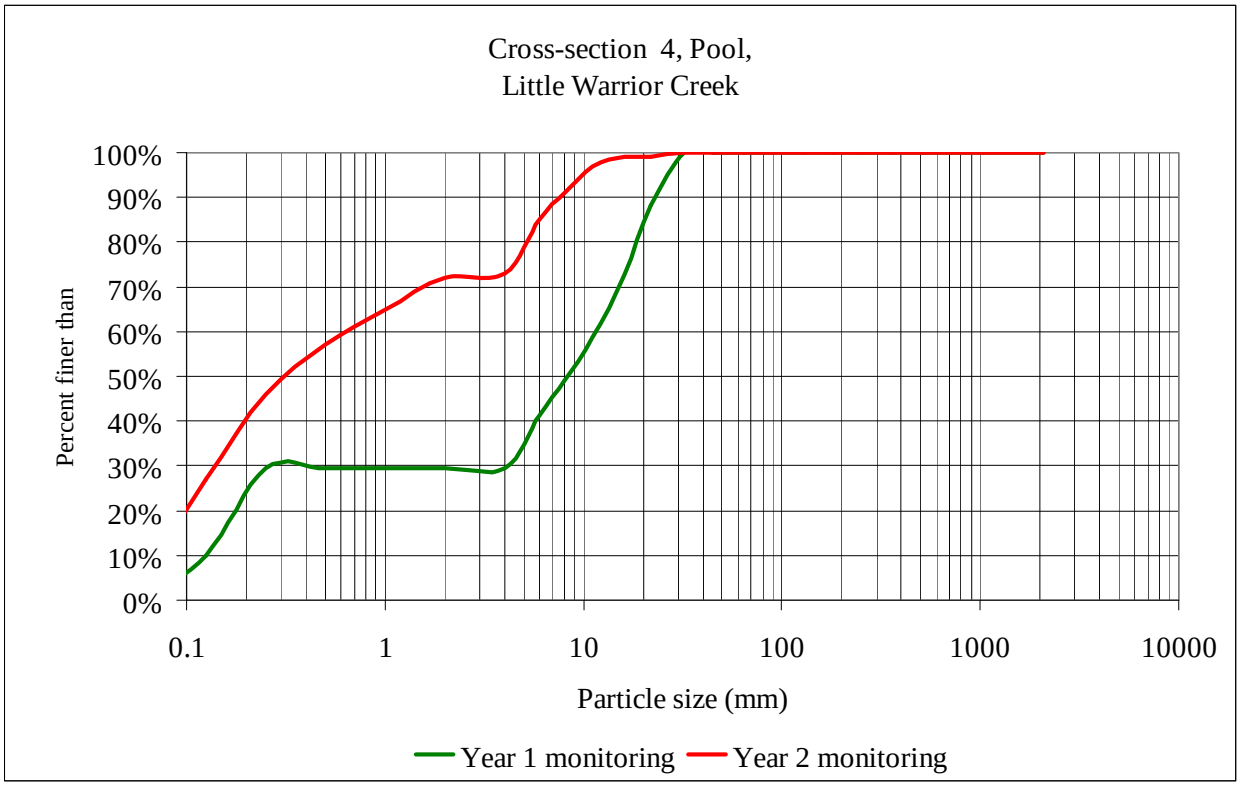
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	0.17	<0.10
D_{35}	0.31	0.23
D_{50}	0.46	0.40
D_{84}	8.50	6.90
D_{95}	41.00	25.00

Appendix B.2.2. Continued.



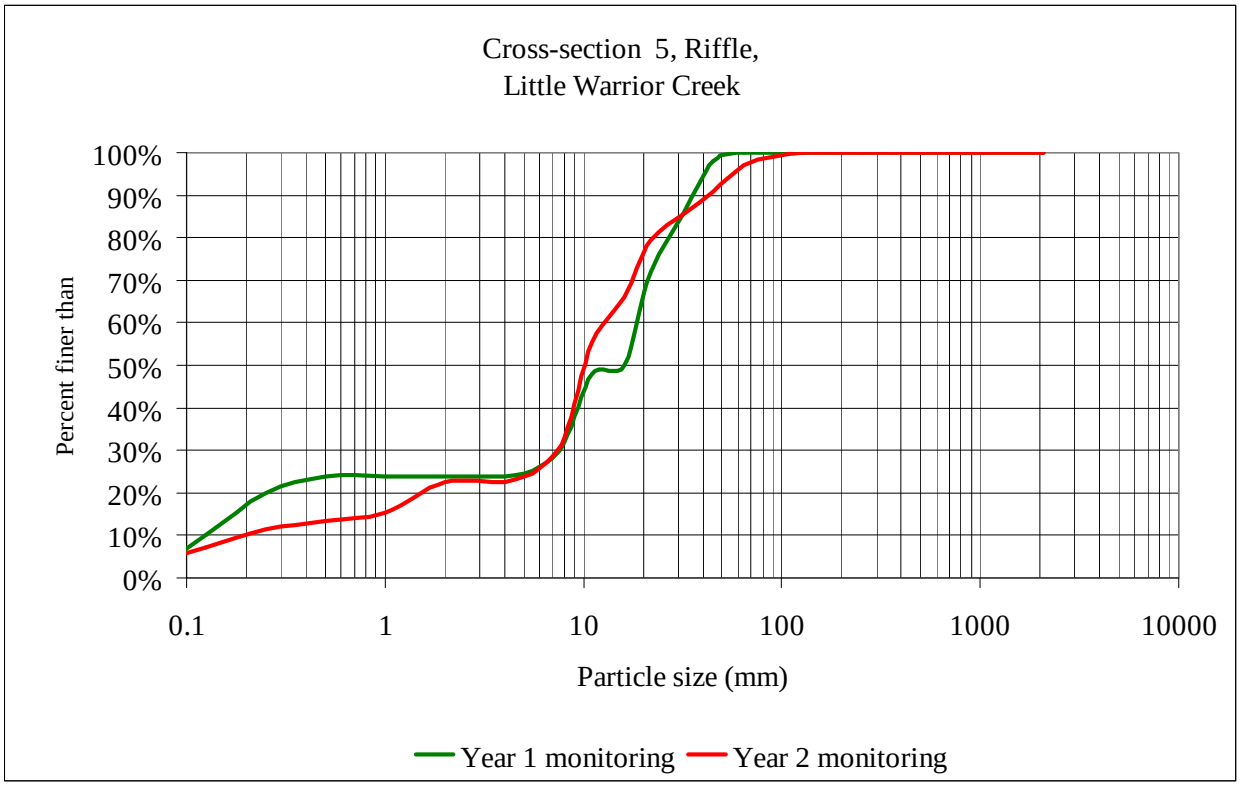
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	0.27	0.15
D_{35}	0.82	0.48
D_{50}	1.40	2.00
D_{84}	9.50	28.00
D_{95}	72.00	110.00

Appendix B.2.2. Continued.



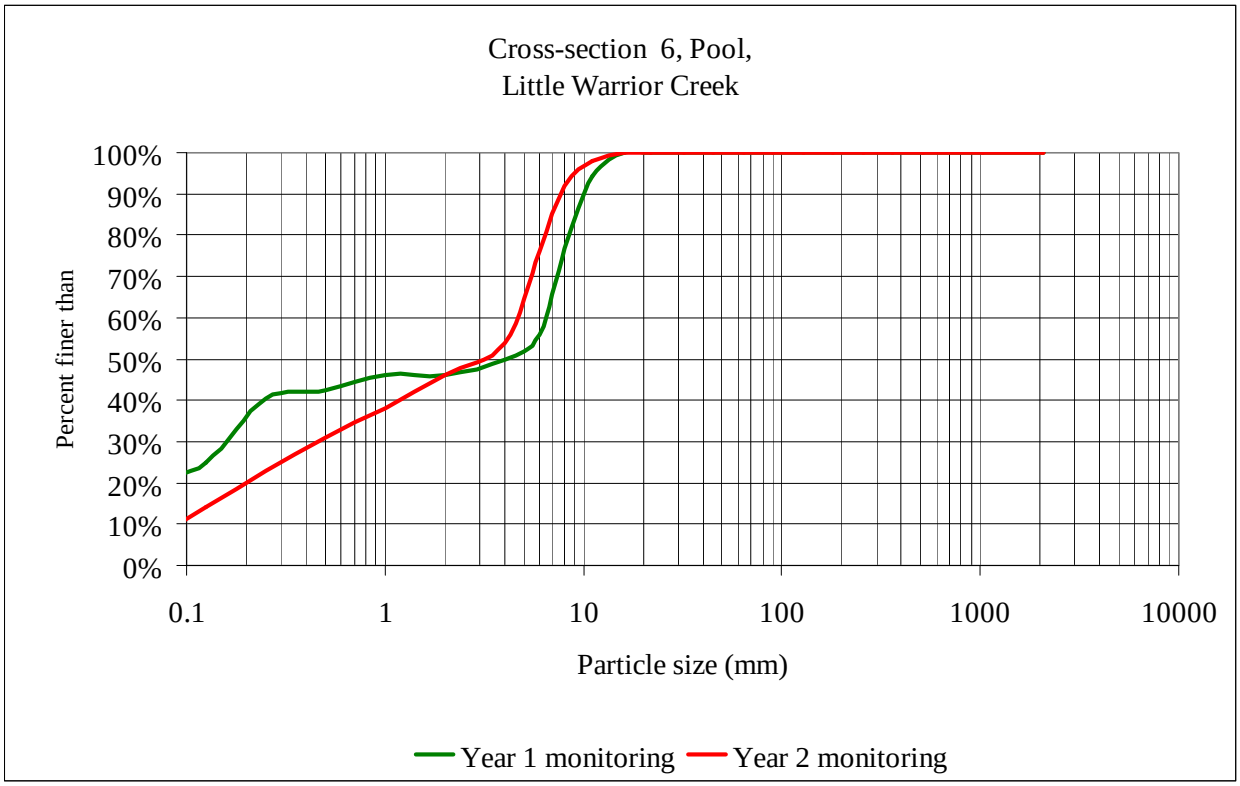
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	0.16	<0.10
D_{35}	4.80	0.17
D_{50}	8.30	0.32
D_{84}	20.00	5.80
D_{95}	27.00	9.90

Appendix B.2.2. Continued.



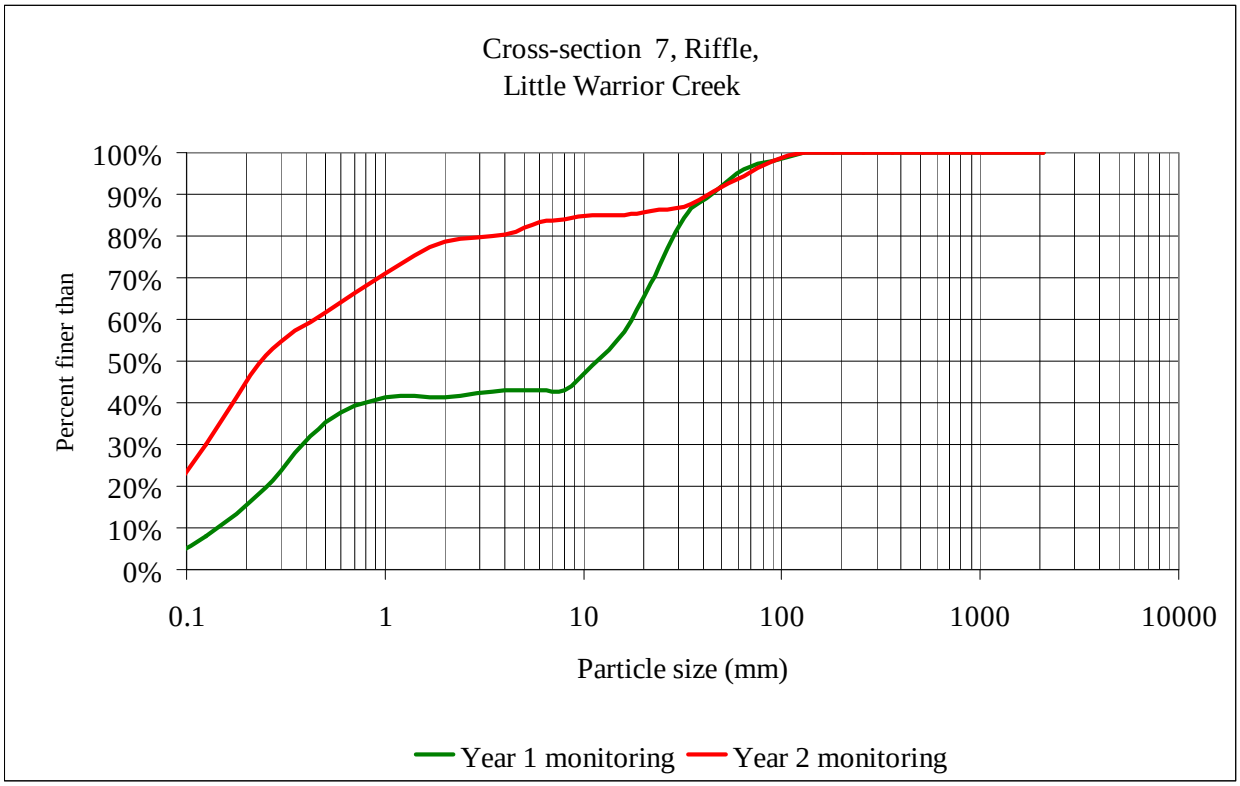
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	0.19	1.10
D_{35}	8.50	8.20
D_{50}	16.00	10.00
D_{84}	30.00	29.00
D_{95}	41.00	57.00

Appendix B.2.2. Continued.



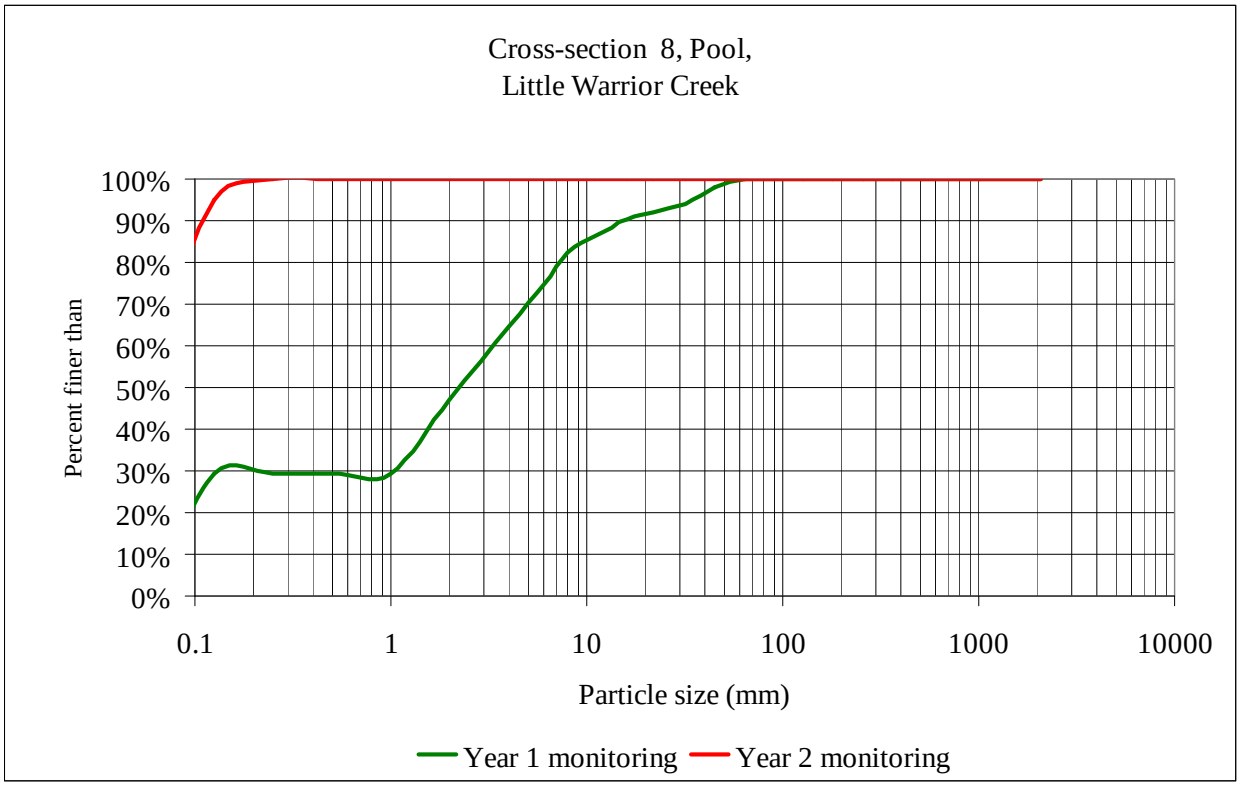
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	<0.10	0.15
D_{35}	0.20	0.74
D_{50}	4.00	2.80
D_{84}	9.10	6.90
D_{95}	12.00	9.40

Appendix B.2.2. Continued.



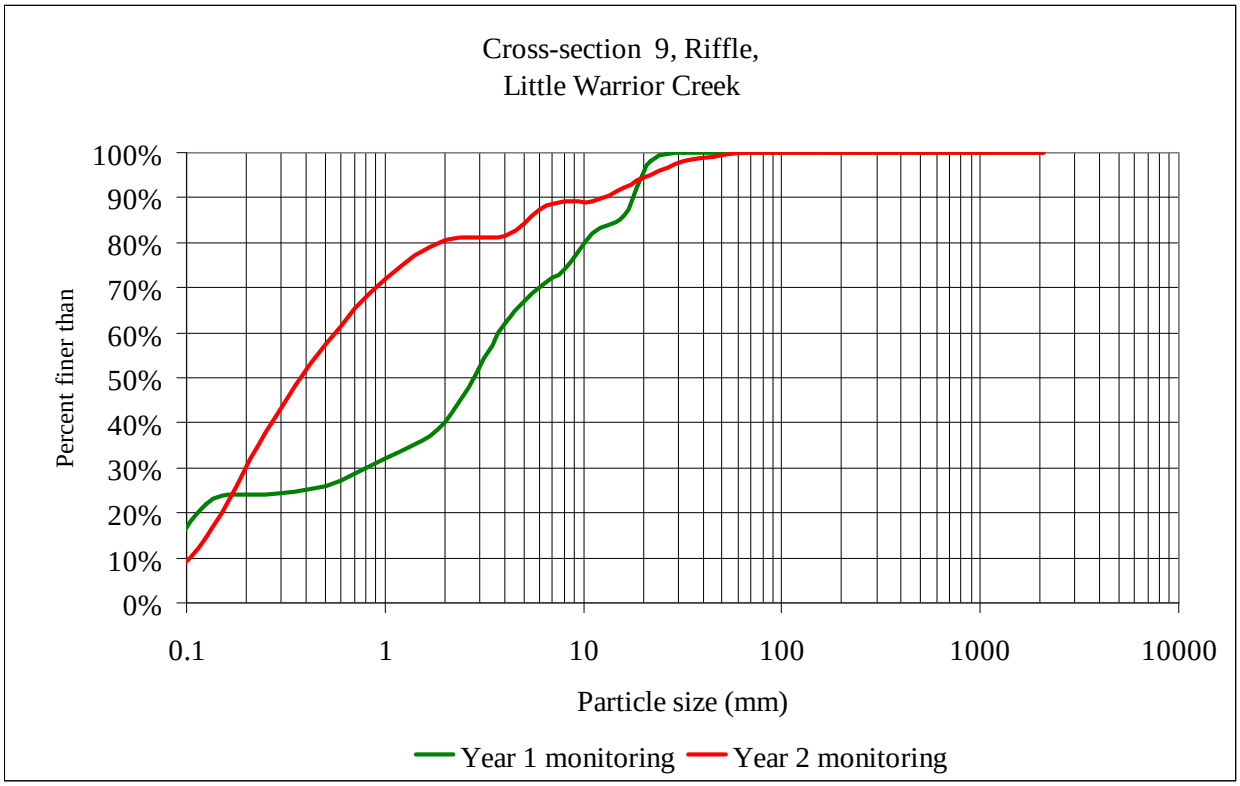
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	0.20	<0.10
D_{35}	0.49	0.15
D_{50}	12.00	0.24
D_{84}	32.00	7.70
D_{95}	60.00	68.00

Appendix B.2.2. Continued.



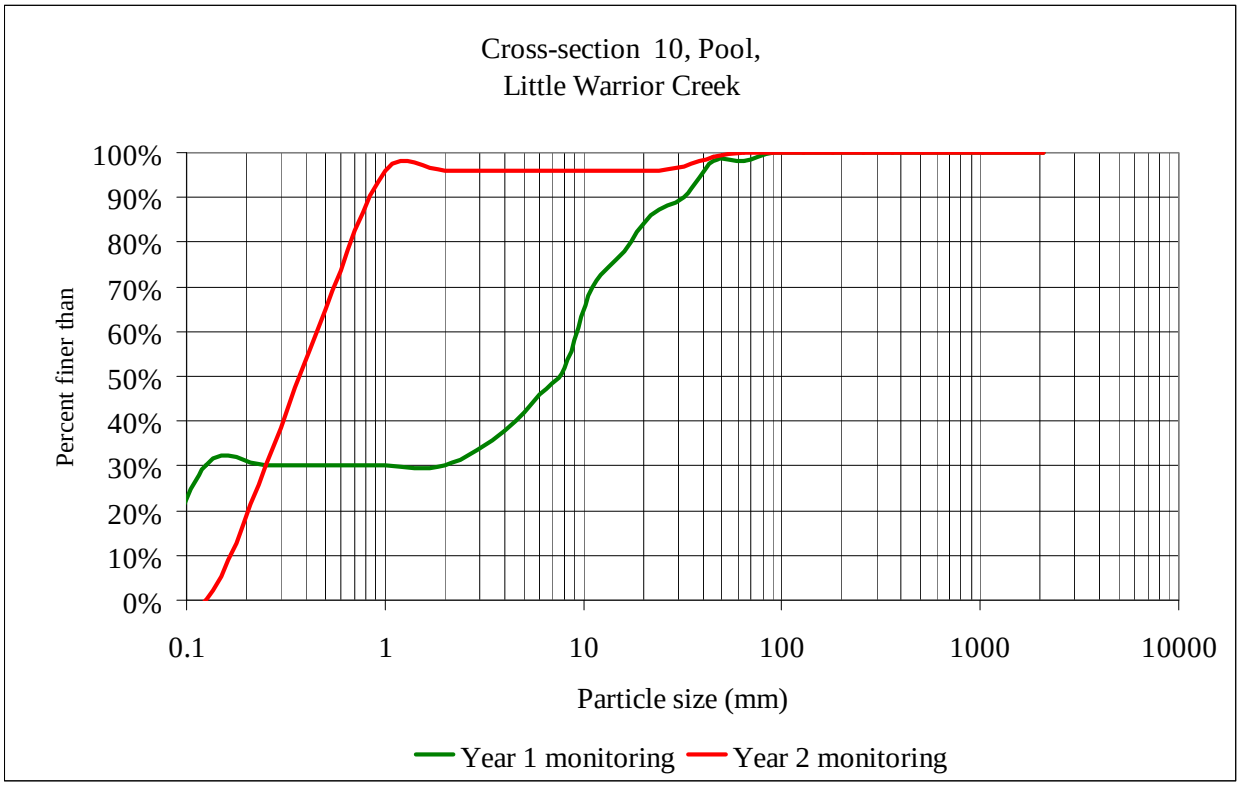
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	<0.10	<0.10
D_{35}	1.20	<0.10
D_{50}	2.20	<0.10
D_{84}	9.10	0.10
D_{95}	35.00	0.13

Appendix B.2.2. Continued.



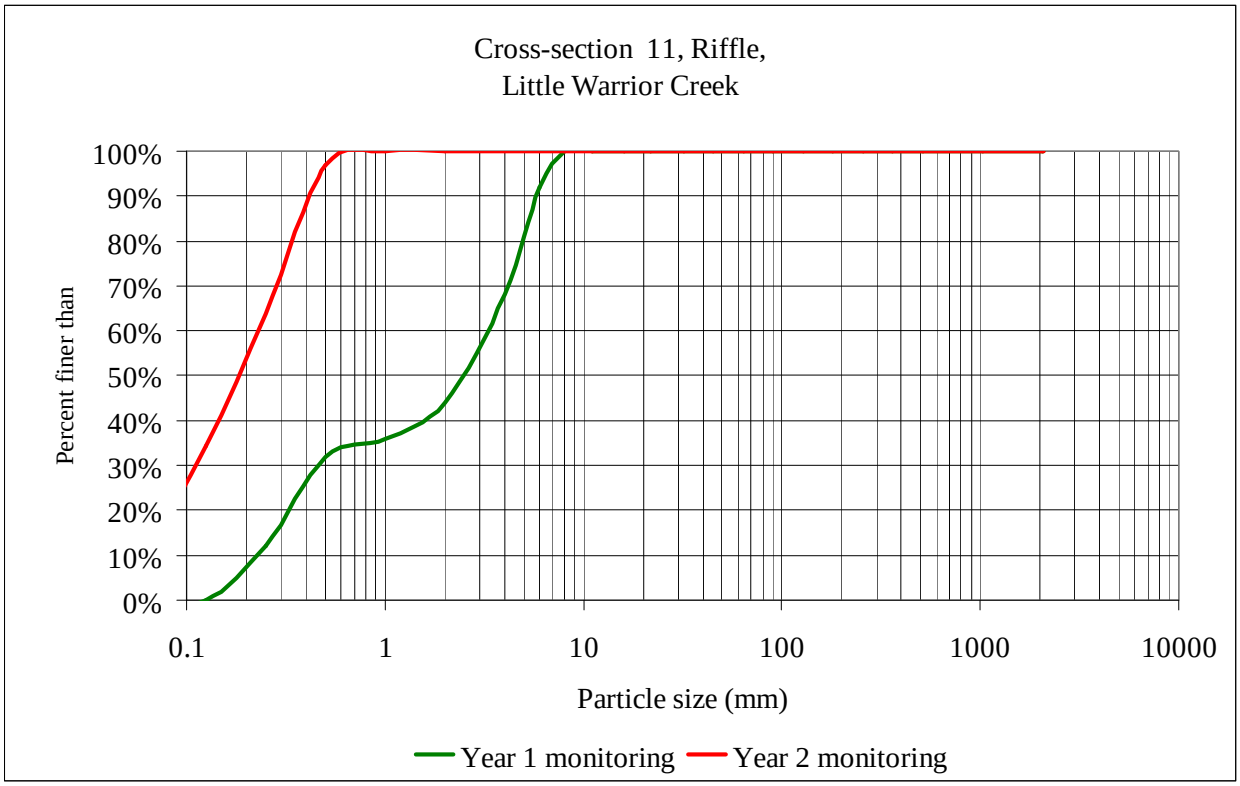
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	0.10	0.13
D_{35}	1.30	0.23
D_{50}	2.70	0.39
D_{84}	13.00	4.70
D_{95}	20.00	22.00

Appendix B.2.2. Continued.



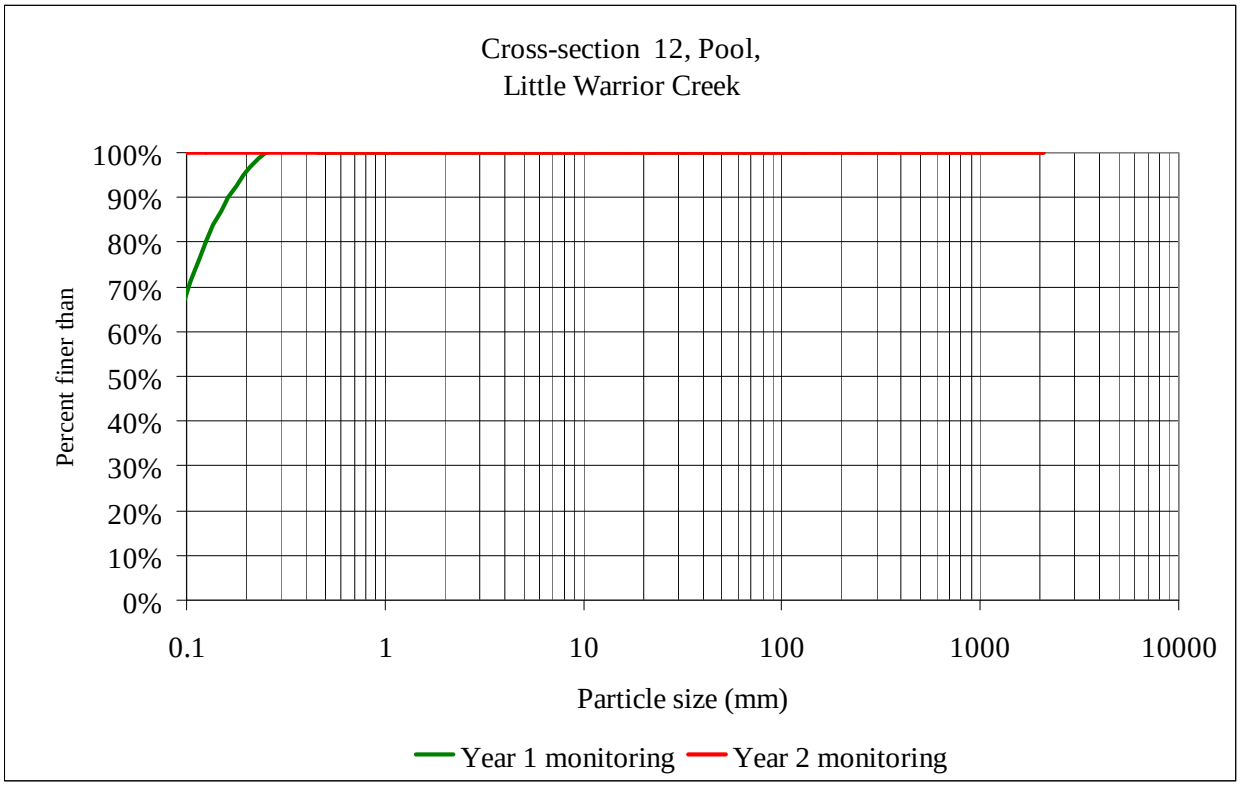
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	<0.10	0.18
D_{35}	3.10	0.28
D_{50}	7.30	0.37
D_{84}	20.00	0.76
D_{95}	40.00	0.98

Appendix B.2.2. Continued.



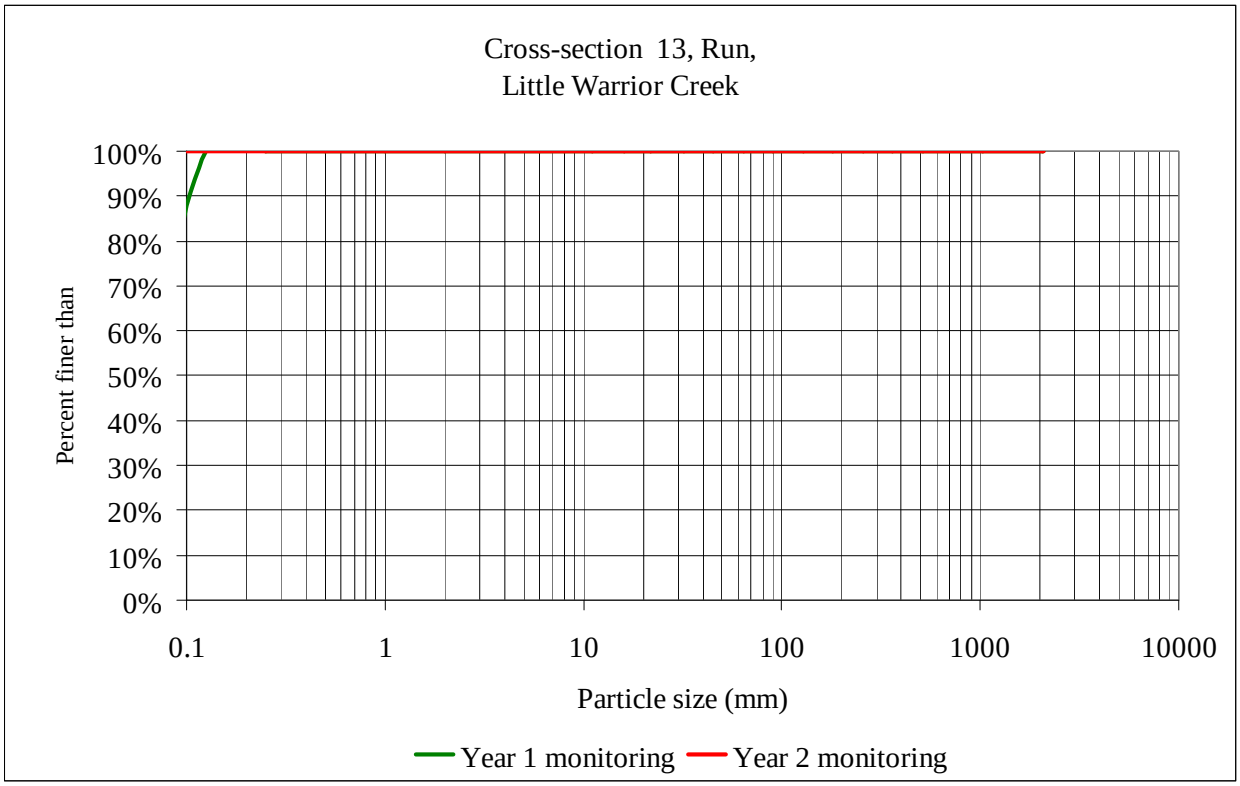
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	0.29	<0.10
D_{35}	0.84	0.13
D_{50}	2.40	0.18
D_{84}	5.20	0.38
D_{95}	6.70	0.48

Appendix B.2.2. Continued.



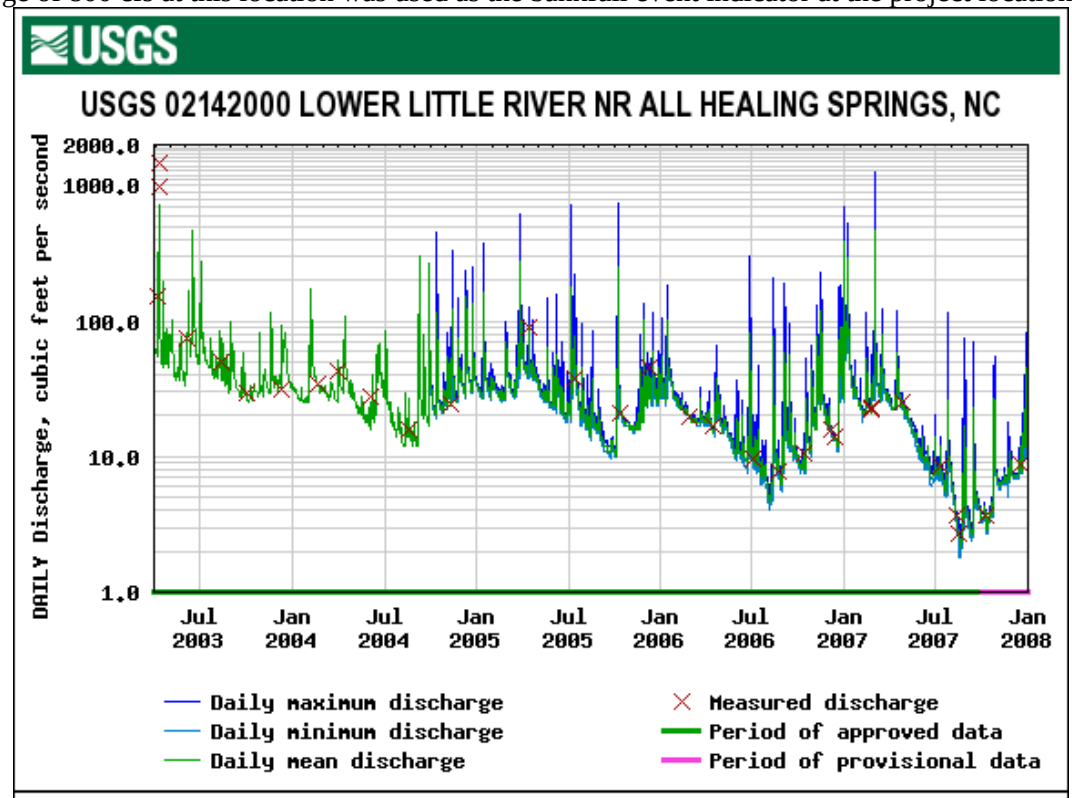
Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	<0.10	<0.10
D_{35}	<0.10	<0.10
D_{50}	<0.10	<0.10
D_{84}	0.14	<0.10
D_{95}	0.21	<0.10

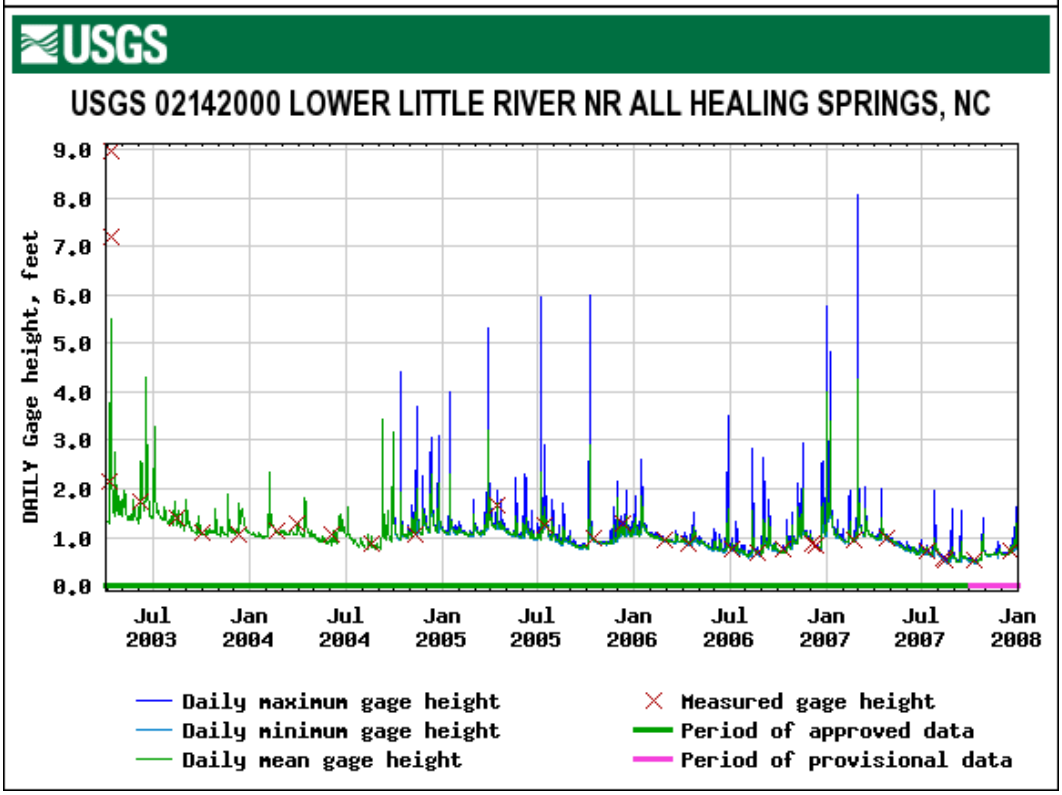
Appendix B.2.2. Continued.



Size class index	Particle size (mm) in year sampled	
	MY 1	MY 2
D_{16}	<0.10	<0.10
D_{35}	<0.10	<0.10
D_{50}	<0.10	<0.10
D_{84}	0.10	<0.10
D_{95}	0.12	<0.10

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 Healing Springs, North Carolina. A discharge of 800 cfs at this location was used as the bankfull event indicator at the project location.



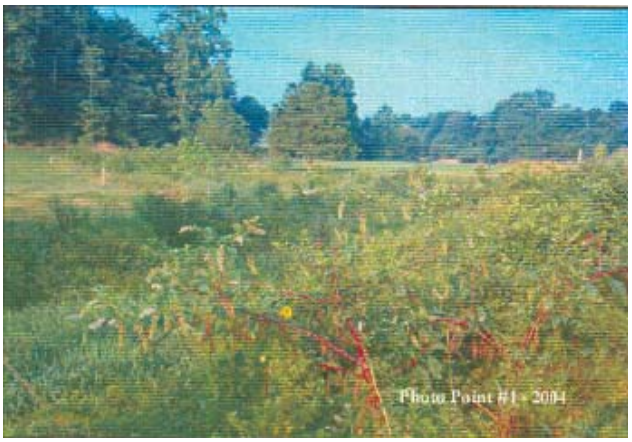


10 Appendix C.– Photograph Stations, Vegetation Plot Photographs, and Stream Problem Photographs

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

Photograph station 1, LUS, December 1998.

Photograph station 1, LUS, March 2003.



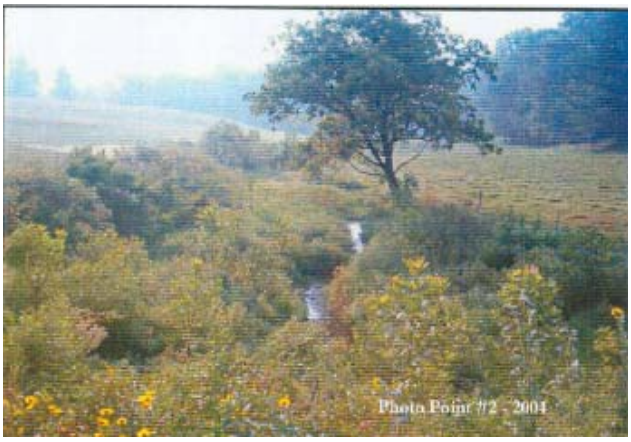
Photograph station 1, LUS, August 2004.

Photograph station 1, LUS, September 2007.

Appendix C.1.1. Continued.

Photograph station 2, LDS, December 1998.

Photograph station 2, LDS, March 2003.



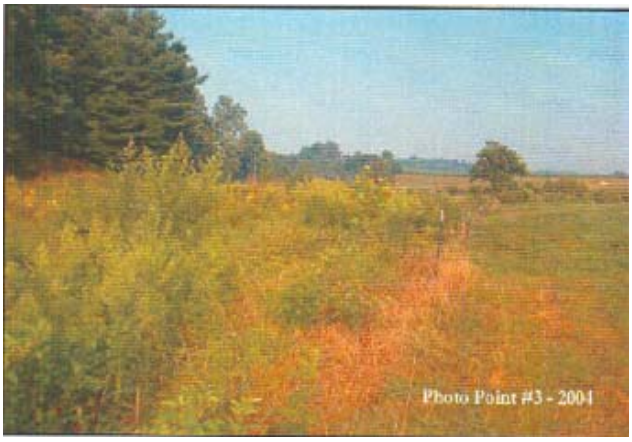
Photograph station 2, LDS, August 2004.

Photograph station 2, LDS, September 2007.

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.

Appendix C.1.1. Continued.

Photograph station 4, LDS, December 1998.

Photograph station 4, LDS, March 2003.

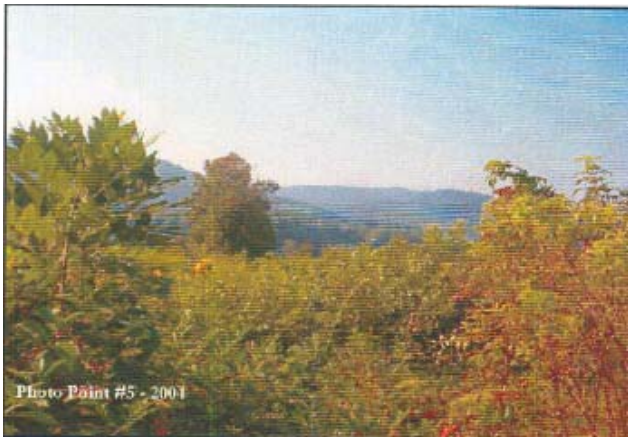
Photograph station 4, LDS, August 2004.

Photograph station 4, LDS, September 2007.

Appendix C.1.1. Continued.

Photograph station 5, LUS, December 1998.

Photograph station 5, LUS, March 2003.



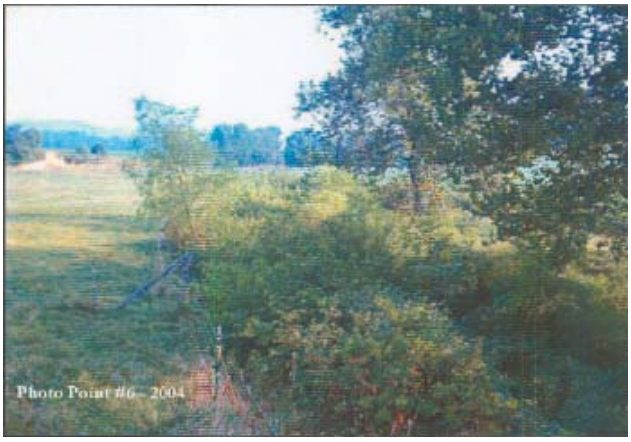
Photograph station 5, LUS, August 2004.

Photograph station 5, LUS, September 2007

Appendix C.1.1. Continued.

Photograph station 6, LDS, December 1998.

Photograph station 6, LDS, March 2003.



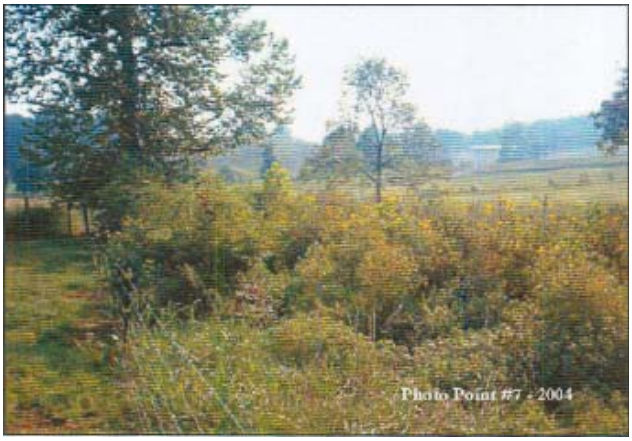
Photograph station 6, LDS, August 2004.

Photograph station 6, LDS, September 2007.

Appendix C.1.1. Continued.

Photograph station 7, LDS, August 2001.

Photograph station 7, LDS, March 2003.



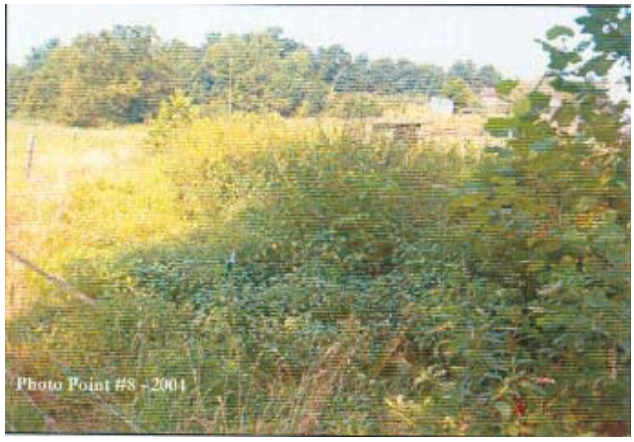
Photograph station 7, LDS, August 2004.

Photograph station 7, LDS, September 2007

Appendix C.1.1. Continued.

Photograph station 8, LUS, August 2001.

Photograph station 8, LUS, March 2003.



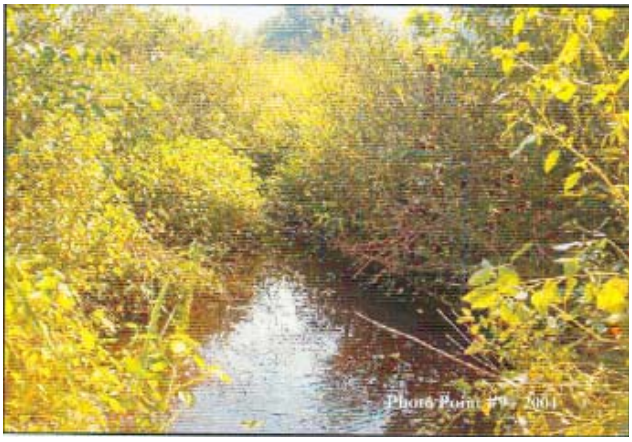
Photograph station 8, LUS, August 2004.

Photograph station 8, LUS, September 2007

Appendix C.1.1. Continued.

Photograph station 9, LDS, August 2001.

Photograph station 9, LDS, March 2003.



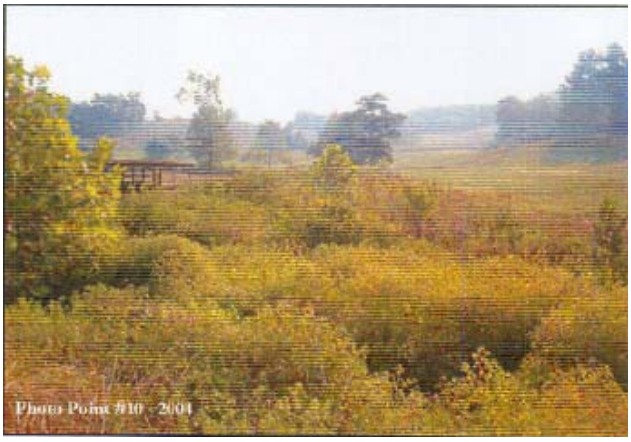
Photograph station 9, LDS, August 2004.

Photograph station 9, LDS, September 2007.

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.

Appendix C.1.1. Continued.

Photograph station 11, LDS, December, 1998.

Photograph station 11, LDS, March 2003.

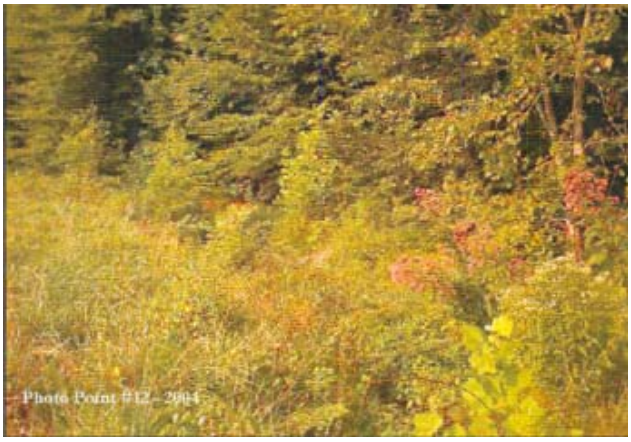
Photograph station 11, LDS, August 2004.

Photograph station 11, LDS, September 2007.

Appendix C.1.1. Continued.

Photograph station 12, LUS, December 1998.

Photograph station 12, LUS, March 2003.



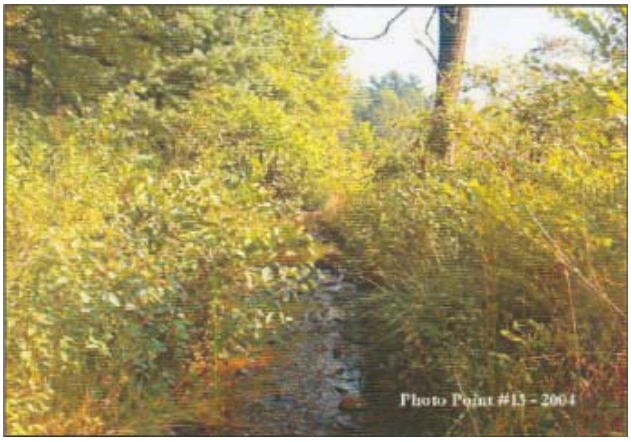
Photograph station 12, LUS, August 2004.

Photograph station 12, LUS, September 2007.

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.

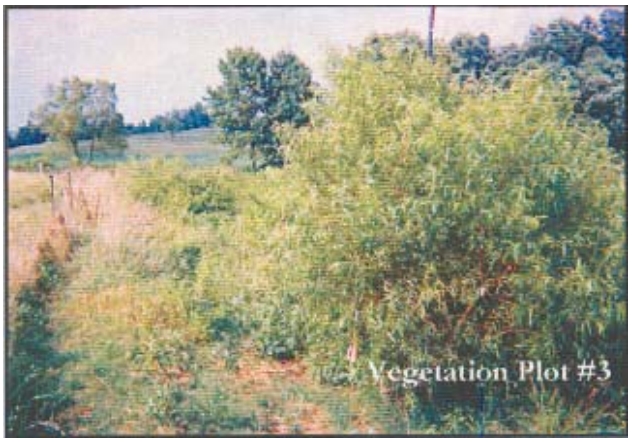
Appendix C.1.2. Big Warrior Creek vegetation plot photographs

Vegetation plot 1, September 2004.


Vegetation plot 1, August 2007.

Vegetation plot 2, September 2004.


Vegetation plot 2, August 2007.



Vegetation plot 3, September 2004.


Vegetation plot 3, August 2007.

Appendix C.1.2. Continued.

Vegetation plot 4, September 2004.


Vegetation plot 4, August 2007.

Vegetation plot 5, September 2004.


Vegetation plot 5, August 2007.

Vegetation plot 6, September 2004.


Vegetation plot 6, August 2007.

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

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

Area below cross-section 2.

Area below cross-section 2.

Appendix C.2.1. Little Warrior Creek Photograph Stations. 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.

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.

Appendix C.2.1. Continued.

Photograph station 3, LUS, July 2001.

Photograph station 3, LUS, March 2003.

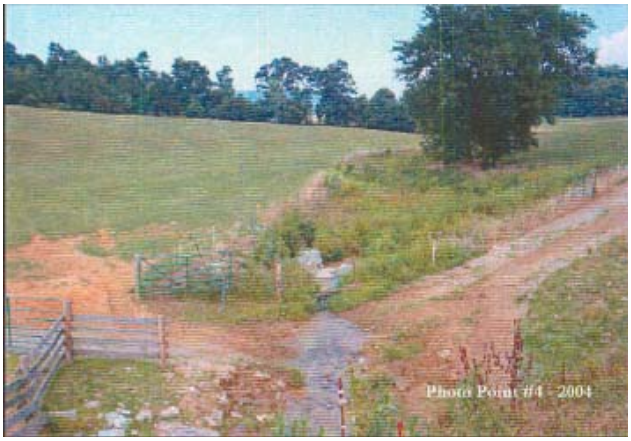
Photograph station 3, LUS, August 2004.

Photograph station 3, LUS, September 2007.

Appendix C.2.1. Continued.

Photograph station 4, LDS, December 1998.

Photograph station 4, LDS, March 2003.



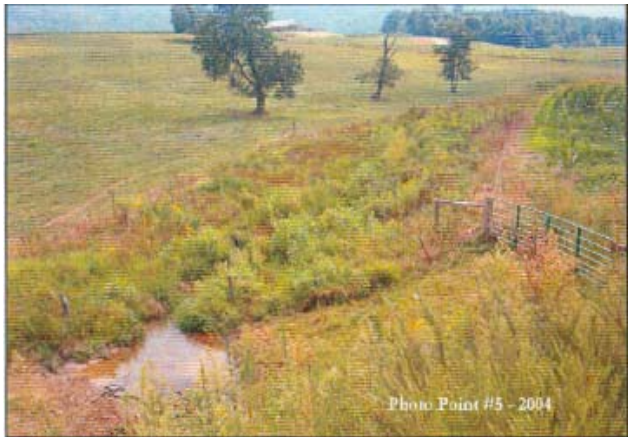
Photograph station 4, LDS, August 2004.

Photograph station 4, LDS, September 2007.

Appendix C.2.1. Continued.

Photograph station 5, LUS, December 1998.

Photograph station 5, LUS, March 2003.



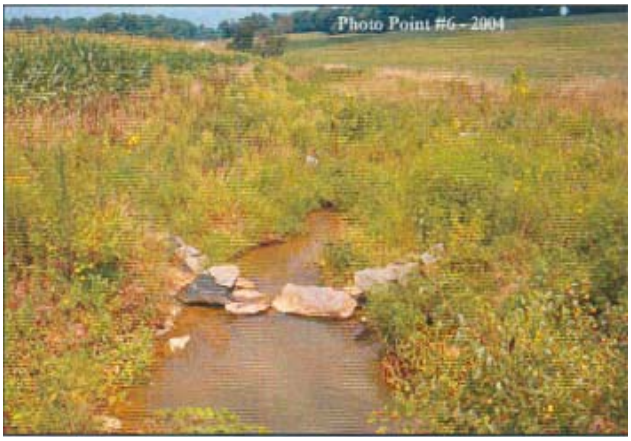
Photograph station 5, LUS, August 2004.

Photograph station 5, LUS, September 2007.

Appendix C.2.1. Continued.

Photograph station 6, LDS, December 1998.

Photograph station 6, LDS, March 2003.



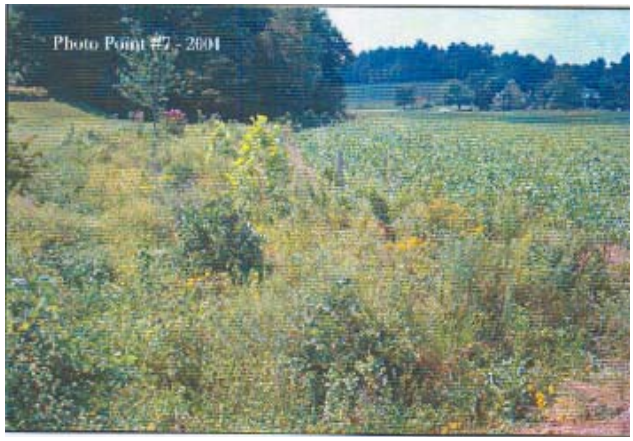
Photograph station 6, LDS, August 2004.

Photograph station 6, LDS, September 2007.

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.

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.

Appendix C.2.1. Continued.

Photograph station 9, LUS, December 1998.

Photograph station 9, LUS, March 2003.

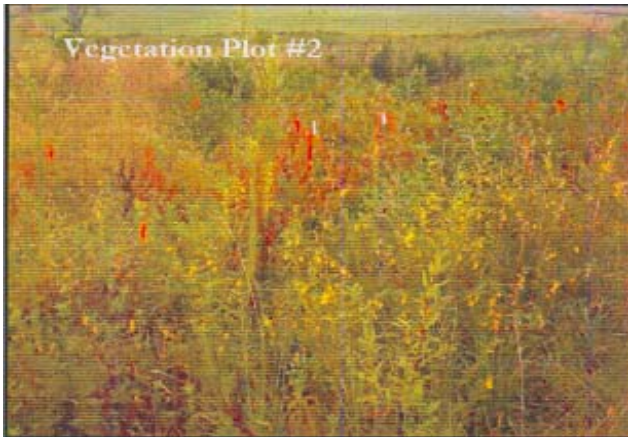
Photograph station 9, LUS, August 2004.

Photograph station 9, LUS, September 2007.

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

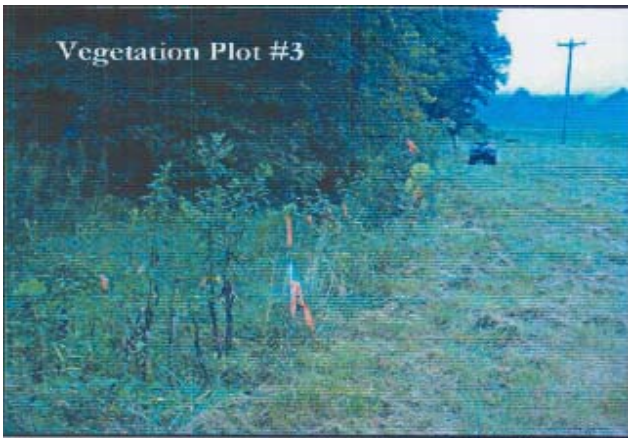
Vegetation Plot 1, September 2004.


Vegetation Plot 1, August 2007.



Vegetation Plot 2, September 2004.

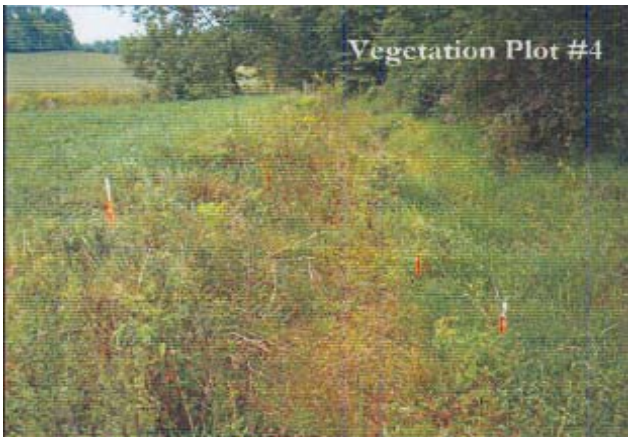

Vegetation Plot 2, August 2007.



Vegetation Plot 3, September 2004.

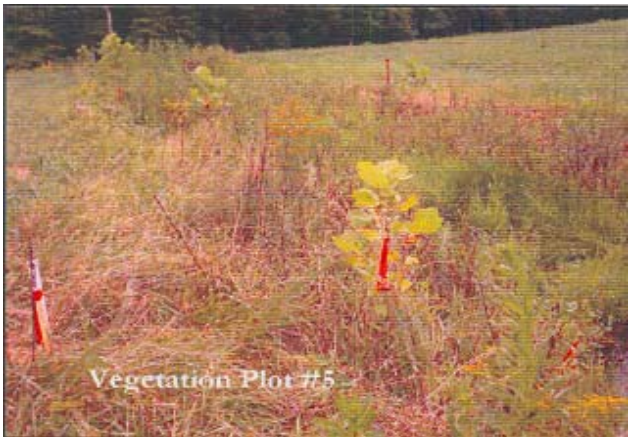

Vegetation Plot 3, August 2007.

Appendix C.2.2. Continued.



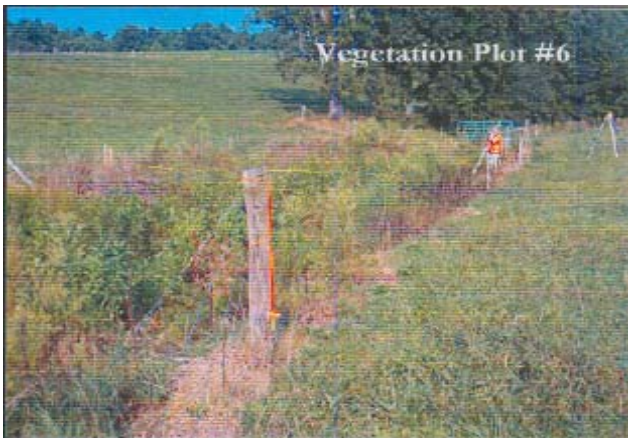
Vegetation Plot 4, September 2004.


Vegetation Plot 4, August 2007.



Vegetation Plot 5, September 2004.


Vegetation Plot 5, August 2007.



Vegetation Plot 6, September 2004.


Vegetation Plot 6, August 2007.

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.

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

Area between cross-sections 1 and 2, LDS.

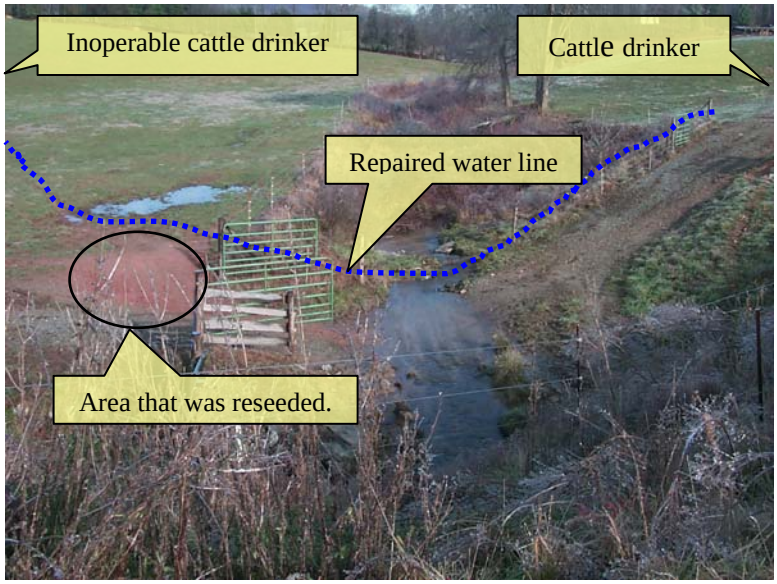
Area located on an unnamed tributary to Little Warrior Creek.

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.

Appendix C.3. Continued.



Repairs to the cattle drinker and reseeding, September 2005.

September 2007.

Appendix C.3. Continued.

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

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

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.