CARP MITIGATION SITE, UNNAMED TRIBUTARY TO LAXON CREEK, WATAUGA COUNTY

Monitoring Report

Prepared for the

NORTH CAROLINA DEPARTMENT OF TRANSPORTATIN STREAM MITIGATION PROGRAM

Transportation Improvement Project R-529 BA, BB, BD

Period Covered: April 2, 2002 - April 15, 2003

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Abstract.—This report summarizes the April 2, 2002 and April 15, 2003 monitoring of 542 linear feet of Priority I stream restoration at the Carp site on an unnamed tributary to Laxon Creek, Watauga County. This monitoring report is submitted in partial fulfillment of the off-site stream mitigation agreement between the North Carolina Department of Transportation (DOT) and North Carolina Wildlife Resources Commission (WRC) for the R-529 US 421 road improvement project in Watauga County. Project objectives at this mitigation site were to improve water quality, aquatic habitat, riparian quality and stream stability of the unnamed tributary on the Carp property. The primary method to achieve the above objectives was to construct a meandering C channel on a new alignment (Priority I restoration) to reestablish proper stream dimension, pattern, and profile through the pasture. Other enhancement activities included placement of in-stream cover, resloping selected stream banks and revegetation of the entire reach. Monitoring surveys included a longitudinal profile, cross-sections, modified Wolman pebble counts, reference photographs, vegetative analysis, and temperature data collection. There has been little change in the post-construction longitudinal profile when compared to the 2002 and 2003 profiles. The meander pattern has remained stable and in-stream structures are functioning as designed. The only noticeable change to the cross-sections has been the formation of an inner berm bench at all cross-sections except station 1+69. The 2002 smaller than normal D50 pebble size is probably a direct result of the 2001-2002 drought. During this period there were few sediment flushing flows, resulting in smaller particle sizes being present.

The purpose of this report is to summarize the April 2, 2002 and April 15, 2003 monitoring data collected from 542 linear feet of Priority I stream restoration at the Carp site (Figure 1) on an unnamed tributary to Laxon Creek, Watauga County. The Priority I construction of the new channel was completed on November 2, 2000. The as-built survey was completed and submitted to North Carolina Department of Transportation (DOT), North Carolina Division of Water Quality (DWQ) and United States Army Corps of Engineers (COE) in May 2001 (Mickey and Scott, 2001). This monitoring report is submitted in partial fulfillment of the off-site stream mitigation agreement between the DOT and North Carolina Wildlife Resources Commission (WRC) for the R-529 (US 421) road improvement project in Watauga County. Under this agreement, a total of 14,814 linear feet of stream mitigation is required by the United States Army Corps of Engineers under COE 404 permit number 199707161 and 7,407 linear feet of stream mitigation is required by DWQ 401 permit number 970616.

Drainage area at the restoration site is 448 acres (0.7 mi^2). The lower end of the project begins at the tributary's confluence with Laxon Creek. The conservation easement of the site totals 0.76 acres. The watershed contains a low density of homes with agricultural operations being the primary land disturbing activity. Most of the hillsides and valleys are used for cattle grazing, hay production, and Christmas tree farming. A significant portion of the watershed remains in second growth forest. At the present time, there is some conversion of agricultural land to single family home sites. Sediment in the stream originates mainly from livestock pastures and gravel roads. Project objectives at this mitigation site were to improve water quality, aquatic habitat, riparian area quality, and channel stability of the unnamed tributary on the Carp property.

The primary method to achieve the above objectives was to construct a meandering C channel (Rosgen 1996) on a new alignment (Priority I restoration) during October and November 2000. This was accomplished by creation of a channel containing the proper dimension, pattern, and profile through the adjacent pasture. Aquatic and riparian area habitats were improved by addition of in-stream cover, reshaping of selected stream banks and revegetation of the entire reach (Mickey and Martinez 2000). An as built survey was completed in April 2001 (Mickey and Scott 2002) using methods described by Harrelson et al. (1994).

Methods

The DWQ and COE require annual monitoring surveys as conditions of their permits. Monitoring surveys must document the dimension, pattern and profile of the restored channel. No less than two bankfull flow events must be documented through the required five year monitoring period. If less than two bankfull events occur during the first five years, monitoring must continue until the second bankfull event is documented. The bankfull events must occur during separate monitoring years.

Monitoring summarized in this report is based on WRC guidelines (Clemmons 2000), DWQ and Division of Land Resources (DLR) (2002) draft guidelines and COE (2003) stream mitigation guidelines. Monitoring data collected at this Priority I restoration includes the following: channel morphology (stability analysis: cross-sections, longitudinal profile, and pebble counts), reference photographs, plant survival analysis, and water temperature.

Morphology

Permanent cross-sections were established at seven locations (Mickey and Scott 2001) during the as-built survey by placing permanent pins in the ground so points along the tape line up exactly year to year. Cross-sections are monitored by taking measurements from left to right, crossing through the channel and up the bank to include some floodplain measurements. All breaks in slope are measured, within and outside the channel. If a potential problem area develops a new cross-section will be established at this location and assessed year to year. If instability occurs, the problem will be repaired.

The longitudinal profile of the stream channel is measured from a known point downstream to the lowest extent of the reach. The location of features measured include the heads of riffles and pools, water surface elevations, in-stream structures, bankfull elevation, top of bank elevation and any other channel forming feature. Longitudinal profiles were plotted over previous year(s) data for comparisons.

Modified Wolman pebble counts (Rosgen 1996) were conducted pre-construction as a basis for comparison with the as-built and monitoring counts. This data is taken to assess changes in the bed composition pre- and post-construction and during the monitoring years. One hundred counts from pools and riffles were taken along a reach (ratio equal to that of the overall reach pool/riffle ratio) and along a riffle cross-section.

Judgements on success or failure of restoration activities based on the data will be subjective. It is anticipated that there will be some minor changes in the cross-sections, longitudinal profile and substrate composition. Changes that may occur during the monitoring period will be evaluated to determine if they represent a movement toward a more unstable condition or are changes that represent an increase in stability.

Reference Photographs

Reference photograph points were located at distinguishing points along the stream. Photographs were taken from the same location and during the same time of year to make accurate comparisons. Photographs were used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of in-stream structures. Photographs were used to indicate if excessive bank erosion or bank instability were occurring. Where potential problem areas appear to be developing, additional photographs were taken and a cross-section transect established. When channel or bank instability occurs, the problem will be repaired.

Vegetation

Vegetation was monitored by direct counts over the length of the reach. Due to the short length of the site, vegetation survival plots were not established. Numbers of live trees and livestakes were be recorded and compared to the numbers planted.

Temperature

Temperature loggers were placed in the stream at the upper and lower ends of the project reach. Loggers were programmed to record temperature hourly and installed in July. Data was downloaded, edited and plotted. Twenty degrees Celsius (68°F) was chosen as the generally accepted maximum water temperature that will sustain coldwater communities (COE 2003). The daily mean water temperatures were calculated by averaging all the readings for that day.

Results

Morphology

Cross-sections and longitudinal profile data were collected on April 2, 2002 and April 15, 2003. Pebble count data were collected on June 13, 2002 and April 15, 2003.

Overlay of data from the seven cross-sections, as shown in Figures 2. 1-2.7, indicate few changes have taken place in the channel with regards to the width/depth ratio, area and entrenchment ratio. Data from the riffle cross-section at station 2+24 and run cross-section 3+76 (Table 1) show that the new channel is classified as C4 (Rosgen 1996). The only noticeable change has been the formation of an inner berm bench at all cross-sections except station 1+69 (Figures 2. 1-2. 7).

Longitudinal profile data were collected from the 542 linear feet of restored stream. Longitudinal profiles were overlaid to show changes in bed form from previous years (Figure 3). The as-built survey data showed there were 44% pools in 2001 (Mickey and Scott), whereas in 2002 and 2003 pool habitat comprised 44% and 42% of the total reach. The longitudinal profile revealed some bed aggradation at stations 0+55-1+45, 3+24-3+76 and 4+90-5+42. A debris jam was located at station 4+35.

Table 2 compares the as-built (2001) pebble count data with 2002 and 2003 monitoring data. The D50 weighted pebble size was 3.9 mm in 2002 and 15.0 mm in 2003. The D50 material is in the high range for medium gravel. The stream is classified as a gravel bed stream, C4 (Rosgen, 1996). Appendix 2 summarizes the 2002 and 2003 pebble count raw data.

Reference Photographs

Reference photographs show a maturing riparian buffer. Photographs also show bank stability from year to year with no development of unstable depositional areas or bank erosion along the reach (Appendix 2).

Vegetation

Since construction, all banks have become well vegetated. Of the five hundred thirty-three (533) live stakes and bare root nursery trees planted on the 0.67 acre site during March 2001, November 2002, and March 2003 (Table 3), 82% of the live stakes and 31% of the trees survived to May 2003. Over a three-year period 363 trees were planted at the site with a 31% surviving to 2003. Combined survival for both trees and livestakes was 47%.

Temperature

Temperature was recorded hourly from July 26 - September 27, 2001 and from June 8 - October 6, 2002 at the upper and lower ends of the project site (Appendix 3). The data indicates that stream temperatures showed little variability in 2001, whereas stream temperatures experienced a wider range of fluctuations in 2002. In order to better understand temperature fluctuations at the site, 20°C (68°F) was selected as a threshold point where water temperatures might begin to negatively impact cold water fish populations. The number of hours and days from July 26 through September 27 were determined, then the number of hours and days that 20°C was exceeded at the upper and lower ends of the site were calculated. In 2001, the upper end of the project had 7 hours spaced over 2 days that exceeded 20°C (0.46%), while the lower end of the project had 38 hours spaced over 11 days that exceeded 20°C (2.5%). In 2002, the upper end of the project had 9 hours spaced over 2 days that exceeded 20°C (0.59%), while the lower end had 215 hours spaced over 36 days that exceeded 20°C (14%). For the period of July 26 to September 27, 2001 and 2002 (Figure 4), the average daily water temperatures at the upper end of the project were 16.4°C and 17.3°C whereas the average daily water temperatures at the lower end of the project were 16.6°C and 17.6°C.

Discussion

Stream flows were at all time lows during 2001 and 2002 and few sediment flushing flows occurred during this period. Bankfull events did occur on March 30, 2001 and February 22, 2002 prior to the April 2, 2002 monitoring survey. Prior to the April 15, 2003 monitoring survey, bankfull events occurred on July 4, 2002 and March 16, 2003. As normal rain events returned to North Carolina during fall 2002 and winter 2003 breaking the drought cycle, there were several inner berm flow events during this time period.

Morphology

There has been little change in the cross-section dimensions since completion of the as-built survey in 2001. However, in 2003, an inner berm bench began forming once the drought cycle was broken in the fall of 2002. High stream flows began to deposit sediments on the constructed floodplain. There has been an indication that some of the pools have become shallower, however, this does not appear to be the result of aggradation, but the result of a shift in the pool thalweg at the permanent cross-section location. These results do not indicate instability within the channel.

There has been some change in the as-built longitudinal profile when compared to the 2002 and 2003 profiles. Pool habitat has remained fairly constant since the as-built survey. There has been some aggradation of materials at some locations and some deepening at other locations; however, none of this activity indicates a migration towards an unstable stream channel. These changes appear to be normal stream adjustments to stream flow and weather conditions. The bed aggradation observed at stations 0+55-1+45 appears to be a natural stream channel adjustment since there was no construction work done at or upstream of this point. The aggradation at the long pool/glide constructed at stations 3+24-3+76 is also the result of natural channel processes. The aggradation at stations 4+90-5+42 is probably the direct result of existing streambed levels taken during 2001, 2002 and 2003 at the confluence with Laxon Creek (station 5+42). There has been no shift in the meander pattern as the stream has remained stable and in-stream structures are functioning as designed. No bank scour or erosion was evident and no problems were noted with any of the structures.

The 2002 smaller than normal D50 reach pebble size is probably a direct result of the 2001-2002 drought. During this period, there were few sediment flushing flows, resulting in smaller particle sizes being present. During reduced flows and small storm events, smaller bed materials can be deposited throughout the site. Off-site sedimentation comes from eroding banks and livestock access upstream of the site. The larger storm events experienced in late 2002 and during 2003 were able to flush these smaller bed materials through the site and allow for larger bed materials to be exposed. The 2003 D50 material compares favorably to the pre construction and as-built pebble count sizes of 15.0 mm and 16.7 mm (Mickey and Scott, 2001).

Reference Photographs

The goal of a conservation easement around this reach of stream is to reestablish a riparian corridor with mature vegetation. The photographs in Appendix 2 show that by restricting use of the riparian corridor, the vegetation will grow and eventually shade the stream, decreasing temperature and improving wildlife and aquatic habitat. The reference photographs also show in-stream structure and channel stability throughout the reach.

Vegetation

The majority of the plantings occurred in 2001. Live stakes, collected from nearby stream corridors, included silky dogwood *Cornus amomum* and silky willow *Salix sericea*. Bare root trees from the N.C. Forest Service were northern red oak *Quercus rubra*, black cherry *Prunus* *serotina*, persimmon *Diospyros virginiana*, sugarberry *Celtis laevigata*, white ash *Fraxinus americana*, white pine *Pinus strobus*, tag alder *Alnus serrulata*, black locust *Robinia pseudoacacia L.*, black walnut *Juglans nigra*, and eastern hemlock *Tsuga canadensis* (Table 3). The lower than expected tree survival can be attributed to the drought occurring in 2001 and 2002. Also, a tall and dense ground cover of fescue and other forbes probably reduced tree survival and could have resulted in some surviving trees being missed during the survey. The high survival of livestakes (82%) is attributed to their being planted at the waters edge where they were not impacted by the drought. Based on DWQ criteria of 320 stems per acre through year three for mitigation sites, this 0.67-acre site should contain 214 trees/shrubs. Currently, 252 trees and live stakes planted at the site are surviving. During the count, tag alder, seeded naturally, were observed at numerous locations along the new stream channel. These volunteer tag alder will provide additional shade and stability to the channel. We will continue to monitor plant survival to ensure that a good stand of shrubs and trees becomes established.

Temperature

The higher water temperatures in 2002 can be attributed to the low flows during the drought of 2002 and the fact that overhanging vegetation has not become well established. As planted vegetation matures, the amount of time water temperatures exceed 20°C should decrease. This will make habitat conditions more favorable to cold water fish species.

Summary

Through natural stream design, a new C channel containing proper pattern, dimension and profile has been constructed at the Carp site. The site has not experienced any failures since construction in 2000. Water quality at the site has been improved through reduced sedimentation from eroding banks. As the riparian zone matures, water temperatures should decrease, improving cold-water fish habitat. In-stream habitat has increased for fish and aquatic invertebrates through placement of in-stream structures. Both aquatic and terrestrial wildlife species will benefit with the return of a functioning riparian corridor and stream aesthetics have been improved. The new channel is functioning as planned.

Recommendations

1. Continue monitoring channel morphology, vegetation survival, and taking photographic records for four additional years.

2. Compile and plot channel morphology (cross-sections, longitudinal profile, and pebble count) data cumulatively and asses for indications of change towards a more unstable or stable condition.

3. Expand site photographic records to show the site during winter and to document any channel or vegetation changes that occur during the year.

4. Inspect the site after potential bankfull storm events to document

damage to the stream banks or structures.

5. Monitor potential problem areas with new cross-sections and photographs to determine if they are migrating towards an unstable condition.
6. Repair problem areas if it is determined that they are creating unstable channel conditions.

References

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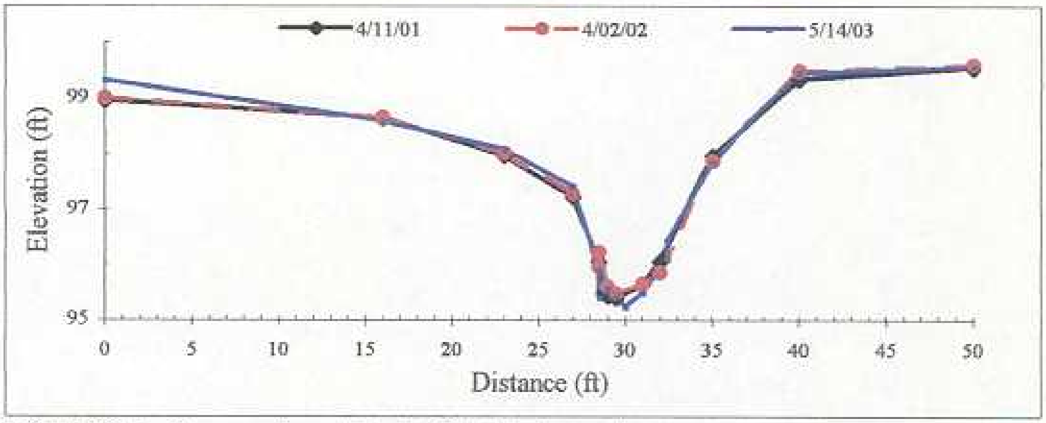


FIGURE 2.1. Cross-section station 1+69, stair step pool.

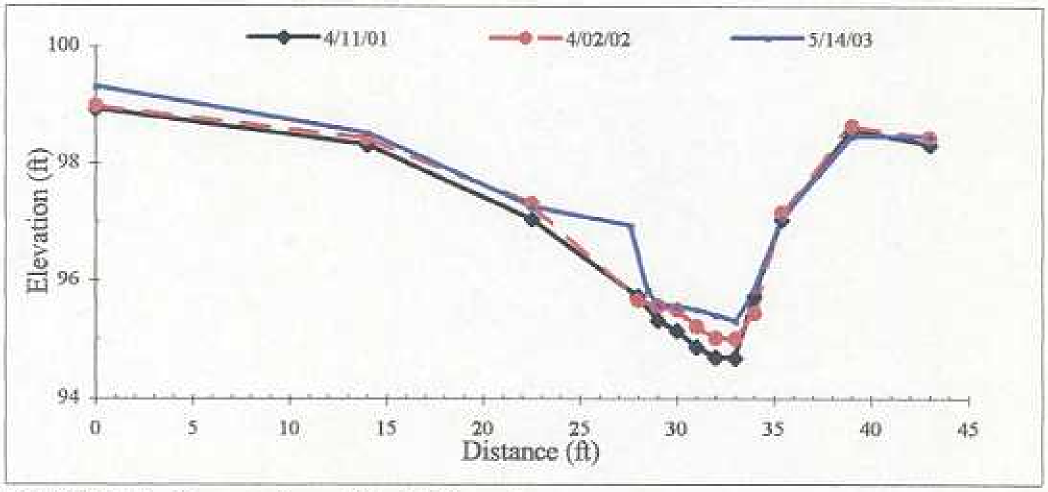


FIGURE 2.2. Cross-section station 1+94, pool.

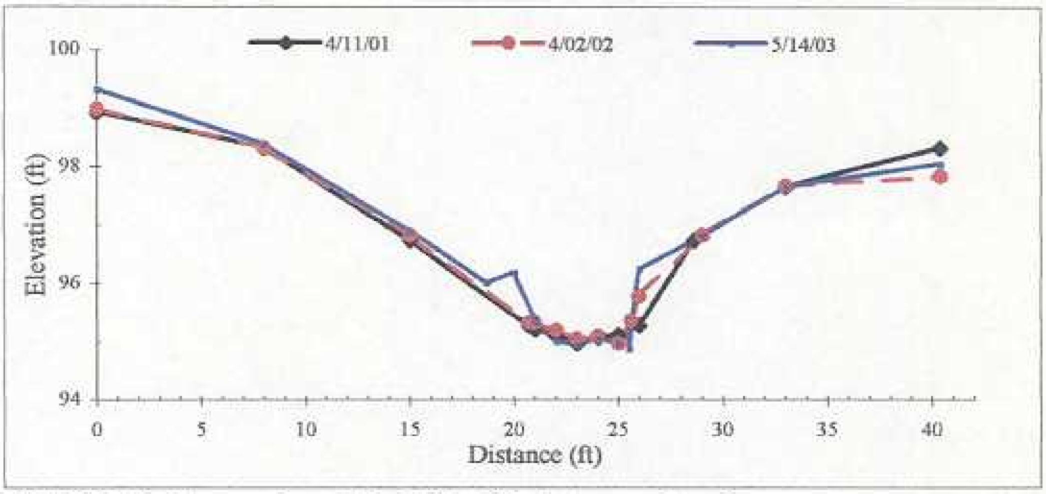


FIGURE 2.3. Cross-section station 2+24, riffle between rock weirs.

FIGURE 2. Seven post-construction and monitoring cross-sections for the Carp mitigation site, unnamed tributary to Laxon Creek, Watauga County, 2001-2003.

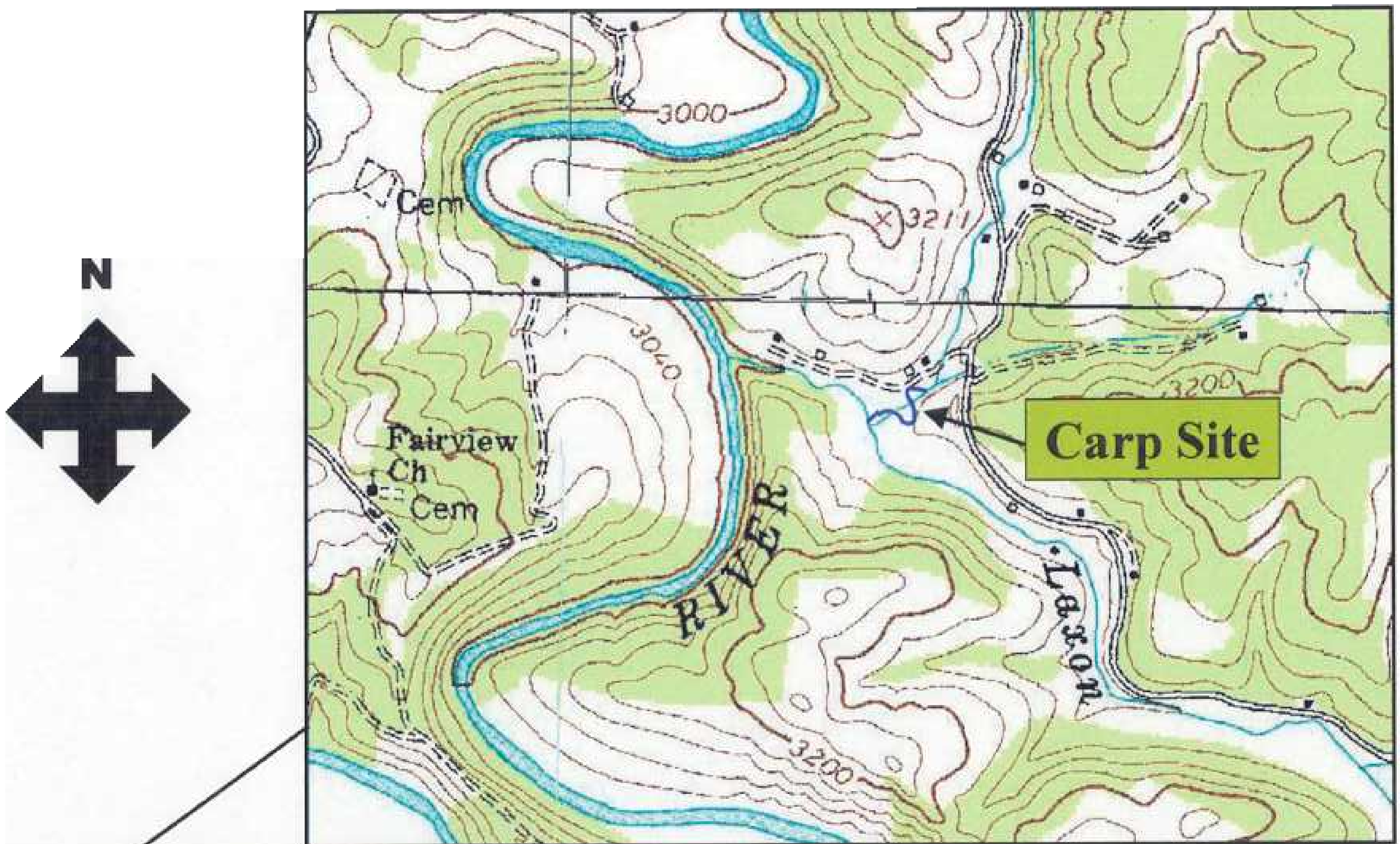


FIGURE 1.— Carp mitigation site on an unnamed tributary to Laxon Creek, Watauga County.

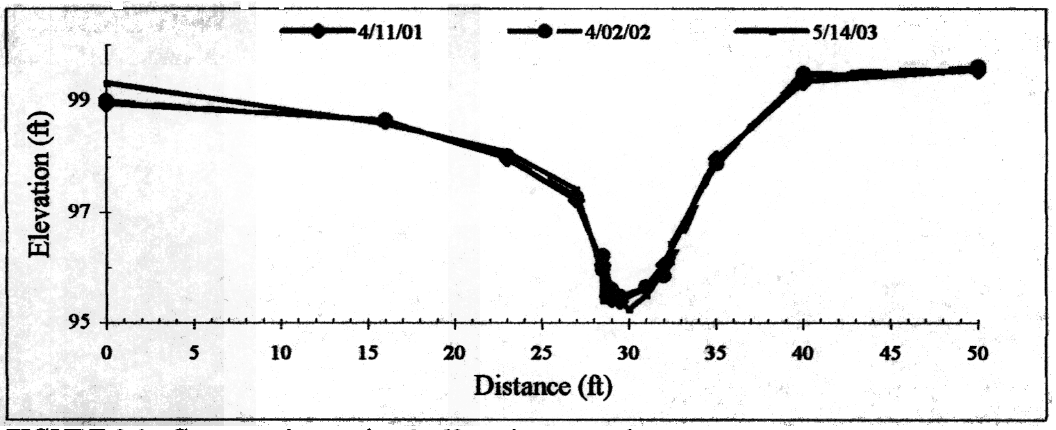


FIGURE 2.1. Cross-section station 1+69, stair step pool.

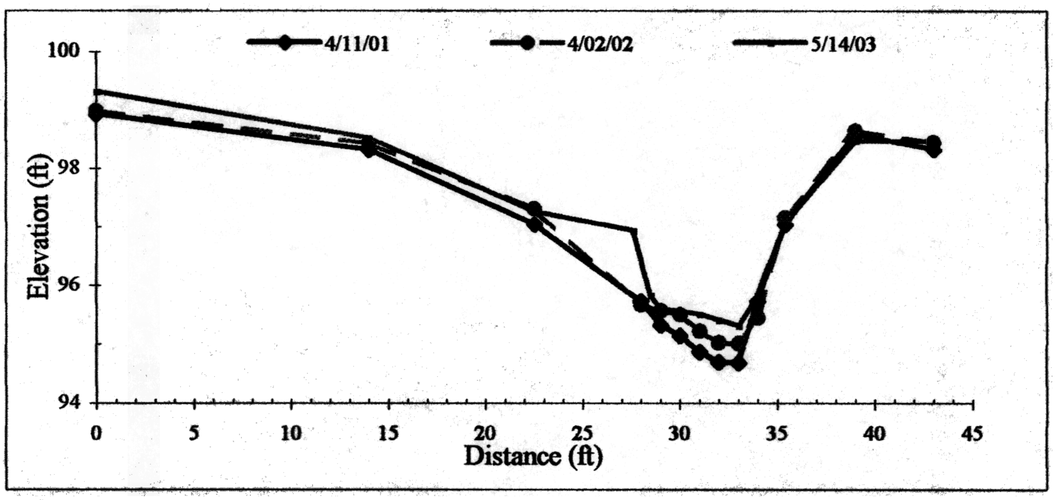


FIGURE 2.2. Cross-section station 1+94, pool.

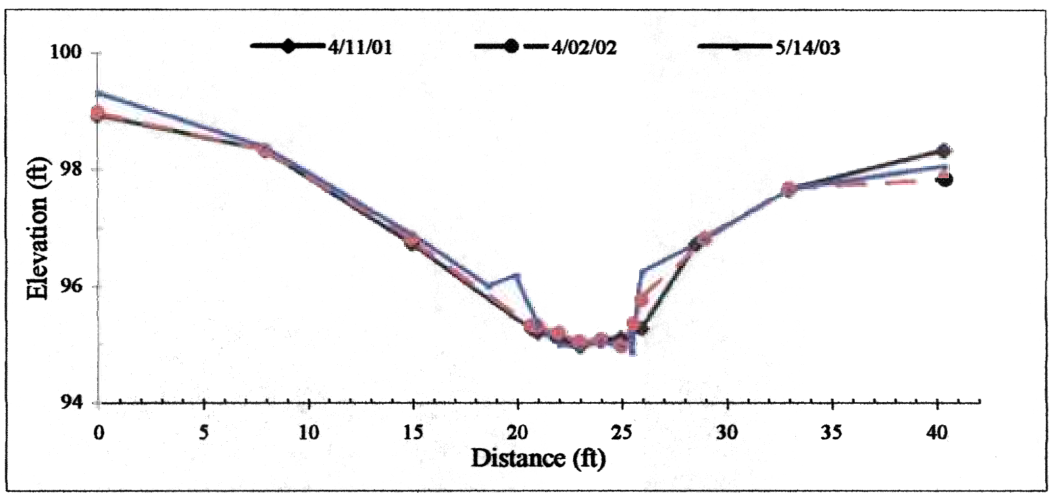


FIGURE 2.3. Cross-section station 2+24, riffle between rock weirs.

FIGURE 2. Seven post-construction and monitoring cross-sections for the Carp mitigation site, unnamed tributary to Laxon Creek, Watauga County, 2001-2003.

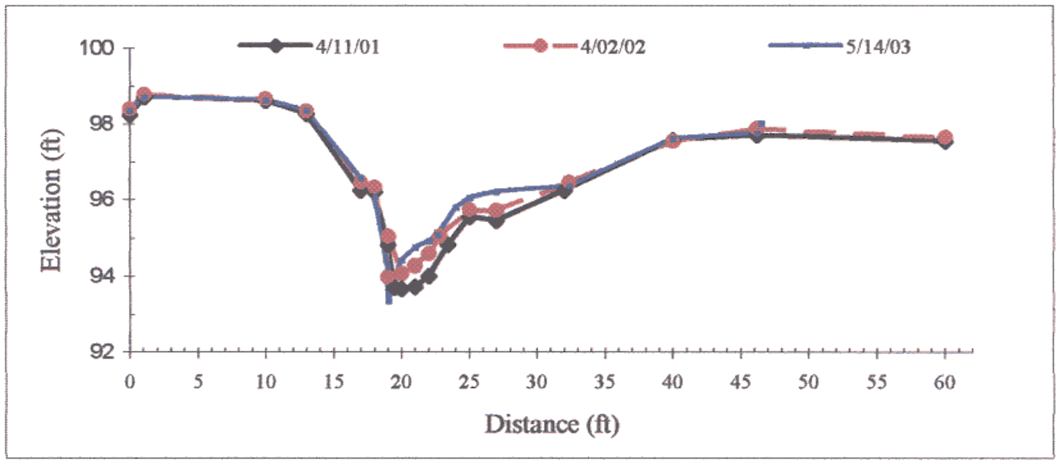


FIGURE 2.4. Cross-section station 2+45, pool.

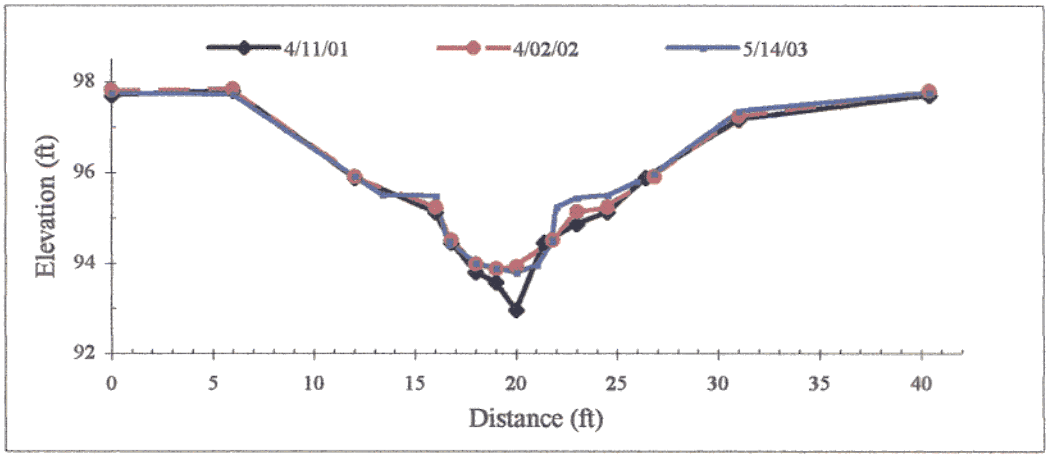


FIGURE 2.5. Cross-section station 2+79, step pool

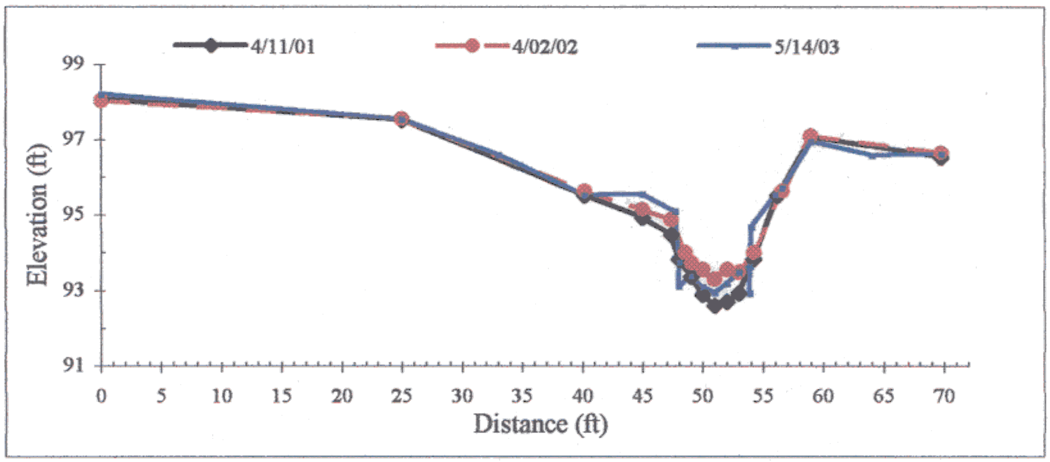


FIGURE 2.6. Cross-section station 3+16, pool behind root wad.

FIGURE 2. Continued.

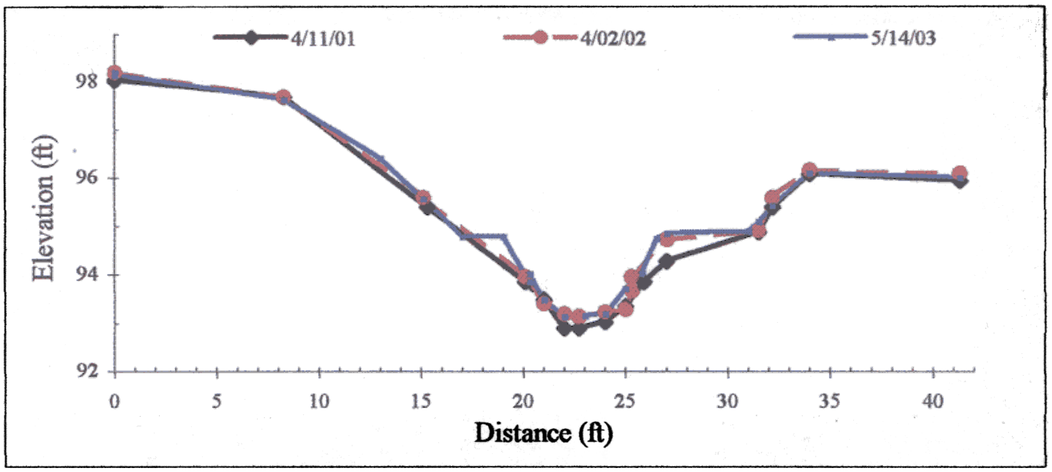
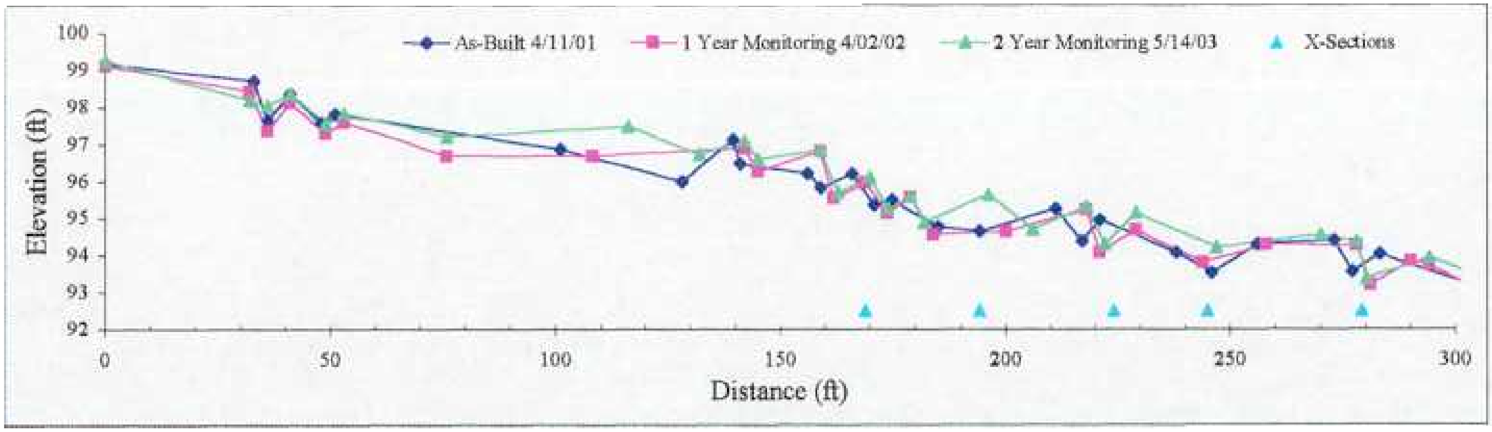


FIGURE 2.7. Cross-section station 3+76, run pool.

FIGURE 2. Continued.



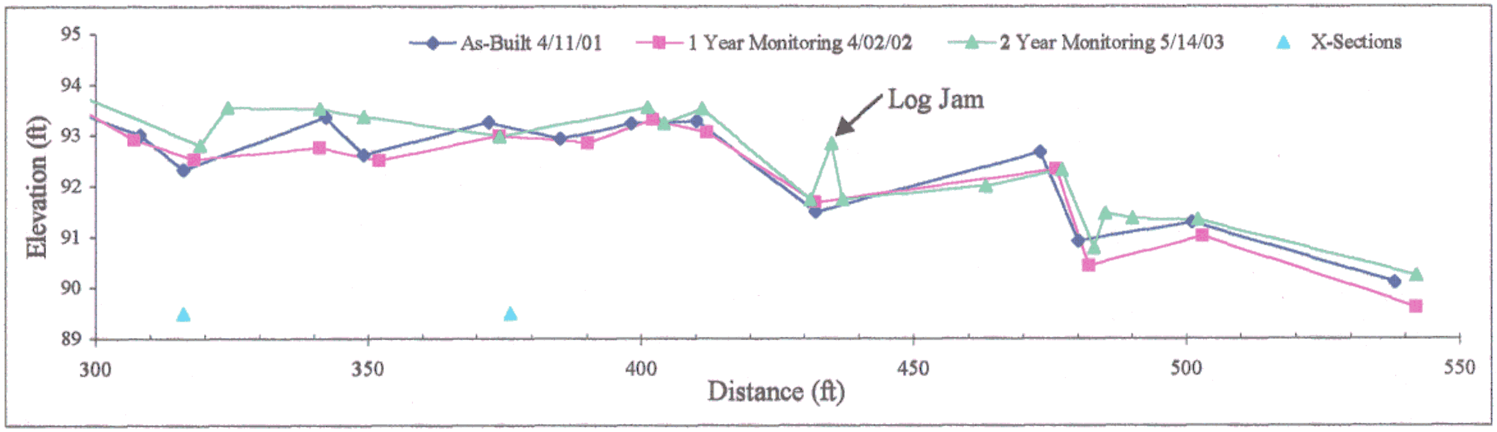
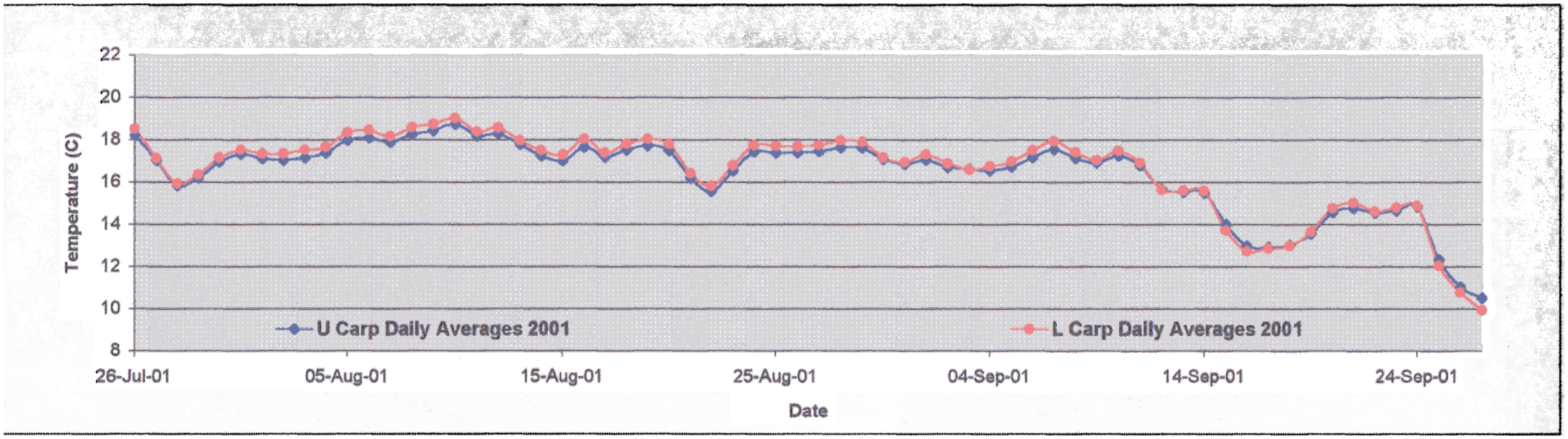


FIGURE 3. Longitudinal profile comparisons between post-construction, 04/11/01, and monitoring, 04/02/03 and 05/14/03, at the Carp mitigation site, unnamed tributary to Laxon Creek, Watauga County, 2001-2003.



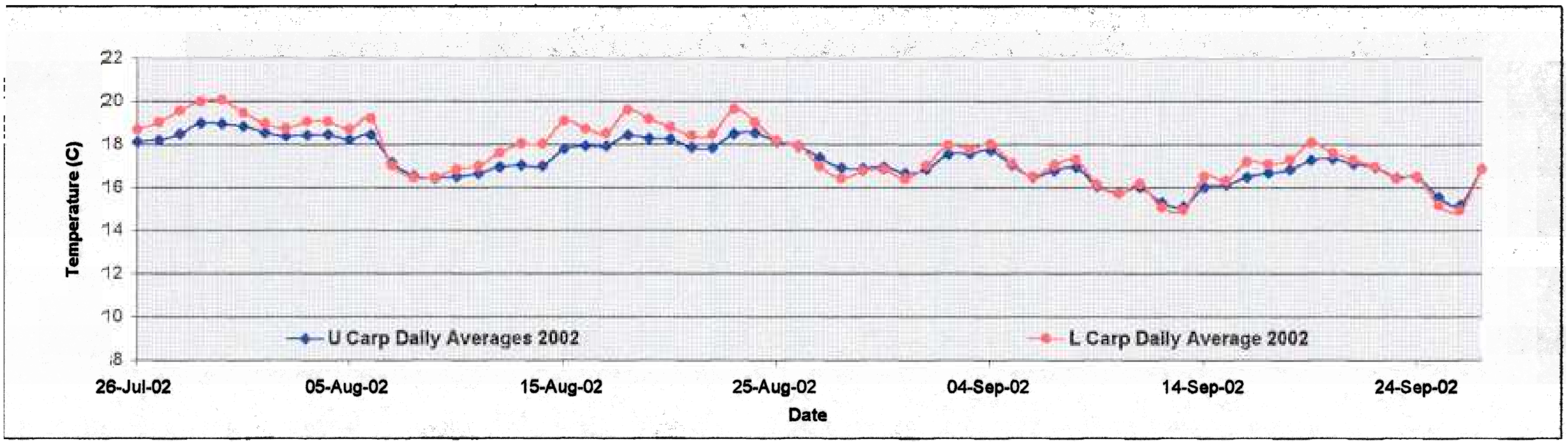


FIGURE 4. Comparison of the average daily water temperatures at the upper (U) and lower (L) ends of the Carp mitigation site, Watauga County, July 26 - September 27, 2001 and 2002.

TABLE 1.—Cross-section summary data of a riffle and run at the Carp mitigation site, unnamed tributary to Laxon Creek, Watuaga County, 2001-2003.

	Cross-section at 2+24 Feature: Riffle			Cross-section at 3+76 Feature: Run		
Date	2001[a]	2002	2003	2001	2002	2003
Area (m^2)	12.9	17.3	14	21.5	21.7	17.5
Bankfull width (m)	13.6	15.5	14.4	16.9	17.1	16.6
Width/Depth ration (m)	14.4	14.2	14.9	13.3	13.5	15.9
Entrenchment ratio	2.9	3.2	3.9	5.9	5.8	6.0
D 50 pebble count size[b] (mm)	10 mm	3.9 mm	15 mm	10 mm	3.9 mm	15 mm
Sinuosity	1.35	1.35	1.35	1.35	1.35	1.35
Water surface slope (%)	0.017	0.016	0.015	0.02	0.016	0.015
Stream type (Rosgen)	C4	C4	C4	C4	C4	C4

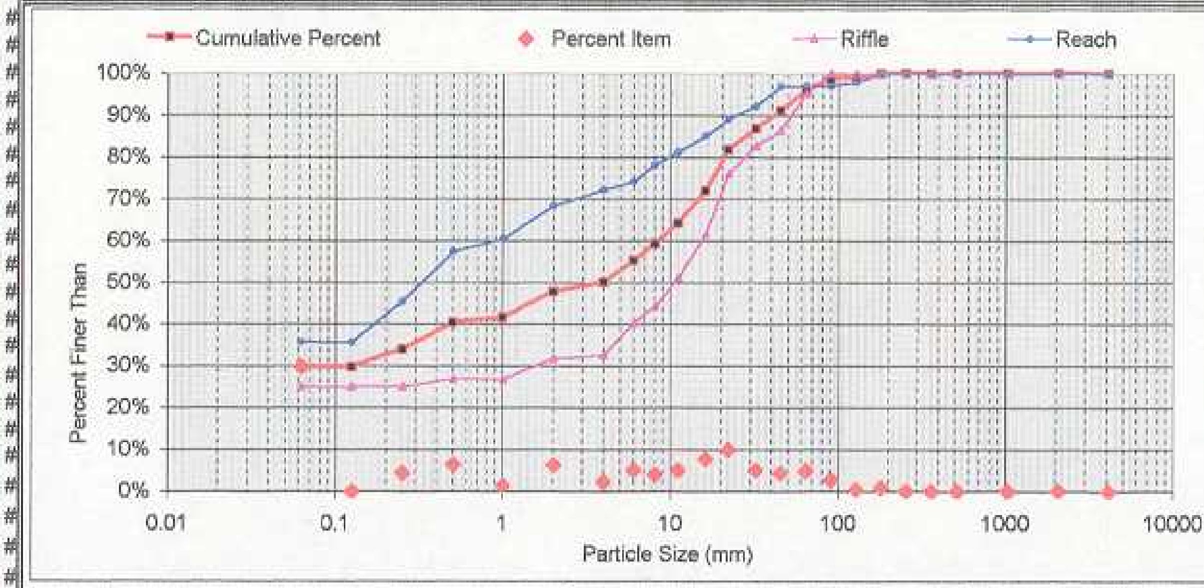
[a] As-built survey.
[b] weighted D50.

Appendix 1: Weighted pebble count data, Carp mitigation site, unnamed tributary to Laxon Creek, Watauga County, 2002-2003.

Percent Riffle:	**56**	Percent Run:	
Percent Pool:	**44**	Percent Glide:	

	UT Laxon Crk
	South Fork New River
Note:	**Carp site**

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	29.7	# #
very fine sand	0.062	0.13	0.0	# #
fine sand	0.13	0.25	4.4	# #
medium sand	0.25	0.5	6.3	# #
coarse sand	0.5	1	1.3	# #
very coarse sand	1	2	6.2	# #
very fine gravel	2	4	2.3	# #
fine gravel	4	6	5.2	# #
fine gravel	6	8	3.9	# #
medium gravel	8	11	5.1	# #
medium gravel	11	16	7.7	# #
coarse gravel	16	22	9.8	# #
coarse gravel	22	32	5.1	# #
very coarse gravel	32	45	4.3	# #
very coarse gravel	45	64	4.8	# #
small cobble	64	90	2.7	# #
medium cobble	90	128	0.4	# #
large cobble	128	180	0.9	# #
very large cobble	180	256	0.0	# #
small boulder	256	362	0.0	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.0	#
		Weighted Count:	100	
		True Total Particle Count:	205	



Size percent less than (mm)				
D16	D35	D50	D84	D95
#N/A	0.28	3.9	26	60

Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
30%	18%	48%	4%	0%	0%

FIGURE A.1.1 Weighted pebble count summary, monitoring year one, 2002.

TABLE 2.—Pebble count data collected in millimeters from the unnamed tributary to Laxon Creek, Carp mitigation site, Watauga County, 2001-2003.

Cross-section at 2+24 (riffle)

Year	2001[a]	2002	2003
D 16	5.6[b]		1.5
D 50	21.5	10.5	16.5
D 84	56	36	55

Reach (40% pools/60% riffles)

Year	2001	2002	2003
D 16	0.10		0.56
D 50	14.3	0.3	13.7
D 84	32	14	42

Weighted[c]

Date	2001	2002	2003
D 16	0.25	N/A	0.96
D 50	16.7	3.9	15
D 84	43	26	50

[a] 2001 as-built survey
[b] Millimeter size
[c] Combined riffle and reach pebble count data

TABLE 3.—Survival of live stakes and trees planted at the Carp mitigation site, unnamed tributary to Laxon Creek, Watauga County, 2001-2003.

Planted February and March 2001	Number planted	Number surviving[a]
White Pine	40	10
Black cherry	50	28
N. Red oak	50	16
Persimmon	65	0
White ashe	65	1
Silky dogwood live stakes	94	56
Silky willow live stakes	77	85
	441	196 (44% survival)
Planted November 2002		
Tag alders	35	20
Black walnut	5	2
Dogwood	15	8
		30 (55% survival)
Planted March 2003		
Persimmon	7	0
Black locust	8	7
Sugarberry	5	5
Black walnut	7	7
Red oak	7	4
Hemlock (planted May 2003)	3	3
	37	26 (70% survival)
Total (trees and live stakes)	533	252 (47% survival)[b]

[a]Counted on May 14, 2003.

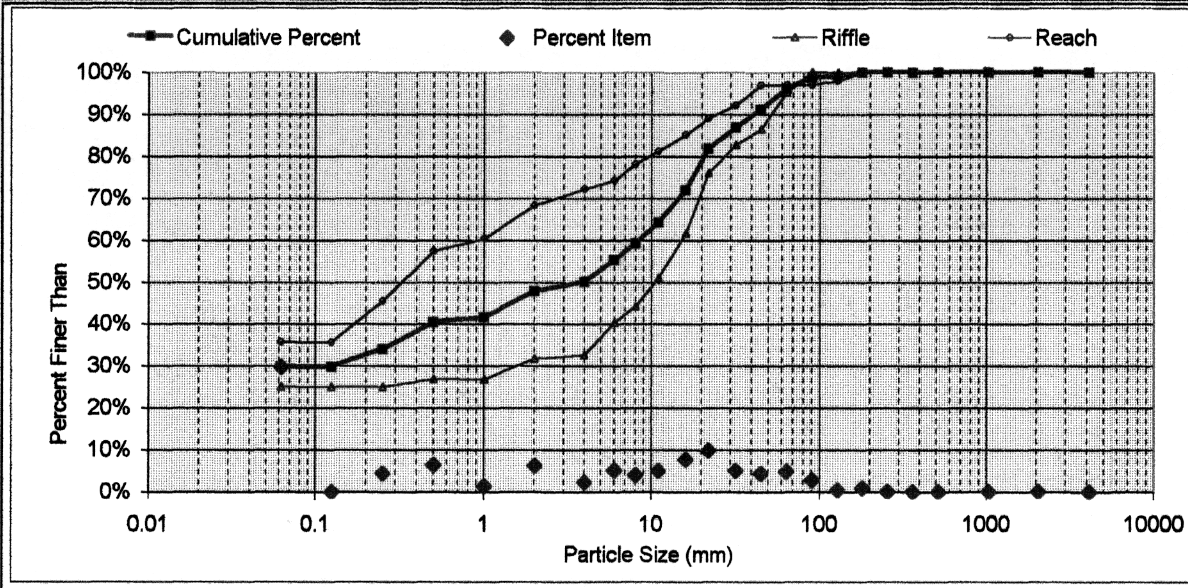
[b]Stem survival required by DWQ at this 0.67 acre site after 3 years is 214 and after 5 years is 174.

Appendix 1: Weighted pebble count data, Carp mitigation site, unnamed tributary to Laxon Creek, Watauga County, 2002-2003.

Percent Riffle:	56	Percent Run:		
Percent Pool:	44	Percent Glide:		

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	29.7	# #
very fine sand	0.062	0.13	0.0	# #
fine sand	0.13	0.25	4.4	# #
medium sand	0.25	0.5	6.3	# #
coarse sand	0.5	1	1.3	# #
very coarse sand	1	2	6.2	# #
very fine gravel	2	4	2.3	# #
fine gravel	4	6	5.2	# #
fine gravel	6	8	3.9	# #
medium gravel	8	11	5.1	# #
medium gravel	11	16	7.7	# #
coarse gravel	16	22	9.8	# #
coarse gravel	22	32	5.1	# #
very coarse gravel	32	45	4.3	# #
very coarse gravel	45	64	4.8	# #
small cobble	64	90	2.7	# #
medium cobble	90	128	0.4	# #
large cobble	128	180	0.9	# #
very large cobble	180	256	0.0	# #
small boulder	256	362	0.0	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.0	#
Weighted Count:			100	
True Total Particle Count:			205	

	UT Laxon Crk
	South Fork New River
Note:	**Carp site**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.28	3.9	26	60	30%	18%	48%	4%	0%	0%

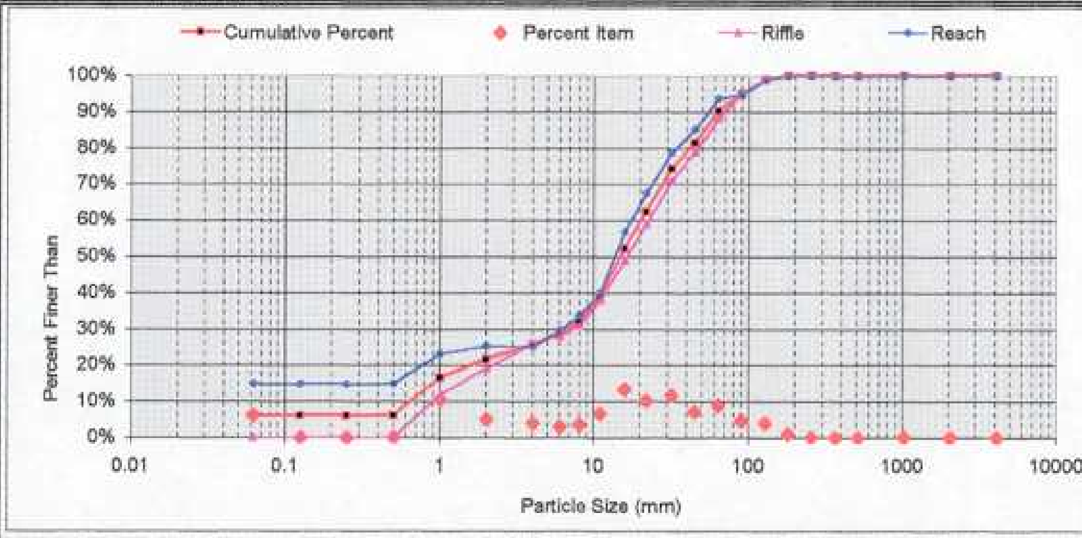
FIGURE A. Weighted pebble count summary, monitoring year one, 2002.

Appendix 1. Continued.

Percent Riffle:	58	Percent Run:	
Percent Pool:	42	Percent Glide:	

	UT Laxon Crk
	South Fork New River
Note:	**Carp Site**

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	5.9	# #
very fine sand	0.062	0.13	0.0	# #
fine sand	0.13	0.25	0.0	# #
medium sand	0.25	0.5	0.0	# #
coarse sand	0.5	1	10.2	# #
very coarse sand	1	2	4.8	# #
very fine gravel	2	4	4.0	# #
fine gravel	4	6	2.8	# #
fine gravel	6	8	3.4	# #
medium gravel	8	11	6.5	# #
medium gravel	11	16	13.0	# #
coarse gravel	16	22	9.9	# #
coarse gravel	22	32	11.4	# #
very coarse gravel	32	45	7.1	# #
very coarse gravel	45	64	8.5	# #
small cobble	64	90	4.4	# #
medium cobble	90	128	4.0	# #
large cobble	128	180	1.0	# #
very large cobble	180	256	0.0	# #
small boulder	256	362	0.0	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			3.2	#
		Weighted Count:	100	
		True Total Particle Count:	202	



Size percent less than (mm)				
D16	D35	D50	D84	D95
0.961	9.18	15.0	50	91

Percent by substrate type					
silt/clay	sand	gravel	cobble	boulder	bedrock
6%	15%	67%	9%	0%	3%

FIGURE A.1.2 Weighted pebble count summary, monitoring year two, 2003.

Appendix 2: Carp site photographs, amed tributary to Laxon Creek, W tauga C nty 2000-2003

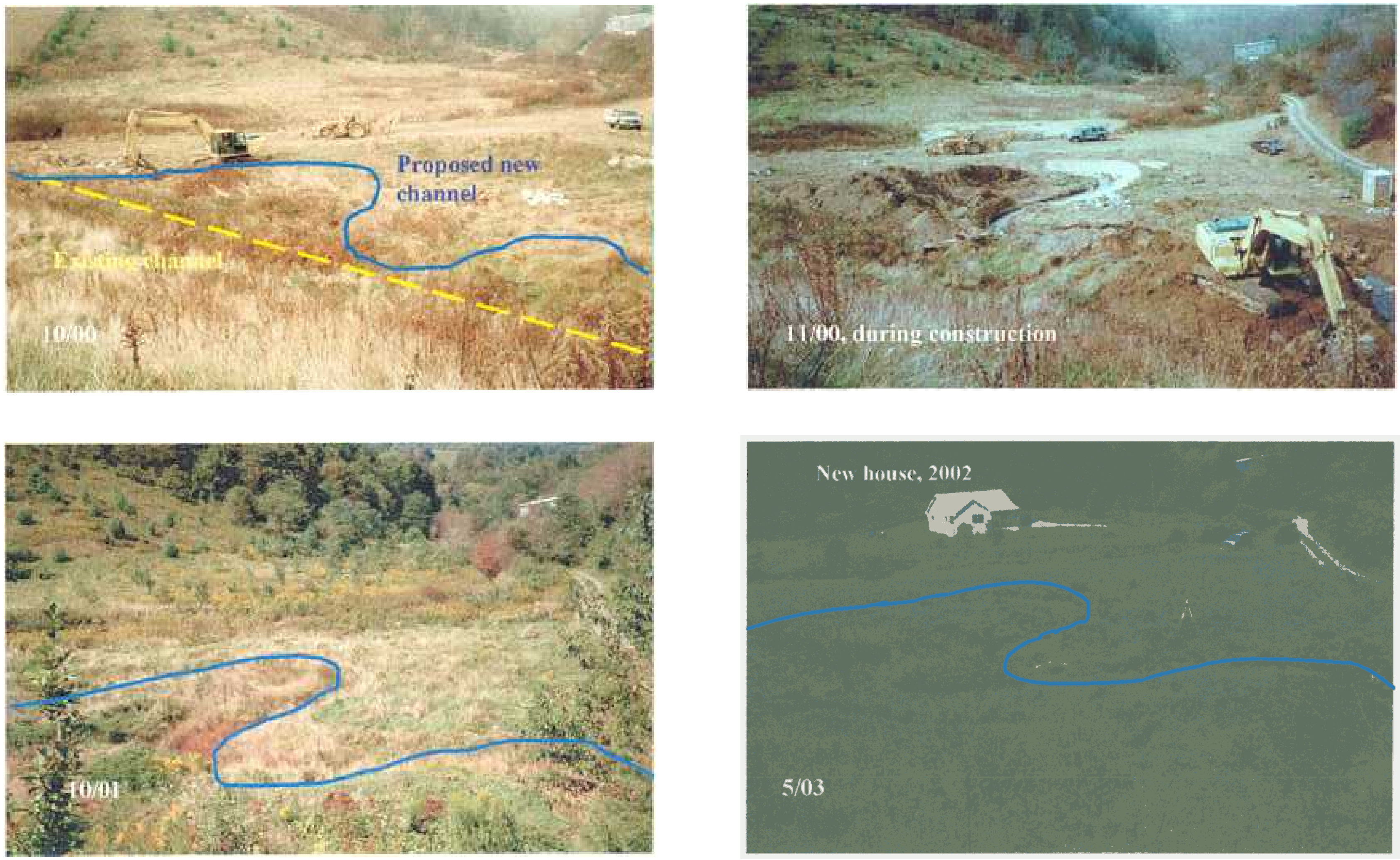
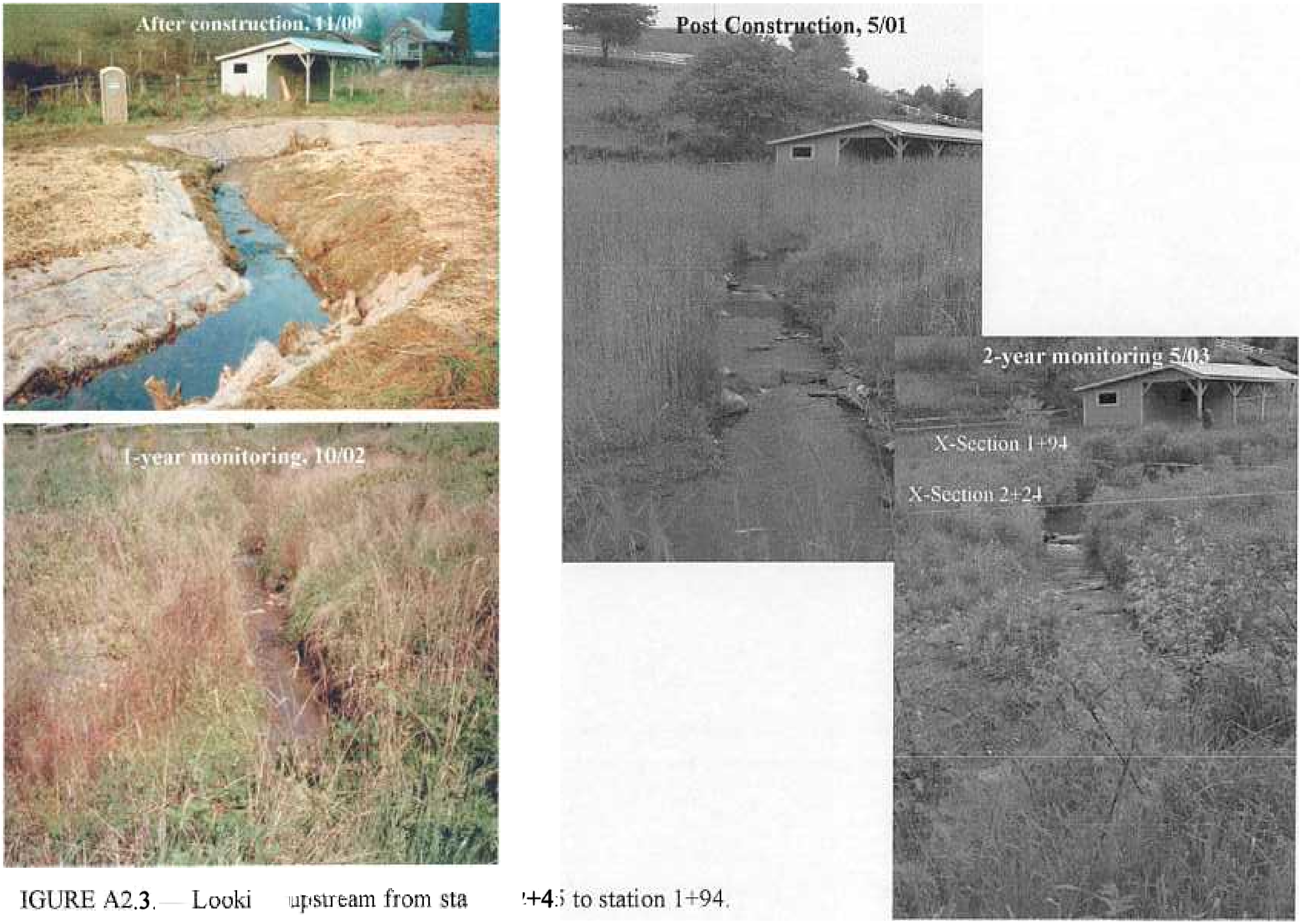


FIGURE A2 —Overvi of Carp te showing pre-construction, construction, and post-constructi condi ons, 2000-2003.

Appendix 2. Continued.

FIGURE A2.2.—Upper end of channel showing stai step pools, ooking upstream from stati +82 to :2.

Appendix 2. Continued.



IGURE A2.3.— Looki upstream from sta 2+45 to station 1+94.

Appendix 2. Contin ed

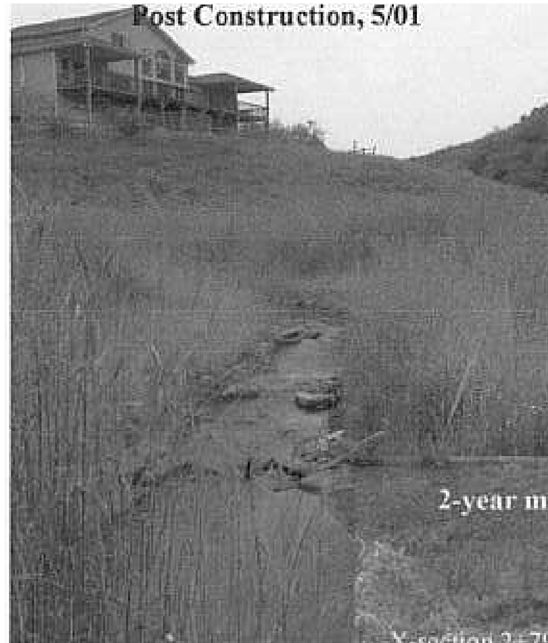


FIGURE A2.4 —Looking upstream from sta to 2+45.

Appendix 2. C   tinued.

'IGURE A2   —Looking upstream from stati   4+3   to

Appendix 2. Continued.

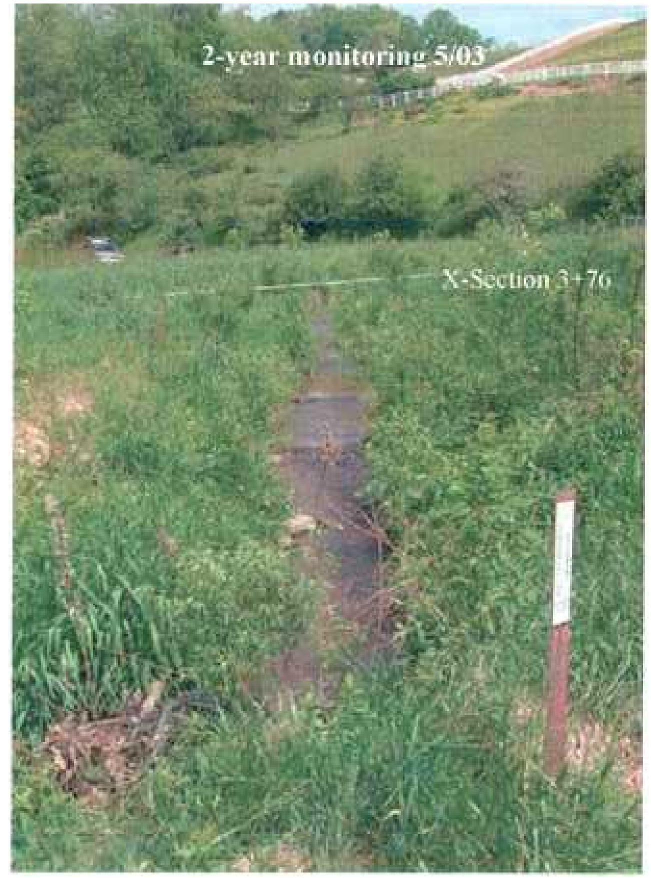


FIGURE A2 Contirued—Looking upstream from stati 4+30 to

Appendix 3. Hourly recorded water temperatures from the upper and lower boundaries of the Carp mitigation site, unnamed tributary to Laxon Creek, Watauga County, 2001-2002.

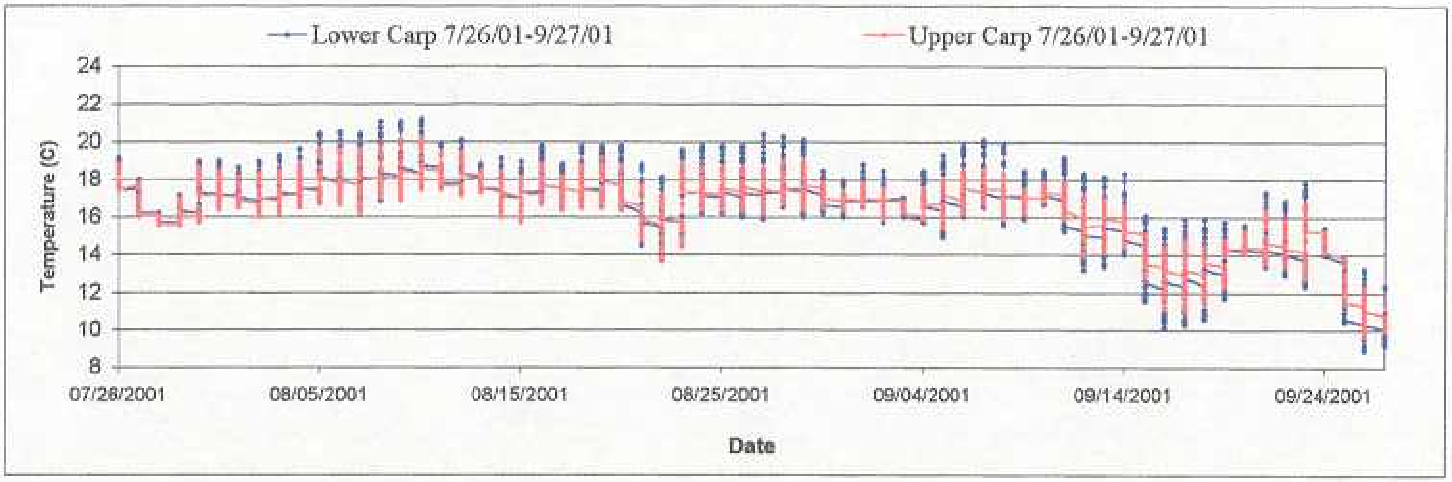


FIGURE A.3.1. Hourly recorded water temperatures, July 26 - September 27, 2001.

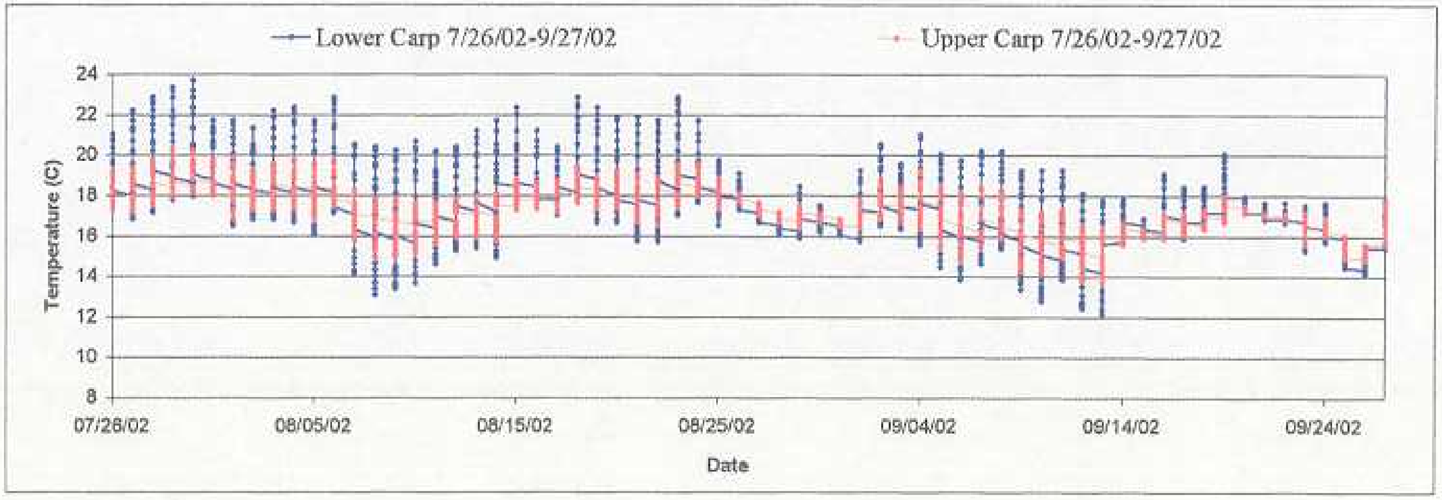


FIGURE A.3.2. Hourly recorded water temperatures, July 26 - September 27, 2002.

Appendix 3. Hourly recorded water temperatures from the upper and lower boundaries of the Carp mitigation site, unnamed tributary to Laxon Creek, Watauga County, 2001-2002.

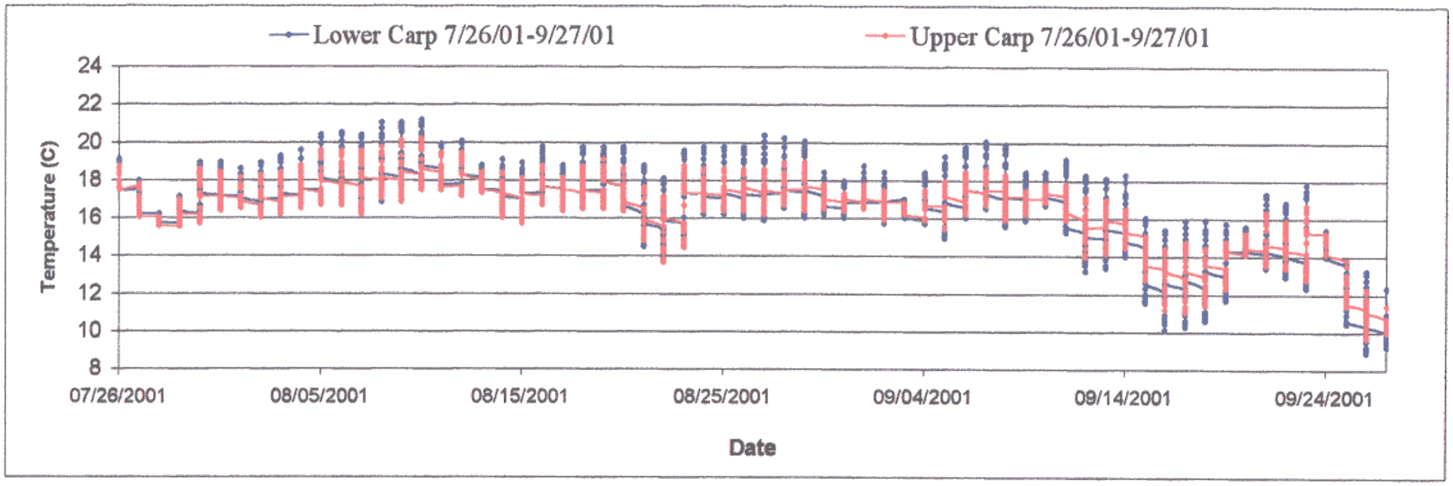


FIGURE A.3.1. Hourly recorded water temperatures, July 26 - September 27, 2001.

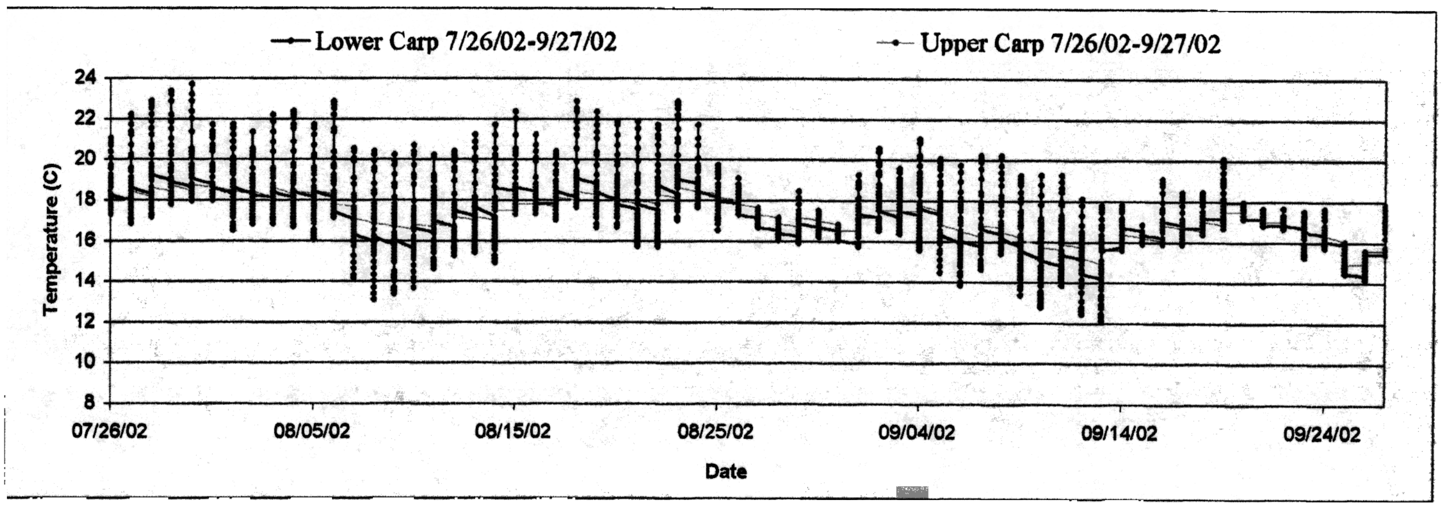


FIGURE A.3.2. Hourly recorded water temperatures, July 26 - September 27, 2002.