MILLER ET AL. MITIGATION SITE ON MEAT CAMP CREEK, WATAUGA COUNTY

Year 5 Monitoring Report
Period Covered: December 22, 2006 – December 1, 2007

Prepared for the

North Carolina Ecosystem Enhancement Program

North Carolina Wildlife Resources Commission
Watershed Enhancement Group
Raleigh

2007

This report summarizes the 2007 monitoring data collected from 652 linear feet of Meat Camp Creek, located on the Miller et al. property in Watauga County (Figure 1), and compares it with the previous years' monitoring data. Mickey and Scott (2002) described pre-construction survey methods, site conditions, and project objectives. The purpose of the project was to improve aquatic habitat, reestablish riparian area vegetation, and reestablish channel stability. This monitoring report is submitted as partial fulfillment of the off-site stream mitigation requirements of the North Carolina Department of Transportation (NCDOT) for the R-0529 (US 421) road improvement project in Watauga County. For that project, a total of 14,814 linear feet of stream mitigation were required by the United States Army Corps of Engineers (USACE) Section 404 permit and 7,407 linear feet of mitigation were required by the North Carolina Division of Water Quality (NCDWQ) Section 401 water quality certification.

From 2002 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 the North Carolina Wildlife Resources Commission. 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

The 2007 monitoring survey was completed on August 22, 2007. These data are compared with as-built data collected in March 2003 and monitoring data collected in 2003, 2005, and 2006 (Mickey and Hining 2003a; Mickey and Hining 2003b; Mickey and Wasseen 2005; NCWRC 2007). Monitoring data were not collected in 2004 because hurricane-caused damage had not been repaired. The 2007 monitoring survey included a longitudinal profile survey, channel cross-section dimension measurements, channel cross-section photographic log, pebble counts, woody plant stem counts (planted trees/live stakes), and repair site photographic log (Appendices 1 and 2).

Bankfull Rain Events

Bankfull rain events were monitored through review of the United States Geological Survey's South Fork New River gage (gage number 03161000) near Jefferson, North Carolina, and by personal observations of bankfull stage stakes placed on site. Bankfull at the Miller site corresponded to approximately 1,400 cubic feet per second at the gage station. However, due to the localization of many rain events, some bankfull events could only be confirmed by direct observation (visiting the site after a rain event or through contact with the landowner). Since completion of the project there have been 47 bankfull or greater events at the site (Table 1). The stream channel and banks have adjusted to these channel forming events and any stream bank and channel instability should be obvious. Additionally, the mitigation site has exceeded the criterion of two bankfull events in 5 years as required by the USACE and necessary to release the mitigation site from further monitoring (USACE 2003).

Longitudinal Profile

The 2007 longitudinal profile data revealed minor changes in the channel thalweg (Figure 2). The pool at station 0+22 aggraded 0.55 feet from 2005; however this pool is deeper than found during the 2003 as-built and 2003 monitoring surveys. The channel profile from stations 0+46 to 1+64 remained virtually unchanged; due to the dense vegetation a thalweg elevation reading was not taken at 1+64. However, based on observations at this location there did not appear to be any changes in the slope of the riffle. The pool at station 1+73 is 0.23 feet deeper than it was in 2005 and 2006; however it is still shallower than found in the 2003 as-built and monitoring surveys, by 1.02 feet and 0.53 feet. There was little change in the channel profile from stations 1+83 to 2+89 based on the data and observations. From stations 3+14 to 3+35 the channel has degraded 0.55 feet. The pool at station 3+66 increased in depth by 0.43 feet since 2006 and is now at a depth found in the as-built survey. It also appears that the pool has shortened by 0.86 feet. From station 3+97 to the end of the project the longitudinal profile closely resembles that found in 2006. The pool between stations 4+60 and 4+74 has aggraded between 0.49 and 0.82 feet since 2005. At station 4+65 the channel aggraded up to the 2003 monitoring survey elevation. From stations 4+97 to 5+34, the thalweg increased in maximum depth by 0.85 feet since 2003. These minor changes in the longitudinal profile appear to be natural occurrences and not because of instabilities caused by the stream enhancement activities. The comparisons of the longitudinal profiles suggests that the channel has been relatively stable since the 2004 repairs, and that most of the changes in the thalweg from 2003 to 2005 were due to the damage of the hurricanes, and the single storm event in November 2003. Repairs included reshaping the damaged left bank and adding three rock vanes and one rock cross-vane between station 3+10 and station 3+55; large boulders were repositioned or installed between station 4+15 and station 4+90. The right stream bank was reshaped between stations 5+00 and 5+34.

Cross-sections

Five cross-sections were surveyed in 2007 and compared with previous cross-section measurements (Figure 3; Mickey and Hining 2003a; Mickey and Hining 2003b; Mickey and Wasseen 2005; NCWRC 2007). Cross-sectional dimension measurements revealed some channel adjustments occurred following the 2004 hurricanes and November 19, 2004 repairs when compared with previous years' monitoring survey data (Figure 3). This included minor adjustments in thalweg depths and minor lateral movement of the channel.

CROSS-SECTION 1+73 – run (Figure 3.1): This cross-section is located below a rock weir and originally transected a pool. Over the years and with the movement of substrate materials it has evolved to a run. The channel widened slightly following the three September 2004 hurricanes. The cross-section data indicate the stream channel is stable with no bank erosion or lateral movement occurring since the 2005 survey.

CROSS-SECTION 3+37 – riffle (Figure 3.2): This cross-section is situated downstream of a rock vane and traverses a riffle. The channel has remained stable at this location since repairs were completed in 2004 (Appendix 1). There has been no bank erosion or lateral movement. Note the pin at location 0+00 was originally positioned in the middle of an overgrazed pasture

and could not be located in 2006. Subsequently, cross-section measurements were taken from a point starting at original location 0+22, the location of a fence line.

CROSS-SECTION 3+66 – pool (Figure3.3): This cross-section traverses the middle of a pool just below a rock vane. The pool has deepened at transect location 0+41 since 2006 and rises sharply (0.37 feet) to transect location 0+42. Cross-section location 0+46 has continued to aggrade since the 2005 survey (1.42 feet). However, the stream channel is stable with no bank erosion or lateral movement occurring. Note that the pin at location 0+00 was positioned in the middle of an overgrazed pasture and could not be located in 2006. Subsequently, the cross-section measurements were taken from a point starting at original location 0+24, the location of a fence line.

CROSS-SECTION 4+74 – riffle (Figure 3.4): This cross-section is situated above a rock weir and traverses a riffle. The point bar on the left bank was lowered during the 2004 repairs under the assumption that it would increase in height over time (Mickey and Wasseen 2005). To date, the point bar has not increased in height, but remains stable (Appendix 2). Channel bed material has not accumulated at this location because boulders were added to upstream rock vanes (stations 4+14 to 4+53) as part of the 2004 repairs. Those boulders appear to be deflecting the stream flow toward the left bank (looking downstream) and keeping the point bar at station 4+74 from reforming. The 2006 transect point at location 0+20 was the top of a point bar; however this year's monitoring shows that this high point has been removed. There has been some minor substrate material build-up between locations 0+41 and 0+53, when compared to previous years. The thalweg has moved towards the center of the channel away from the right bank. The banks are stable and there has been no lateral shift in the stream channel since the 2004 repairs.

CROSS-SECTION 4+97 – pool (Figure 3.5): The point bar between transect locations 0+25 and 0+35 has degraded and not reformed for the same reasons as the point bar at cross-section 4+74. The channel at transect locations 0+36 to 0+44 displays some signs of aggradation. Some of the woody debris that was caught by the stumps between transect locations 0+45 and 0+50 has been washed away since the 2006 monitoring survey was completed. The banks are stable with no bank erosion or lateral movement occurring.

Substrate

Pebble count data were collected from a riffle at cross-section 3+37 (Figure 4). Substrate analyses indicate fluctuations in most particle size classes when compared to the previous years' monitoring data. In 2007, there was a slight downward shift of all particle sizes except for D_{95}, which showed an increase over the 2006 count. Since 2003 the D_{50} has decreased from very coarse (47 mm), to coarse (25 mm) gravel (Figure 4). The D_{84} cumulative distribution has ranged from 83 mm to 120 mm (small cobble) (Figure 4). The D_{16} cumulative distribution has decreased from 18 mm (medium gravel) to 3 mm (very fine gravel). This is a result of an increase in the percentage of sand and fine gravels since the 2003 as-built survey. There are four reasons that could explain the decrease in particle sizes:

1. Finer particle sizes are settling out of suspension due to the drought affecting this portion of North Carolina at the time of sampling.

2. Sampling variability.
3. Sediment was transported from disturbed land higher in the watershed.
4. Or a combination of the three.

No signs of active bank erosion were observed during the survey. These changes in particle sizes are not significant enough to be of concern.

Riparian Improvements

A total of 232 live stakes and bare root nursery trees were planted within the 0.10 acre of riparian area disturbed during construction and the area repaired during 2004 (Table 2). The remaining 0.60 acre of the conservation easement contained mature trees. Total stem counts (trees and live stakes) were made within the disturbed areas. No effort was made to distinguish between planted stems and naturally regenerated stems. Plantings included tag alder *Alnus serrulata*, silky willow *Salix sericea*, black walnut *Juglans nigra*, and black locust *Robinia pseudoacacia*. The 2007 vegetation survey revealed a total of 78 stems (780 stems per acre) present on the site. Although this is 33.6% of the original number planted, the density of counted stems present in 2007 exceeded the 260 stems per acre required for woody species planted at mitigation sites through monitoring year five (USACE 2003). Closely grouped stem masses of silky willow and tag alder were counted as one individual plant instead of several plants. Stem counts for these species would have been much higher if individual stems were counted.

Seven species of native plants, red maple *Acer rubrum* (1 stem), tulip poplar *Liriodendron tulipifera* (2 stems), sycamore *Platanus occidentalis* (1 stem), red oak *Quercus rubra* (2 stems), sassafras *Sassafras albidum* (2 stems), witch-hazel *Hamamelis virginiana* (2 stems), and elderberry *Sambucus canadensis* (3 stems), were found to be naturally recolonizing the site.

The invasive exotic multiflora rose *Rosa multiflora* also was present throughout the site and large colonies were growing on the adjacent upland pastures. Left unchecked, the multiflora rose could spread throughout the project and threaten the viability of the native species. To prevent this from occurring, it will be necessary to control it by mechanical grubbing or with the application of herbicides.

Livestock Exclusion

The livestock management program developed for this project included the installation of a well with pressurized water lines, two watering tanks, and fencing to exclude cattle from the riparian zone. These agricultural best management practices, installed as a part of the restoration management plan, are functioning properly.

Site Repairs

Streambank stabilization work at the Miller et al. mitigation site on Meat Camp Creek was completed on September 23, 2002. A storm event on November 19, 2003 caused major bank failures between stations 3+10 and 3+55 (45 linear feet) and 5+00 and 5+34 (34 linear feet). Before repairs could be made, flooding caused by three hurricanes in September 2004 caused

additional damage to the site, from stations 4+15 to 4+90, (Appendices 1 and 2). This damage was repaired on November 19, 2004 (Mickey and Wasseen 2005).

A photographic log of the damages, 2004 repairs, and 2007 monitoring from station 3+10 to station 3+55 and station 4+15 to station 4+90 is also provided (Appendices 1 and 2). The repairs stabilized the stream banks and sediment is accumulating on the upstream side of rock vanes. Vegetation has become established on the stream banks from station 3+10 to station 3+55. Vegetation has had a harder time becoming reestablished between station 4+15 and station 4+90 due to the rocky substrate.

Summary

Since completion of the project on September 23, 2002, the Miller et al. mitigation site on Meat Camp Creek remained stable until the November 19, 2003 flood and the September 8, 13, 27, 2004 hurricanes. As a result of these floods, some damage occurred to streambanks. Repairs were completed on November 19, 2004. The longitudinal profile and the cross-sections have revealed some aggradation and degradation of the stream thalweg during the five-year monitoring period. This is most likely due to substrate being transported from upstream sources (unstable streambanks, pastures, construction activities, and unpaved roads), repairs to the banks and structures in 2004, or both. Substrate composition sizes have fluctuated for much of the same reasons as the longitudinal profile and cross-sections, and weather conditions likely play a role in substrate size variability. The riparian vegetation is flourishing, preserving bank integrity and channel sinuosity. There have been 47 bankfull events, through the five years of monitoring. The stream channel and banks are stable and in-stream structures are functioning as designed.

Recommendations

1. Consider this stabilized and release it from further monitoring.
2. Award 652 mitigation credits to EEP for this site as approved by the original USACE and NCDWQ permits. Note: A subsequent letter from NCDWQ referencing the original certification (Number 97-0616 dated August 21, 2001) approved this site at a 3:1 mitigation credit ratio. This disparity needs to be resolved.
3. Implement a multiflora rose control plan to prevent the species from displacing native plants within the easement area before they have matured.

Acknowledgements

J. Wasseen, II and Todd Ewing of the NCWRC watershed enhancement group collected and analyzed the field data; J. Wasseen, II prepared this report. M. Fowlkes and J. Borawa improved the report with their thorough review and thoughtful suggestions.

References

Mickey, J. H. and S. S. Hining. 2003a. As-built report for the Meat Camp Creek mitigation site, Watauga County. North Carolina Wildlife Resources Commission, Raleigh.

Mickey, J. H. and S. S. Hining. 2003b. 2003 monitoring report for the Miller et al. mitigation site on Meat Camp Creek, Watauga County. North Carolina Wildlife Resources Commission, Raleigh.

Mickey, J. H. and S. Scott. 2002. Stream restoration plan, Miller site, Meat Camp Creek, Watauga County. North Carolina Wildlife Resources Commission, Raleigh.

Mickey, J. H. and J. A. Wasseen. 2005. 2005 monitoring report for the Miller et al. mitigation site on Meat Camp Creek, Watauga County. North Carolina Wildlife Resources Commission, Raleigh.

NCWRC (North Carolina Wildlife Resources Commission). 2007. Miller et al. mitigation site on Meat Camp Creek, Watauga County, year 4 monitoring report, period covered: March 30, 2005 – December 22, 2006. Raleigh.

USACE (U.S. Army Corps of Engineers), Wilmington District, U. S. Environmental Protection Agency, North Carolina Wildlife Resources Commission, and the North Carolina Division of Water Quality. 2003. Stream Mitigation guidelines. Wilmington, North Carolina.

FIGURE 1.—Location of the Miller et al. mitigation site on Meat Camp Creek, New River basin, Watauga County.

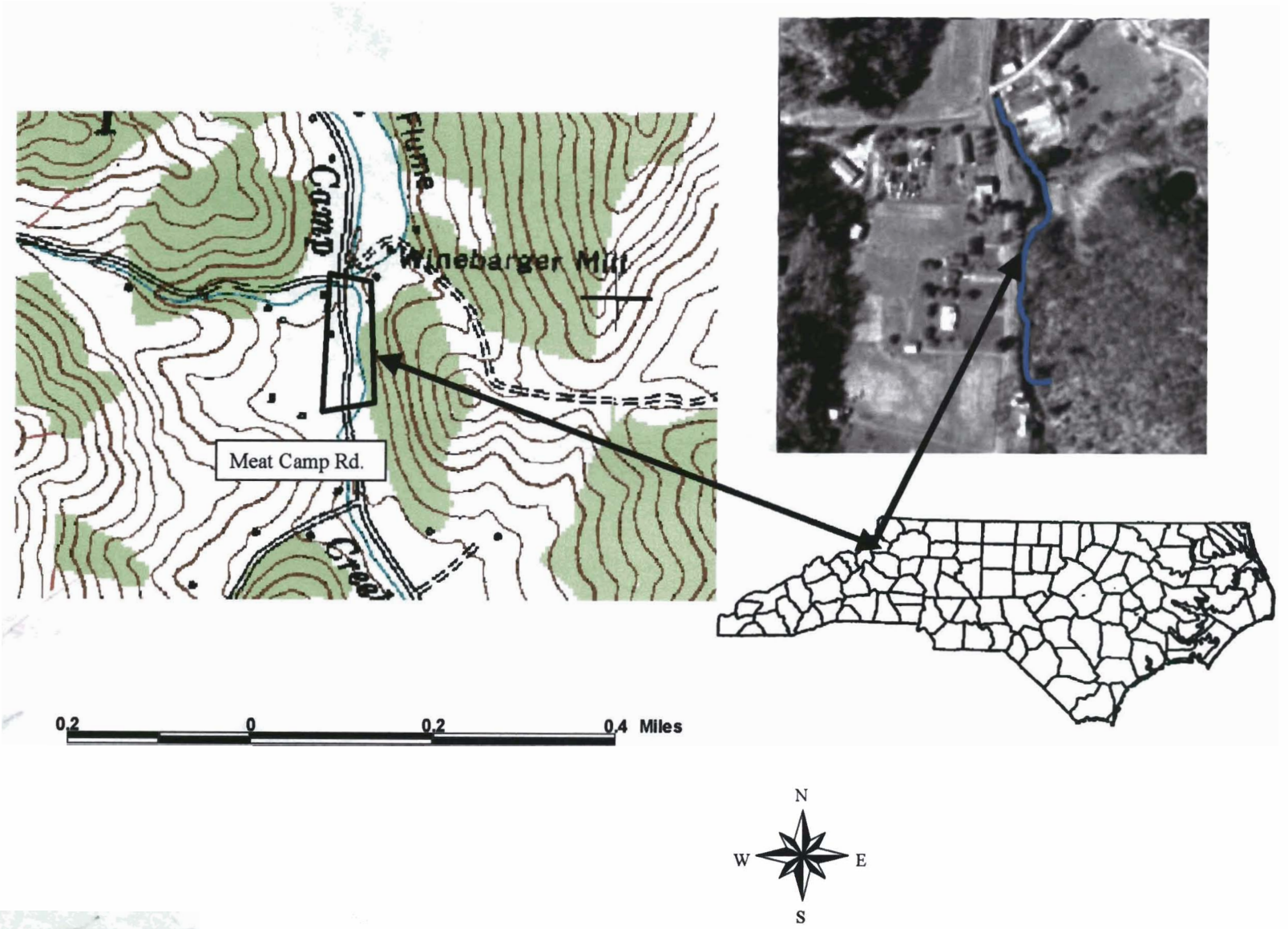


FIGURE 2.—Comparison of the 2003 as-built, 2003, 2005, 2006, and 2007 longitudinal profile data taken at the Miller et al. mitigation site, Meat Camp Creek, New River basin, Watauga County.

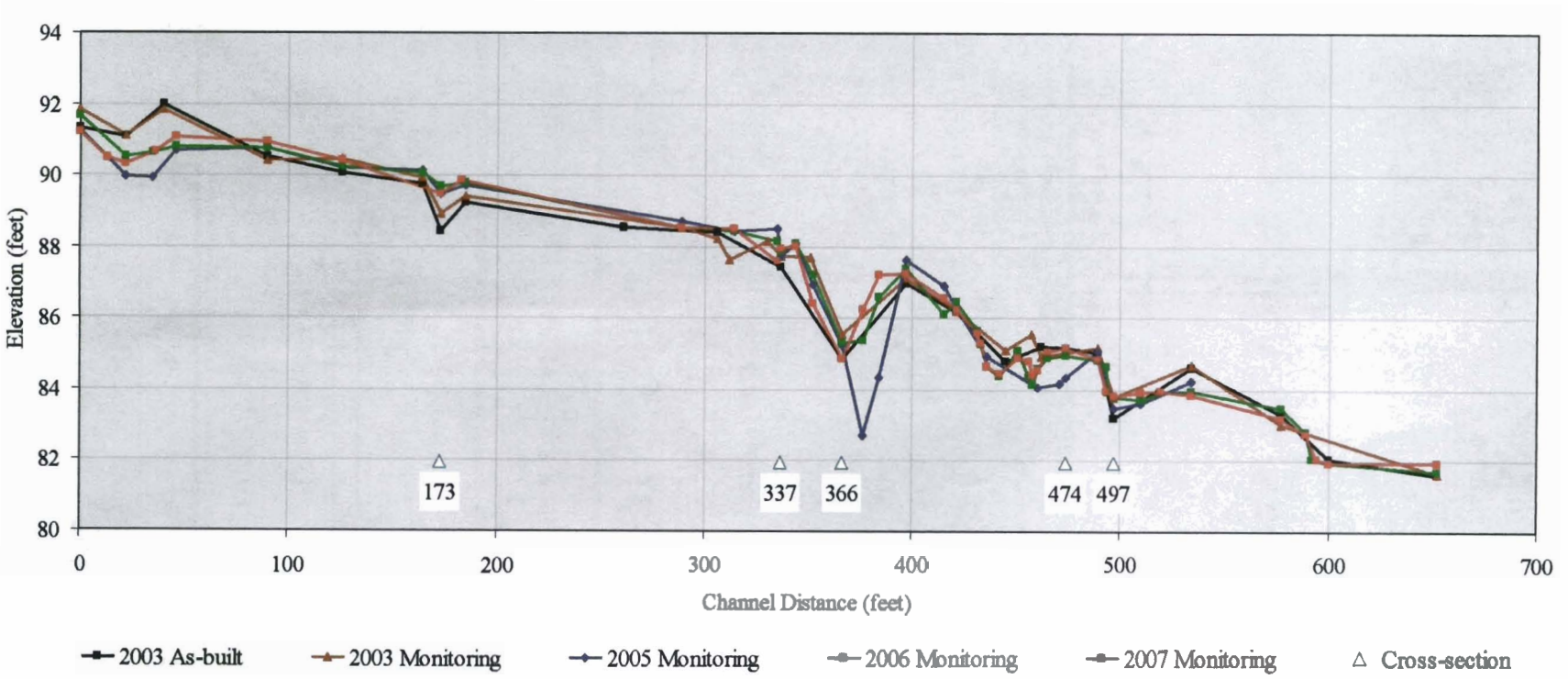
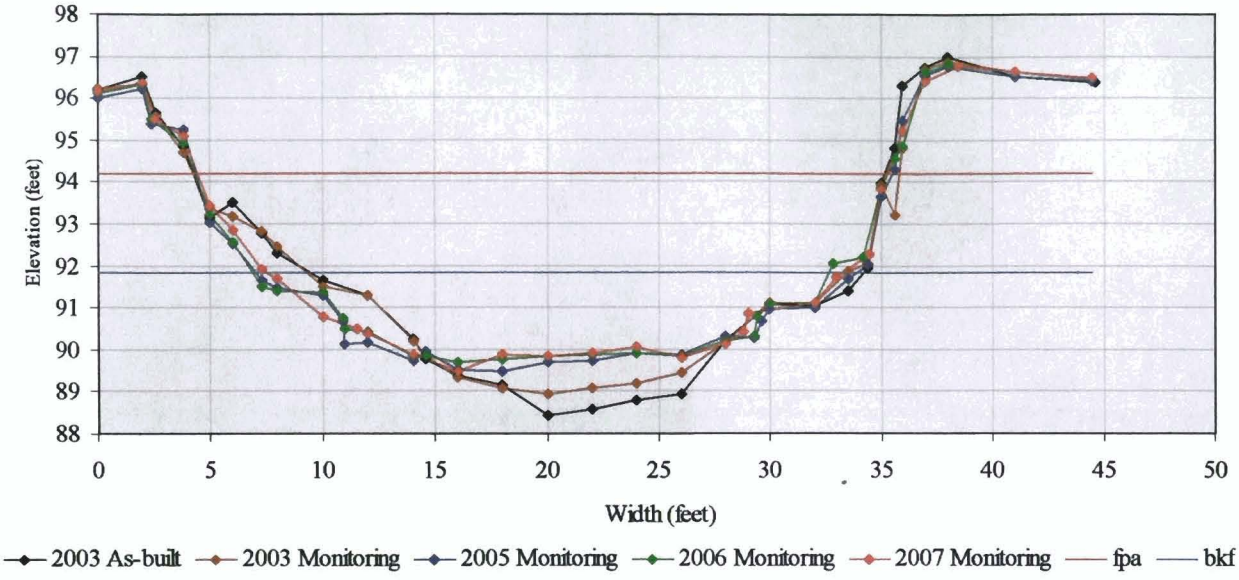


FIGURE 3.—Cross-sectional dimension comparisons at five locations on the Miller et al. mitigation site, Meat Camp Creek, New River basin, Watauga County, 2003-2007. All views are looking downstream. The flood prone area (fpa) and bankfull (bkf) elevations are depicted with red and blue horizontal lines.



3.1.—Cross-section at station 1+73, run.

FIGURE 3.—Continued.

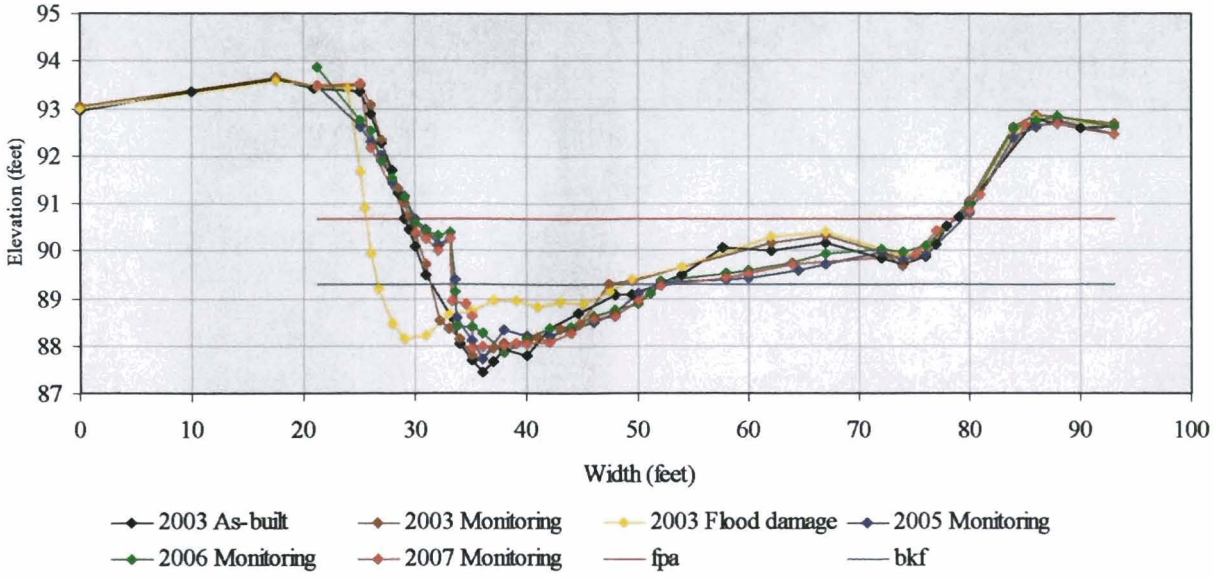


FIGURE 3.2.—Cross-section at station 3+37, riffle.

FIGURE 3.—Continued.

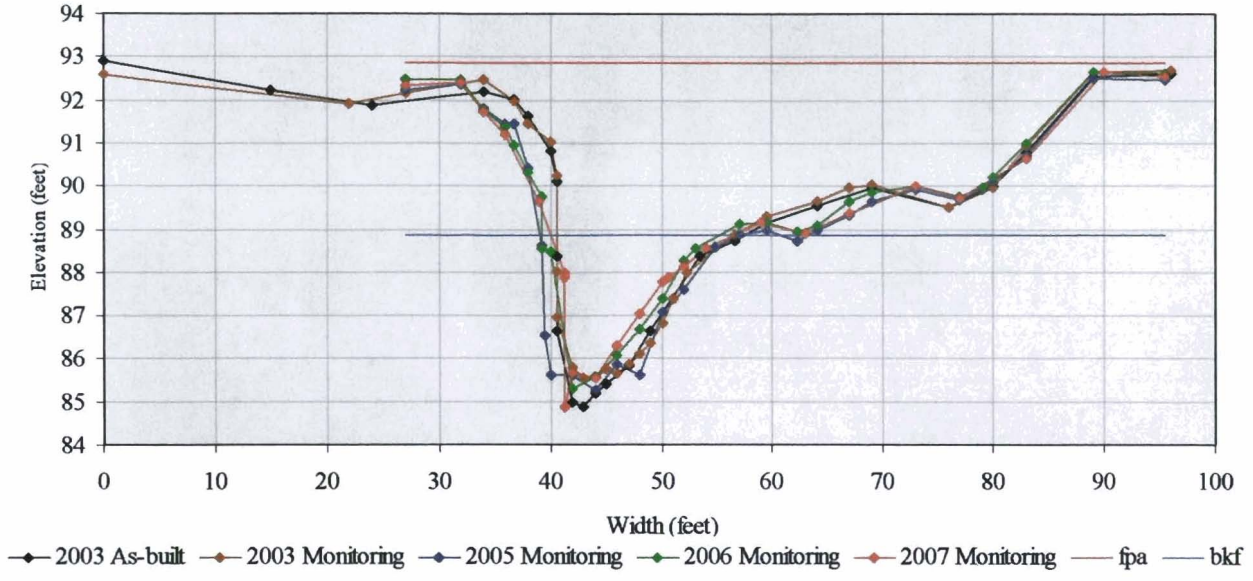


FIGURE 3.3.—Cross-section at station 3+66, pool.

FIGURE 3.—Continued.

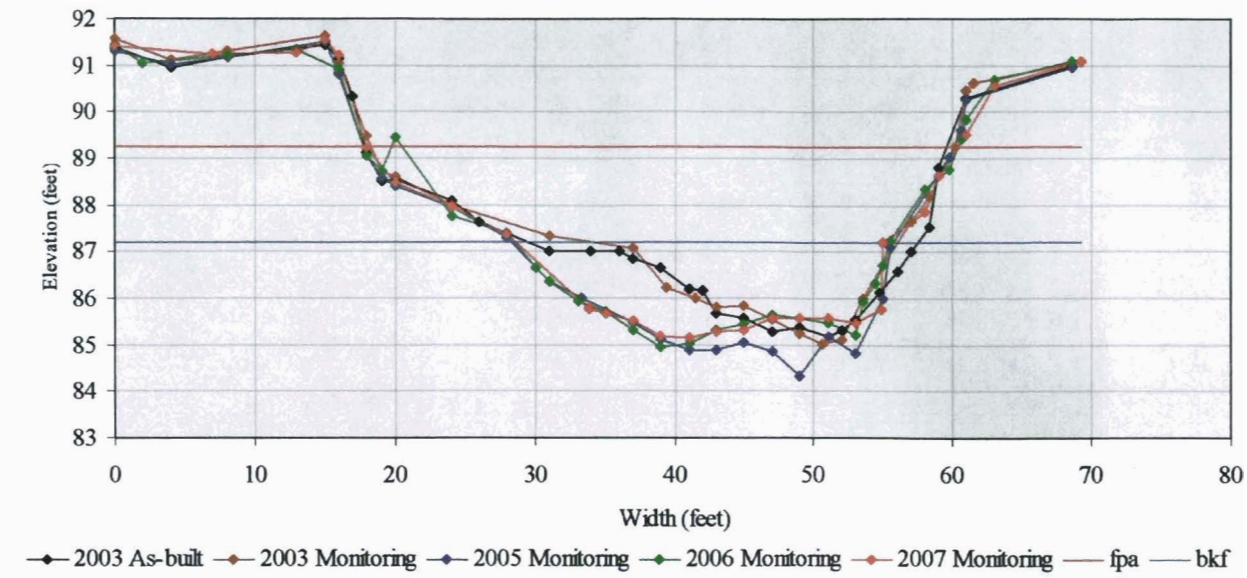


FIGURE 3.4.—Cross-section at station 4+74, riffle.

FIGURE 3.—Continued.

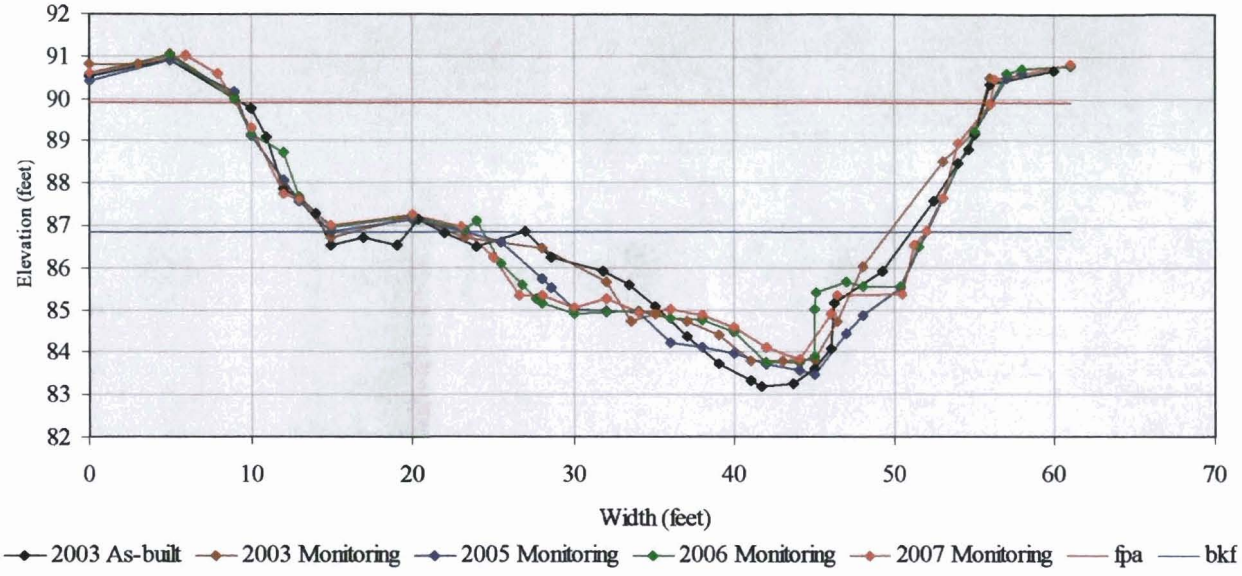
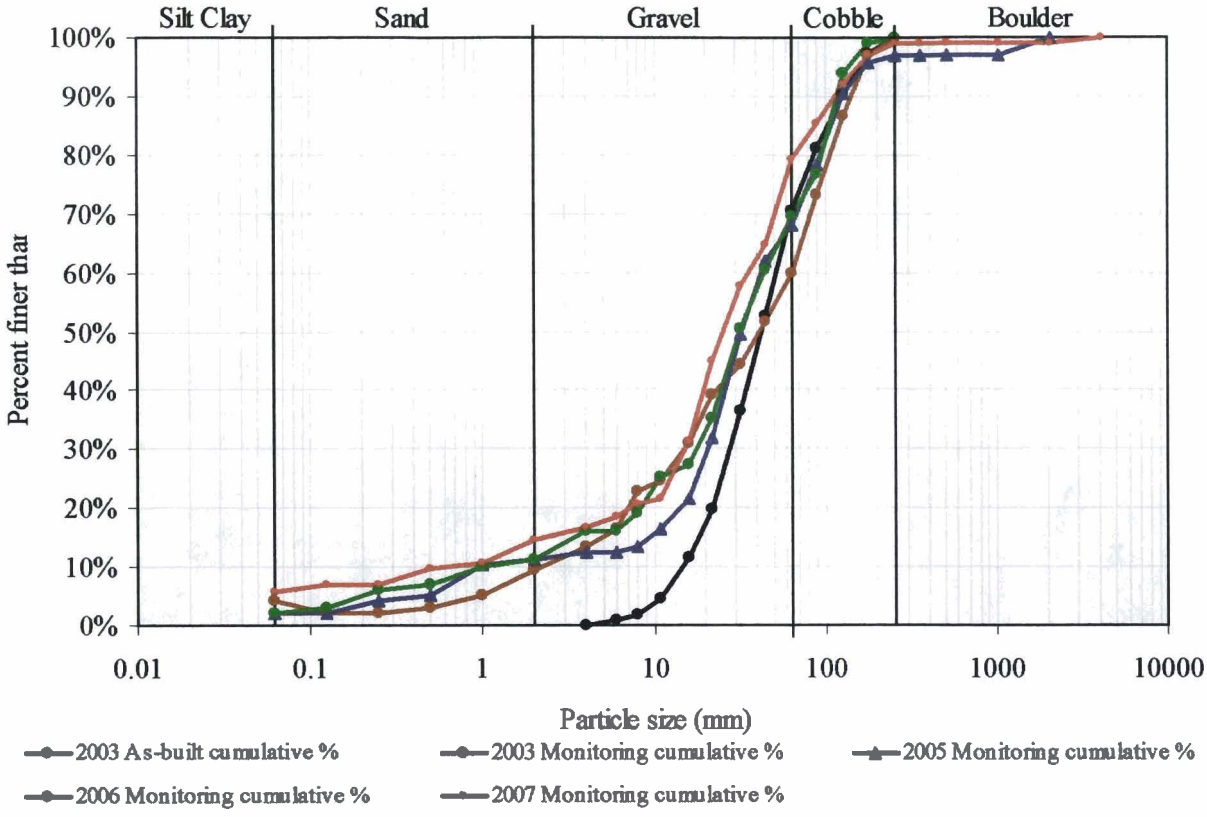


FIGURE 3.5.—Cross-section at station 4+97, pool.

FIGURE 4.—Pebble count data comparisons, Miller et al. mitigation site, Meat Camp Creek, New River basin, Watauga County, 2003-2007.



Size Class Index	Particle size (mm) in year sampled				
	2003 As-built	2003	2005	2006	2007
D_{16}	18	6	10	4	3
D_{35}	32	19	23	22	17
D_{50}	47	42	32	32	25
D_{84}	106	120	110	100	83
D_{95}	165	170	170	140	160

TABLE 1.—Bankfull stream flow events occurring at the Miller et al. mitigation site as documented from the United States Geological Survey South Fork New River gage (gage number 03161000) near Jefferson, Ashe County, North Carolina and from on-site observations.

Date	Gage height (ft)	Flows (ft^3/s)	Comments
2/22-23/03	5.0	2,250	Gage quit working
3/16/03	4.4	1,725	Bankfull event
4/10/03	5.4	2,819	Bankfull event
4/18/03	5.6	3,200	Bankfull event
6/7/03	4.1	1,820	Bankfull event
6/17/03	4.7	2,000	Bankfull event
8/9/03	4.2	1,450	Bankfull event
8/10/03	4.1	1,400	Bankfull event
11/19/03[a]	5.4	1,880	Bankfull event
2/7/04	4.8	2,080	Bankfull event
9/2/04	11.7	14,700	Bankfull event (hurricane)
9/13/04	8.6	7,550	Bankfull event (hurricane)
9/28/04	6.3	3,820	Bankfull event (hurricane)
11/25/04	4.2	1,490	Bankfull event
12/23/04	4.6	1,850	Bankfull event
12/24/04	4.6	1,820	Bankfull event
1/14/05	6.5	4,050	Bankfull event
1/15/05	4.5	1,790	Bankfull event
3/28/05	5.0	2,260	Bankfull event
3/29/05	4.5	1,790	Bankfull event
4/2/05	4.5	1,740	Bankfull event
4/3/05	4.3	1,560	Bankfull event
7/8/05	4.6	1,840	Bankfull event
7/16/05	5.0	2,270	Bankfull event
10/7/05	4.0	1,410	Bankfull event
11/29/05	6.5	4,130	Bankfull event
11/30/05	6.4	3,930	Bankfull event
1/18/06	5.2	2,460	Bankfull event
2/5/06	4.4	1,690	Bankfull event
4/22/06	4.3	1,610	Bankfull event
4/23/06	4.2	1,510	Bankfull event
6/25/06	6.8	4,470	Bankfull event
6/26/06	5.3	2,610	Bankfull event
6/27/06	5.7	3,130	Bankfull event
6/28/06	4.2	1,510	Bankfull event

TABLE 1.—Continued.

Date	Gage height (ft)	Flows (ft^3/s)	Comments
8/31/06	4.5	1,780	Bankfull event
9/1/06	4.8	2,090	Bankfull event
9/5/06	4.2	1,530	Bankfull event
11/8/06	4.9	2,160	Bankfull event
11/9/06	4.1	1,460	Bankfull event
11/16/06	5.4	2,670	Bankfull event
11/17/06	5.0	2,310	Bankfull event
12/22/06	4.1	1,430	Bankfull event
12/23/06	4.6	1,860	Bankfull event
1/1/07	5.6	2,980	Bankfull event
1/2/07	4.5	1,760	Bankfull event
3/2/07	4.3	1,620	Bankfull event

[a]This event produced rainfall in excess of 6 inches at the Miller et al. site that resulted in major localized flooding.

TABLE 2.—Vegetation monitoring results for the Miller et al. mitigation site, Meat Camp Creek, New River basin, Watauga County, 2003-2007.

Scientific name	Common name	Amount planted[a]	2007 Stem count	Percent change in numbers[b]
Live stakes				
Salix sericea	Silky willow	166	33	-80.1%
Bare root nursery stock				
Alnus serrulata	Tag alder	35	33	-5.7%
Juglans nigra	Black walnut	5	1	-80.0%
Robinia pseudoacacia	Black locust	26	11	-57.7%
Totals		232	78	-66.4%
Volunteers				
Liriodendron tulipifera	Tulip poplar		2	
Acer rubrum	Red maple		1	
Platanus occidentalis	Sycamore		1	
Quercus rubra	Red oak		2	
Sambucus canadensis	Elderberry		3	
Hamamelis virginiana	Witch-hazel		2	
Sassafras albidum	Sassafras		2	
Totals			91	

[a]Total number of plants planted in 2003 and 2005.

[b]Calculated using 2007 total stem count and number planted.

Appendix 1: Photographs of damage and repairs between station 3+10 and station 3+55 at the Miller et al. mitigation site on Meat Camp Creek, New River drainage, Watauga County, November 19, 2003 – August 22, 2007. All photographs were taken facing downstream.

After November 19, 2003 flood. Notice that 6 ft of the watering tank drainage pipe is exposed.

Bank damage after the series of hurricanes in September 2004.

Bank after repairs using three rock vanes, one rock weir, and bank reshaping, November 2004.

March 2005.

April 2006.

August 2007

Appendix 2: Pre and Post Photographs of September 8, 13, 27, 2004 hurricane damage between station 4+15 and station 4+97 at the Miller et al. mitigation site on Meat Camp Creek, New River drainage, Watauga County. This site was repaired on November 19, 2004. All photographs are looking upstream. Notice the disappearance of the point bar adjacent to the large brown boulder.

As-built photo before the storm damage, April 2003.

Left and right bank damage after the series of hurricanes, October 2004.

Bank repairs completed, November 2004.

March 2005

April 2006

August 2007