LOWELL MILL DAM-LITTLE RIVER WATERSHED RESTORATION SITE
2006 Annual Monitoring Report (Year 1)

Johnston County, North Carolina
EEP Project No. D04008-2
Design Firm: Milone and MacBroom, Inc.

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JOHNSTON COUNTY, NORTH CAROLINA

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EXECUTIVE SUMMARY

Introduction

Unlike success measurements required of Rosgen Natural Channel Design mitigation projects, dam removal projects performed pursuant to the North Carolina Dam Removal Task Force (DRTF) (DRTF 2001) are required to quantitatively demonstrate chemical and biological improvements to the watershed in order to achieve compensatory mitigation credit. The following monitoring report documents the unique efforts of Restoration Systems (RS), on behalf of the N.C. Ecosystem Enhancement Program (NCEEP), to achieve these higher standards at the Lowell Mill Dam removal site (Neuse Hydrologic Unit 03020201). The suite of ecological evaluations performed and described here establish a new and higher standard for mitigation monitoring. This higher standard is in keeping with the goal of the North Carolina Department of Environment and Natural Resources (NCDENR), U.S. Army Corps of Engineers (USACE), and the North Carolina Department of Transportation (NCDOT) to provide functional gains to North Carolina watersheds and move beyond the much discredited acre-for-acre and foot-for-foot compensatory programs of the past.

The site of the former Lowell Mill Dam is approximately 0.3 mile downstream (south) of Interstate 95 between the towns of Micro and Kenly (Figure 1, Appendix A) on the Little River, a tributary of the Neuse. Approximately 36,875 linear feet of the Little River and certain tributaries (Little Buffalo Creek and an unnamed tributary) were impounded by the dam (Figure 2, Appendix A). Impacts to water quality within the former Site Impoundment (i.e., river and stream reaches formerly impounded by the dam) were manifested in the form of lower dissolved oxygen concentrations, higher temperatures, and increased sedimentation. The character of the aquatic communities within the former Site Impoundment shifted from that representative of a free-flowing (lotic) river system towards an impounded (lentic) condition following construction of a dam at the site. Rare and endangered mussel and fish habitat, which depended on free-flowing lotic conditions, was extirpated or greatly diminished within areas of the Little River impounded by the former dam.

The dam was removed in a manner that minimized impacts to water resources both upstream and downstream of the dam site. Gradual dewatering began in March of 2004, and dam removal began in December 2005. The dam structure and associated mill works were completely removed by January 18, 2006.

This report summarizes Year-1 (2006) project monitoring. Monitoring data indicate a demonstrable favorable shift towards the restoration of aquatic community and water quality attributes more typical of lotic flow conditions within the former Site Impoundment. Furthermore, American shad (*Alosa sapidissima*) were captured within the Little River well upstream of the former dam, confirming the restoration of anadromous fish passage within (and upstream of) the former Site Impoundment.

Monitoring Plan

A monitoring plan was developed in accordance with DRTF guidelines to evaluate success in fulfilling the project's primary success criteria, which include 1) re-introduction of rare and

endangered aquatic species, 2) improved water quality, 3) an improved aquatic community, and 4) restoration of anadromous fish passage (under crest pool). Reserve success criteria include 1) anadromous fish passage (above crest pool), 2) downstream benefits below the dam, and 3) human values (scientific value and human recreation).

In order to evaluate project success for the above criteria, a monitoring network was deployed throughout the former Site Impoundment and in reference areas both upstream and downstream of the former dam (Figure 3, Appendix A). Within the network, biological surveys were conducted to provide baseline (i.e., pre-dam removal) aquatic community data and to assess changes in community composition following dam removal. Monitoring cross-section stations were established to assess changes in bankfull channel geometry, channel substrate composition, and aquatic habitat. Fish, mussel, and snail surveys were conducted to record diversity and qualitative prevalence of taxa within these groups. Anadromous fish survey locations were also established to track the extent of anadromous fish passage within the upstream watershed (Figure 4, Appendix A). Water quality data (dissolved oxygen concentrations) within the former Site Impoundment and at a downstream reference area were obtained from North Carolina Division of Water Quality (NCDWQ) Ambient Monitoring Stations (AMS).

Year-1 (2006) Monitoring Results

Re-introduction of rare and endangered aquatic species
The two federally endangered species that occur within the Little River sub-basin are the dwarf wedgemussel (*Alasmidonta heterodon*) and Tar spinymussel (*Elliptio steinstansanna*). Although baseline mollusk community data was obtained during pre-removal (baseline) biological surveys in 2005, mollusks will not be sampled again until the fourth year of project monitoring (2009) owing to the length of time predicted for this taxonomic group to respond to habitat restoration. Favorable habitat for these mollusk species has developed within much of the former Site Impoundment.

Water quality
AMS data indicate that dissolved oxygen concentrations within the former Site Impoundment have persisted above the established threshold of 6.0 mg/L for achievement of success criteria. Additionally, benthic biotic indices (used as a proxy for water quality) were lower (i.e., more indicative of better water quality) in samples within the former Site Impoundment relative to those from reference samples, indicating improved water quality.

Improved aquatic community
Benthic data from stations within the former Site Impoundment indicate that the number of EPT (Ephemeroptera [mayflies], Plecoptera [stoneflies], and Trichoptera [caddisflies]) taxa has nearly converged with the number of EPT taxa from reference samples. The total number of benthic taxa from samples within the former Site Impoundment exceeded the total number of taxa from reference samples. In summary, benthic monitoring data has achieved success criteria. Fish sampling data indicate that fish communities within the former Site Impoundment are transitioning from those associated with lentic conditions (i.e., pre-dam removal) to those characteristic of lotic, free-flowing conditions.

Anadromous fish passage
Spawning adults of American shad (*Alosa sapidissima*) were captured in the Little River immediately below Atkinson Mill Dam (Figure 2, Appendix A), indicating that anadromous fish passage under the crest pool has been achieved. American shad were also captured well above the limits of the former Site Impoundment within Buffalo Creek, indicating that the Lowell Mill Dam removal will likely generate additional SMUs (stream mitigation units) for sale in the watershed pursuant to the reserve success criteria guidelines (see discussion below).

In addition to the above primary criteria, the project has also achieved success in fulfilling reserve success criteria. The Lowell Mill Dam removal project has provided funding to the University of North Carolina at Chapel Hill to support original research by Adam Riggsbee, Ph.D. Dr. Riggsbee's research investigates the effects of the dam's removal on nutrient and sediment dynamics as they are transmitted through the former Site Impoundment. In addition to his published dissertation, Dr. Riggsbee has submitted a manuscript for publication in a peer-reviewed journal. Also, the Lowell Mill Dam project has funded the design of plans for a public park to be developed at the site of the former mill and dam. These plans will be implemented this fall and the property will be transferred to Johnston County following completion of the park's construction (slated to begin on or before October 15, 2006).

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1.0 PROJECT BACKGROUND

1.1 Location and Setting

The project location includes the site of the former Lowell Mill Dam and associated mill works situated within the Little River, approximately 0.3 mile south (downstream) of Interstate Highway 95 (I-95, Exit 105), between the towns of Micro and Kenly (Figure 1, Appendix A). For the purposes of this document, the former dam site and immediate adjacent areas will hereafter be referred to as the "Site."

Approximately 36,875 linear feet of the Little River, Little Buffalo Creek, and an unnamed tributary (Tributary 1) (Figure 2, Appendix A) were impounded by the Lowell Mill Dam. These stream reaches collectively comprise the "Site Impoundment."

The dam served to obstruct the movement of fish and other mobile aquatic organisms. The functional benefit area (FBA) for this restoration project is defined as the maximum extent of the watershed lying upstream of the dam, which could serve as anadromous fish spawning habitat. This area includes approximately 204,920 linear feet (38.8 miles) of main stream channel along the Little River, Buffalo Creek, Little Buffalo Creek, and Long Branch in Johnston County (Figure 2, Appendix A). The FBA begins at the Site and extends upstream along these waterways to include relatively free-flowing (i.e., unimpeded) tributaries in the watershed. Its upper limit is defined by dams (Atkinson Mill, Lake Wendell) or stream headwaters.

1.2 Restoration Structure and Objectives

The Lowell Mill Dam removal is one of the first stream restoration projects of its kind in North Carolina. The project entailed stream channel restoration via the removal of Lowell Mill Dam, a run-of-the-river dam, in which the bankfull channel is impounded but the river valley is typically not flooded as is often the case with storage dams.

Site restoration efforts consisted primarily of the physical removal of the Lowell Mill Dam and the adjacent mill works. Construction activities associated with the removal of the dam were phased in order to minimize impacts to aquatic resources upstream, downstream, and in the immediate vicinity of the Site. Furthermore, throughout the dam removal process, numerous construction practices were undertaken to minimize potential impacts to aquatic resources.

The project is expected to generate at least 36,875 Stream Mitigation Units (SMUs) for use by the North Carolina Ecosystem Enhancement Program (EEP) (Table 1). Primary and reserve success criteria are being monitored in accordance with the DRTF guidance. The mitigation ratios have also been derived from the DRTF guidance. Depending on project monitoring results (predominately anadromous survey data), up to 48,859 additional SMUs may potentially be generated in accordance with the DRTF guidance (Table 1).

Table 2 displays project mitigation success criteria, the parameters used to evaluate success, and the anticipated results of project monitoring. Project monitoring results are presented in Section 2.0.

Table 1. Potential Stream Mitigation Units (SMUs)[1] Generated by Removal of Lowell Mill Dam.

	Channel Restored (feet)	Mitigation Ratio	SMUs
Primary success criteria:			
1) Re-introduction of rare and endangered aquatic species 2) Improved water quality, 3) Improved aquatic community 4) Anadromous fish passage (under crest pool)	36,875 feet of free-flowing river and tributaries **under the crest pool**	1:1	36,875
Reserve success criteria:			
Anadromous fish passage (**above crest pool**)	Up to 204,920 feet of second order or higher, free-flowing tributaries	5:1	40,984
Downstream benefits below the dam	500 feet below dam	1:1	500
Human values 1) Scientific value 2) Human recreation	-----	Up to 20 percent bonus	7,375
Total potential additional SMUs			48,859
Committed SMUs			**36,875**

[1] Primary success criteria will be monitored to verify and confirm positive changes to each functional criterion as outlined in this report and in the Dam Removal Guidance. Reserve criteria will be monitored for possible augmentation of the primary SMUs.

Table 2. Mitigation Success Criteria Evaluation

	Criterion	Parameter	Anticipated Change/Result
Primary success criteria:	Re-introduction of rare and endangered aquatic species	Presence/absence of rare/endangered individuals	Unknown
		Rare/endangered species habitat	Improvement/expansion
	Improved water quality	Benthic biotic indices	Decrease (i.e., improve)
		AMS dissolved oxygen data	Increase within former Site Impoundment (must be ≥ 6.0 mg/L or consistent with reference station data)
	Improved aquatic community	Ephemeroptera, Plecoptera, and Trichoptera taxa, total number of benthic taxa	Increase (i.e., converge with reference station data)
		Fish, Mussel, and Snail community data	Demonstrated shifts in communities from lentic to lotic character
	Anadromous fish passage (under crest pool)	Presence/absence of spawning adults within or above former Site Impoundment	Presence
Reserve success criteria:	Anadromous fish passage (above crest pool)	Presence/absence of spawning adults above former Site Impoundment within FBA	Presence
	Downstream benefits below dam	Little River bankfull channel within formerly eddied/scoured areas below dam	Narrowing/increased stabilization of channel
	Scientific value	Published research	Successful completion
	Public recreation	Construction of planned on-Site park	Successful completion

1.3 Project History and Background

Table 3. Project Activities and Reporting History: Lowell Mill Dam Restoration Site

Activity Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	July 1, 2004	N/A	August 1, 2005
Final Design	July 1, 2004	N/A	August 1, 2005
Construction	January 2006	N/A	January 2006
Temporary S&E mix applied to entire project area	Dec.-Jan. 2006	N/A	Dec.-Jan. 2006
Permanent seed mix applied to reach/segments	January 2006	N/A	January 2006
Bare Root Seedling Installation	February 2006	N/A	February 2006
Mitigation Plan	January 15, 2005	N/A	June 30, 2006
Minor repairs made filling small washed out areas	N/A	N/A	N/A
Final Report	N/A	N/A	N/A
Year 1 Vegetation Monitoring	N/A	N/A	N/A
Year 1 Stream Monitoring	August 2006	July 2006	July 2006

1.4 Project Restoration Goals

The primary goal of the Lowell Mill Dam removal is the restoration of formerly impounded reaches of the Little River and affected tributaries to their pre-disturbance, lotic conditions. To demonstrate the achievement of this goal, the affected river and stream reaches will be monitored for successful reestablishment of several functional attributes, which include lotic flow and habitat improvements for aquatic communities that are characteristic of a coastal plain lotic environment. Baseline data were collected in 2005 prior to the removal of the dam and mill works. Additionally, efforts will be made to confirm that anadromous fish species have been restored to their historical spawning grounds and that vertebrate and invertebrate species favoring lotic habitats, including rare or endangered species, are able to re-colonize these restored habitats. The specific goals of this project are to:

- **Restore approximately 36,875 linear feet of free-flowing river** and stream channels formerly inundated under the spillway crest pool elevation of Lowell Mill Dam.

- **Restore the natural flow** and corresponding sediment transport relationships through and well beyond the approximately 36,875 linear feet of former impoundment.

- **Improve water quality and aquatic communities within impaired (303[d]) rivers** and streams degraded by stagnated flow within the former Site Impoundment. A minimum of 36,875 feet of river and stream channel will be converted from impeded, lentic conditions into restored, lotic streams and rivers supporting a more diverse aquatic community characteristic of pre-impoundment conditions.

- **Restore rare and endangered species habitat** within rivers and streams formerly lost within the Site Impoundment. Twenty documented rare aquatic species will directly benefit from restoration of a continuous, free-flowing river, including dwarf

wedgemussel and the only documented population of Tar River spinymussel in the Neuse River Basin.

- **Restore anadromous fish passage**, foraging, and spawning opportunities within 36,875 linear feet within the former Site Impoundment, as well as an additional 204,920 linear feet of main stem stream and river channels within the FBA above the former Site Impoundment.

- **Provide new academic research and data** regarding the effects of dam removal on aquatic and terrestrial ecosystems.

- **Provide public recreation opportunities**, including the establishment of a park and canoe/kayak launch facilities at the Site.

- **Generate a minimum of 36,875 linear feet of Stream Mitigation Units (SMUs)** for use by the EEP to offset impacts to streams in the specific Neuse River hydrologic unit (see Table 1 for details). Additional SMUs may also be generated for use by the EEP, dependent upon results of post-project monitoring programs.

Table 4. Project contacts: Lowell Mill Dam Restoration Site

Designer Milone and MacBroom, Inc. (MMI)	307B Falls Street Greenville, SC 29601 (864) 271-9598
Construction Contractor Backwater Environmental, Inc.	P.O. Box 1654 Pittsboro, NC 27312 (919) 523-4375
Planting Contractor Carolina Silvics, Inc.	908 Indian Trail Road Edenton, NC 27932 (252) 482-8491
Seeding Contactor Backwater Environmental, Inc.	P.O. Box 1654 Pittsboro, NC 27312 (919) 523-4375
Seed Mix Sources Mellow Marsh Farm	1312 Woody Store Road Siler City, NC 27344 (919) 742-1200
Nursery Stock Suppliers Mellow Marsh Farm Taylor's Nursery Coastal Plain Conservation Nursery International Paper Supertree Nursery	 1312 Woody Store Road Siler City, NC 27344 (919) 742-1200 3705 New Bern Avenue Raleigh, NC 27610 (919) 231-6161 3067 Conners Drive Edenton, NC 27932 (252) 482-5707 5594 Highway 38 South Blenheim, SC 29516 (800) 222-1290
Monitoring Performers EcoScience Corporation	1101 Haynes Street Suite 101 Raleigh, NC 27604 (919) 828-3433
Stream Monitoring POC	Jens Geratz
Vegetation Monitoring POC	N/A (project does not require vegetation monitoring)

Table 5. Project background: Lowell Mill Dam Restoration Site

Project County	Johnston County, NC
Drainage Area	Approximately 215 square miles
Impervious cover estimate (%)	10%
Stream Order	4th-order
Physiographic Region	Upper Coastal Plain
Ecoregion (Griffith and Omernik)	Rolling Coastal Plain/Northern Outer Piedmont
Rosgen Classification of As-built	N/A
Cowardin Classification	R2SB3/4
Dominant soil types	N/A (stream restoration project only)
Reference Site ID	N/A
USGS HUC for Project and Reference	03020201
NCDWQ Sub-basin for Project and Reference	03-04-06
NCDWQ classification for Project and Reference	WS-V NSW (Little River and Tributary 1), C NSW (Little Buffalo Creek, Buffalo Creek, and Long Branch)
Any portion of any project segment 303d listed?	Yes (Little River from confluence with Little Buffalo Creek to 4.2 miles upstream of NC 581)
Any portion of any project segment upstream of a 303d listed segment?	Yes (see above—reach extends downstream of project extents)
Reasons for 303d listing or stressor	Low dissolved oxygen
Percent of project easement fenced	N/A

2.0 PROJECT MONITORING RESULTS

Project monitoring results discussed below document Year-1 (2006) monitoring activities. Monitoring stations were established prior to dam removal to collect baseline (i.e., pre-dam removal) data (Figure 3, Appendix A). One additional station was added immediately downstream of the former dam in 2006 to evaluate the geomorphic restoration of the channel anomaly below the dam under the reserve success criterion (Table 1). Anadromous fish survey locations are displayed on Figure 4 (Appendix A). Pre-removal baseline data (2005) and Year-1 monitoring data (2006) will be compared to evaluate improvements in water quality, the aquatic community, re-introduction of rare and endangered species, and andromous fish passage within the former Site Impoundment.

2.1 Water Quality

2.1.1 Biotic Indices

Table 6 displays the biotic index values for both pre-removal (performed in 2004) and Year-1 (2006) monitoring. According to the project's Mitigation Plan (Restoration Systems 2006), success criteria will be achieved when the mean value of the biotic index from benthic stations within the former Site Impoundment fall within one standard deviation of mean of the same dataset collected at the reference stations by the end of the project monitoring period.

Table 6. Benthic biotic indices of formerly impounded and reference stations

	2004 (Baseline)		2006 (Year 1)	
	IMPOUNDED STATIONS	**REFERENCE STATIONS**	**IMPOUNDED STATIONS**	**REFERENCE STATIONS**
	Biotic Index	Biotic Index	Biotic Index	Biotic Index
High	7.36	5.52	7.71	7.31
Low	6.72	5.24	6.11	6.56
Mean	**7.02**	5.38	**6.71**	6.88
Median	6.98	5.38	6.57	6.83
Standard Deviation	0.32	0.20	0.58	0.35
Standard Deviation of Reference mean **(Success Criterion)**	**5.58**		**7.23**	

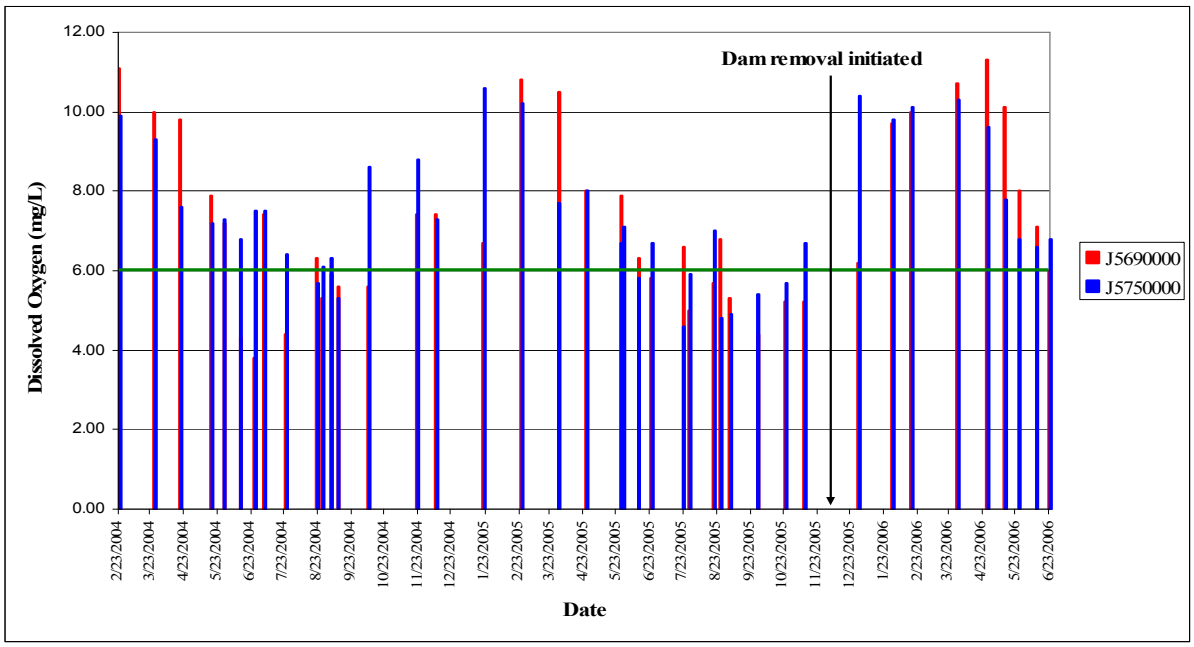
Since the mean of the biotic index from the formerly impounded stations (μ=6.71) is already less (i.e., indicative of a benthic community less tolerant of poorer water quality) than the mean of the reference stations (μ=6.88), success in this category may be inferred.

2.1.2 Ambient Monitoring Station Dissolved Oxygen Data

Dissolved oxygen concentrations at a 0.1-meter depth are measured at an Ambient Monitoring Station (AMS) within the former Site Impoundment on the Little River at US 301 (Station ID# J5690000), approximately 1.5 miles upstream of the Site. A reference AMS is located approximately 1.0 miles downstream of the Site on the Little River at State Road (SR) 2339 (Station ID# J5750000). Dissolved oxygen concentrations (mg/L) are measured semimonthly at both stations.

Graph 1 displays measured dissolved oxygen concentrations at both stations. As stated in the Mitigation Plan (Restoration Systems 2006), in order to achieve success criteria, dissolved oxygen concentrations measured within the former Site Impoundment (AMS J5690000) must not dip below 6.0 mg/L unless concentrations are also less than 6.0 mg/L at the reference AMS (J5750000) within the same sampling timeframe. As of June 23, 2006, dissolved oxygen concentrations within the former Site Impoundment have remained at or above 6.0mg/L.

Graph 1: AMS Dissolved Oxygen Concentrations



**The green line highlights a dissolved oxygen concentration of 6.0 mg/L, which must be exceeded by AMS #J5690000 in order to achieve success criteria (unless dissolved oxygen concentrations at reference AMS #J5750000 are also below 6.0 mg/L within the same sampling timeframe).*

2.2 Aquatic Communities

2.2.1 Benthic Macroinvertebrates

Table 7 displays baseline (performed in 2004) and Year-1 (2006) benthic macroinvertebrate data for both formerly impounded and reference stations. Since the mean number of total taxa and EPT richness from the formerly impounded stations is within one standard deviation of the reference station means, success criteria is being met. Benthic macronivertebrate data is located in Appendix B. Data in Appendix B are based on laboratory identifications of benthic macroinvertebrate taxa by Pennington and Associates, Inc. (P&A) of Cookeville, Tennessee. P&A is a North Carolina Division of Water Quality (NCDWQ)-certified benthic identification laboratory.

Table 7. EPT and total number of taxa

	2004 (Baseline)				2006 (Year 1)			
	IMPOUNDED		REFERENCE		IMPOUNDED		REFERENCE	
	Total Taxa	EPT Richness	Total Taxa	EPT Richness	Total Taxa	EPT Richness	Total Taxa	EPT Richness
HIGH	45.00	6.00	57.00	21.00	90.00	21.00	43.00	19.00
LOW	25.00	0.00	56.00	19.00	33.00	0.00	35.00	6.00
MEAN	37.33	4.00	56.50	20.00	**41.86**	**10.70**	39.75	11.00
MEDIAN	42.00	6.00	56.50	20.00	37.00	11.00	40.50	9.50
STANDARD DEVIATION	10.79	3.46	0.71	1.41	10.33	6.37	3.40	5.28
Success Criterion	**55.79**	**18.59**			**36.35**	**5.72**		

2.2.2 Fish

Year-1 (2006) fish sampling was performed by The Catena Group (TCG). Sampling was performed at stations displayed on Figure 3 (Appendix A). TCG's report summarizing fish sampling is located in Appendix C.

Data indicate that the former Site Impoundment fish communities are transitioning from those characteristic of impounded, lentic conditions to lotic, free-flowing conditions. Qualitative observations during aquatic surveys by TCG revealed that habitat for fish started to transition from lentic to lotic conditions in direct response to dam removal. In general, a greater number of fish species were documented at each monitoring station in Year 1 (2006) relative to baseline (2005) sampling. For additional information, please consult TCG's report (Appendix C).

2.2.3 Anadromous Fish

Year-1 (2006) anadromous fish sampling was performed in spring by TCG. Figure 4 (Appendix A) provides anadromous fish survey locations; however, it should be noted that actual survey locations within a given stream reach may be adjusted in subsequent surveys due to ambient stream conditions.

American shad (*Alosa sapidissima*) were captured immediately below Atkinson Mill Dam on May 9, 2006, indicating that anadromous fish passage below the crest pool has been successfully achieved. A spawning American shad female was also captured in Buffalo Creek at Woodruff Road (SR 2129) on May 9, 2006, indicating anadromous fish species have begun to access higher-order stream reaches within the FBA. For additional information, please consult TCG's report summarizing andromous fish survey efforts (Appendix C).

2.2.4 Mollusks

Mussel, snail, and clam sampling data will be used to evaluate success evaluation for the aquatic community and threatened and endangered aquatic species criteria. Mollusks were sampled at the fish, mussel, and snail survey locations depicted on Figure 3 (Appendix A) by TCG preceding dam removal to obtain baseline community data in 2005. Since these fauna are slow colonizers,

demonstrable changes in mollusk communities are not expected during the first few years of project monitoring. Mollusks will be re-sampled in the fourth year (2009) of project monitoring.

2.2.5 Habitat Assessment

2.2.5.1 Channel Cross-Sections

Twenty-four (24) cross-section stations have been established within the former Site Impoundment and at four reference locations to assess bankfull channel stability following dam removal. Cross-section locations are displayed on Figure 3 (Appendix A). Baseline and Year-1 cross-sectional surveys are displayed on Figures 5A-5C (Appendix A). Table 8 displays baseline and Year-1 bankfull channel geometry, including bankfull cross-sectional area (Abkf), bankfull width (Wbkf), maximum bankfull depth (Dmax), mean bankfull depth (dbkf), and width-to-depth ratio (width:depth).

Since the removal of Lowell Mill Dam, the greatest discharge, as recorded at the United States Geologic Survey (USGS) Princeton gauge, occurred on June 18, 2006 with a value of 2,380 cfs (cubic feet per second). According to recurrence interval analysis conducted by ESC (using the annual maximum series taken from the USGS Princeton gauge), an event of this magnitude occurs within the restoration reach every 1.9 years. A return interval between 1.2 and 1.4 years is assumed to represent bankfull discharge and thus is responsible for the shape and size of channels (Rosgen 1994). Therefore, the aforementioned event with the 1.9 years return interval represents a channel forming flow.

In general, bankfull channel parameters were largely unchanged from baseline conditions in the first monitoring year. Based on this observation, and the previously described recurrence interval analysis, channel geometry within the former site impoundment is likely stable. The following should be noted: 1) Cross-section 20, which was installed approximately 200 ft. downstream of the former Lowell Mill dam on the Little River, was established following dam removal. Thus, there is no baseline (2005) bankfull channel geometry data for this station. 2) Cross-section 16, located just upstream of the former dam site, was impact during dam removal activities. Hence, the discrepancies in cross-sectional dimensions and bankfull channel geometry between baseline and Year-1 monitoring data.

Table 8. Cross-section bankfull channel geometry

Station	2005 (Baseline)					2006 (Year 1)				
	Abkf (ft.)	Wbkf (ft.)	Dmax (ft.)	dbkf (ft.)	width: depth	Abkf (ft.)	Wbkf (ft.)	Dmax (ft.)	dbkf (ft.)	width: depth
1	547.3	84.5	9.1	6.5	13.0	583.1	84.0	9.5	6.9	12.2
2	614.3	88.2	9.4	7.0	12.6	579.3	85.5	8.6	6.8	12.6
3	304.6	52.3	6.8	5.8	9.0	308.6	52.3	6.7	5.9	8.9
4	420.1	72.2	9.0	5.8	12.4	432.8	63.7	9.5	6.8	9.4
5	344.2	62.9	6.5	5.5	11.4	326.7	62.8	6.5	5.2	12.1
6	425.8	71.6	8.5	5.9	12.1	403.4	71.3	8.1	5.7	12.5
7	618.0	91.0	9.4	6.8	13.4	607.5	89.1	9.1	6.8	13.1
8	514.0	78.6	10.5	6.5	12.1	506.2	77.0	10.2	6.6	11.7
9	615.2	72.1	11.4	8.5	8.5	517.0	67.7	10.0	7.6	8.9
10	467.5	67.4	10.1	6.9	9.8	459.9	67.4	10.1	6.8	9.9
11	612.5	121.8	9.2	5.0	24.4	605.5	122.8	9.3	4.9	25.1
12	848.2	111.5	9.9	7.6	14.7	781.0	111.6	9.4	7.0	15.9
13	666.7	89.7	11.1	7.4	12.1	645.8	88.6	10.2	7.3	12.1
14	786.9	105.6	10.6	7.4	14.3	780.3	104.9	10.4	7.4	14.2
15	940.5	114.8	12.3	8.2	14.0	915.5	113.9	12.0	8.0	14.2
16*	517.7	81.2	11.0	6.4	12.7	691.2	105.2	9.9	6.6	15.9
17	82.6	28.8	3.9	2.9	9.9	83.7	29.4	3.8	2.8	10.5
18	36.2	27.8	3.3	1.3	21.4	33.9	24.3	3.0	1.4	17.4
19	5.6	10.7	1.0	0.5	21.4	4.5	11.7	0.5	0.4	29.3
20	Cross-section not established in 2005					809.5	119.7	9.1	6.8	17.6
Reference 1	261.8	48.9	6.1	5.4	9.1	255.2	48.9	5.8	5.2	9.4
Reference 2	368.5	67.5	6.8	5.5	12.3	364.8	66.3	7.5	5.5	12.1
Reference 3	419.0	66.0	8.6	6.4	10.3	403.3	62.4	8.6	6.5	9.6
Reference 4	582.1	80.2	8.6	7.7	10.4	580.3	80.3	9.3	7.2	11.2

**Cross-section 16 was disturbed during dam removal activities; hence, the large discrepancies between baseline and Year 1 data.*

2.2.5.2 Sediment Class Size Distribution

Sediment grain size distributions were assessed at each channel cross-section location (Figure 3, Appendix A). Table 9 displays baseline and Year 1 sediment grain size distributions for each cross-section.

Table 9: Sediment class size distribution

Station	Baseline (2005)				Year 1 (2006)			
	d16	d50	d84	d100	d16	d50	d84	d100
1	<2 mm	<2 mm	<2 mm	16-32 mm	<2 mm	<2 mm	<2 mm	16-22 mm
2	<2 mm	<2 mm	<2 mm	8-16 mm	<2 mm	<2 mm	<2 mm	4-6 mm
3*	<2 mm	<2 mm	<2 mm	16-32 mm	<2 mm	8-16 mm	16-32 mm	16-32 mm
4*	<2 mm	<2 mm	8-16mm	16-32 mm	<2 mm	<2 mm	<2 mm	2-4 mm
5	<2 mm	<2 mm	<2 mm	4-8 mm	<2 mm	4-8mm	16-32 mm	32-53 mm
6	<2 mm	<2 mm	<2 mm	4-8 mm	<2 mm	<2 mm	<2 mm	4-8 mm
7	<2 mm	<2 mm	2-4 mm	16-32 mm	<2 mm	<2 mm	4-8 mm	16-32 mm
8	<2 mm	<2 mm	32-53 mm	32-53 mm	<2 mm	<2 mm	<2 mm	16-32 mm
9	<2 mm	<2 mm	<2 mm	32-53 mm	<2 mm	2-4 mm	16-32 mm	16-32 mm
10*	<2 mm	<2 mm	16-32 mm	32-53 mm	2-4 mm	2-4 mm	16-32 mm	32-53 mm
11	<2 mm	<2 mm	<2 mm	2-4 mm	<2 mm	<2 mm	<2 mm	4-8 mm
12	<2 mm	<2 mm	4-8 mm	16-32 mm	<2 mm	<2 mm	4-8 mm	16-32 mm
13	<2 mm	<2 mm	<2 mm	< 2 mm	<2 mm	<2 mm	4-6 mm	4-6 mm
14	<2 mm	<2 mm	<2 mm	4-8 mm	<2 mm	<2 mm	4-6 mm	8-11 mm
15	<2 mm	<2 mm	<2 mm	8-16 mm	<2 mm	<2 mm	8-11 mm	64-90 mm
16	<2 mm	16-32 mm	32-53 mm	32-53 mm	<2 mm	8-11 mm	16-22 mm	64-90 mm
17	<2 mm	<2 mm	<2 mm	<2 mm	4-6 mm	11-16 mm	16-22 mm	32-45 mm
18	<2 mm	<2 mm	<2 mm	<2 mm	<2 mm	<2 mm	<2 mm	8-16 mm
19	<2 mm	<2 mm	<2 mm	<2 mm	<2 mm	<2 mm	<2 mm	<2 mm
20	Cross-section not established in 2005				<2 mm	<2 mm	4-6mm	16-22 mm
Reference 1	<2 mm	8-16 mm	16-32 mm	32-53 mm	6-8 mm	16-22 mm	32-45 mm	128-180 mm
Reference 2	<2 mm	<2 mm	<2 mm	4-8 mm	<2 mm	<2 mm	<2 mm	8-11 mm
Reference 3*	32-53 mm	53-64 mm	53-64 mm	53-64 mm	53-64 mm	53-64 mm	53-64 mm	53-64 mm
Reference 4*	<2 mm	32-53 mm	32-53 mm	32-53 mm	4-8 mm	32-53 mm	53-64 mm	53-64 mm

**Station underlain by bedrock—sediment analysis reflects the distribution of the sediment veneer overlaying the channel bed.*

Sediment grain size classes are defined as follows (per Rosgen 1994):

Particle Size	Size Class
<2 mm	Sand/silt
2-8 mm	Fine gravel
8-16 mm	Medium gravel
16-32 mm	Coarse gravel
32-64 mm	Very coarse gravel
64-128 mm	Small cobble
128-256 mm	Large cobble

Weighted sieve analyses (using Rosgen [1994] methodology for performing bar samples) were performed to assess sediment grain size distributions of monitoring stations with water depths

exceeding 3 feet, where a ponar dredge was used to collect sediment samples (see Mitigation Plan [Restoration Systems 2006] for sampling methodology details). For water depths less than 3 feet (i.e., wadeable areas), 100-count pebble counts were performed consistent with the Wolman method (Rosgen 1994). Since the sieve analyses provided substrate composition data based on sieve size, the sediment class sizes displayed on Table 5 reflect the sieve sizes that the particular grain size falls within (e.g., at Station 5 in 2006, the d50 occurred between the 4 mm and 8mm sieve sizes).

The d50 (median particle size) increased during the first year of project monitoring from baseline conditions at Stations 3, 5, 9, 10, and Reference 1. Stations 3 and 10 are underlain by bedrock, and the coarsening of substrate occurred within the sediment veneer overlaying the bedrock. As stated in the project's Mitigation Plan (Restoration Systems 2006), substrate within the former Site Impoundment is expected to coarsen. However, the duration of time required for this change to occur may eclipse the five-year project monitoring period. Thus, project success evaluation is not contingent upon changes in channel substrate size class.

2.2.5.3 Habitat Assessment Form Scores

NCDWQ Habitat Assessment Forms were completed at each cross-section station to evaluate the quality and extent of aquatic habitat. Table 10 displays the NCDWQ Habitat Assessment Form scores for each cross-section station. A blank NCDWQ Habitat Assessment Form has been included in Appendix D for reference. The mean scores of formerly impounded stations have increased following dam removal and the subsequent establishment of lotic flow conditions. The mean score for formerly impounded stations increased from 48.3 in 2005 to 56.2 in 2006. The mean score for reference stations remained slightly increased from a score of 74.8 in 2005 to 77.5 in 2006.

Table 10: NCDWQ habitat assessment form scores

2.2.5.4 Photography and Videography

As discussed in the project's Mitigation Plan (Restoration Systems 2006), photography and videography were conducted during baseline and Year-1 monitoring data collection to assess qualitative changes in channel cross-sections and in-stream habitat. Monitoring photographs have been included on a data compact disc in Appendix E. Videography is available upon request.

Flat, stagnant water surface looking upstream on the Little River at Cross-Section 16 prior to dewatering

Looking upstream at Cross-Section 16 in May 2006 following dam removal—note lotic flow conditions and stable, vegetated stream banks

Looking downstream at the US 301 and railroad bridges over the Little River prior to dewatering—note high water surface relative to bankfull elevation

Looking upstream at the US 301 and railroad bridges following dewatering—note lower water surface elevation and stable, vegetated stream banks

2.3 Protected Species

Two federally endangered species have been documented in the Little River sub-basin: the dwarf wedgemussel (*Alasmidonta heterodon*) and Tar spinymussel (*Elliptio steinstansanna*). Both of these species are mollusks. As discussed in Section 2.2.4 ("Mollusks"), mollusks will be sampled during the fourth year of project monitoring. Favorable habitat (lotic flow conditions with gradually coarsening substrate) for these mollusk species has developed within much of the former Site Impoundment (see Appendix C).

2.4 Bonus Criteria

2.4.1 Public Recreation

Plans for the establishment of a public park at the Site have been developed by Milone and MacBroom, Inc. (MMI). Plans consist of picnic and fishing areas, canoe and kayak launch areas, and vehicular parking. Site plans for the park are in Appendix F. Park construction is scheduled to begin on or before October 15, 2006.

The amount of credit to be derived from the successful implementation of the park has not yet been determined, but may be used to offset any unanticipated loss of credits in lieu of failed primary success criteria.

2.4.2 Scientific Research

The former Site Impoundment is subject to a study by University of North Carolina at Chapel Hill scientist Adam Riggsbee, Ph.D. (Riggsbee 2006). Sediment accumulated for many decades within the former Site Impoundment before the dam's removal. Dr. Riggsbee's study investigated the flushing of these sediments and associated nutrients and organic materials as they were routed through the downstream associated channel network. Additionally, the study assesses physical and biological controls on nitrogen and phosphorous leaching from wetland sediments exposed by dam removal.

The amount of credit to be derived from the successful support of this research by RS has not yet been determined, but may be used to offset any unanticipated loss of credits from other aspects of the project.

3.0 EROSION EVALUATION

ESC performed an erosion evaluation of the former Site Impoundment following a rain event that resulted in river discharge of greater than 750 cubic feet per second (cfs) at the Princeton gauging station. The erosion evaluation consists of a canoe transit of the Little River within the former Site Impoundment. The evaluation was performed to document any evidence of erosion within the former Site Impoundment including but not limited to bank failure, loss of stream bank trees, severe head-cuts, and the loss or gain of large depositional features. The erosion evaluation was performed on June 20, 2006. A detailed report documenting this evaluation is included in Appendix G.

4.0 REFERENCES

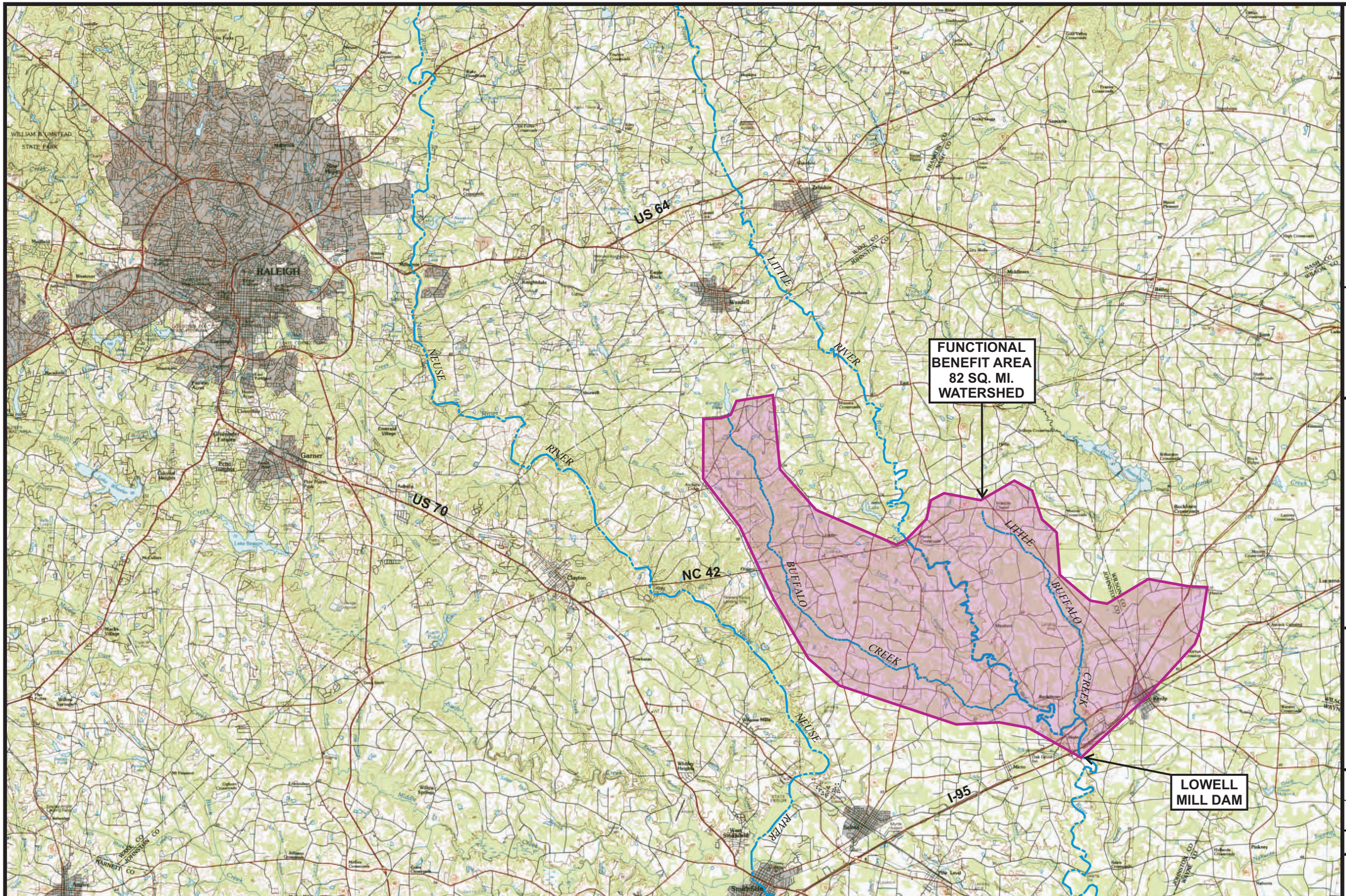
North Carolina Dam Removal Task Force (DRTF). 2001 (unpublished). Interagency Memorandum of Agreement for Dam Removal and Dam Removal Ranking System. U.S. Fish and Wildlife Service. Raleigh, NC.

Riggsbee, J.A. 2006. Spatial and temporal heterogeneity of impounded nutrient and sediment fluxes following dam removal. Ph.D. dissertration. University of North Carolina at Chapel Hill.

Rosgen, D. 1994. Applied Fluvial Geomorphology. Widland Hydrology: Pagosa Springs, CO.

Restoration Systems. 2006. Mitigation Plan: Lowell Mill Dam-Little River Watershed. Technical Report Submitted to the North Carolina Ecosystem Enhancement Program, June 2006. 31pp.

APPENDIX A: Figures



2 mi. 0 2 mi. 4 mi.

1:200000

Source: 2004 Terrain Navigator Pro (Raleigh, NC)

N W E S

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LOWELL MILL DAM-LITTLE RIVER WATERSHED RESTORATION SITE

Johnston County
North Carolina

Title:

SITE LOCATION

Dwn By:	Date:
MAF	SEPT 2006
Ckd By:	Scale:
JDC	As Shown

ESC Project No.: 06-289

FIGURE

1

WENDELL LAKE DAM

ATKINSON MILL DAM

FUNCTIONAL BENEFIT AREA 82 SQ. MI. WATERSHED

LITTLE BUFFALO CREEK MAXIMUM EXTENT OF DAM INFLUENCE (STREAM BED ELEV.=131.0)

LITTLE RIVER MAXIMUM EXTENT OF DAM INFLUENCE (STREAM BED ELEV.=131.0)

LOWELL MILL DAM (CREST POOL ELEV.=131.0 FT.)

RESTORED AQUATIC ECOSYSTEMS

Anadromous Fish / Endangered Species Habitat

Little Buffalo Creek	32,580 ln. ft.
Little River	54,810 ln. ft.
Long Branch	30,890 ln. ft.
Buffalo Creek	86,640 ln. ft.
Total Main Stem Length	204,920 ln. ft.

Site Impoundment (131.0 feet above MSL)

Little River Pool	27,680 ln. ft.
Little Buffalo Creek Pool	8,260 ln. ft.
Additional Tributary	935 ln. ft.
Total Channel Under Crest Pool	36,875 ln. ft.

1 mi. 0 1 mi. 2 mi.

1:100000

Source: 2004 Terrain Navigator Pro (Raleigh, NC)

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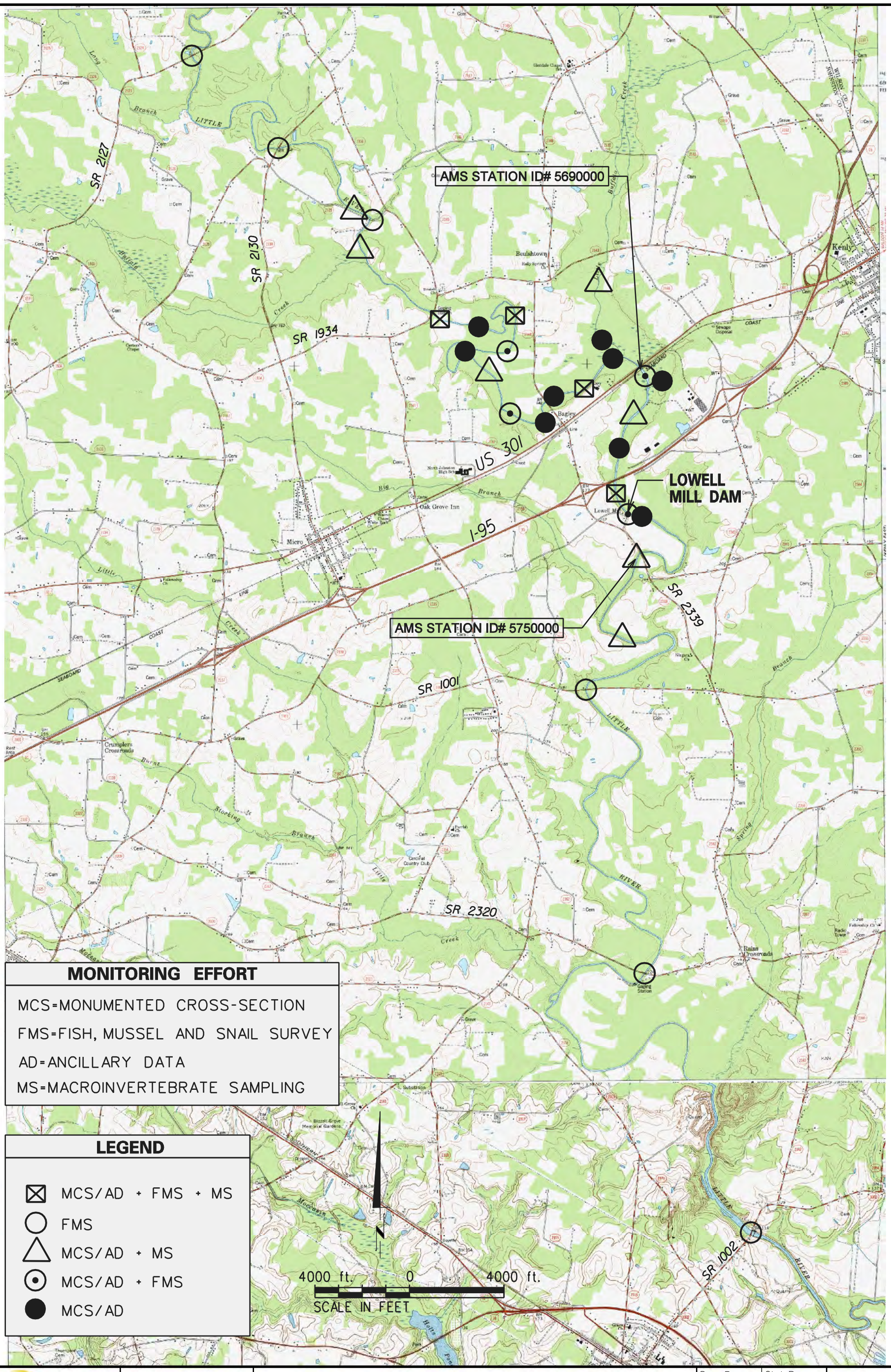
FUNCTIONAL BENEFIT AREA

Dwn By: MAF	Date: SEPT 2006
Ckd By: JDC	Scale: As Shown

ESC Project No.: 06-289

FIGURE

2



MONITORING EFFORT

MCS=MONUMENTED CROSS-SECTION

FMS=FISH, MUSSEL AND SNAIL SURVEY

AD=ANCILLARY DATA

MS=MACROINVERTEBRATE SAMPLING

LEGEND

- MCS/AD + FMS + MS
- FMS
- MCS/AD + MS
- MCS/AD + FMS
- MCS/AD

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MONITORING NETWORK DEPLOYMENT

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WATERSHED RESTORATION SITE

Johnston County, North Carolina

Dwn By:	Ckd By:
MAF	JDC

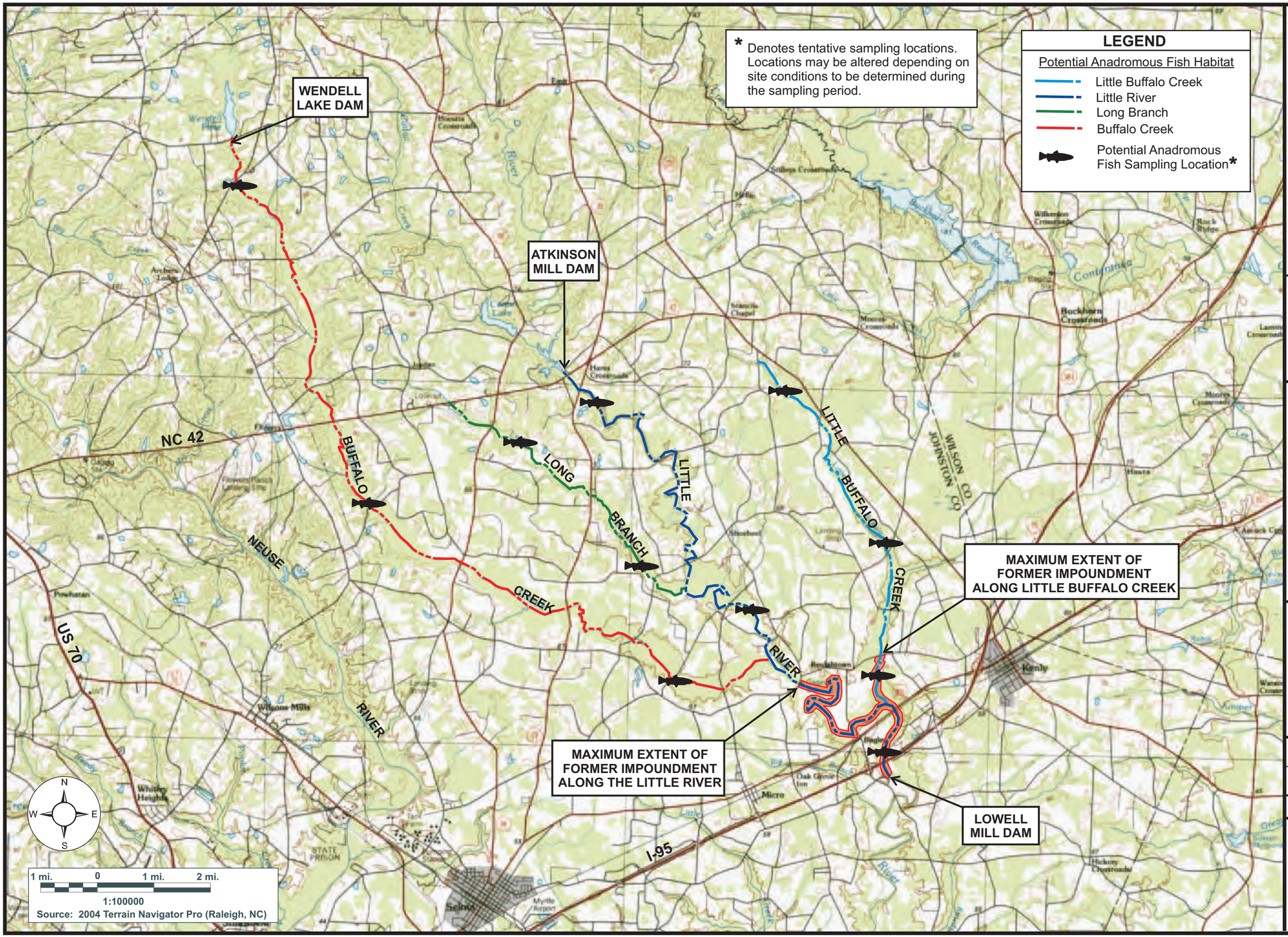
Date: SEPT 2006

Scale: 1"=4000'

ESC Project No.: 06-289

FIGURE

3



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ANADROMOUS FISH SURVEY STATION LOCATIONS

Dwn By:	Date:
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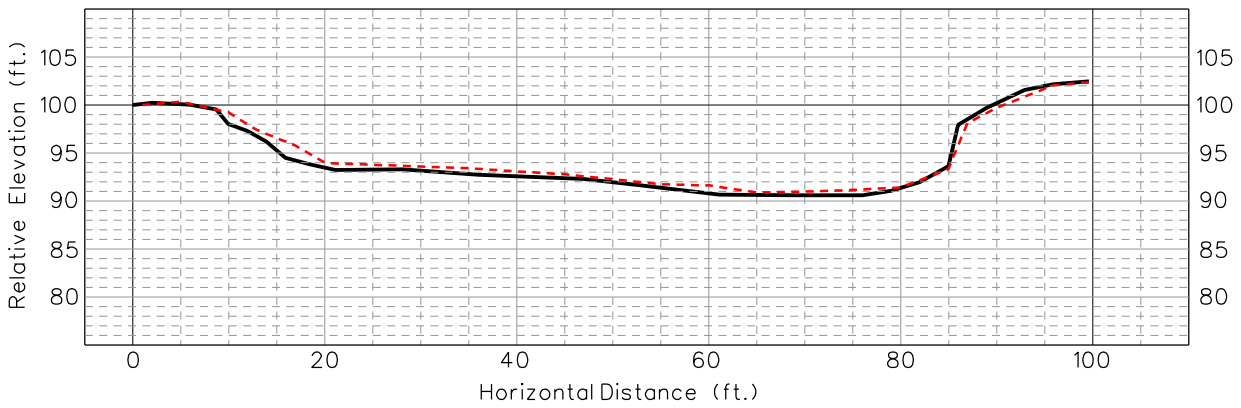
JDC	As Shown

ESC Project No.: 06-289

FIGURE

4

CROSS-SECTION 1



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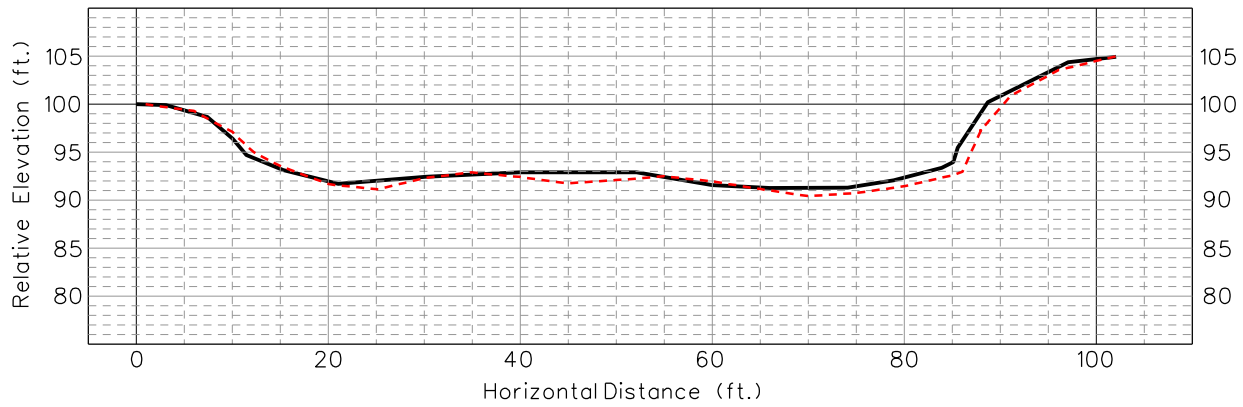

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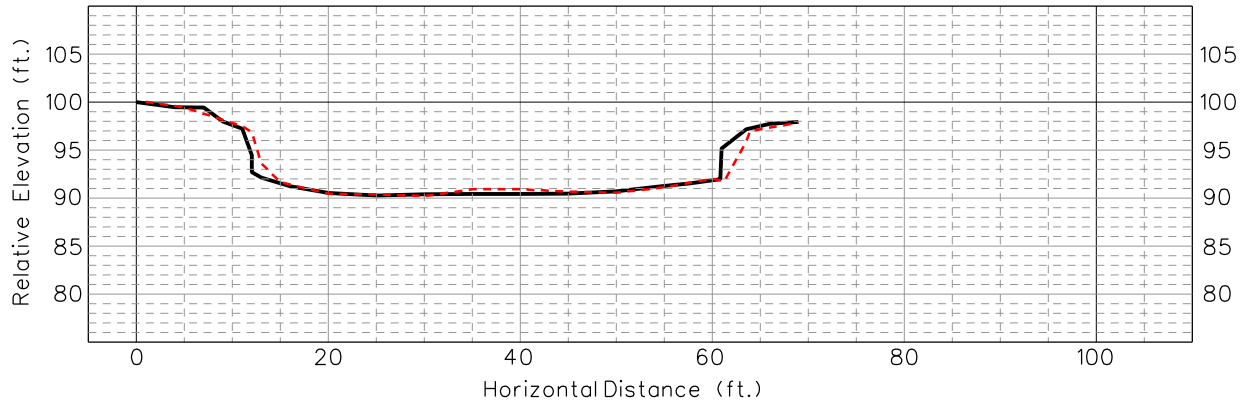

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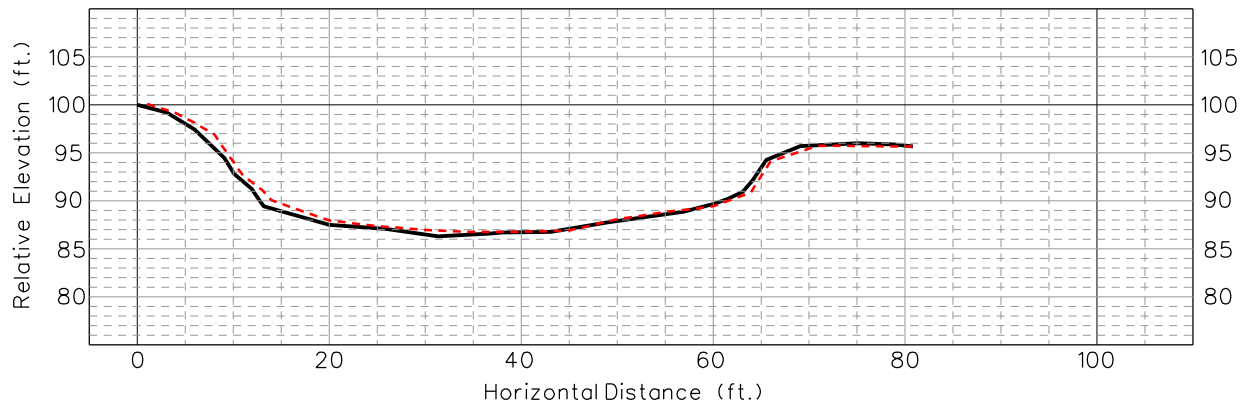

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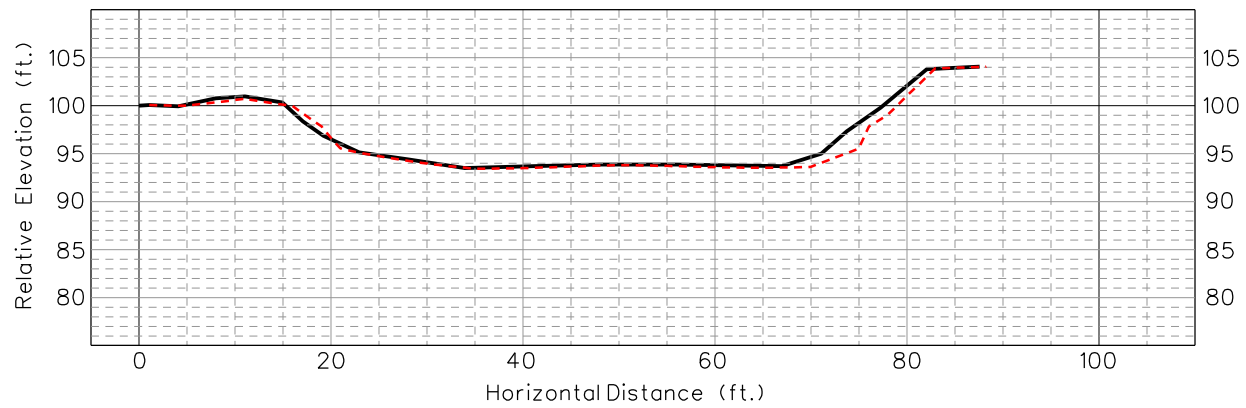

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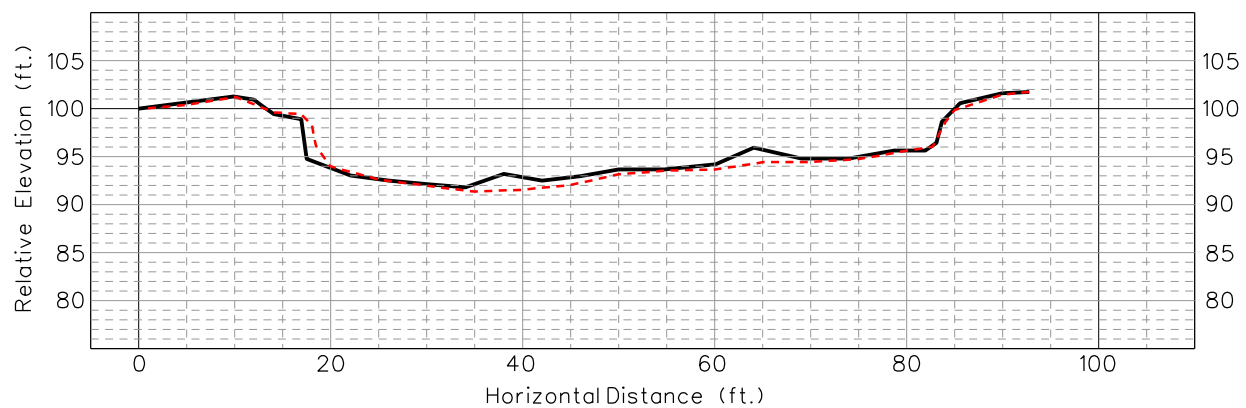

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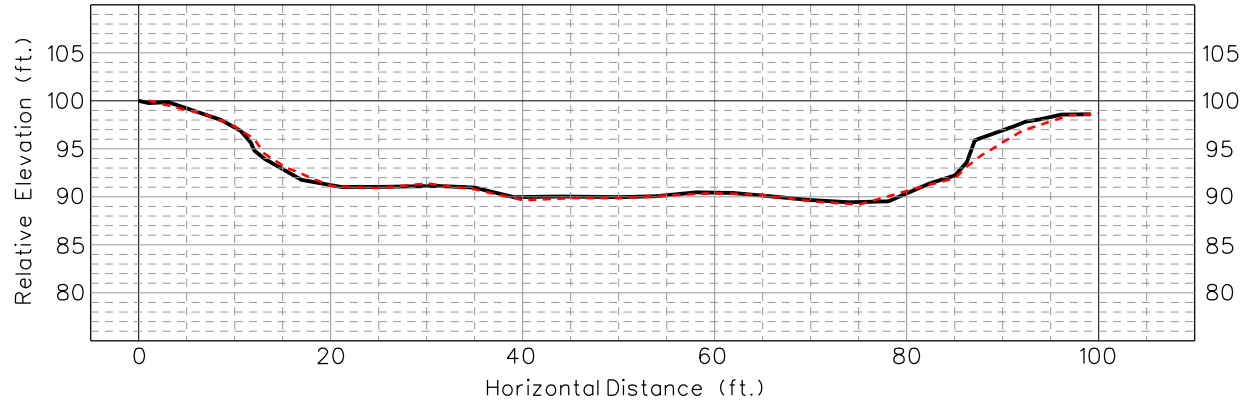

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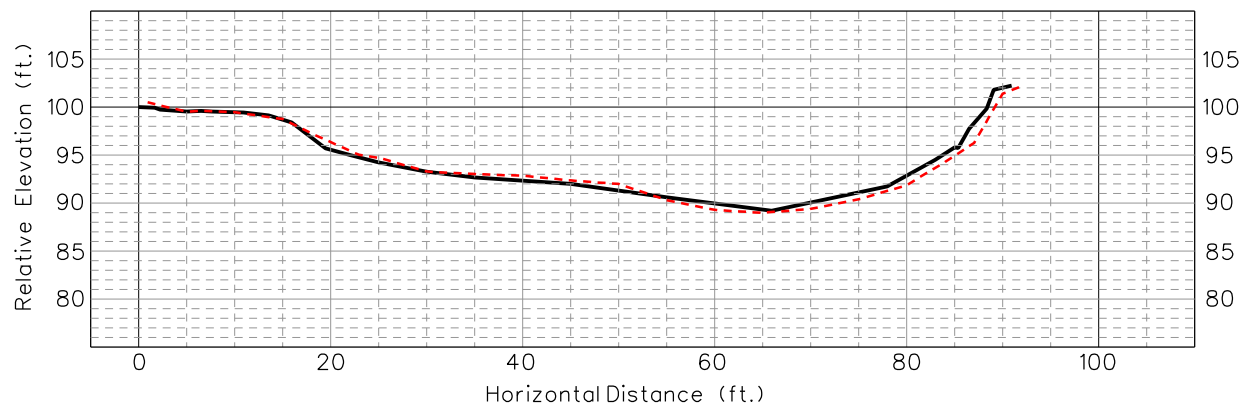

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JOHNSTON COUNTY, NORTH CAROLINA

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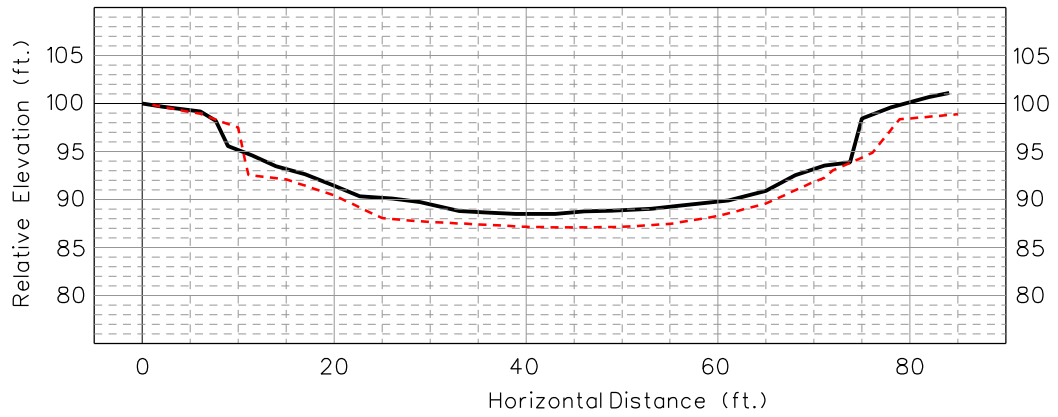
FIGURE

5A

CROSS-SECTION 9



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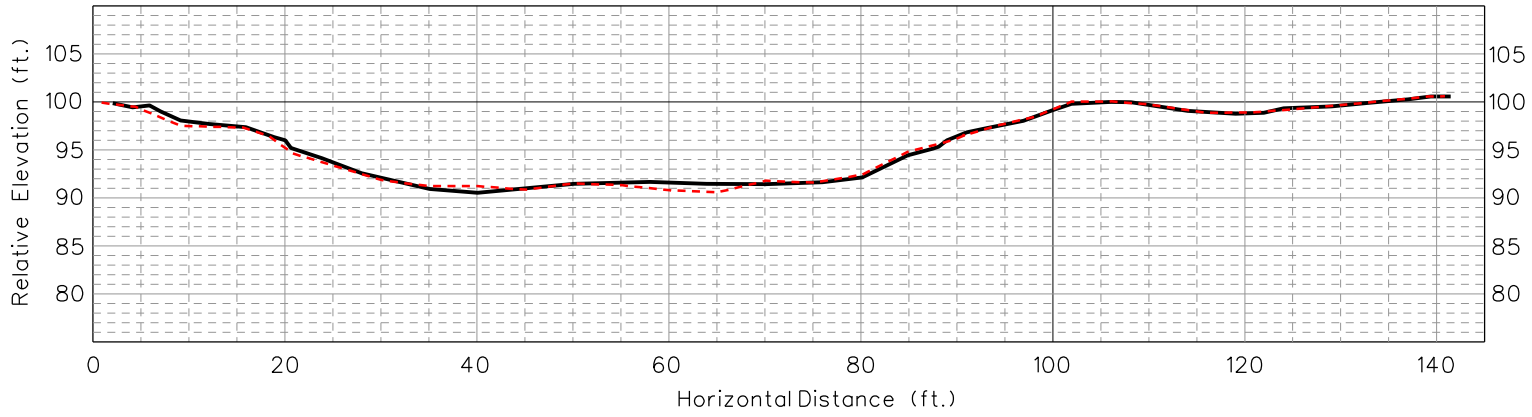

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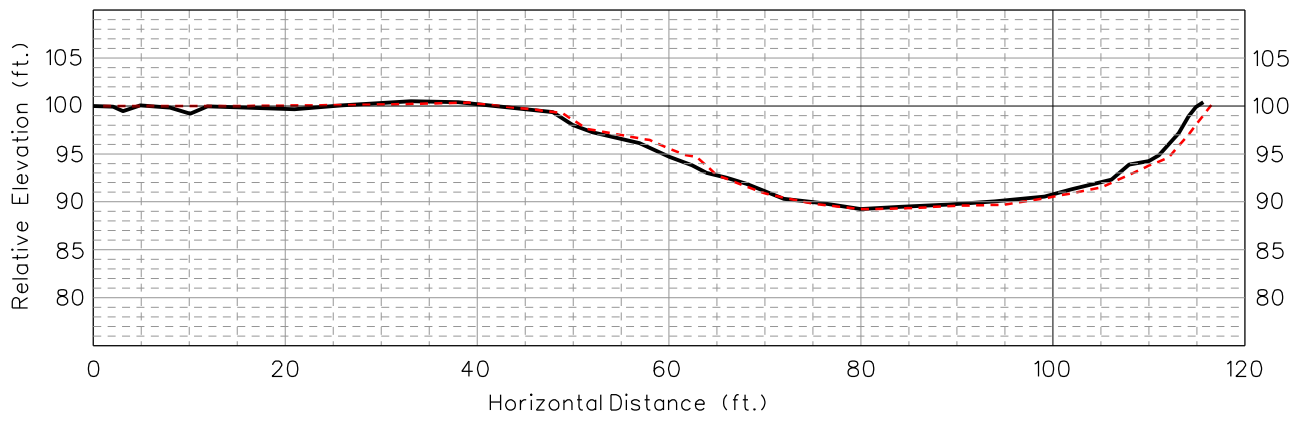

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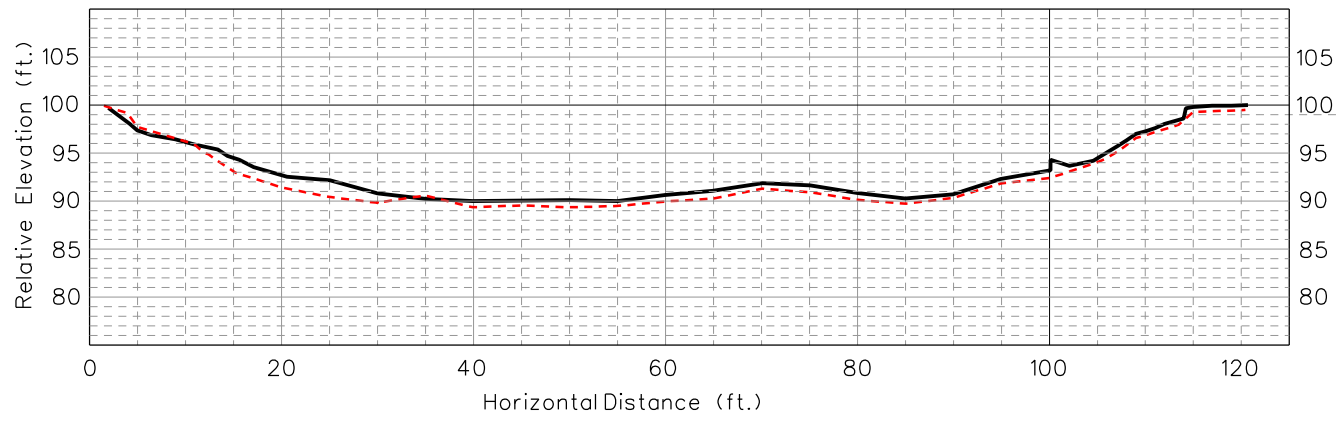

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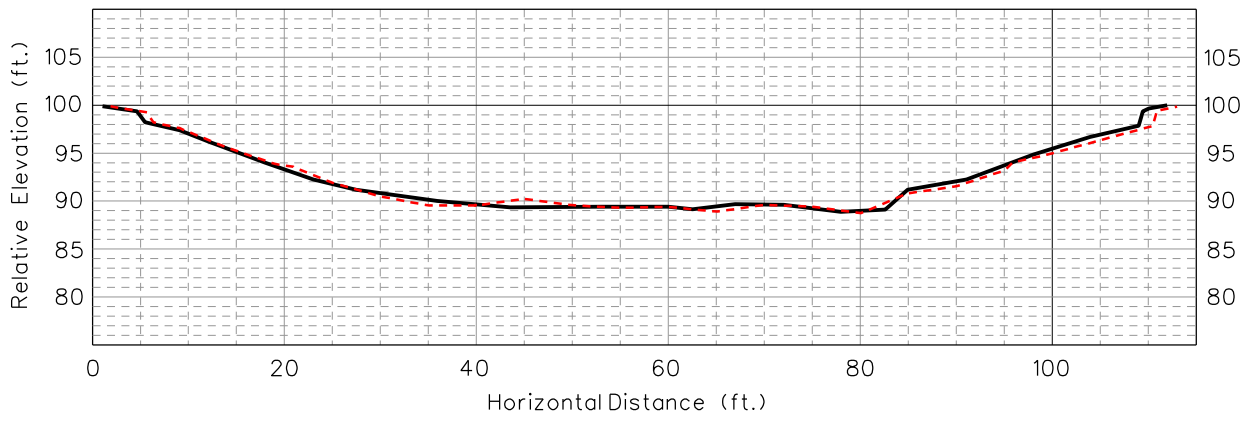

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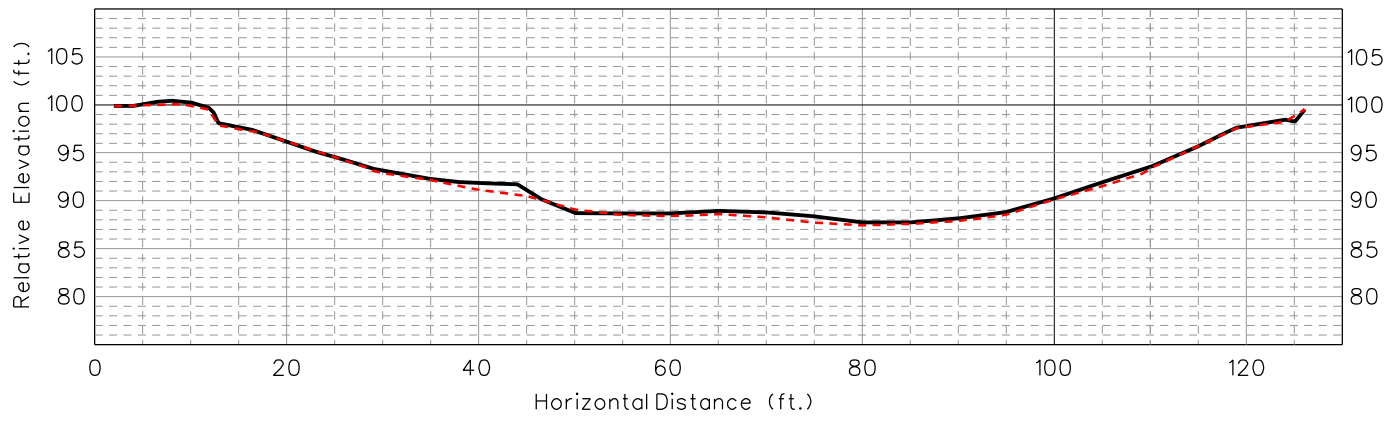

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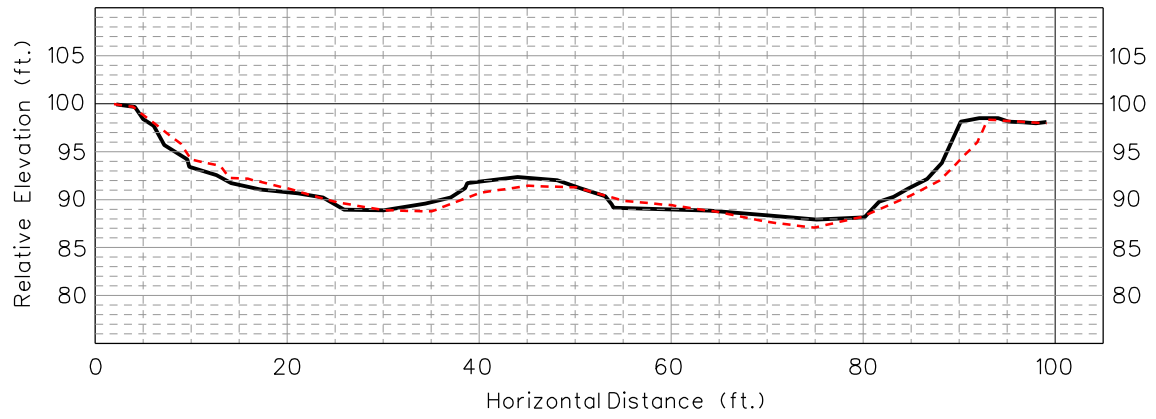

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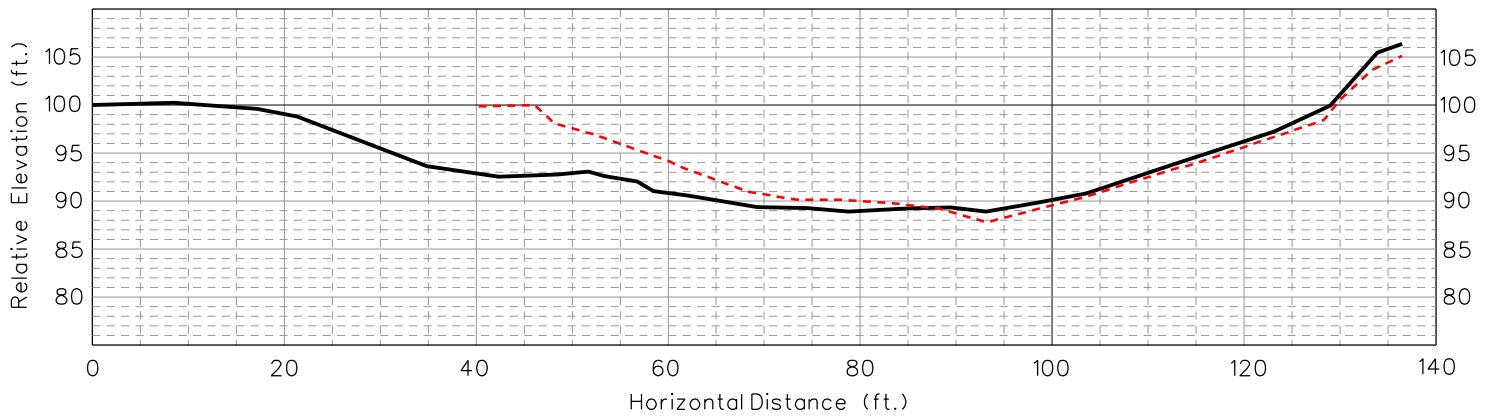

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- YEAR 2006 MONITORING

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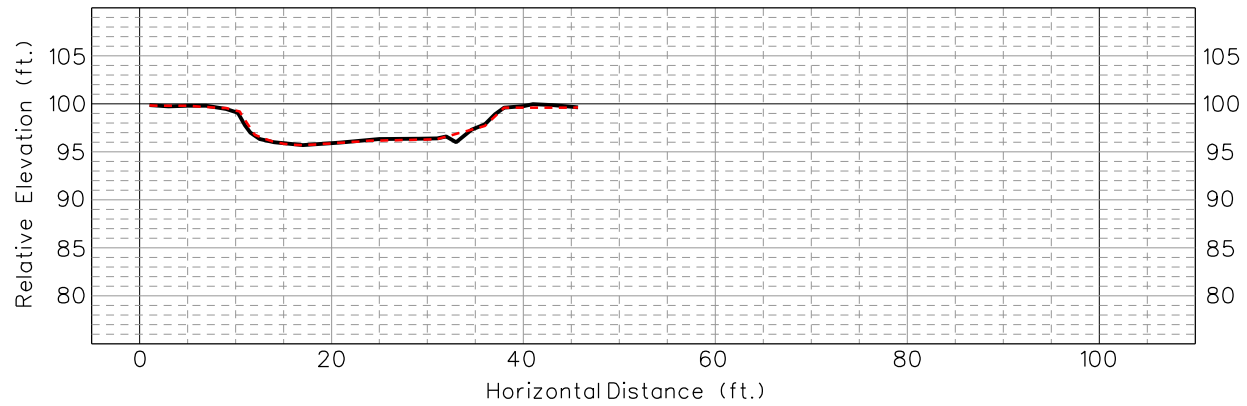
FIGURE

5B

CROSS-SECTION 17



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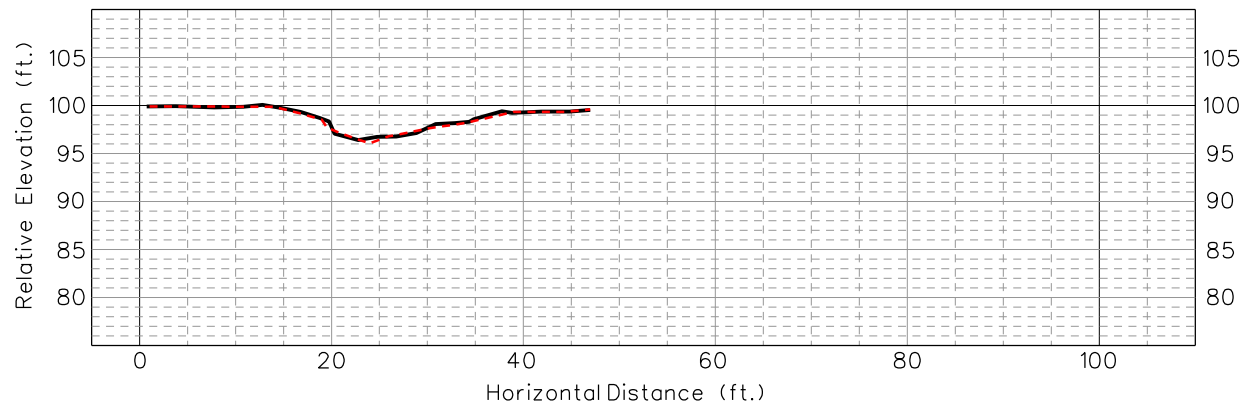

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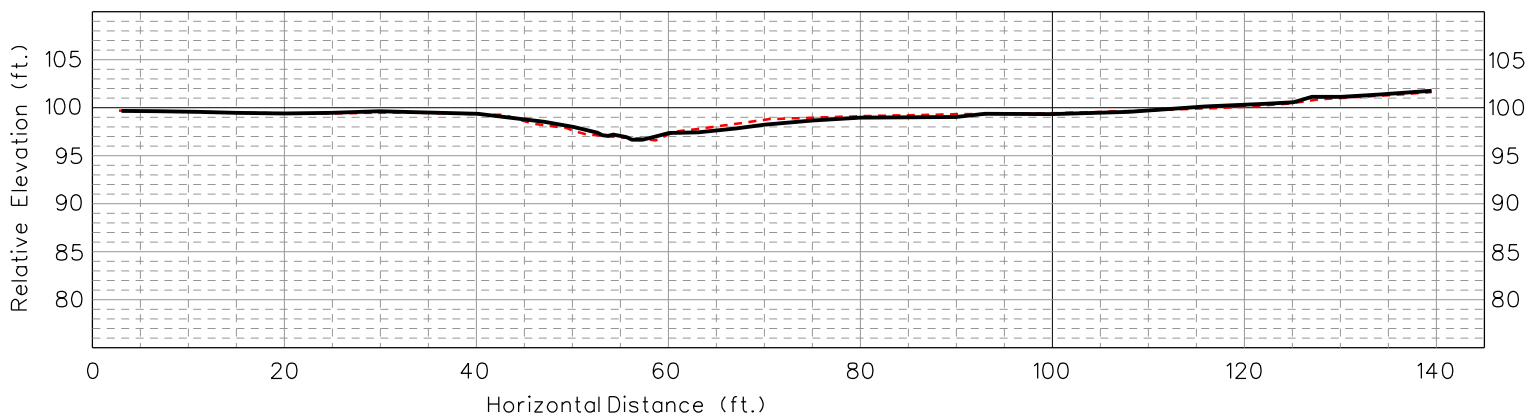

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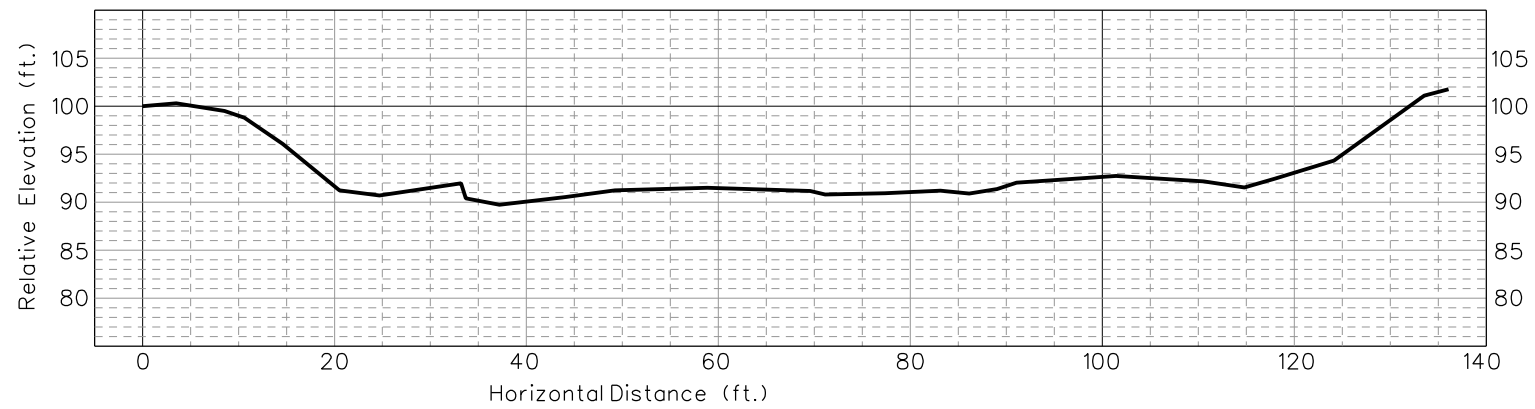

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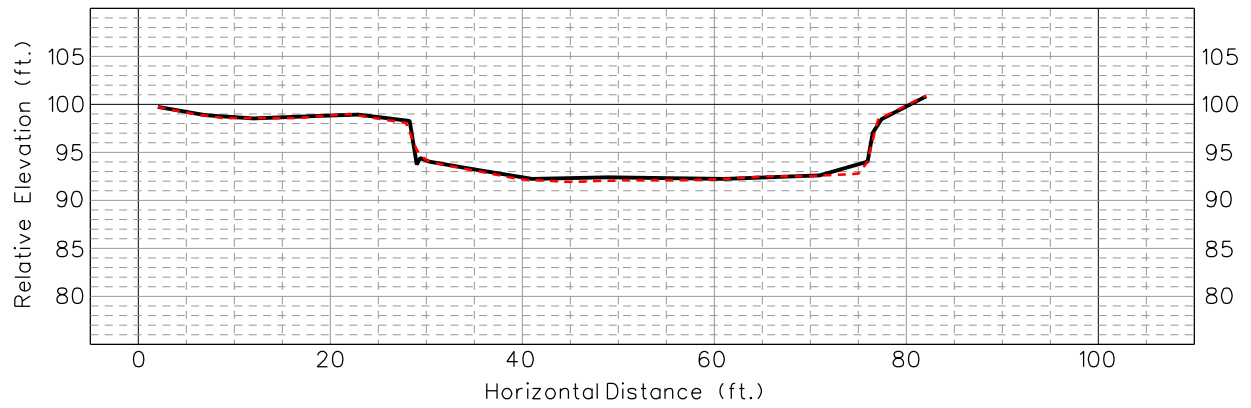

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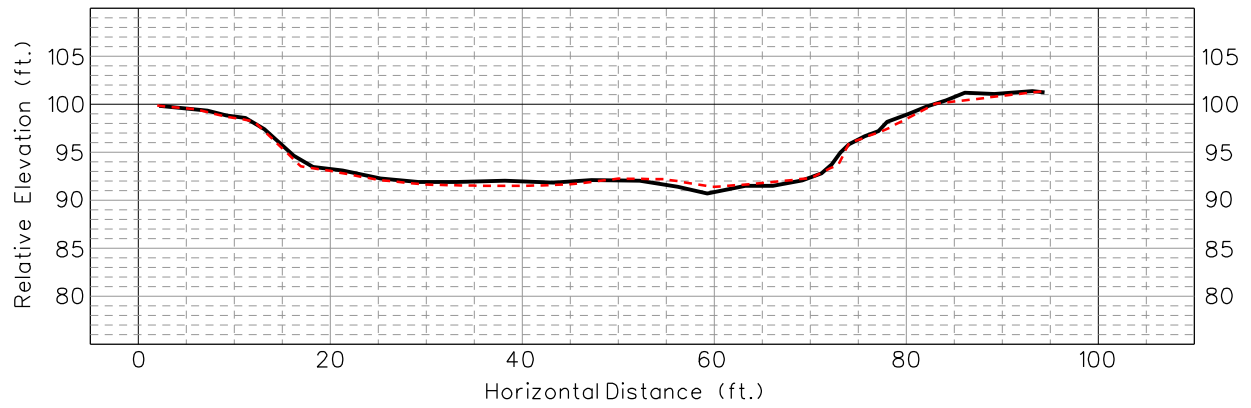

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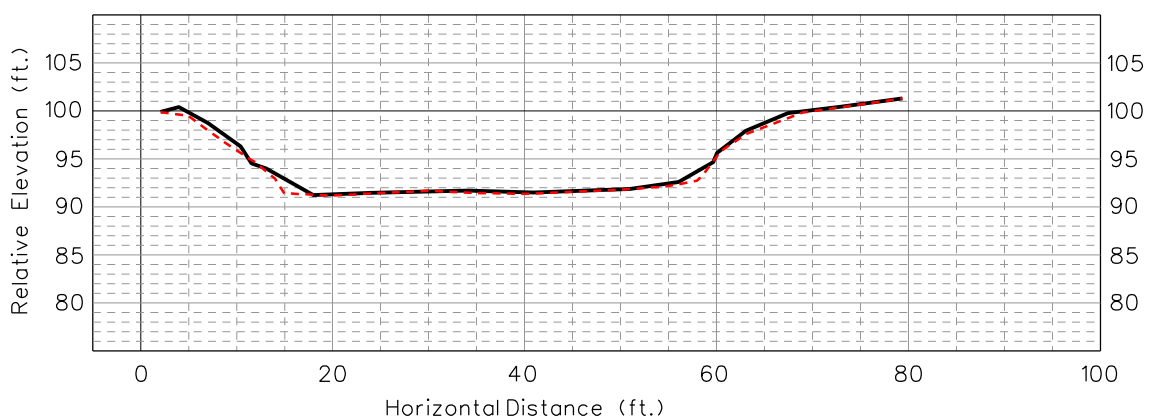

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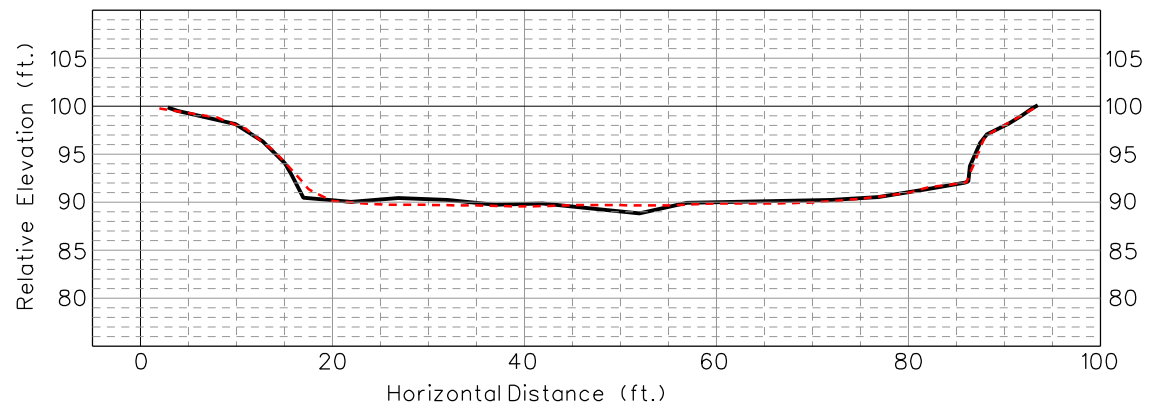

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FIGURE

5C

APPENDIX B: Benthic Macroinvertebrate Data

BENTHIC MACROINVERTEBRATE COLLECTED FROM LOWELL MILL, JOHNSON COUNTY, NC, MAY 31, 06.

SPECIES	T.V.	F.F.G.	REF 1	REF 2	REF 3	REF 4	XS 1	XS 3	XS 6
PLATYHELMINTHES									
Turbellaria									
Tricladida									
Dugesiidae									
MOLLUSCA									
Bivalvia									
Veneroida									
Corbiculidae									
Corbicula fluminea	6.1	FC	2		1	1	3		1
Sphaeriidae	*8	FC							
Sphaerium sp.	7.6	FC							
Gastropoda									
Mesogastropoda									
Hydrobiidae	*8	SC				2	1		
Basommatophora									
Ancylidae		SC							
Physidae									
Physella sp.	8.8	CG							
ANNELIDA									
Oligochaeta	*10	CG							
Tubificida									
Lumbricidae		CG						3	3
Tubificidae w.h.c.	7.1	CG	1						
Tubificidae w.o.h.c.	7.1	CG		1			1		
Branchiura sowerbyi	8.3	CG	1						
Lumbriculida									
Lumbriculidae	7	CG				2	1		1
Branchiobdellida									
Hirudinea		P							
Erpobdellidae		P							
Rhynchobdellida									
Glossiphoniidae		P							
Batrachobdella phalera	7.6	P	1						
Helobdella triserialis	9.2	P							
Placobdella sp.	9	P							
ARTHROPODA									
Arachnoidea									
Acariformes	5.5								
Hygrobatidae	5.5								
Atractides sp.	5.5	-	5	2	6	1	1	2	4
Lebertiidae	5.5								
Lebertia sp.	5.5						2		
Crustacea									
Ostracoda							1		
Cladocera									
Chydoridae									
Isopoda									
Asellidae		SH							
Caecidotea sp.	9.1	CG							2
Lirceus sp.	7.9	CG							

BENTHIC MACROINVERTEBRATE COLLECTED FROM LOWELL MILL, JOHNSON COUNTY, NC, MAY 31, 06.

SPECIES	T.V.	F.F.G.	REF 1	REF 2	REF 3	REF 4	XS 1	XS 3	XS 6
Amphipoda		CG							
Crangonyctidae									
Crangonyx sp.	7.9	CG					1		1
Hyalellidae									
Hyalella azteca	7.8	CG					1		
Decapoda									
Cambaridae	7.5								
Cambarus sp.	7.6	CG							1
Palaemonidae									
Palaemonetes sp.	7.1	CG	1				2		1
Insecta									
Ephemeroptera									
Baetidae		CG		1	2		1		
Baetis intercalaris	7	CG		22	33		4	3	13
Baetis sp.		CG		1	1				
Centroptilum sp.	6.6	CG				1			
Plauditus sp.		CG							
Procloeon sp.	5								
Pseudocloeon sp.	4	CG		1			3	3	1
Caenidae		CG							
Brachycercus nitidus		CG							
Caenis sp.	7.4	CG	20	1	1	8	38	4	4
Heptageniidae		SC			1				
Heptagenia marginalis	2.3	SC			3				
Heptagenia sp.	2.6	SC							
Maccaffertium (Stenonema) sp.		SC		52	32	12	37		
Maccaffertium (Stenonema) exiguum	3.8	SC			1			2	2
Maccaffertium (Stenonema) integrum	5.8	SC							
Maccaffertium (Stenonema) modestum	5.5	SC	31					33	6
Maccaffertium (Stenonema) pudicum	2	SC							13
Stenacron interpunctatum	6.9	SC			3	1			2
Isonychiidae		FC							
Isonychia sp.	3.5	FC					1		
Potamanthidae		CG							
Anthopotamus (Potamanthus) myops	1.5	CG	1						
Tricorythidae		CG							
Tricorythodes sp.	5.1	CG	21	8	24	31	17	5	7
Odonata									
Aeshnidae		P							
Boyeria vinosa	5.9	P		3				2	
Nasiaeschna pentacantha	8.1								
Coenagrionidae		P							
Argia sp.	8.2	P	3	4	1	8	1	2	1
Enallagma sp.	8.9	P							
Corduliidae		P							
Epicordulia princeps	5.6	P							
Macromia alleghaniensis	6.2	P	2		1				
Macromia sp.	6.2	P		1		5	1		
Neurocordulia obsoleta	5.2		5			4	1		
Progomphus obscurus	8.2	P			1		1		
Gomphidae		P							

SPECIES	T.V.	F.F.G.	REF 1	REF 2	REF 3	REF 4	XS 1	XS 3	XS 6
Dromogomphus spinosus	5.1	P	4						
Gomphus sp.	5.8	P				3			1
Hagenius brevistylus	4	P				1	1		1
Progomphus obscurus	8.2	P							
Libellulidae		P							
Plecoptera									
Perlidae		P							
Perlesta placida sp. gp.	4.7	P	3	7	1		5	1	1
Hemiptera									
Belostomatidae									
Corixidae	9	PI							
Gerridae		P							
Trepobates sp.		P			1				
Megaloptera									
Corydalidae		P							
Chauliodes sp.		P		3					
Chauliodes rastricornis	8.4	P							
Sialidae		P							
Sialis sp.	7.2	P	4				1	2	
Trichoptera									
Hydropsychidae		FC							
Cheumatopsyche sp.	6.2	FC		16	23	2	5		5
Hydropsyche incommoda	4.8				1				
Hydropsyche simulans									
Hydropsyche venularis	5	FC		1	5			1	
Hydropsyche sp.		FC							1
Hydroptilidae		PI							
Hydroptila sp.	6.2	PI			1		4		1
Oxyethira sp.	2.2	PI						1	
Leptoceridae		CG			1				
Nectopsyche exquisita	4.1	SH	1						
Nectopsyche sp.	2.9	SH			2		1		
Oecetis sp.	4.7	P				1			
Triaenodes sp.	4.5	SH				1			
Philopotamidae		FC							
Chimarra sp.	2.8	FC		1	1				
Chimarra obscurus	2.8	FC							
Chimarra socia	2.8								
Wormaldia moesta	0.7	FC							
Polycentropodidae		FC							
Cyrnellus fraternus	7.3	FC			1				
Neureclipsis sp.	4.2	FC							
Coleoptera									
Dytiscidae		P							
Celina sp.	8	P							
Coptotomus sp.	9.3								
Hydroporus sp.	8.6	PI		1		1			
Elmidae		CG		4					
Ancyronyx variegata	6.5	SC	3	5	1	9	2	5	1
Dubiraphia sp.	5.9	SC	4	2		2	1	1	
Dubiraphia bivittata	6.5							1	

SPECIES	T.V.	F.F.G.	REF 1	REF 2	REF 3	REF 4	XS 1	XS 3	XS 6
Dubiraphia quadrinotata			2			1	1		
Dubiraphia vittata	4.1	SC			2				
Macronychus glabratus	4.6	SH	2	41	20	18	23	23	23
Stenelmis sp.	5.1	SC		5			1	4	
Gyrinidae		P							
Dineutus sp.	5.5	P		4	3		5	2	9
Haliplidae									
Peltodytes sp.	8.7	SH							
Hydrophilidae		P		3			4		
Berosus sp.	8.4	CG							1
Enochrus sp.	8.8	CG		1					
Sperchopsis tesselatus	6.1	CG		1			1		
Tropisternus sp.	9.7	P							
Staphylinidae		P					2		
Diptera									
Ceratopogonidae		P		2					
Atrichopogon sp.	6.5	P		1					
Bezzia/Palpomyia gp.	6.9	P							
Chironomidae									
Ablabesmyia mallochi	7.2	P	6	4	2	39	21	10	7
Chironomus sp.	9.6	CG							
Cladotanytarsus sp.	4.1	FC	1			1		1	
Clinotanypus sp.		P							
Corynoneura sp.	6	CG					3	1	1
Cricotopus bicinctus	8.5	CG	3	18	7	25	12	4	33
Cricotopus trifascia	2.8	CG		2			1		
Cricotopus sp.		CG							
Cryptochironomus sp.	6.4	P					1		
Dicrotendipes neomodestus	8.1	CG	20	7	72	49	23	12	27
Dicrotendipes simpsoni	10								
Glyptotendipes sp.	9.5	FC							
Labrundinia sp.	5.9	P							
Nanocladius distinctus	7.1	CG	1				2		
Nilotanypus sp.	3.9	P							
Orthocladius lignicola	5.4	CG							
Paracladopelma sp.	5.5	CG	1			1	1		
Parametriocnemus sp.	3.7	CG	1						
Polypedilum flavum (convictum)	4.9	SH	3	13	2				1
Polypedilum fallax	6.4	SH	10	11			1	1	
Polypedilum halterale gp.	7.3	SH	10		1	1			
Polypedilum illinoense	9	SH	4	158	4	9	11	5	7
Potthastia longimana	6.5	CG	1		1		2		
Procladius sp.	9.1	P	6	4		13	7	2	
Pseudochironomus sp.	5.4	CG				5		1	
Rheocricotopus robacki	7.3	CG	2	7	2		2		6
Rheotanytarsus sp.	5.9	FC	1	4	1				
Stenochironomus sp.	6.5	SH		4	5	1	2	5	1
Synorthocladius semivirens		CG				1			
Tanytarsus sp.	6.8	FC	66	26	24	10	60	2	10
Thienemanniella xena	5.9	CG	1				8		1
Tribelos jucundum	6.3		6	18		3		9	

BENTHIC MACROINVERTEBRATE COLLECTED FROM LOWELL MILL, JOHNSON COUNTY, NC, MAY 31, 06.

SPECIES	T.V.	F.F.G.	REF 1	REF 2	REF 3	REF 4	XS 1	XS 3	XS 6
Tvetenia vitracies	3.6	CG			2				
Zavrelimyia sp.	9.1	P							
Xylotopus par	6	SH						1	
Culicidae		FC							
Anopheles sp.	8.6	FC					2		
Simuliidae		FC							
Simulium sp.	6	FC							
Tabanidae		PI							
Chrysops sp.	6.7	PI							
Tipulidae		SH	1						
Tipula sp.	7.3	SH		1					
TOTAL NO. OF ORGANIMS			**261**	**472**	**297**	**273**	**335**	**154**	**201**
TOTAL NO. OF TAXA			**40**	**43**	**41**	**35**	**53**	**33**	**37**
EPT INDEX			**6**	**11**	**19**	**8**	**11**	**9**	**12**
BIOTIC INDEX			**6.56**	**7.31**	**6.63**	**7.03**	**6.75**	**6.11**	**6.57**
Assigned BIOTIC INDEX VALUE			**6.55**	**6.55**	**6.17**	**6.83**	**6.70**	**6.30**	**6.29**
EPT ABUNDANCE			**77**	**111**	**137**	**57**	**116**	**53**	**56**

****some sample vials were damaged during shipping. The organisms in these vials were identified, but not included in analyses**

T.V. = tolerance value
F.F.G. = functional feeding group:
FC = filtering/collector
SC = scraper
CG = collector/gatherer
P = predator
SH = shredder
PI = piercer

BENTHIC MACROINVERTEBRATE COLLECTED FROM LOWELL MILL, JOHNSON COUNTY, NC, MAY 31, 06.

SPECIES	XS 10	XS 13	XS 15	XS 17	XS 3, XS10, & Ref 2**
PLATYHELMINTHES					
Turbellaria					
Tricladida					
Dugesiidae			2		
MOLLUSCA					
Bivalvia					
Veneroida					
Corbiculidae					
Corbicula fluminea	8	1	1		
Sphaeriidae					
Sphaerium sp.	1				
Gastropoda					
Mesogastropoda					
Hydrobiidae					
Basommatophora					
Ancylidae			1		
Physidae					
Physella sp.				2	
ANNELIDA					
Oligochaeta					
Tubificida					
Lumbricidae					
Tubificidae w.h.c.					
Tubificidae w.o.h.c.					
Branchiura sowerbyi					
Lumbriculida					
Lumbriculidae	2			5	
Branchiobdellida				2	
Hirudinea					
Erpobdellidae			1		
Rhynchobdellida					
Glossiphoniidae			1		
Batrachobdella phalera					
Helobdella triserialis			1		
Placobdella sp.	2				
ARTHROPODA					
Arachnoidea					
Acariformes					
Hygrobatidae					
Atractides sp.	1				
Lebertiidae					
Lebertia sp.			3		
Crustacea					
Ostracoda			2		
Cladocera					
Chydoridae			2		
Isopoda					
Asellidae					
Caecidotea sp.					
Lirceus sp.				80	

BENTHIC MACROINVERTEBRATE COLLECTED FROM LOWELL MILL, JOHNSON COUNTY, NC, MAY 31, 06.

SPECIES	XS 10	XS 13	XS 15	XS 17	XS 3, XS10, & Ref 2**
Amphipoda					
Crangonyctidae					
Crangonyx sp.				37	
Hyalellidae					
Hyalella azteca					
Decapoda					
Cambaridae					
Cambarus sp.				3	
Palaemonidae					
Palaemonetes sp.					
Insecta					
Ephemeroptera					
Baetidae		7	1		
Baetis intercalaris	1	13	59		1
Baetis sp.					
Centroptilum sp.			4		
Plauditus sp.			1		
Procloeon sp.			5		
Pseudocloeon sp.			6		
Caenidae					
Brachycercus nitidus			1		
Caenis sp.	1	1	6		1
Heptageniidae		3	2		
Heptagenia marginalis					
Heptagenia sp.		2			
Maccaffertium (Stenonema) sp.	8		28		
Maccaffertium (Stenonema) exiguum					2
Maccaffertium (Stenonema) integrum		1			
Maccaffertium (Stenonema) modestum	20	21			19
Maccaffertium (Stenonema) pudicum					
Stenacron interpunctatum					
Isonychiidae					
Isonychia sp.		3			
Potamanthidae					
Anthopotamus (Potamanthus) myops					
Tricorythidae					
Tricorythodes sp.	6	9	21		5
Odonata					
Aeshnidae				1	
Boyeria vinosa					2
Nasiaeschna pentacantha				2	
Coenagrionidae	1				
Argia sp.	9	1	4	1	
Enallagma sp.				5	
Corduliidae					
Epicordulia princeps	1				
Macromia alleghaniensis	1				
Macromia sp.		1	2		1
Neurocordulia obsoleta	2				
Progomphus obscurus		1			
Gomphidae					

BENTHIC MACROINVERTEBRATE COLLECTED FROM LOWELL MILL, JOHNSON COUNTY, NC, MAY 31, 06.

SPECIES	XS 10	XS 13	XS 15	XS 17	XS 3, XS10, & Ref 2**
Dromogomphus spinosus					
Gomphus sp.					
Hagenius brevistylus			2		
Progomphus obscurus			1		
Libellulidae				5	
Plecoptera					
Perlidae			2		
Perlesta placida sp. gp.					5
Hemiptera					
Belostomatidae				3	
Corixidae			2	1	
Gerridae					
Trepobates sp.					
Megaloptera					
Corydalidae					
Chauliodes sp.					
Chauliodes rastricornis				1	1
Sialidae					
Sialis sp.	2			4	
Trichoptera					
Hydropsychidae		1	7		
Cheumatopsyche sp.		23	11		3
Hydropsyche incommoda					
Hydropsyche simulans			2		
Hydropsyche venularis					
Hydropsyche sp.		2	1		1
Hydroptilidae			3		
Hydroptila sp.			12		
Oxyethira sp.					
Leptoceridae					
Nectopsyche exquisita	1				
Nectopsyche sp.			5		
Oecetis sp.					
Triaenodes sp.					
Philopotamidae					
Chimarra sp.			1		
Chimarra obscurus		1			
Chimarra socia		1			
Wormaldia moesta	1				
Polycentropodidae					
Cyrnellus fraternus			1		
Neureclipsis sp.	1				
Coleoptera					
Dytiscidae	2				
Celina sp.	1				
Coptotomus sp.				1	
Hydroporus sp.	2	1		16	
Elmidae			2		
Ancyronyx variegata	10	1	10	2	2
Dubiraphia sp.	2	1	3		
Dubiraphia bivittata					

BENTHIC MACROINVERTEBRATE COLLECTED FROM LOWELL MILL, JOHNSON COUNTY, NC, MAY 31, 06.

SPECIES	XS 10	XS 13	XS 15	XS 17	XS 3, XS10, & Ref 2**
Dubiraphia quadrinotata					
Dubiraphia vittata					
Macronychus glabratus	31	48	11		10
Stenelmis sp.	1		3	1	
Gyrinidae					
Dineutus sp.	2	11	2	10	1
Haliplidae					
Peltodytes sp.				1	
Hydrophilidae					
Berosus sp.		1			
Enochrus sp.					
Sperchopsis tesselatus					1
Tropisternus sp.				1	
Staphylinidae			1		
Diptera					
Ceratopogonidae			3		
Atrichopogon sp.					
Bezzia/Palpomyia gp.	1			1	
Chironomidae					
Ablabesmyia mallochi	30	13	66	36	6
Chironomus sp.			6		
Cladotanytarsus sp.					
Clinotanypus sp.	1				
Corynoneura sp.					
Cricotopus bicinctus	3	18	97	1	
Cricotopus trifascia					
Cricotopus sp.					1
Cryptochironomus sp.		4	3		
Dicrotendipes neomodestus		33	172	4	26
Dicrotendipes simpsoni				5	
Glyptotendipes sp.			3		
Labrundinia sp.				1	
Nanocladius distinctus			3		
Nilotanypus sp.		1			
Orthocladius lignicola				1	
Paracladopelma sp.					
Parametriocnemus sp.					
Polypedilum flavum (convictum)					
Polypedilum fallax					1
Polypedilum halterale gp.					
Polypedilum illinoense	8	8	11		42
Potthastia longimana			9		
Procladius sp.	5		3	1	
Pseudochironomus sp.					1
Rheocricotopus robacki		1	6		5
Rheotanytarsus sp.		1	11		
Stenochironomus sp.	5	2	6	3	4
Synorthocladius semivirens			3		
Tanytarsus sp.	1	5	43	5	
Thienemanniella xena		3	3		
Tribelos jucundum	17				2

BENTHIC MACROINVERTEBRATE COLLECTED FROM LOWELL MILL, JOHNSON COUNTY, NC, MAY 31, 06.

SPECIES	XS 10	XS 13	XS 15	XS 17	XS 3, XS10, & Ref 2**
Tvetenia vitracies		12	20		
Zavrelimyia sp.	1				
Xylotopus par				1	1
Culicidae				3	
Anopheles sp.	1				
Simuliidae					
Simulium sp.		3			
Tabanidae					
Chrysops sp.				1	
Tipulidae					
Tipula sp.					
TOTAL NO. OF ORGANIMS	**193**	**259**	**704**	**247**	
TOTAL NO. OF TAXA	**38**	**37**	**60**	**35**	
EPT INDEX	**8**	**14**	**21**	**0**	
BIOTIC INDEX	**6.40**	**6.19**	**7.23**	**7.71**	
Assigned BIOTIC INDEX VALUE	**6.45**	**6.20**	**6.53**	**7.56**	
EPT ABUNDANCE	**39**	**88**	**179**	**0**	

****some sample vials were damaged during shipping. The organisms in these vials were identified, but not included in analyses**

T.V. = tolerance value
F.F.G. = functional feeding group:
FC = filtering/collector
SC = scraper
CG = collector/gatherer
P = predator
SH = shredder
PI = piercer

APPENDIX C: Lowell Dam Removal Year-1 Monitoring Report (The Catena Group)

The Catena Group

410-B Millstone Drive
Hillsborough, NC 27278
(919) 732-1300

LOWELL DAM REMOVAL YEAR-1 MONITORING REPORT

Little River Watershed Restoration Site Neuse River Basin Catologing Unit 03020201

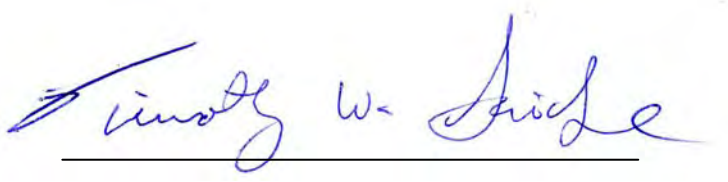
Prepared For:

Restoration Systems LLC
1101 Haynes Street, Suite 107
Raleigh, NC 27604

Prepared By:

The Catena Group
Hillsborough, North Carolina

September 10, 2006



Timothy W. Savidge

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1.0 INTRODUCTION

The removal of Lowell Dam on the Little River within the Neuse River Basin by Restoration Systems LLC (RS) is projected to result in the restoration of more than 34,990 linear feet of river and tributaries under the former reservoir pool. The project is expected to restore significant riverine habitat for mussels, fish (including anadromous fish), and other lotic aquatic species documented within the Little River, as well as providing a mitigation bank for future activities within the Neuse River Basin.

Based on the restoration success criteria established by U.S. Fish and Wildlife Service (USFWS) and the goals of RS, documenting the effectiveness of the restoration initiative requires that the aquatic fauna that occurred within the reservoir pool be identified and then monitored for changes in composition after the dam is removed. The Catena Group Inc. (TCG) was retained by RS in 2005 to conduct pre-removal aquatic species surveys at selected locations within the former reservoir pool, as well as at a number of upstream and downstream locations. The aquatic fauna sampled include freshwater mussels and clams, aquatic snails, aquatic salamanders, and freshwater fish. The results of the pre-removal surveys were presented in a report submitted to RS on April 04, 2006 (Lowell Pre-removal Survey Report).

A five-year monitoring plan of aquatic species communities (freshwater mussels, aquatic snails, aquatic salamanders and freshwater fist) and anadromous fish has been initiated to evaluate the success of the dam removal. TCG was retained by RS in 2006 to conduct post-removal monitoring surveys for both the aquatic species communities and anadromous species.

The aquatic community survey plan involves conducting aquatic species surveys at the same six stations within the former reservoir pool that were sampled during the pre-removal surveys (Table 1). Fish surveys were not conducted at sites 6 (CX-12) and 7 (CX 16) during the pre-removal surveys due to water depth.

Table 1. Post Dam Removal Permanent Monitoring Survey Locations

Site #	Corresponding TCG Pre-removal Site #	GPS Location
1	4- Impoundment 1 (CX-1)	35.58878ºN, -78.18713ºW
2	5-Impoundment 2 (CX-3)	35.59071ºN, -78.17819ºW
3	6-Impoundment 3 (CX-4)	35.58519ºN, -78.17772ºW
4	7-Impoundment 4 (CX-7)	35.57771ºN, -78.17752ºW
5	8-Impoundment 5 (CX-10)	35.58051ºN, -78.16672ºW
6	9-Impoundment 6 (CX-12)	35.58329ºN, -78.15951ºW
7	10-Impoundment 7 (CX-16)	35.56751ºN, -78.16239ºW

CX denotes corresponding Cross Sections being evaluated by RS

Changes in freshwater mussel fauna resulting from dam removal will likely not be evident for at least four years post removal because of their life histories. Thus, these

sites will be not be monitored for mussels until four years post removal when recruitment of freshwater mussels into the restored habitats will be visible. Aquatic snails and freshwater clams will also not be sampled until this time, as similar survey methodologies are used. The results of the Year-4 monitoring will determine if future monitoring is warranted. It was determined that fish community and anadromous species surveys would be conducted during the first year following removal. Additionally, a quantitative study of freshwater mussels was conducted below the former dam to monitor potential adverse sedimentation effects resulting from dam removal.

The anadromous species survey plan involves conducting multiple surveys at multiple locations during peak spawning runs of a number of anadromous species (February-May) to document the effects of barrier removal and the utilization of newly accessible habitats.

The results of the Year-1 fish community monitoring (Year-1 monitoring), the post-removal anadromous species surveys (anadromous surveys) and the quantitative mussel survey (quantitative surveys) are presented in this report. The results of these studies will factor into the decision for future monitoring.

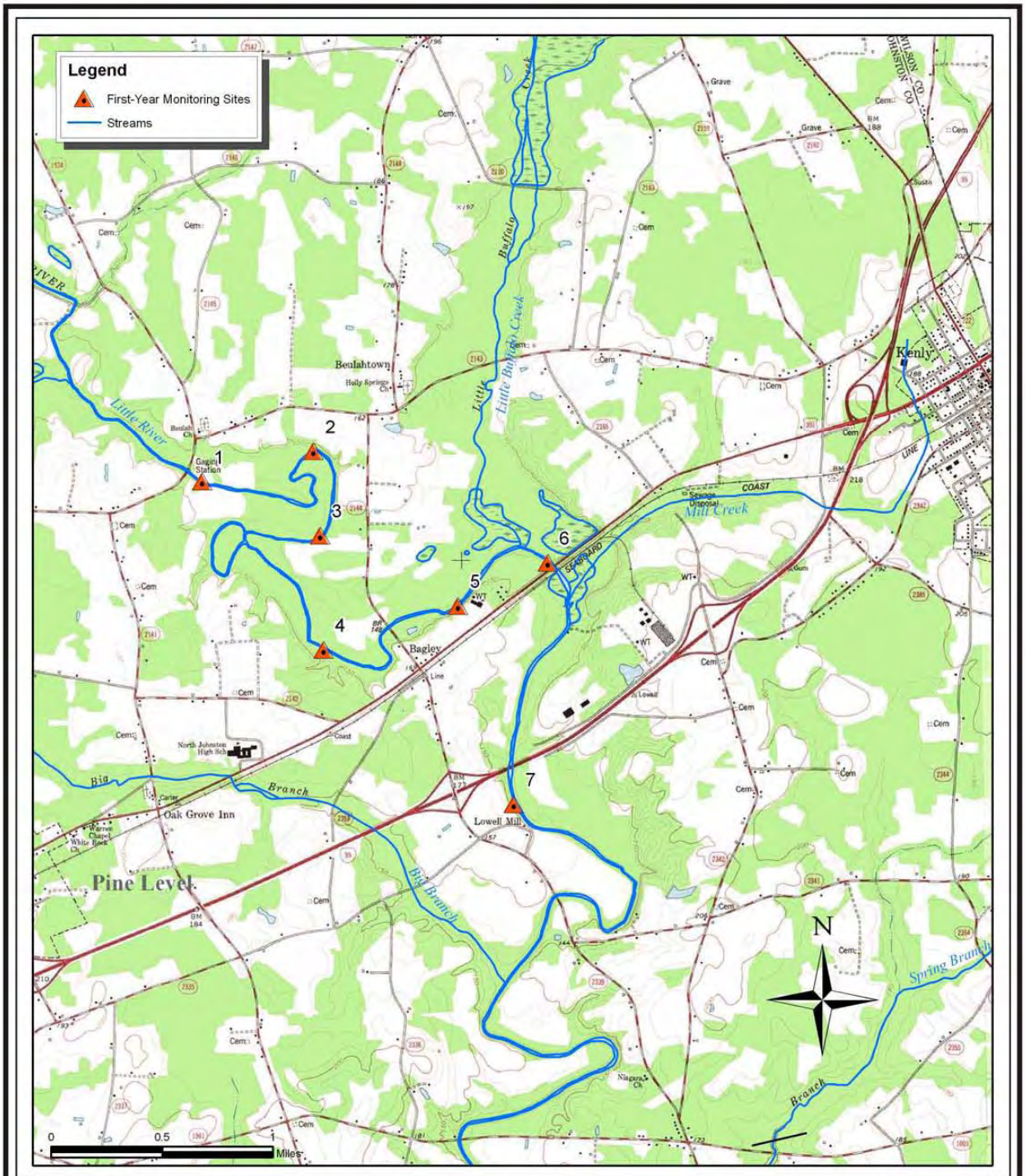
2.0 FISH COMMUNITY SURVEY EFFORTS

Fish surveys were conducted in August 2006, for the Year-1 monitoring at all of the sites listed in Table 1 and depicted in Figure 1, with the exception of TCG Site 9 (Impoundment 6), which was omitted due to the water level being too deep to follow the sampling protocol:

Tom Dickinson – August- 8, 9, 17
Shay Garriock – August- 8, 17
Kate Montieth – August- 8, 9, 17
Fred C. Rhode Ph.D* – August-8, 9
Tyler Rhode* – August-8, 9
Tim Savidge – August 17
Chris Sheats - August 8, 17
*** Contracted by TCG to assist field crew**

2.1 Fish Community Survey Methodology

A fish sampling protocol patterned after the North Carolina Division of Water Quality (NCDWQ) Standard Operating Procedure Biological Monitoring Stream Fish Community Assessment (NCDENR 2001) was developed specifically for this project, to document changes in fish communities in the Little River over time following dam removal. The NCDWQ has developed a method of assessing water quality based on an evaluation of the fish community. This evaluation results in a numerical score called the North Carolina Index of Biotic Integrity (NCIBI) being assigned to the water body. The NCIBI evaluates 12 metrics (parameters) pertaining to species richness and composition,



The Catena Group	**Site Map** Lowell Dam Removal First-Year Fish Monitoring Johnston County, North Carolina	Date: August 2006 Scale: As Shown Job No.: 3177	Figure 1

trophic composition, and fish abundance and condition. Each metric value is converted into a score of 1, 3 or 5, with 5 representing conditions expected for a relatively undisturbed reference stream in the specific river basin, or ecoregion (NCDENR 2001). NCIBI reference indices for the Outer Piedmont of the Neuse River Basin have been developed. The sampling protocol states that the NCIBI is applicable only in streams within ecoregions that have established reference indices, and only if collection methodology and data analysis is strictly followed.

The purpose of applying the NCIBI methodology to the post-removal monitoring is not necessarily to compare scores generated at each of the monitoring sites with other streams in the reference ecoregion, but rather to compare scores generated at the monitoring sites overtime to monitor changes at each site in response to the dam removal. Thus, the scores generated during the Year-1 monitoring surveys will be compared to scores generated using the same methodologies under similar conditions (time of year, water levels, etc) in future years.

A standard 600 linear feet of stream at each of the survey sites listed in Table 1 (except Site 6:CX 12) and depicted in Figure 1 was sampled for fish community parameters using a 4-person survey team, with two backpack electroshocker units, and dipnets. Survey methodology, data analysis, and interpretation (scoring) essentially follow procedures outlined in Standard Operating Procedures Biological Monitoring Stream Fish Community Assessment (NCDENR 2001).

3.0 FISH COMMUNITY SURVEY RESULTS

It was apparent from field observations and fish surveys that the habitats within the former reservoir pool created by the Lowell Dam are in the process of reverting to lotic conditions, as a total of 36 fish species were captured within the former reservoir pool (Tables 2-7).

3.1 Species Composition and Site Descriptions

Brief descriptions of current habitat conditions and the results of the fish surveys for each site are provided below.

3.2 Site 1 (CX-1)

The habitat is characterized by runs and pools with a sand, and occasionally pea gravel, substrate. A large vegetative sand bar is present along the left descending bank. Woody debris is common through the reach. Accumulations of silt and detritus occur in the pools and slack-water areas along the river banks.

Table 2. Site 1 (CX 1): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Ameiurus platycephalus	flat bullhead	4	3
Amia calva	Bowfin	2	2
Anguilla rostrata	American eel	1	1
Aphredoderus sayanus	pirate perch	3	2
Centrarchus macropterus	flier	1	1
Cyprinella analostanus	satinfin shiner	4	3
Etheostoma nigrum	johnny darter	4	3
Etheostoma olmstedi	tessellated darter	49	5
Etheostoma vitreum	glassy darter	13	4
Gambusia holbrookii	eastern mosquitofish	3	3
Lepomis auritus	redbreast sunfish	32	7
Lepomis cyanellus	green sunfish	1	1
Lepomis macrochirus	bluegill	13	6
Lepomis microlophus	redear sunfish	4	4
Luxilus albeolus	white shiner	1	1
Micropterus salmoides	largemouth bass	3	2
Moxostoma colapsum	notchlip redhorse	4	3
Notropis amoenus	comely shiner	2	2
Notropis procne	swallowtail shiner	54	5
Noturus gyrinus	margined madtom	2	2
Percina nevisense	chainback darter	10	3
Percina roanoka	Roanoke darter	9	4
Pomoxis nigromaculatus	black crappie	1	1

3.3 Site 2 (CX-3)

This site occurs in a fairly sharp bend in the river. Habitat consists of a long shallow riffle run area with a consolidated sand and gravel substrate with scattered cobble. Prior to dam removal, this site was considered to provide the "best" aquatic species habitat within the reservoir pool. High quality habitat conditions remain at this site following removal, and it was the most species rich (27 species) site sampled during the Year-1 monitoring surveys.

Table 3. Site 2 (CX- 3): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Ameiurus platycephalus	flat bullhead	2	2
Anguilla rostrata	American eel	14	4
Aphredoderus sayanus	pirate perch	1	1
Cyprinella analostanus	satinfin shiner	1	1
Erimyzon oblongus	creek chubsucker	1	1

Esox americanus	redfin pickerel	1	1
Etheostoma olmstedi	tessellated darter	48	3
Etheostoma vitreum	glassy darter	5	3
Gambusia holbrookii	eastern mosquitofish	5	3
Ictalurus punctatus	channel catfish	1	1
Lepisosteus osseusi	longnose gar	2	1
Lepomis auritus	redbreast sunfish	50	7
Lepomis macrochirus	bluegill	7	4
Lepomis microlophus	redear sunfish	3	3
Luxilus albeolus	white shiner	11	4
Lythrurus matutinus	pinewoods shiner	2	1
Micropterus salmoides	largemouth bass	3	2
Moxostoma pappillosum	V-lip redhorse	1	1
Nocomis leptocephalus	bluehead chub	3	3
Nocomis raneyi	bull chub	3	3
Notropis amoenus	comely shiner	1	1
Notropis cummingsae	dusky shiner	3	2
Notropis procne	swallowtail shiner	32	3
Noturus gyrinus	margined madtom	11	4
Percina nevisense	Chainback darter	5	3
Percina roanoka	Roanoke darter	42	4
Scartomyzon cervinus	black jumprock	2	2

3.4 Site 3 (CX-4)

Site 3 is located below a wide bend of the river with clay banks and bedrock outcrops. The habitat is characterized as a series of riffles and runs separated by shallow pools. The substrate is dominated by rocky cobble and sand, with large accumulations of woody debris and a fair amount of fine sediments (silt and mud) in the pools. Stream banks are actively eroding, which was also noted during the pre-removal surveys in 2005 (Lowell Pre-removal survey report).

Table 4. Site 3 (CX-4): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Ameiurus platycephalus	flat bullhead	12	3
Anguilla rostrata	American eel	15	4
Aphredoderus sayanus	pirate perch	4	2
Etheostoma olmstedi	tessellated darter	49	4
Gambusia holbrookii	eastern mosquitofish	17	3
Lepomis auritus	redbreast sunfish	57	6
Lepomis macrochirus	bluegill	11	4
Lepomis microlophus	redear sunfish	3	3
Micropterus salmoides	largemouth bass	3	3

Notropis procne	swallowtail shiner	3	2
Noturus gyrinus	margined madtom	5	3
Percina nevisense	chainback darter	7	3
Percina roanoka	Roanoke darter	18	3

3.5 Site 4 (CX-7)

This site occurs in a long straight run of the river. Small riffles formed by woody debris occur throughout. The substrate is sand with silt deposits in slack-water areas below bars and along the river banks. Shallow sand bars and woody debris are common.

Table 5. Site 4 (CX 7): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Ameiurus platycephalus	flat bullhead	2	2
Anguilla rostrata	American eel	5	3
Aphredoderus sayanus	pirate perch	1	1
Cyprinella analostanus	satinfin shiner	8	3
Etheostoma olmstedi	tessellated darter	27	4
Etheostoma vitreum	glassy darter	7	3
Lepomis auritus	redbreast sunfish	33	6
Lepomis macrochirus	Bluegill	3	3
Lepomis microlophus	redear sunfish	2	2
Luxilus albeolus	white shiner	10	4
Lythrurus matutinus	pinewoods shiner	1	1
Micropterus salmoides	largemouth bass	3	3
Moxostoma colapsum	notchlip redhorse	1	1
Nocomis leptocephalus	bluehead chub	1	1
Notropis procne	swallowtail shiner	33	4
Noturus gyrinus	margined madtom	1	1
Percina nevisense	chainback darter	4	1
Percina roanoka	Roanoke darter	16	3

3.6 Site 5 (CX-10)

This site occurs in the vicinity of the WRC boat landing located off of SR 2144 (Weaver Road) and is characterized by a series of small riffles formed by woody debris. The substrate is sand with silt deposits in slack-water areas below bars and along the river banks. Shallow sand bars and accumulations of woody debris are common in this reach.

Table 6. Site 5 (CX 10): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Anguilla rostrata	American eel	5	3
Aphredoderus sayanus	pirate perch	1	1

Cyprinella analostanus	satinfin shiner	3	3
Etheostoma nigrum	johnny darter	4	2
Etheostoma olmstedi	tessellated darter	63	4
Etheostoma vitreum	glassy darter	3	2
Gambusia holbrookii	eastern mosquitofish	13	3
Ictalurus punctatus	channel catfish	1	1
Lepomis auritus	redbreast sunfish	40	5
Lepomis macrochirus	Bluegill	35	6
Lepomis microlophus	redear sunfish	2	2
Lythrurus matutinus	pinewoods shiner	4	1
Micropterus salmoides	largemouth bass	4	3
Notropis amoenus	comely shiner	4	3
Notropis hudsonius	spottail shiner	1	1
Notropis procne	swallowtail shiner	16	3
Noturus gyrinus	margined madtom	5	5
Percina nevisense	chainback darter	9	3
Percina roanoka	Roanoke darter	21	3

3.7 Site 6 (CX-12)

Site 6 is in the vicinity of the US 301 crossing of the river. During the pre-removal survey, the habitat was characterized as a deep (max. depth 10 feet) slack-water run of the river, with substrate composed of sand and occasional rock. Large amounts of woody debris and fallen trees were evident. Habitat conditions have changed little following dam removal. Although it is new shallower, the site remains a 2 to 5 foot deep slack-water pool/run, with large amounts of woody debris. This site was not sampled because there was not a 600 foot wadeable stretch that could be sampled using the NCIBI methodology.

3.8 Site 7 (CX-16)

This site is the location of the former Lowell Dam, extending upstream 600 feet through a fairly long, straight, and narrow section of the river. Multiple riffles with comparatively fast current have formed. The substrate is gravel and shifting sand with scattered rock, particularly along the banks. Moderate accumulations of woody debris are scattered throughout.

Table 7. Site 7 (CX- 16): Aquatic Species Found

Scientific Name	Common Name	#	# of size classes
Anguilla rostrata	American eel	7	5
Cyprinella analostanus	satinfin shiner	11	4
Enneacanthus gloriosus	bluespotted sunfish	1	1
Etheostoma olmstedi	tessellated darter	17	4
Etheostoma vitreum	glassy darter	3	3

Gambusia holbrookii	eastern mosquitofish	7	2
Hypentelium nigricans	northern hogsucker	1	1
Ictalurus punctatus	channel catfish	2	1
Lepomis auritus	redbreast sunfish	39	5
Lepomis macrochirus	bluegill	46	6
Lepomis microlophus	redear sunfish	12	6
Lythrurus matutinus	pinewoods shiner	4	2
Micropterus salmoides	largemouth bass	2	2
Nocomis raneyi	bull chub	1	1
Notropis amoenus	comely shiner	1	1
Notropis procne	swallowtail shiner	55	3
Noturus gyrinus	margined madtom	2	2
Percina nevisense	chainback darter	7	2
Percina roanoka	Roanoke darter	33	3
Pylodictis olivaris	flathead catish	1	1
Pomoxis nigromaculatus	black crappie	1	1

3.9 NCIBI Scores

The NCIBI scores of the Year-1 monitoring surveys range from 38 (Fair) at Site 3 to 54 (Excellent) at Site 2 (Table 8). Score sheets for each site are included in Appendix A.

Table 8. NCIBI Scores Post Dam Removal Permanent Monitoring Survey Locations

Site #	# of Species	NCIBI Score
1 (CX-1)	23	46 (Good)
2 (CX-3)	27	54 (Excellent)
3 (CX-4)	13	38 (Fair)
4 (CX-7)	18	46 (Good)
5 (CX-10)	19	44 (Good-Fair)
6 (CX-12)	Not Sampled	Not Sampled
7 (CX-16)	21	48 (Good)

CX denotes corresponding Cross Sections being evaluated by RS

4.0 FISH COMMUNITY SURVEY DISCUSSION/CONCLUSIONS

The results of the Year-1 fish community monitoring indicate that the Little River is transitioning towards lotic conditions within the former reservoir pool as a result of dam removal. Some areas within the former impoundment appear to have retained some of the pre-removal lentic habitat characteristics such as slack flow, large deposits of fine sediments and accumulations of woody debris. The lack of major flow events in the Little River watershed since the removal of the dam in late 2005 have likely contributed to the slow pace of habitat change. Fish surveys employing NCIBI methodologies were conducted at six previously defined locations in the former reservoir pool to document

establishment of lotic habitats and improving habitat conditions in this reach overtime following dam removal.

4.1 Fish Surveys

Lotic fish communities are developing within the former reservoir pool in response to dam removal. The most upstream sites, Sites 1 and 2, contained the highest species diversity, 23 and 27 species, respectively. Based on habitat observations and aquatic species survey results during the 2005 pre-removal surveys, it was concluded that these upstream sites may have already been reverting to lotic conditions as a result of the water level lowering efforts that began in November of 2004 (Lowell Pre-removal Survey Report).

As discussed earlier, the implementation of the NCIBI methodologies for the post-removal monitoring surveys will allow for quantitative comparison of the fish community overtime in response to dam removal. The purpose of the pre-removal survey was to establish a baseline inventory of aquatic species in the Little River and thus, determine targeted faunal community composition. Multiple collection/observation methods were employed (electro-fishing, seine netting, dip net sweeps of banks, visual observations, and hook and line) to maximize the number of species that were documented. NCIBI methods could not be applied during pre-removal conditions due to insufficient lengths of wadeable habitat.

Although different fish survey methodologies were used during the pre-removal surveys in 2005 (Lowell Pre-removal Survey Report) and the Year-1 fish community monitoring surveys, general comparisons between the two results can be made. With the exceptions of Site 6, which was not sampled, and Site 3, which produced only 13 species, a greater number of fish species were documented at each site during the Year-1 fish community monitoring surveys than previously during the 2005 pre-removal surveys (Table 9).

Table 9. Comparison of Pre-removal and Year-1 Monitoring Surveys

Site #	# Species Pre-removal	# Species Year-1 monitoring
1 (CX-1)	21	23
2 (CX-3)	26	27
3 (CX-4)	16	13
4 (CX-7)	15	18
5 (CX-10)	11	19
6 (CX-12)	5*	Not Sampled
7 (CX-16)	3*	21

*visual observations only

Although differences in sampling methodologies may account for some of the differences in species richness, it can be concluded that habitat restoration in response to dam

removal is a major reason for these changes. Because the combined methodologies used during the pre-removal surveys were likely to detect more species than the NCIBI survey methodology, which only utilizes back-pack electro-fishing, the increases in species richness are more likely attributable to other factors, such as improved habitat conditions. The reasons for the relatively low species diversity and corresponding low NCIBI score from Site 3 are not clear, though moderate amounts of stream-bank erosion and scour were noted at this site as well as a fair amount of accumulated fine sediments and woody debris.

4.2 Future Fish Survey Monitoring

Habitat within the former impoundment is expected to continue to transition from lentic to lotic conditions in response to dam removal. As discussed earlier, this further transition pertains primarily to the middle and lower portions of the former reservoir pool, as the upper segments appear to be more advanced in this habitat transition. This transition is expected to be reflected in changes of the aquatic communities. One of the fish community components of the success criteria is to demonstrate an increase in species diversity and population vitality. Therefore, future monitoring surveys using the same NCIBI methodology employed during the Year-1 surveys will allow for this analysis to be made.

It is recommended that fish survey monitoring take place in at least three of the remaining four years of the monitoring plan. However, each site, particularly the upper sites, does not necessarily have to be sampled every year. Additionally, reference sites in the Little River outside of the former dam effects should be sampled in a similar manner near the end (year 4-5) of the monitoring program for comparison.

5.0 ANADROMOUS SPECIES SURVEY EFFORTS

Eight species of anadromous fish are known to occur in North Carolina (Table 10). The Lowell Dam was recognized as an impediment to anadromous species spawning runs, and its removal was designated by the North Carolina Dam Removal Task Force (NCDRTF) as the highest priority for dam removal in North Carolina (NCDRTF 2001).

Table 10. Anadromous Fish Species of North Carolina

Scientific Name	Common Name
Acipenser brevirostrum	shortnose sturgeon[1]
Acipenser oxyrhynchus oxyryinchus	Atlantic sturgeon
Alosa aestivalis	blueback herring
Alosa mediocris	hickory shad
Alosa pseudoharengus	Alewife
Alosa sapidissima	American shad
Morone saxatilis	striped bass
Petromyzon marinus	sea lamprey[2]

1-The shortnose sturgeon is Federally and State Endangered.
2- The sea lamprey is on the NCWRC freshwater list prioritized for conservation.

Based on habitat conditions, watershed size, biology, and distribution, the species most likely to benefit from the dam removal are American shad and hickory shad, followed by striped bass, blueback herring, and alewife. Although it is conceivable that shortnose sturgeon, Atlantic sturgeon, and sea lamprey could benefit from the dam removal, it is unlikely due to low population numbers in the Neuse River Basin and lack of typical habitat for these species in the Little River.

Surveys targeting anadromous fish species were conducted February-May, 2006, by the following personnel from TCG on the listed dates:

Alex Adams – March 2
Tom Dickinson – February 23, 24; March 9, 10, 23, 24, 31; April 4, 6, 10; May 9, 11
Shay Garriock – March 2, 31; April 10
Kate Montieth - February 24; April 6; May 9, 11
Fred C. Rhode Ph.D * - March 23, 24, 31; April 6, 10; May 9
Bryant Savidge - April 14
Daniel Savidge - April 14
Tim Savidge - February 23, 24; March 2, 9, 10; April 14; May 11
Chris Sheats – March 23, 24, 31; April 6, 10; May 9, May 11
*** Contracted by TCG to assist field crew**

5.1 Anadromous Species Surveys Methodology

A combination of survey methodologies were employed in an effort to document spawning runs of anadromous species upstream of the former Lowell Dam following its removal in January 2006.

5.1.1 Fish Capture

A number of active and passive fish collection methods were used during this effort, often in conjunction with one another.

Passive/ Semi-passive Capture (Gill netting)
Gill netting was used as a passive and semi-passive capture technique during anadromous fish sampling. During likely peak spawning periods, a gill net was set (tied across an appropriate section of river) at the beginning of a sampling day and checked at the end of the day. Semi-passive gill netting techniques consisted of two people slowly dragging a gill net through a pool or slow run areas and were sometimes used in conjunction with electro-fishing to herd fish into the gill net.

Active Capture (Electro-fishing/Seine/Hook and Line) Methods
After the gill net was set, the survey team would move to the next site and use a combination of electro-fishing and seine netting to capture anadromous fish. The survey team began at the downstream point of the survey site and proceeded upstream. Two

back-pack electroshocking units were used in most reaches. One person with a dip net accompanied each shocker and a straight haul seine net was positioned downstream of the shockers where appropriate. The two shockers often worked in concert to herd fish towards the seine net, or gill net, a technique termed "block-shocking." All appropriate habitat types in the survey reach were sampled using these methods, moving upstream until the entire length of the habitat type (riffle/run, pool) was sampled. This process was performed in the middle of the channel and close to each bank, in order to survey the entire habitat. This method was effective in riffle and run habitats of shallow to moderate depths, but was fairly ineffective in deep runs and wide deep pools.

All fish captured were placed into a water bucket until they could be identified, counted, and released. The length of time necessary to identify, count, and release the fish depended on the number of fish in the bucket and their condition. Any fish that did not recover from the electroshocking were preserved in 95% ethanol. Habitat notes were recorded at each collection site. A relative abundance was assigned to each species captured or observed at each site. Relative abundance for fish species were estimated using the following criteria:

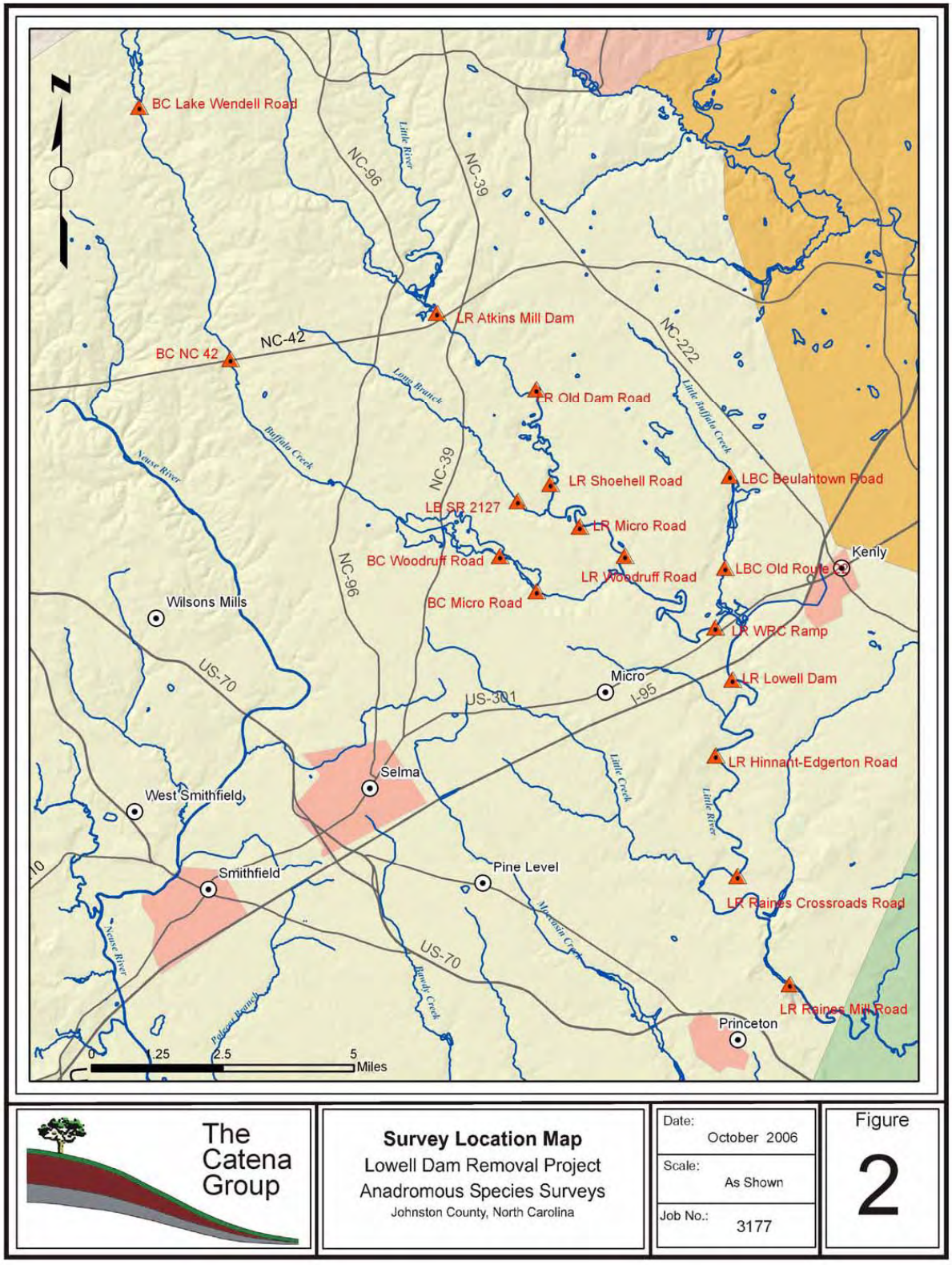
- Very abundant > 30 collected at survey station
- Abundant 15-30 collected at survey station
- Common 6-15 collected at survey station
- Uncommon 3-5 collected at survey station
- Rare 1-2 collected at survey station

Hook and line fishing with shad darts and spoons was also employed at a few locations. This was not a primary method of sampling and mainly used during the time between other capture methods. It did not produce any species that were not detected using other sampling methods.

The anadromous fish surveys were conducted at a number of general sampling locations in Little River, Buffalo Creek, Little Buffalo Creek, and Long Branch on various dates during. Potential anadromous fish habitat was noted during the 2005 pre-removal sampling and during habitat reconnaissance on February 23 and 24, 2006. Habitat types, substrate composition, and water levels were all considered in deciding what areas would be best to sample and what survey methodologies would be most effective. Additionally, potential fish barriers upstream of the impoundment area (Atkins Mill on Little River, Wendell Lake on Buffalo Creek) were targeted as sampling areas. General site location, survey dates, and GPS location of the midpoint of the survey site are included in Table 11. The approximate midpoints of each survey locations listed in Table 11 are depicted in Figure 2.

Table 11. Anadromous Survey Locations in Little River (downstream to upstream)

Site #/Location	Survey Dates 2006	GPS Location
LR Raines Mill Road	4/10	35.48168ºN, -78.14261ºW
LR Raines Crossroads Road	4/10	35.51162ºN, -78.16001ºW
LR Hinnant-Edgerton Road	4/10	35.54519ºN, -78.16701ºW


N
BC Lake Wendell Road
NC-96
Little River
NC-39
LR Atkins Mill Dam
NC-42
BC NC 42
NC-222
Little Buffalo Creek
LR Old Dam Road
Long Branch
Buffalo Creek
Neuse River
NC-39
LR Shoehell Road
LBC Beulahtown Road
LB SR 2127
LR Micro Road
Kenly
BC Woodruff Road
LR Woodruff Road
LBC Old Route
NC-96
Wilsons Mills
BC Micro Road
LR WRC Ramp
US-70
Micro
LR Lowell Dam
US-301
I-95
LR Hinnant-Edgerton Road
Selma
Little Creek
Little River
West Smithfield
Smithfield
Pine Level
LR Raines Crossroads Road
Neuse River
US-70
Buffalo Creek
LR Raines Mill Road
Princeton
0
1.25
2.5
5
Miles
The Catena Group
Survey Location Map
Lowell Dam Removal Project
Anadromous Species Surveys
Johnston County, North Carolina
Date:
October 2006
Scale:
As Shown
Job No.:
3177
Figure
2

LR Lowell Dam	2/23, 3/31	35.56609°N, 78.16112°W
LR WRC Ramp	2/23, 2/24, 3/2, 3/23, 4/6, 4/10, 4/16	35.58051ºN, -78.16672ºW
LR Woodruff Road	3/23, 3/24, 3/31	35.60047ºN, -78.19724ºW
LR Micro Road	3/23, 4/6, 4/14	35.60858ºN, -78.21242ºW
LR Shoehell Road	4/6	35.62049ºN, -78.22219ºW
LR Old Dam Road	4/6	35.64702ºN, -78.22681ºW
LR Atkins Mill Dam	2/23, 3/24, 3/31, 4/6, 5/9, 5/11	35.66832ºN, -78.26021ºW
LB SR 2127	2/24,3/24, 5/11	35.61582°N, 78.23340°W
BC Micro Road	2/24	35.59091°N, 78.22722°W
BC Woodruff Road	3/24, 5/9	35.60070°N, 78.23949°W
BC NC 42	5/11	35.65602°N, 78.33038°W
BC Lake Wendell Road	3/24, 5/11	35.72581°N, 78.36069°W
LBC Old Route 22	5/9	35.59691ºN, -78.16331ºW
LBC Beulahtown Road	2/24, 3/2	35.62232ºN, -78.16138ºW

LR,LB,BC and LBC denote Little River, Long Branch, Buffalo Creek and Little Buffalo Creek respectively

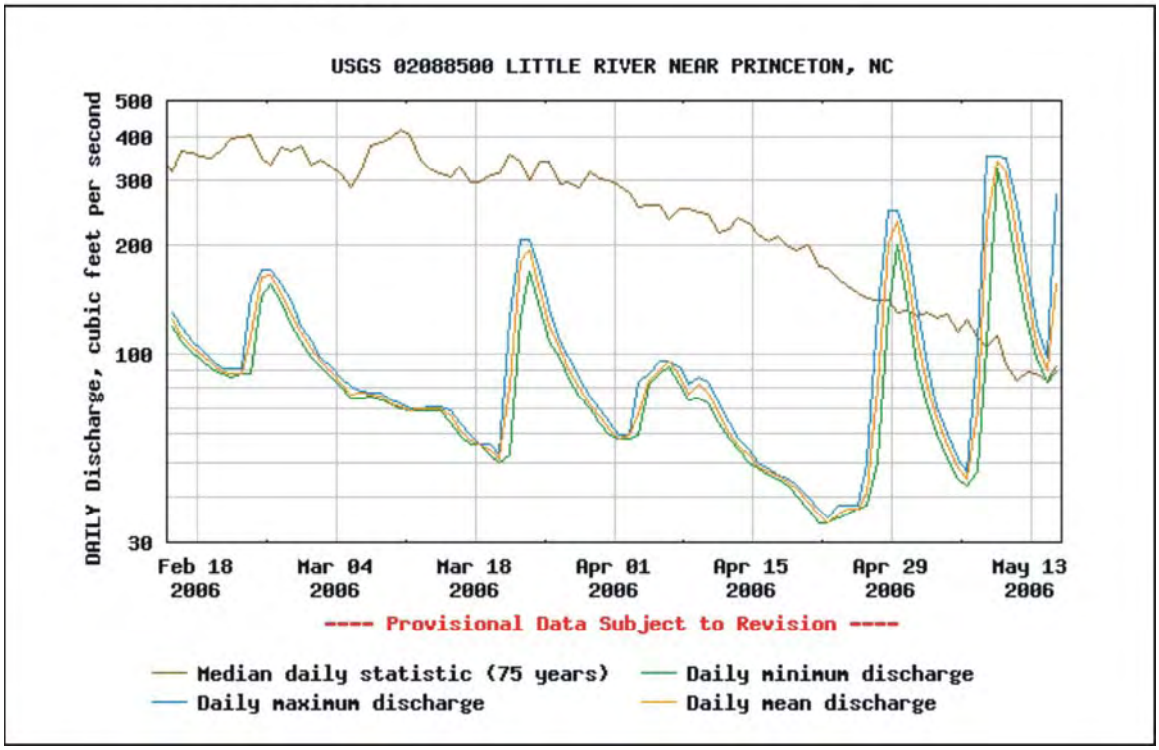
5.1.2 Creel Surveys

Valuable information pertaining to specific fisheries can be gathered through interviews with anglers (creel surveys). A questionnaire was developed (Appendix B) and posted at various businesses (country stores/bait shops, restaurants, gas stations) within the Little River watershed. Anyone interested in participating in the survey was asked to fill out the questionnaire and mail it to the TCG office in Raleigh. The participants had the option of being identified in the survey reports for this project. A self addressed stamped envelope was attached to the questionnaires that were distributed. Efforts were also made to interview local fisherman encountered in the watershed while conducting fish surveys at the survey stations listed in Table 11. Fisherman were asked questions pertaining to their fishing activities in the Little River (catch and methods) and prior fishing experience in the Little River, particularly with regards to the targeted anadromous species (shad, herring etc.).

6.0 ANADROMOUS SPECIES SURVEY RESULTS

Attempts were made to document anadromous fish species above the former Lowell Dam beginning in late February and extending through early May 2006. Efforts were to begin on a bi-weekly schedule, and increase to weekly during the expected “peak” spawning period; however, extreme low flow conditions persisted in the Little River during this time (Figure 3), and sampling efforts were scaled back in April. Efforts were resumed following moderate rain events in late April and early May that resulted in above mean discharge rates.

Figure 3. Lowell Dam Removal Anadromous Species Surveys: Flow Data for Little River February - May, 2006



6.1 Results: Anadromous Fish Sampling Efforts

The results of the anadromous fish sampling efforts are presented by date and the corresponding survey locations:

6.1.1 February 23

The majority of time on this date was spent conducting habitat reconnaissance in the Little River, Buffalo Creek, Little Buffalo Creek and Long Branch. Habitat conditions (stream width, depth, accessibility, flow rate etc.) were recorded. The information gathered was used to determine future survey sites and appropriate survey methodologies. Creel survey questionnaires were also distributed at various businesses in the area and interviews with local fisherman were conducted at the site of the former Lowell Dam and at the WRC boat ramp off of Weaver Road (SR 2144). A brief fish survey was conducted using seine and dip nets in Long Branch at Shoeheel Road (SR 2127), and hook and line methods were conducted in the Little River at the site of the former Lowell dam, WRC ramp, and tailrace of Atkins Mill Dam.

Site 1 Little River Former Lowell Dam Site:

Approximately 0.5 hours (0.25 hrs x 2) of time was spent casting shad darts and rooster tails in the Little River in the general area immediately above the site of the former

Lowell Dam and no fish were captured. A gentleman (name not provided) who claimed the Little River as "his river" was interviewed. He reported that during the previous ten years he made annual trips in early March to the base of the former Lowell Dam to fish for American and hickory shad, and now with the dam being removed, he would focus his future fishing efforts at the base of Atkins Mill Dam. The gentleman also stated that originally he was not in favor of the dam removal project; however, he was impressed with "how good the river looks" in the former reservoir.

Site 2 Little River (WRC ramp @ Weaver Road/SR 2144):

Approximately 0.5 hours (0.25 hrs x 2) of time was spent casting shad darts and rooster tails in the vicinity of the WRC boat ramp located off of Weaver Road. One largemouth bass and one bluegill were captured. An interviewed gentleman (name not provided) stated that he often fished for shad in the Little River below the former Lowell Dam; however he spent more time shad fishing further downstream in the Neuse River. He reported that "white shad" (American shad) were being captured in the Neuse River near Goldsboro and it was "3-4 weeks early" for shad in the Little River.

Site 3 Long Branch (Shoeheel Road/SR 2127):

Active sampling was conducted in Long Branch using seine and dip nets. Seine hauls were performed by a two person team beginning at the Shoeheel Road bridge and proceeded upstream for a distance of approximately 50 meters (164 feet). Dip net sweeps were conducted in submerged rootmats along the banks.

Table 12. February 23 Site 3 Long Branch at Shoeheel Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish*	~	~
Aphredoderus sayanus	pirate perch	Uncommon
Esox americanus	redfin pickerel	Uncommon
Etheostoma olmstedi	tessellated darter	Common
Gambusia holbrookii	Eastern mosquitofish	Abundant
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Common
Luxilus albeolus	white shiner	Uncommon
Notropis procne	swallowtail shiner	Common

Site 4 Little River Tailrace of Atkins Mill Dam (above NC 42):

Approximately 1 hour (0.5 hrs x 2) of time spent casting shad darts and rooster tails in the spillway of the Atkins Mill Dam yielded three largemouth bass. An interview was conducted with an employee of the Atkins Mill (name not provided) regarding fishing efforts at this site. The employee reported that the base of the dam was a popular fishing spot that people accessed off of NC 42 on the southwest side of the dam. He stated that largemouth bass, various sunfish and "shad" were commonly captured at the base of the

dam, and bass and blackfish (bowfin) occur in the mill pond above the dam. Based on a description provided, it was concluded that the "shad" he was referring to were gizzard shad (*Dorosoma cepedianum*).

6.1.2 February 24

Site 1 Little River (WRC Ramp @ Weaver Road/SR 2144):

Approximately 1.5 hours (0.5 hrs x 3) of time was spent casting shad darts and rooster tails in the vicinity of the WRC boat ramp located off of Weaver Road. One largemouth bass was captured. A fisherman (name not provided) interviewed during this time stated that he had just begun to catch low numbers of American Shad at Cox Mill on Mill Creek, a tributary to the Neuse River in Wayne County and that the "shad runs" in the Little River near Lowell Dam were usually 2-3 weeks later than in Mill Creek. A couple (names not provided) was also interviewed who reported that they often fished from the banks at the WRC ramp and routinely catch largemouth bass and various "bream" (sunfish), and had never caught, or heard of anyone catching shad from this section of the river.

Site 2 Buffalo Creek Micro Road/SR 2130:

An approximate 250 meter (820 foot) stretch of Buffalo Creek, beginning at the bridge crossing and proceeding upstream, was sampled using electro-fishing and block-shocking to a seine net for 2,699 seconds of electro-shocking time.

Table 13. February 24 Site 2: Buffalo Creek at Micro Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Aphredoderus sayanus	pirate perch	Common
Centrarchus macropterus	flier	Uncommon
Enneacanthus obseus	banded sunfish	Rare
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Uncommon
Luxilus albeolus	white shiner	Rare
Lythrurus matutinus	pinewoods shiner	Common
Notropis procne	swallowtail shiner	Abundant
Percina nevisense	chainback darter	Rare
Percina roanoka	Roanoke darter	Rare

Site 3 Little Buffalo Creek Beulahtown Road/SR 2148:

The braided channel swamp upstream of the Beulahtown Road crossing of Little Buffalo Creek was surveyed for approximately 200 meters (656 feet) to the base of a large beaver (*Castor canadensis*) dam complex upstream. Electro-fishing sampling was conducted for 1,348 seconds of electro-shocking time. Two species of aquatic salamanders were captured.

Table 14. February 24 Site 3: Little Buffalo Creek at Beulahtown Rd: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Amia calva	bowfin	Common
Anguilla rostrata	American eel	Rare
Centrarchus macropterus	flier	Abundant
Elassoma zonatum	banded pygmy sunfish	Rare
Erimyzon oblongus	creek chubsucker	Very Abundant
Esox americanus	redfin pickerel	Uncommon
Gambusia holbrooki	Eastern mosquitofish	Abundant
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Uncommon
Aquatic salamanders	~	~
Amphiuma means	two-toed amphiuma	Common
Siren lacertian	greater siren	Uncommon

6.1.3 March 2

Site 1 Little River (WRC Ramp @ Weaver Road/SR 2144):

Approximately 1.5 hours (0.5 hrs x 3) of time was spent casting shad darts and rooster tails in the vicinity of the WRC boat ramp located off of Weaver Road. No fish were captured. One seine haul was conducted in the run immediately below the boat ramp. Survey effectiveness was limited due to the amount of woody debris in the river.

Table 15. March 2 Site 1: Little River at WRC Ramp: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Etheostoma olmstedi	tessellated darter	Uncommon
Lepomis auritus	redbreast sunfish	Uncommon
Lepomis macrochirus	bluegill	Common
Notropis procne	swallowtail shiner	Uncommon
Percina nevisense	chainback darter	Uncommon

Site 2 Little Buffalo Creek Beulahtown Road/SR 2148:

Little Buffalo Creek was sampled in the same reach that was surveyed on February 24. Electro-fishing and block-shocking to a seine net was conducted in the sampling area for 2,910 seconds of electro-shocking time. Three species of aquatic salamander were captured during this effort.

Table 16. March 2 Site 2: Little Buffalo Creek at Beulahtown Rd.: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Amia calva	bowfin	Common
Centrarchus macropterus	flier	Common
Enneacanthus obesus	banded sunfish	Rare
Erimyzon oblongus	creek chubsucker	Very Abundant
Esox americanus	redfin pickerel	Uncommon
Gambusia holbrooki	Eastern mosquitofish	Abundant
Hybognathus regius	Eastern silvery minnow	Rare
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Uncommon
Micropterus salmoides	largemouth bass	Uncommon
Aquatic salamanders	~	~
Amphiuma means	two-toed amphiuma	Common
Siren intermedia	lesser siren	Uncommon
Siren lacertian	greater siren	Uncommon

6.1.4 March 9

Approximately 2 hours (0.5 hours x 4 people) was spent hook and line fishing using shad darts and spinner baits immediately upstream of the former Lowell Dam. The primary focus of this visit to conduct quantitative freshwater mussel surveys and the fishing effort was done during surface intervals of the mussel survey. One largemouth bass was captured. An interview with a local fisherman (Gary Scott) was conducted. Mr. Scott stated that he had fished in the Little River periodically and shad had not “shown up” as far upstream as the Lowell dam site at that time, but were reported to be at the mouth of the Little River in Wayne County.

6.1.5 March 10

Approximately 1 hour (0.25 hours x 4 people) was spent hook and line fishing using shad darts and spinner baits immediately upstream of the Micro Road crossing of the Little River. The primary focus of this visit to was to conduct quantitative freshwater mussel surveys. This fishing effort was done during surface intervals of the mussel survey efforts. No fish were captured during this time.

6.1.6 March 23

Site 1 Little River (WRC Ramp @ Weaver Road/SR 2144):

A combination of passive and active sampling techniques was employed. The gill net was set approximately 100 meters below the ramp site in a deep run for 4 hours and no fish were caught. Active sampling was conducted in an approximately 100 meter (328 feet) reach upstream of the ramp area. Electro-fishing and block-shocking to a gill net was conducted for 489 seconds of electro-shocking time.

Table 17. March 23 Site 1: Little River at WRC Ramp: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Lepomis auritus	redbreast sunfish	Common
Lepomis cyanellus	green sunfish	Uncommon
Lepomis macrochirus	bluegill	Uncommon
Luxilus albeolus	white shiner	Uncommon
Micropterus salmoides	largemouth bass	Rare
Notropis procne	swallowtail shiner	Uncommon

Site 2 Little River (Micro Road/SR 2130):

Active sampling was conducted in an approximately 200 meter (656 feet) reach of the Little River in the vicinity of Micro Road. Electro-fishing and block-shocking samplings to a seine net were conducted for 938 seconds of electro-shocking time.

Table 18. March 23 Site 2: Little River at Micro Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Ameiurus platycephalus	flat bullhead	Rare
Anguilla rostrata	American eel	Rare
Cyprinella analostanus	Satinfin shiner	Common
Etheostoma nigrum	Johnny darter	Abundant
Etheostoma olmstedi	tessellated darter	Abundant
Ictalurus punctatus	Channel catfish	Rare
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Uncommon
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Moxostoma pappillosum	V-lip redhorse	Rare-milting
Nocomis leptocephalus	bluehead chub	Common
Nocomis raneyi	bull chub	Common
Notropis procne	swallowtail shiner	Uncommon
Noturus furiosus	Carolina madtom	Rare
Noturus insignis	margined madtom	Common

Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Common

Site 3 Little River (Woodruff Road SR 2129):

Active sampling was conducted in an approximately 200 meter reach upstream of Woodruff Road. Electro-fishing and block-shocking to a gill net was conducted for 1,193 seconds of electro-shocking time.

Table 19. March 23 Site 3: Little River at Woodruff Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Cyprinella analostanus	satinfin shiner	Uncommon
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Common
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Common
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Nocomis raneyi	bull chub	Uncommon
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Common
Percina roanoka	Roanoke darter	Rare

6.1.7 March 24

Site 1 Little River (Woodruff Road SR 2129):

The gill net was set approximately 100 meters upstream of the road crossing in a moderately deep run with sandy/gravel substrate for 6 hours and no fish were caught.

Site 2 Little River Tailrace of Atkins Mill Dam (above NC 42):

The Atkins Mill dam, which is the next upstream impediment to fish passage in the Little River, was sampled below the dam in an approximately 100 meter reach upstream of NC 42. Electro-fishing and block-shocking to a gill net was conducted for 1,049 seconds of electro-shocking time. Semi-passive techniques of dragging a gill net were used for two passes through the sampling area.

Table 20. March 24 Site 2: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~

Amia calva	bowfin	Rare
Anguilla rostrata	American eel	Common
Cyprinella analostanus	satinfin shiner	Uncommon
Dorosoma cepedianum	gizzard shad	Abundant
Erimyzon oblongus	Creek chubsucker	Uncommon
Lepomis auritus	redbreast sunfish	Common
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Abundant
Lepomis microlophus	redear sunfish	Common
Notemigonus crysoleucas	golden shiner	Common
Noturus gyrinus	tadpole madtom	Rare
Pomoxis nigromaculatus	Black crappie	Rare

Site 3 Buffalo Creek (Lake Wendell Road SR 1716):

Buffalo Creek was sampled in an approximately 150 meter (492 feet) reach below the Lake Wendell Dam, in the vicinity of Lake Wendell Road. Electro-fishing and block-shocking sampling was conducted for 682 seconds of electro-shocking time.

Table 21. March 24 Site 3: Buffalo Creek at Lake Wendell Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Ameiurus natalis	yellow bullhead	Rare
Anguilla rostrata	American eel	Uncommon
Etheostoma nigrum	Johnny darter	Rare
Etheostoma olmstedi	tessellated darter	Rare
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Abundant
Lepomis microlophus	redear sunfish	Common
Notemigonus crysoleucas	golden shiner	Uncommon
Micropterus salmoides	largemouth bass	Rare
Noturus gyrinus	tadpole madtom	Rare
Pomoxis nigromaculatus	black crappie	Rare

Site 4 Long Branch (Shoeheel Road SR 2127):

Active sampling was conducted in Long Branch in an approximately 100 meter (328 feet) reach in the vicinity of Shoeheel Road using electro-fishing and block-shocking for 437 seconds of electro-shocking time.

Table 22. March 24 Site 4: Long Branch at Shoeheel Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Aphredoderus sayanus	pirate perch	Uncommon
Centrarchus macropterus	flier	Rare

Esox americanus	redfin pickerel	Rare
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Gambusia holbrookii	Eastern mosquitofish	Abundant
Lepomis auritus	redbreast sunfish	Abundant
Lepomis cyanellus	green sunfish	Rare
Lepomis macrochirus	bluegill	Abundant
Luxilus albeolus	white shiner	Uncommon

Site 5 Buffalo Creek (Woodruff Road SR 2129):

Active sampling was conducted in an approximately 200 meter (656 feet) reach in the vicinity of the Woodruff Road crossing. Electro-fishing and block-shocking sampling was conducted in the sampling area for 1,122 seconds of electro-shocking time.

Table 23. March 24 Site 5: Buffalo Creek at Woodruff Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Common
Cyprinella analostanus	satinfin shiner	Common
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Abundant
Luxilus albeolus	white shiner	Common
Lythrurus matutinus	Pinewoods shiner	Abundant
Notropis procne	swallowtail shiner	Abundant
Percina nevisense	chainback darter	Abundant
Percina roanoka	Roanoke darter	Uncommon

6.1.8 March 31

Site 1 Little River (below former Lowell Dam):

Active sampling was conducted in an approximately 100 meter (328 feet) reach downstream of the old dam site using electro-fishing for 486 seconds of electro-shocking time.

Table 24. March 31 Site 1: Little River below Lowell Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Etheostoma olmstedi	tessellated darter	Common
Ictalurus punctatus	channel catfish	Rare
Lepomis auritus	redbreast sunfish	Abundant

Lepomis macrochirus	bluegill	Common
Lepomis microlophus	redear sunfish	Common
Lythrurus matutinus	pinewoods shiner	Abundant
Nocomis raneyi	bull chub	Uncommon
Notropis procne	swallowtail shiner	Abundant

Site 2 Little River (Woodruff Road SR 2129):

Active sampling was conducted in an approximately 150 meter (492 feet) reach upstream of Woodruff Road using electro-fishing and block-shocking for 490 seconds of electro-shocking time.

Table 25. March 31 Site 2: Little River at Woodruff Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Abundant
Lepomis microlophus	redear sunfish	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Nocomis raneyi	bull chub	Uncommon
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Uncommon
Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Uncommon

Site 3 Little River Tailrace of Atkins Mill Dam (above NC 42):

The Little River was semi-passively sampled below Atkins Mill Dam in an approximately 100 meter (328 feet) reach by sweeping the gill net once through the pool below the dam.

Table 26. March 31 Site 3: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Dorosoma cepedianum	gizzard shad	Abundant
Lepomis microlophus	redear sunfish	Uncommon
Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Common

6.1.9 April 6

Site 1 Little River (WRC ramp @ Weaver Road SR 2144):

A gill net was set approximately 100 meters (328 feet) downstream of the WRC ramp in a deep run for a soak time of six hours and no fish were caught.

Site 2 Little River Tailrace of Atkins Mill Dam (above NC 42):

The Little River was sampled below Atkins Mill Dam in an approximately 100 meter (328 feet) reach. Electro-fishing and block-shocking sampling to a gill net was conducted for 963 seconds of electro-shocking time.

Table 27. April 06 Site 2: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Common
Dorosoma cepedianum	gizzard shad	Abundant
Erimyzon oblongus	creek chubsucker	Rare
Etheostoma nigrum	Johnny darter	Uncommon
Etheostoma olmstedi	tesseslatedtessellated darter	Uncommon
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Common
Lepomis microlophus	redear sunfish	Common
Lythrurus matutinus	pinewoods shiner	Rare
Micropterus salmoides	largemouth bass	Common
Moxostoma pappillosum	V-lip redhorse	Rare
Notropis albeolus	white shiner	Rare

Site 3 Little River (Old Dam Road/SR 2123):

Active sampling was conducted in an approximately 200 meter (656 feet) reach of the Little River in the vicinity of Old dam Road crossing. Electro-fishing and block-shocking sampling was conducted for 1,078 seconds of electro-shocking time.

Table 28. April 06 Site 3: Little River at Old Dam Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant
Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Etheostoma vitreum	glassy darter	Rare
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Common

Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Moxostoma pappillosum	V-lip redhorse	Rare
Nocomis leptocephalus	bluehead chub	Common
Nocomis raneyi	bull chub	Common
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Abundant
Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Abundant

Site 4 Little River (Shoeheel Road SR 2127):

Active sampling was conducted in an approximately 200 meter reach of the Little River in the vicinity of Shoeheel Road. Electro-fishing and block-shocking sampling was conducted for 671 seconds of electro-shocking time.

Table 29. April 06 Site 4: Little River at Shoeheel Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepisosteus osseusi	longnose gar	Rare
Lepomis auritus	redbreast sunfish	Common
Lepomis macrochirus	bluegill	Uncommon
Lythrurus matutinus	pinewoods shiner	Abundant
Moxostoma pappillosum	V-lip redhorse	Rare
Notropis procne	swallowtail shiner	Abundant
Percina nevisense	chainback darter	Uncommon
Percina roanoka	Roanoke darter	Common

Site 5 Little River (Micro Road SR 2130):

Active sampling was conducted in an approximately 200 meter (656 feet) reach of the Little River in the vicinity of Micro Road. Electro-fishing and block-shocking sampling was conducted for 1,518 seconds of electro-shocking time.

Table 30. April 06 Site 2: Little River at Micro Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant
Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Abundant
Etheostoma olmstedi	tessellated darter	Abundant
Etheostoma vitreum	glassy darter	Rare
Lepomis auritus	redbreast sunfish	Abundant

Lepomis macrochirus	bluegill	Abundant
Lepomis microlophus	redear sunfish	Abundant
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Rare
Moxostoma cervinum	black jumprock	Rare
Moxostoma collapsum	notchlip redhorse	Common
Moxostoma pappillosum	V-lip redhorse	Common
Nocomis leptocephalus	bluehead chub	Common
Nocomis raneyi	bull chub	Common
Noturus insignis	margined madtom	Common
Percina nevisense	chainback darter	Common
Percina roanoka	Roanoke darter	Common

6.1.10 April 10

Site 1 Little River (WRC ramp @ Weaver Road SR 2144):

A gill net was set approximately 100 meters (328 feet) downstream of the WRC ramp in a deep run for a soak time of six hours and no fish were caught.

Site 2 Little River (Old Raines Mill @ Pine Street SR 1002):

To this point in the survey effort, no anadromous fish species had been captured at any of the survey locations. This lack of anadromous species was believed to have been attributed to the extreme low flow in the river. A decision was made to add sampling locations downstream of the former Lowell Dam in areas where anadromous species were known to have traversed in years past. Active sampling was conducted in an approximately 200 meter (656 feet) reach downstream of Pine Street. Electro-fishing and block-shocking sampling was conducted for 1,943 seconds of electro-shocking time.

Table 31. April 10 Site 2: Little River at Old Raines Mill : Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant
Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Abundant
Etheostoma olmstedi	tessellated darter	Abundant
Etheostoma vitreum	glassy darter	Uncommon
Ictalurus punctatus	channel catfish	Rare
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Abundant
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Common
Moxostoma collapsum	notchlip redhorse	Uncommon

Moxostoma macrolepidotum	shorthead redhorse	Common
Nocomis raneyi	bull chub	Common
Notropis amoenus	comely shiner	Uncommon
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Abundant
Percina nevisense	chainback darter	Common
Percina roanoka	Roanoke darter	Abundant

Site 3 Little River (Raines Crossroads Road SR 2320):

This site is also located downstream of the former Lowell Dam site. Active sampling was conducted in an approximately 150 meter (490 feet) reach in the vicinity of Raines Crossroads Road. Electro-fishing and block-shocking sampling was conducted for 1,506 seconds of electro-shocking time.

Table 32. April 10 Site 3: Little River at Raines Crossroads Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant
Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Abundant
Etheostoma olmstedi	tessellated darter	Abundant
Lepomis auritus	redbreast sunfish	Abundant
Lepomis microlophus	redear sunfish	Common
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Common
Moxostoma collapsum	notchlip redhorse	Common
Nocomis raneyi	bull chub	Common
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Common
Noturus gyrinus	tadpole madtom	Rare
Percina roanoka	Roanoke darter	Abundant

Site 4 Little River (Lizzie Mill Road SR 1001):

This site is also located downstream of the former Lowell Dam site. Active sampling was conducted in an approximately 150 meter (490 feet) reach in the vicinity of Lizzie Mill Road (SR 1001). Electro-fishing and block-shocking sampling was conducted for 1,762 seconds of electro-shocking time.

Table 33. April 10 Site 4: Little River at Lizzie Mill Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Abundant

Cyprinella analostanus	satinfin shiner	Abundant
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Lepomis auritus	redbreast sunfish	Abundant
Lepomis macrochirus	bluegill	Common
Lepomis microlophus	redear sunfish	Abundant
Luxilus albeolus	white shiner	Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Common
Nocomis raneyi	bull chub	Common
Notropis amoenus	comely shiner	Common
Notropis procne	swallowtail shiner	Abundant
Noturus insignis	margined madtom	Abundant
Pomoxis nigromaculatus	black crappie	Rare
Percina roanoka	Roanoke darter	Abundant

6.1.11 April 14

Site 1 Little River (Micro Road/SR 2130):

The primary focus of this visit to the Little River involved the quantitative mussel survey, however an approximately 200 meter (656 feet) reach of the Little River was sampled (1 pass) using electrofishing for 877 seconds of shock time.

Table 34. April 14 Site 1: Little River at Micro Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Common
Aphredoderus sayanus	pirate perch	Uncommon
Etheostoma olmstedi	tessellated darter	Abundant
Etheostoma vitreum	glassy darter	Rare
Gambusia holbrooki	Eastern mosquitofish	Common
Hypentelium nigricans	Northern hogsucker	Common
Lepomis auritus	redbreast sunfish	Abundant
Lepomis cyanellus	green sunfish	Uncommon
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Abundant
Luxilus albeolus	white shiner	Very Abundant
Lythrurus matutinus	pinewoods shiner	Abundant
Micropterus salmoides	largemouth bass	Uncommon
Moxostoma collapsum	notchlip redhorse	Common
Notropis procne	swallowtail shiner	Very Abundant
Noturus insignis	margined madtom	Abundant
Percina nevisense	chainback darter	Common
Percina roanoka	Roanoke darter	Abundant
Scartomyzon cervinum	black jumprock	Common

6.1.12 May 9

Site 1 Little River Tailrace of Atkins Mill Dam (above NC 42):

The tailrace of Atkins Mill Dam was sampled below the dam in an approximately 100 meter reach upstream of NC 42. The pool below the dam was semi-passively sampled by sweeping a gill net slowly through the pool five times. This effort resulted in the first capture of American shad upstream of Lowell Mill since the removal of the dam. The specimen was placed on ice and transported to the North Carolina State Museum of Natural Sciences (NCSM) and deposited as a voucher.

Table 35. May 09 Site 1: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Alosa sapidissima	American shad	Rare (1)
Dorosoma cepedianum	gizzard shad	Rare
Lepomis microlophus	redear sunfish	Rare

Site 2 Buffalo Creek (Woodruff Road SR 2129):

Active sampling was conducted in an approximately 150 meter (490 feet) reach in the vicinity of the Woodruff Road crossing. Electro-fishing and block-shocking sampling was conducted for 1,065 seconds of electro-shocking time. One spawning female American shad was captured, placed on ice, transported to the NCSM, and deposited as a voucher.

Table 36. May 09 Site 2: Buffalo Creek at Woodruff Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Alosa sapidissima	American shad	Rare (1)
Centrarchus macropterus	flier	Rare
Cyprinella analostanus	satinfin shiner	Common
Etheostoma nigrum	Johnny darter	Common
Etheostoma olmstedi	tessellated darter	Common
Esox americanus	redfin pickerel	Common
Lepisosteus osseusi	longnose gar	Rare
Lepomis auritus	redbreast sunfish	Abundant
Luxilus albeolus	white shiner	Common
Lythrurus matutinus	pinewoods shiner	Common
Moxostoma macrolepidotum	shorthead redhorse	Rare
Moxostoma pappillosum	V-lip redhorse	Rare
Notropis procne	swallowtail shiner	Abundant
Percina nevisense	chainback darter	Common
Percina roanoka	Roanoke darter	Common

Site 3 Little Buffalo Creek (Old Rt. 22/SR 2143):

Little Buffalo Creek was sampled in an approximately 100 meter (328 feet) reach in the vicinity of the Old Route 22 (SR 2143) crossing. Electro-fishing and block-shocking sampling was conducted for 459 seconds of electro-shocking time.

Table 37. May 09 Site 3: Little Buffalo Creek Old Rt. 22: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Centrarchus macropterus	flier	Rare
Lepomis gulosus	warmouth	Common
Lepomis macrochirus	bluegill	Rare

6.1.13 May 11

Site 1 Long Branch (Shoeheel Road SR 2127):

An approximately 200 meter (656 feet) reach of Long Branch in the vicinity of Shoeheel Road was surveyed using electro-fishing and block-shocking to a seine net for 437 seconds of electro-shocking time.

Table 38. May 11 Site 1: Long Branch at Shoeheel Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Ameiurus platycephalus	flat bullhead	Rare
Aphredoderus sayanus	pirate perch	Uncommon
Centrarchus macropterus	flier	Rare
Cyprinella analostanus	satinfin shiner	Abundant
Enneacanthus gloriosus	bluespotted sunfish	Rare
Esox americanus	redfin pickerel	Abundant
Etheostoma olmstedi	tessellated darter	Rare
Gambusia holbrookii	Eastern mosquitofish	Abundant
Lepomis auritus	redbreast sunfish	Abundant
Lepomis cyanellus	green sunfish	Rare
Lepomis gulosus	warmouth	Rare
Lepomis macrochirus	bluegill	Rare
Lepomis microlophus	redear sunfish	Rare
Luxilus albeolus	white shiner	Common
Notropis procne	swallowtail shiner	Very Abundant

Site 2 Little River Tailrace of Atkins Mill Dam (above NC 42):

Approximately 1.5 hours (0.5 hrs x 3) spent casting shad darts and rooster tails in the spillway of the Atkins Mill Dam yielded three largemouth bass as well as one gizzard shad that was hooked, but not landed. The Little River was sampled below Atkins Mill

Dam in an approximately 100 meter (328 feet) reach. Electro-fishing and block-shocking sampling to a seine net was conducted for 1,353 seconds of electro-shocking time. Several dip-net sweeps were also conducted along the banks and at the base of the dam. Although not captured, one American shad was observed swimming away from the electric field at the base of the dam.

Table 39. May 11 Site 2: Little River Tailrace of Atkins Mill Dam: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Ameiurus natalis	yellow bullhead	Rare
Anguilla rostrata	American eel	Common
Cyprinella analostanus	satinfin shiner	Uncommon
Dorosoma cepedianum	gizzard shad	Abundant
Etheostoma olmstedi	tessellated darter	Uncommon
Lepomis macrochirus	Bluegill	Uncommon
Lepomis microlophus	redear sunfish	Uncommon
Luxilus albeolus	white shiner	Rare
Micropterus salmoides	largemouth bass	Rare
Nocomis raneyi	bull chub	Rare
Notropis amoenus	comely shiner	Rare
Percina nevisense	Chainback darter	Common
Scartomyzon cervinum	black jumprock	Rare

Site 3 Buffalo Creek (Lake Wendell Road SR 1716):

Buffalo Creek was sampled below the Lake Wendell dam in an approximately 200 meter (656 feet) reach in the vicinity of Lake Wendell Road using electro-fishing for 1,318 seconds of electro-shocking time.

Table 40. May 11 Site 3: Buffalo Creek at Lake Wendell Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Common
Erimyzon oblongus	creek chubsucker	Rare
Etheostoma nigrum	Johnny darter	Rare
Etheostoma olmstedi	tessellated darter	Rare
Lepomis auritus	redbreast sunfish	Abundant
Lepomis cyanellus	green sunfish	Rare
Lepomis gulosus	Warmouth	Rare
Lepomis macrochirus	Bluegill	Very Abundant
Lepomis microlophus	redear sunfish	Common
Notemigonus crysoleucas	golden shiner	Common
Micropterus salmoides	largemouth bass	Common
Pomoxis nigromaculatus	black crappie	Rare

Site 4 Buffalo Creek above NC 42:

Buffalo Creek was sampled in an approximately 200 meter (656 feet) reach above the NC 42 crossing using electro-fishing for 1,218 seconds of electro-shocking time. Fish were generally rare in this reach.

Table 41. May 11 Site 3: Buffalo Creek at Lake Wendell Road: Species Found

Scientific Name	Common Name	Relative Abundance
Freshwater Fish	~	~
Anguilla rostrata	American eel	Rare
Erimyzon oblongus	creek chubsucker	Rare
Esox americanus	redfin pickerel	Common
Lepomis macrochirus	Bluegill	Uncommon
Umbrea pygmaea	Eastern mudminnow	Rare

6.2 Results Creel Surveys

A total of 32 creel survey questionnaires were posted at various businesses in the Little River watershed or given to fishermen when encountered. Although several people expressed interest in participating in the survey, to date, no questionnaires have been returned.

7.0 ANADROMOUS SPECIES SURVEY DISCUSSION/CONCLUSIONS

Despite extreme low flow conditions throughout this sampling effort, the anadromous surveys demonstrated that the removal of the Lowell Dam eliminated the impediment for upstream spawning runs of the American shad. The late arrival and apparent low numbers are presumed to be attributed to the extreme low flow conditions rather than any residual effect of the dam. However, more robust data is needed to draw any definitive conclusions regarding the magnitude of spawning runs.

Anadromous species surveys should resume in subsequent years during the 5-year monitoring plan, to obtain a better understanding of the magnitude of the newly restored spawning runs of American shad, as well as to determine if other anadromous species are utilizing the newly restored river reaches.

These surveys also demonstrated how seasonality effects species composition and apparent relative abundances at a particular site. Comparisons of the pre-removal and Year-1 fish community monitoring surveys conducted in summer months with the anadromous species surveys conducted in late winter to early spring, demonstrate that species such as redear sunfish, black jumprock, notchedlip redhorse and V-lip redhorse were found at more sites and generally in greater numbers during winter/spring surveys than during summer surveys. Conversely the glassy darter was more likely to be encountered during the summer months.

A total of forty two fish species were captured in the Little River during the pre-removal surveys conducted in 2005 (Lowell Pre-removal Survey report). It was stated that a more comprehensive survey effort utilizing multiple survey methodologies conducted at various times throughout the year was needed, particularly in the deeper habitats, to obtain a complete list of all fish species occurring in the Little River watershed. As anticipated, the results of the Anadromous species surveys and the Year-1 Fish Community Monitoring resulted in collection of eleven additional fish species, bringing the total to fifty-three species.

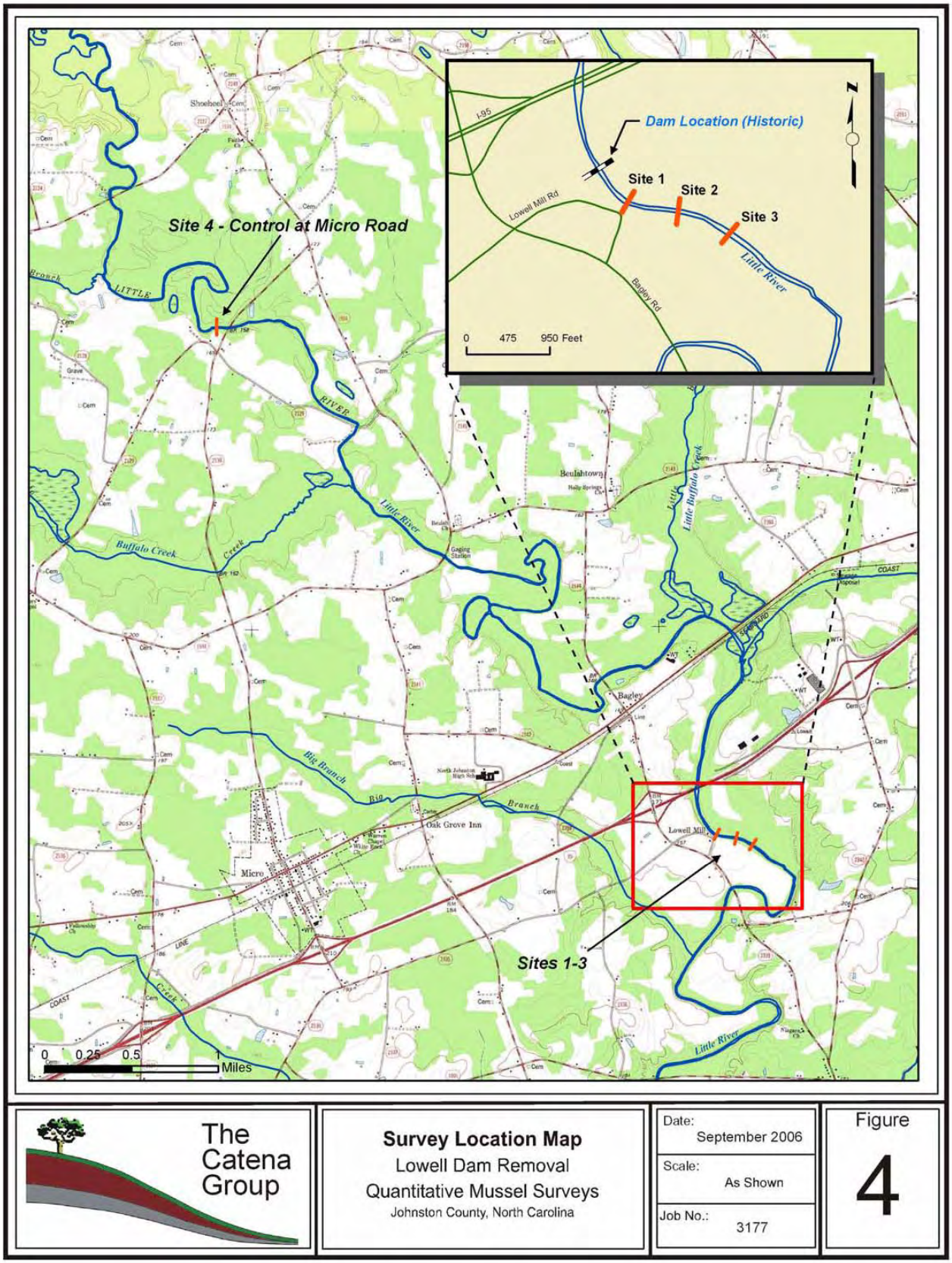
8.0 QUANTITATIVE MUSSEL SURVEY EFFORTS

Based on the results of the freshwater mussel component of the pre-removal surveys conducted in 2005 (Lowell Pre-removal surveys report), it was apparent that high densities of freshwater mussels occurred in the Little River immediately below the dam. These densities (based on Catch per unit effort) were higher than any other location sampled throughout the Little River.

8.1 Quantitative Mussel Surveys Methodology

Freshwater mussels were quantitatively sampled in the Little River at varying intervals (approximately 30, 200 and 400 meters) below the Lowell dam, as well as at an upstream control site (Micro Road/SR 2130) on December 28, 2005, and January 09, 2006, prior to dam removal (Figure 4). Transects were established at each location across the river. The river width is approximately 16 meters (52 feet) at the 400 meter transect, 18 meters (59 feet) at the 200 meter transect, 20 meters (65 feet) at the 30 meter transect and 10 meters (33 feet) at the upstream control site. Each transect of the river was divided into 16, 18, 20 and 10 (depending on the exact width of each transect) 1-m^2 quadrates respectively. The location of each transect was marked by driving rebar stakes into both banks (to serve as a semi-permanent marker) and recorded using a GPS unit with sub-meter accuracy. Transect sampling was employed to allow analysis of near shore and mid–channel habitats of the river.

Quadrates in the four study transects were surveyed for freshwater mussels using SCUBA at the three transects below the dam and wading with bathyscopes (glass-bottom view buckets) at the upstream control site. One out of every six quadrates in each study transect was randomly selected (roll of dice) to serve as controls for handling effects in winter months and were not sampled. Each mussel found in each quadrate was identified, measured (total length), and tagged before being returned to their respective quadrates. The tags (Hallprint Tags) are made of polyethylene, oval in shape, and approximately 9 mm long by 4 mm wide. Each tag is colored (e.g., green) and also has a unique 4-character code, which begins with a letter followed by 3 numbers. The tags were applied to the mussels using Instant Krazy Glue©, or another quick dry epoxy. A portable 1-m^2 quadrate constructed from 5-cm schedule 40 polyvinyl chloride (PVC) positioned along a rope stretched across the river was used to delineate each quadrate sampled.



The Catena Group

Survey Location Map
Lowell Dam Removal
Quantitative Mussel Surveys
Johnston County, North Carolina

Date: September 2006
Scale: As Shown
Job No.: 3177

Figure 4

The four study transects were resurveyed approximately three months after dam removal on March 9 and 10, 2006. The 3-month monitoring was conducted to assess initial mortality resulting from dam removal and to detect movement of mussels within and outside of the study transects. Survey methodology during the 3-month monitoring followed the methods used for the pre-removal surveys, however water depths had decreased at the 30 meter and 200 meter downstream transects to a level that wading with bathyscopes replaced SCUBA as the primary sampling method used. Every quadrate (including the random controls) was sampled during the 3-month monitoring. The river was also sampled for a distance of 10 meters (33 feet) upstream and downstream of the transect locations to detect movement of mussels. Recaptured (recovered) tagged mussels were recorded and returned to their respective quadrates. Untagged (immigrated) mussels which were captured during the 3-month monitoring were measured, assigned a tag, and returned to their respective quadrates as before. Mortality was assessed by the number of dead tagged shells found. Recapture of individual mussels two meters (quadrates) or greater in any direction from their original quadrate was considered movement. Mussels recovered in quadrates adjacent to their original ones were not considered to have moved, since exact location of replacement within a respective quadrate was not recorded during the initial sampling.

9.0 QUANTITATIVE MUSSEL SURVEY RESULTS

A total of 605 freshwater mussels were tagged in four study transects prior to dam removal. The eastern elliptio (*Elliptio complanata*) accounted for 98% (591) of the mussels found. Six other species comprised the remaining 2% (14) of tagged mussels. Recovery of tagged live mussels during the 3-month monitoring was highest at the upstream Control Site and the 400 meter Site (84% and 80 % respectively) and lowest at the 30 meter and 200 meter sites (45% and 59% respectively). Observed mortality of tagged mussels was 1% at the 200 Meter Transect and 0.2% at the 400 meters transect. No mortality of tagged mussels was observed at the 30 meter transect, or the upstream control transect. This data is displayed in Table 43.

Table 42. Quantitative Mussel Study 3-Month Monitoring Results

Transect	Tagged mussels pre-removal	Recovered tagged mussels	Dead tagged mussels	% of Recovered mussels showing movement
30 meter	31	14 (45.2%)	0	71.4% (10)
200 meter	96	56 (59.4%)	1 (1%)	42.1% (24)
400 meter	439	352 (80.4%)	1 (0.2%)	1.7% (6)
Upstream	38	32 (84.2%)	0	6.2% (2)

10.0 QUANTITATIVE MUSSEL SURVEY DISCUSSION/CONLUSIONS

Significant freshwater mussel mortality attributed to dam removal was not evident during the 3-month quantitative mussel survey monitoring. However, mark/recapture recovery rates of the tagged mussels decrease dramatically with increased proximity to the former dam site.

Habitat observations following dam removal identified a wedge of sediment gradually migrating downstream from the dam site, covering the substrate of the river. The low recovery rates at the 30 meter and 200 meter transects are likely attributable to this wedge of sediment. The sediment wedge had not progressed to the 400 meter transect at the time of the 3-month monitoring, however, it has done so since that time (personal observations). As mentioned above, due to water depths, SCUBA was needed to sample all transects below the dam prior to removal, but was only required at the 400 meter transect during the 3-month monitoring, because the 30 meter and 200 meter transects had been filled with sediment. This sedimentation of substrate in the transects can affect mark/recapture rates in two ways: 1) mussels become buried by the sediment and are not recovered during resurvey efforts and likely die from the effects of burial, or 2) mussels exhibit a behavioral response to the sediment and attempt to move away from the disturbance (sediment). Horizontal (across the substrate) movements of mussels are often haphazard in direction, and occur in response to habitat disturbance. These movements are often visible as "crawls" or trails made in the substrate. Numerous mussel crawls were evident in the migrating sediment wedge below the former dam site. In addition to having the lowest recapture (recovery) rates, the 30 meter and 200 meter transects also had the highest percentage of recaptured mussels exhibiting movement (71.4% and 42.1% respectively) compared to relatively little movement of recaptured mussels in the 400 meter and upstream control transects (1.7% and 6.2% respectively). Lower recapture rates and higher movement rates would be expected in future monitoring of the 400 meter transect since encroachment of the sediment wedge has taken place in this stretch of the river since the 3-month monitoring was completed.

Three months appears to not have been a long enough for dam removal related mortality to become evident. However, it is apparent that post-removal sedimentation has adversely affected mussel populations downstream of the former dam. Further monitoring of the study transects is needed to: 1) determine the extent of the initial sedimentation–related mortality, and 2) to assess changes in population density and recovery over time.

It is recommended that the study transects be re-surveyed in the late winter/early spring of 2007 (1-year following removal) to document the extent of project related mortality, and again at Year-5 post removal to document changes in population density and possible recovery.

11.0 LITERATURE CITED

NCDENR 2001. Standard Operating Procedures Biological Monitoring Stream Fish Community Assessment and Fish Tissue. Available online at http://www.esb.enr.state.nc.us/BAUwww/IBI%20Methods%202001.pdf

APPENDIX A. NCIBI SCORE SHEETS FOR EACH SITE SAMPLED YEAR-1 FISH COMMUNITY MONITORING

Table 1. NCIBI Score Site 1 (CX-1)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	23	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	220	3
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	5	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	6	5
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	1	3
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	2	3
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	21%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	0%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	97%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	3%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	0.45%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	56%	5
NCIBI Score		46 (Good)

Table 2. NCIBI Score Site 2 (CX-3)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	27	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	252	5
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	4	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	3	3
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	24%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	3%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	89%	5
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	8%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	52%	5
NCIBI Score		54 (Excellent)

Table 3. NCIBI Score Site 3 (CX- 4)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	13	3
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	204	3
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	3	3
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	0	1
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	2	3
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	48%	3
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	0%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	91%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	9%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	<1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	85%	5
NCIBI Score		38 (Fair)

Table 4. NCIBI Score Site 4 (CX- 7)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	18	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	158	3
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	4	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	3	3
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	1	3
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	27%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	1%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	94%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	5%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	<1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	56%	5
NCIBI Score		46 (Good)

Table 5. NCIBI Score Site 5 (CX-10)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	19	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	167	3
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	4	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	3	3
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	0	1
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	24%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	<1%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	96%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	4%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	<1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	61%	5
NCIBI Score		44 (Good-Fair)

Table 6. NCIBI Score Site 7(CX-16)

Metric/score criteria	Site Metric #	Site Metric Score
No. of species ≥ 16 species = 5 10-15 species = 3 <10 species = 1	21	5
No. of fish ≥ 225 fish = 5 150-224 fish = 3 <150 fish = 1	253	5
No. of species of darters ≥ 3 species = 5 1-2 species = 3 0 species = 1	4	5
No. of species of sunfish ≥ 4 species = 5 3 species = 3 0-2 species = 1	5	5
No. of species of suckers ≥ 3 species = 5 1-2 species = 3 0 species = 1	1	3
No. of intolerant species ≥ 3 species = 5 1-2 species = 3 0 species = 1	3	5
% of tolerant individuals ≤ 35% = 5 36-50% = 3 >50% = 1	23%	5
% of omnivorous and herbivorous individuals 10-35% = 5 36-50% = 3 >50% or <10% = 1	<1%	1
% of insectivorous individuals 65-90% = 5 45-64% = 3 <45% or >90% = 1	96%	1
% of piscivorous individuals 1.4-15% = 5 0.4-1.3% = 3 <0.4% or >15% = 1	4%	5
% of diseased fish ≤1.75% = 5 1.76-2.75% = 3 >2.75% = 1	<1%	5
% of species with multiple age groups ≥50% = 5 35-49% = 3 <35% = 1	38%	3
NCIBI Score		48 (Good)

APPENDIX B. CREEL SURVEY QUESTIONAIRRE

Dear Fisherman:

We are conducting a survey to gather information regarding fishing activity in the Little River and it tributaries (Little River, Buffalo Creek, Little Buffalo Creek, and Long Branch). We are particularly interested in the shad, river herring, and striped bass runs now that Lowell Dam has been removed. We would appreciate it if you would take a few minutes to complete the following survey (see back of this sheet) and return it to the location you received it. Please fill out a separate survey for each day of fishing. If you would like to be included in the report that will be created with this information, please include your name at the bottom of the form. If you have any questions or comments please contact Tim Savidge at (919) 417-2314.

Thank you for your participation.

FISHING SURVEY

DATE (Month/Day): _____

START OF FISHING (Time): _____am/pm END OF FISHING (Time): _____am/pm

TOTAL TIME FISHING: HRS _____ MIN_____

WHERE DID YOU FISH? (Provide location, nearest road crossing, boat landing, etc)

Little River_____

Buffalo Creek_____

Little Buffalo Creek_____

Long Branch_____

SPECIES FISHED FOR:

American Shad _____ (number caught)

Hickory Shad _____ (number caught)

River Herring _____ (number caught)

Striped Bass _____ (number caught)

Other _____ (type and number caught)

FISHING METHOD:

Stillfishing_____ Spinfishing_____ Flyfishing_____

BAIT TYPE:

Artificial Lures/Flies_____ Live Bait (type) _____

LOCATION:

On Bank_____ Wading_____ In Boat_____

WOULD YOU LIKE TO BE IDENTIFIED IN THE ENVIRONMENTAL DOCUMENT AS A

PARTICIPANT OF THIS SURVEY? NO _____ YES _____

IF YES, PLEASE INCLUDE NAME HERE: _____

APPENDIX D: NCDWQ Habitat Assessment Form

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Unit, DWQ **TOTAL SCORE_____**

Directions for use: The observer is to survey a **minimum of 100 meters with 200 meters preferred** of stream, preferably in an **upstream** direction starting above the bridge pool and the road right-of-way. The segment which is assessed should represent average stream conditions. To perform a proper habitat evaluation the observer needs to get into the stream. To complete the form, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. A final habitat score is determined by adding the results from the different metrics.

Stream_____Location/road: _____(Road Name_____)County_____

Date_____**CC#**_____Basin_____Subbasin_____

Observer(s)_____ Type of Study: ☐ Fish ☐Benthos ☐ Basinwide ☐Special Study (Describe) _____

Latitude _____Longitude _____Ecoregion: ☐ MT ☐ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature_____^{0}C DO _____mg/l Conductivity (corr.) _____µS/cm pH _____

Physical Characterization: Visible land use refers to immediate area that you can see from sampling location - include what you estimate driving thru the watershed in watershed land use.

Visible Land Use: _____%Forest _____%Residential _____%Active Pasture _____% Active Crops
_____%Fallow Fields _____% Commercial _____%Industrial _____%Other - Describe:_____

Watershed land use : ☐Forest ☐Agriculture ☐Urban ☐ Animal operations upstream

Width: (meters) Stream_____ Channel (at top of bank)_____ **Stream Depth**: (m) Avg_____Max ____
☐ Width variable ☐ Large river >25m wide
Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (m)_____

Bank Angle: _____° or ☐ NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)
☐ Channelized Ditch
☐Deeply incised-steep, straight banks ☐Both banks undercut at bend ☐Channel filled in with sediment
☐ Recent overbank deposits ☐Bar development ☐Buried structures ☐Exposed bedrock
☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐Green tinge ☐ Sewage smell
Manmade Stabilization: ☐N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Flow conditions : ☐High ☐Normal ☐Low
Turbidity: ☐Clear ☐ Slightly Turbid ☐Turbid ☐Tannic ☐Milky ☐Colored (from dyes)
Good potential for Wetlands Restoration Project?? ☐ YES ☐NO Details_____
Channel Flow Status
Useful especially under abnormal or low flow conditions.

A. Water reaches base of both lower banks, minimal channel substrate exposed	☐
B. Water fills >75% of available channel, or <25% of channel substrate is exposed.....	☐
C. Water fills 25-75% of available channel, many logs/snags exposed.....	☐
D. Root mats out of water.....	☐
E. Very little water in channel, mostly present as standing pools.....	☐

Weather Conditions:_____**Photos:** ☐N ☐Y ☐ Digital ☐35mm

Remarks:_____
_____

I. Channel Modification

	Score
A. channel natural, frequent bends	5
B. channel natural, infrequent bends (channelization could be old)	4
C. some channelization present	3
D. more extensive channelization, >40% of stream disrupted	2
E. no bends, completely channelized or rip rapped or gabioned, etc	0

☐ Evidence of dredging ☐Evidence of desnagging=no large woody debris in stream ☐Banks of uniform shape/height

Remarks_____ Subtotal____

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >70% of the reach is rocks, 1 type is present, circle the score of 17. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as **R**are, **C**ommon, or **A**bundant.

____Rocks ____Macrophytes ____Sticks and leafpacks ____Snags and logs ____Undercut banks or root mats

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>70% Score	40-70% Score	20-40% Score	<20% Score
4 or 5 types present	20	16	12	8
3 types present	19	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

☐ No woody vegetation in riparian zone Remarks_____ Subtotal_____

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) Look at entire reach for substrate scoring, but only look at riffle for embeddedness, and use rocks from all parts of riffle-look for "mud line" or difficulty extracting rocks.

	Score
A. substrate with good mix of gravel, cobble and boulders	
1. embeddedness <20% (very little sand, usually only behind large boulders)	15
2. embeddedness 20-40%	12
3. embeddedness 40-80%	8
4. embeddedness >80%	3
B. substrate gravel and cobble	
1. embeddedness <20%	14
2. embeddedness 20-40%	11
3. embeddedness 40-80%	6
4. embeddedness >80%	2
C. substrate mostly gravel	
1. embeddedness <50%	8
2. embeddedness >50%	4
D. substrate homogeneous	
1. substrate nearly all bedrock	3
2. substrate nearly all sand	3
3. substrate nearly all detritus	2
4. substrate nearly all silt/ clay	1

Remarks_____Subtotal_____

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams, or side eddies.

A. Pools present	Score
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	10
b. pools about the same size (indicates pools filling in)	8
2. Pools Infrequent (<30% of the 200m area surveyed)	
a. variety of pool sizes	6
b. pools about the same size	4
B. Pools absent	0

Subtotal_____

☐ Pool bottom boulder-cobble=hard ☐ Bottom sandy-sink as you walk ☐ Silt bottom ☐ Some pools over wader depth

Remarks_____

Page Total_____

V. Riffle Habitats

Definition: Riffle is area of reaeration-can be debris dam, or narrow channel area.

	Riffles **Frequent** Score	Riffles **Infrequent** Score
A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream....	16	12
B. riffle as wide as stream but riffle length is not 2X stream width	14	7
C. riffle not as wide as stream and riffle length is not 2X stream width	10	3
D. riffles absent.....	0	

Channel Slope: ☐Typical for area ☐Steep=fast flow ☐Low=like a coastal stream Subtotal_____

VI. Bank Stability and Vegetation

FACE UPSTREAM	Left Bank Score	Rt. Bank Score
A. Banks stable		
1. little evidence of erosion or bank failure(except outside of bends), little potential for erosion..	7	7
B. Erosion areas present		
1. diverse **trees**, shrubs, grass; plants healthy with good root systems.....	6	6
2. few trees or small trees and **shrubs**; vegetation appears generally healthy.....	5	5
3. sparse **mixed** vegetation; plant types and conditions suggest poorer soil binding.....	3	3
4. mostly **grasses**, few if any trees and shrubs, high erosion and failure potential at high flow..	2	2
5. little or no bank vegetation, mass erosion and bank failure evident.....	0	0
		Total_____

Remarks_____

VII. Light Penetration Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead. Note shading from mountains, but not use to score this metric.

	Score
A. Stream with **good** canopy with some breaks for light penetration	10
B. Stream with **full canopy** - breaks for light penetration absent.....	8
C. Stream with **partial** canopy - sunlight and shading are essentially equal.....	7
D. Stream with **minimal** canopy - full sun in all but a few areas.....	2
E. **No canopy** and no shading.....	0

Remarks_____Subtotal____

VIII. Riparian Vegetative Zone Width

Definition: Riparian zone for this form is area of natural vegetation adjacent to stream (can go beyond floodplain). Definition: A break in the riparian zone is any place on the stream banks which allows sediment or pollutants to directly enter the stream, such as paths down to stream, storm drains, uprooted trees, otter slides, etc.

FACE UPSTREAM Dominant vegetation: ☐ Trees ☐ Shrubs ☐ Grasses ☐ Weeds/old field ☐Exotics (kudzu, etc)	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters.....	5	5
2. width 12-18 meters.....	4	4
3. width 6-12 meters.....	3	3
4. width < 6 meters.....	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters.....	4	4
b. width 12-18 meters.....	3	3
c. width 6-12 meters.....	2	2
d. width < 6 meters.....	1	1
2. breaks common		
a. width > 18 meters.....	3	3
b. width 12-18 meters.....	2	2
c. width 6-12 meters.....	1	1
d. width < 6 meters.....	0	0
		Total_____

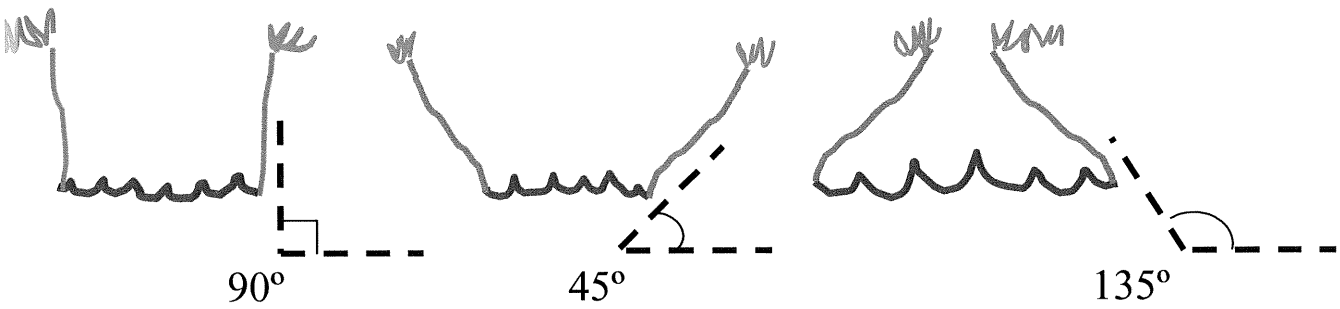
Remarks_____

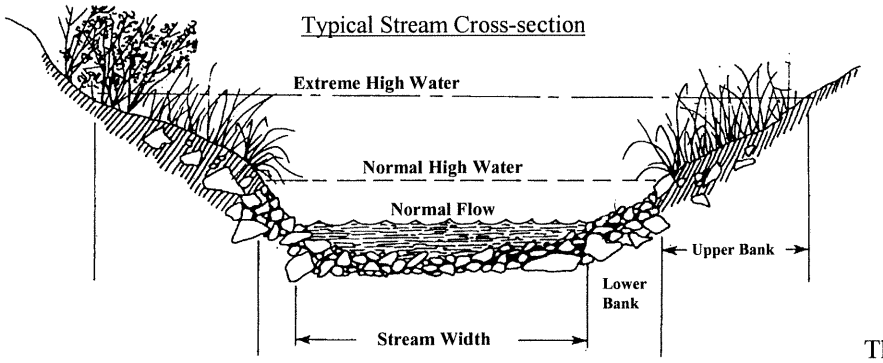
Page Total_____

☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream. **TOTAL SCORE**_____

Supplement for Habitat Assessment Field Data Sheet

Diagram to determine bank angle:





This side is 45° bank angle.

Site Sketch:

Other comments:_____

_____

_____

_____

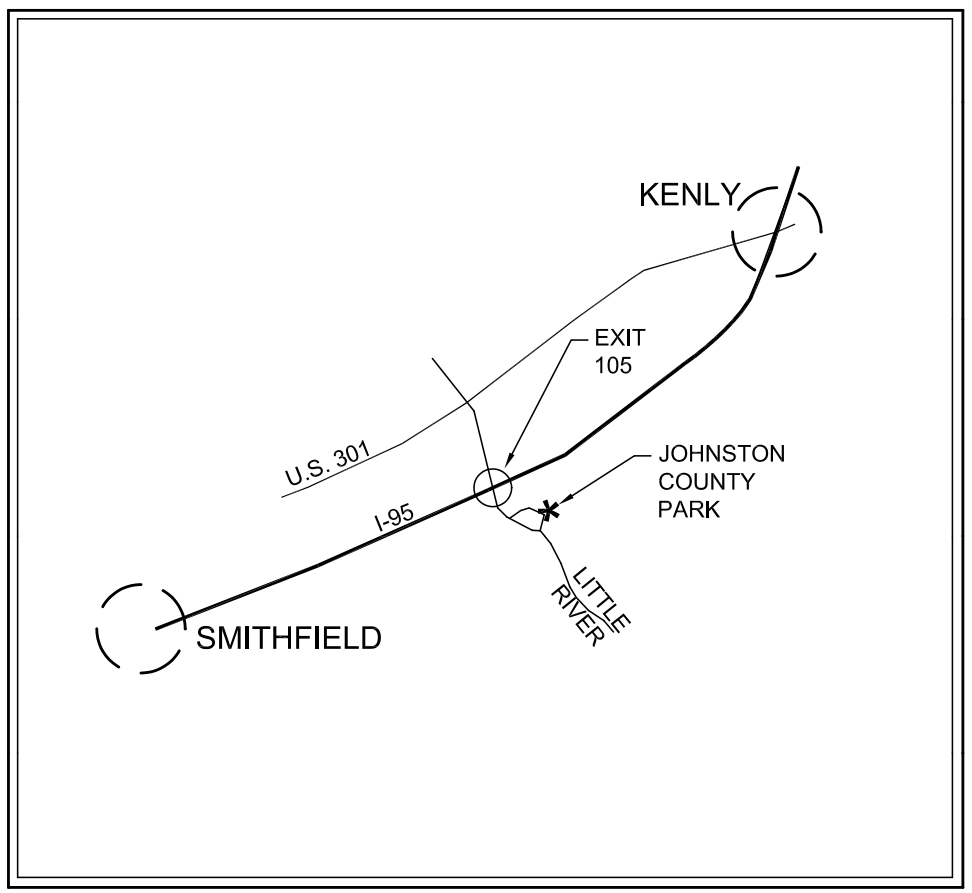
_____

APPENDIX E: Monitoring Photographs

JOHNSTON COUNTY PARK

LITTLE RIVER
KENLY
NORTH CAROLINA

JULY 2006



PROJECT SITE VICINITY MAP

LIST OF DRAWINGS:

L1	SITE PLAN - LAYOUT
G1	SITE PLAN - GRADING
SE1	SITE PLAN - SEDIMENT & EROSION CONTROL
SD1-SD2	SITE DETAILS

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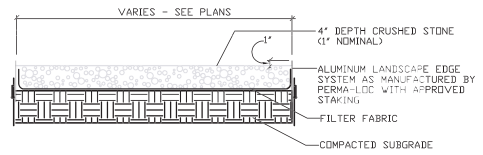
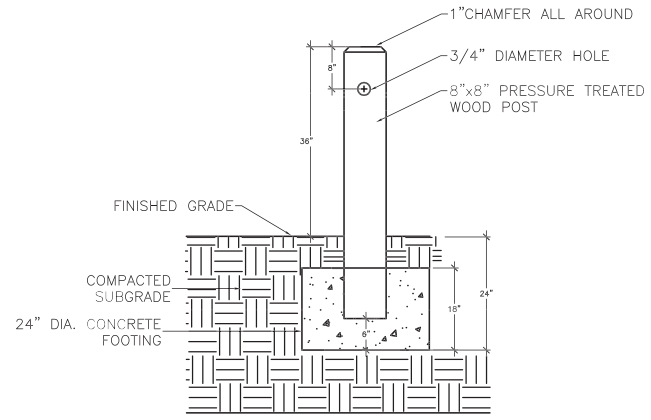
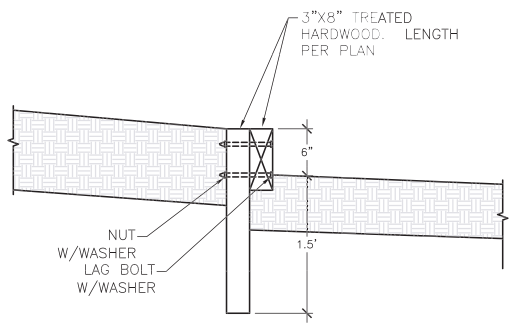


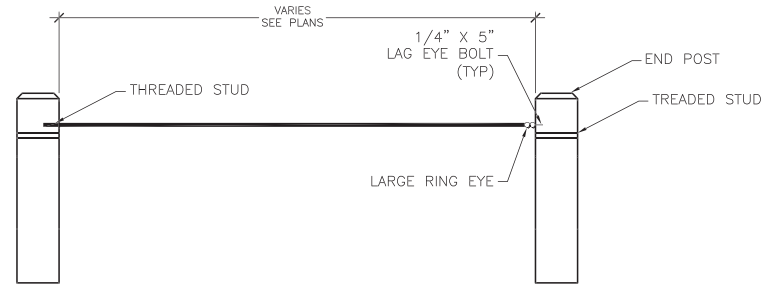
GRAVEL PARKING LOT AND ROADWAY
N.T.S.



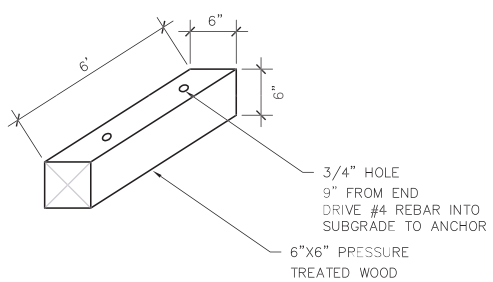
WOOD BOLLARD W/WIRE STRAND
N.T.S.



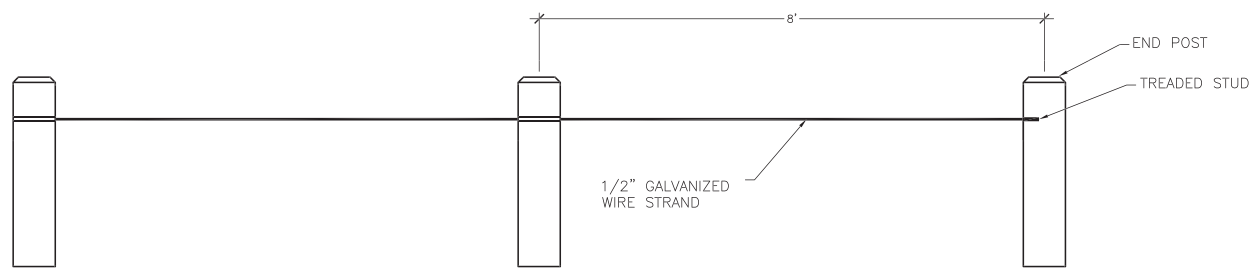
WOOD STEP
N.T.S.



WOOD BOLLARD W/WIRE STRAND GATE
N.T.S.



6' WOOD WHEELSTOP



WOOD BOLLARD W/WIRE STRAND ASSEMBLY
N.T.S.

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REVISIONS

SEDIMENT & EROSION CONTROL DETAILS

LITTLE RIVER
JOHNSTON COUNTY PARK PLAN

LOWELL MILL ROAD
KENLY, NORTH CAROLINA

PBS DESIGNED	PBS DRAWN	KWK CHECKED

SCALE

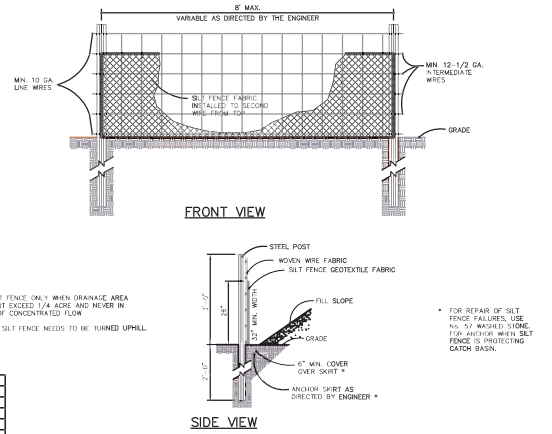
DATE JULY 19, 2006

PROJECT NO. 2691-01-05

2961-02\lowell\dwg\parkfinaldetails

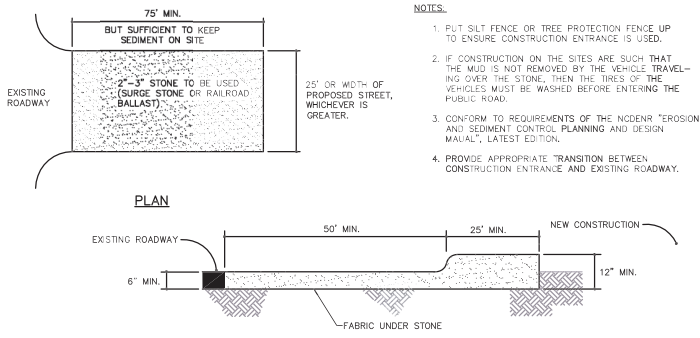
SD2

SHEET NO.



REVISIONS	
DATE	DESCRIPTION

STANDARD TEMPORARY SILT FENCE | 1



NOTES:

1. PUT SILT FENCE OR TREE PROTECTION FENCE UP TO ENSURE CONSTRUCTION ENTRANCE IS USED.
2. IF CONSTRUCTION ON THE SITES ARE SUCH THAT THE MUD IS NOT REMOVED BY THE VEHICLE TRAVELING OVER THE STONE, THEN THE TIRES OF THE VEHICLES MUST BE WASHED BEFORE ENTERING THE PUBLIC ROAD.
3. CONFORM TO REQUIREMENTS OF THE NCDENR "EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL", LATEST EDITION.
4. PROVIDE APPROPRIATE "TRANSITION BETWEEN CONSTRUCTION ENTRANCE AND EXISTING ROADWAY.

REVISIONS	
DATE	DESCRIPTION

CONSTRUCTION ENTRANCE | 7

CONSTRUCTION SEQUENCE / SEDIMENT & EROSION CONTROL NOTES

EROSION AND SEDIMENT CONTROL SHALL PROCEED IN THE FOLLOWING MANNER:

1. PRIOR TO COMMENCEMENT OF WORK, A PRECONSTRUCTION MEETING SHALL BE HELD WITH THE ENGINEER AND REPRESENTATIVES OF THE CONTRACTOR, UTILITIES AND OWNER. AT THIS MEETING, THE SEDIMENT AND EROSION CONTROL PLAN WILL BE DISCUSSED.
2. CONTRACTOR TO STAKE OUT LIMIT OF DISTURBANCE AND VEGETATION TO BE RETAINED. NO DISTURBANCE IS TO TAKE PLACE BEYOND THE LIMITS STAKED. CONTRACTOR SHALL TAKE SPECIAL PRECAUTIONS TO PROTECT TREES AND AND EXISTING IMPROVEMENTS TO REMAIN.
3. CONTRACTOR TO COORDINATE WORK SCHEDULE WITH IMPACTED PROPERTY OWNERS TO MAINTAIN SAFE VEHICLE AND PEDESTRIAN ACCESS AND PARKING. CONTRACTOR TO MINIMIZE DISRUPTION TO THE GREATEST EXTENT PRACTICABLE.
4. CONTRACTOR TO INSTALL SEDIMENT AND EROSION CONTROLS PRIOR TO CLEARING AND GRUBBING. INSTALL CONSTRUCTION ENTRANCE PADS AS DEPICTED ON THE PLANS.
5. THROUGH FLOW OF WATERCOURSE SHALL BE MAINTAINED DURING CONSTRUCTION SO AS NOT TO SUSPEND SEDIMENT FROM EARTHWORK ACTIVITIES.
6. INITIATE EARTHWORK OPERATIONS AFTER ALL SEDIMENT AND EROSION CONTROLS ARE IN PLACE.
7. AREAS OF ACTIVITY AND EXPOSED AREAS ARE TO BE MINIMIZED. STABILIZE ALL SLOPES IMMEDIATELY AFTER THEIR ESTABLISHMENT.
8. ESTABLISH ALL SLOPES TO GRADE IN AREAS OF DISTURBANCE AS SOON AS POSSIBLE. TEMPORARY SEED AND MULCH.
9. THE SEDIMENT AND EROSION CONTROL PLAN MAY BE MODIFIED BY THE SITE ENGINEER AS NECESSITATED BY CHANGING SITE CONDITIONS. ADDITIONAL CONTROL DEVICES BESIDES WHAT IS SHOWN IN PLANS WILL BE ADDED BY THE ENGINEER IF NEEDED.
10. ALL SEDIMENT CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE EVERY SEVEN CALENDAR DAYS AND AFTER STORMS GREATER THAN 0.5 INCHES OF PRECIPITATION DURING ANY 24-HOUR PERIOD. DAMAGED OR INEFFECTIVE DEVICES SHALL BE REPAIRED OR REPLACED, AS NECESSARY. ALL SEDIMENT CONTROL FEATURES SHALL BE MAINTAINED UNTIL FINAL STABILIZATION HAS BEEN OBTAINED.
11. INSPECTION OF THE SITE FOR EROSION SHALL CONTINUE FOR A PERIOD OF THREE MONTHS AFTER COMPLETION WHEN RAINFALLS OF ONE INCH OR MORE OCCUR.
12. ALL EROSION CONTROL DEVICES SHALL BE PROPERLY MAINTAINED DURING ALL PHASES OF CONSTRUCTION UNTIL THE COMPLETION OF ALL CONSTRUCTION ACTIVITIES AND ALL DISTURBED AREAS HAVE BEEN STABILIZED. ALL TEMPORARY CONTROL DEVICES SHALL BE REMOVED WHEN CONSTRUCTION IS COMPLETE AND THE SITE IS STABILIZED.
13. THE CONTRACTOR MUST TAKE NECESSARY ACTION TO MINIMIZE THE TRACKING OF MUD ONTO THE PAVED ROADWAY FROM CONSTRUCTION AREAS. THE CONTRACTOR SHALL REMOVE MUD/SOIL FROM PAVEMENT DAILY, AS MAY BE REQUIRED.
14. THE SITE SHOULD BE KEPT CLEAN OF LOOSE DEBRIS AND BUILDING MATERIALS SUCH THAT NONE OF THE ABOVE ENTER STORMWATER FACILITIES, ROADWAYS, WATERCOURSES, OR WETLANDS.
15. A COPY OF ALL PLANS AND REVISIONS, AND THE SEDIMENT AND EROSION CONTROL PLAN, SHALL BE MAINTAINED ON-SITE AT ALL TIMES DURING CONSTRUCTION.
16. A COPY OF ALL INSPECTION LOGS SHALL BE RETAINED FOR THE DURATION OF THE PROJECT.
17. ALL SEDIMENT AND EROSION CONTROL MEASURES SHALL BE REMOVED ONLY UPON STABILIZATION OF ALL UPGRADIENT AREAS.

SEDIMENT & EROSION CONTROL SPECIFICATIONS

GENERAL:

THESE GUIDELINES SHALL APPLY TO ALL WORK CONSISTING OF ANY AND ALL TEMPORARY AND/OR PERMANENT MEASURES TO CONTROL WATER POLLUTION AND SOIL EROSION, AS MAY BE REQUIRED, DURING THE CONSTRUCTION OF THE PROJECT.

IN GENERAL, ALL CONSTRUCTION ACTIVITIES SHALL PROCEED IN SUCH A MANNER SO AS NOT TO POLLUTE ANY WETLANDS, WATERCOURSE, WATERBODY, CONDUIT CARRYING WATER, ETC. THE CONTRACTOR SHALL LIMIT, INSOFAR AS POSSIBLE, THE SURFACE AREA OF EARTH MATERIALS EXPOSED BY CONSTRUCTION METHODS AND IMMEDIATELY PROVIDE PERMANENT AND TEMPORARY POLLUTION CONTROL MEASURES TO PREVENT CONTAMINATION OF ADJACENT WETLANDS, WATERCOURSES, WATERBODIES AND TO PREVENT, INSOFAR AS POSSIBLE, EROSION ON THE SITE.

LAND GRADING GENERAL:

1. THE RESHAPING OF THE GROUND SURFACE BY EXCAVATION AND FILLING OR A COMBINATION OF BOTH, TO OBTAIN PLANNED GRADES, SHALL PROCEED IN ACCORDANCE WITH THE FOLLOWING CRITERIA:
   a. THE CUT FACE OF EARTH EXCAVATION SHALL NOT BE STEEPER THAN TWO HORIZONTAL TO ONE VERTICAL (2:1).
   b. THE PERMANENT EXPOSED FACES OF FILLS SHALL NOT BE STEEPER THAN TWO HORIZONTAL TO ONE VERTICAL (2:1).
   c. THE CUT FACE OF ROCK EXCAVATION SHALL NOT BE STEEPER THAN ONE HORIZONTAL TO FOUR VERTICAL. (1:4).
   d. PROVISION SHOULD BE MADE TO CONDUCT SURFACE WATER SAFELY TO STORM DRAINS TO PREVENT SURFACE RUNOFF FROM DAMAGING CUT FACES AND FILL SLOPES.

TOPSOILING GENERAL:

1. TOPSOIL SHALL BE SPREAD OVER ALL EXPOSED AREAS IN ORDER TO PROVIDE A SOIL MEDIUM HAVING FAVORABLE CHARACTERISTICS FOR THE ESTABLISHMENT, GROWTH AND MAINTENANCE OF VEGETATION.
2. UPON ATTAINING FINAL SUBGRADES, SCARIFY SURFACE TO PROVIDE A GOOD BOND WITH TOPSOIL.
3. REMOVE ALL LARGE STONES, TREE LIMBS, ROOTS AND CONSTRUCTION DEBRIS.
4. APPLY LIME ACCORDING TO SOIL TEST OR AT THE RATE OF TWO (2) TONS PER ACRE.

MATERIAL:

1. TOPSOIL SHOULD HAVE PHYSICAL, CHEMICAL AND BIOLOGICAL CHARACTERISTICS FAVORABLE TO THE GROWTH OF PLANTS.
2. TOPSOIL SHOULD HAVE A SANDY OR LOAMY TEXTURE.
3. TOPSOIL SHOULD BE RELATIVELY FREE OF SUBSOIL MATERIAL AND MUST BE FREE OF STONES (OVER 1" IN DIAMETER), LUMPS OF SOIL, ROOTS, TREE LIMBS AND TRASH OR CONSTRUCTION DEBRIS. IT SHOULD BE FREE OF ROOTS OR RHIZOMES SUCH AS THISTLE, NUTGRASS AND QUACKGRASS.
4. AN ORGANIC MATTER CONTENT OF SIX PERCENT (6%) IS REQUIRED. AVOID LIGHT COLORED SUBSOIL MATERIAL.
5. SOLUBLE SALT CONTENT OF OVER 500 PARTS PER MILLION (PPM) IS LESS SUITABLE. AVOID TIDAL MARSH SOILS BECAUSE OF HIGH SALT CONTENT AND SULFUR ACIDITY.
6. THE pH SHOULD BE MORE THAN 6.0. IF LESS, ADD LIME TO INCREASE pH TO AN ACCEPTABLE LEVEL.

APPLICATION:

1. AVOID SPREADING WHEN TOPSOIL IS WET OR FROZEN.
2. SPREAD TOPSOIL UNIFORMLY TO A DEPTH OF AT LEAST SIX INCHES (6") OR TO THE DEPTH SHOWN ON THE LANDSCAPING PLANS.

TEMPORARY VEGETATIVE COVER

1. TEMPORARY VEGETATIVE COVER SHALL BE ESTABLISHED ON ALL UNPROTECTED AREAS THAT PRODUCE SEDIMENT, AREAS WHERE FINAL GRADING HAS BEEN COMPLETED AND AREAS WHERE THE ESTIMATED PERIOD OF BARE SOIL EXPOSURE IS LESS THAN 12 MONTHS. TEMPORARY SEED AND MULCH ALL DISTURBED AREAS ACCORDING TO NCDOT STANDARD SPECIFICATIONS.

SITE PREPARATION:

1. INSTALL REQUIRED SURFACE WATER CONTROL MEASURES.
2. REMOVE LOOSE ROCK, STONE AND CONSTRUCTION DEBRIS FROM AREA.
3. APPLY LIME ACCORDING TO SOIL TEST OR AT A RATE OF ONE 45 LBS OF GROUND DOLOMITIC LIMESTONE PER SF.
4. APPLY FERTILIZER ACCORDING TO SOIL TEST OR AT THE RATE OF 1000 LBS. OF 10-10-10 PER ACRE (23 LBS. PER 1,000 SQ. FT.) AND SECOND APPLICATION OF 200 LBS. OF 10-10-10 PER ACRE(5 LBS. PER 1,000 SQ. FT.) WHEN GRASS IS FOUR INCHES (4") TO SIX INCHES (6") HIGH. APPLY ONLY WHEN GRASS IS DRY.
5. UNLESS HYDROSEEDED, WORK IN LIME AND FERTILIZER TO A DEPTH OF FOUR (4") INCHES USING A DISK OR ANY SUITABLE EQUIPMENT.
6. TILLAGE SHOULD ACHIEVE A REASONABLY UNIFORM, LOOSE SEEDBED. WORK ON CONTOUR IF SITE IS SLOPING.

ESTABLISHMENT:

1. SELECT APPROPRIATE SPECIES FOR THE SITUATION. NOTE RATES AND SEEDING DATES (SEE VEGETATIVE COVER SELECTION & MULCHING SPECIFICATION).
2. APPLY SEED UNIFORMLY ACCORDING TO THE RATE INDICATED BY BROADCASTING, DRILLING OR HYDRAULIC APPLICATION.
3. UNLESS HYDROSEEDED, COVER RYE GRAIN WITH NOT MORE THAN 1/4 INCH OF SOIL USING SUITABLE EQUIPMENT.
4. MULCH IMMEDIATELY AFTER SEEDING IF REQUIRED (SEE VEGETATIVE COVER SELECTION & MULCHING SPECIFICATION BELOW). APPLY STRAW OR HAY MULCH AND ANCHOR TO SLOPES GREATER THAN 3% OR WHERE CONCENTRATED FLOW WILL OCCUR.

VEGETATIVE COVER GENERAL:

1. PERMANENT VEGETATIVE COVER SHALL BE ESTABLISHED AS VARIOUS SECTIONS OF THE PROJECT ARE COMPLETED IN ORDER TO STABILIZE THE SOIL, REDUCE DOWNSTREAM DAMAGE FROM SEDIMENT AND RUNOFF, AND TO ENHANCE THE AESTHETIC NATURE OF THE SITE. IT WILL BE APPLIED TO ALL CONSTRUCTION AREAS SUBJECT TO EROSION WHERE FINAL GRADING HAS BEEN COMPLETED AND A PERMANENT COVER IS NEEDED.

SITE PREPARATION:

1. INSTALL REQUIRED SURFACE WATER CONTROL MEASURES.
2. REMOVE LOOSE ROCK, STONE AND CONSTRUCTION DEBRIS FROM AREA.
3. PERFORM ALL PLANTING OPERATIONS PARALLEL TO THE CONTOURS OF THE SLOPE.
4. APPLY TOPSOIL AS INDICATED ELSEWHERE HEREIN.
5. APPLY FERTILIZER ACCORDING TO SOIL TEST OR:
   - OF 10-10-10 FERTILIZER PER ACRE (23 LBS. PER 1,000 SQ. FT.); THEN SIX TO EIGHT WEEKS LATER, APPLY ON THE SURFACE AN ADDITIONAL 300 LBS. OF 10-10-10 FERTILIZER PER ACRE. AFTER SEPTEMBER 1, TEMPORARY VEGETATIVE COVER SHALL BE APPLIED.

VEGETATIVE COVER SELECTION & MULCHING TEMPORARY VEGETATIVE COVER:

JANUARY 1 – APRIL 15
RYE GRAIN
120 LBS/AC

APRIL 15 – AUGUST 15
GERMAN MILLET
40 LBS/AC

AUGUST 15 – DECEMBER 30
RYE GRAIN
120 LBS/AC

SOIL AMENDMENTS FOR TEMOPORARY VEGETATION

AGRICULTURAL LIMESTONE 2000LBS/AC
10-10-10 FERTILIZED 1000LBS/AC
MULCH/STRAW 4000 LBS/AC

PERMANENT VEGETATIVE COVER:

PERMANENT GRASS: COMMON BERMUDAGRASS, CYNODON DACTYLON AT 7LBS/ACRE OR APPROVED EQUAL

TEMPORARY MULCHING:
STRAW OR HAY 70-90 LBS./1,000 SQ.FT.
(TEMPORARY VEGETATIVE AREAS)

WOOD FIBER IN HYDROMULCH SLURRY 25-50 LBS./1,000 SQ. FT.

ESTABLISHMENT:

1. SMOOTH AND FIRM SEEDBED WITH CULTIPACKER OR OTHER SIMILAR EQUIPMENT PRIOR TO SEEDING (EXCEPT WHEN HYDROSEEDING).
2. SELECT ADAPTED SEED MIXTURE FOR THE SPECIFIC SITUATION. NOTE RATES AND THE SEEDING DATES (SEE VEGETATIVE COVER SELECTION & MULCHING SPECIFICATION BELOW).
3. APPLY SEED UNIFORMLY ACCORDING TO RATE INDICATED, BY BROADCASTING, DRILLING OR HYDRAULIC APPLICATION.
4. COVER GRASS AND LEGUME SEED WITH NOT MORE THAN 1/4 INCH OF SOIL WITH SUITABLE EQUIPMENT (EXCEPT WHEN HYDROSEEDING).
5. MULCH IMMEDIATELY AFTER SEEDING, IF REQUIRED, ACCORDING TO TEMPORARY MULCHING SPECIFICATIONS. (SEE VEGETATIVE COVER SELECTION & MULCHING SPECIFICATION BELOW).
6. USE PROPER INOCULANT ON ALL LEGUME SEEDINGS, USE FOUR TIMES NORMAL RATES WHEN HYDROSEEDING.
7. USE SOD WHERE THERE IS A HEAVY CONCENTRATION OF WATER AND IN CRITICAL AREAS WHERE IT IS IMPORTANT TO GET A QUICK VEGETATIVE COVER TO PREVENT EROSION.

MAINTENANCE:

1. TEST FOR SOIL ACIDITY EVERY THREE YEARS AND LIME AS REQUIRED.
2. ON SITES WHERE GRASSES PREDOMINATE, BROADCAST ANNUALLY 500 POUNDS OF 10-10-10 FERTILIZER PER ACRE (12 LBS. PER 1,000 SQ. FT.) OR AS NEEDED ACCORDING TO ANNUAL SOIL TESTS.
3. ON SITES WHERE LEGUMES PREDOMINATE, BROADCAST EVERY THREE YEARS OR AS INDICATED BY SOIL TEST 300 POUNDS OF 0-20-20 OR EQUIVALENT PER ACRE (8 LBS PER 1,000 SQ. FT.).

Engineering, Landscape Architecture, Land Development Science
MILONE & MACBROOM
307-B Falls Street
Greenville, SC 29601
(864) 232-7776
www.milonemacbroom.com

REVISIONS

SEDIMENT & EROSION CONTROL DETAILS

LITTLE RIVER
JOHNSTON COUNTY PARK PLAN

LOWELL MILL ROAD
KENLY, NORTH CAROLINA

PBS	PBS	KWK
DESIGNED	DRAWN	CHECKED

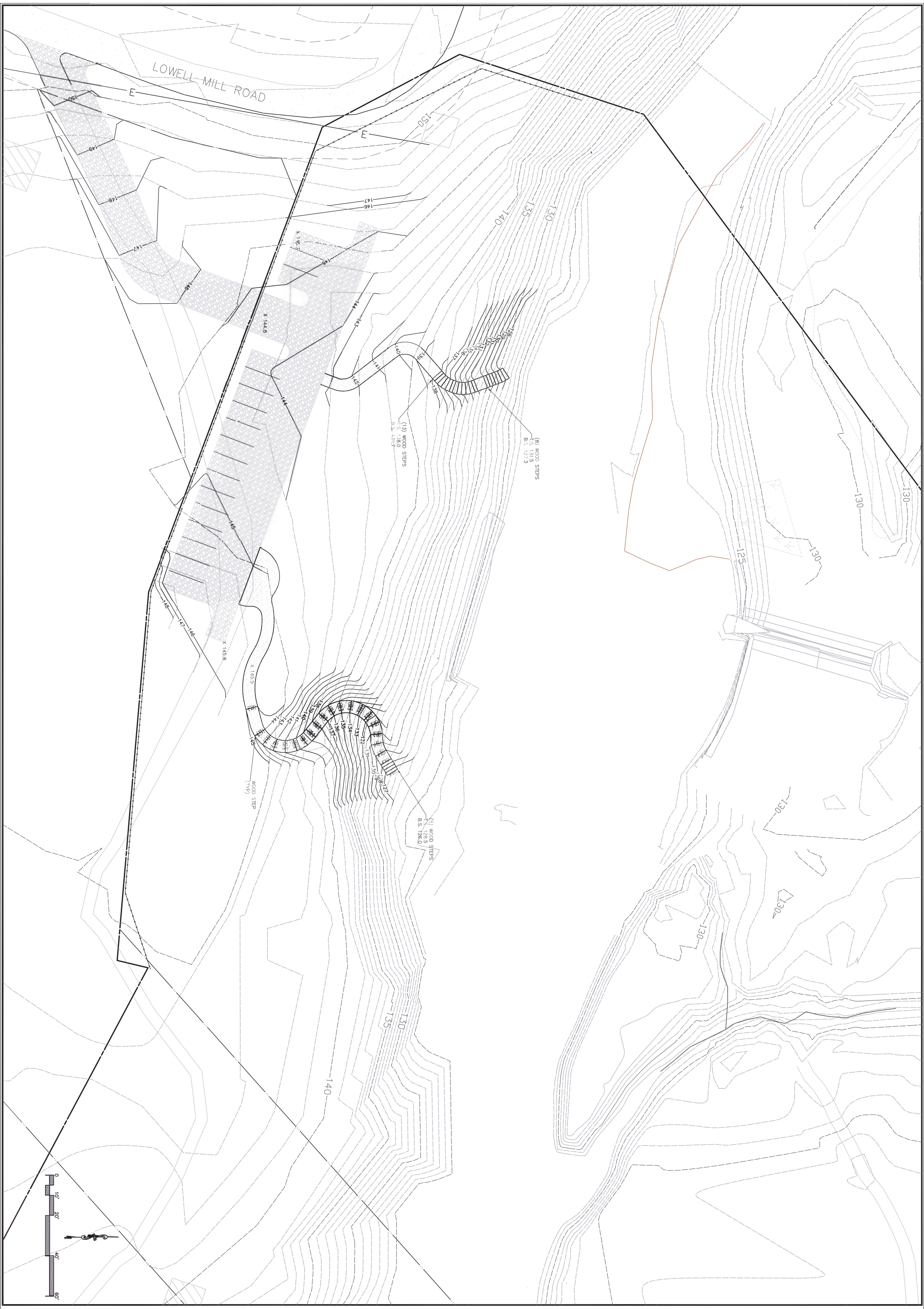
SCALE

DATE JULY 19, 2006

PROJECT NO. 2691-01-05

2961-02\cad\dwg\parkfinal\sddetails

SHEET NO. SD1



SHEET NO. G1

DWG NAME pantsgrading

PROJECT NO. 2691-02

DATE JULY 19, 2006

SCALE 1"=20'

DESIGNED PBS

DRAWN PBS

CHECKED KWK

GRADING PLAN

LITTLE RIVER
JOHNSTON COUNTY PARK PLAN

LOWELL MILL ROAD
KENLY, NORTH CAROLINA

REVISIONS

Engineering, Landscape Architecture and Environmental Science

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307B Falls Street
Greenville, South Carolina 29601
(864) 271-9598 Fax (864) 271-4135
www.miloneandmacbroom.com

SHEET NO. L1

DWG NAME parkstyout

PROJECT NO. 2691-02

DATE JULY 19, 2006

SCALE 1"=20'

DESIGNED PBS

DRAWN PBS

CHECKED KWK

LAYOUT PLAN

LITTLE RIVER
JOHNSTON COUNTY PARK PLAN

LOWELL MILL ROAD
KENLY, NORTH CAROLINA

REVISIONS

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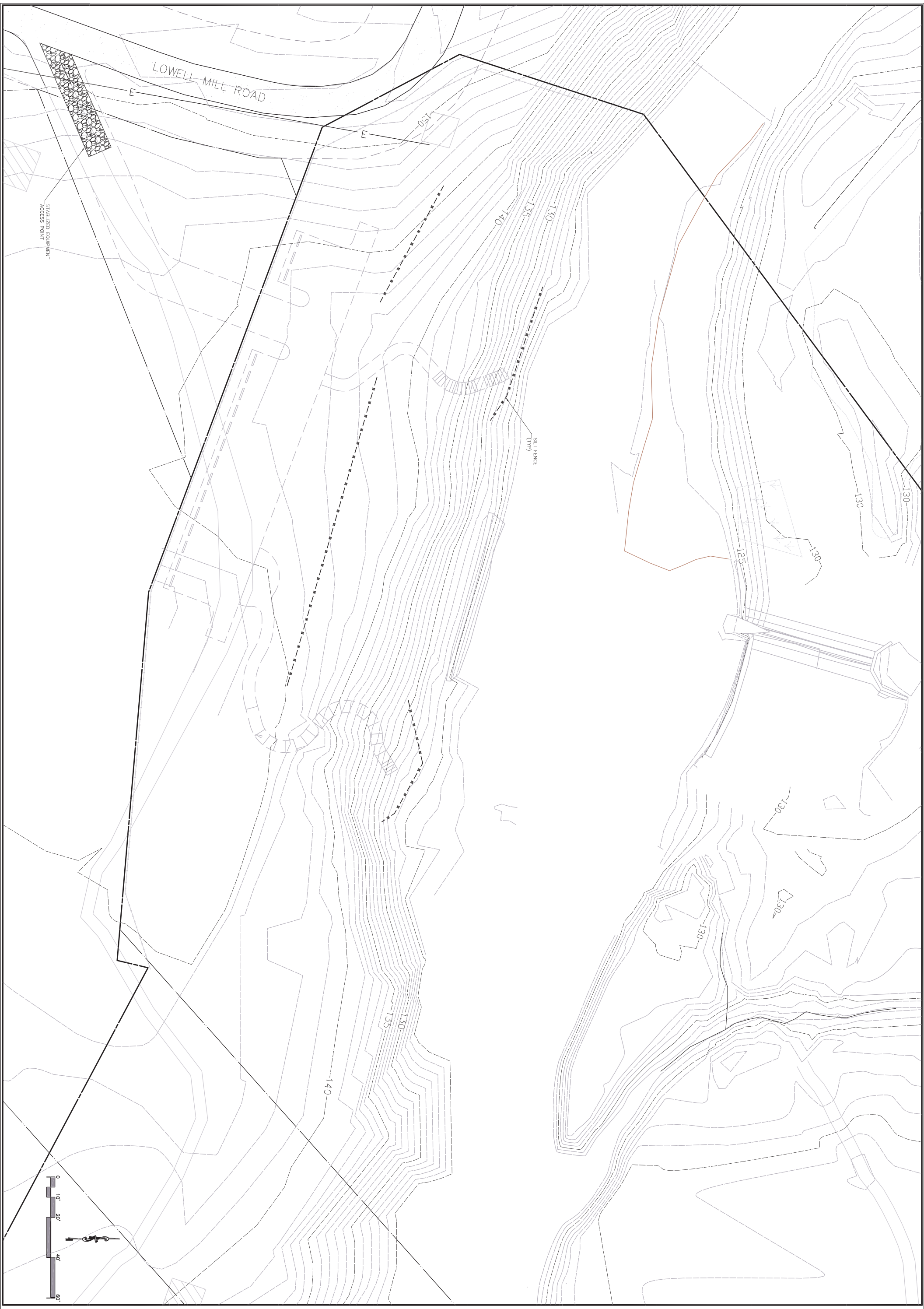

SEDIMENT & EROSION CONTROL PLAN

LITTLE RIVER
JOHNSTON COUNTY PARK PLAN

LOWELL MILL ROAD
KENLY, NORTH CAROLINA

REVISIONS

SHEET NO. SE1

DWG NAME park-s4a

PROJECT NO. 2691-02

DATE JULY 19, 2006

SCALE 1"=20'

DESIGNED PBS
DRAWN PBS
CHECKED KWK

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APPENDIX F: Lowell Mill Dam Site Park Plans (Milone and MacBroom, Inc.)

APPENDIX G: Erosion Evaluation Report

EcoScience

EcoScience Corporation

1101 Haynes Street, Suite 101
Raleigh, North Carolina 919-828-3433

MEMORANDUM

TO: George Howard,
Restoration Systems, LLC (RS)

FROM: Jens Geratz

DATE: June 30, 2006

RE: Erosion Evaluation No. 1 (6-20-2006) **06-276**

INTRODUCTION

The North Carolina Division of Water Quality (NCDWQ) Section 401 permit condition #8 associated with the Lowell Mill Dam – Little River Watershed Restoration Site requires that a "survey [of] the present lake bed and its flooded tributaries [shall occur] at least every two weeks (bi-weekly) or within three days of a rain more than or equal to one inch at Princeton, NC." Modifications to the permit condition described above are proposed. The text below describes the reason behind the modification and proposed methodology to satisfy, in spirit, the permit condition set forth in the permit.

The permit condition requested by NCDWQ presents several logistical difficulties. First, only a USGS river gauge is present near Princeton. No publicly available or trustworthy real-time weather data are available in or around Princeton, NC. The nearest weather station to Princeton is located in Smithfield, NC. Second, ESC believes that using rainfall from one weather station from within the 215-square mile watershed is not properly indicative of increased river stage conditions within the former impoundment. Thus, ESC has investigated and developed a new method for determining when a field evaluation should be performed.

In preparation of the erosion evaluation, EcoScience Corporation (ESC) collected three years of continuous daily precipitation and river stage data from 1990 through 1993. The data showed that a one inch rainfall event is a relatively commonplace weather occurrence. If the permit condition #8 remains as stated, then more than 33 field evaluations (>10 per year) would have been required during the period for which ESC collected the correlated rain/river stage data. It is important to note that one inch rain events do not appear to have a corresponding rise in river stage. Since the perceived purpose of the NCDWQ permit condition is to evaluate the former impoundment after increased river stage to monitor for erosion, then a one inch rainfall event is not the best indicator for the initiation of a site evaluation. Isolated thunderstorms can produce large amounts of precipitation in a localized area, without contributing significant rain to the overall watershed. To monitor multiple weather stations in real-time throughout the watershed to identify a regional precipitation event is time consuming and not practicable. Alternatively, ESC proposes to use the correlation between large, regional rain events that cause more than a 750 cubic feet per second (cfs) reading at the Princeton gauging station (USGS 02088500) to be the "initiation threshold" for a field evaluation. ESC estimates that this initiation threshold will occur after a river stage rise equal to approximately 30 percent of bankfull.

Once the initiation threshold for evaluation has been exceeded, ESC proposes that we monitor the river stage until the river falls below 500 cfs, which is proposed as an "evaluation threshold" river stage. Once the river stage falls below the evaluation threshold, ESC personnel will perform an erosion evaluation within a 72 hour period. Using the initiation and evaluation thresholds for the field effort will facilitate ESC personnel in reviewing the former impoundment under the safest and most data productive periods after a substantial rise in river stage.

In order to satisfy the modified permit condition #9, RS has authorized EcoScience Corporation (ESC) to conduct weather related erosion evaluation within the former Lowell Mill Dam Impoundment (ESC Proposal P06-004 January 19, 2006). The purpose of the evaluation is to document any evidence of erosion within the former dam impoundment including but not limited to bank failure, loss of stream bank trees, severe head-cuts, and the loss or gain of large depositional features.

The remnants of Alberto, the season first tropical storm unleashed heavy rain over a large area of central North Carolina on June 13, 2006 (Figure 1). The National Weather Service recorded 7.6 inches of rain at its Raleigh office with as much as 8 inches of rain recorded along the storm's path (Figure 2). Included in the storms path was the upper watershed of the Little River including Wake, Franklin, and Johnston counties. The resulting event caused the USGS gauge at Princeton to register a peak discharge on June 18, 2006 of 2370 cubic feet per second (cfs) (Figure 3). The initiation threshold occurred on June 14th and the evaluation threshold occurred on June 20th. An erosion evaluation was conducted within the former impounded reaches of the Little River on June 20, 2006.

LITTLE RIVER EROSION EVALUATION

A two-person team performed a 7-mile canoe transit of the Little River. The point of ingress was the bridge crossing at Old Beulah Road (SR1934) and the point of egress was the former Lowell Mill Dam location (Figure 4). The team stopped at the mouth of all credited tributaries as well as at points along the river where notable conditions occurred. At each observation point, GPS data was collected for the location, photographs were taken, and notes where recorded to describe the condition.

River Observation Point 1

River Observation Point 1 is located on the Little River within Horsehead Bend (Figure 4). At this point on the Little River, the sediment deposition on vegetation is clearly observed at or near bankfull height following the rise in storm flow. Numerous other areas along the canoe transit were observed to have sediment deposition at a similar height (Photo 1).

River Observation Point 2

River Observation Point 2 is located on the Little River at the Wildlife Resource Commission boat ramp (Figure 4). At this location sediment was observed to have been deposited approximately 5 feet up the ramp signifying the high water mark following the rise in storm flow (Photo 2).

River Observation Point 3

River Observation Point 3 is located on the Little River approximately 1000 feet downstream of the Wildlife Resource Commission boat ramp (Figure 4). At this location a newly formed log jam caused by a recent tree fall created an obstruction across the entire length of the Little River. The tree was most likely uprooted due to instability as a result of it's location on the river bank. Additional woody debris and floating particulate has begun to collect behind the fallen tree (Photos 3-4).

River Observation Point 4

River Observation Point 4 is located on the Little River approximately 600 feet below the US 301 bridge crossing (Figure 4). Battery Bar, named for the presence of discarded batteries, was formerly a large depositional area constricting flow at this location. Following the rise in storm flow the sandbar was observed to have been downsized significantly due to an increase in sediment transport capacity. The channel is currently reestablishing bankfull dimensions (Photos 5-8).

River Observation Point 5

River Observation Point 5 is located on the Little River approximately 1100 feet below the CSX Seaboard Rail crossing (Figure 4). At this location well established herbaceous vegetation was observed along both banks of the river below the elevation of the former dam crest pool. The establishment of herbaceous vegetation aids in stabilizing the banks and preventing loss of bank material following the rise in storm flow (Photo 9).

River Observation Point 6

River Observation Point 6 is located on the Little River approximately half way between the CSX Seaboard Rail crossing and the I-95 overpass (Figure 4). At this location well established herbaceous vegetation was observed along both banks of the river below the elevation of the former dam crest pool. The establishment of herbaceous vegetation aids in stabilizing the banks and preventing loss of bank material following the rise in storm flow (Photo 10).

River Observation Point 7

River Observation Point 7 is located on the Little River at the I-95 overpass (Figure 4). At this location well established herbaceous vegetation was observed along both banks of the river below the elevation of the former dam crest pool. Within the NCDOT right-of-way the vegetation has been mowed. The establishment of herbaceous vegetation aids in stabilizing the banks and preventing loss of bank material following the rise in storm flow. The bridge pilings located within the Little River contained only a small amount of debris and no evidence of scouring was observed (Photos 11-12).

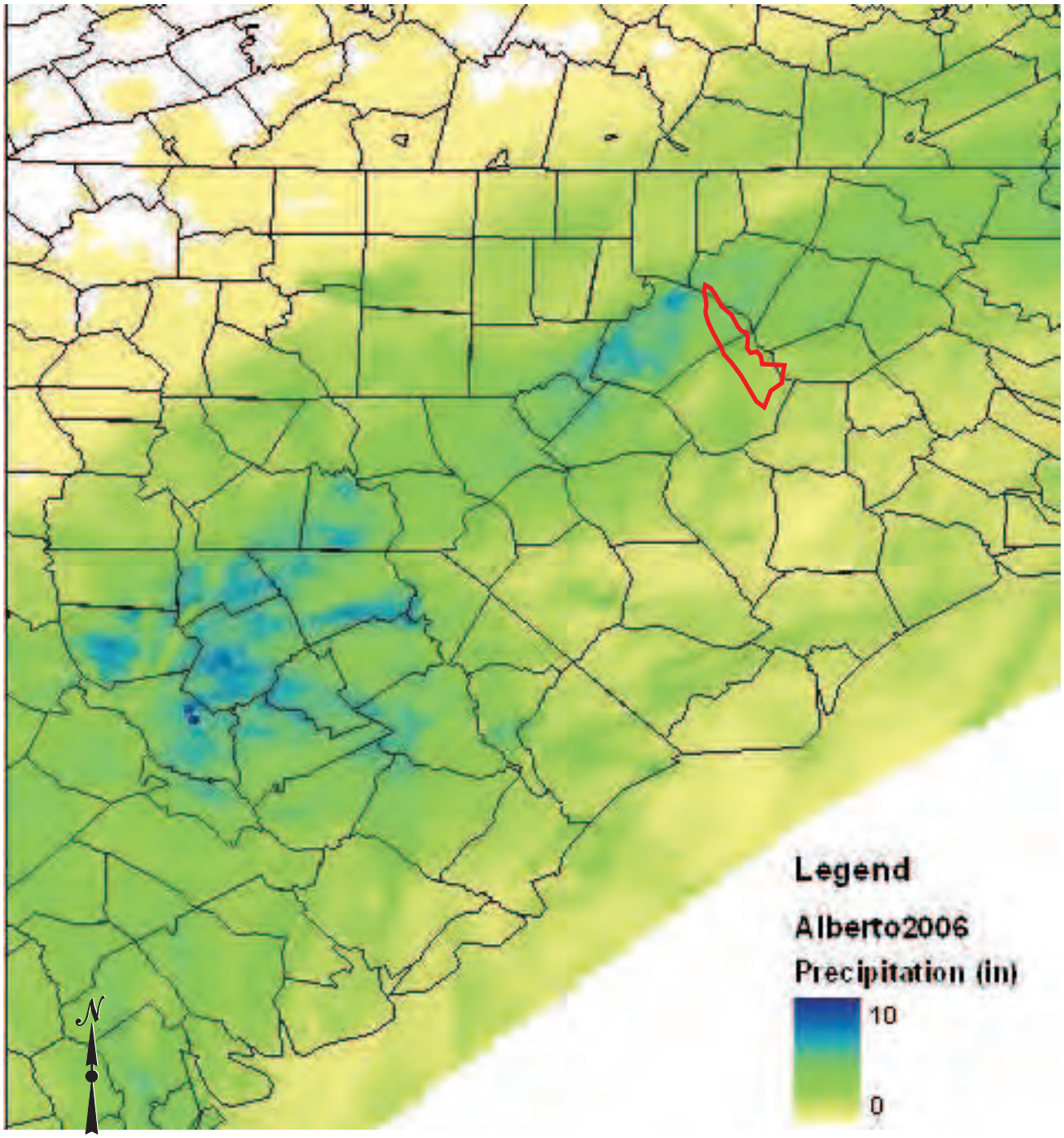
River Observation Point 8

River Observation Point 8 is located approximately 300 feet upstream of the former dam site (Figure 4). At this location a change in river dynamic was observed as a result of a log jam break directly upstream of the former dam. Several feet of sediment and organic debris was scoured from the river bank and transported downstream. Additional scouring of the river bank may occur until herbaceous vegetation is able to reestablish (Photos 13-14).

River Observation Point 9

River Observation Point 8 is located along the inside bend of the Little River at the former dam site (Figure 4). At this location a sand bar is forming as result of sediment deposition that has accumulated on the inside bend of the channel. Newly established herbaceous vegetation has begun to establish along the bar. Swift moving water was observed to be flowing only in the center of the channel, with slack water present at the over widened reach along the left bank. Additional sediment may continue to deposit along the newly formed bar as the Little River narrows to a width consistent with other reaches. Toe of slope protection and vegetation along the south embankment of the former dam site was intact following the rise in storm flow (Photos 15-18).

LITTLE RIVER EROSION EVALUATION FIGURES



Source: National Weather Service
http:/www4.ncsu.edu/~nwsfo/storage/cases/20060614/

0 25 50 mi.

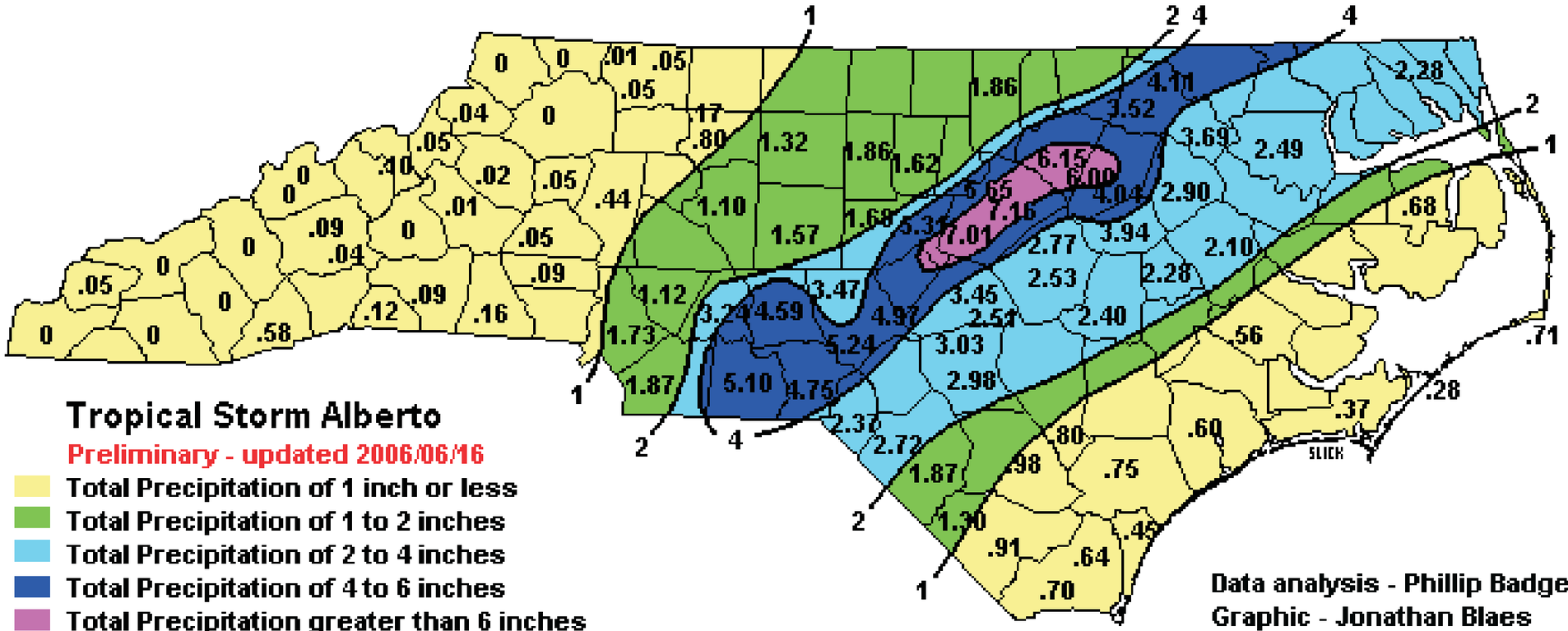
Little River Watershed

EcoScience Corporation
Raleigh, North Carolina

ALBERTO PRECIPITATION EVENT
Lowell Mill Dam Restoration Site
Johnston County, North Carolina

Dwn. by:	JWG
Ckd by:	JWG
Date:	JUN 2006
Project:	06-276

FIGURE
1



EcoScience Corporation
Raleigh, North Carolina 27605

Client:
Restoration Systems, LLC
Natural Resources Restoration & Conservation

Project:
LOWELL MILL DAM RESTORATION SITE

RICHMOND COUNTY, NORTH CAROLINA

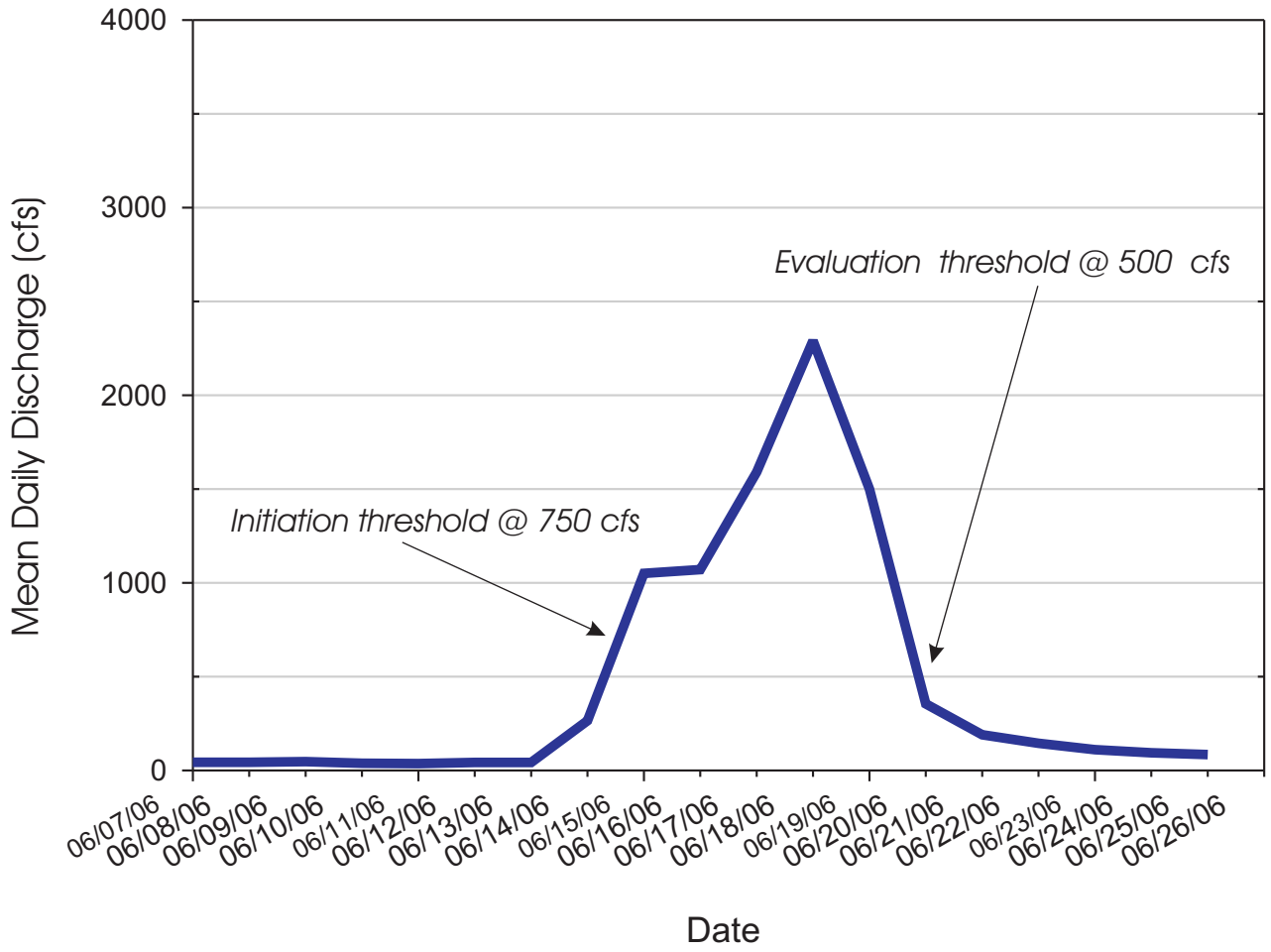
Title:
PRECIPITATION TOTALS FROM TROPICAL STORM ALBERTO

Dwn By:	Date:
JWG	June 2006
Ckd By:	Scale:
JWG	As Shown

ESC Project No.: 06-276

FIGURE
2

USGS 02088500 Little River near Princeton, NC

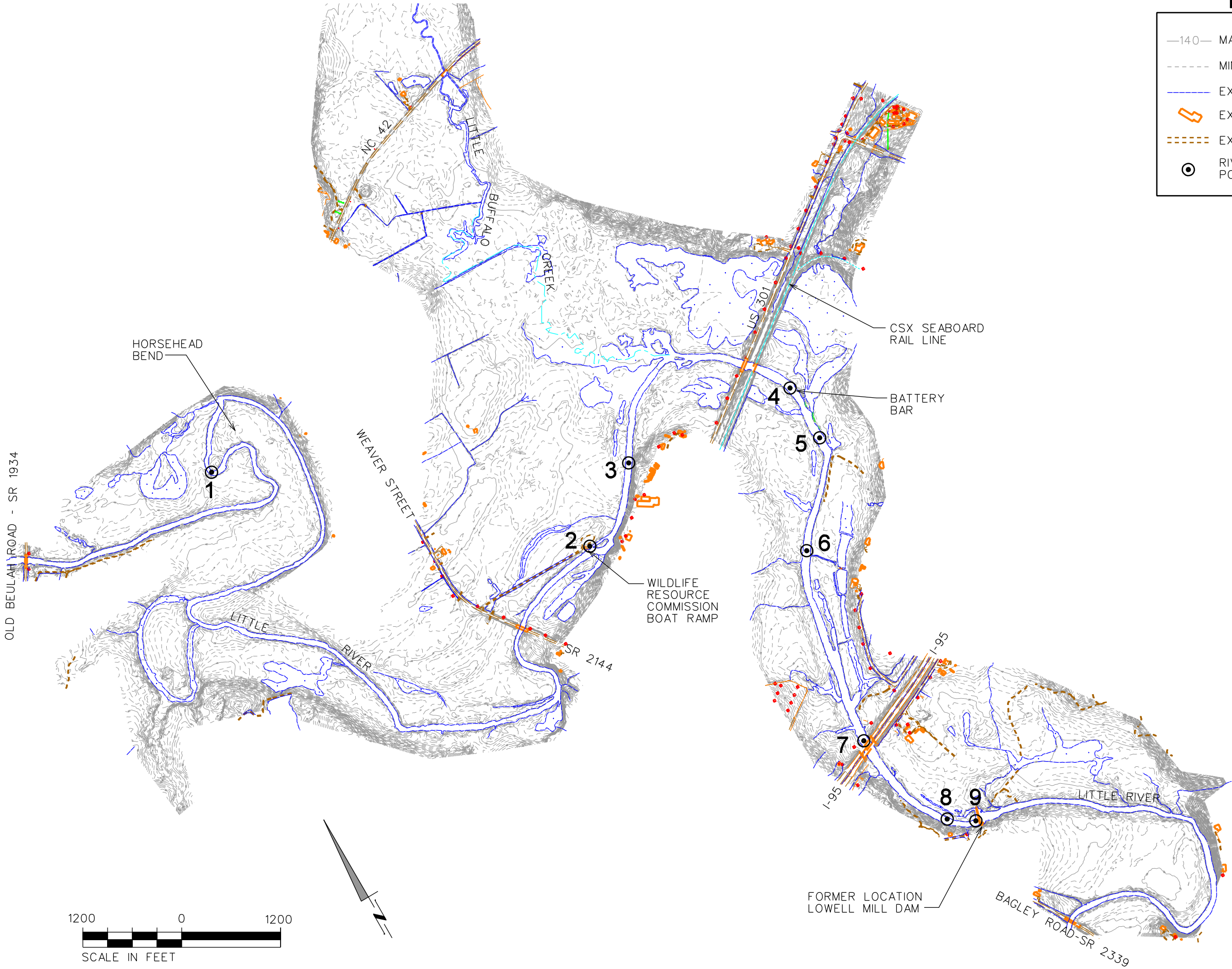


EcoScience Corporation
Raleigh, North Carolina

EVENT DISCHARGE AT GAUGE NEAR PRINCETON
LOWELL MILL DAM RESTORATION SITE
Erosion Evaluation (6-20-2006)
Johnston County, North Carolina

Dwn. by:	JWG
Ckd by:	JWG
Date:	Jun 2006
Project:	06-276

FIGURE 3



EcoScience Corporation
Raleigh, North Carolina

Client:

Restoration Systems, LLC
Natural Resources Restoration & Conservation

Ecosystem Enhancement Program

Project:

LOWELL MILL DAM RESTORATION SITE

JOHNSTON COUNTY, NORTH CAROLINA

Title:

EROSION EVALUATION OBSERVATION POINTS

6-20-2006

Dwn By:	Date:
MAF	JUN 2006
Ckd By:	Scale:
JWG	1"=1200'

ESC Project No.: 06-276

FIGURE

4

LITTLE RIVER EROSION EVALUATION PHOTOS

Photo 1. River Observation Point 1. Sediment deposition on vegetation indicating discharge at or near bankfull in Horsehead Bend. Little River, Johnston County.

Photo 2. River Observation Point 2. Sediment deposition and high water mark at the Wildlife Resource Commission boat ramp. Little River, Johnston County.

Photo 3. River Observation Point 3. Newly formed log jam caused by recent tree fall. Little River, Johnston County.

Photo 4. River Observation Point 3. Newly formed log jam looking upstream. Little River, Johnston County.

Photo 5. River Observation Point 4. Change in sediment transport capacity has caused the removal of a large section of Battery Bar, formerly a large depositional area constricting flow. Little River, Johnston County.

Photo 6. River Observation Point 4. The remains of Battery Bar located approximately 600 feet below US 301 crossing, looking downstream. Little River, Johnston County.

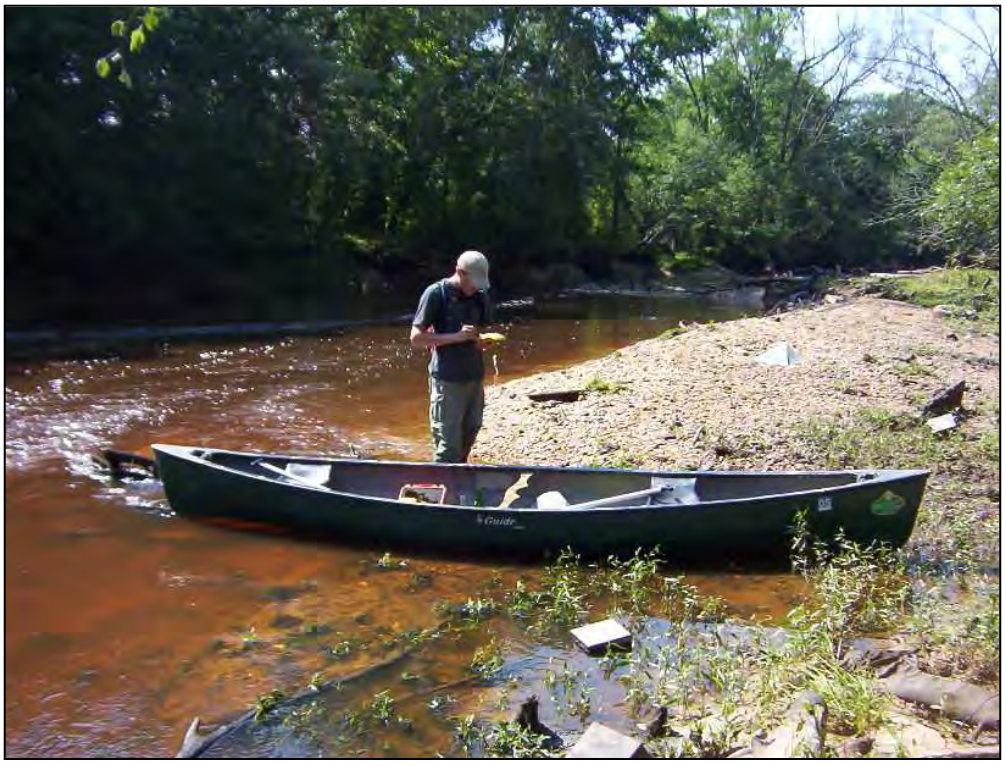


Photo 7. River Observation Point 4. Establishing GPS coordinates at Battery Bar, named for the discarded batteries found at this location. Batteries visible in foreground, Little River, Johnston County.

Photo 8. River Observation Point 4. Reestablishment of channel dimensions at Batter Bar, looking upstream toward CSX Seaboard bridge viewed in background. Little River, Johnston County.

Photo 9. River Observation Point 5. Well established herbaceous vegetation along the banks of the river below the elevation of the former dam crest pool. Little River, Johnston County.

Photo 10. River Observation Point 6. Herbaceous vegetation establishment along both banks of the river, within the former Site Impoundment. Little River, Johnston County.

Photo 11. **River Observation Point 7.** Well established herbaceous vegetation along the north banks of the river at the I-95 overpass. Note the vegetation in the NCDOT right-of-way has been mowed. Little River, Johnston County.

Photo 12. **River Observation Point 7.** Photo looking upstream at the I-95 overpass. Note: No evidence of scouring and only a small amount of debris among the pilings. Little River, Johnston County.

Photo 13. River Observation Point 8. Change in river dynamics as evidenced by log jam break directly upstream of the former dam. Little River, Johnston County.

Photo 14. River Observation Point 8. Transport of several feet of sediment and organic debris from log jam Little River, Johnston County.

Photo 15. River Observation Point 9. Sediment deposition and bar formation along the inside bend of the river at the former dam site. Note swift moving water in center of channel. Little River, Johnston County.

Photo 16. **River Observation Point 9.** Sediment deposition and bar formation along the inside bend of the river at the former dam site. Note slack water at the over widened reach of river through to the right of the dam remnant. Little River, Johnston County.

Photo 17. **River Observation Point 9.** Toe of slope protection along the south embankment, location of the dam's south abutment and mill works. Little River, Johnston County.

Photo 18. **River Observation Point 9.** Photo taken from the remnant dam structure (north bank) looking south at the toe protection placed at the location of the dam's south abutment and mill works. Little River, Johnston County.