Neu-Con Umbrella Wetland and Stream Mitigation Bank

Westbrook Lowgrounds Wetland and Stream Mitigation Site
Annual Monitoring Report for 2004 (Year 2)

Environmental Banc & Exchange, LLC
Managers, Bankers, and Traders of Environmental Rights

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ANNUAL REPORT FOR 2004 (Year 2)

Westbrook Lowgrounds Mitigation Site

SUMMARY

This Annual Report details the monitoring activities during the 2004 growing season on the Westbrook Lowgrounds Mitigation Site. Construction of the site, including planting of trees, was completed in February 2003. The 2004 data represents results from the second year of hydrologic and vegetation monitoring for both wetlands and streams.

The design for the Westbrook Lowlands property involved the restoration of a Coastal Plain small stream swamp and associated wet flats as described by Schafale and Weakley (1990). The Coastal Plain small stream swamp communities exist as the floodplains of small blackwater streams in which separate fluvial features and associated vegetation are too small or poorly developed to distinguish. After construction, it was determined that 5,414 feet of stream and 66.2 acres of wetland hydrology were restored.

This Annual Report presents the data from five hydrologic monitoring stations, 13 vegetation monitoring stations, and stream monitoring, as required by the approved Mitigation Plan for the site. Two of the hydrologic stations are equipped with manual groundwater gauges and three stations are equipped with automated gauges and a manual calibration gauge. Additionally, the gauges are used as points from which photographs are taken over time.

Weather station data from the Smithfield Weather Station were used in conjunction with a manual rain gauge located on the site to document precipitation amounts. The manual gauge is used to validate observations made at the automated station. For the 2004 growing season, total rainfall during the monitoring period approximated the long-term average. However, the spring months were unusually dry, with much of the rainfall for the period occurring in the months of May, June, and August.

In 2004, three of five hydrology monitoring gauges have met the hydrologic success criteria based on field observations. One of the remaining gauges that did not meet success criteria exhibited a hydroperiod greater than 5% of the growing season, and correlated well with data collected from gauges located on the reference site and with the associated wetland systems that are targeted. The remaining gauge that did not meet success criteria exhibited conditions drier than expected. Based on these results, it was concluded that most of the site is performing as designed; however, one area on the western side of the site may require remedial action to improve hydrologic performance.

Thirteen monitoring plots 0.1 acre in size were used to predict survivability of the woody vegetation planted on site. The vegetation monitoring indicated an average survivability of over 520 stems per acre, which is on a trajectory to achieve the initial vegetation survival criteria of 320 stems per acre surviving after the third growing season.

1. INTRODUCTION

1.1 PROJECT DESCRIPTION

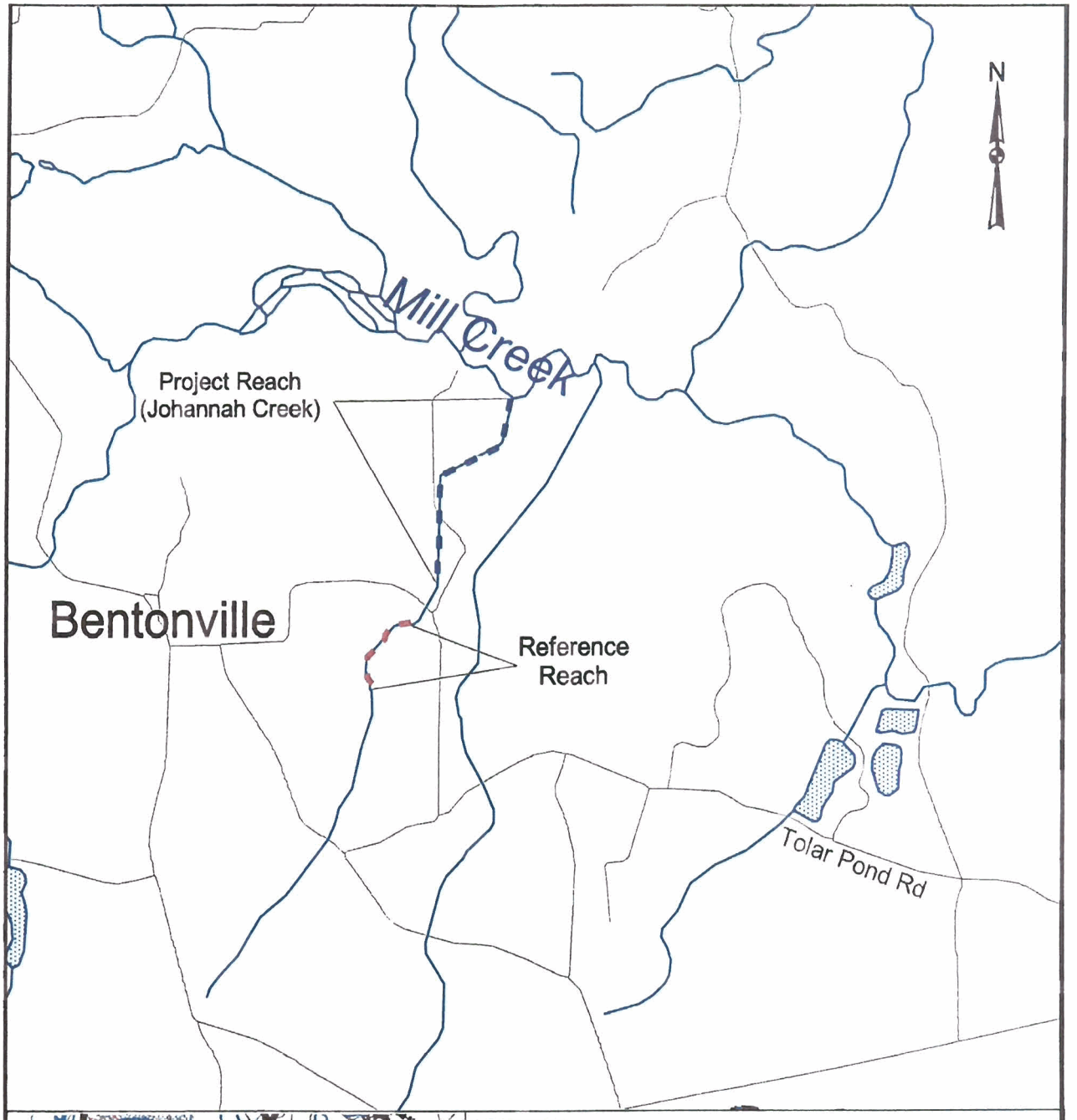
Located in Johnston County, the entire Westbrook Lowlands Mitigation Site encompasses approximately 140 acres. It is located approximately one mile east of the town of Bentonville, North Carolina (Figure 1). This project provides compensatory mitigation for stream and wetland impacts associated within the resident hydrologic unit. The Westbrook Lowlands site is designed to restore a Coastal Plain small stream swamp and associated wet flats as described by Schafale and Weakley (1990). The Coastal Plain small stream swamp communities exist as the floodplains of small blackwater streams in which separate fluvial features and associated vegetation are too small or poorly developed to distinguish. Construction was completed in January 2003, with 66.2 acres of planting being completed in February 2003. Groundwater, surface water, and rain gauges were functional beginning March 7, 2003. The 2004 monitoring season represents the second year of monitoring for the site.

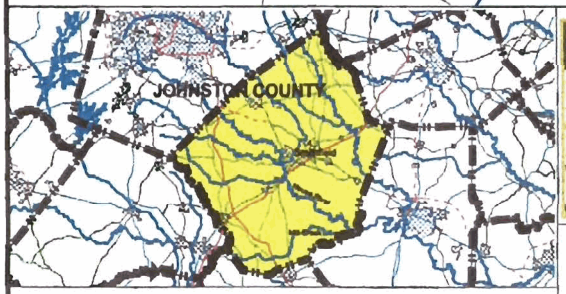
1.2 PURPOSE

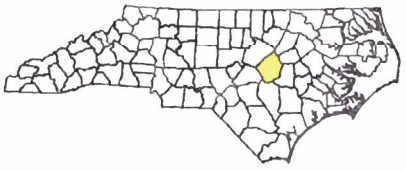
Monitoring of the Westbrook Lowland Site is required to demonstrate successful mitigation based on the criteria found in the Mitigation Plan, the Neu-Con Umbrella Stream and Wetland Mitigation Bank Instrument, and through a comparison to reference site conditions. Hydrologic, vegetation, and stream monitoring are conducted on an annual basis. Success criteria must be met for five consecutive years. This Annual Report details the results of the monitoring efforts for 2004 (Year 2) at the Westbrook Lowgounds Mitigation Site.

1.3 PROJECT HISTORY

June 2001	Pre-restoration Monitoring Gauges Installed
Fall 2002	Approved Mitigation Plan
November 2002	Construction Began
January 2003	Construction Completed
February 2003	Planting Completed
March 2003	Post-restoration Monitoring Begins
November 2003	1st Annual Monitoring Report
November 2004	2nd Annual Monitoring Report
November 2005 (scheduled)	3rd Annual Monitoring Report
November 2006 (scheduled)	4th Annual Monitoring Report
November 2007 (scheduled)	5th Annual Monitoring Report







EBX

Environmental Banc and Exchange, LLC
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Owings Mills, MD 21117

Figure 1
Location of Westbrook Lowgrounds Wetland and Stream Mitigation Site

2000 0 2000 4000 Feet

2. HYDROLOGY

2.1 SUCCESS CRITERIA

As stated in the approved Mitigation Plan, the hydrologic success criteria for the site are to restore the water table at the site so that it will remain within 12 inches of the soil surface for at least 9% of the growing season continuously (approximately 21 days). The day counts are based on the growing season for Johnston County, which is 232 days long, beginning on March 17 and ending November 5, as calculated from National Weather Service Wetlands Determination Tables (WETS) for Johnston County. As specified in the approved Mitigation Plan, data are collected from three automated and two manual groundwater gauges.

The Mitigation Plan further specified that in order for the hydrologic data to be considered successful it must demonstrate wetland conditions are present in normal or dryer than normal conditions. During the 2004 growing season, the rainfall total over the entire period of record was close to the long-term average; however the distribution of rainfall throughout the period was very irregular. Monitoring data from the reference site demonstrate positive correlations between the restoration site and the natural hydrology of the target system.

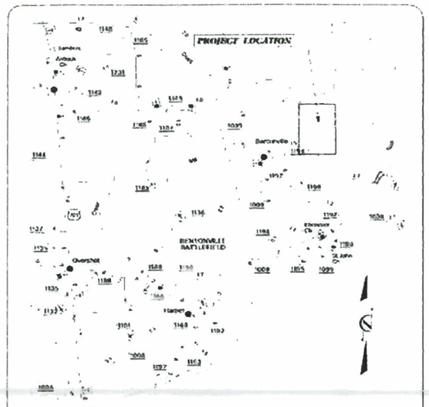
2.2 DESCRIPTION OF HYDROLOGIC MONITORING EFFORTS

Two manual groundwater gauges, three automated Remote Data Systems (RDS) WL 40 groundwater gauges, and one rain gauge were installed prior to the beginning of the first growing season (Figure 2). Groundwater gauges, both manual and automated, were installed to a minimum depth of at least 32 inches below the ground surface. The monitoring protocol for the site specifies that automated monitoring stations will be downloaded and checked for malfunctions on a monthly basis. During monthly site visits, manual groundwater gauges are read and rainfall totals are collected from the on-site rain gauge. During the 2004 growing season, all three automated loggers performed well and no periods of missing data were incurred.

Figure 2. As-Built Figures for the Westbrook Lowgrounds Mitigation Site.

WESTBROOK LOWGROUNDS

PROJECT: 043



VICINITY MAP

INDEX OF SHEETS:

1	TITLE SHEET
2-8	AS-BUILT PLAN SHEETS

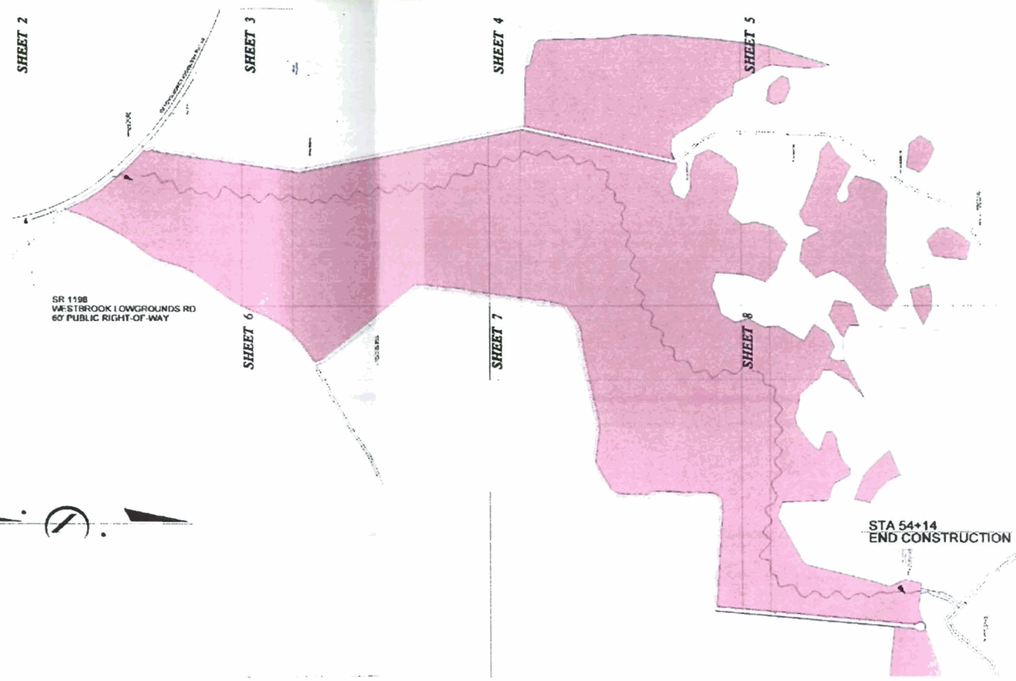
STREAM AND WETLAND RESTORATION PROJECT
ENVIRONMENTAL BANC AND EXCHANGE, LLC
WESTBROOK LOWGROUNDS SITE
JOHNSTON COUNTY

STATE	SITE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	043	1	8

NO.	DATE	CHECKED BY	APPROVED BY
1	28 JAN 2003	KEVIN TWEEDY	KEVIN TWEEDY

LOCATION: WESTBROOK LOWGROUNDS ROAD (SR 1198) NEAR BENTONVILLE, NC

TYPE OF WORK: AS-BUILT DRAWING FOR WETLAND AND STREAM MITIGATION



GRAPHIC SCALES

50 25 0 50 100

PLANS

PROJECT SUMMARY

RESTORED STREAM LENGTH = 5414 FEET
RESTORED WETLAND ACREAGE = 66.2 ACRES

PREPARED FOR THE OFFFICE OF:
ENVIRONMENTAL BANC AND EXCHANGE, LLC

EBX

10055 RED RUN BOULEVARD, SUITE 130
OWING MILLS, MD 21117

8000 REGENCY PARKWAY SUITE 200A
CARY, NORTH CAROLINA 27511

EBX CONTACT:
GEORGE KELLY
PROJECT MANAGER

PREPARED IN THE OFFICE OF:

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

APRIL 11, 2003
DATE PREPARED:

KEVIN L. TWEEDY, PE
PROJECT ENGINEER

Figure 2a. As-Built Drawing for the Westbrook Lowgrounds Mitigation Site.

PROJECT REFERENCE NO.	SHEET NO.
043	2

EEK WESTBROOK LOWGROUNDS

PLAN VIEW OF
EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

Figure 2b. As-Built Drawing for the Westbrook Lowgrounds Mitigation Site.

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MATCHLINE SHEET 3

SR 1198 WESTBROOK LOWGROUNDS RD.

ROAD DITCH

CULVERT #4 18" RCP
PERMANENT SITE ACCESS
LENGTH = 40 FT

X-SECTION 2
STA 2+67

X-SECTION 1
STA 1+59

VEGETATION
PLOT #7

DITCH PLUG

DITCH PLUG

DIVERSION DITCH TO
ROUTE ROAD RUNOFF
INTO WETLAND SITE

DITCH PLUG

STATION 0+00
BEGIN CONSTRUCTION
N=4746.7993
E=5392.6200

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

50 25 0 50 100
SCALE (FT)

PROJECT REFERENCE NO.	SHEET NO.
043	3

EBX WESTBROOK LOWGROUNDS

AS-BUILT ASBUILT LOWGROUNDS

PROJECT ENGINEER

Figure 2c. As-Built Drawing for the WestbrookLowgrounds Mitigation Site.

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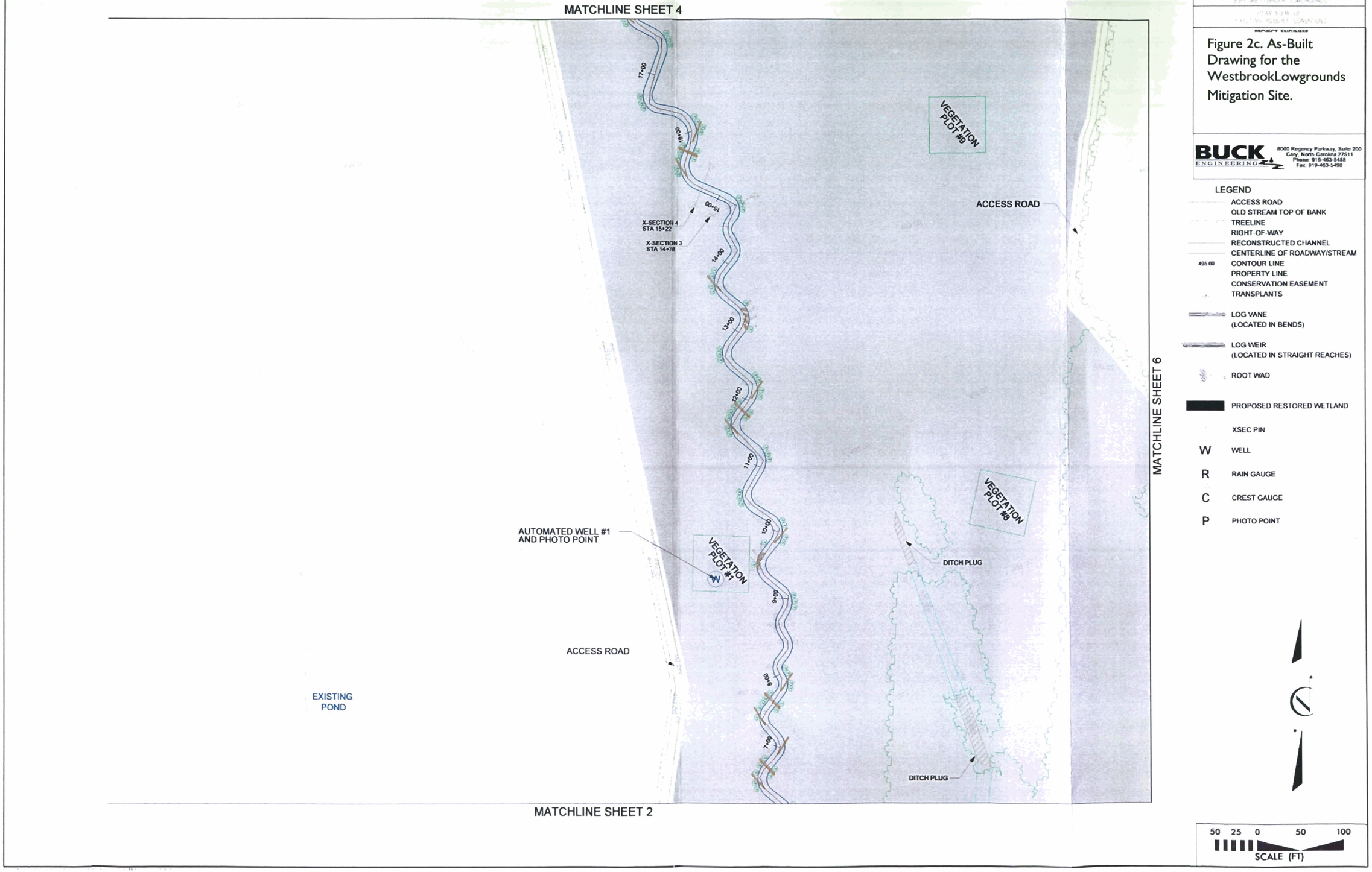
Fax: 919-463-5490



LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

50 25 0 50 100
SCALE (FT)

PROJECT REFERENCE NO.	SHEET NO.
043	4

LAYOUT OF EXISTING ASBUILT CONDITIONS

Figure 2d. As-Built Drawing for the Westbrook Lowgrounds Mitigation Site.

BUCK ENGINEERING
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Fax 919-463-5490

MATCHLINE SHEET 5

VEGETATION PLOT #5

ACCESS ROAD

CHANNEL BLOCK

VEGETATION PLOT #3

MANUAL WELL #1 AND PHOTO POINT

X-SECTION 5 STA 28+15

X-SECTION 6 STA 28+44

P

VEGETATION PLOT #2

ACCESS ROAD

AUTOMATED WELL #2 AND PHOTO POINT

VEGETATION PLOT #10

ACCESS ROAD

MATCHLINE SHEET 7

MATCHLINE SHEET 3

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

N

50 25 0 50 100
SCALE (FT)

PROJECT REFERENCE NO.	SHEET NO.
043	5

RALEIGH REGIONAL OFFICE

PLAN VIEW OF EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

Figure 2e. As-Built Drawing for the Westbrook Lowgrounds Mitigation Site.

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Phone 919-463-5488
Fax 919-463-5490

ACCESS ROAD CONTINUES TO MILL CREEK

ACCESS ROAD

MANUAL WELL #2 AND PHOTO POINT

VEGETATION PLOT #4

ACCESS ROAD

MATCHLINE SHEET 4

MATCHLINE SHEET 8

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

50 25 0 50 100
SCALE (FT)

MATCHLINE SHEET 7

MATCHLINE SHEET 3

EARTHEN BERM CONSTRUCTED
ACROSS ABANDONED ROAD

PROJECT REFERENCE NO.	SHEET NO.
043	6

Figure 2f. As-Built Drawing for the Westbrook Lowgrounds Mitigation Site.

BUCK ENGINEERING
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Cary, North Carolina 27511
Phone 919-463-5488
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LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

50 25 0 50 100
SCALE (FT)

PROJECT REFERENCE NO.	SHEET NO.
043	7

PROJECT ENGINEER

Figure 2g. As-Built Drawing for the Westbrook Lowgrounds Mitigation Site.

BUCK ENGINEERING
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MATCHLINE SHEET 8

CHANNEL BLOCK

CHANNEL BLOCK

VEGETATION PLOT #12

AUTOMATED WELL #3 AND PHOTO POINT

ACCESS ROAD

VEGETATION PLOT #11

ACCESS ROAD

MATCHLINE SHEET 4

MATCHLINE SHEET 6

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CONSERVATION EASEMENT
- TRANSPLANTS
- LOG VANE (LOCATED IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSED RESTORED WETLAND
- XSEC PIN
- W WELL
- R RAIN GAUGE
- C CREST GAUGE
- P PHOTO POINT

50 25 0 50 100
SCALE (FT)

INSET "A"

MILL CREEK
(APPROX. LOCATION)

MATCHLINE SHEET 5

LEGEND

	ACCESS ROAD
	OLD STREAM TOP OF BANK
	TREELINE
	RIGHT-OF-WAY
	RECONSTRUCTED CHANNEL
	CENTERLINE OF ROADWAY/STREAM
495.00	CONTOUR LINE
	PROPERTY LINE
	CONSERVATION EASEMENT
	TRANSPLANTS
	LOG VANE (LOCATED IN BENDS)
	LOG WEIR (LOCATED IN STRAIGHT REACHES)
	ROOT WAD
	PROPOSED RESTORED WETLAND
	XSEC PIN
W	WELL
R	RAIN GAUGE
C	CREST GAUGE
P	PHOTO POINT

PROJECT REFERENCE NO.	SHEET NO.
043	5

Figure 2h. As-Built Drawing for the Westbrook Lowgrounds Mitigation Site.

BUCK ENGINEERING
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Fax 919-463-5490

SEE INSET "A"

STATION 54+14
END CONSTRUCTION
N=7744.4772
E=7046.1261

54+00
X-SECTION 11
STA 53+08
53+00
52+00
51+00
50+00
49+00
48+00
47+00
46+00
45+00
44+00
43+00
42+00
41+00
40+00
39+00
38+00
37+00

VEGETATION PLOT #6
VEGETATION PLOT #13
VEGETATION PLOT #12
CHANNEL BLOCK
CHANNEL BLOCK
ACCESS ROAD
X-SECTION 7 STA 37+11
X-SECTION 8 STA 37+31
X-SECTION 9 STA 44+94
X-SECTION 10 STA 45+22
C
P

MATCHLINE SHEET 7

50 25 0 50 100
SCALE (FT)

2.3 RESULTS OF HYDROLOGIC MONITORING

2.3.1 Site Data

The following hydroperiod statistics were calculated for each monitoring station during the growing season: 1) most consecutive days that the water table was within twelve inches of the surface; 2) cumulative number of days that the water table was within twelve inches of the soil surface; and 3) number of times that the water table rose to within twelve inches of the soil surface. The results of these calculations are presented in Table 1. Figure 3 provides a chart of the water depth for each of the monitoring gauges on the site. Precipitation is shown across the top of the graph. This graph demonstrates the reaction at each monitoring location of the groundwater level to specific rainfall events. Raw hydrograph data collected from the monitoring gauges is provided in Appendix A.

The site was designed to function as a riparian wetland system with associated wet flats. Hydrology in the riparian areas is driven primarily by groundwater discharge and overbank flooding, whereas precipitation is the primary hydrologic influence in the wet flat areas. Monitoring has thus far demonstrated that most of the site is functioning as designed, with varying degrees of wetness and saturation across the site. Gauges A2, A3, M1, and M2 have exceeded the 9% hydrologic success criteria, while gauge AW1 is exhibiting continuously saturated conditions of much less than 9% during the 2004 season.

Table 1. Hydrologic Monitoring Results for 2004 (Year 2).
Percentage indicates percent of the growing season.

Monitoring Station	Most Consecutive Days Meeting Criteria[1]	Cumulative Days Meeting Criteria[2]	Number of Instances Meeting Criteria[3]
WB-AW1	5.5 (2.4%)	17.5 (7.5%)	6
WB-AW2	24 (10.3%)	45.5 (19.6%)	6
WB-AW3 [4]	24 (10.3%)	50 (21.5%)	6
WB-M1 [5]	> 24 (> 10.3%)	> 50 (> 21.5%)	~ 6
WB-M2 [5]	> 24 (> 10.3%)	> 50 (> 21.5%)	~ 6

[1] Indicates the most consecutive number of days within the monitored growing season with a water table less than 12 inches from the soil surface.

[2] Indicates the cumulative number of days within the monitored growing season with a water table less than 12 inches from the soil surface.

[3] Indicates the number of instances within the monitored growing season when the water table rose to less than 12 inches from the soil surface.

[4] During the period of 24 days meeting hydrologic criteria, the water table fell to 0.3 inches below the 12 inch criteria line for one day. This discrepancy was deemed to be within the range of measurement error, therefore the entire 24 day period was considered to appropriately document the hydrologic conditions at gauge WB-AW3.

[5] Groundwater gauges WB-M1 and WB-M2 are manual gauges. Hydrologic parameters are estimated based on data from gauge WB-AW3, however wetter conditions were documented at both M1 and M2 as compared to AW3.

The approved mitigation plan for the Westbrook Lowgrounds Site states in Section 3.5:

"*... [model] simulations indicate that, on average, the water table will be less than 30 cm [12 inches] deep continuously for approximately 9% of the growing season. This scenario can be*

assumed to represent average conditions across the site, with the majority of the restored acreage on the site being represented by this hydrologic scenario. It is probable that there will be areas slightly drier or slightly wetter than the modeled scenario within the restoration area. The modeled scenario provides a basis for estimating the average hydrologic condition over the restored site, based on the proposed restoration practices. However, it is important to note that the hydrology of the targeted restored wetland system (coastal plain small stream swamp) is highly variable across a given site, supporting the ecological and functional diversity that makes these systems so valuable."

The model simulations performed during the design phase of the project indicated that the entire site would range from slightly higher than the minimum wetland criteria of 5% to more saturated areas that would exceed 12.5%. While most of the site is performing as described in the Mitigation Plan, there are concerns that the upper west corner of the site (represented by gauge AW1) is not on a trajectory to meet the hydrologic success criteria. Conclusions and recommendations are provided in Section 2.4

2.3.2 Climatic Data

Table 2 is a comparison of the 2004 monthly rainfall to historical precipitation (collected between 1961 and 1990) for Johnston County. Historic data presented were collected from an automated weather station in Smithfield. For the period of record in which rainfall measurements were collected on-site (January 15 through October 1), the rainfall total from the Smithfield gauge (38.38 inches) correlates well with data collected from the onsite manual rain gauge (38.18 inches). In general, monthly rainfall amounts for the area were much lower than normal for months January – April and higher than normal for the months of May, June, and August. Table 2 gives an indication of how 2004 compares to historical data in terms of average rainfall. For the 2004 period of record shown, total rainfall was approximately one inch greater than the long-term average. Monthly rainfall for October, November, and December 2004 were not available at the time this report was compiled.

Table 2. Comparison of Historic Average Rainfall to Observed Rainfall (Inches).

Month	Average	30%	70%	Observed 2004 Precipitation
January	3.96	2.96	4.63	0.92
February	3.99	2.81	4.73	3.63
March	4.29	3.12	5.06	1.55
April	3.14	1.96	3.80	2.44
May	4.12	2.86	4.91	7.26
June	3.97	2.68	4.74	7.20
July	5.47	3.59	6.57	2.96
August	4.48	2.92	5.39	7.93
September	4.06	2.06	5.03	4.49
October	3.11	1.64	3.79	**N/A**
November	3.04	2.00	3.65	**N/A**
December	3.21	2.06	3.86	**N/A**

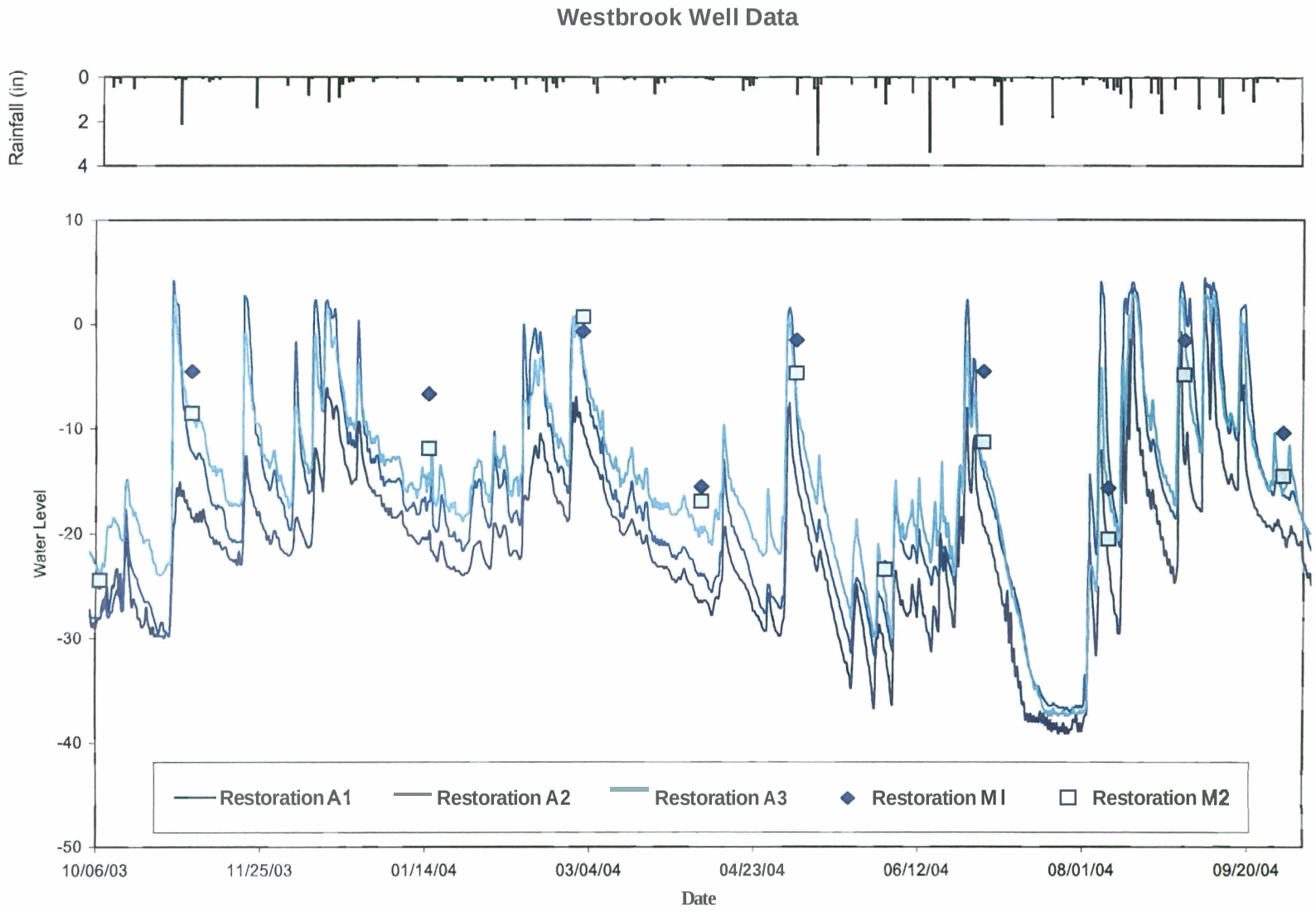

Figure 3. 2004 Groundwater Gauge Data Graph.

2.4 HYDROLOGIC CONCLUSIONS

Data collected from all the groundwater monitoring gauges on Westbrook Lowgrounds Mitigation Site indicate that approved hydrologic success criteria have been met during the 2004 growing season for four out of the five stations. One of the stations (gauge AW1) met the wetland hydrology criteria for 2.4% of the growing season, which is drier than typically associated with wetland functions.

With two years of monitoring completed, the data indicate concerns regarding the hydrologic status of the area represented by gauge AW1. During 2003, gauge AW1 met a 6.5% criteria under conditions of above average rainfall. This information compared closely with data collected from areas of the reference site and fell within the 5% to 12.5% hydrologic criteria commonly used to determine wetland status. However, the data from 2004 indicate that under drier rainfall conditions, the area represented by gauge AW1 may not be on a trajectory to meet the hydrologic success criteria established for the site.

Other areas of the site are performing as designed and predicted, with varying degrees of saturation across the site. The site, in general, exhibits flashy hydrographs that appear to be indicative of the soils and hydrology of the targeted wetland system, since similar trends have been documented on the adjacent reference site (see Section 5).

Remedial action is proposed for the area represented by gauge AW1 to improve its hydrologic functioning. The proposed treatment will involve raising the restored stream bed in the affected area by several tenths of a foot. This small adjustment is expected to increase flooding of the adjacent floodplain areas, as well as raise the overall baseflow elevation of the adjacent water table. Pattern of the stream will not be changed, therefore the proposed treatment can be accomplished with only minimal disturbance to the existing stream channel.

3. VEGETATION

3.1 SUCCESS CRITERIA

The interim measure of vegetative success identified in the approved Mitigation Plan will be the survival of at least 320 3-year old trees per acre at the end of year 3 of the monitoring period. The final vegetative success criteria will be the survival of 260 5-year old trees per acre at the end of the monitoring period. Up to 20% of the site species composition may be comprised of invaders. Remedial action may be required should these (i.e. loblolly pine, red maple, sweet gum, etc.) present a problem and exceed 20% composition.

Construction of the site, planting of bare root trees, and spreading of the permanent seed mixture was completed in March 2003. Approximately 45,000 trees were planted over 66.2 acres.

3.2 DESCRIPTION OF SPECIES AND MONITORING PROTOCAL

Table 3. Tree species planted in the Westbrook Wetland Restoration Area.

ID	Common Name	Scientific Name	FAC Status
1	*Celtis laevigata*	Sugarberry	FACW
2	*Nyssa biflora*	Swamp Tupelo	OBL
3	*Nyssa sylvatica*	Blackgum	FAC
4	*Quercus laurifolia*	Laurel Oak	FACW
5	*Quercus* lyrata	Swamp White Oak	OBL
6	*Quercus michauxii*	Swamp Chestnut Oak	FACW-
7	*Quercus nigra*	Water Oak	FAC
8	*Quercus pagoda*	Cherrybark Oak	FAC+
9	*Quercus phellos*	Coastal Willow Oak	FACW-
10	*Quercus shumardii*	Shumard Oak	FACW-
11	*Taxodium distichum*	Bald Cypress	OBL

The following monitoring protocol was designed to predict vegetative survivability. Thirteen plots were established on the Westbrook Mitigation Site, to monitor approximately 2% of the site. The vegetation monitoring plots were designed to be 0.1 acre in size, or 66' x 66' dimensionally. The plots were randomly located and randomly oriented within the wetland restoration area.

Plot construction involved using metal fence posts at each of the four corners to clearly and permanently establish the area that was to be sampled. Then ropes were hung connecting all four corners to determine if trees close to the plot boundary were inside or outside of the plot. Trees immediately on the boundary, and trees just outside of the boundary that appear to have greater than 50% of their canopy inside the boundary were counted inside the plot. A piece of white PVC pipe ten feet tall was placed over the metal post on one corner to facilitate visual location of site throughout the five-year monitoring period.

All of the planted stems inside the plot were flagged to mark them as the planted stems (vs. any colonizers) and to help in locating them in the future. Each stem was then tagged with a permanent numbered aluminum tag.

3.3 RESULTS OF VEGETATIVE MONITORING

Table 4 presents stem counts for each of the monitoring stations. Each planted tree species is identified across the top row and each plot is identified down the left column. The numbers on the top row correlate to the ID column given in Table 3. Trees are flagged in the field on a quarterly basis before the flags degrade. Flags are utilized because they will not interfere with the growth of the tree. Volunteers are also flagged during this process.

Table 4. 2004 Vegetation Monitoring Plot Species Composition.

Plot	1	2	3	4	5	6	7	8	9	10	11	Total	Stem/ac
W1	0	5	6	6	5	0	5	4	5	3	13	52	520
W2	4	4	6	10	0	0	2	6	0	22	4	58	580
W3	6	2	5	7	1	0	2	13	2	5	12	55	550
W4	0	0	3	4	1	18	12	1	6	20	0	65	650
W5	0	1	0	1	1	9	3	4	4	36	2	61	610
W6	5	0	0	18	0	8	4	2	2	8	2	49	490
W7	2	4	7	5	3	8	3	0	10	4	7	53	530
W8	0	7	11	4	1	2	4	3	1	6	15	54	540
W9	0	3	6	1	1	10	7	10	5	5	5	53	530
W10	1	0	3	5	0	4	7	3	16	1	2	42	420
W11	1	2	11	4	0	2	12	11	3	2	0	48	480
W12	3	0	0	2	0	0	0	1	0	36	13	55	550
W13	0	1	3	4	5	3	13	2	2	1	5	39	390

Average Stems/Acre: 526

Volunteer species will also be monitored throughout the five-year monitoring period. Table 5 presents the most commonly found woody volunteer species.

Volunteer woody species were observed in most all of the vegetation plots, but were deemed too infrequent and too small to tally. Identifiable volunteers accounted for no more than 20 stems per plot; these specimens were typically less than 6 inches tall. If these trees persist into next growing season they will be flagged and added to the overall stems per acre assessment of the site. Sweetgum (*Liquidambar styraciflua*) is the most common volunteer, though Red Maple (*Acer rubrum*) and Persimmon (*Diospyros virginiana*) were also observed.

Table 5. Volunteer Tree Species Identified within in the Wetland Restoration Area.

ID	Species	Common Name	FAC Status
A	*Liquidambar styraciflua*	Sweetgum	FAC+
B	*Acer rubrum*	Red Maple	FAC
C	*Diospyros virginiana*	Persimmon	FAC
D	*Taxodium distichum*	Bald Cypress	OBL

3.4 VEGETATION CONCLUSIONS

Approximately 66.2 acres of this site were planted with hardwood species in March 2003. There were thirteen 0.1 acre vegetation monitoring plots established throughout the planting areas. The 2004 vegetation monitoring revealed an average tree density greater than 520 stems per acre. We feel that this site is on trajectory for meeting the minimum success interim criteria of 320 trees per acre by year three and the final success criteria of 260 trees per acre by year five.

4. STREAM MONITORING

4.1 SUCCESS CRITERIA

As stated in the approved Mitigation Plan, the stream restoration success criteria for the site include the following:

- *Bankfull Events*: Two bankfull flow events must be documented within the five year monitoring period.

- *Cross Sections:* There should be little change in as-built cross-sections. Cross-sections shall be classified using the Rosgen stream classification method and all monitored cross-sections should fall within the quantitative parameters defined for "E" or "C" type channels.

- *Longitudinal Profiles:* The longitudinal profiles should show that the bedform features are remaining stable, e.g. they are not aggrading or degrading. Bedforms observed should be consistent with those observed in "E" and "C" type channels.

- *Photo Reference Stations*: Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and effectiveness of erosion control measures.

- *Benthic Macroinvertebrate and Fish Sampling*: Sampling of benthic macroinvertebrates and fish within the restored stream channel shall be conducted for the first three years of post-restoration monitoring. No success criteria are applied to the sampling data which will be collected.

4.2 DESCRIPTION OF STREAM MONITORING

To document the stated success criteria, the following monitoring program was instituted following construction completion on the Westbrook Site:

Bankfull Events: A crest gauge was installed on the site to document bankfull events. The gauge is checked each month, and records the highest out-of-bank flow event that occurred during the past month. The gauge is located near stream station 43+50 (see Figure 2h).

Cross Sections: Two permanent cross-sections were installed per 1,000 linear feet of stream restoration work, with one (1) of the locations being a riffle cross-section and one (1) location being a pool cross-section. A total of 11 permanent cross sections were established across the mitigation site. Each cross section was marked on both banks with permanent pins to establish the exact transect used. Permanent cross section pins were surveyed and located relative to a common benchmark to facilitate easy comparison of year-to-year data. The annual cross section surveys include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg. Riffle cross sections are classified using the Rosgen stream

classification system. Permanent cross sections for 2003 (year 1) were surveyed in March and April 2003. Permanent cross sections for 2004 (year 2) were surveyed in February 2004.

Longitudinal Profiles: A complete longitudinal profile will be completed in years one, three, and five. The profile will be conducted for a length of restored channel at least 3,000 feet in length. Measurements will include thalweg, water surface, inner berm, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature, e.g. riffle, run, pool, and glide, and the max pool depth. A common benchmark will be used each year to facilitate comparison of year-to-year data. The longitudinal survey for 2003 (year 1) was conducted during March and April 2003. A longitudinal profile was not conducted for year 2.

Photo Reference Stations: Photographs are used to visually document restoration success. Nine reference photo stations have been established across the Westbrook Site. Reference stations are marked with wooden stakes and GPS coordinates have been determined for each location. Reference photos are taken at least once per year. Reference photos are taken at each permanent cross section from both streambanks. The survey tape is centered in the photographs of the bank, and the water line is located in the lower edge of the frame with as much of the bank as possible included in each photo. Structure photos of each grade control structure are also taken.

Benthic Macroinvertebrates and Fish Sampling: Benthic macroinvertebrate and fish sampling data were collected from the reference reach (upstream of project reach) and within the project reach. Pre-restoration data were collected on January 17, 2002, prior to initiation of stream restoration practices. Post-restoration sampling will begin one year after construction activities have been completed, and annually thereafter for a total of three years. Sampling will be conducted each year between November and February, since the stream in the past has experienced periods of very low flow during summer months. Sample collection follows protocols described in the standard operating procedures of the Biological Assessment Unit of the NC Division of Water Quality. The Qual-4 collection method is used for the collection of macroinvertebrate samples, and a NC certified laboratory performs the identification of the macroinvertebrate samples. The metrics calculated include total and EPT taxa richness, EPT abundance and biotic index values.

For Year 1, biological sampling was conducted in February of 2004 (one year following completion of construction). Results are presented in the following sections.

4.3 RESULTS OF STREAM MONITORING

During 2004, bankfull events on the site were documented during at least two site visits through the use of the onsite crest gauge and visual evidence of out-of-bank flow. The largest stream flow documented by the crest gauge on the site was a flow that occurred during the month of September and was approximately 0.4 feet above the bankfull stage at the crest gauge. Based on observations of ponded water, debris lines, and deposited sediment on the floodplain, the bankfull event spread over much of the restored wetland areas adjacent to the stream.

Year 2 cross section monitoring data for stream stability were collected during March 2004 and compared to baseline data collected in April of 2003. Longitudinal profile information was not

scheduled to occur for year 2 but will be documented in monitoring year 3 (2005). Permanent cross-sections document the stream dimension at eleven locations (6 riffles and five pools, see Appendix C). The cross-sections show that there has been very little adjustment to stream dimension since construction. The two cross-sections on the lower end of the stream (45+22 and 53+08) show that some aggradation has occurred since year 1. This area is subject to periodic backwater conditions from Mill Creek and, therefore, bed elevation will be dependent on the baseflow water level in Mill Creek. Cross-section 15+22 shows some erosion on the left bank, however the cross-section appears to have stabilized and vegetation is becoming established. Several other pool cross-sections indicate the development of point bar features, which is expected. All monitored cross-sections fell within the quantitative parameters defined for "E" or "C" type channels.

Instream structures installed within the restored stream included rock cross-vanes, log vanes, log weirs, and root wads. Visual observations of structures throughout the past growing season have indicated that nearly all structures are functioning as designed. Log vanes placed in meander pool areas have provided scour to keep pools deep and provide cover for fish. Log weirs placed in riffle areas have maintained riffle elevations and provided a downstream scour hole which provides habitat. Some log weirs experienced scour of the streambanks directly downstream of the weirs. This was primarily caused by high flows shortly after construction before vegetation on the banks could become well established. These small and localized areas have continued to stabilize through the growing season as vegetation has become more established. Root wads placed on the outside of meander bends have provided bank stability and instream cover for fish and other aquatic organisms.

Five rock cross-vanes were installed on the lower end of the project to step the restored stream down to the elevation of Mill Creek. Some areas of erosion and instability were observed during the 2004 growing season. To prevent any further instability, a trackhoe and several tons of Class A/B stone were brought to the site in mid-August to stabilize the structures. The repair work involved placing the stone in areas along the cross-vane arms to seal areas of scour around the arms. Additional stone was also placed below the structures to dissipate energy and reduce the depth of pool scour. Since repair, the stability of the structures has improved.

Photographs have been taken throughout the monitored season to document the evolution of the restored stream channel (see Appendix B). The most observable change to the stream during 2004 has been the prevalence of native hydrophytic vegetation along the restored streambanks. Herbaceous vegetation is dense along the restored stream, making it difficult to take photographs of the stream channel itself. Pools have maintained a variety of depths and habitat qualities, depending on the location and type of scour features (logs, root wads, transplants, etc.).

4.3.1 Stream Benthic Macroinvertebrates

Benthic macroinvertebrate samples were collected at two sites within and upstream of the project area on February 19, 2004, as part of the first year of post-monitoring requirements. One sampling site is located within the downstream section of the project reach below SR 1198, while the other sampling site (reference reach) is located upstream of the project reach above SR 1198. The sampling methodology followed the Qual-4 protocol listed in the NCDWQ's *Standard Operating Procedures for Benthic Macroinvertebrates.* A summary of the benthic

macroinvertebrate sampling results at each location is presented in Table 6, with complete results presented in Appendix C.

Mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera), collectively referred to as EPT taxa, are considered by aquatic ecologists to be intolerant of pollution or other forms of environmental degradation. Therefore, the presence of substantial numbers of EPT taxa and individuals is considered indicative of relatively undisturbed "higher quality" streams. Lower biotic indices also indicate healthier benthic macroinvertebrate communities.

Table 6. Summary of benthic macroinvertebrate data for the project reach and the reference reach.

Sites	EPT Taxa Richness	EPT Abundance	EPT Biotic Index	Biotic Index	Total Taxa Richness
Project Reach in 2002	7	45	4.8	6.5	30
Project Reach in 2004	13	66	5.3	6.0	31
Reference Reach in 2002	10	43	4.7	4.5	28
Reference Reach in 2004	10	57	4.9	5.6	27

Total taxa richness, EPT taxa richness, and EPT abundance values were greater in the project reach than in the reference reach in 2004 (first year of post-construction monitoring). More importantly, these values in the project reach increased from the 2002 pre-construction values. The EPT taxa almost doubled from 7 to 13 from pre-construction to post-construction of the restoration project. Increases in the previously mentioned values indicate overall improvement of the benthic macroinvertebrate community.

While the EPT taxa richness and abundance values were greater in the project reach in 2004 than both the project reach in 2002 and reference reach in 2004, the EPT biotic index value in the project reach in 2004 was more. The increase in the EPT taxa richness was mainly contributed by addition of fairly tolerant mayflies. The increase in the EPT biotic index is contributed by replacement of less tolerant EPTs with more tolerant EPTs.

A shift in the benthos community was also observed in the restoration reach between years sampled and between sites in 2004. The project reach after construction has a completely open canopy, thus limiting potential input of coarse particulate organic matter (CPOM) to the aquatic system. Inputs of CPOM provide a critical resource base for the benthic macroinvertebrate community, especially in a low-order stream such as the project reach. Low-order streams such as the project reach are expected to exhibit high CPOM:FPOM (fine particulate organic matter) ratios. In response to the lack of CPOM no shredder organisms were found in the project reach in 2004. The reference reach in 2004 and the project reach in 2002 had significant canopy and CPOM as evidenced by abundance of shredder organisms and higher CPOM:FPOM consumer ratios observed.

Open canopy areas such as those found in the project reach allow more photosynthesis thus increasing growth of periphyton and aquatic macrophytes. In response to the increase in periphyton and aquatic plant standing crop, an increase in scrapers, filterer collectors, and collector-gatherers were observed in the project reach in 2004 compared to 2002 and the reference reach in 2004. The filterer-collectors and collector-gatherers are considered consumers of fine particulate organic matter (FPOM) which is produced by breakdown of CPOM. Overall the CPOM:FPOM consumer ratio was very low in the project reach in 2004, representing mid-order streams further down the river continuum. Once the woody vegetation becomes more established within the project reach buffer area, more CPOM consumers such as shredders should invade and help increase the CPOM:FPOM consumer ratio to a level typical of a healthy low-order stream. In addition, the increase in EPT taxa experienced in the project reach in 2004 and provision of a great source of refugia for CPOM consumers from the reference site and also from Mill Creek just downstream should help secure the success of obtaining a healthier benthic macroinvertebrate community during the progression of this restoration project.

4.3.2 Fish Sampling

Fish sampling was conducted on March 12, 2004. Three segments were surveyed with a backpack electroshocker and one other person dip netting. Two segments of approximately 200 yards in length were shocked within the restoration area and one segment of approximately 100 yards was shocked in the natural headwaters above SR 1198. One of the two segments in the restoration area was the lower most 200 yards while the other one was upstream, approximately ¼ mile below SR 1198. Approximately 1 hour was spent at each segment shocking all available habitats.

Water levels on March 12, 2004 ranged between a few inches and 3 feet in the restoration segments and up to 8 inches in the natural segment; the current was slight but noticeable. Water temperature was 61 F. All fish were released after being identified and counted.

Survey results are as follows:

1) Lowermost Segment of Restoration Site
   Redfin pickerel – 2 adults
   Satinfin shiner – 6 adults
   White shiner – 2 subadults
   Golden shiner – 1 subadult
   Creek chubsucker – 20, subadults to small adults
   Yellow bullhead – 4 subadults
   Pirate perch – 2 adults
   Eastern mosquitofish – 1 adult
   Bluespotted sunfish – 1 adult
   Green sunfish – 2, adult and subadult
   Bluegill – 1 subadult
   Largemouth bass – 8 subadults
   Tessellated darter – 2 adults

2) Uppermost Segment of Restoration Site
Eastern mudminnow – 1 adult
Redfin pickerel – 2 adults
Creek chubsucker – 44, subadults to small adults
Yellow bullhead – 11 subadults
Eastern mosquitofish – 1 adult
Bluespotted sunfish – 1 adult
Green sunfish – 1 subadult
Largemouth bass – 2 subadults

3) Reference Site
Redfin pickerel – 2, young and adult
Creek chubsucker – 4 subadults

Fourteen species of fishes were collected in the restoration segment of the stream. These are species typical of this part of North Carolina and in numbers similar to natural streams of a similar size. It is interesting to note how quickly the stream was re-colonized after restoration that coincided with the prolonged drought. The diversity and abundance of species is partly due to the heterogeneity of habitats offered in the restoration area.

4.4 CONCLUSIONS

Based on the data collected thus far, the restored channel is stable and is providing the functions intended (Figure 4). Stable riffle and pool features have developed and native vegetation has colonized the site quickly, especially the streambank areas and adjacent floodplain. It is expected that stability of the system will continue to improve in the coming years as permanent vegetation becomes more established.

Remedial action is proposed for the area represented by gauge AW1. The streambed elevation in this area will be raised by several tenths of a foot to increase flooding and raise the water table of the adjacent floodplain areas. This proposed remedial action can be accomplished with minimal disturbance to the restored stream channel, and with no changes to the stream's pattern. Grade control structures along the reach (log weirs) will be raised in order to raise the baseflow stream elevation. In this way, the only disturbance to the restored channel will be in the locations of the log weirs. Stream stability and function will not be affected by this proposed action.

5. REFERENCE SITE CONDITIONS

The approved Mitigation Plan provides that if the rainfall data for any given year during the monitoring period is not normal, the reference wetland data can be accessed to determine if there is a positive correlation between the performance of the restoration site and the natural hydrology of the reference site.

Reference site data were compared to onsite hydrographs to compare the performance of the restored site to reference conditions. One automated groundwater gauge (WB-RA1) and one manual gauge (WB-RM1) were installed in the reference site during March 2003. When data collected from the reference site were reviewed early in the growing season of 2003, that data indicated wetter conditions than could visually be confirmed for the majority of the reference site. Gauge RA1 was installed in a depressional area near the stream channel which apparently receives significant overland runoff during rain events. Gauge RM1 was located further from the stream channel, but was also determined to be located in a depressional area. The decision was made to install three additional manual groundwater gauges (WB-RM2, WB- RM3, and WB-RM4) to document the range of conditions observed across the reference site, for comparison against the range of hydrologic conditions which were being documented on the restoration site. RM2 and RM3 were installed in areas away from the stream channel, yet well within the wetland floodplain. RM4 was installed closer to the periphery of the reference wetland to document conditions near the transition from wetland system to upland. The three additional gauges were installed on May 14, 2003.

The automated gauges on the restoration site (AW1, AW2, and AW3) were installed in areas most similar to gauges RM2 and RM3 on the reference site, and were assumed to represent average conditions across the restoration site. Data from the automated gauges on the restoration site correlate very well with reference site gauges RM2, RM3, and RM4, and indicate the same general hydrologic trends in both systems (Figure 5), with the exception of data collected from the restoration site at gauge AW1. As previously discussed in Section 2.4, the area represented by gauge AW1 is exhibiting drier conditions than would be expected.

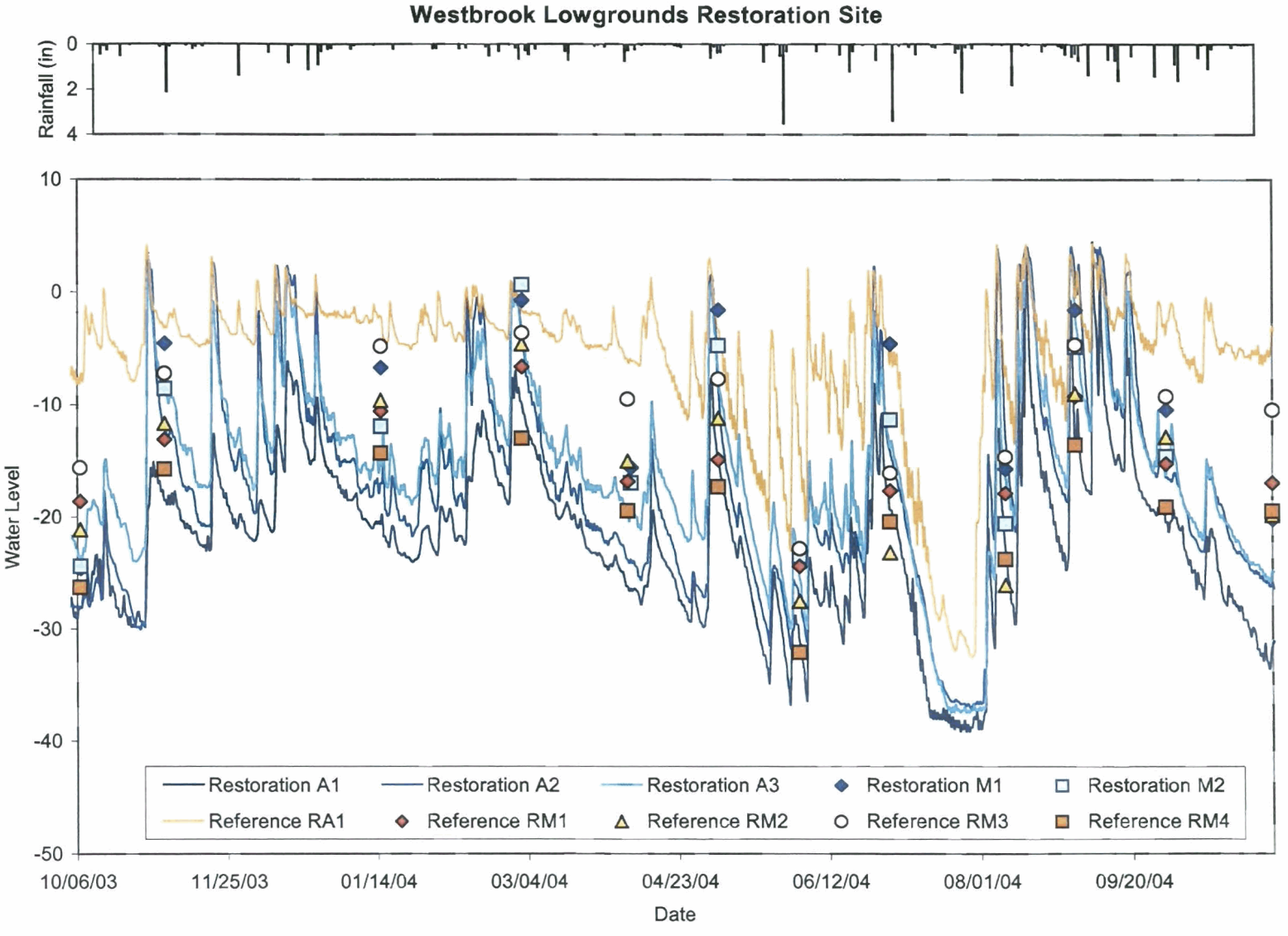

Figure 4. **mparison Reference Site Data Restoration Site Data.**

6. OVERALL CONCLUSIONS AND RECOMMENDATIONS

- Second year hydrologic monitoring has shown that suitable minimum wetland hydrology criteria have been achieved on most of the site. Four of the five hydrologic monitoring gauges documented that the targeted success criteria were achieved. The one remaining gauge (AW1) demonstrated a hydroperiod of 2.4% and is exhibiting drier conditions than expected.
- The restored stream channel has remained stable and is providing the intended habitat and hydrologic functions. All monitoring cross-sections for 2004 showed very little adjustment in stream dimension.
- Vegetation monitoring efforts have calculated the average number of stems per acre on site to be 526 which is a survival rate of greater than 85% based on the initial planting count of 590 stems per acre. We feel that vegetation survivability should remain excellent on site and vegetative success criteria will easily be met.
- Remedial action is proposed for the area represented by gauge AW1. The streambed elevation in this area will be raised by several tenths of a foot to increase flooding and raise the water table of the adjacent floodplain areas. This proposed remedial action can be accomplished with minimal disturbance to the restored stream channel, and with no changes to the stream's pattern. Grade control structures along the reach (log weirs) will be raised in order to raise the baseflow stream elevation. In this way, the only disturbance to the restored channel will be in the locations of the log weirs.
- Benthic macroinvertebrate and fish sampling data indicate that the restored stream is providing appropriate habitat for a variety of aquatic organisms. Data collected one year after restoration show considerable improvements in fish and benthos communities as compared to data collected before restoration.
- Monitoring of vegetation and groundwater and surface water levels will continue.

7. WILDLIFE OBSERVATIONS

Observations of deer and deer tracks are common on the Westbrook Lowgrounds site. During certain times of the year, frogs have been very prevalent across the site. Hog tracks are fairly common in the lower portions of the site adjacent to Mill Creek. Birds, turtles and black snakes have also been observed on the site.

8. VEGETATION OBSERVATIONS

After construction of the mitigation site a permanent ground cover seed mixture of Virginia wild rye (*Elymus virginicus*), switch grass (*Panicum virgatum*), and fox sedge (*Carex vulpinoidea*) was broadcast on the site at a rate of 10 pounds per acre. These species are dominant on the site, though they pose no threat to the survival or health of the planted or naturally occurring hydrophytic vegetation. Hydrophytic herbaceous vegetation is also occurring on site. Rush (*Juncus effusus*), spike-rush (*Eleocharis obtusa*), climbing hempweed (*Mikania scandens*), tearthumb (*Polygonum sagittatum*), Boxseed (*Ludwigia* sp.), and sedge (*Carex* sp.), all hydrophytic herbaceous plants, are frequently observed across the site particularly in areas of

inundation. The presence of these herbaceous wetland plants helps to confirm the presence of wetland hydrology on the site.

There are zones of weedy species occurring on the site, though none seem to be posing any problems for the woody or herbaceous hydrophytic vegetation. The majority of the weedy species are annuals and believed to pose very little threat to survivability in site. Commonly seen weedy vegetation includes ragweed (*Ambrosia artemisiifolia*), dill (*Foeniclum vulgare*), and Morning Glory (*Ipomoea* sp.). Any threatening weedy vegetation found in the future will be documented and discussed.

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Appendices