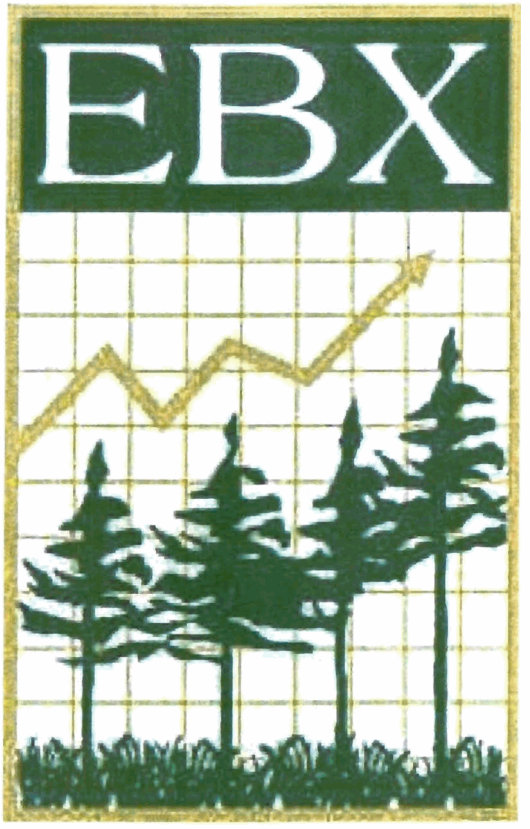
Neu-Con Umbrella Wetland and Stream Mitigation Bank

Westbrook Lowgrounds Wetland Mitigation Site
Annual Monitoring Report For 2003 (Year 1)



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ANNUAL REPORT FOR 2003 (Year 1)

Westbrook Lowgrounds Mitigation Site

SUMMARY

This Annual Report details the monitoring activities during the 2003 growing season on the Westbrook Lowgrounds Mitigation Site. Construction of the site, including planting of trees, was completed in February 2003. The 2003 data represents results from the first 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 2003 growing season, higher than average rainfall totals were documented on the mitigation site.

In 2003, three of five hydrology monitoring gauges have met the hydrologic success criteria based on field observations. The two remaining gauges exhibited hydroperiods 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. Based on these results, it was concluded that the site is performing as designed and is mimicking conditions documented on the reference site upstream.

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 540 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.

INTRODUCTION

1.1 PROJECT DESCRIPTION

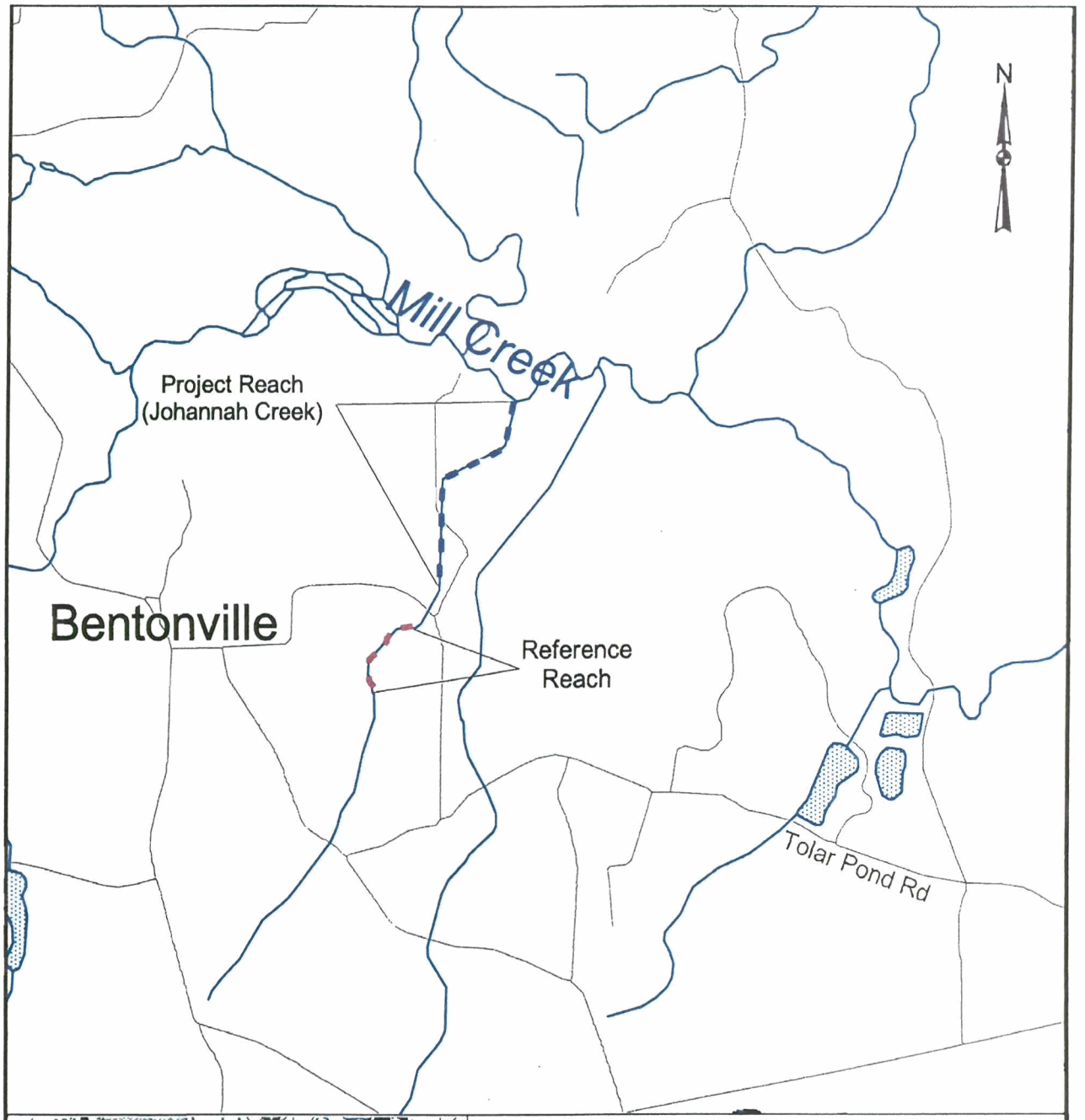
Located in Johnston County, the entire Westbrook Lowlands Mitigation Site encompasses approximately 140 acres. It is located approximately one mile east of the town of Bentonville, North Carolina (Figure 1). This project provides compensatory mitigation for stream and wetland impacts associated within 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 on March 7, 2003. The 2003 monitoring season represents the first year of monitoring for the site.

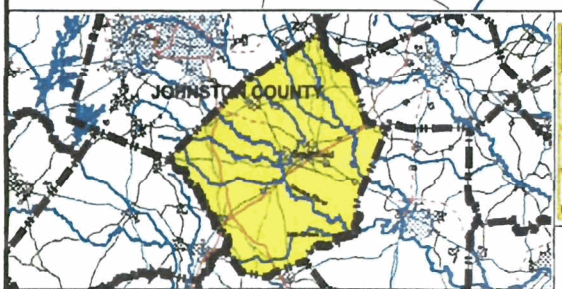
1.2 PURPOSE

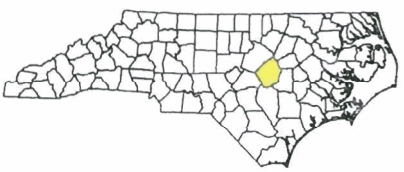
Monitoring of the Westbrook Lowland Site is required to demonstrate successful mitigation based on the criteria found in the Mitigation Plan, the Neu-Con Umbrella Stream and Wetland Mitigation Bank Instrument, and through a comparison to reference site conditions. Hydrologic, vegetation, and stream monitoring 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 2003 (Year 1) at the Westbrook Lowgounds Mitigation Site.

1.3 PROJECT HISTORY

June 2001	Pre-restoration Monitoring Wells 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 (scheduled)	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
10055 Red Run Boulevard, Suite 130
Owings Mills, MD 21117

Figure 1
Location of Westbrook Lowgrounds
Wetland and Stream Mitigation Site

2000 0 2000 4000 Feet

HYDROLOGY

2.1 SUCCESS CRITERIA

As stated in the approved Mitigation Plan, the hydrologic success criteria for the site is 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 continuosly (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 2003 growing season, higher than normal rainfall amounts were documented on the restoration site. 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 40 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 2003 growing season, all three automated loggers performed well and no periods of missing data were incurred.

WESTBROOK LOWGROUNDS

PROJECT: 043

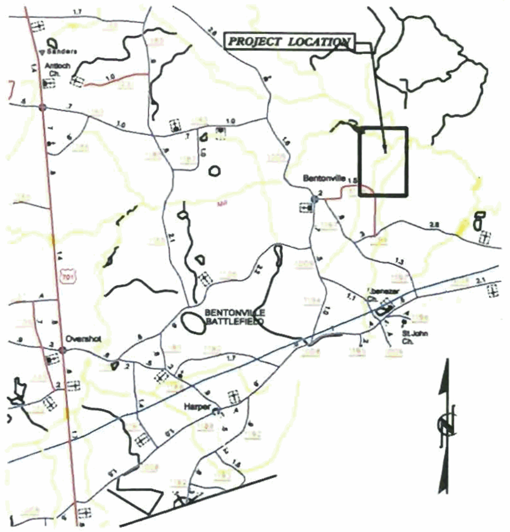
STREAM AND WETLAND RESTORATION PROJECT
ENVIRONMENTAL BANC AND EXCHANGE, LLC
WESTBROOK LOWGROUNDS SITE

JOHNSTON COUNTY

[illegible]TION: WE[illegible] LOWGROUNDS ROAD (SR 1198)
NEA[illegible]VILLE, NC

[illegible] OF WORK: [illegible] DRAWING FOR WETLAND
AND STREAM MITIGATION

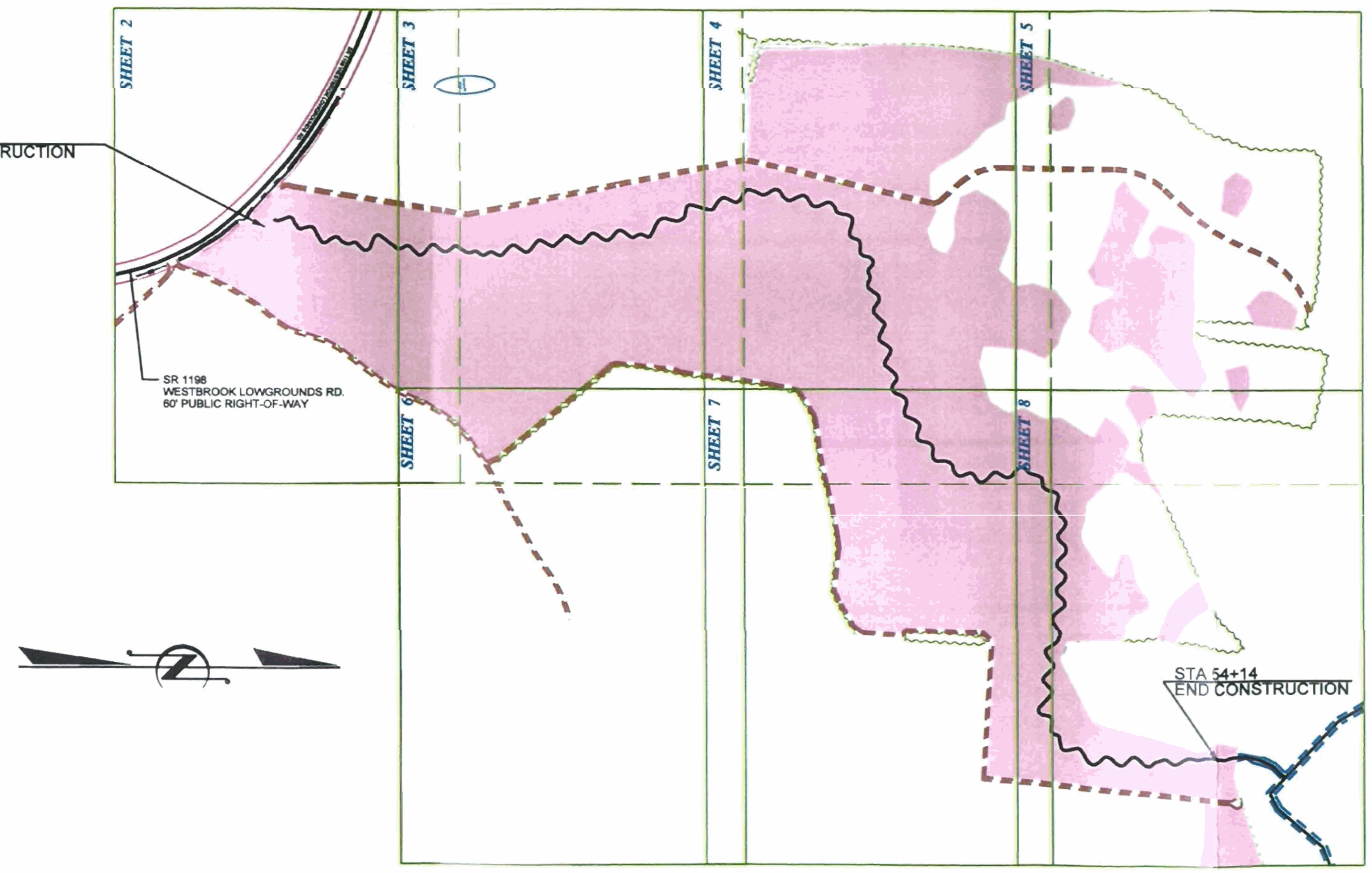
N.C.			
NO.	DATE	CHECKED BY	APPROVED BY



VICINITY MAP

INDEX OF SHEETS:

1 TITLE SHEET
2 8 AS-BUILT PLAN SHEETS



GRAPHIC SCALES

PROJECT SUMMARY

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

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

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

DATE PREPARED:

PROJECT ENGINEER

PROJECT ENGINEER

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

SIGNATURE: P.E.

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+07

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

PROJECT REFERENCE NO.	SHEET NO.
043	2

EBX WESTBROOK LOWGROUNDS

PLAN VIEW OF
EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

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

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

MATCHLINE SHEET 4

17+00

16+00

15+00

X-SECTION 4
STA 15+22

X-SECTION 3
STA 14+78

14+00

13+00

12+00

11+00

10+00

9+00

8+00

7+00

VEGETATION PLOT #9

ACCESS ROAD

MATCHLINE SHEET 6

AUTOMATED WELL #1
AND PHOTO POINT

VEGETATION PLOT #7

VEGETATION PLOT #8

DITCH PLUG

ACCESS ROAD

EXISTING POND

DITCH PLUG

MATCHLINE SHEET 2

PROJECT REFERENCE NO.	SHEET NO.
043	3

EBX WESTBROOK LONGROUNDS

PLAN VIEW OF
EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

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

BUCK
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
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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)

MATCHLINE SHEET 5

MATCHLINE SHEET 7

MATCHLINE SHEET 3

ACCESS ROAD

CHANNEL BLOCK

MANUAL WELL #1
AND PHOTO POINT

VEGETATION PLOT #3

VEGETATION PLOT #5

VEGETATION PLOT #2

VEGETATION PLOT #10

ACCESS ROAD

AUTOMATED WELL #2
AND PHOTO POINT

ACCESS ROAD

X-SECTION 5
STA 28+15

X-SECTION 6
STA 29+44

30+00
29+00
28+00
27+00
26+00
25+00
24+00
23+00
22+00
21+00
20+00
19+00
18+00

PROJECT REFERENCE NO.	SHEET NO.
043	4

EBX WESTBROOK LONGROUNDS

PLAN VIEW OF
EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

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

BUCK
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
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	5
EBX WESTBROOK LONGROUNDS	
PLAN VIEW OF EXISTING ASBUILT CONDITIONS	
PROJECT ENGINEER	

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

BUCK
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
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 8

MATCHLINE SHEET 4

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

EBX WESTBROOK LOWGROUNDS

PLAN VIEW OF EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

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

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

LEGEND

- ACCESSROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTEDCHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 495.00 CONTOUR LINE
- PROPERTY LINE
- CONSERVATIONEASEMENT
- TRANSPLANTS
- LOG VANE (LOG VANE IN BENDS)
- LOG WEIR (LOCATED IN STRAIGHT REACHES)
- ROOT WAD
- PROPOSEDRESTORED WETLAND
- XSEC PIN
- @ —
- R FW
- C CREST GAUGE
- P PHOTO POINT

50 25 0 50 100
SCALE (FT)

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

PROJECT REFERENCE NO.	SHEET NO.
043	7
EBX WESTBROOK LONGROUNDS	
PLAN VIEW OF EXISTING ASBUILT CONDITIONS	
PROJECT ENGINEER	

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

BUCK
8000 Regency Parkway, Suite 200
Cary, North Carolina 27511
Phone: 919-483-5488
Fax: 919-483-5490

LEGEND

- ACCESS ROAD
- OLD STREAM TOP OF BANK
- TREELINE
- RIGHT-OF-WAY
- RECONSTRUCTED CHANNEL
- CENTERLINE OF ROADWAY/STREAM
- 485 m 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	8

EBX WESTBROOK LONGROUNDS

PLAN VIEW OF EXISTING ASBUILT CONDITIONS

PROJECT ENGINEER

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

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

INSET " A

MILL CREEK (APPROX. LOCATION)

SEE INSET "A"

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

MATCHLINE SHEET 5

VEGETATION PLOT #6

CHANNEL BLOCK

X-SECTION 8 STA 37+31

X-SECTION 7 STA 37+11

CHANNEL BLOCK

X-SECTION 10 STA 45+22

X-SECTION 9 STA 44+84

VEGETATION PLOT #12

VEGETATION PLOT #13

ACCESS ROAD

X-SECTION 11 STA 53+08

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, therefore, 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 the site is functioning as designed, with varying degrees of wetness and saturation across the site. Gauges A3, M1, and M2 have exceeded the 9% hydrologic success criteria, while gauges A1 and A2 exhibit continuous saturation conditions of slightly less than 9%, which is consistent with wet flats.

Table 1. Hydrologic Monitoring Results for 2003 (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-A1	14.5 (6.5%)	79 (34%)	14
WB-A2	18 (8.5%)	90.5 (39%)	11
WB-A3	45 (19%)	115.5 (50%)	7
WB-M1 [4]	> 45 (> 19%)	> 115.5 (> 50%)	< 7
WB-M2 [4]	> 45 (> 19%)	> 115.5 (> 50%)	< 7

[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] Groundwater gauges WB-M1 and WB-M2 are manual gauges. Hydrologic parameters are estimated based on data from gauge WB-A3, however wetter conditions were documented at both M1 and M2 as compared to A3.

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%. As the data collected for 2003 indicate, the site is performing as described in the Mitigation Plan, with varying degrees of wetness documented and the majority of the site meeting the stated criteria of 9%.

2.3.2 Climatic Data

Table 2 is a comparison of the 2003 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 (March 7 through October 7), the rainfall total from the Smithfield gauge (37.98 inches) correlates well with data collected from the onsite manual rain gauge (40.10 inches). In general, monthly rainfall amounts for the area were higher than normal for the 2003 monitoring season, with the exceptions of the months of January, June, and September. This comparison gives an indication of how 2003 compares to historical data in terms of average rainfall. For the 2003 period of record shown, total rainfall was approximately ten inches greater than the long-term average. Monthly rainfall for October, November, and December 2003 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 2003 Precipitation
January	3.96	2.96	4.63	2.35
February	3.99	2.81	4.73	6.11
March	4.29	3.12	5.06	6.56
April	3.14	1.96	3.80	4.29
May	4.12	2.86	4.91	6.21
June	3.97	2.68	4.74	3.03
July	5.47	3.59	6.57	8.88
August	4.48	2.92	5.39	6.80
September	4.06	2.06	5.03	3.57
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**

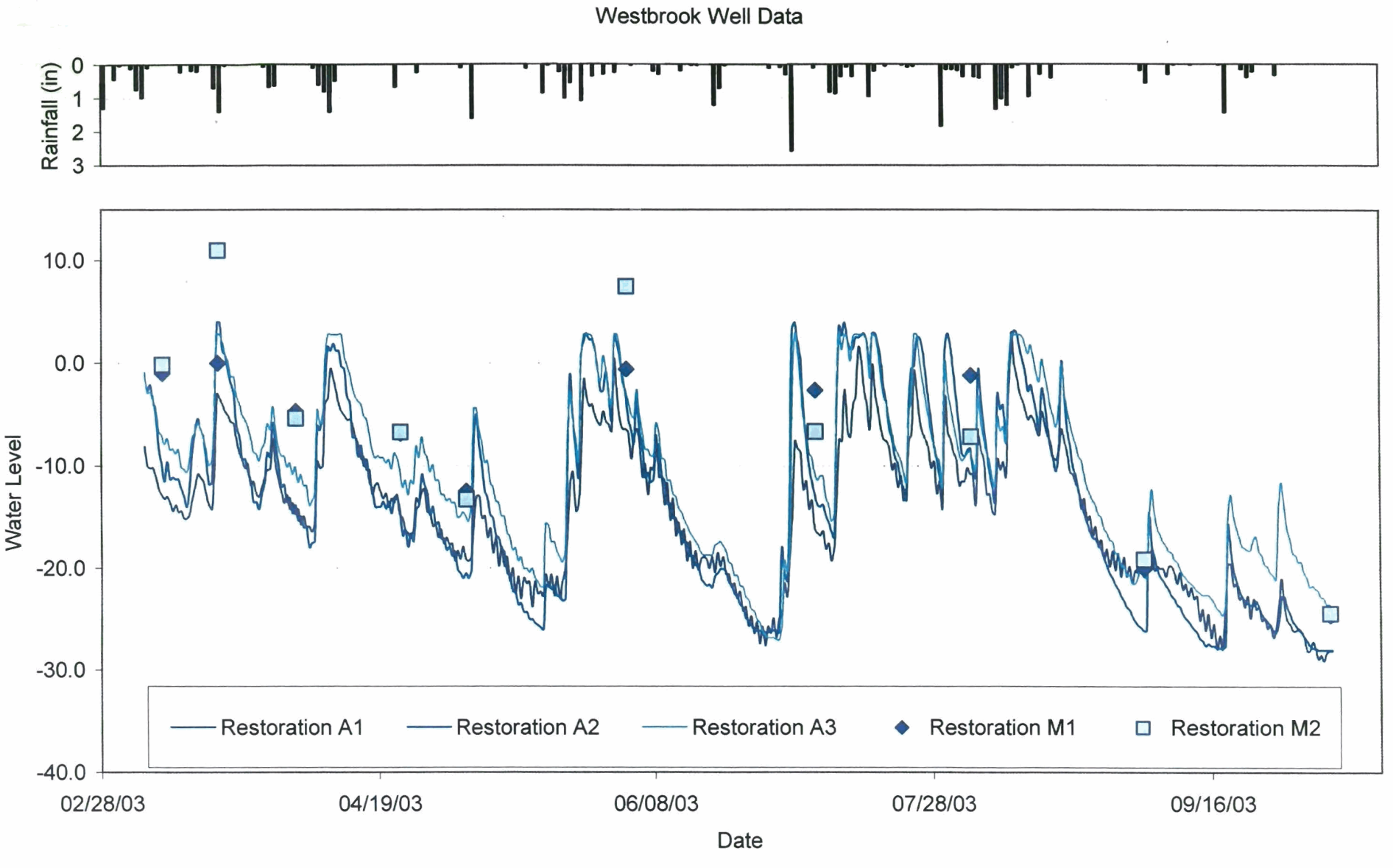

Figure 3. 2003 Groundwater Gauge Data Graph.

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 2003 growing season for three out of the five stations. Two of the stations did not meet the 9% criteria but achieved hydrologic conditions consistent with the reference wells and associated wet flat conditions. The site is 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). For stations A1 and A2, the criteria were not met because the hydrograph dropped one to two inches below the 12 inch depth criteria for just a few days. This is apparent in Figure 3 when noting how closely the hydrographs for the three automated station track each other, yet the calculated hydroperiods are quite different and are dependent on where the hydographs "bottom out" between rainfall events. This is further indication that the site is performing as predicted.

Although wetter than average conditions were experienced during 2003, the hydroperiods calculated for the site appear to be more dependent on the timing of rainfall events than the cumulative rainfall totals during the year. We therefore expect that the site will likely exhibit similar hydroperiods as documented for the 2003 growing season during more normal rainfall years.

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. In addition, for the five year monitoring period, the presence of volunteer facultative softwood species such as red maple, sweet gum, and loblolly pine will be limited to less than 10% each of the total number of trees utilized to determine success. These trees may contribute more than 10% of the total trees on the site, but they will not constitute more than 10% each of the 260 trees per acre.

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 help in determining 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. 2003 Vegetation Monitoring Plot Species Composition.

Plot	1	2	3	4	5	6	7	8	9	10	11	Total	Stem/ac
W1	2	0	13	6	6	0	2	3	6	5	13	56	560
W2	4	1	9	10	1	0	1	4	0	24	3	57	570
W3	4	0	9	9	0	0	0	6	2	13	15	58	580
W4	0	0	4	5	3	17	6	2	6	22	0	65	650
W5	0	0	3	1	1	8	2	4	2	37	2	60	600
W6	5	0	0	17	1	2	3	9	2	8	2	49	490
W7	2	0	13	5	4	11	1	0	8	4	7	55	550
W8	0	2	16	3	2	3	3	3	1	6	15	54	540
W9	0	0	11	1	5	10	2	10	5	5	5	54	540
W10	3	0	7	10	5	4	3	3	9	2	2	48	480
W11	1	1	18	4	0	2	11	10	3	3	0	53	530
W12	6	0	2	1	0	1	0	1	0	33	13	57	570
W13	0	0	7	6	4	0	8	5	3	7	5	45	450

Average Stems/Acre: 546.9

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 2003 vegetation monitoring revealed an average tree density greater than 540 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.

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 from "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 13 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.

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.

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 will be 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 will follow protocols described in the standard operating procedures of the Biological Assessment Unit of the NC Division of Water Quality. The Qual-4 collection method will be used for the collection of macroinvertebrate samples, and a NC certified laboratory will perform the identification of the macroinvertebrate samples. The metrics to be calculated will include total and EPT taxa richness, EPT abundance and biotic index values.

4.3 RESULTS OF STREAM MONITORING

Bankfull events on the site were documented during several 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 October and was approximately 0.6 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. Photographs taken on March 21, 2003 (see Appendix B) were taken immediately following another bankfull event that occurred the night before.

Year 1 monitoring data for stream stability were collected during April 2003 to set a baseline for stream monitoring to occur in subsequent years. The longitudinal profile information documents the elevations and locations of streambed features and instream grade control structures (see

Appendix C). The longitudinal profile also documents that the overall design stream slope (0.0024 ft/ft) was achieved in the completed stream. Permanent cross-sections document the stream dimension at thirteen locations (seven riffles and six pools, see Appendix C). The cross-sections show that the constructed stream was built to the design dimensions and ratios indicated in the plans.

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 become more stable through the growing season as vegetation has become 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. Following the high water bankfull event on March 21, 2003, cross-vane #3 experienced scour behind the left vane arm due to floodplain flow that cut back into the channel in an area of sandy soil. A trackhoe and four additional boulders were brought to the site in mid-April to repair the structure. The repair involved rebuilding the left arm and invert which had shifted due to the scour, rebuilding the left bank such that future high flows would route around the cross-vane area, and installing additional cane transplants around the cross-vane structure. Since repair, the structure has shifted slightly, but has maintained its invert elevation and appears to be stable.

One of the most effective restoration techniques used during construction was the placement of transplanted vegetation around the outside of meander bends. Transplanted vegetation consisted primarily of native cane (*Arundinaria gigantea*) and other herbaceous vegetation growing around the cane. Transplants were excavated from around the field borders and ditches and placed along the restored streambanks. Survival of the transplants has been nearly 100% and the transplanted vegetation has provided excellent protection of streambanks, as well as improved habitat and shading.

Although fish and macroinvertebrate sampling are scheduled to occur in the January 2004, fish have been observed within the restored stream channel during the past year. Frogs have also been very prevalent around the stream channel at various times throughout the year.

Photographs have been taken throughout the monitored season to document the evolution of the restored stream channel (see Appendix B). Due to the presence of numerous high flows early in the growing season, development of sand bed features within the channel occurred quickly. Restored pools have maintained a variety of depths and habitat qualities, depending on the location and type of scour features (logs, root wads, transplants, etc.). Permanent vegetation seeded on the restored streambanks established quickly due to frequent rain events during the first half of the growing season. Live stakes were installed on restored streambanks and, based on visual observations, survivability during the first growing season has been high.

4.4 CONCLUSIONS

The total length of stream channel restored on the site was 5,414 feet. 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 developed quickly after construction and it is expected that stability of the system will only improve in the coming years as permanent vegetation becomes more established.

Figure 4. **Restored stream channel segment on August 12,2003, showing the growth of vegetation along the stream channel.** The inset picture was taken on March 21, 2003, less than one month after the completion of construction, and is shown for comparison.

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.

Although above average rainfall was experienced during 2003, 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, 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 determined to also 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 and RM3, and indicate the same general hydrologic trends in both systems (Figure 5). Gauge RM4, installed near the periphery of the reference site, indicates drier conditions overall than the hydrologic conditions documented on the restoration site.

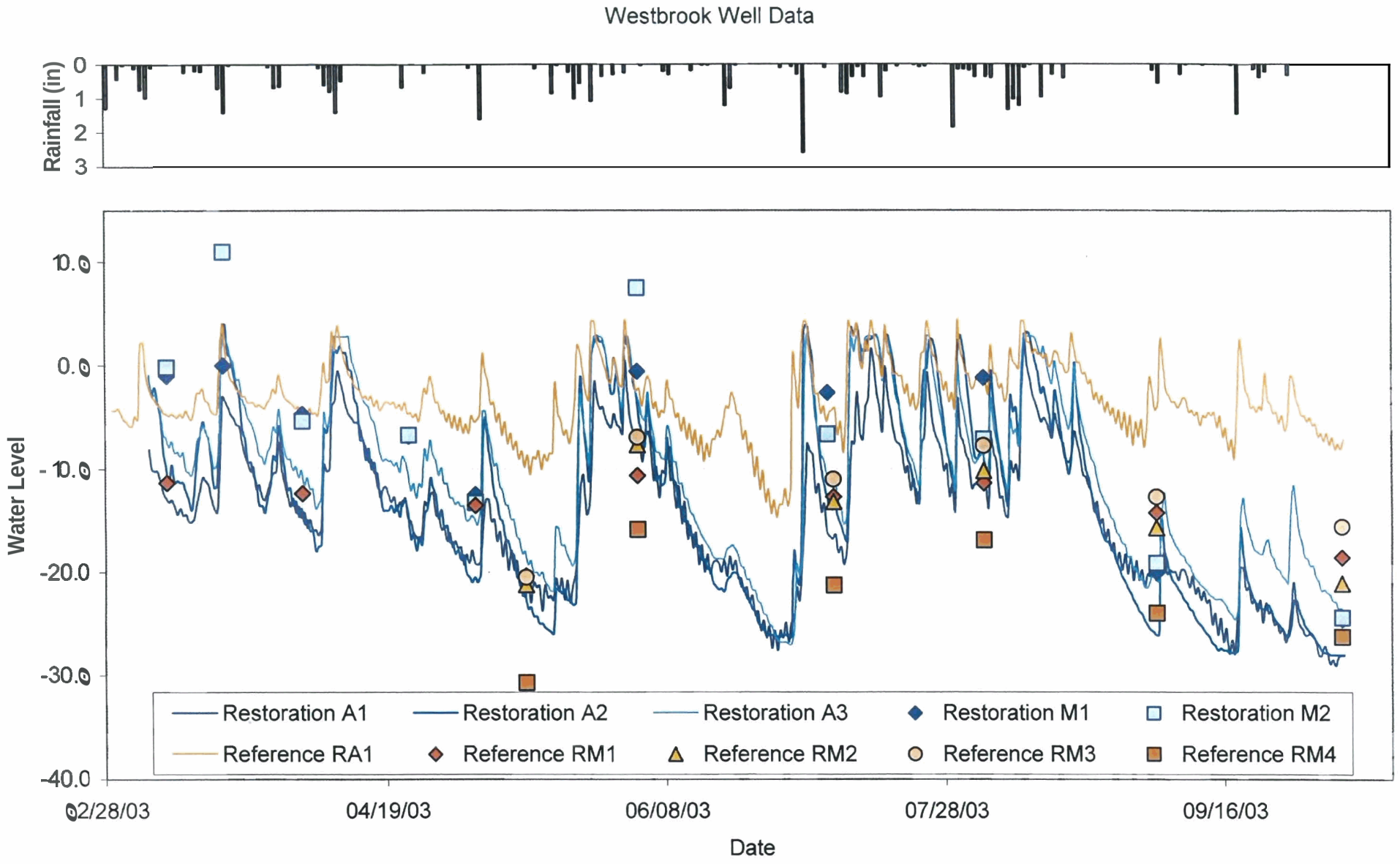

Figure 5. Comparison of Reference Site Data to Restoration Site Data.

OVERALL CONCLUSIONS AND RECCOMENDATIONS

- First year hydrologic monitoring has shown that suitable minimum wetland hydrology criteria have been achieved. Three of the five hydrologic monitoring gauges documented that the targeted success criteria were achieved. The two remaining gauges demonstrated hydroperiods greater than 5% and mimicked conditions documented on the reference site.
- Despite numerous bankfull flows during the first growing season, the restored stream channel has remained stable and is providing the intended habitat and hydrologic functions. Only several small areas of instability have been observed, and it is believed that these areas will stabilize themselves in the next growing season as vegetation continues to colonize and mature on the site.
- Vegetation monitoring efforts have calculated the average number of stems per acre on site to be 546.9 which is a survival rate of almost 93% based on the initial planting count of 590 stems per acre.
- Since the first growing season usually experiences the greatest mortality of planted vegetation, we believe that vegetation survivability should remain high on site and vegetative success criteria will be met, with very little if any anticipated maintenance or replanting.
- Monitoring of vegetation and groundwater and surface water levels will continue.

WILDLIFE OBSERVATIONS

Observations of deer tracks are common on the Westbrook Lowgrounds site. During certain times of the year, frogs have been very prevalent across the site. During September, a wild hog was observed walking along one of the access roads, and hog tracks are fairly common in the lower portions of the site adjacent to Mill Creek.

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 and volunteering panic grass (*Dicanthelium spp*), rice cut grass (*Leersia spp*) and a bent grass (*Agrostis spp*) dominate 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 a few drier 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 found on isolated hummocks and they are believed to pose very little threat to survivability in site. Weedy vegetation includes ragweed (*Ambrosia artemisiifolia*), partridge pea (*Cassia fasciculata*), Morning Glory (*Ipomoea* sp.). The hummock dynamic is consistent with the targeted wetland system. No vines or perennials were observed. Any threatening weedy vegetation found in the future will be documented and discussed.

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Appendices