Rowel Branch Tract:
Year Three Monitoring Report

Brunswick County, NC

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November 2003

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Monitoring Report for the
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1.0 Introduction

Throughout 2000 and 2001, ECOBANK restored 16.1 acres of bottomland hardwood wetlands at the Rowel Branch tract (Figure 1) in Brunswick County, North Carolina. This restoration was used as mitigation for unavoidable wetland impacts associated with the construction of the Wilmington Bypass by the NCDOT. Details of the mitigation activities are presented in the Revised Compensatory Mitigation Plan for the Rowel Branch Tract, dated July 21, 2000. Construction activities were consistent with the mitigation plan.

The Rowel Branch tract consists of a riverine ecosystem, which was bypassed in the 1970's with the construction of a large water diversion canal (Figure 2). In addition, four areas within this floodplain were filled to facilitate better tract access during construction of an adjacent railroad yard. In order to restore this tract, ECOBANK 1) removed the fill from these four different sections of the site to restore the natural floodplain (winter of 2000), 2) planted trees within the floodplain (spring of 2000), 3) removed the earthen plug that separated the natural stream and the canal (spring of 2001), and 4) filled the large diversion canal with the previously excavated material in order to restore hydrology back to the stream and its floodplain (summer of 2001).

2.0 Hydrology

2.1 Success Criteria

According to the Rowel Branch Tract Mitigation Plan, two hydrological success criteria were established. The first criterion ensures that wetland hydrology for this site is achieved and requires the establishment of a static water table at or within 12” of the soil surface, ponded or flooded for 12.5% of the growing season during normal precipitation conditions. The growing season in Brunswick County extends 265 days, between March 7 and November 28. Normal precipitation is defined as total monthly precipitation falling

within the 30th and 70th percentiles of a 30-year period. Therefore, to meet the first success criterion, the water table should remain at or within 12" of the soil surface for at least 33 consecutive days between March 7 and November 28. The second criterion deals with riverine hydrology and requires the establishment of overbank flooding events at a frequency and duration within 10% of the reference site.

2.2 Methods

Six automated groundwater monitoring gauges were installed throughout the Rowel Branch site to monitor groundwater hydrology for at least five years (Figure 3). These gauges were located within three transects, with each transect containing two gauges: one within the stream channel and one 50' from the channel. Four of these gauges (A1, A2, B1, and B2) were installed on July 20, 2000 and the remaining two gauges (C1 and C2) were installed on November 29, 2000. Two reference gauges located off site were installed on July 29, 2000 (Figure 2). Each automated gauge was programmed to read the groundwater level once a day.

In March of 2000, the channel in the restored wetland was restored to the grade of the previous streambed, resulting in 2,640 linear feet of stream restoration to be utilized by NCDOT. In June and July of 2001, the existing diversion canal was filled to divert all flow back through the restored riverine system. The existing fill was removed and contoured to natural grade. Topographical data and drainage calculations demonstrated that the restored floodplain was lower and wider than the old canal; therefore the restoration would not cause upstream flooding (see Appendix A). Also in July of 2001, NCDOT maintenance contractors installed a second 7' drainage culvert under Mt. Misery Road to enhance downstream flow.

For this monitoring report, hydrology and riverine data between October of 2002 and September of 2003 were analyzed. To evaluate the riverine success criterion, the cross-section of each gauge transect was surveyed in 2002 (Figure 4) and the gauges were calibrated to mean sea level so that water level data collected on site could be compared to reference gauge data. The number of events (frequency) and the length of

each event (duration) that gauges documented overbank flooding between October of 2002 and September of 2003 was calculated and compared to data from the reference gauges to evaluate this success criterion. It should be noted that the riverine success criteria were not fulfilled during the second year of monitoring (2002).

2.3 Results

As in 2001 and 2002, all six gauges located within Rowel Branch fulfilled the wetland hydrology criterion of a water table within 12" of the soil surface for 12.5% of the growing season, or 33 days (Table 1). In fact, all six gauges recorded wetland hydrology from the beginning of the growing season (March 7, 2003) until the last reading taken prior to submitting this report (September 22, 2003). Likewise, the two reference gauges (R1 and R2) also exceeded the wetland hydrology criterion and had a water table within 12" of the soil surface for 200 and 48 consecutive days, respectively.

The 30-day running total for 2003 shows normal or above normal rainfall for most of the year (Appendix B).

Table 1. Groundwater monitoring results for gauges located within the Rowel Branch tract and the reference site between March 7, 2003 and September 22, 2003.

Type	Gauge Number	Serial Number	# of Consecutive Days above 12"
Restoration	A1	S353B9B	200
	A2	S353A32	200
	B1	S213EB6	200
	B2	S369807	200
	C1	S353979	200
	C2	S126F6B	200
Reference	R1	S3539A7	200
	R2	S126F2F	48

An evaluation of the riverine success criterion determined the frequency and duration of overbank flooding for all gauges within the tract and within the reference site (Table 2). The reference gauge in the stream (R1) documented overbank flooding on 18 occasions. Each flooding event had an average duration of 13.4 days. As in 2002, all three of the stream gauges at Rowel Branch experienced fewer flooding events than the reference stream gauge. Gauge A1 experienced 8 flooding events with an average duration of 13.6 days and gauge B1 documented 16 flooding events with average duration of 1.8 days. The stream gauge located farthest north (C1) only recorded two flooding events with an average duration of 1 day. The average duration of flooding events at the A1 gauge (13.6 days) was within 10% of the duration of the reference gauge R1 (13.4 days). However, the number of flooding events at A1 was far fewer than the number at R1 (8 vs. 18) and did not meet the 10% criterion. None of the other mitigation gauges located at the stream met the success criterion of establishing overbank flooding events at a frequency or duration within 10% of R1.

The reference gauge 50' away from the stream (R2) documented flooding on 6 occasions, with an average duration of 2.2 days. The frequency of flooding events documented at A2 (21) and at C2 (24) was much higher than the frequency observed at R2. However, both B2 and R2 documented 6 flooding events during the time period and, therefore, B2 met the 10% success criterion for frequency. All three of the mitigation gauges recorded longer durations of flooding events than the reference gauge and did not meet the 10% success criterion for duration.

Table 2. Frequency and duration of flooding events for gauges located within the Rowel Branch tract and the reference site in 2003.

Type	Gauge Number	Serial Number	Frequency of Flooding Events	Average Duration of Flooding Events (days)
Restoration	A1	S353B9B	8	13.6
	A2	S353A32	21	10.0
	B1	S213EB6	16	1.8
	B2	S369807	6	4.5
	C1	S353979	2	1
	C2	S126F6B	24	5.8
Reference	R1	S3539A7	18	13.4
	R2	S126F2F	6	2.2

As in previous years, it was observed throughout 2003 that beavers were building dams in several locations within the creek, causing water levels near these dams to increase. Because of concern raised by neighbors that these dams were backing up water onto their property, the dams were periodically monitored and removed. The dates that the dams were knocked down can be observed in the hydrographs. The creek will continue to be monitored for the reappearance of dams.

3.0 Vegetation

3.1 Success Criteria

The Rowel Branch Mitigation Plan states that the vegetation success criterion for this project is the survival of 320 trees per acre, including acceptable volunteer species. In addition, no individual hardwood species may account for more than 20% of the total number of stems.

3.2 Methods

A list of the tree species that were planted in the spring of 2000 at the Rowel Branch tract is given in Table 3. These one-year and two-year seedlings were obtained from the NC Forest Service Nursery and were planted on a ten-foot spacing within the

floodplain of Rowel Branch. The vegetation survey consisted of establishing a circular plot every 25 feet along two transects within the tract (Figure 5). The center of each plot was marked with a pink pin flag and the ends of the transects were marked with orange flagging. Each plot had a radius of 10 feet and an area of 314.2 ft^2. Transect 1 contained 7.5 plots and transect 2 contained 6.5 plots. Therefore, the total area surveyed was 4398 ft^2, or approximately 0.1 acre. Transect 1 was approximately 200 feet in length and began along the edge of a planted area that was relatively high in elevation. Progressing along the transect, elevation gradually dropped until the stream was encountered, which represented the lowest elevation and wettest point along the transect. Then the elevation rose again as it moved toward the stockpile area, where it ended. Transect 2 was approximately 175 feet in length. No major changes in elevation were observed along this transect except for a low ponded spot in the middle. The transect began at the canal, near where it turns 90E, and ended at the stream.

Table 3. Number and types of trees planted at Rowel Branch on March 15 and April 1 of 2000. Trees were planted at a density of 435/acre.

Common Name	**Scientific Name**	**# Planted**
Atlantic White Cedar (2 yr)	*Chamaecyparis thyoides*	1000
Bald Cypress (1 yr)	*Taxodium distichum*	1600
Green Ash (1 yr)	*Fraxinus pennsylvanica*	800
Water Oak (1 yr)	*Quercus nigra*	1000
Willow Oak (1 yr)	*Quercus phellos*	1300
Yellow Poplar (1 yr)	*Liriodendron tulipifera*	600
TOTAL		**6300**

3.3 Results

As in previous years, herbaceous vegetation observed within the drier areas of both transects included *Eupatorium capillifolium*, *E. hyssopifolium*, and *Rubus spp*. In the wetter areas, *Scirpus cyperinus*, *Peltandra virginica*, *Mikania scandens*, *Juncus effusus*, *Polyganum sagittatum*, and several sedge species (*Cyperus* and *Carex* spp.) were

observed. Again, more herbaceous vegetation was observed in transect 1 than in transect 2, although transect 2 was becoming dense in vegetation (Appendix C). One noticeable difference between the herbaceous vegetation in 2003 and in previous years was the increased amount of blackberry (*Rubus spp*.) present, especially near the stream.

The planted trees that were observed within the transects were found to be in good condition and continue to grow. Several bald cypress (*Taxodium distichum*) trees were over 10 feet tall. Volunteer alder (*Alnus serrulata*) and black willow (*Salix nigra*) trees were found in wetter spots, especially near the stream in transect 1. As in previous years, most of the red maple observed was in transect 2, where the herbaceous layer was not as thick and sunlight was able to reach the ground. Most of the red maple seedlings were typically 12-18 inches tall, however several 5-8' maples were observed.

Table 4. Number and species of trees surveyed within two transects at Rowel Branch (8/13/03).

Common Name	**Scientific Name**	**Average Height (in)**	**Total # of Trees Observed**	**# Counted Towards Criteria**
Alder	*Alnus serrulata*	51.3	104	95.8
Atlantic White Cedar*	*Chamaecyparis thyoides*	25.5	4	4
Bald Cypress*	*Taxodium distichum*	67.7	46	46
Black Willow	*Salix nigra*	63.1	31	18
Eastern Baccharis	*Baccharis halimifolia*	69.0	2	2
Eastern Sycamore*	*Platanus occidentalis*	32.0	3	3
Green Ash	*Fraxinus pennsylvanica*	66.0	10	10
Loblolly Pine	*Pinus taeda*	26.3	16	16
Overcup Oak	Quercus	21.0	2	2
Red Maple	*Acer rubrum*	45.1	219	95.8
Sweetgum	*Liquidambar styraciflua*	28.8	10	10
Wax Myrtle	*Myrica cerifera*	36.0	11	11
Willow Oak*	*Quercus phellos*	41.3	8	8
Winged Sumac	*Rhus copallina*	20.8	13	13
TOTAL			**479**	**334.6**

(Data for the individual transects are given in Appendix D.)
*Species was planted in 2000.

A total of 479 trees was observed within the surveyed plots (Table 4), which was an increase from 283 trees observed in 2002. The mitigation plan stated that no single tree species could represent more than 20% of the total number of trees observed. After

factoring in this requirement, the number that was counted towards the vegetation success criterion was 334.6 trees. Because the total area of all the plots represented approximately 0.1 acre, the average number of trees/acre was 3346. This was more than 10 times the minimum 320 trees/acre required by the mitigation plan. Therefore, vegetation met the success criterion during year three monitoring.

4.0 Conclusions

ECOBANK has restored 16.1 acres of bottomland hardwood wetlands at the Rowel Branch tract in Brunswick County, North Carolina as mitigation for unavoidable wetland impacts associated with the construction of the Wilmington Bypass by the NCDOT. To restore this area, fill was removed from the riverine floodplain, trees were planted within the floodplain, and a large diversion canal was filled to restore hydrology to the stream.

As in 2001 and 2002, groundwater monitoring data collected from automated gauges during 2003 showed Rowel Branch to support wetland hydrology. Not only did all six of the gauges on site demonstrate groundwater levels at or within 12" of the soil surface for at least 12.5% of the growing season (33 days), but they recorded wetland hydrology from the beginning of the growing season (March 7, 2003) until the last reading taken prior to submitting this report (September 22, 2003). The only gauge that did not document a long period of wetland hydrology was the reference gauge located 50’ from the stream (R2). This gauge recorded wetland hydrology for 48 continuous days, much shorter than the 200 days observed by the other gauges. The reason for this difference may be due to greater topographical relief in the reference area that allows water to flow quickly to the stream.

An evaluation of the riverine success criterion determined the frequency and duration of overbank flooding within the tract and within the reference site. As in 2002, this evaluation did not determine a clear pattern between gauges. All three of the gauges located within the restored stream at Rowel Branch (A1, B1, and C1) experienced fewer flooding events than the gauge located within the reference stream (R1) and did not meet the 10% success criterion for frequency. Gauges B1 and C1 had shorter flooding durations than R1, however the average duration of flooding events at the A1 gauge (13.6 days) was within 10% of the duration of R1 (13.4 days) and met the success criterion for duration.

The reference gauge 50' away from the stream (R2) documented flooding on 6 occasions, with an average duration of 2.2 days. The frequency of flooding events documented at A2 (21) and at C2 (24) was much higher than the frequency observed at R2. However, both B2 and R2 documented 6 flooding events during the time period and, therefore, B2 met the 10% success criterion for frequency. All three of the mitigation gauges (A2, B2, and C2) recorded longer durations of flooding events than the reference gauge (R2) and did not meet the 10% success criterion for duration.

The cross-sections showed that the reference stream at its transect location is smaller in area than the restored stream at those transect locations. Therefore, when comparing these points, the reference stream gauge floods more frequently. As in 2002, the number of flooding events and average flood frequency documented by the three gauges located 50' away from the restored stream (A2, B2, and C2) varied considerably from the reference gauge (R2). Gauges A2 and C2 documented more frequent flooding than R2 with longer average durations. Gauge B2 had the same number of flooding events (6), but with a longer average frequency. It should also be noted that as in 2002, the A and C transects experienced more frequent flooding events 50' away from the stream than directly adjacent to the stream even though the gauges 50' away from the stream were at higher elevations than the top of the bank. This may be because the topography is flatter 50' away from the stream and short-term rainfall can create ponding in these areas. Closer to the stream, slopes are greater and rainfall is transported at a fast rate downstream, decreasing overbank flooding.

As discussed in the year two monitoring report, there are several reasons why the riverine success criterion was largely not achieved. First, the reference stream is located in the middle of Leland Industrial Park and receives a large amount of stormwater runoff from impervious cover associated with this development, which may cause additional flooding. Property surrounding Rowel Branch is mostly small residential units or undeveloped parcels, which contribute less stormwater flow into the restored stream. In addition, the dimensions of the restored stream were not based on those of the reference stream. The unchannelized bottomland hardwood reference site was chosen as a general control for groundwater hydrology. Site selection of the gauge placement was not based on similar cross-sectional profile data between the reference and the

restored sites. Therefore, overbank flooding results are difficult to compare particularly when the four transects were selected at random with no pre-project elevation information.

Just like most coastal streams, Rowel Branch's stream bank heights show great variability and, therefore, overbank flooding events should not be referenced to one spot along an entire stream gradient. Rack lines, fresh sediment buildup, and compressed herbaceous plant stems are better indicators of flooding throughout the system. Further compounding the comparative results of random monitoring points is the braided nature of the coastal floodplain. In one instance, the reference gauge may be situated near a lower shelf braided branch of the main stream while the restoration gauge may be on a higher position on the floodplain. It is important to look at the entire system rather than at individual points. The requirement that all restored gauges must be within 10% of one sample reference transect is too restrictive and does not account for the high variability of the coastal bottomland hardwood stream system. A better solution would be to put more importance on achieving survivability of similar hydrophytic plants and maintaining wetland hydrology over the course of five years. Flooding events could be modeled with a design storm of a certain event (i.e. 10, 25 or 50-year) and then compare the extent of flooding over the four transects. In this manner one can project the flooding dissipation function of the floodplain in both reference and restored sites in a manner similar to FEMA and stormwater/sediment control models.

However, because the Rowel Branch gauges documented frequent flooding events and because wetland vegetation is flourishing throughout the site, it is achieving its overall goal of restoring a riverine floodplain system. As stated in the year two monitoring report, the riverine success criterion appears to be too restrictive and may need to be redefined by the commenting agencies.

The vegetation analysis determined a total of 479 trees within the surveyed plots (Table 4), an increase from 283 trees observed in 2002. After factoring in percentage requirements, the number of trees that were counted towards the vegetation success criterion was 334.6 trees, or 3346 trees/acre. This was more than 10 times the minimum 320 trees/acre required by the mitigation plan and was an increase in number from monitoring performed in 2001 (205.6) and 2002 (214.2). Therefore, vegetation met the success criterion during year three monitoring.

Based on the data analysis within this report, the conclusion of the year three monitoring is that the Rowel Branch tract has fulfilled the vegetation and hydrology success criteria established in the mitigation plan and that the wetland restoration of the tract is thus far successful.

Appendix A. Engineering Report performed by Wrightsville Engineering Services

Appendix B. Hydrographs

Appendix D. Vegetation Data by Transect

Table 1. Number and type of trees observed in Transect 1 in 2003.

Common Name	Scientific Name	Average Height (in)	# Observed
Atlantic White Cedar	*Chamaecyparis thyoides*	25.5	4
Bald Cypress	*Taxodium distichum*	66.6	28
Black Willow	*Salix nigra*	60.7	25
Common Alder	*Alnus serrulata*	53.5	39
Eastern Baccharis	*Baccharis halimifolia*	69.0	2
Green Ash	*Fraxinus pennsylvanica*	48.0	4
Loblolly Pine	*Pinus taeda*	19.3	9
Overcup Oak	*Quercus lyrata*	30.0	1
Red Maple	*Acer rubrum*	35.1	33
Sweetgum	*Liquidambar styraciflua*	28.8	10
Wax Myrtle	*Myrica cerifera*	36.0	11
Willow Oak	*Quercus phellos*	41.3	8
Winged Sumac	*Rhus copallina*	20.8	13
TOTAL			**187**

Table 2. Number and type of trees observed in Transect 2 in 2003.

Common Name	Scientific Name	Average Height (in)	# Observed
Bald Cypress	*Taxodium distichum*	69.3	18
Black Willow	*Salix nigra*	73.0	6
Common Alder	*Alnus serrulata*	49.9	65
Green Ash	*Fraxinus pennsylvanica*	78.0	6
Loblolly Pine	*Pinus taeda*	35.1	7
Overcup Oak	*Quercus lyrata*	12.0	1
Red Maple	*Acer rubrum*	46.9	186
Sycamore	*Platanus occidentalis*	32.0	3
TOTAL			**292**

Appendix C. Pictures of Site