# ANNUAL REPORT FOR 2003

**Haws Run Mitigation Site**
**Pender and Onslow Counties**
**Project No. 6.259002T**
**TIP No. R-2405WM**

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## SUMMARY

The following report summarizes the monitoring activities that have occurred in the past year at the Haws Run Mitigation Site. This site was constructed in 1998 and planted in early 1999. The site must demonstrate both hydrologic and vegetation success for a minimum of five consecutive years.

Restoration activities at Haws Run included swamp forest and pine savanna restoration, enhancement, and preservation components. The site is equipped with twenty-five groundwater-monitoring gauges, two surface gauges, and one rain gauge.

The daily rainfall data depicted on the monitoring gauge graphs is recorded from an onsite rain gauge, which was installed in July 2001. Historical rainfall data used for the 30$^{th}$ – 70$^{th}$ percentile analysis was recorded at the Wilmington Rain Gauge, maintained by the NC State Climate Office. The onsite rain gauge experienced malfunctions twice during the growing season; during these periods the Wilmington data was used for Appendix A graphs.

Hydrologic monitoring results are presented by three methods: jurisdictional wetland criteria, average depth to groundwater, and duration of soil saturation.

Based on jurisdictional wetland criteria, the Haws Run Mitigation Site met hydrologic success for the 2003-year. In the swamp forest area, all gauges exceeded the 12.5% jurisdictional wetland criteria. In the pine savanna area, all gauges recorded hydroperiods of 8% of the growing season, or greater. Two gauges along the haul road (southern swamp) met the jurisdictional criteria of 12.5%. Both reference gauges HR-24 and HR-25 did not meet the success criteria. The gauges also exhibited comparable depths to groundwater and duration of the hydroperiods for the 2003-growing season.

Hydrologic patterns of flooding in the restoration areas across the Haws Run Mitigation Site followed patterns in the reference areas. The duration of saturation between the restoration gauges and the reference gauges were also comparable for the swamp, savanna, and haul road (southern swamp) areas.

Vegetation monitoring consists of three 500 feet by 500 feet sample plots in the savanna areas and seven 50 feet by 50 feet sample plots within the bottomland hardwood area. Various types of grasses were planted in ten 100 feet by 100 feet test plots. Vegetation success criteria were met for 2003, with 30 trees per acre in the savanna area and 436 trees per acre in the swamp forest area. The planted grass areas were establishing well.

NCDOT will continue to monitor the Haws Run Mitigation Site for hydrology and vegetation.

# 1.0 INTRODUCTION

## 1.1 Project Description

The Haws Run Mitigation Site was purchased in 1995 by the North Carolina Department of Transportation (NCDOT) to provide compensatory mitigation for unavoidable impacts to wetlands resulting from highway construction in the region. The site is located approximately 28 miles northeast of Wilmington, North Carolina, straddling the Pender-Onslow County Line (Figure 1). The site consists of riverine swamp forests at the northern and southern ends and a cutover interior of former wet flats and savannas with an extensive ditch and canal system. The central canal and lateral ditches, north of the electrical transmission line, were plugged in December 1997 for a short–term study to determine the effects of ditch-plugging and filling.

Full site construction began in Summer 1998 with excavation of the northern end of the site to the reference swamp elevation and plugging/filling of the central canal and lateral field ditches to the north of the powerline crossing. Construction was completed in February 1999 and the site was planted in early Spring 1999.

Final planting of pond cypress in the savanna area occurred in the spring of 2000. This planting was delayed due to difficulty in obtaining needed quantities of this particular species.

After the hurricane season in 1999, the northern slope between the swamp forest and savanna was eroded in several locations. The Roadside Environmental Unit in cooperation with the Natural Systems Unit, Division Construction personnel, and the United States Army Corps of Engineers developed a slope remediation plan, dated June 8, 2000. Eleven eroded areas were backfilled and stabilized with stone lined swales. Two areas were stabilized with seeding and matting. A low berm was constructed to direct overland flow into the stabilized swales. This slope constitutes the transition zone between the swamp restoration area and the savanna restoration area. In summer 2003 repairs were made to the two slopes that were initially seeded and matted. Stone lined swales were used to stabilize these areas, and superficial repairs were made to the remaining stone swales. No wetland mitigation credit is expected from this zone. A revised debit ledger is included within this report.

**Figure 1: Vicinity Map**

## 1.2 Purpose

In order to demonstrate successful mitigation, hydrologic and vegetative monitoring must be conducted for a minimum of five consecutive years. Development of the success criteria is discussed in the Haws Run Mitigation Plan. The following report documents the results of the hydrologic and vegetative monitoring activities during the 2003-year on the Haws Run Mitigation Site.

## 1.3 Project History

| | |
|---|---|
| Winter 1997 | Pilot Study |
| Summer 1998 – Winter 1999 | Site Construction |
| Spring 1999 | Site Planted (Entire Site, Except Pond Cypress) |
| October 1999 | Vegetation Monitoring (Year 1) |
| March – November 1999 | Hydrologic Monitoring (Year 1) |
| March 2000 | Pond Cypress Planting Completed |
| August - October 2000 | Slope Repair |
| October 2000 | Vegetation Monitoring (Restart Year 1) |
| March – November 2000 | Hydrologic Monitoring (Year 2) |
| October 2001 | Vegetation Monitoring (Year 2) |
| March – November 2001 | Hydrologic Monitoring (Year 3) |
| July 2002 | Vegetation Monitoring (Year 3) |
| March – November 2002 | Hydrologic Monitoring (Year 4) |
| September 2003 | Slope Repair |
| September 2003 | Vegetation Monitoring (Year 4) |
| March – November 2003 | Hydrologic Monitoring (Year 5) |

## 1.4 Debit Ledger

| Haws Run | Mit. Plan | | | TIP DEBIT | TIP DEBIT | TIP DEBIT | TIP DEBIT | TIP DEBIT | TIP DEBIT | TIP DEBIT | TIP DEBIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pender/Onslow Co. | | | | | | | | | | | |
| Habitat | Acres at Start: | Acres Remaining | | U-2107 | R-2405C | U-3616 | R-2633CC | U-2734 | Sec. Rd. (Pender) | U-92A | R-2405A |
| Swamp Forest Restoration | 26 | 11.8 | 45.38 | 14.2 | | | | 3.6 | 0.64 | 0.14 | 4.3 |
| Swamp Forest Enhancement | 25 | 25 | 100.00 | | | | | | | | |
| Swamp Forest Preservation | 171 | 171 | 100.00 | | | | | | | | |
| Wet Savanna Restoration | 81 | 49.36 | 60.94 | | 14.64 | 17 | | | | | |
| Wet Savanna Enhancement | 99 | 99 | 100.00 | | | | | | | | |
| Wet Savanna Preservation | 11 | 11 | 100.00 | | | | | | | | |
| Dry Savanna Enhancement | 113 | 113 | 100.00 | | | | | | | | |
| TOTAL | 526 | 480.16 | 91.29 | | | | | | | | |

# 2.0 HYDROLOGY

## 2.1 Success Criteria

The Haws Run Mitigation Plan and the Final Responses to Agency Comments describe the success criteria for hydrology on the site. The success criteria for the swamp restoration area are based on the hydrologic regime of the Sandy Run Swamp reference area. Specifically, the mean depth to groundwater for wells in the swamp restoration area should be at, above, or no more than 25% deeper than the mean depth to groundwater for wells in the reference area.

The success criteria for the pine savanna restoration area were initially tied to the Lanier Quarry Savanna reference site. Subsequent to review by NCDOT and the USACE, Lanier Quarry savanna was deemed unsuitable as a reference site. Therefore, the success criteria for the Haws Run savanna restoration area reverted to federal guidelines for wetlands as described in the 1987 USACE Wetlands Delineation Manual. These guidelines state that the area must be inundated or saturated (within 12" of the surface) by surface or groundwater for a consecutive 12.5% of the growing season. Areas inundated less than 5% of the growing season are always classified as non-wetlands. Areas inundated between 5% - 12.5% of the growing season can be classified as wetlands depending upon factors such as the presence of hydrophytic vegetation and hydric soils.

Success criteria for the area isolated by the forestry haul road (southern swamp) were based on re-establishing the hydrologic connection of that area to the southern swamp. Reference gauges were installed in the southern swamp area to compare with those in the restoration southern swamp area. The flooding regime and groundwater depths should be similar in each area or show recovery of these processes after removal of the haul road (southern swamp).

This document uses three methods to report the hydrologic monitoring results for the Haws Run Mitigation Site: jurisdictional wetland criteria, average depth to groundwater, and duration of soil saturation.

The growing season for the Haws Run Site was calculated as an average of data from Pender County, Onslow County, and the U.S. Weather Bureau publication, *Low Temperature Probabilities in North Carolina.* Using all three data sets, the average growing season for the Haws Run Site was estimated to be 238 days in length, lasting from March 23 to November 15. Therefore, for Haws Run to meet the 12.5% jurisdictional wetland hydrology, the water table must not fall below the 12-inch threshold for at least 30 consecutive days during the growing season under normal precipitation. This hydroperiod is expected in the swamp forest restoration area. The pine savanna restoration area is expected to support jurisdictional wetland hydrology for 8% to 12.5% of the growing season.

This translates into a hydroperiod of 19 to 30 consecutive days during the growing season along with the presence of hydrophytic vegetation and hydric soils.

## 2.2 Hydrologic Description

After site construction, nineteen groundwater-monitoring gauges (RDS WL-40) were installed on the site (Figure 2). Two additional gauges, HR-20 and HR-21, were installed in early Spring 2000. HR-15 was reported in the 1999 Monitoring report as being located in the delineated wetland in the pine savanna reference area. A GPS survey placed the actual location in the pine savanna restoration area. This revised location is reported below along with all of the gauges located at Haws Run.

- Three in the swamp reference area (HR –1, HR-2, HR-4).
- Five in the swamp restoration area (HR-3, HR-5, HR-6, HR-21).
- Two on the slope transition area (HR-7, HR-8).
- Six in the pine savanna restoration area (HR-9 through 12, HR-15, HR-20).
- Five in the pine savanna jurisdictional wetlands (HR-13, HR-14, HR-16, HR-17, HR-18).
- Three in the southern swamp restoration (haul road) area (HR-19, HR-22, HR-23).
- Two in the southern swamp reference (haul road) area (HR-24, HR-25).

After field inspection in April 1999, monitoring gauges HR-1 through HR-6 were relocated (as shown on Figure 2) to better represent site conditions. Ground surface elevation was surveyed at each well and was used to correlate well data for restoration area and reference area comparisons. Based on similar elevations, the following wells were paired for hydrologic monitoring:

- HR-1 and HR-3 at a relative elevation of 6.2 ft
- HR-2 and HR-5 at a relative elevation of 5.8 ft
- HR-4 and HR-6 at a relative elevation of 4.9 ft

There are also four groundwater gauges, HR-22 through 25, and two surface gauges, SG-1 and SG-2, located along the forestry haul road (southern swamp), which were installed during the pre-construction monitoring phase. All of the monitoring gauges automatically record daily depth to groundwater or surface water on the site. Appendix A contains the graphs for each gauge along with daily rainfall data. Appendix B contains comparison graphs of the restoration and reference areas.

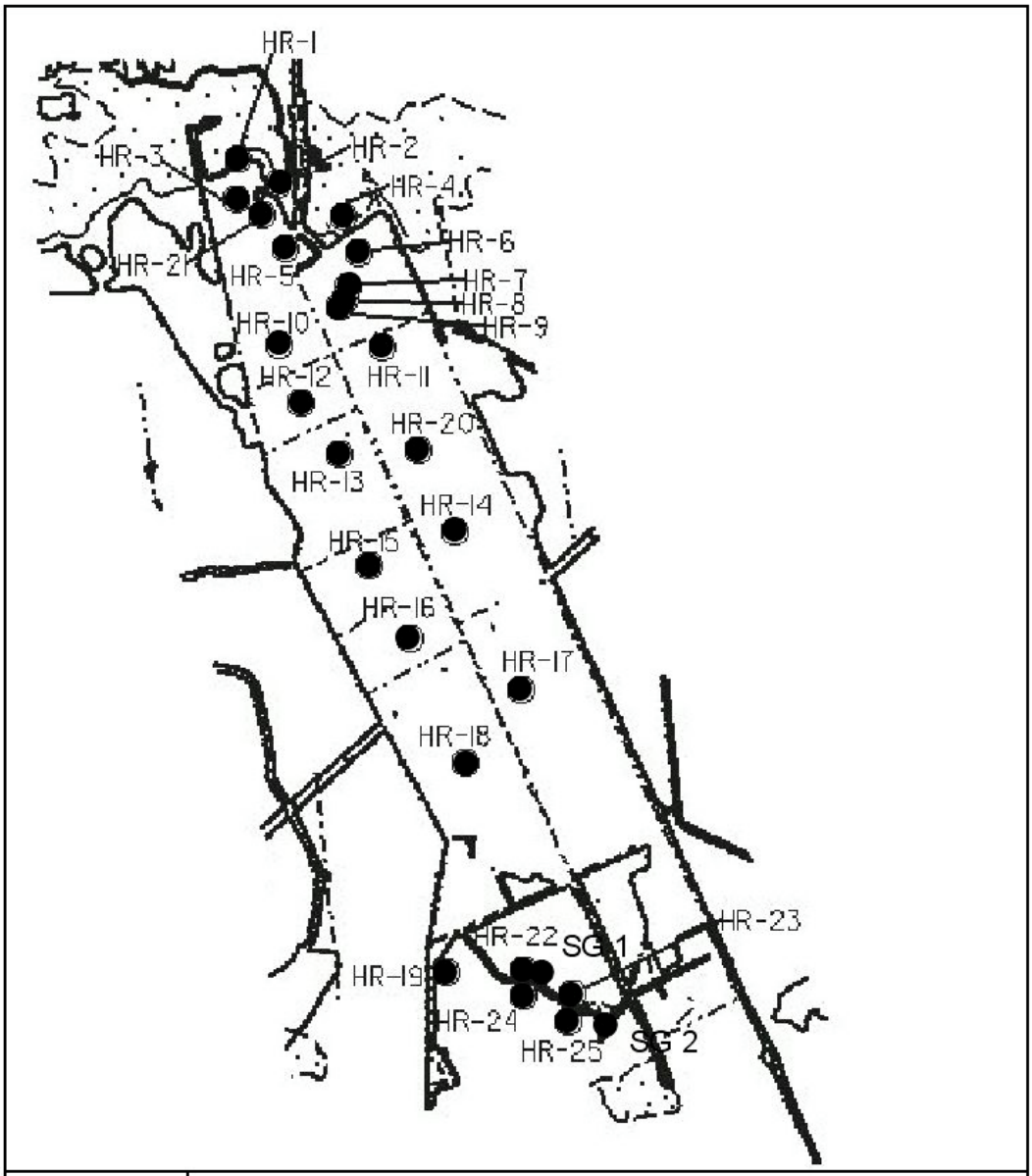



**Figure 2. Gauge Location Map**

Not to Scale

## 2.3 Results of Hydrologic Monitoring

### 2.3.1 Site Data

The hydrologic monitoring results from the restoration areas are presented in this report by three methods:

1) Comparison to jurisdictional wetland criteria;
2) Comparison to reference area mean depth to groundwater;
3) Comparison to reference area duration of saturation.

***Comparison to Jurisdictional Wetland Criteria***

The maximum number of consecutive days that the groundwater was within twelve inches of the surface was determined at each gauge. This number was converted into a percentage of the 238-day growing season. Because of the variability between wetland systems and within wetland types, the monitoring gauge results are segmented into percentage ranges (Figure 3). Table 1 presents the monitoring results for the 2003 growing season as a range of percentages, actual percentages, and success dates of the longest hydroperiod for each gauge on the site. The reference gauges are also provided in Table 1.

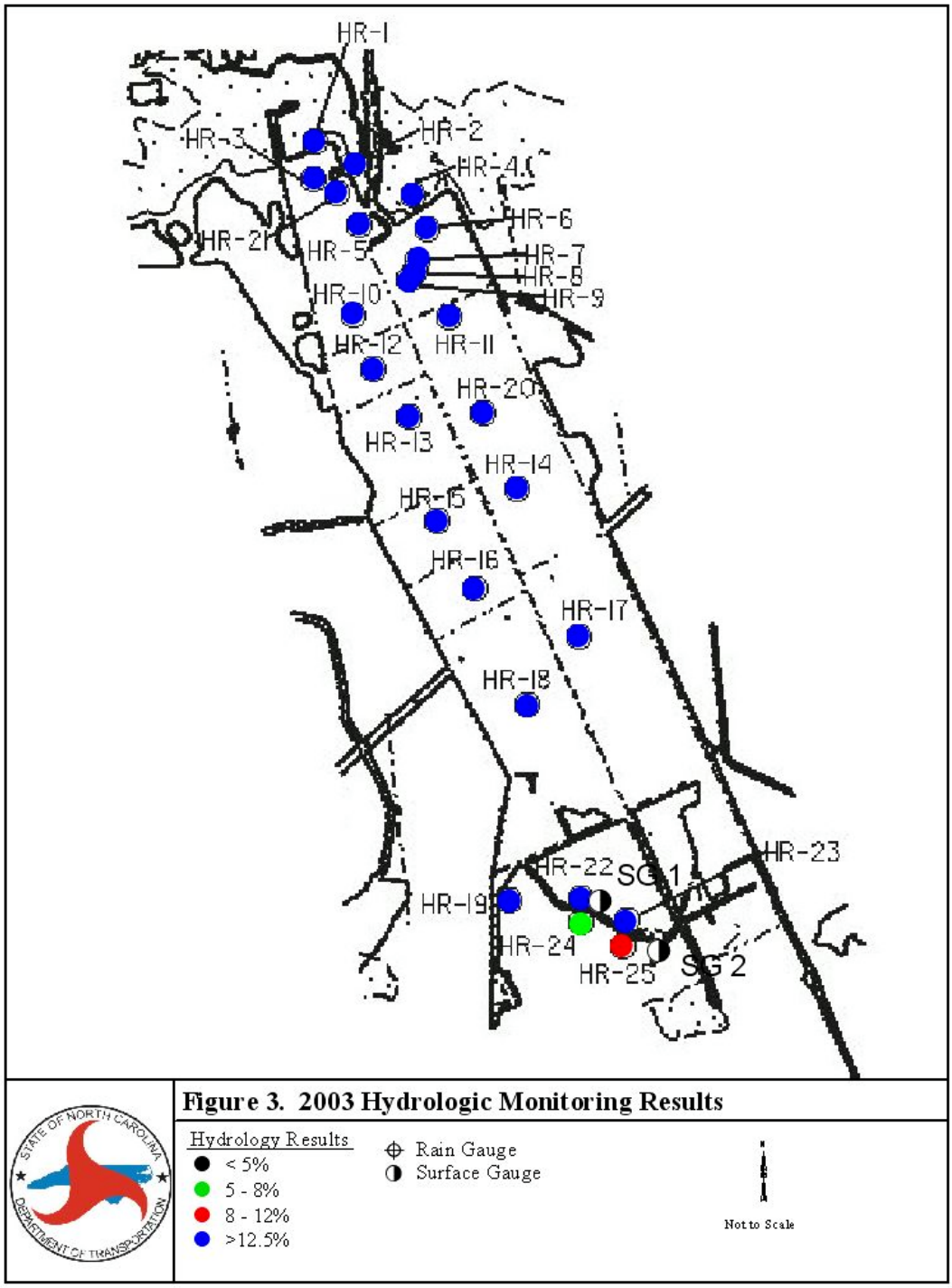



**Figure 3. 2003 Hydrologic Monitoring Results**

***Table 1.*** 2003 HYDROLOGIC MONITORING RESULTS

| | Monitoring Gauge | < 5% | 5 - 8% | 8 – 12.5% | > 12.5% | Actual % | Dates Meeting Success |
|---|---|---|---|---|---|---|---|
| Swamp Forest (12.5% Expected) | HR-1Ref+ | | | | ✕ | 100 | March 23-Nov 15 |
| | HR-2 Ref+ | | | | ✕ | 100 | March 23-Nov 15 |
| | HR-3+ | | | | ✕ | 76.1 | March 23-May 14<br>May 19-Nov 15 |
| | HR-4 Ref+ | | | | ✕ | 100 | March 23-Nov 15 |
| | HR-5+ | | | | ✕ | 24.8 | March 23-May 12<br>May 23-July 6<br>Sept 18-Nov 15 |
| | HR-6+ | | | | ✕ | 100 | March 23-Nov 15 |
| | | | | | | | |
| Trans. Slope (8-12.5% Expected) | HR-21+ | | | | ✕ | 24.8 | March 23-May 10<br>Sept 18-Nov 15 |
| | HR-7+ | | | | ✕ | 13.9 | May 23-June 24 |
| | HR-8+ | | | | ✕ | 21.4 | March 23-May 12<br>July 18-Aug 29 |
| Pine Savanna (8-12.5% Expected) | HR-9+ | | | | ✕ | 24.4 | March 23-May 16<br>May 19-June 30<br>Sept 19-Nov 15 |
| | HR-10+ | | | | ✕ | 24.8 | March 23-May 13<br>July 18-Aug 31<br>Sept 18-Nov 15 |
| | HR-11+ | | | | ✕ | 24.8 | March 23-May 16<br>May 19-July 6<br>Sept 18-Nov 15 |
| | HR-12+ | | | | ✕ | 84.5 | March 23-Oct 9 |
| | HR-13 Ref+ | | | | ✕ | 50.8 | April 15-July 7<br>July 18-Nov 15 |
| | HR-14 Ref+ | | | | ✕ | 24.8 | July 18-Sept 5<br>Sept 18-Nov 15 |
| | HR-15+ | | | | ✕ | 100 | March 23-Nov 15 |
| | HR-16 Ref+ | | | | ✕ | 24.8 | March 23-May 12<br>July 18-Aug 29<br>Sept 18-Nov 15 |
| | HR-17 Ref+ | | | | ✕ | 50.8 | March 23-May 26<br>July 18-Nov 15 |
| Haul Road (southern swamp forest) (12.5% Expected) | HR-18 Ref+ | | | | ✕ | 50.8 | March 23-July 16<br>July 18-Nov 15 |
| | HR-20+ | | | | ✕ | 50.8 | March 23-July 11<br>July 18-Nov 15 |

| | | | | | | |
|---|---|---|---|---|---|---|
| HR-19+ | | | | ✕ | 24.4 | March 23-May 14<br>Sept 19-Nov 15 |
| HR-22+ | | | | ✕ | 16.4 | May 23-June 30<br>Oct 18-Nov 15 |
| HR-23 | | | | ✕ | 13.0 | March 23-April 22 |
| HR-24 Ref | | ✕ | | | 7.1 | Oct 28-Nov 13 |
| HR-25 Ref | | | ✕ | | 11.3 | May 19-June 14 |

+ Gauge met the success criterion during an average rainfall month (May, June, August, November).

**Comparison of Average Depth to Groundwater**

The average depth to groundwater for both the reference and restoration area gauges was calculated and plotted for the growing season (Appendix B). Appendix B also contains the comparisons of depth to groundwater for paired gauges. The results are presented as a percentage of the days when the depth to groundwater in the restoration area was at, above, or no deeper than 25% of the depth to groundwater in the reference area. The results are as follows.

Average Swamp Restoration Area was comparable for 17.6% of days in the Average Swamp Reference Area.

- HR-3: 85.3% of days at HR-1.
- HR-5: 8.8% of days at HR-2.
- HR-6: 100% of days at HR-4.

It should be noted that there were 204 days (out of 238) during the growing season that the average swamp restoration area reported inundation (positive readings above the surface). Approximately 80% (162 days) of these days are discounted because the average reading in the restoration area is not within 25% of the average reference value. This omission occurs, in spite of, the inundated average restoration area conditions. The comparable percentage increases to 86% of the growing season when these inundation days (by default) are included as successful hydrology days.

The Average Pine Savanna Restoration Area was comparable for 83.6% of days in the Average Pine Savanna Reference Area.

The Average Haul Road (southern swamp) Restoration Area was comparable for 55.5% of days in the Average Haul Road (southern swamp) Reference Area.

**Comparison of Duration of Saturation**

For each well, the longest hydroperiod (i.e., the number of consecutive days of soil saturation within 12 inches of the surface) was calculated and averaged for the restoration areas and the reference areas. The average hydroperiod for the restoration area is reported as a percentage of the average hydroperiod for the reference area.

The comparison is also made for the paired wells. The results are as follows.

Average Swamp Restoration Area hydroperiod was 56.4% of Average Swamp Reference Area hydroperiod.

- HR-3: 76.1% of HR-1.
- HR-5: 24.8% of HR-2.
- HR-6: 100% of HR-4 (Gauge exceeded hydroperiod in reference).

Average Pine Savanna Restoration Area hydroperiod was 127.5% of Average Pine Savanna Reference Area hydroperiod.

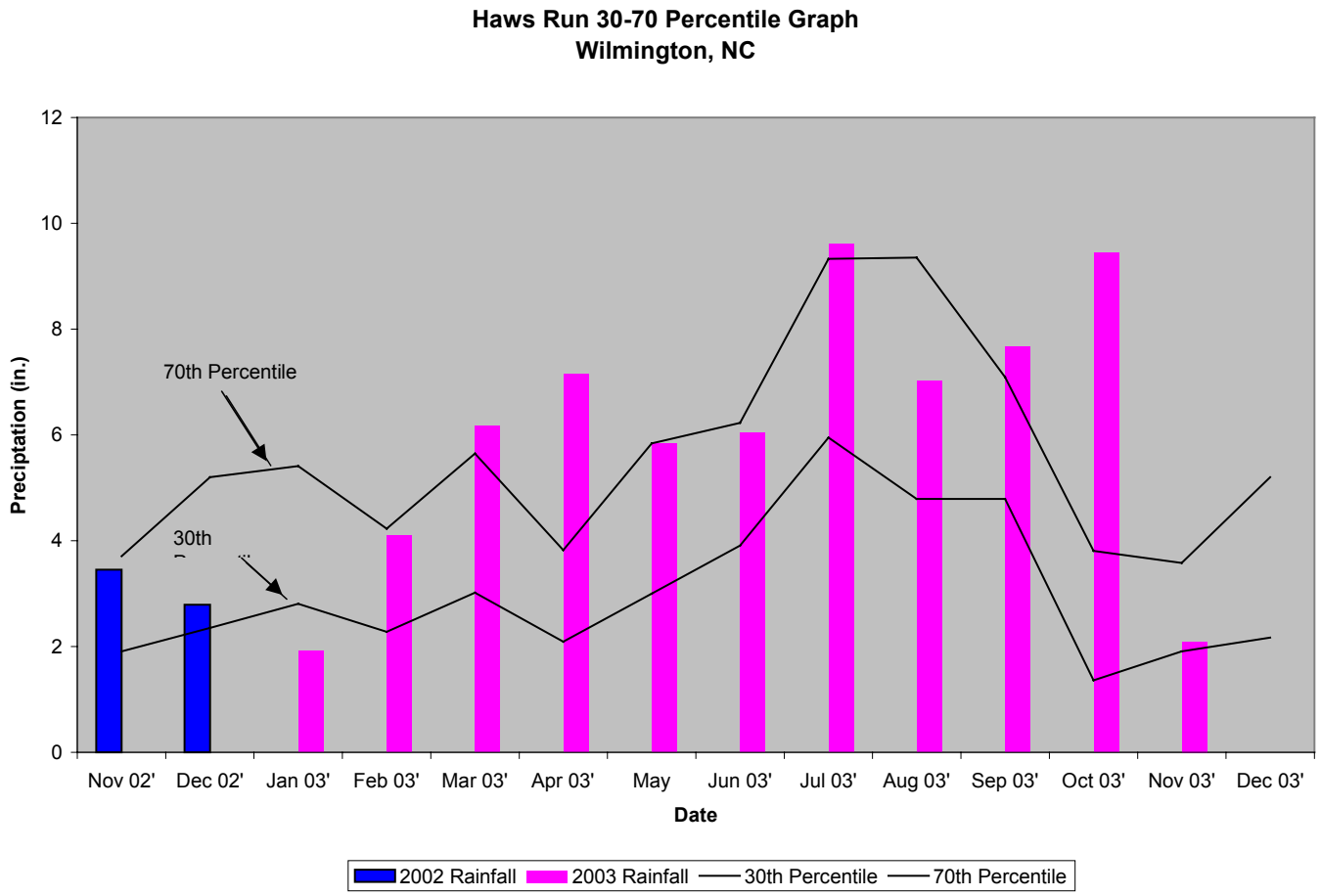
Average Haul Road (southern swamp) Restoration Area hydroperiod was 129.6% of Average Haul Road (southern swamp) Reference Area hydroperiod.

### 2.3.2 Climatic Data

Figure 4 represents an evaluation of the local climate in comparison with historical data in order to determine whether 2003 was "average" in terms of climate conditions. The two lines represent the 30$^{th}$ and 70$^{th}$ percentiles of monthly precipitation for Wilmington, NC. The bars are monthly rainfall totals for 2002 and 2003. The historical data was collected from the State Climate Office of North Carolina.

For the 2003-year, March, April, July, September, and October experienced above average rainfall. The month of January recorded below average rainfall and November (02'), December (02'), February, May, June, August, and November experienced average rainfall. Overall, 2003 experienced an average rainfall year.

## Figure 4. 30-70 Percentile Graph



## 2.4 Conclusions

Based on jurisdictional wetland criteria, the Haws Run Mitigation Site met hydrologic success for the 2003-year. In the swamp forest area, all gauges exceeded the 12.5% jurisdictional wetland criteria. The three swamp reference area gauges showed similar data and resulted in 100% of the growing season. For the pine savanna area, all gauges recorded hydroperiods of 8% of the growing season or greater. The pine savanna reference area at Haws Run also showed similar results as the restoration area. Three gauges along the haul road (southern swamp) met the jurisdictional criteria of 12.5%. Neither reference gauge (HR 24, HR-25) for the southern swamp met the success criteria of 12.5%. All gauges met the optimum hydrology for wetland success, with the exception of HR-24 and HR-25.

Hydrologic patterns in the restoration areas across the Haws Run Mitigation Site followed patterns in the reference areas. Flooding frequency and depth in the swamp restoration area coincided with flooding in the swamp reference area. The comparison plots in Appendix B clearly illustrate the restoration hydrologic regime coinciding with the reference area hydrologic regime. The water table did decline quicker in the swamp restoration area than in the swamp reference area, resulting in less storage time. This can be partially attributed to differences in soil organic matter content and surface roughness between the two areas. Gauge HR-19 is located in the southern swamp restoration area; therefore it was not included in the restoration average since it's performing in a different system.

The plots in Appendix B show the similarities in hydrologic regime between the savanna reference and restoration areas. Average restoration and reference area values were very similar in the pine savanna area.

The average hydrologic regime for the haul road (southern swamp) restoration area was similar to the reference area; the flooding patterns coincided well. The data illustrated the effects of removal of the haul road (southern swamp) (re-establishing the hydrologic connection of the isolated area to the southern swamp area). Data for reference gauge HR-24 in the haul road (southern swamp) was not used in the reference averages due to its minimal saturation. NCDOT will further investigate this gauge.

The duration of saturation between the restoration gauges and the reference gauges were also comparable to the swamp and savanna areas. The average length of the hydroperiod for the Swamp Forest restoration area was approximately 134 days compared to the 238-day hydroperiod in the reference area. For the Pine Savanna area, the average hydroperiod length for the restoration area was approximately 122 days compared to 96 days for the reference area. The restoration gauges in the haul road (southern swamp) area indicated an average hydroperiod of 35 days compared to 27 days for the

reference area. The hydroperiod results indicate that the saturation among the restoration and reference areas is very similar.

# 3.0 VEGETATION: HAWS RUN MITIGATION SITE (YEAR 4 MONITORING)

## 3.1 Success Criteria

### A. Savanna Areas

Success criteria state that there must be a minimum of 20 trees per acre living for at least five consecutive years.

### B. Swamp Forest Area

NCDOT will monitor the site for five years. A 320 stems per acre survival criterion for planted seedlings will be used to determine success for the first three years. The required survival criterion will decrease by 10% per year after the third year of vegetation monitoring (i.e., for an expected 290 stems per acre for year 4, and 260 stems per acre for year 5). The number of plants of one species will not exceed 20% of the total number of plants of all species planted.

### C. Grass Area

No success criteria were established for the planted grass areas.

## 3.2 Description of Species

### A. Savanna Areas

The following tree species were planted in the Savanna Restoration and Enhancement Areas:

**Zone 1: Wet Savanna Restoration and Enhancement Area (202 acres)**

*Pinus palustris*, Longleaf Pine

*Pinus serotina*, Pond Pine

*Taxodium ascendens*, Pond Cypress

**Zone 2: Dry Savanna Enhancement Area (113 acres)**

*Pinus palustris*, Longleaf Pine

**B. Swamp Forest Area**

The following tree species were planted in the Swamp Forest Area:

**Zone 3: Swamp Forest Restoration Area (33 acres)**

*Nyssa sylvatica* var. *biflora*, Swamp Blackgum

*Taxodium distichum*, Baldcypress

*Quercus laurifolia*, Laurel Oak

*Quercus lyrata*, Overcup Oak

*Quercus michauxii*, Swamp Chestnut Oak

*Liriodendron tulipifera*, Tulip Poplar

*Quercus falcata* var. *pagodaefolia*, Cherrybark Oak

*Fraxinus pennsylvanica*, Green Ash

*Platanus occidentalis*, American Sycamore

**C. Grass Area**

The following grass species were planted in ten 100’ x 100’ grass plots:

Wiregrass

Carolina Dropseed

Toothache grass

Savanna muhly

## 3.3 Results of Vegetation Monitoring (Tables 2A. & 2B.)

### A. Savanna Areas

| ZONE | Plot # | Longleaf Pine | Pond Pine | Pond Cypress | Total (4 year) | Density (Trees/Acre) |
|---|---|---|---|---|---|---|
| 1 | S1 | 20 | 130 | 26 | 176 | 31 |
| | S3 | 48 | 185 | | 233 | 41 |
| | ZONE 1 AVG. | | | | | 36 |
| | | | | | | |
| 2 | S2 | 99 | | | 99 | 17 |
| | ZONE 2 AVG. | | | | | 17 |
| | | | | | | |
| | TOTAL AVG. | | | | | 30 |

To determine tree density, 500' by 500' plots (5.7 acres) were installed immediately following planting. The actual numbers of planted trees, which occur within the plot, were counted. Since the actual plot size is 5.7 acres, actual trees per acre can be estimated.

**Site Notes:** Pines in savanna areas are growing well. Broomsedge present throughout the plots.

### B. Swamp Forest Area

| Plot # | Swamp Blackgum | Baldcypress | Laurel Oak | Overcup Oak | Swamp Chestnut Oak | Tulip Poplar | Cherrybark Oak | Green Ash | American Sycamore | Total (4 year) | Total (at planting) | Density (Trees/Acre) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 30 | | 10 | | | | 5 | | 53 | 53 | 680 |
| 2 | 6 | 9 | | 6 | 3 | | | 14 | | 38 | 53 | 488 |
| 3 | 2 | 5 | | 1 | 5 | | | 8 | | 21 | 34 | 420 |
| 4 | 4 | 3 | | 5 | 5 | | 2 | 1 | | 20 | 35 | 389 |
| 5 | 1 | | | 15 | 3 | | 1 | | | 20 | 39 | 349 |
| 6 | 5 | | 3 | 2 | | | 2 | 2 | | 14 | 36 | 264 |
| 7 | 2 | 2 | 2 | 5 | | | 1 | 5 | 12 | 29 | 43 | 459 |
| TOTAL AVG. | | | | | | | | | | | | 436 |

**Site Notes:** Other species noted: Fennel, *Juncus* sp., cattail, *Bidens* sp., *Baccharis halimifolia*, various grasses and sedges, broomsedge, woolgrass, giant cane, *Panicum* sp., fern, *Distichlis spicata*, *Eleocharis* sp., sweet bay, sweetgum, red maple, black willow, blackgum, goldenrod, and pine. Plot 1 had 8 to 10 inches of standing water. Plots 3 and 5 had heavy herbaceous vegetation.

### C. Grass Area

Only visual inspection was done within the grass plots. Grasses appear to be establishing well.

## 3.3 Conclusions

### A. Savanna Areas

Of the 595 acres on this site, approximately 315 acres involved savanna tree planting. There were three test plots established throughout the planted area. The 2003 vegetation monitoring of the planted areas revealed an average density of 30 trees per acre, which is above the minimum requirement of 20 trees per acre.

### B. Swamp Forest Area

Of the 595 acres on this site, approximately 33 acres involved tree planting. There were seven test plots established throughout the planted area. The 2003 vegetation monitoring of the planted areas revealed an average density of 436 trees per acre, which is well above the minimum requirement of 290 trees per acre.

The transect areas at the southern end of the site had supplemental planting in the spring of 2000. The area around plot one has been inundated with water at every site visit (See Photos 1 and 2). The planted tree seedlings did not survive in this area. NCDOT performed supplemental planting in this area with bald cypress, swamp blackgum, overcup oak, and green ash in March 2002. These more wet tolerant trees have survived well in the wet area.

### C. Grass Area

Of the 595 acres on this site, approximately 2.3 acres involved grass planting. The grasses were planted in ten 100’ by 100’ test plots. The vegetation monitoring of the planted areas revealed that the planted grasses are becoming well established.

NCDOT will continue vegetation monitoring at the Haws Run Mitigation Site.

## 4.0 OVERALL CONCLUSIONS / RECOMMENDATIONS

Overall, the Haws Run Mitigation Site performed successfully in 2003. Hydrologic monitoring revealed trends in the restoration areas similar to those in the reference areas. With the exception of the HR-24 and HR-25 reference gauges, all gauges onsite met the jurisdictional wetland criteria. The gauges also exhibited comparable depths to groundwater and duration of the hydroperiods for the 2003-growing season.

Vegetation monitoring for 2003 revealed that the Savanna and Swamp Forest areas are performing successfully, with average densities above the minimum requirements. The vegetation monitoring of the planted areas revealed that the planted grasses were establishing well.

NCDOT will continue to monitor the site for both hydrologic and vegetative success.

# Appendix A

# Gauge Data Graphs

# Appendix B

# Comparison of Reference & Restoration Gauges

# Appendix C

# Site Photos

# &

# Photo and Plot Locations

# Haws Run

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

2003

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

Photo 12

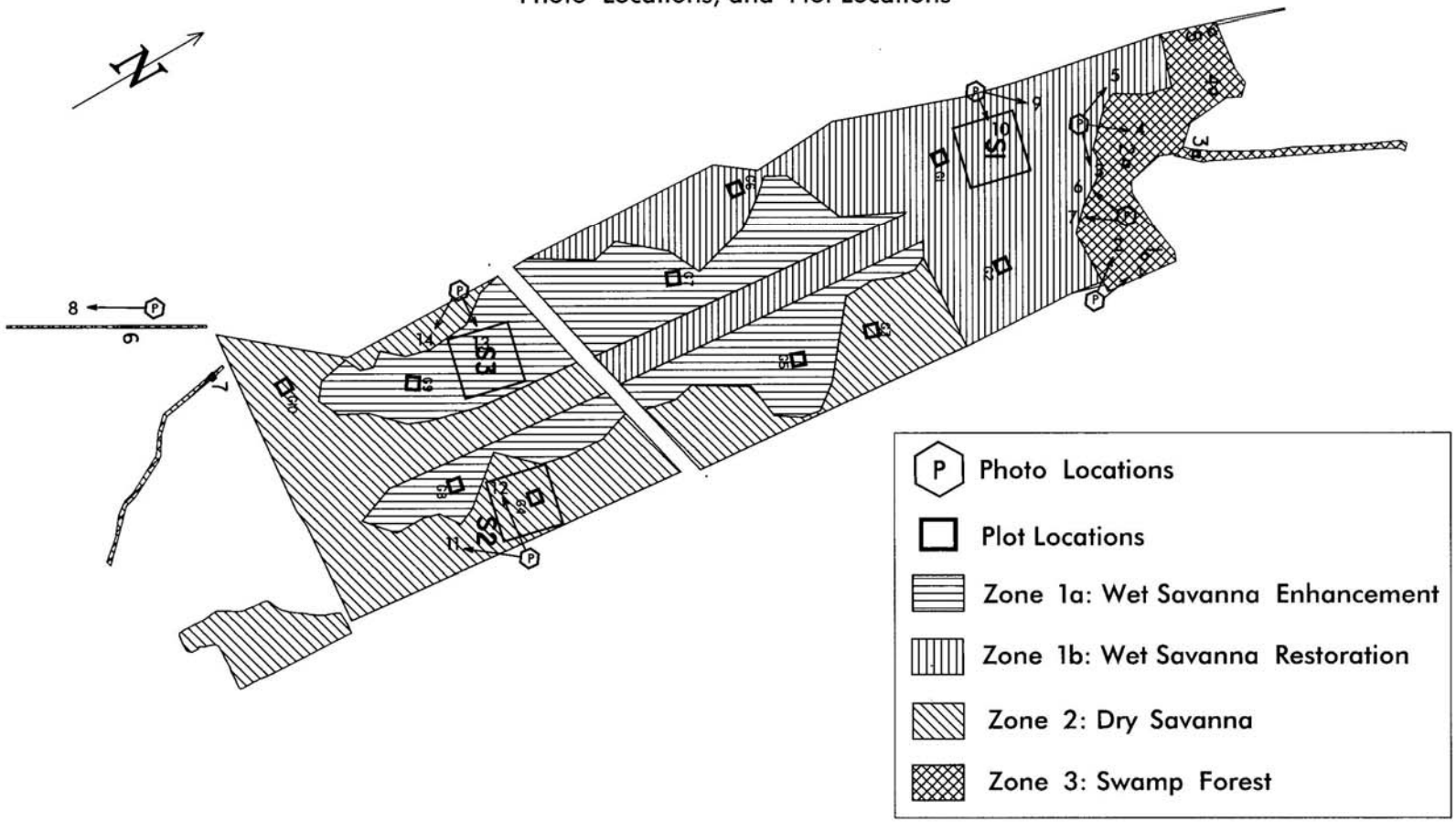
2003

Photo 13

Photo 14

2003

| PROJ. REFERENCE NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|
| R-0525G | MAP | |
| STATE PROJECT NO. | F.A. PROJ. NO. | DESCRIPTION |
| | | |

# HAWS RUN MITIGATION SITE

## Planting Plan, Photo Locations, and Plot Locations