ANNUAL MONITORING REPORT
WILSON BAY (STURGEON CITY) PHASE I

WETLAND RESTORATION
ONSLOW COUNTY, NORTH CAROLINA
(EEP Project Number .00090)

Monitoring Year 6 (2006)

Submitted to:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

Prepared by:
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Axiom Environmental, Inc.

Ecosystem Enhancement PROGRAM

March 2007

EXECUTIVE SUMMARY

The Wilson Bay (Surgeon City) Wetland Restoration Phase I Site (Site) is located within the United States Geological Survey (USGS) Hydrologic Unit 03030001 (North Carolina Division of Water Quality [NCDWQ] subbasin 03-05-02) of the White Oak River Basin. The Site includes approximately 3.5 acres, located at Sturgeon City in Jacksonville, North Carolina in Onslow County (Figure 1). The Site is located adjacent to abandoned drying beds of an inactive municipal wastewater treatment plant. This closeout report summarizes data for year 1 (2001) through year 6 (2006) monitoring. No quantitative data was gathered for vegetation during year 6 (2006) monitoring; however, pictures and gauge data were collected and are included in this report.

The primary goals of the project included the following.

1. Reduce nutrient and stormwater inputs to adjacent estaurine waters.
2. Stabilize the shoreline through restoration of native vegetation.
3. Improve the aesthetics to that of a natural estuarine marsh.
4. Enhance wildlife habitat.
5. Educate visitors about the importance of coastal wetlands

One 10-meter square shrub/bay forest plot and eight 1-meter square marsh grass plots along two transects were previously established within the Site. No stem counts were performed in year 6 (2006); however, vegetative sampling performed in previous years 3 through 5 (2003 to 2005) supports the successful colonization and continued growth of planted species. Vegetative growth has been excellent in the brackish marsh, with many native volunteer salt marsh species; in addition an organic mat typical of a coastal salt marsh is continuing to develop. Undesirable or invasive species have not been observed within the Site during the entire monitoring period. In summary, the Site is stable, the desired plant communities are developing, the plants are healthy, and the marsh has an aesthetic appeal.

Vegetation problem areas include an area between the drying beds and the boardwalk along the edge of the Site where vegetation had been removed prior to year 6 (2006) monitoring. However, this area is beginning to recover and is expected to recover naturally as long as vegetation removal activities are not resumed.

No wetland problem areas have been identified during the year 6 (2006) monitoring year. Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the year 6 (2006) growing season. The gauge has met success criteria for the fourth consecutive year since its installation.

In summary, based on available data the site achieved success criteria for hydrology and vegetation over the entire monitoring period, and is expected to do so into the future.

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1.0 PROJECT BACKGROUND

1.1 Location and Setting

The Wilson Bay (Surgeon City) Wetland Restoration Phase I Site (Site) is located within the United States Geological Survey (USGS) Hydrologic Unit 03030001 (North Carolina Division of Water Quality [NCDWQ] subbasin 03-05-02) of the White Oak River Basin. The Site includes approximately 3.5 acres, located at Sturgeon City in Jacksonville, North Carolina in Onslow County (Figure 1). The Site is located adjacent to abandoned drying beds of an inactive municipal wastewater treatment plant.

Directions to the Site:
From Raleigh:

- Travel east on Interstate 40 to Exit 373 (NC24/903 east)
- Follow NC 24 to Jacksonville
- In Jacksonville, veer right onto Old Bridge Street to cross over the New River
- Turn right on Court Street
- At the end of Court Street take a left into the inactive wastewater treatment plant
- The Site is adjacent to Wilson Bay at the far end of the property

The Site is located in the Middle Atlantic Coastal Plain Physiographic Province, within the Carolina Flatwoods ecoregion.

1.2 Mitigation Structure and Objectives

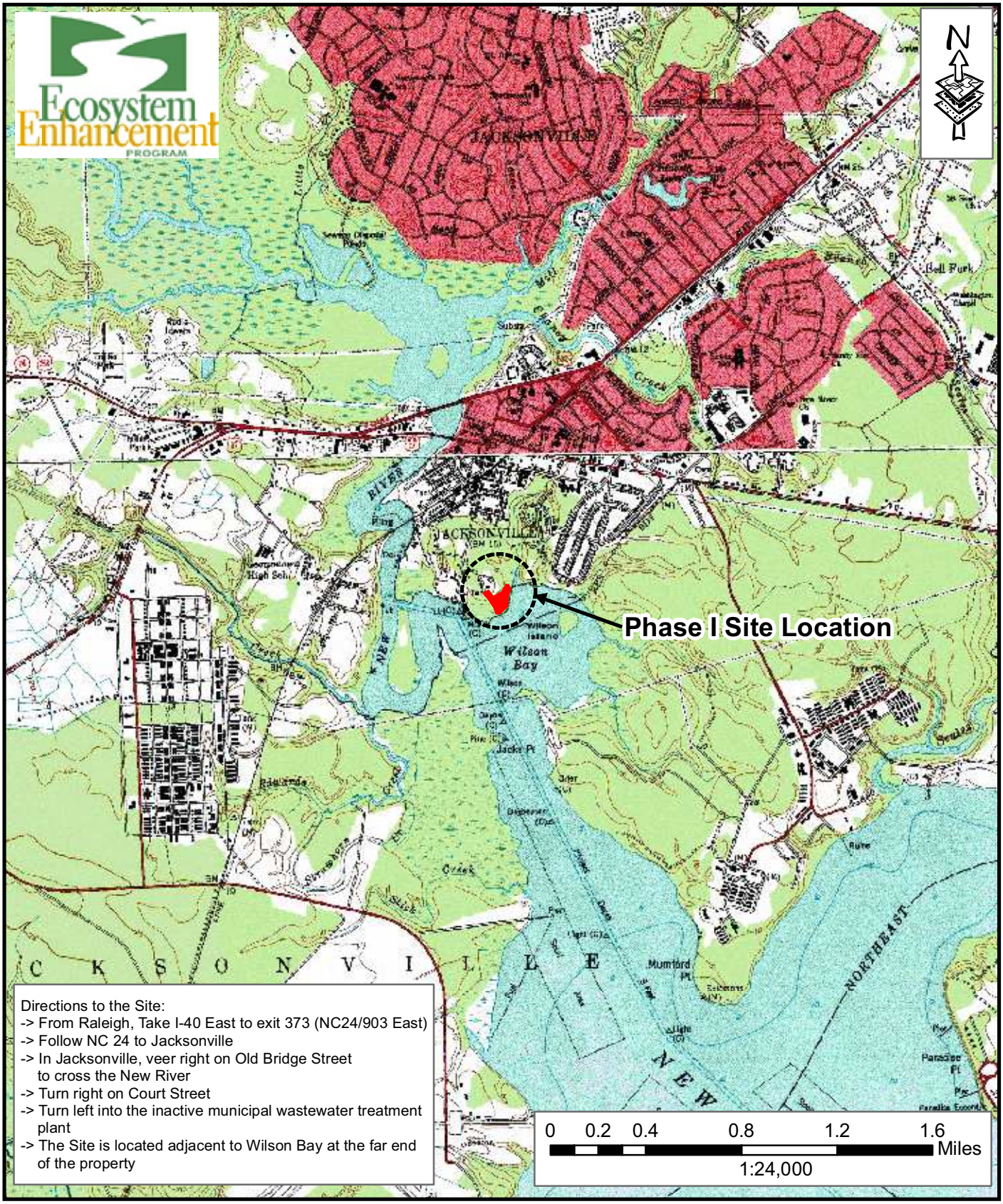
Prior to implementation of wetland restoration activities, the Site was used as a municipal wasterwater treatment plant.

Restoration at the Site entailed 1) removal of trash laden fill material, 2) grading the Site to the desired elevations to restore wetland hydrology, and 3) planting the Site. The primary goals of this project were to reduce nutrient and stormwater inputs to adjacent estaurine waters, stabilize the shoreline through restoration of native vegetation, improve the aesthetics to that of a natural estuarine marsh, enhance wildlife habitat, and educate visitors about the importance of coastal wetlands. Project structures and objectives are summarized in Table 1.

Table 1. Project Mitigation Structures and Objectives

Wilson Bay (Sturgeon City) Wetland Restoration Phase I (EEP Project Number .00090)

Project Segment or Reach ID	Mitigation Type**	Approach	Linear Footage or Acreage	Stationing	Comment
Bay Forest Wetland	Buffer	---	0.28 acre	---	---
Cypress Gum Wetland Fringe	Buffer	---	0.07 acre	---	---
Salt Shrub Fringe	Buffer	---	0.46 acre	---	---
Brackish Marsh	Restoration	---	2.23 acres	---	Planted with *Spartina cynosuroides* in the lower elevations and *Spartina patens* in the higher elevations.



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SITE LOCATION
WILSON BAY (STURGEON CITY) PHASE I
EEP Project Number .00090
2006 Annual Monitoring Year 6
Onslow County, North Carolina

CLF

Date: February 2007

Project: 06-021

FIGURE 1

1.3 Project History and Background

Completed project activities, reporting history, and completion dates are summarized in Table 2.

Table 2. Project Activity and Reporting History

Wilson Bay (Sturgeon City) Wetland Restoration Phase I (EEP Project Number .00090)

Activity or Report	Scheduled Completion	Data Collection Completion	Actual Completion or Delivery
Restoration Plan	2000	---	Jan. 14, 2001
Final Design – 90%	Unknown	---	Unknown
Construction	2001	---	March 2001
Temporary Sediment & Erosion Mix Applied to Nonbrackish Marsh Project Areas	2001	---	March 2001
Permanent Seed Mix Applied	Not Applicable	Not Applicable	Not Applicable
Brackish Marsh Planting	2001	---	April 2001
Containerized and B&B Plantings in Shrub/Forest Wetland/Buffer Areas	2001	---	June 2001
As-built Report (Year 0 Monitoring – map only)	2001	---	Sept. 30, 2001
Year 1 Monitoring (2001)	Fall 2001	---	Nov. 2001
Year 2 Monitoring (2002)	Fall 2002	---	Not Completed
Year 3 Monitoring (2003)	Fall 2003	---	Oct. 2003
Year 4 Monitoring (2004)	Fall 2004	---	Oct. 2004
Year 5 Monitoring (2005)	Fall 2005	---	Sept. 2005
Year 6 Monitoring (2006)	Fall 2006	Nov. 2006	Feb. 2007

Contact information regarding project designer, construction, planting contractor, and monitoring personnel are summarized in Table 3 and relevant project background information is summarized in Table 4.

Table 3. Project Contact Table

Wilson Bay (Sturgeon City) Wetland Restoration Phase I (EEP Project Number .00090)

Designer	BLUE: Land, Water, Infrastructure, PA 1271 Old Highway 1 Southern Pines, NC 28387 Thomas Blue (910) 692-6461
Property Owner	City of Jacksonville PO Box 128 Jacksonville, North Carolina 28541 Glenn Hargett (910) 938-5200
Construction Contractor	Eastern Excavating 143 Penquin Lane Jacksonville, North Carolina 28546 Terry Williams (910) 353-9100

Table 3. Project Contact Table (continued)	
Planting Contractor	Southern Landscaping and Grounds Management 1379 Burgaw Highway Jacksonville, North Carolina 28540 George Smith (910) 346-6092
Seeding Contractor	Unknown
Temporary Seed Mix Sources	Unknown
Nursery Stock Suppliers (marsh plants)	Campbells Greenhouse Raleigh, North Carolina Street Address and Point of Contact: Unknown
Monitoring Performers	Axiom Environmental, Inc. 2126 Rowland Pond Dr. Willow Spring, NC 27592 Grant Lewis 919-215-1693

Table 4. Project Background Table

Wilson Bay (Sturgeon City) Wetland Restoration Phase I (EEP Project Number .00090)

Project County	Onslow County, North Carolina
Drainage Area	20 acres
Drainage impervious cover estimate (%)	< 10
Stream Order	First (tidal creek)
Physiographic Region	Coastal Plain
Ecoregion	Carolina Flatwoods
Rosgen Classification of As-built	Not Applicable
Cowardin Classification	Estaurine Intertidal Emergent Persistant Mixohaline (E213)
Dominant Soil Types	Wando fine sand
Reference Site ID	No Reference
USGS HUC for Project and Reference	Project – 03030001
NCDWQ Subbasin for Project and Reference	Project – 03-05-02
NCDWQ Classification for Project and Reference	Project – SC HQW NSW
Any portion of any project segment 303d listed?	No (Stream Index #19-14)
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	Not Applicable
% of project easement fenced	100 percent of landward side

1.4 Monitoring Plan View

Monitoring activities for the Site, including relevant structures and utilities, project features, specific project structures, and monitoring features are detailed in Figure 2.

Site features have been monitored with one 10-meter square shrub/bay forest vegetation plot, eight 1-meter square marsh grass vegetation plots along two transects, one continuous recording groundwater gauge, and photographic documentation.

Feature	Latitude	Longitude
Groundwater Gauge 1	34.741643487	-77.431228651
Shrub Plot 1	34.741696247	-77.431225657
	34.741655352	-77.431330626
	34.741739487	-77.431376742
	34.741776396	-77.431273374
Marsh Transect 1		
C1	34.741340854	-77.430998143
C2	34.741314931	-77.430954052
C3	34.741113037	-77.430719486
P1	34.741449707	-77.431041836
Marsh Transect 2		
C4	34.741650037	-77.430170750
C5	34.741619545	-77.430158886
C6	34.741476388	-77.430030525
P2	34.741774648	-77.430143815

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MONITORING PLAN
WILSON BAY (STURGEON CITY) PHASE I
EEP Project Number .00090
2006 Annual Monitoring Year 6
Onslow County, North Carolina

CLF

Date: February 2007

Project: 06-021

FIGURE 2

This closeout report summarizes data for year 1 (2001) through year 6 (2006) monitoring. No quantitative data was gathered for vegetation during year 6 (2006) monitoring; however, pictures and gauge data were collected and are included in this report.

2.0 PROJECT CONDITION AND MONITORING RESULTS

2.1 Vegetation Assessment

Vegetation monitoring plots were randomly established within the Site and measured during the five-year monitoring period. Measured parameters within all vegetation plots included vegetation height, counted stems, and percent coverage. One 10-meter by 10-meter shrub/bay forest vegetation plot located within the shrub/bay forest wetland area was used to measure survivability of tree species, while a smaller 5-meter square nested plot assessed shrub species, and a 1-meter square nested plot looked at herbaceous coverage. In addition, eight 1-meter by 1-meter marsh grass plots were sampled along two transects established within the brackish marsh area perpendicular to the shoreline.

2.1.1 Soil Data

General soil conditions found onsite, including level of erosion and percentage of organic matter, are summarized in Table 5.

Table 5. Preliminary Soil Data

Wilson Bay (Sturgeon City) Wetland Restoration Phase I (EEP Project Number .00090)

Series	Max Depth (inches)	% Clay on Surface	K	T	OM %
Wando	85	1	0.1	5	<1

2.1.2 Vegetative Problem Areas

Vegetation problem areas within the Site are depicted on Figure 3 and are outlined in Table 6. Vegetation problem areas include an area between the drying beds and the boardwalk along the edge of the Site where vegetation had been removed prior to year 6 (2006) monitoring. However, this area is beginning to recover and is expected to recover naturally as long as vegetation removal activities are not resumed.

Table 6. Vegetation Problem Areas

Wilson Bay (Sturgeon City) Wetland Restoration Phase I (EEP Project Number .00090)

Feature/Issue	Location	Probable Cause	Photo
Vegetation removal	Between the drying beds and the boardwalk	Vegetation removal associated with boardwalk construction	Problem Area Photo 6 (Appendix A)

2.1.3 Stem Counts

One 10-meter square shrub/bay forest vegetation plot and eight 1-meter square brackish marsh grass vegetation plots (along two linear transects) were previously established by North Carolina State University in 2003 as depicted in Figure 2. The plots were located randomly within the Site. The western linear marsh transect was shifted slightly for the year 5 (2005) surveys due to construction of the boardwalk. Vegetation trends during the monitoring years are summarized in Tables 7 and 8. No reference area was studied; therefore no comparisons could be made to reference conditions.

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VEGETATION PROBLEM AREAS PLAN VIEW
WILSON BAY (STURGEON CITY) PHASE I
EEP Project Number .00090
2006 Annual Monitoring Year 6
Onslow County, North Carolina

CLF

Date: February 2007

Project: 06-021

FIGURE 3

Table 7. Vegetation Trends (Marsh Area)

Wilson Bay (Sturgeon City) Wetland Restoration Phase I (EEP Project Number .00090)

Lower Marsh (*Spartina cynosuroides*) Data Range				
Monitoring Year	**Firm**	**Stem Count**	**Height (meters)**	**Percent Cover**
2001	S&EC	Not available		
2002	Not measured			
2003*	NCSU	55-87	2-2.5	35-60
2004**	NCSU	52-66	1.75-2.5	45-60
2005*	BLWI	24-41	1.0-3.4	60-80
Upper Marsh (*Spartina patens*) Data Range				
Monitoring Year	**Firm**	**Stem Count**	**Height (meters)**	**Percent Cover**
2001	S&EC	Not available		
2002	Not measured			
2003	NCSU	Not applicable	0.75-1	100
2004	NCSU	Not applicable	0.75-1	100
2005	BLWI	Not applicable	1.1-1.4	60-65

* - Based on four plots.
** - Based on six plots.

Table 8. Vegetation Trends (Shrub/Bay Forest Area)

Wilson Bay (Sturgeon City) Wetland Restoration Phase I (EEP Project Number .00090)

Monitoring Year	**Firm**	**Tree Stratum Density* (# in plot [# per acre])**	**Shrub Stratum Density** (# in plot [# per acre])**	**Total Tree + Shrub Stratum Density**	**Shrub Stratum % Coverage**	**Herbaceous Layer % Coverage**
2001	S&EC	Not available				
2002	Not measured					
2003*	NCSU	4 trees (162 trees per acre)	5 shrubs (820 shrubs per acre)	982 stems per acre	1	100
2004**	NCSU	6 trees (243 trees per acre)	6 shrubs (984 shrubs per acre)	1227 stems per acre	1.5	100
2005*	BLWI	7 trees (283 trees per acre)	3 shrubs (492 shrubs per acre)	775 stems per acre	8	100

* - Based on one 10-meter square bay forest plot (0.0247-acre plot).
** - Based on one 5-meter square (0.0061-acre plot) nested shrub plot within the above 10-meter square bay forest tree plot.

According to previous monitoring reports, vegetative success criteria requires 25 percent coverage after the first year, 50 percent coverage after the second year, and 75 percent coverage after the third year.

The average percent coverage within the lower marsh (*Spartina cynosuroides*) was greater than 75 percent for year 5 (2005) monitoring and within the upper marsh (*Spartina patens*) was greater than 75 percent for years 3 and 4 (2003 and 2004) monitoring. The percent coverage dipped between 60 and 65 percent coverage in year 5 (2005) monitoring in the upper marsh (*Spartina patens*); however, vegetative growth has been excellent in the brackish marsh, with many native volunteer salt marsh species; in addition an organic mat typical of a coastal salt marsh is continuing to develop.

The average plot density monitored within the shrub/bay forest is greater than 260 stems per acre with greater than 75 percent coverage and is considered successful. The average plot density has been measured between 775 and 1227 tree and shrub stems per acre during the monitoring period. The dominant species identified within the shrub/bay forest plot were pond pine (*Pinus serotina*) and large gallberry (*Ilex coriacea*).

Undesirable or invasive species have not been observed within the Site during the entire monitoring period. In summary, the Site is stable, the desired plant communities are developing, the plants are healthy, and the marsh has an aesthetic appeal.

2.1.4 Vegetation Plot Photos

Photographs taken in the vegetation monitoring area are included in Appendix A; locations of each are depicted on Figure 2. The photographs show that the marsh grasses are growing well and the shrub/bay forest area continues to mature with a diversity of woody and herbaceous species.

2.2 Wetland Assessment

One groundwater monitoring gauge has been maintained and monitored throughout the year 6 (2006) growing season. The gauge is located within the shrub/bay forest area and records daily readings of groundwater depth. Daily rainfall data recorded from a rain gauge maintained and monitored at the nearby New River Station in Jacksonville, North Carolina was used for seasonal comparison (SCONC 2007). The graph of groundwater hydrology and precipitation is included in Appendix B.

Success criteria for wetland groundwater hydrology require inundation or saturation within 12 inches of the ground surface for a consecutive period of 12.5 percent of the growing season. The growing season in Onslow County begins April 8 and ends November 5 (212 days). In order to attain hydrologic success in the shrub/bay forest area, saturation within 12 inches of the ground surface is required for at least 27 consecutive days (12.5 percent of the growing season).

The groundwater gauge was installed prior to year 3 (2003) monitoring; therefore, no groundwater data is available for years 1 and 2 (2001 and 2002) monitoring. The groundwater gauge graph for year 3 (2003) through year 6 (2006) is included in Appendices B through G. The following table summarizes success criteria achievement for the groundwater gauge over the six-year monitoring period.

Table 9. Summary of Groundwater Gauge Results for Years 1 through 6

Wilson Bay (Sturgeon City) Wetland Restoration Phase I
(EEP Project Number .00090)

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)					
	Year 1 (2001)	Year 2 (2002)	Year 3 (2003)	Year 4 (2004)	Year 5 (2005)	Year 6 (2006
1	No Data*	No Data*	Yes/42 days (19.8 %)	Yes/47 days (22.2 %)	Yes/47 days (22.2 %)	Yes/37 days (17.5 %)

* - The groundwater gauge was not installed until year 3 (2003) monitoring; therefore, no hydrology data is available for years 1 or 2.

Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season for the year 6 (2006) growing season with 37 days (17.5 percent) of consecutive saturation or inundation. The gauge has met success criteria each year since its installation.

2.2.1 Wetland Problem Area Plan View

No wetland problem areas have been identified during the year 6 (2006) monitoring year.

2.2.2 Wetland Criteria Attainment

The groundwater gauge located within the bay forest restoration area met success criteria of inundation/saturation within 12 inches of the surface for greater than 12.5 percent of the growing season (Table 10). Hydrographs containing precipitation data for each gauge can be found in Appendix B. Photographs within the vegetation monitoring areas can be found in Appendix A. No quantitative data was gathered for vegetation during year 6 (2006) monitoring; vegetation trend data can be found above in Section 2.1.3 (Stem Counts).

Table 10. Wetland Criteria Attainment

Wilson Bay (Sturgeon City) Wetland Restoration Phase I (EEP Project Number .00090)

Gauge ID	Hydrology Threshold Met?	Hydrophytic Vegetation Criteria Met?	Site Mean
1	Yes	Yes	100 %

3.0 SIX-YEAR MONITORING ASSESSMENT

In summary, based on available data over the six-year monitoring period, the restoration site achieved success criteria for vegetation and hydrology, and is expected to do so into the future.

No stem counts were performed in year 6 (2006); however, vegetative sampling performed in previous years supports the successful colonization and continued growth of planted species. Vegetative growth has been excellent in the brackish marsh, with many native volunteer salt marsh species; in addition an organic mat typical of a coastal salt marsh is continuing to develop. Undesirable or invasive species have not been observed within the Site during the entire monitoring period. In summary, the Site is stable, the desired plant communities are developing, the plants are healthy, and the marsh has an aesthetic appeal.

Vegetation problem areas include an area between the drying beds and the boardwalk along the edge of the Site where vegetation had been removed prior to year-6 (2006) monitoring. However, this area is beginning to recover and is expected to recover naturally as long as vegetation removal activities are not resumed.

No wetland problem areas have been identified during the year 6 (2006) monitoring year. Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the year 6 (2006) growing season. The gauge has met success criteria each year since its installation.

4.0. REFERENCES

State Climate Office of North Carolina (SCONC). 2007. North Carolina Climate Retrieval and Observations Network of the Southeast Database. (online). Available: http://www.nc-climate.ncsu.edu/cronos/ [January 24, 2007]. State Climate Office of North Carolina, Raleigh, North Carolina.

United States. Department of Agriculture (USDA). 1992. Soil Survey of Onslow County, North Carolina. United States Department of Agriculture.

APPENDIX A

VEGETATION PHOTOGRAPHS

1. Vegetation Monitoring Photographs
2. Vegetation Problem Area Photograph

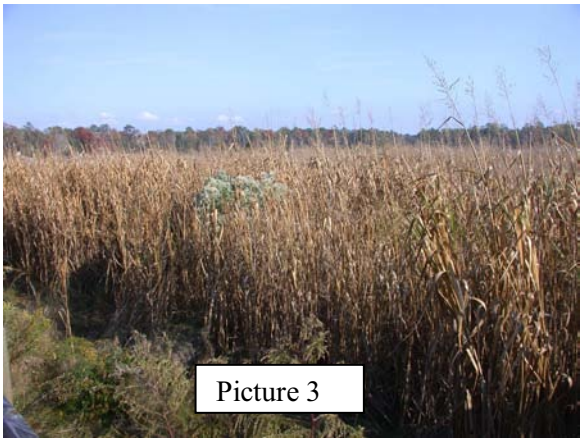
Appendix A

1. Vegetation Monitoring Photographs

Taken November 14, 2006

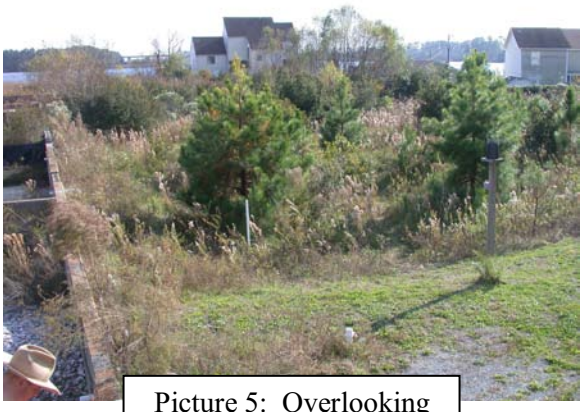
Picture 1: Looking towards the tidal creek.

Picture 2: Looking at the edge of the marsh from dock



Picture 3

Picture 4



Picture 5: Overlooking the shrub area

Appendix A

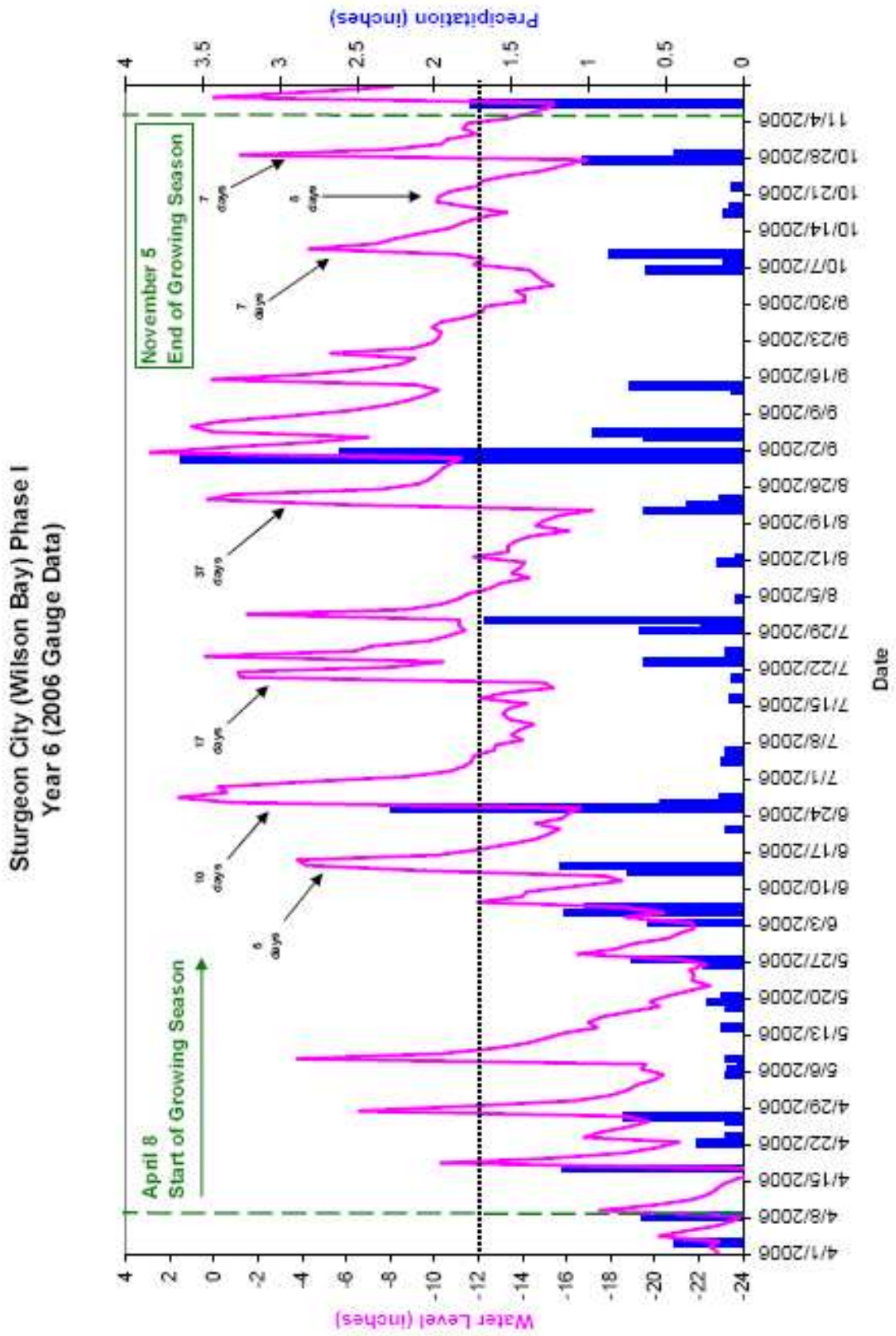
2. Vegetation Problem Area Photographs

Taken November 14, 2006

Picture 6: This area had been mowed and shrubs were removed between the boardwalk and the drying basins. However, the area is started to recover and is expected to recover naturally.

APPENDIX B

YEAR 6 (2006) GROUNDWATER GAUGE GRAPH


Sturgeon City (Wilson Bay) Phase I
Year 6 (2006 Gauge Data)
Precipitation (inches)
Water Level (inches)
Date
April 8
Start of Growing Season
November 5
End of Growing Season
6 days
10 days
17 days
37 days
7 days
7 days
8 days

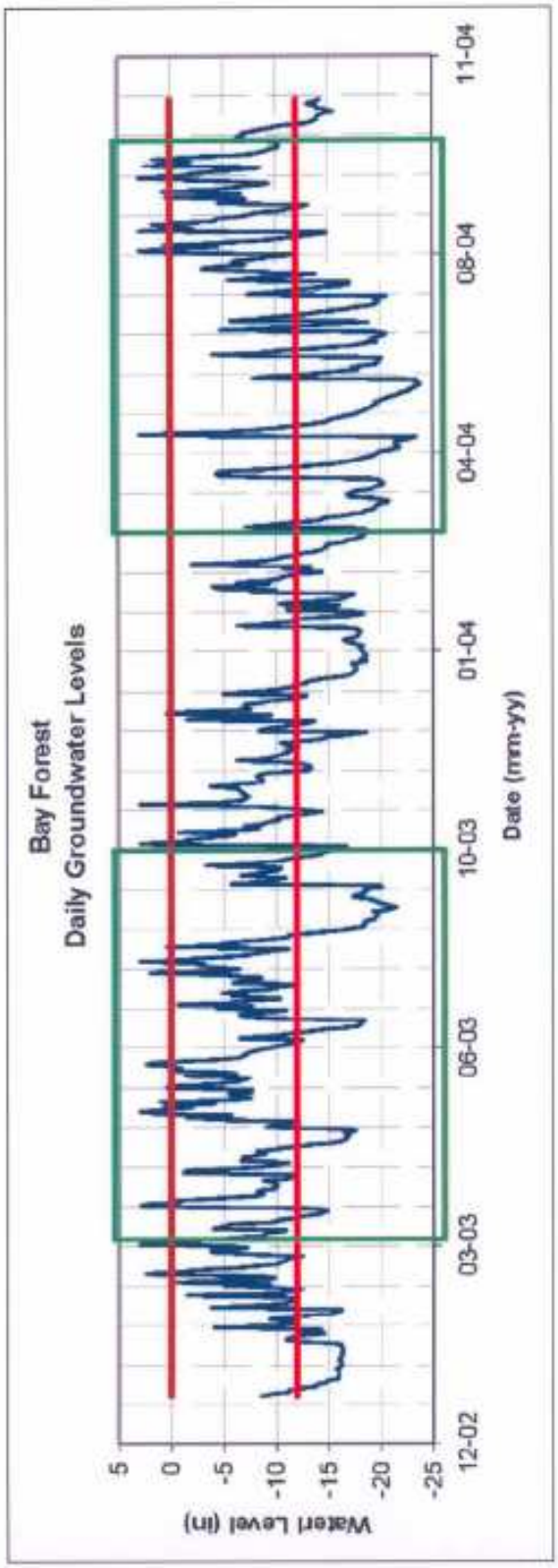
APPENDIX C

YEAR 5 (2005) GROUNDWATER GAUGE GRAPH

Sturgeon City Phase I
S353919
(Figure 5)
Precipitation (in)
Depth (in)
Date
Rainfall
Water Level
Required Level
End of growing season
47 days
Beginning of growing season
Rainfall data from: Albert Ellis Airport Jacksonville, NC begins: 5/25/05. Data prior to this date unavailable.

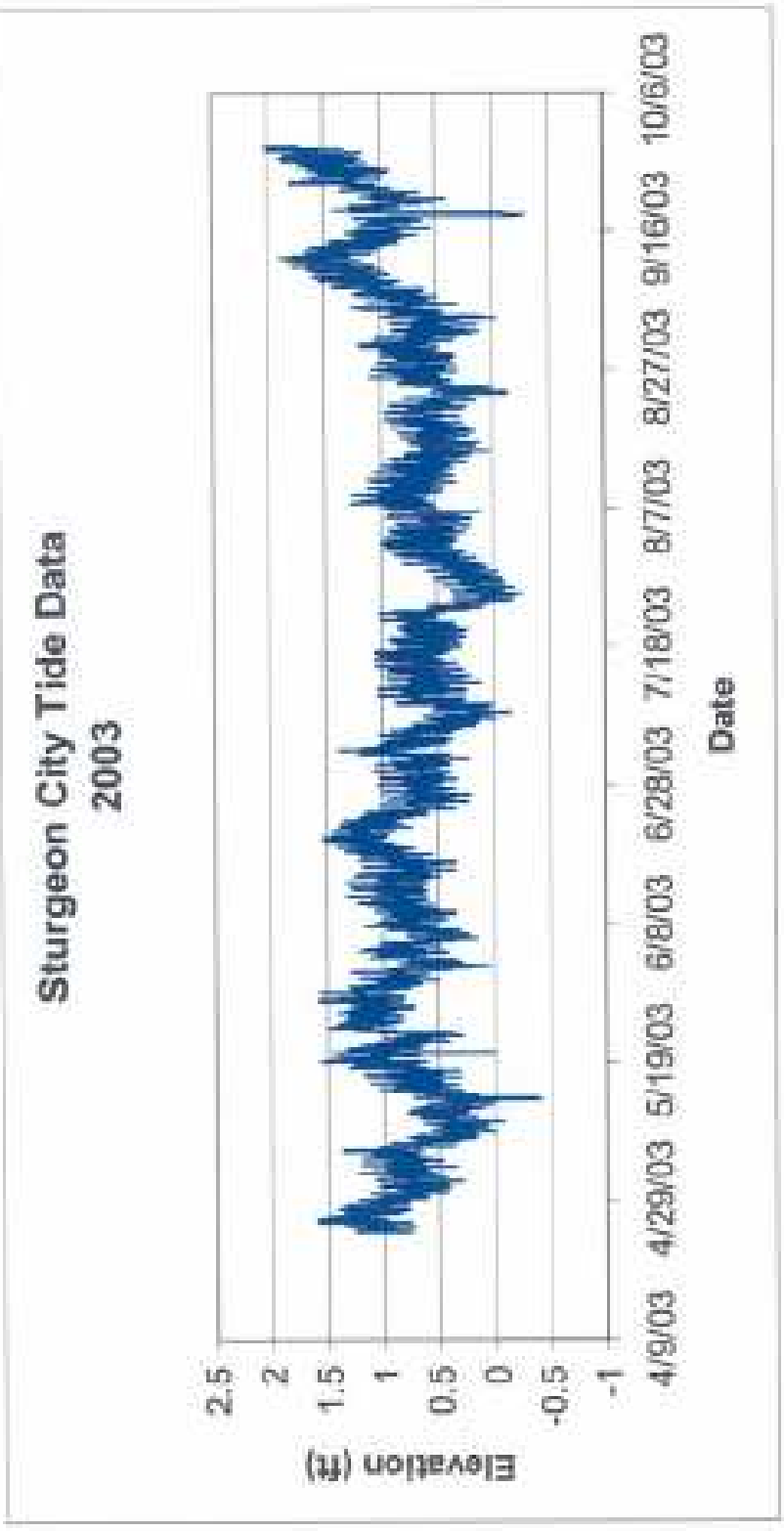
APPENDIX D

YEAR 4 (2004) GROUNDWATER GAUGE GRAPH


Bay Forest
Daily Groundwater Levels
Water Level (in)
5
0
-5
-10
-15
-20
-25
12-02
03-03
06-03
10-03
01-04
04-04
08-04
11-04
Date (mm-yy)

APPENDIX E

YEAR 3 (2003) GROUNDWATER GAUGE GRAPH


Sturgeon City Tide Data
2003
Elevation (ft)
2.5
2
1.5
1
0.5
0
-0.5
-1
4/9/03
4/29/03
5/19/03
6/8/03
6/28/03
7/18/03
8/7/03
8/27/03
9/16/03
10/6/03
Date