

# Unnamed Tributary to Pembroke Creek Wetland and Stream Restoration

Chowan County, North Carolina, EEP Project #283

Year 1 of 5 Monitoring Report



North Carolina Department of the Environment and Natural Resources  
**Ecosystem Enhancement Program** (NCDENR-EEP)  
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## **Table of Contents**

Executive Summary .....	1
1.0 General Project Description .....	3
1.1 Location and Setting .....	3
1.2 Restoration Summary .....	3
2.0 Monitoring Plan.....	6
2.1 Hydrology .....	7
2.1.1 Methodology .....	7
2.1.2 Frequency .....	8
2.1.3 Success Criteria.....	8
2.1.4 1-Year Data.....	8
2.2 Vegetation.....	9
2.2.1 Methodology.....	9
2.2.2 Frequency .....	10
2.2.3 Success Criteria.....	10
2.2.4 1-Year Data.....	10
2.3 Headwater Stream Geomorphology .....	11
2.3.1 Methodology.....	11
2.3.2 Frequency .....	11
2.3.3 Success Criteria.....	11
2.3.4 1-Year Data.....	12
3.0 Maintenance and Contingency Plans.....	12
4.0 References .....	14

## **Tables**

Table 1 - Restoration Summary Table.....	1
Table 2 - Project Summary Table.....	4
Table 3 - Monitoring Summary .....	7
Table 4 - Monitoring Gauge Location Summary .....	8
Table 5 - Annual Rainfall versus Mean Rainfall.....	8
Table 6 - Local Rainfall versus Site Rainfall .....	9
Table 7 - Vegetative Plot Summary .....	11

## **1.0 Figures**

- Figure 1 - Vicinity Map
- Figure 2 - Mitigation Summary
- Figure 3 - Vegetation Plots
- Figure 4 - Reference Site Locations

## **2.0 Appendices**

- Appendix 1 - Year 1 Monitoring
- Appendix 2 - Vegetation Data
- Appendix 3 - Vegetation Plot and Site Photos
- Appendix 4 - Groundwater Monitoring Summary
- Appendix 5 - Cross Section Groundwater Elevations and Rainfall Data

## Executive Summary

The restoration site contains an unnamed tributary to Pembroke Creek (UT Pembroke Creek) and was selected for wetland and stream restoration by the North Carolina Department of the Environmental and Natural Resources Ecosystem Enhancement Program (NCDENR-EEP). The purpose of the restoration project was to restore and enhance the headwater wetland/stream complex located within the Pasquotank River Basin.

The site is located 3.5 miles west-northwest of Edenton, Chowan County, North Carolina; specifically three miles west-northwest of the Route 17 Bypass and Route 32 interchange (**Figure 1**). The drainage area for this project is 0.4 square miles (265 acres) measured at the downstream end where the cell tower access road crosses the unnamed tributary to Pembroke Creek. The drainage area at the northern portion of the project area is 0.08 square miles (50 acres).

The project goal for the restoration plan was to modify the ditch, based on reference conditions (e.g., reference cross-sections, hydrology, and vegetation), with the intent to restore its primary headwater wetland functions such as nutrient cycling, flood storage, and providing wildlife habitat. The ideal end product, after the wetland becomes established, is a self maintaining vegetated corridor containing a diversity of native plant and animal species. The current base flow conditions had been modified to emulate reference conditions and to ensure that the necessary success criteria are met (**Figure 2**).

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**Table 1 - Restoration Summary Table**

Post Project	Wetland Type	Quantity
Headwater Wetland Valley	Riparian	4,488 ft
Wetland Restoration	Riparian	17.03 ac
Wetland Enhancement	Non-Riparian	5.99 ac
Preservation	Non-Riparian	26.67 ac

Note: Wetland area listed as Riparian Wetland is the same area that makes up the 100-foot wide area (9.96 acres) counted toward the headwater valley.

Six (6) acres of wetlands were enhanced and 17 acres of wetlands and 4,488 linear feet of headwater wetland corridor were restored. The headwater wetland corridor was restored by filling in the eastern drainage feature north of the access road and creating microtopography throughout the site. The wetland enhancement areas were planted with native species. The enhancement areas are located primarily in near the beginning of the project at the start of each headwater valley.

Establishing the water table near, or at, the surface was targeted for the restored wetlands on the project site. More specifically, the water table shall be within 12 inches of the soil surface continuously for greater than 5% of the growing season under normal rainfall

conditions (USACE, 1987). The water table has been monitored by using 14 automated groundwater gauges within the restoration area, and one (1) groundwater gauge in nearby Reference Area 1.

The ecological benefits of this project included improving water quality downstream by allowing nutrients and sediment to settle and be processed in the wetland. The natural terrestrial and aquatic habitats had been restored allowing for more diversity among plant and animal species. Non-native and invasive species had been removed which will create a more natural habitat for the animals living on the site.

The restoration site was planted with species appropriate for the three (3) targeted community types on the site. For each community, the vegetation had been monitored on an annual basis to determine survival. This monitoring process had been conducted in an effort to show the survival of a diverse target community such that the restored site has survival rate at a density of 320 stems/acre after three (3) years. Data had been monitored using sample plots (USACE, 2003) and in accordance with the most recent version of the CVS-EEP document entitled “CVS-EEP Protocol for Recording Vegetation” (Lee et. al, 2007).

The primary hydrologic area of concern along the stream was the standing water downstream of the former pond (Stations 21+00 to 25+00). This standing water ranged in depth between approximately 1.0 feet and 1.5 feet. The area did not present a problem from a morphological standpoint; however, the water depth may have been too deep to support one of the target plant communities selected for the site. Measured rainfall during 2008 (73.96 inches) was exceptionally above the 30 year mean of 48.30 inches. This suggested that the site may actually be much drier during a year with mean rainfall. The recommended approach was to wait multiple years and observe the area. If the area continues to stay over-saturated then adjusting the water elevation can be considered.

Invasive species from station 21+00 to 25+00 includes: cattail (*Typha latifolia*), Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), Chinese privet (*Ligustrum sinense*), and parrotfeather (*Myriophyllum aquaticum*). These invasive species were previously noted in the Final Mitigation Plan and primarily isolated within the remaining drainage ditches. Continued monitoring is recommended to check for any significant encroachment of these invasive species. It is also recommended that a plan of action be developed to control cattail (*Typha latifolia*) encroachment.

## 1.0 General Project Description

### 1.1 Location and Setting

The project site is approximately 3.5 miles west-northwest of Edenton, in Chowan County, North Carolina as depicted on **Figure 1**, Vicinity Map. The site is specifically located approximately three (3) miles west-northwest of the Route 17 Bypass and Route 32 Interchange (exit 227). The project is located in USGS Cataloging Unit 03010205. To reach the site from the Route 17 Bypass, take Route 32 north approximately 1.2 miles then turn left onto Wildcat Road. Continue north on Wildcat Road for 1.8 miles. Approximately 1,000 feet before reaching the end of Wildcat Road where it intersects Macedonia Road, UT Pembroke Creek and the site will be on the left.

### 1.2 Restoration Summary

Several distinct conclusions can be drawn from analysis of the photographs and the information regarding historic land use. The 1927 tile drain schematic provided by the property owner and developed by the North Carolina Cooperative Extension Service indicates that circa 1927 the land was drained for the purposes of agriculture. The FSA information reviewed by Natural Systems Engineering (NSE) indicated that the majority of the site was designated as prior converted (PC) cropland. According to FSA records the PC call was made on June 12, 1990 (Form SCS CPA 026) farm serial number 1299 tract 204. Aerial photographs dating from 1948 until today indicate that the site had been used for agricultural purposes for at least the past 59 years, although it has likely been closer to 80 years. All of the facts reviewed for this site support the notion that the groundwater, vegetation, surface drainage, and potentially soil parameters had been modified. Soil structure and surface texture had been altered from intensive agricultural operations. Although most on-site soil series were classified as poorly drained, the ditching and lowering of the groundwater table on-site had caused these soils to be effectively drained. Further information regarding historical land use is presented in the Restoration Plan for this site (NSE, 2006).

The goal for the restoration project was to modify the channelized water features, based on reference conditions, with the intent to restore the sites primary wetland functions such as nutrient cycling, flood storage, and providing wildlife habitat. The ideal end product, once the wetland becomes established, is a self maintaining vegetated corridor containing a diversity of native plant and animal species. The current base flow conditions were modified to emulate reference conditions and to ensure that the necessary success criteria are met. The design was based on reference conditions, USACE guidance (USACE, 2005; USACE, 1987) and criteria that were developed during this project to achieve success. Reference conditions included reference cross-sections, hydrology, and vegetation. Goals and objectives of the restoration project included the following: (next page)

- Improve water quality in the basin by filtering nutrients through on-site wetlands
- Buffer flood flows downstream by increasing infiltration and storage areas
- Design a waterway through the wetland complex with the appropriate cross-section, slope, and pattern as to provide nutrient filtering, flood storage, and wildlife habitat while meeting the appropriate success criteria for the wetland
- Improve terrestrial and aquatic habitat diversity
- Establish a contiguous buffer along the project that can serve as a migration corridor for local fauna
- Ensure hydraulic stability of the restored waterway through the use of natural materials (i.e., log sills) to create the desired hydrology within the project site as guided by reference data
- Use natural materials and native vegetation into the proposed restoration design to the greatest extent possible
- Establish a native forested riparian plant community within the non-wetland buffer area
- Establish a headwater wetland community
- Provide an aesthetically pleasing landscape

**Table 2 - Project Summary Table**

<b>Pre-Construction</b>	
Channelized water feature (ditch)	5,391 ft
Wetlands <sup>1</sup>	1.6 ac
<b>Post-Construction</b>	<b>Mitigation Amount</b>
Headwater Wetland Valley	4,488 ft
Wetland Restoration	17.03 ac
Wetland Enhancement	5.99 ac
Preservation	26.67 ac

<sup>1</sup> – Pre project jurisdictional areas were confined to the ditch feature and pond area near station 21+00.

The Restoration Plan for the UT Pembroke Creek site outlined a method for restoring the existing heavily modified agricultural property into a natural headwater wetland feature (**Figure 2**). A pool and hummock complex was restored at the site to disrupt flow and retain water on-site to the greatest extent possible. Native vegetation was incorporated into the design using reference conditions as a guide. The existing ditches were filled and existing surface drainage was modified to promote the retention of water on site. Upon completion of grading activities, the subsoil was scarified and any compaction was deep tilled before the topsoil was placed back over the site. This process provided favorable soil conditions for plant growth. Vegetation consists of Non Riverine Wet Hardwood plant community, but functions similarly to a bottomland hardwood forest, transitioning into a Coastal Plain Small Stream Swamp plant community, according to reference data (see **Figure 3**). Bare root tree

seedlings for species of each community type were planted at a density of 681 trees per acre (8 by 8-foot spacing).

The restoration plan for the site will be described in two (2) parts to simplify discussion. The first portion of the site is extremely flat and begins where UT Pembroke Creek flows under Wildcat Road (SR 1208) and ends where the access road to the hog lagoon passes over UT Pembroke Creek. The second portion of the site has minor relief and begins at the east-west access road and ends where the cell tower access road crosses the stream that is the UT to Pembroke Creek.

Near station 1+00 a wetland valley feature was graded to divert the existing flow from the main ditch onto the site. The intent of grading this feature was to avoid hydrologic trespass and restore the headwater valley downstream. The wetland valley dimensions were based on reference data and yielded a bottom width of 10 feet and side slopes of 1:8. The invert of the culvert under Wildcat Road was 17.0 feet, and the top of the pipe had an elevation of 19.0 feet. Setting the wetland valley invert at 18.0 feet allowed 2.5 feet of water storage above the design invert, before water extends onto Wildcat Road. More importantly, the design elevation of 18.0 feet was based on measured water surface elevations therefore the project will not be creating a water surface increase for any upstream offsite properties or rights-of-way.

Filling the main ditch feature north of the access road required approximately 1,500 cubic yards of fill material. The wetland valley generated approximately 5,000 cubic yards of fill material. Placement of excess fill material outside of Area 1 or on areas above 21.0 feet within Area 1 ensured that a net gain of water storage capacity was achieved.

At station 11+00 the wetland valley transitions into the existing land surface. Small channels, hummock areas, and pools were created throughout the wetland area. Reference cross-sections indicated that approximately 30 percent of the “flat” wetted width had standing water or pools; therefore, approximately 30% of the project area was constructed to have standing water. Pool dimensions are based on reference data. Reference data used in the design was collected between April 13, 2006 and June 20, 2006. Material pushed aside to make pool areas were used for the creation of hummock areas.

At station 40+00 to 50+00 the surface was roughened by means of minor earthwork to promote sheet flow. Small channels (6” to 12” deep by 6” to 12” wide) were created along the axis of Area 1B and also perpendicular across the valley. The conveyance of water across the valley promoted wetland hydrology near station 12+00 and possibly stations 11+00 and 10+00. The existing access road was modified to have a constant elevation with two (2) crossings that conveyed flow during large storm events. The elevation of these areas was 18.0 feet. Geoweb® material was used to reinforce the crossings and ensure the invert elevation of each crossing remained constant over time.

Downstream of the access road it was likely that the groundwater table would be at or near the surface during the majority of the year. The two (2) headwater valleys continued south until they combine near main ditch station 24+00. Once the two valleys combined, the



easement area became narrow for the remainder of the project. Two (2) crossings in the road, similar in design to the crossings along the access road, were located at the end of the project. The first crossing in the road allowed flow from Reference Area 1 into the project site. The second crossing would be higher than the first, and assist in conveying large storm events.

A structure constructed of rock, logs, and coir matting was installed at the downstream end of the project site to transition flow from the restored headwater wetland area to the lower elevation of the existing ditch. The structure consisted of four (4) pairs of logs and a small rock structure that formed a series of steps that transitioned flow from elevation 15.0 feet to elevation 10.0 feet. The steps were constructed within a 100-foot section of channel and the structure was designed to allow the establishment of vegetation so that over time, the vegetation would mask the structure and promote a more natural appearance.

## **2.0 Monitoring Plan**

The methods, frequencies, and success criteria, for each monitoring element is listed below. A determination will be made regarding the success of the project following the collection and evaluation of ecological and physical monitoring data, photographs, site observations, and the performance of the restoration project during a minimum five year period. Monitoring components that will be evaluated include wetland hydrology, vegetation, and stability of surface flow features. This report was prepared using the most recent EEP Mitigation Plan guidance document (EEP, 2005b) and also incorporated the relevant aspects of the monitoring guidelines (EEP, 2005a).

Headwater wetland systems have a variable water table. The restored wetland will function similarly to a bottomland hardwood forest (USACE, 2005), but consists of a Non-Riverine Wet Hardwood plant community, transitioning into a Coastal Plain Small Stream Swamp plant community, according to reference data (**Appendix 5**). Therefore, the wetlands restored on this project site shall target establishing the water table to be within 12 inches of the soil surface continuously for greater than 5% of the growing season under normal rainfall conditions (USACE, 1987). The water table will be monitored by using 14 automated groundwater gauges within the restoration area and one (1) groundwater gauge in nearby Reference Area 1. Performance criteria may be defined more specifically based on long term reference data (USACE, 2002).

The restoration site was planted with species appropriate for the three targeted community types on the site. For each community, the vegetation will be monitored on an annual basis to determine survival. This monitoring process will be conducted in an effort to show the survival of a diverse target community such that the restored site has survival at a density of 320 stems/acre after three (3) years. This data will be monitored using sample plots in accordance with the most recent version of the EEP document entitled “CVS-EEP Protocol for Recording Vegetation” (Lee et. al, 2007). Vegetation success criteria applies to wetland restoration, enhancement, and the headwater valley.

Natural channel erosion and sedimentation across the site will be monitored through observation and measurement of cross-sections. Four (4) permanent cross-sections were installed to record any aggradation or degradation within the site and to also show flow patterns and channel formation.

Four (4) road crossings were installed to allow occasional flow over the on-site roads during storm events. The crossings will be visually monitored during site visits to document any sediment deposition or other maintenance concerns.

**Table 3 - Monitoring Summary**

<b>Parameter</b>	<b>Methodology</b>	<b>Frequency</b>	<b>Success Criteria</b>	<b>1 Year Data</b>
Hydrology	Monitoring gauge readings	Annually and as needed	Water table near or at the surface. The water table shall be within 12 inches of the soil surface for greater than 5% of the growing season.	Data collected indicates that success criteria has been met in groundwater gauges 7, 9, 10, 11, 12, and 15. On-site rain gauge data indicates on-site rainfall may be less than Edenton.
Vegetation	Stem counts within the 16 established vegetation plots	Annually between June and September	Stem survival greater than 320 stems/acre through year 3	7 vegetation plots had stem survival greater than 320 stems/acre
Flow Features	Measurement of cross sections	Annually	No significant aggradation or degradation	No significant aggradation or degradation was observed; see cross-section data

## **2.1 Hydrology**

### **2.1.1 Methodology**

The water table is being monitored by using 14 automated groundwater gauges within the project area and one (1) groundwater gauge in nearby Reference Area 1. These monitoring gauges have a sensor that is set to record groundwater depth every six (6) hours. Using a Meazura Rugged Digital Assistant, the data is downloaded and stored in the field until it can be transferred onto a computer in the office where it can then be analyzed. The location of each groundwater gauge is summarized in **Table 4** below.

**Table 4 - Monitoring Gauge Location Summary**

Location	Groundwater Gauge (Well) Number
Wetland Restoration Area	4,5,6,9,13
Wetland Enhancement Area	2,3
Headwater Wetland Valley	7,8,10,11,14,15
Wooded preservation	12 and 16

Note: Monitoring Well 1 was outside of project easement and was pulled before construction started.

### 2.1.2 Frequency

Monitoring gauges shall be inspected once a month during the growing season which begins in March and concludes in November. Site visits should be conducted, when possible, subsequent to known major rain events to ensure accuracy in gauge readings. The results of the inspection shall be documented for each gauge. Once documentation is complete, the gauges will be reset to continue recording.

### 2.1.3 Success Criteria

The water table shall be within 12 inches of the soil surface continuously for greater than 5% of the growing season under normal rainfall conditions (USACE, 1987).

### 2.1.4 Year-1 Data

Pre-construction monitoring was conducted during September 2007. The monitoring gauges were removed prior to construction and were re-installed during November 2007. As shown in **Table 5** rainfall amounts were above normal in 2006 prior to construction, below normal in 2007 during construction, and above normal after construction.

**Table 5 - Annual Rainfall versus Mean Rainfall**

	2006 (rainfall inches)	2007 (rainfall inches)	2008 (rainfall inches)
Edenton (312635)	56.66	29.95	73.96
Edenton Rainfall Above or Below Mean Value	Above	Below	Above
Mean Annual Rainfall		48.30	

Note: The Edenton weather station (312635) is located in Edenton approximately 3.5 miles to the west-southwest of the site. Mean values were calculated from data collected from 1971 to 2000. 2008 precipitation data includes rainfall up to 12/9/08.

Although rainfall amounts were above normal in 2008, when compared to the mean rainfall for Edenton, the on-site rain gauge showed that in 2008 nearly half of the measured rain in Edenton actually fell on the site. **Table 6** provides a comparison between on-site rainfall versus rainfall recorded in Edenton for the same time period.

**Table 6 - Local Rainfall versus Site Rainfall**

Station	2006 (May to Dec.)	2007	2008 (Jan – Apr)
Edenton (312635)	47.56	29.95	22.84
Site Rain Gauge 1	24.39	26.90	11.49

Note: The Edenton weather station (312635) is located in the town of Edenton approximately 3.5 miles to the west-southwest of the site. Mean values were calculated from data collected from 1971 to 2000. Rain amounts are reported within similar time periods to compare the rainfall data collected on-site versus the rainfall data collected in Edenton.

As stated in the Restoration Plan for this site, the success criteria are based on the reference sites and on traditional wetland hydrology criteria (**Figure 4**). Part of the success criteria is having groundwater table elevations within 12 inches of the soil surface continuously for 13 days, which is 5% of the 262 day growing season. Groundwater gauges 7, 9, 10, 11, 12, and 15 indicated that groundwater in these areas was within 12 inches of the soil surface continuously for at least 13 days. The groundwater elevations at all three reference sites were within 12 inches of the soil surface continuously for at least 13 days. Please see **Appendices 4 and 5** for detailed groundwater gauge data and rainfall Summary Data.

Groundwater gauges within the restoration area exhibited mixed results for meeting the hydrologic success criteria; however, gauge numbers 7, 9, 10, 11, and 15 did meet the success criteria. Site rain gauge data (**Table 6**) indicated the rainfall may be below normal conditions which may explain why all of the gauges did not meet the hydrologic success criteria. Approximately half (45 percent) of the gauges met the success criteria and long term monitoring may prove that a higher percentage will meet the hydrology threshold.

Groundwater gauges 2 and 3 are the only monitoring gauges in the Enhancement area and neither met the hydrology threshold. Both gauges are located in areas that are physically separated from the headwater wetland valley. Gauge 2 is approximately three (3) feet higher in elevation compared to the headwater wetland valley. Gauge 2 is approximately two (2) feet higher and 300 feet away from the headwater wetland valley. These facts were evident during the design and planning process and support the designation of enhancement for these areas.

## 2.2 Vegetation

### 2.2.1 Methodology

Proposed vegetation monitoring will follow the criteria outlined in the NC EEP 2006 Monitoring Report Guidelines document (NC EEP, 2006) and the CVS-EEP 2007 vegetation monitoring training class. The taxonomic standard for vegetation that was applied was Flora of the Carolinas, Virginia, Georgia, northern Florida, and surrounding areas (Weakley,

2008). Based on discussions with EEP and the required plots spreadsheet set up by EEP, the project would normally require 11 vegetation plots along the stream/headwater wetland valley. To fully represent all plant community types in the project area, 16 vegetation plots were established with 11 inside the stream/headwater wetland valley and 5 in the restored wetland area (**Figure 3**). Monitoring will follow the CVS-EEP Protocol for Recording Vegetation Version 4.0 (Lee et al., 2006), Protocol Level 1, which stipulates measuring only planted stems. The taxonomic protocol used for identification must be documented so subsequent investigators will know how the identification was derived. All plots have dimensions of 10 by 10 meters. Each vegetation plot was monumented at all corners with recoverable markers made of galvanized pipe.

### 2.2.2 Frequency

The vegetation plots shall be inventoried and documented annually between June and September. This timeframe will ensure that the maximum number of characteristics will be present to properly identify each species within the plots.

### 2.2.3 Success Criteria

The vegetation success shall be based on the Wilmington District Army Corps of Engineers April 2003 mitigation guidelines. The survival rate for the planted woody species on the mitigation site should be greater than 320 stems per acre through year three (3). A ten (10) percent mortality rate will be acceptable in year four (4) (288 stems per acre) and an additional ten percent in year five (5) resulting in a required survival rate of 260 woody stems per acre through year five (5).

### 2.2.4 Year-1 Data

The survival decline of planted woody species can be attributed to concerns associated with hydrology, invasive and competitive species, and damage. Vegetation monitoring plot stem counts are located in **Appendix 2** and vegetation plot and site photos are located in **Appendix 3**. Of the 16 vegetation monitoring plots, seven (7) vegetation monitoring plots met the vegetation success criteria of 320 stems per acre. Nine (9) vegetation monitoring plots failed to meet the vegetation success criteria.

Excess water present within some vegetation plots was due to the necessity of having hummock and pool areas. The vegetation plot locations were selected randomly; therefore, some were inadvertently placed in low areas which were later inundated. To ensure that the entire area was planted and to maximize the potential tree growth on-site, all wetland areas were planted – including pool areas. Mortality of species planted in low areas was anticipated.

Invasive species and competitive species which were formerly associated with past agricultural production are likely causes of survival decline to planted woody species. In many cases, herbaceous species from seed sources in the soil surmounted the bare root seedling. Damage concerns after planting also existed from the complete or partial removal

of a vegetation plot where apparent site disturbance had occurred. **Table 7** provides a summary of living stems per acre associated with each vegetation plot and the likely occurrence of planted woody species survival decline if the vegetation plot did not meet the vegetation success criteria. Growth in Enhancement areas did not differ significantly from the growth patterns for the remainder of the site.

**Table 7 - Vegetation Plot Summary**

Vegetation Plot	Total living stems per acre	Likely Occurrence of Planted Woody Species Decline
1*	364	
2	121	Competitive species dominating planted woody species
3	607	
4*	243	Competitive species dominating planted woody species
5	526	
6	81	Excessively wet and competitive species dominating planted woody species
7	405	
8	405	
9	zero	Excessively wet and competitive species dominating planted woody species
10	324	
11	202	Competitive species dominating planted woody species
12	zero	Excessively wet
13	41	Damage and competitive species dominating planted woody species
14	81	Damage
15	364	
16	283	Damage and competitive species dominating planted woody species

\* - Denotes vegetation plot in Enhancement area; all other plots in restoration area.

### 2.3 Headwater Stream Geomorphology

#### 2.3.1 Methodology

Flow features will be monitored by measuring the four (4) established cross-sections. Cross section diagrams are included in **Sheets 5 and 6** of **Appendix 1**. Flooding events will be documented through on-site visual assessment.

#### 2.3.2 Frequency

The cross-sections will be surveyed annually or as needed in cases where severe aggradation and/or degradation have been observed.

#### 2.3.3 Success Criteria

The overland flow component shall be deemed successful if conditions become stable over time. This will be evaluated annually and will be documented through measurement of the established cross-sections and site observations.

### 2.3.4 Year-1 Data

No aggradation or degradation was observed along the flow features at the site. Cross-section data (**Appendix 1 – Sheets 5 and 6**) supports this observation.

### 3.0 Maintenance and Contingency Plans

During annual monitoring, problem areas will be noted by site personnel and provided to the Ecosystem Enhancement Program (EEP). EEP will evaluate the problem area and determine the best course of action. Additional site visits will be conducted by the monitoring contractor and EEP on an occasional basis throughout the year to identify potential problem areas. This approach of frequent site visits will ensure that any developing problem can be addressed before it poses a major risk to the success of the project.

Problem area photos are located in **Appendix 3**. Problem areas can be grouped into two categories: hydrology and invasive/competitive species.

The primary hydrologic area of concern along the stream is the standing water downstream of the former pond (stations 21+00 to 25+00). This standing water ranges in depth between approximately 1.0 feet and 1.5 feet. This area is approximately one (1) acre and is roughly five (5) percent of the entire project area. The target design conditions for the site were 30 percent pools (or depressions) and 70 percent hummocks. Assuming that the rest of the site is exactly 30 percent pools, the area between stations 21+00 to 25+00 would indicate the site is 35 percent pools or depressions. This is within an acceptable tolerance observed at the natural reference systems used during design. The intended plant community for this area was Non-riverine Wet Hardwood Forest, although it is functioning more like a Coastal Plain Small Stream Swamp plant community; similar to the on-site reference area.

The standing water between stations 21+00 and 25+00 does not present a problem from a morphological standpoint; however, the water depth may be too deep to support some of the plant species selected for the site. Fortunately, some species planted in this area such as tulip poplar (*Liriodendron tulipifera*) and swamp tupelo (*nyssa biflora*) are suitable for either plant community type. Diffuse flow may not be evident within this area, but it is achieved throughout the majority of the site. As stated throughout this document; design was based on reference conditions which exhibited areas of standing water.

Through the completion of this project, the primary function of reconnecting the system to its effective floodplain has been achieved (USACE, 2007). Measured rainfall during 2008 (73.96 inches) was exceptionally above the 30 year mean of 48.30 inches. This suggests that the site may actually be much drier during a year with mean rainfall. The recommended approach is to wait multiple years and observe the area. If the area continues to stay over-saturated then adjusting the water elevation can be considered.

Invasive species from station 21+00 to 25+00 includes: cattail (*Typha latifolia*), Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), Chinese

privet (*Ligustrum sinense*), and parrotfeather (*Myriophyllum aquaticum*). These invasive species were previously noted in the Final Mitigation Plan and primarily isolated within the remaining drainage ditches. Continued monitoring is recommended to check for any significant encroachment of these invasive species. It is also recommended that a plan of action be developed to control cattail (*Typha latifolia*) encroachment.

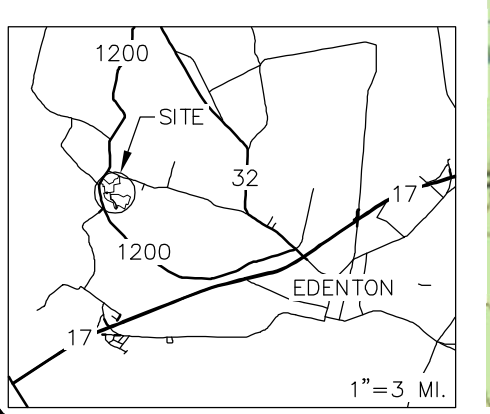
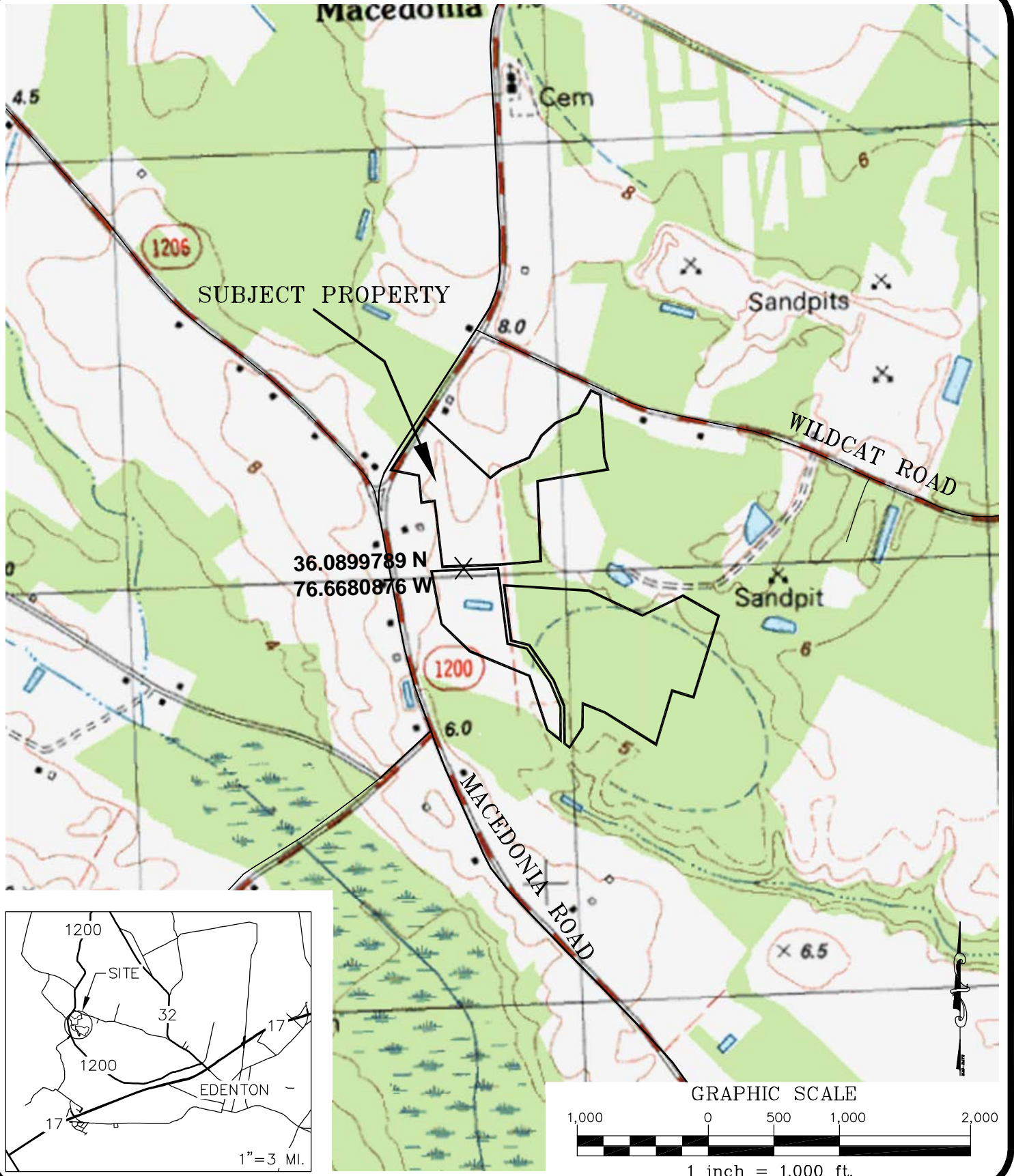


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# **Section 1.0 Figures**

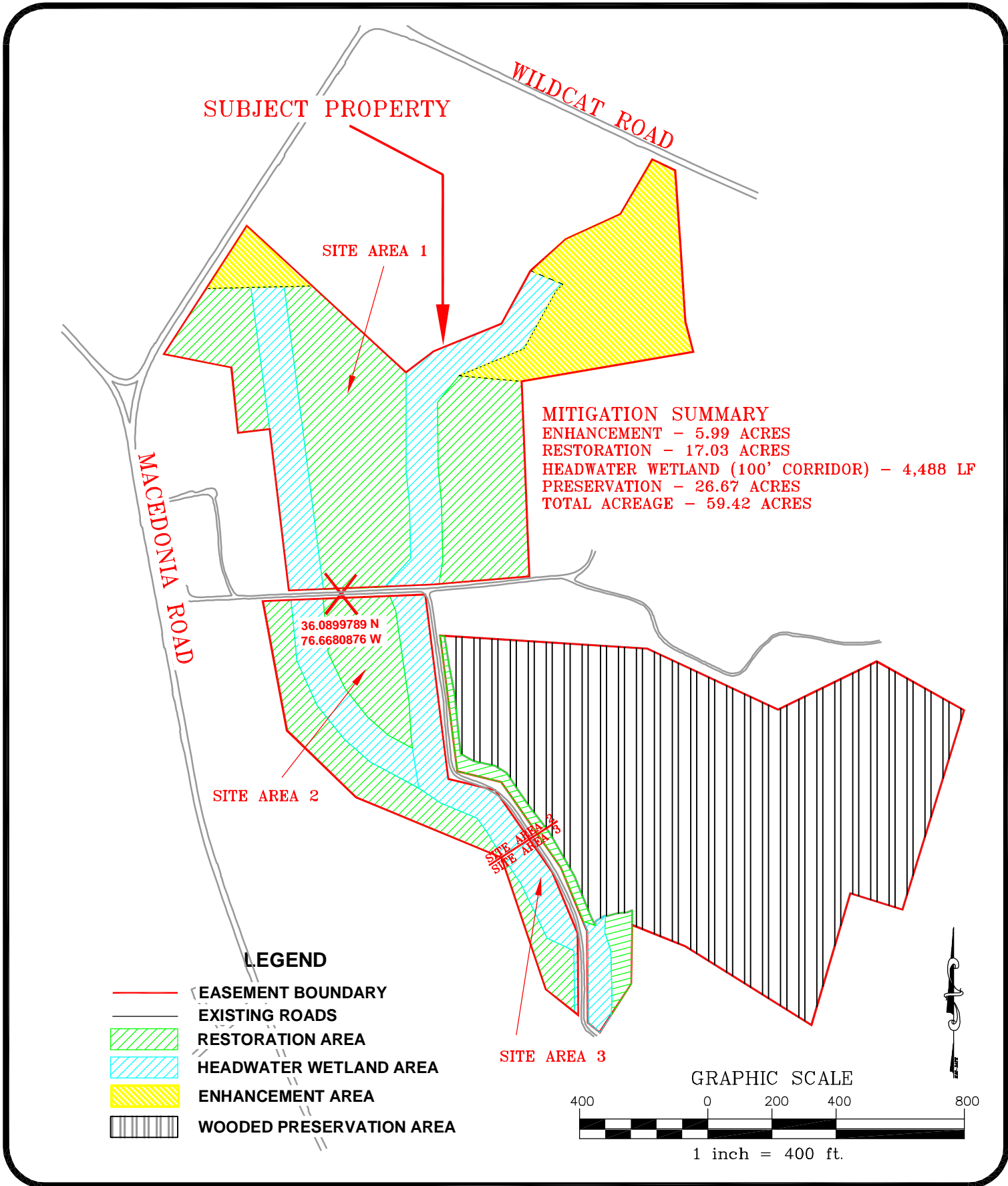
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	SCALE:	1"=1,000'
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**FIGURE 1 VICINITY MAP**  
**UT PEMBROKE CREEK**  
**EDENTON**  
**CHOWAN COUNTY, NORTH CAROLINA**  
**USGS HUC 03010205**

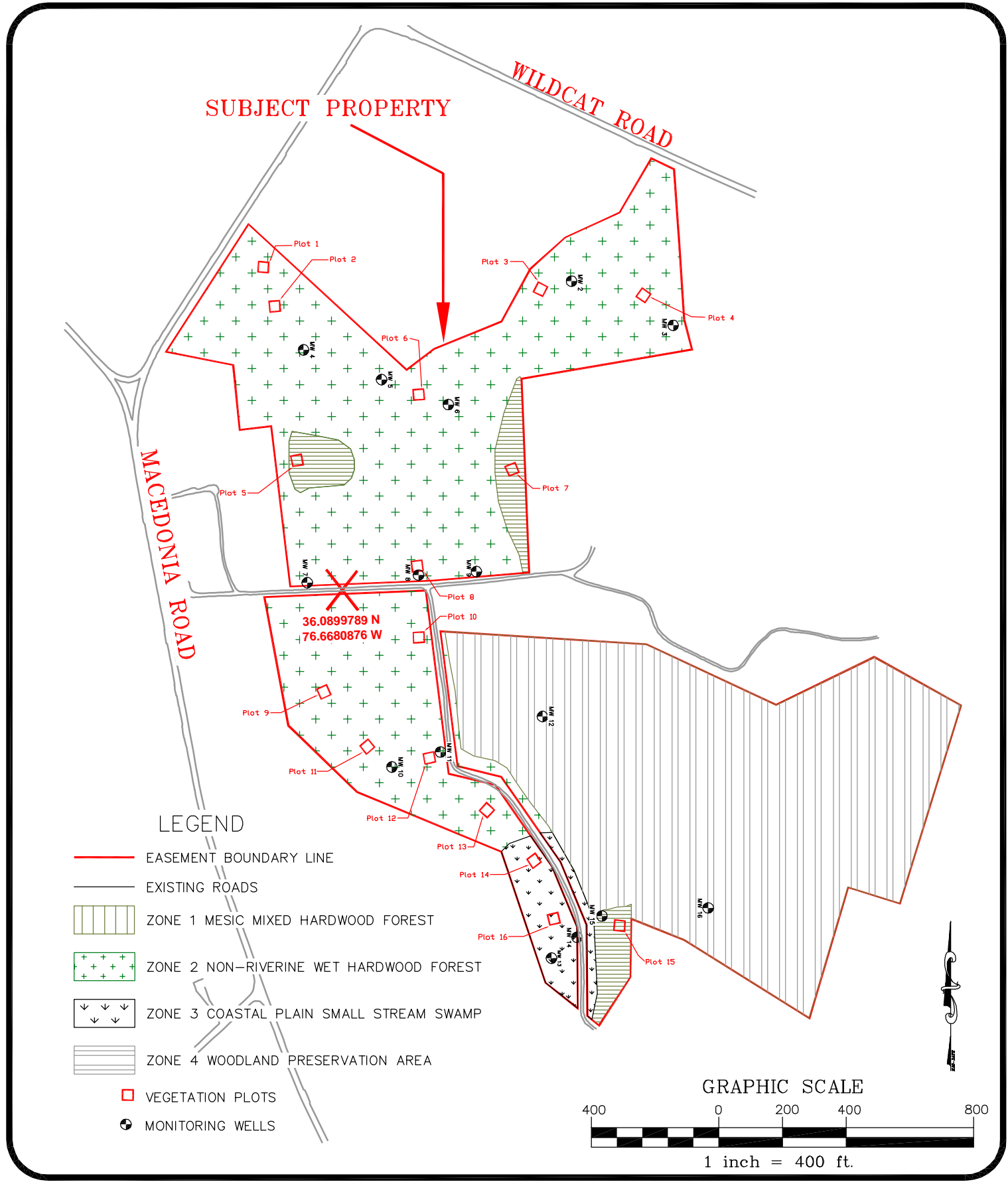
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	PROJECT NO. EEP-06010
	FILENAME: EEP06010X.DWG
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**FIGURE 2 MITIGATION SUMMARY**  
**UT PEMBROKE CREEK**  
**EDENTON**  
 CHOWAN COUNTY, NORTH CAROLINA  
 USGS HUC 03010205

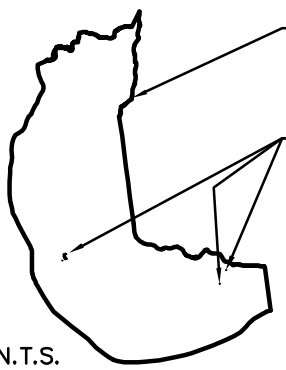
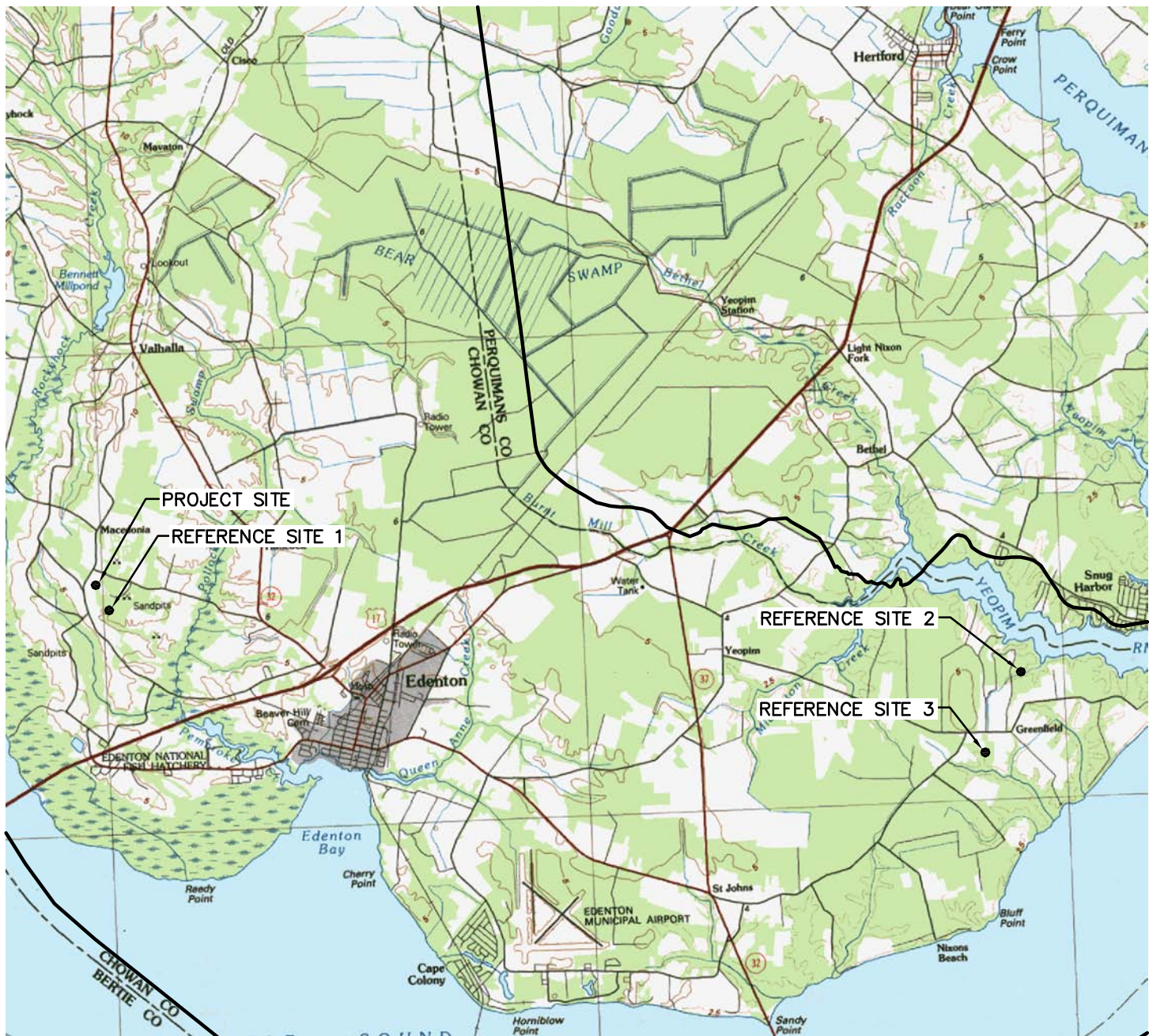
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	PROJECT NO.	EEP-06010
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**FIGURE 3 VEGETATION PLOTS**  
**UT PEMBROKE CREEK**  
**EDENTON**  
 CHOWAN COUNTY, NORTH CAROLINA  
 USGS HUC 03010205

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COUNTY BOUNDARY

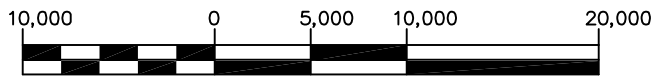
REFERENCE SITE LOCATIONS

N.T.S.

NOTE:  
 REFERENCE SITES LOCATED ON PRIVATE PROPERTY. NO ACCESS WITHOUT OWNER PERMISSION. ALL THREE REFERENCE SITES ARE ENCOMPASSED BY USGS HUC 03010205.




GRAPHIC SCALE



1 inch = 10,000 ft.

PROJECT NO.	EEP-06010
FILENAME:	EEP06010X.DWG
SCALE:	1"=10,000'
DATE:	10-20-08

**FIGURE 4 REFERENCE SITE LOCATIONS**  
**UT PEMBROKE CREEK**  
**EDENTON**  
 CHOWAN COUNTY, NORTH CAROLINA  
 USGS HUC 03010205



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## **Section 2.0 Appendices**

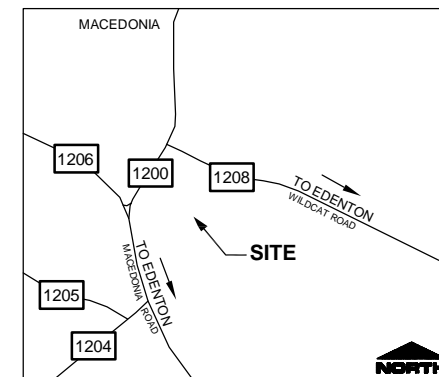
# **Appendix 1**

# **Year 1 Monitoring**

**UT to Pembroke Wetland and Stream Restoration Project**



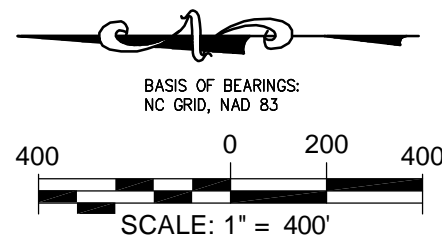
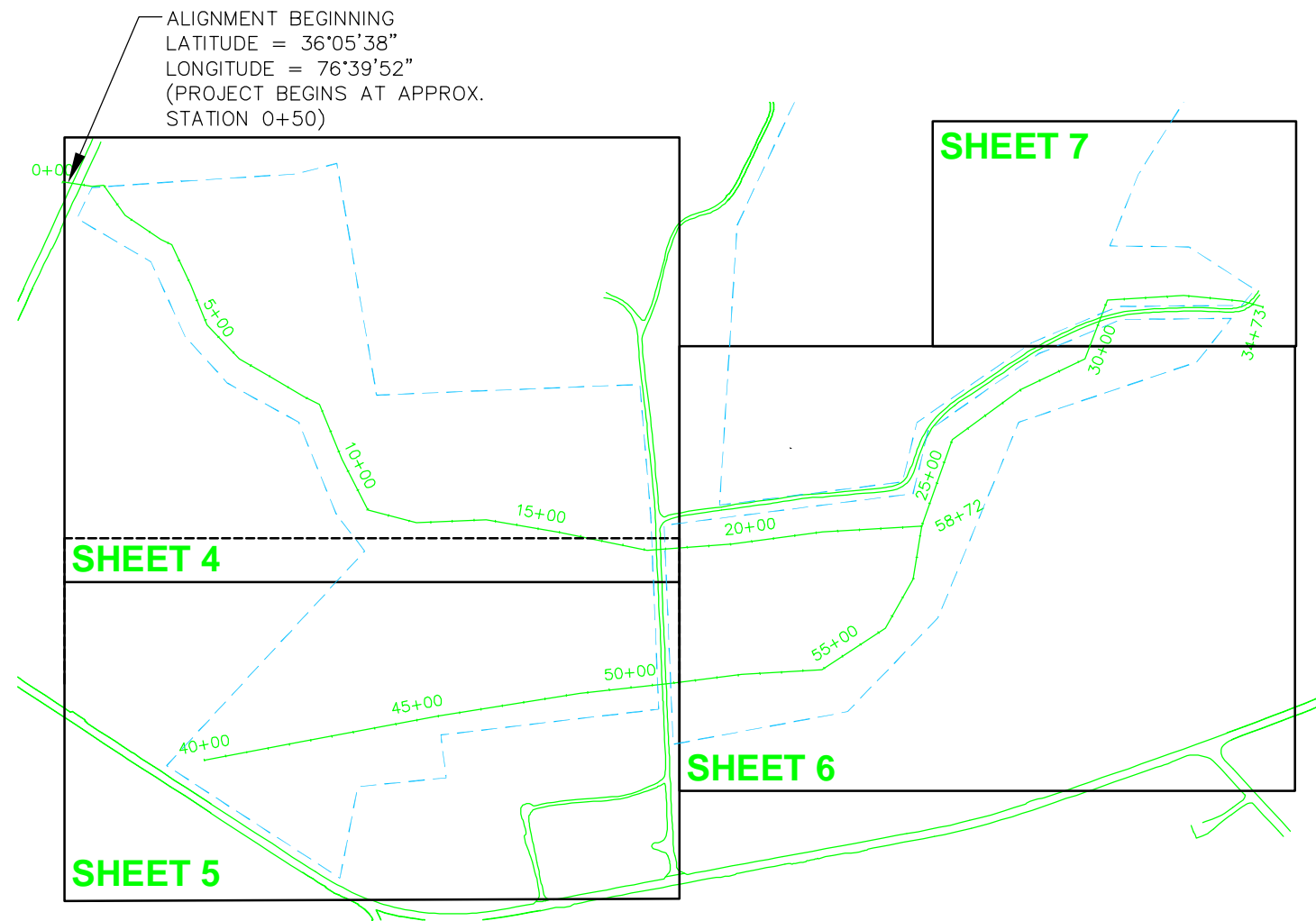
**YEAR 1 MONITORING - UT TO PEMBROKE CREEK  
STREAM AND WETLAND RESTORATION PROJECT  
EDENTON, CHOWAN COUNTY, NORTH CAROLINA  
NC ECOSYSTEM ENHANCEMENT PROGRAM PROJECT  
SCO# 050658801**



VICINITY MAP EDENTON, NC  
NOT TO SCALE

**GENERAL NOTES**

1. PREPARED FOR NC ECOSYSTEM ENHANCEMENT PROGRAM, 1652 MAIL SERVICE CENTER, RALEIGH, NC 27699-1652.
2. THE TOTAL EASEMENT ACREAGE FOR THIS PROJECT IS 59.42 ACRES.
3. THE SENIOR DESIGN CONTACT FOR THIS PROJECT IS JAMES M. HALLEY, PE OF THE JOHN R. MCADAMS COMPANY, 919-361-5000.
4. THE EEP PROJECT MANAGER IS TRACY MORRIS, 919-715-1658.
5. THE EEP REVIEW COORDINATOR IS LIN XU, PE, 919-715-7571.
6. THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES PROJECT NUMBER IS D06102S (EEP PROJECT NUMBER 283).
7. A BOUNDARY SURVEY WAS NOT PERFORMED WHILE OBTAINING THE FIELD SURVEYED DATA SHOWN HEREON AND THIS SET OF RECORD DRAWINGS WAS PREPARED WITHOUT THE BENEFIT OF A TITLE REPORT AND IS SUBJECT TO ANY FACTS AND EASEMENTS WHICH MAY BE DISCLOSED BY A FULL AND ACCURATE TITLE SEARCH.
8. BOUNDARY INFORMATION SHOWN HEREON BASED ON A CONSERVATION EASEMENT SURVEY PREPARED BY NATURAL SYSTEMS ENGINEERING AND RECORDED IN PLAT CABINET NUMBER 2, SLIDE 34G OF THE CHOWAN COUNTY REGISTER OF DEEDS.
9. PHYSICAL FEATURES SHOWN HEREON SUCH AS BUILDINGS AND ROADWAYS ARE BASED ON AN AERIAL TOPOGRAPHIC SURVEY PREPARED BY GEODATA CORPORATION UNDER THE SUPERVISION OF JAMES M. SALMONS, PLS, PPS, LICENSE NUMBER L-4041 FROM MARCH 24, 2006 AERIAL PHOTOGRAPHY.
10. FIELD SURVEYED SPOT ELEVATIONS AND THE TOPOGRAPHIC DATA SHOWN HEREON OBTAINED BY GPS METHOD. THE DATA WAS DERIVED BY KINEMATIC GPS OBSERVATIONS USING A TRIMBLE R8 RECIEVER ON-SITE AND THE NCGS NETWORK RTK SYSTEM FROM 11-28-2007 TO 11-30-2007. THE DERIVED HORIZONTAL PRECISION ON POINTS ESTABLISHED ON-SITE IS 0.031'. THE ELEVATIONS ARE BASED ON THE NAVD 88 VERTICAL DATUM AND THE NC GRID (NAD 83) HORIZONTAL DATUM.
11. PLANTING WAS COMPLETED ON DECEMBER 18, 2007 - DECEMBER 19, 2007. THE VEGETATION PLOTS WERE LOCATED USING A TRIMBLE GEO XT SUBMETER GPS UNIT ON THESE DATES.



SHEET INDEX:

SHEET 1	-	TITLE AND INDEX
SHEET 2	-	LEGEND
SHEET 3	-	POST-CONSTRUCTION CONDITIONS
SHEET 4	-	SITE VEGETATION
SHEET 5	-	CROSS-SECTIONS 1 & 2
SHEET 6	-	CROSS-SECTIONS 3 & 4

**SHEET  
1 OF 6**

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**TITLE AND INDEX SHEET**  
**UT to PEMBROKE CREEK  
STREAM AND WETLAND RESTORATION  
CHOWAN COUNTY, NORTH CAROLINA**





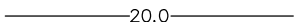

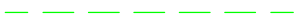
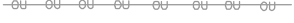

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
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### DETAIL KEY



-  EASEMENT BOUNDARY LINE
-  ROADS
-  FENCE
-  DESIGN CONTOUR
-  EXISTING CONTOUR
-  HUMMOCK CREATION LINE
-  FINE GRADING LIMIT
-  OVERHEAD UTILITIES
-  HEADWATER VALLEY CENTERLINE

-  TREE LINES / WOODS
-  UTILITY POLE
-  MW 1  
MONITORING WELL
-  +16.5  
SPOT GROUND ELEVATION

-  RUINS STRUCTURES
-  ROAD CROSSING
-  DESIGN SURFACE FLOW DIRECTION
-  GRADE TRANSITION
-  RIP RAP

**SHEET  
2 OF 6**

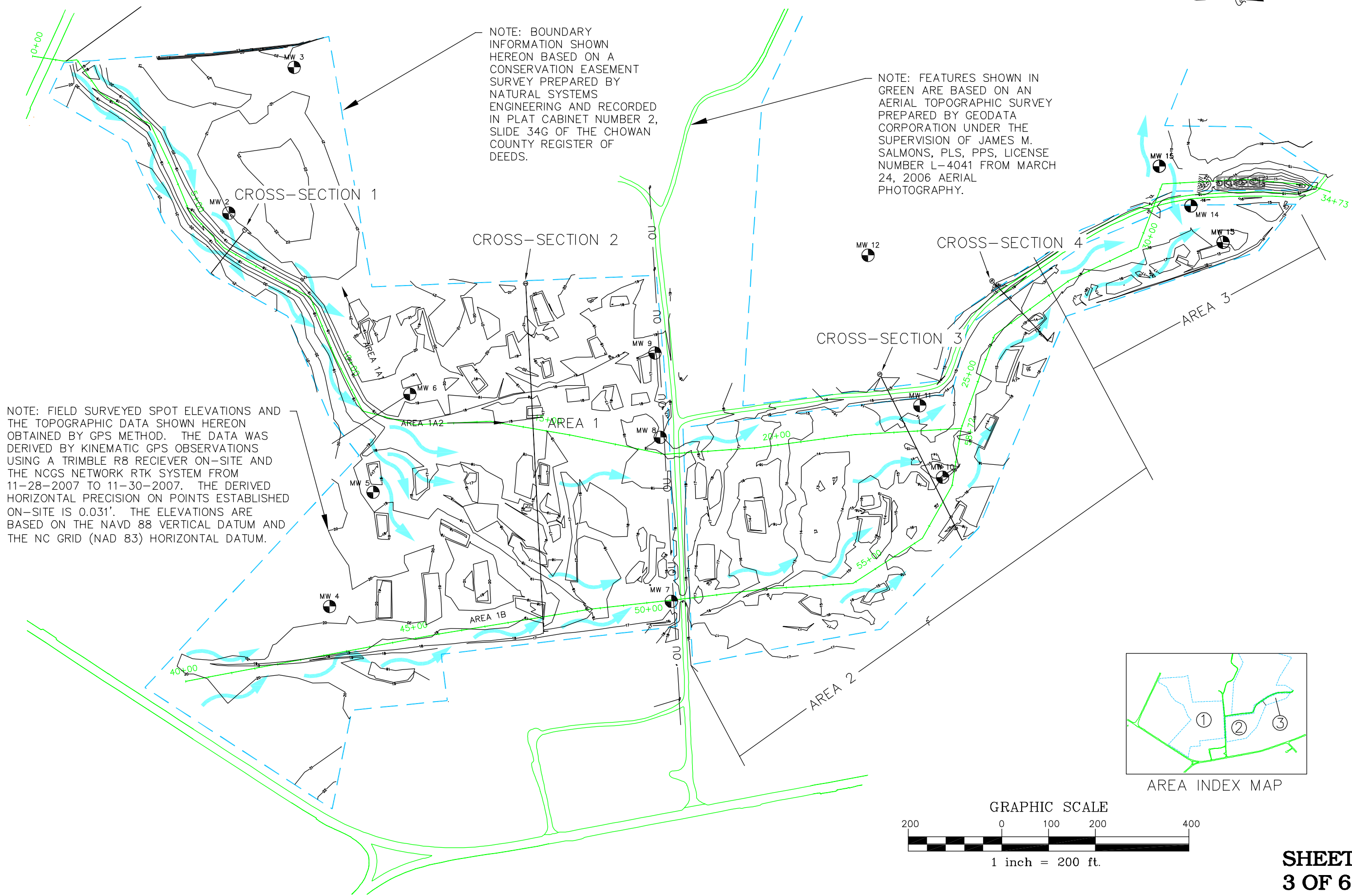
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**LEGEND**  
 UT to PEMBROKE CREEK  
 STREAM AND WETLAND RESTORATION  
 CHOWAN COUNTY, NORTH CAROLINA

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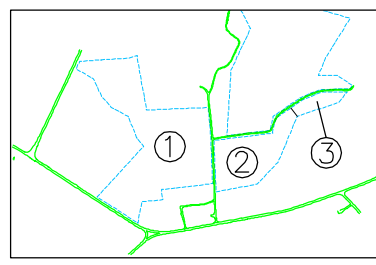
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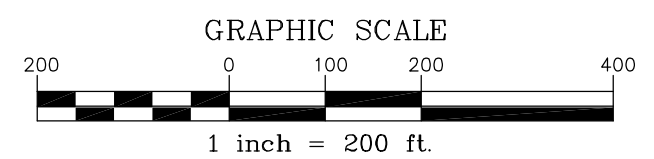
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NOTE: FEATURES SHOWN IN GREEN ARE BASED ON AN AERIAL TOPOGRAPHIC SURVEY PREPARED BY GEODATA CORPORATION UNDER THE SUPERVISION OF JAMES M. SALMONS, PLS, PPS, LICENSE NUMBER L-4041 FROM MARCH 24, 2006 AERIAL PHOTOGRAPHY.

NOTE: FIELD SURVEYED SPOT ELEVATIONS AND THE TOPOGRAPHIC DATA SHOWN HEREON OBTAINED BY GPS METHOD. THE DATA WAS DERIVED BY KINEMATIC GPS OBSERVATIONS USING A TRIMBLE R8 RECIEVER ON-SITE AND THE NCGS NETWORK RTK SYSTEM FROM 11-28-2007 TO 11-30-2007. THE DERIVED HORIZONTAL PRECISION ON POINTS ESTABLISHED ON-SITE IS 0.031'. THE ELEVATIONS ARE BASED ON THE NAVD 88 VERTICAL DATUM AND THE NC GRID (NAD 83) HORIZONTAL DATUM.



AREA INDEX MAP



**SHEET  
3 OF 6**

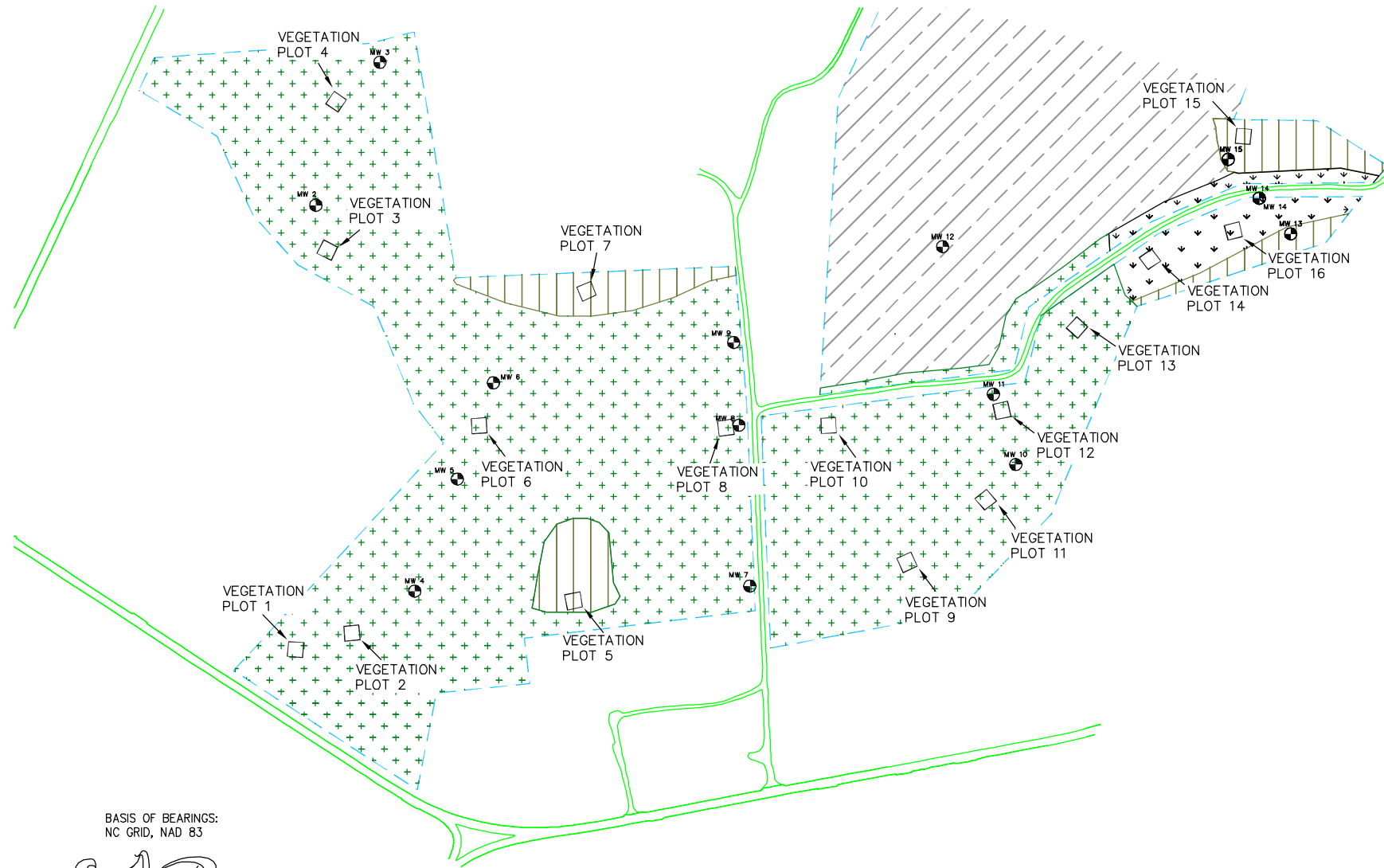
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**POST-CONSTRUCTION CONDITIONS**  
**UT to PEMBROKE CREEK**  
**STREAM AND WETLAND RESTORATION**  
CHOWAN COUNTY, NORTH CAROLINA

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FILENAME: AS-BUILTS  
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DATE: 10-20-08

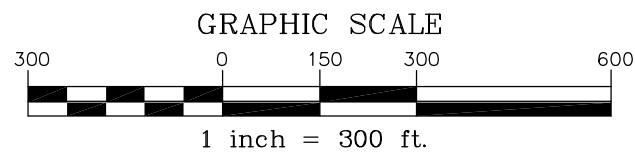


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BASIS OF BEARINGS:  
NC GRID, NAD 83

NOTE: SEE GENERAL NOTES ON SHEET 1  
REGARDING DATA SOURCES



ZONE 1 VEGETATION			
COMMON NAME	SCIENTIFIC NAME	DESCRIPTION	STEMS PLANTED
WHITE OAK	QUERCUS ALBA	BARE ROOT	300
SWAMP CHESTNUT OAK	QUERCUS MICHAUXII	BARE ROOT	400
WATER OAK	QUERCUS NIGRA	BARE ROOT	400
TULIP POPLAR	LIRIODENDRON TULIPIFERA	BARE ROOT	350
AMERICAN ELM	ULMUS AMERICANA	BARE ROOT	300
COMMON ELDERBERRY	SAMBUCUS CANADENSIS	CONTAINERIZED	189
RED TOP	AGROSTIS ALBA	WETLAND SEED	BROADCAST
WILD RYE	ELYMUS VIRGINICUS	WETLAND SEED	BROADCAST
RUSH	JUNCUS EFFUSES	WETLAND SEED	BROADCAST

ZONE 2 VEGETATION			
COMMON NAME	SCIENTIFIC NAME	DESCRIPTION	STEMS PLANTED
TULIP POPLAR	LIRIODENDRON TULIPIFERA	BARE ROOT	3,000
SWAMP TUPELO	NYSSA BIFLORA	BARE ROOT	3,050
SWAMP CHESTNUT OAK	QUERCUS MICHAUXII	BARE ROOT	3,100
LAURAL OAK	QUERCUS LAURIFOLIA	BARE ROOT	2,600
WATER OAK	QUERCUS NIGRA	BARE ROOT	3,100
AMERICAN ELM	ULMUS AMERICANA	BARE ROOT	3,100
WAX MYRTLE	MORELLA CERIFERA	CONTAINERIZED	3,100
RED TOP	AGROSTIS ALBA	WETLAND SEED	BROADCAST
WILD RYE	ELYMUS VIRGINICUS	WETLAND SEED	BROADCAST
RUSH	JUNCUS EFFUSES	WETLAND SEED	BROADCAST

ZONE 3 VEGETATION			
COMMON NAME	SCIENTIFIC NAME	DESCRIPTION	STEMS PLANTED
TULIP POPLAR	LIRIODENDRON TULIPIFERA	BARE ROOT	250
SWAMP TUPELO	NYSSA BIFLORA	BARE ROOT	250
OVERCUP OAK	QUERCUS LYRATA	BARE ROOT	200
SWAMP BAY	PERSEA PALUSTRIS	BARE ROOT	200
VIRGINIA SWEETSPIRE	ITEA VIRGINICA	CONTAINERIZED	101
RED TOP	AGROSTIS ALBA	WETLAND SEED	BROADCAST
WILD RYE	ELYMUS VIRGINICUS	WETLAND SEED	BROADCAST
RUSH	JUNCUS EFFUSES	WETLAND SEED	BROADCAST

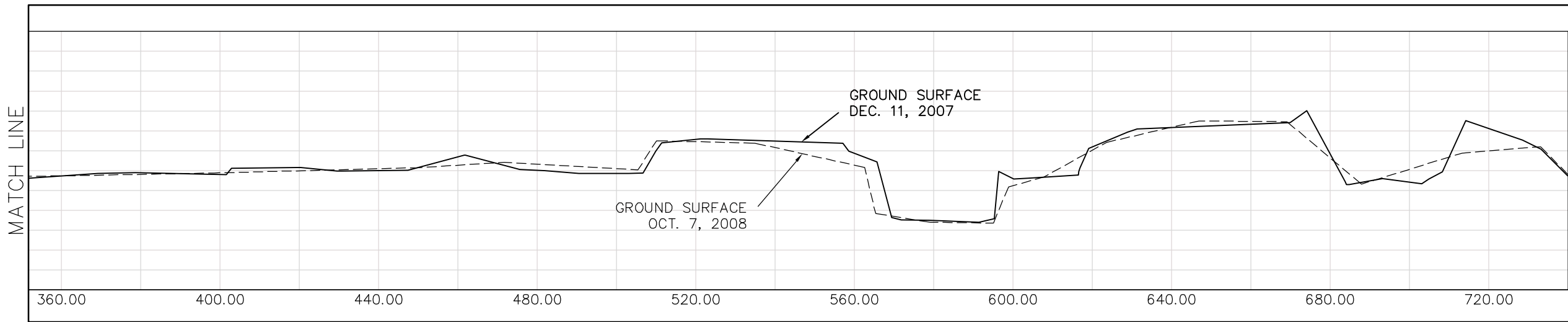
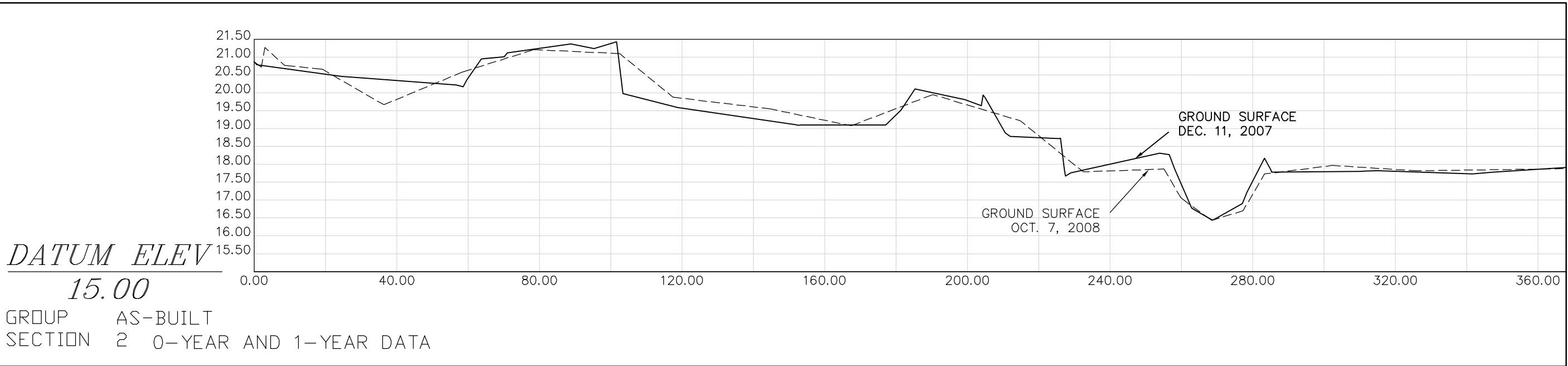
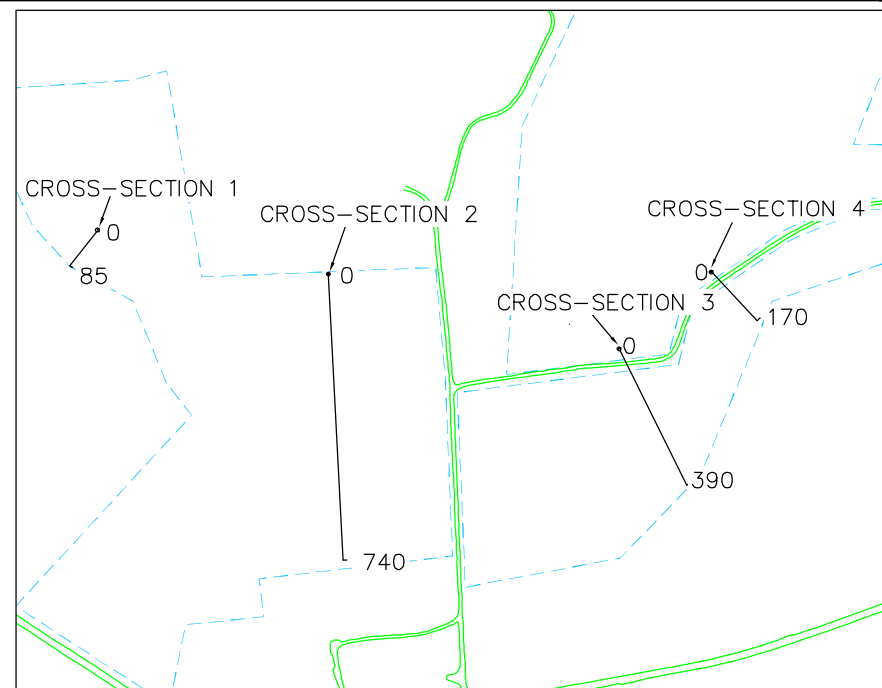
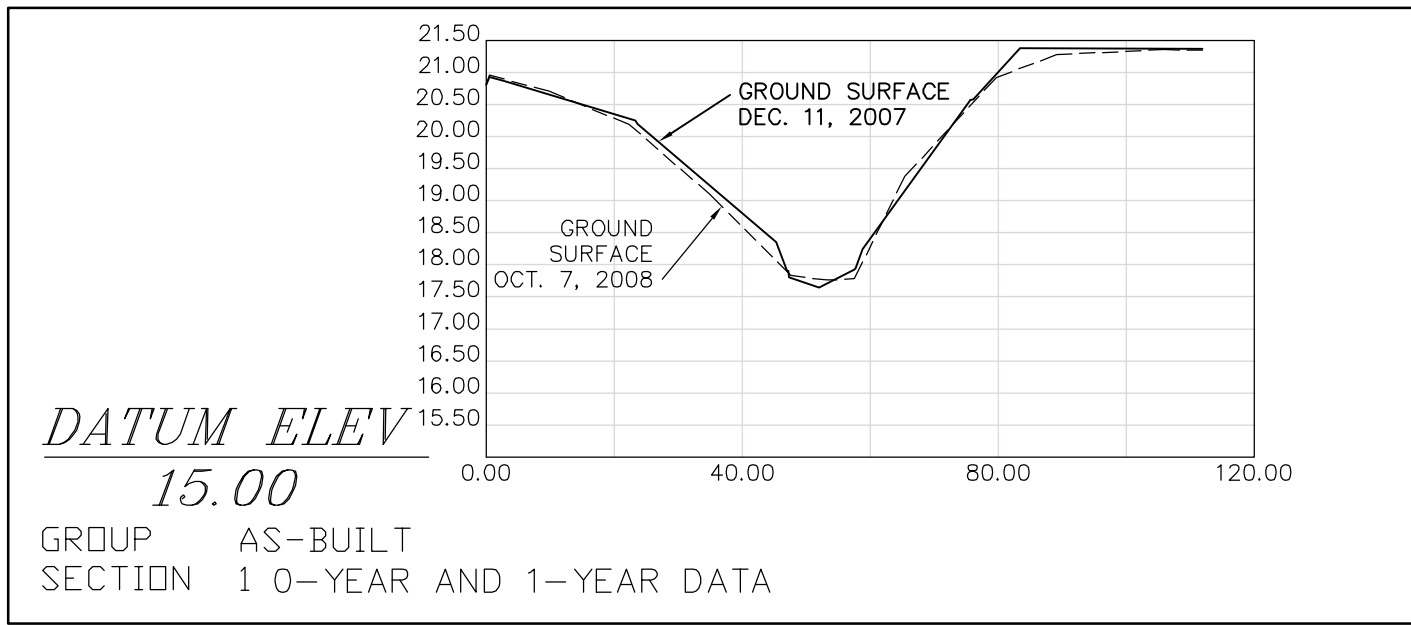
\*NOTE: PLANTING WAS COMPLETED ON DECEMBER 18, 2007 –  
DECEMBER 19, 2007. THE VEGETATION PLOTS WERE LOCATED  
USING A TRIMBLE GEO XT SUBMETER GPS UNIT ON THESE DATES.

LEGEND

- EASEMENT BOUNDARY LINE
- EXISTING ROADS
- ZONE 1 MESIC MIXED HARDWOOD FOREST
- ZONE 2 NON-RIVERINE WET HARDWOOD FOREST
- ZONE 3 COASTAL PLAIN SMALL STREAM SWAMP
- ZONE 4 WOODLAND PRESERVATION AREA

**SHEET  
4 OF 6**

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**SHEET 5 OF 6**

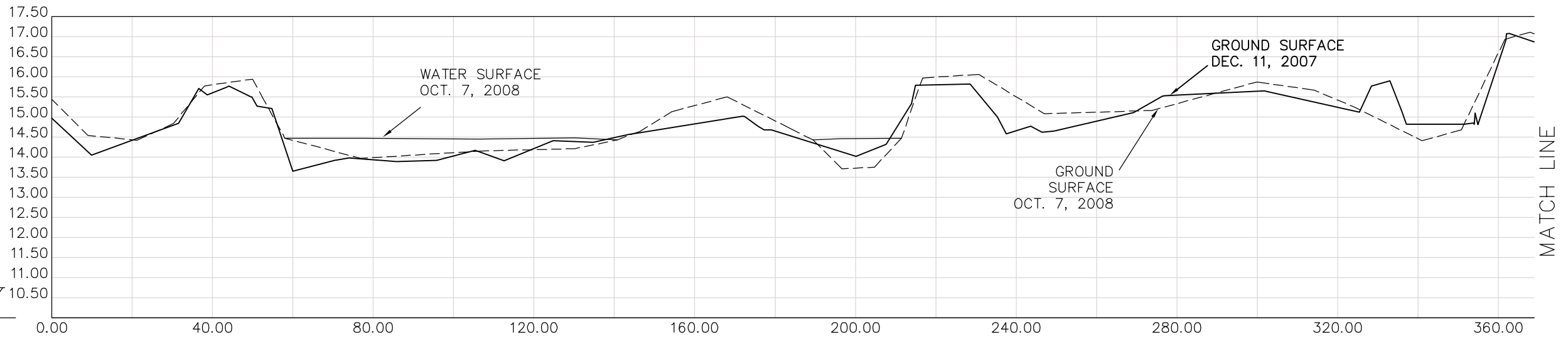
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**CROSS-SECTIONS**  
UT to PEMBROKE CREEK  
STREAM AND WETLAND RESTORATION  
CHOWAN COUNTY, NORTH CAROLINA

PROJECT NO. EEP-06010  
FILENAME: AS-BUILTS  
SCALE: 1" = 30'  
DATE: 10-20-08



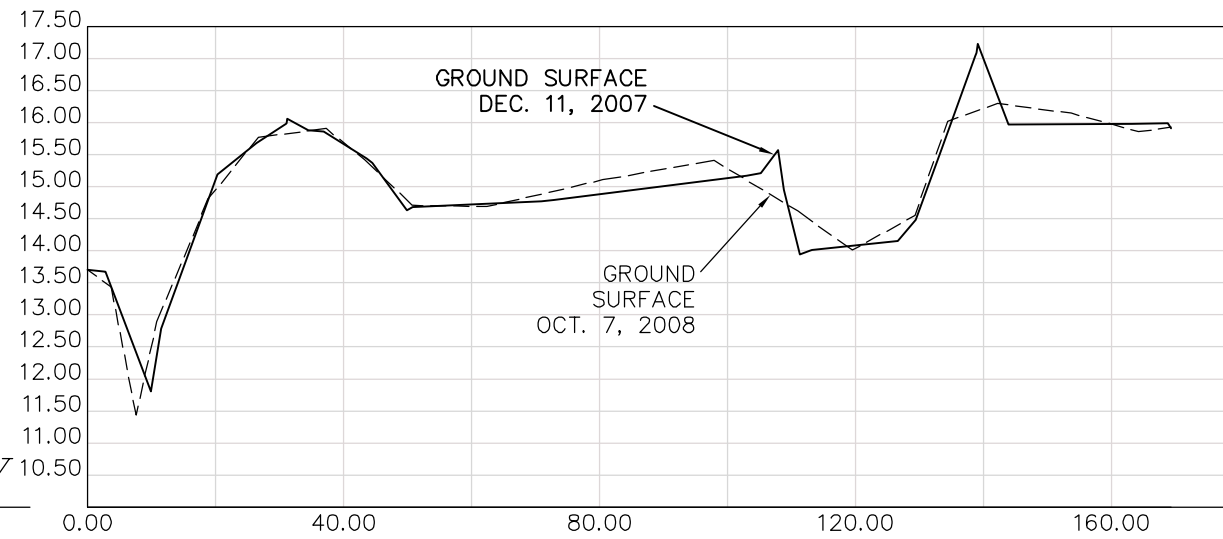
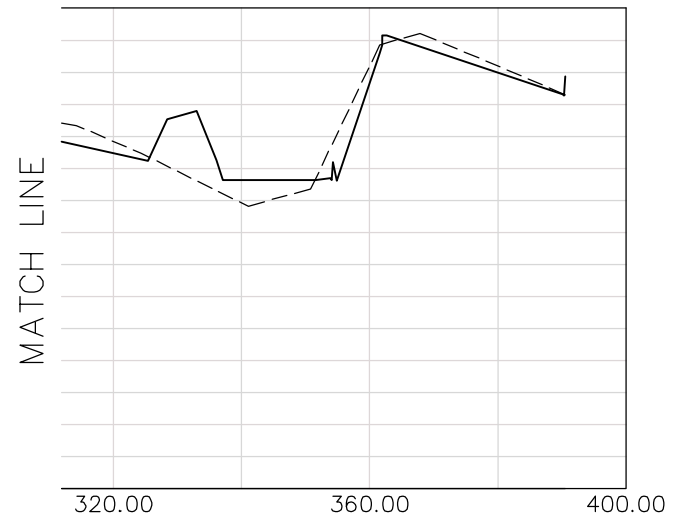
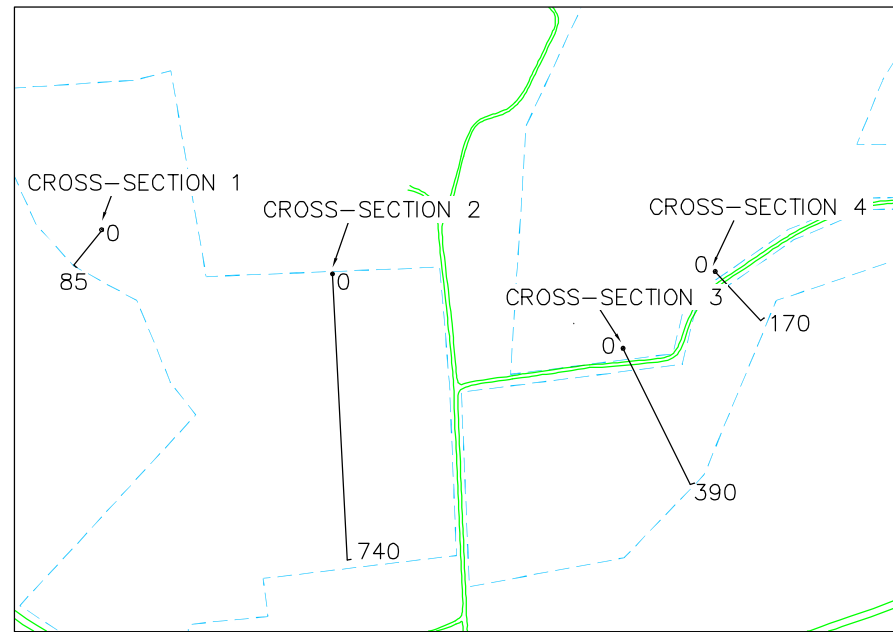
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*DATUM ELEV*

10.00

GROUP AS-BUILT  
SECTION 3 0-YEAR AND 1-YEAR DATA



*DATUM ELEV*

10.00

GROUP AS-BUILT  
SECTION 4 0-YEAR AND 1-YEAR DATA

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**CROSS-SECTIONS**  
UT to PEMBROKE CREEK  
STREAM AND WETLAND RESTORATION  
CHOWAN COUNTY, NORTH CAROLINA

PROJECT NO. EEP-06010  
FILENAME: AS-BUILTS  
SCALE: 1" = 30'  
DATE: 10-20-08

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**SHEET**  
**6 OF 6**

# **Appendix 2**

## **Vegetation Data**

Table 1: Plots

Plot	Plot Level	Year	Northing	Easting	Datum	Date Sampled	Planted Living Stems	Planted Living Stems (excluding Live Stakes)	Dead/Missing Stems	Natural Stems	Total Living Stems	Total Living Stems (excluding Live Stakes)	Planted Living Stems per Acre	Planted Living Stems (excluding Live Stakes per Acre)	Total Living Stems per Acre	Total Living Stems (excluding Live Stakes per Acre)	# Species
Plot 1	1	1	860817.88	2688648.83	NAD83/WGS84	10/9/2008	9	9	5	0	9	9	364.2	364.2	364.2	364.2	4
Plot 2	1	1	860695.5	2688684.07	NAD83/WGS84	10/9/2008	3	3	8	0	3	3	121.4	121.4	121.4	121.4	3
Plot 3	1	1	860748.71	2689518.60	NAD83/WGS84	10/9/2008	15	15	3	0	15	15	607.0	607.0	607.0	607.0	6
Plot 4	1	1	860730.32	2689841.77	NAD83/WGS84	10/9/2008	6	6	8	0	6	6	242.8	242.8	242.8	242.8	2
Plot 5	1	1	860212.3	2688754.21	NAD83/WGS84	10/9/2008	13	13	3	0	13	13	526.1	526.1	526.1	526.1	4
Plot 6	1	1	860418.21	2689135.64	NAD83/WGS84	10/9/2008	2	2	10	0	2	2	80.9	80.9	80.9	80.9	1
Plot 7	1	1	860182.80	2689429.38	NAD83/WGS84	10/8/2008	10	10	4	0	10	10	404.7	404.7	404.7	404.7	4
Plot 8	1	1	859880.43	2689131.2	NAD83/WGS84	10/7/2008	10	10	4	0	10	10	404.7	404.7	404.7	404.7	4
Plot 9	1	1	859485.41	2688837.86	NAD83/WGS84	10/8/2008	0	0	18	0	0	0	0.0	0.0	0.0	0.0	0
Plot 10	1	1	859656.25	2689136.73	NAD83/WGS84	10/8/2008	8	8	4	0	8	8	323.7	323.7	323.7	323.7	3
Plot 11	1	1	859313.66	2688974.63	NAD83/WGS84	10/8/2008	5	5	10	0	5	5	202.3	202.3	202.3	202.3	3
Plot 12	1	1	859278.04	2689169.08	NAD83/WGS84	10/8/2008	0	0	14	0	0	0	0.0	0.0	0.0	0.0	0
Plot 13	1	1	859114.35	2689350.17	NAD83/WGS84	10/8/2008	1	1	14	0	1	1	40.5	40.5	40.5	40.5	1
Plot 14	1	1	858955.49	2689498.78	NAD83/WGS84	10/8/2008	2	2	12	0	2	2	80.9	80.9	80.9	80.9	2
Plot 15	1	1	858751.7	2689766.42	NAD83/WGS84	10/8/2008	9	9	6	0	9	9	364.2	364.2	364.2	364.2	4
Plot 16	1	1	858773.83	2689560.16	NAD83/WGS84	10/8/2008	7	7	9	0	7	7	283.3	283.3	283.3	283.3	4



<b>Vigor</b>	<b>Count</b>	<b>Percent</b>
0	29	12.5
1	14	6
2	44	19
3	42	18.1
Missing*	103	44.4

Note: Refer to Section 2.2.4 - Year 1 Data for a discussion on the missing stems.  
 Problem Areas 1 through 5 of Appendix 3 displays photographs of site conditions that support the amount of missing stems.

<b>Species</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>Missing*</b>
Itea virginica						5
Nyssa biflora		3	11	2	3	15
Persea palustris		1		2		5
Quercus alba		1	1		1	1
Quercus laurifolia			4	2	9	19
Quercus lyrata		1	2			3
Quercus michauxii		2	8	3	2	6
Quercus nigra		3	4	1	4	11
Sambucus nigra		3	3	1		3
Morella cerifera		9	1	1	1	6
Liriodendron tulipifera		9	5	2	7	13
Ulmus americana		10	5		2	16
<b>TOT:</b>	<b>12</b>	<b>42</b>	<b>44</b>	<b>14</b>	<b>29</b>	<b>103</b>

\* Note: The comment “missing” was used to describe a planted stem was not found.

<b>Damage</b>	<b>Count</b>	<b>Percent Of Stems</b>
(No Damage)	166	71.6
Vine Strangulation	31	13.4
Unknown	17	7.3
(Other Damage)	14	6
Insects	2	0.9
Human Trampled	2	0.9

**Table 5: Damage by Species Type**

Species	All Damage Categories	No Damage	Human Trampled	Insects	Unknown	Vine Strangulation	(Other Damage)
<i>Itea virginica</i>	5	5					
<i>Liriodendron tulipifera</i>	36	29	1			5.0	1.0
<i>Morella cerifera</i>	18	16			1	1.0	
<i>Nyssa biflora</i>	34	21			4	7.0	2.0
<i>Persea palustris</i>	8	6	1		1		
<i>Quercus alba</i>	4	3					1.0
<i>Quercus laurifolia</i>	34	24			5	5.0	
<i>Quercus lyrata</i>	6	4					2.0
<i>Quercus michauxii</i>	21	10		1	3	2.0	5.0
<i>Quercus nigra</i>	23	16			3	2.0	2.0
<i>Sambucus nigra</i>	10	6				4.0	
<i>Ulmus americana</i>	33	26		1		5.0	1.0
<b>TOT:</b>	<b>12</b>	<b>232</b>	<b>2</b>	<b>2</b>	<b>17</b>	<b>31.0</b>	<b>14.0</b>

<b>Table 6: Damage by Plot</b>							
<b>Plot</b>	<b>All Damage Categories</b>	<b>No Damage</b>	<b>Human Trampled</b>	<b>Insects</b>	<b>Unknown</b>	<b>Vine Strangulation</b>	<b>(Other Damage)</b>
Plot 1	14	2			4	7	1
Plot 2	11	7			2	2	
Plot 3	18	10		1	7		
Plot 4	14	13				1	
Plot 5	16	3				11	2.0
Plot 6	12	10			2		
Plot 7	14	13				1	
Plot 8	14	6				7	1.0
Plot 9	18	18					
Plot 10	12	9		1	1	1	
Plot 11	15	15					
Plot 12	14	14					
Plot 13	15	15					
Plot 14	14	12	1				1.0
Plot 15	15	7				1	7.0
Plot 16	16	12	1		1		2.0
<b>TOT:</b>	<b>16</b>	<b>232</b>	<b>166</b>	<b>2</b>	<b>2</b>	<b>17</b>	<b>14.0</b>

**Table 7: Planted Stems by Plot and Species Type**

Species	Total Planted Stems	# plots	Average Number of Stems	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15	Plot 16	
Liriodendron tulipifera	16	5	3			3	3	4		4									2	
Morella cerifera	11	5	2	2		4					1.0		3.0	1.0						
Nyssa biflora	16	6	3		1	3					7.0		3.0			1			1	
Persea palustris	3	2	2														1		2	
Quercus alba	2	1	2															2		
Quercus laurifolia	6	4	2	3	1	1					1.0									
Quercus lyrata	3	2	2														1		2	
Quercus michauxii	13	5	3	3		2			2	2								4		
Quercus nigra	8	6	1	1		2		2			1			1				1		
Sambucus nigra	7	2	4					4		3										
Ulmus americana	15	7	2		1		3	3		1			2	3				2		
<b>TOT:</b>	<b>11</b>	<b>100</b>	<b>11</b>		<b>9</b>	<b>3</b>	<b>15</b>	<b>6</b>	<b>13</b>	<b>2</b>	<b>10</b>	<b>10</b>		<b>8</b>	<b>5</b>		<b>1</b>	<b>2</b>	<b>9</b>	<b>7</b>

# **Appendix 3**

## **Vegetation Plot and Site Photos**



VEGETATION PLOT 1 - Facing Macedonia Road on the northwestern portion of the subject property



VEGETATION PLOT 2 - Facing Macedonia Road on the northwestern portion of the subject property

McADAMS

PROJECT NO. EEP-06010

FILENAME: YEAR-1 PHOTOS

SCALE: NTS

DATE: 11-24-08



**UT PEMBROKE**  
**YEAR-1 MONITORING PHOTOS**  
**CHOWAN COUNTY, NORTH CAROLINA**



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VEGETATION PLOT 3 - Facing intersection of Macedonia Road and Wildcat Road



VEGETATION PLOT 4 - Facing intersection of Macedonia Road and Wildcat Road on northeastern portion of subject property

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VEGETATION PLOT 5 - Facing Macedonia Road on western portion of the subject property



VEGETATION PLOT 6 - Facing Macedonia Road on central portion of the subject property

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VEGETATION PLOT 7 - Facing Macedonia Road on western portion of subject property



VEGETATION PLOT 8 - Facing Macedonia Road on central portion of subject property just north of main road

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VEGETATION PLOT 9 - Facing Macedonia Road on western portion of property near pond



VEGETATION PLOT 10 - Facing Macedonia Road just southwest of intersection of main road and dirt access road

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VEGETATION PLOT II - Facing Macedonia Road just south of Plot 9 near pond



VEGETATION PLOT I2 - Facing Macedonia Road just south of pond

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VEGETATION PLOT 13 - Facing Macedonia Road on southwestern portion of subject property



VEGETATION PLOT 14 - Facing Macedonia Road on southwestern portion of subject property

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VEGETATION PLOT 15 - Facing east on southeastern portion of subject property



VEGETATION PLOT 16 - Facing Macedonia Road on southwestern portion of subject property

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Road Crossing Type B - Station 30+50



Road Crossing Type C - Station 32+50

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First Road Crossing Type A - Station 50+75 - Facing east toward Macedonia Road



Second Road Crossing Type A - Station 17+75 - Facing east toward Macedonia Road

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Grade Transition - Facing Downstream



Grade Transition - Facing Upstream

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Problem Area 1 - Cattail (*Typha latifolia*) Encroachment. Stationing from 21+00 to 25+00.



Problem Area 2 - Damaged Veg Plot 16

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Problem Area 3 - Damaged Veg Plots 13 and 14



Problem Area 4 - Excess Water at Veg Plot 12

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Problem Area 5 - Competitive species dominating planted woody stem species

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**Appendix 4**  
**Groundwater Monitoring**  
**Summary**

**Appendix 4. Groundwater Monitoring Summary**  
**Depth to Water from Ground Surface (inches)**  
**UT to Pembroke Creek**

Well Cross Section	Well	Apr-06			May-06			Jun-06			Jul-06		
		High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.
Cross Section 1	MW 1	-33	-38	-41	-18	-32	-41	0	-13	-39	-12	-25	-28
	MW 2	No Data	No Data	No Data	-41	-41	-41	-8	-28	-41	-27	-40	-41
	MW 3	-30	-32	-33	-26	-31	-34	-12	-24	-35	-25	-30	-31
Cross Section 2	MW 4	-28	-31	-34	-13	-27	-35	-4	-14	-32	-16	-21	-22
	MW 5	-21	-23	-26	-8	-20	-26	-3	-11	-22	-13	-17	-18
	MW 6	-20	-24	-27	-2	-19	-28	2	-5	-26	-6	-18	-20
Cross Section 3	MW 7	-16	-18	-20	0	-14	-21	3	-5	-19	-7	-13	-14
	MW 8	-27	-33	-37	-3	-27	-38	1	-12	-36	-14	-27	-29
	MW 9	-28	-35	-40	-9	-30	-41	0	-12	-38	-16	-32	-34
Cross Section 4	MW 10	-15	-19	-22	-1	-14	-23	1	-7	-22	-8	-19	-21
	MW 11	-13	-17	-19	-3	-13	-20	3	-5	-18	-7	-17	-18
	MW 12	-16	-24	-31	-11	-28	-39	-2	-13	-40	-12	-30	-32
Cross Section 5	MW 13	-30	-34	-37	-21	-31	-39	-2	-16	-36	-17	-28	-30
	MW 14	-41	-41	-41	-37	-41	-41	-17	-30	-41	-31	-40	-41
	MW 15	-11	-17	-22	-9	-17	-26	-2	-8	-28	-6	-8	-9
Reference 1	MW 16	-1	-1	-2	1	-3	-13	5	1	-16	3	2	0
Reference 2	MW 17	-42	-42	-42	-26	-41	-42	2	-5	-10	1	-8	-20
Reference 3	MW 18	-42	-42	-42	-27	-41	-42	0	-9	-16	1	-13	-23

Shaded area indicates groundwater is within 12 inches of ground surface.

Monitoring well locations are provided on Sheet 3 - Post Construction Conditions

**Appendix 4. Groundwater Monitoring Summary**  
**Depth to Water from Ground Surface (inches)**  
**UT to Pembroke Creek**

Well Cross Section	Well	Aug-06			Dec-06			Jan-07			Feb-07		
		High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.
Cross Section 1	MW 1	-23	-30	-35	-9	-22	-30	-10	-22	-30	-13	-24	-30
	MW 2	-40	-40	-41	-28	-39	-41	-26	-38	-41	-33	-39	-41
	MW 3	-30	-32	-33	-19	-26	-29	-19	-26	-29	-24	-28	-29
Cross Section 2	MW 4	-21	-25	-28	-2	-17	-22	-3	-16	-23	-4	-17	-24
	MW 5	-16	-19	-22	-7	-13	-16	-10	-13	-16	-10	-14	-16
	MW 6	-12	-19	-24	0	-9	-17	0	-5	-13	0	-8	-14
Cross Section 3	MW 7	-8	-12	-16	0	-5	-7	-1	-5	-7	-1	-6	-9
	MW 8	-18	-25	-30	0	-16	-26	0	-7	-21	0	-9	-19
	MW 9	-22	-30	-36	-3	-20	-28	-3	-15	-25	-4	-18	-25
Cross Section 4	MW 10	-13	-20	-25	0	-5	-11	0	-2	-6	0	-5	-12
	MW 11	-10	-17	-23	0	-4	-7	1	-3	-5	-1	-5	-10
	MW 12	-24	-32	-37	-3	-9	-13	-2	-6	-10	-3	-7	-10
Cross Section 5	MW 13	-26	-31	-35	-14	-25	-30	-14	-23	-28	-13	-23	-26
	MW 14	-41	-41	-41	-31	-38	-41	-29	-37	-41	-33	-37	-40
	MW 15	-8	-16	-23	-5	-7	-8	-4	-7	-7	-6	-8	-9
Reference 1	MW 16	2	0	-4	4	4	3	4	3	2	3	2	2
Reference 2	MW 17	-5	-7	-11	1	0	-1	3	0	-1	1	-1	-1
Reference 3	MW 18	-8	-14	-18	2	0	-2	3	2	1	2	2	2

Shaded area indicates groundwater is within 12 inches of ground surface.

Monitoring well locations are provided on Sheet 3 - Post Construction Conditions

**Appendix 4. Groundwater Monitoring Summary**  
**Depth to Water from Ground Surface (inches)**  
**UT to Pembroke Creek**

Well Cross Section	Well	Mar-07			Apr-07			May-07			Jun-07		
		High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.
Cross Section 1	MW 1	-17	-28	-35	-7	-38	-42	No Data	No Data	No Data	No Data	No Data	No Data
	MW 2	-37	-40	-41	-19	-38	-40	-40	-40	-41	-39	-40	-40
	MW 3	-23	-29	-31	-16	-29	-33	-31	-34	-38	-38	-39	-39
Cross Section 2	MW 4	-10	-22	-26	-2	-23	-30	-27	-32	-36	-36	-36	-36
	MW 5	-11	-16	-19	-5	-18	-22	-20	-25	-29	-28	-33	-35
	MW 6	2	-12	-21	1	-17	-26	-22	-28	-34	-27	-35	-36
Cross Section 3	MW 7	-1	-9	-14	1	-13	-19	-18	-22	-27	-26	-31	-36
	MW 8	-1	-14	-24	0	-20	-31	-24	-32	-36	-23	-33	-36
	MW 9	-11	-24	-32	-2	-27	-36	-33	-34	-35	-33	-35	-35
Cross Section 4	MW 10	0	-12	-21	0	-18	-25	-23	-25	-30	-28	-33	-36
	MW 11	-1	-9	-16	1	-14	-22	-14	-21	-29	-22	-29	-31
	MW 12	-4	-11	-18	-3	-19	-29	-31	-36	-37	-37	-37	-37
Cross Section 5	MW 13	-20	-27	-32	-14	-31	-37	-35	-37	-38	-37	-37	-38
	MW 14	-36	-40	-41	-30	-39	-41	-41	-41	-41	-40	-41	-41
	MW 15	-7	-9	-10	-5	-11	-18	-20	-26	-32	-32	-34	-35
Reference 1	MW 16	3	2	2	4	2	0	0	-11	-26	-20	-28	-30
Reference 2	MW 17	0	-1	-1	3	-1	-3	0	-5	-14	-4	-15	-25
Reference 3	MW 18	3	2	2	5	0	-7	-4	-11	-21	-14	-24	-30

Shaded area indicates groundwater is within 12 inches of ground surface.

Monitoring well locations are provided on Sheet 3 - Post Construction Conditions

**Appendix 4. Groundwater Monitoring Summary**  
**Depth to Water from Ground Surface (inches)**  
**UT to Pembroke Creek**

Well Cross Section	Well	Jul-07			Aug-07			Sep-07			Oct-07		
		High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.
Cross Section 1	MW 1	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	MW 2	-40	-40	-40	-38	-40	-41	-41	-41	-42	-42	-42	-42
	MW 3	-39	-39	-39	-39	-41	-41	-41	-41	-41	-41	-41	-42
Cross Section 2	MW 4	-36	-36	-36	-36	-37	-38	-38	-40	-41	-40	-41	-41
	MW 5	-35	-35	-35	-35	-40	-41	-41	-41	-42	-41	-41	-41
	MW 6	-36	-36	-36	-36	-38	-39	-38	-39	-39	-39	-39	-40
Cross Section 3	MW 7	-33	-36	-36	-36	-40	-42	-41	-41	-42	-41	-41	-42
	MW 8	-28	-34	-36	-35	-40	-41	-41	-41	-42	-41	-41	-41
	MW 9	-35	-35	-35	-35	-36	-38	-38	-40	-41	-41	-41	-41
Cross Section 4	MW 10	-36	-36	-37	-36	-37	-37	-37	-38	-41	-41	-41	-41
	MW 11	-30	-31	-32	-32	-38	-41	-41	-41	-42	-41	-41	-41
	MW 12	-36	-36	-37	-34	-35	-36	-34	-36	-36	-36	-37	-37
Cross Section 5	MW 13	-37	-38	-38	-38	-40	-41	-41	-41	-41	-41	-41	-41
	MW 14	-40	-41	-41	-40	-40	-40	No Data *	No Data	No Data	No Data	No Data	No Data
	MW 15	-35	-35	-36	-35	-37	-37	-37	-37	-38	-38	-38	-39
Reference 1	MW 16	-28	-30	-30	-29	-30	-30	-29	-30	-30	-30	-30	-31
Reference 2	MW 17	-8	-22	-30	1	-21	-31	-5	-16	-26	-1	-11	-20
Reference 3	MW 18	-29	-33	-37	-12	-35	-38	-34	-38	-40	-38	-40	-40

\* MW 14 destroyed during vegetative trimming.

Shaded area indicates groundwater is within 12 inches of ground surface.  
 Monitoring well locations are provided on Sheet 3 - Post Construction Conditions



**Appendix 4. Groundwater Monitoring Summary**  
**Depth to Water from Ground Surface (inches)**  
**UT to Pembroke Creek**

Well Cross Section	Well	Nov-07			Dec-07			Jan-08			Feb-08		
		High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.
Cross Section 1	MW 1	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	MW 2	-41	-41	-41	-39	-40	-41	-40	-40	-41	-29	-38	-40
	MW 3	-41	-41	-42	-36	-40	-41	-37	-40	-41	-22	-33	-40
Cross Section 2	MW 4	-37	-38	-39	-43	-43	-43	-43	-43	-43	-43	-43	-43
	MW 5	-38	-38	-38	-33	-38	-38	-38	-38	-38	-10	-27	-38
	MW 6	-36	-37	-37	-26	-36	-37	-35	-36	-37	-6	-25	-37
Cross Section 3	MW 7	-37	-37	-38	-12	-30	-38	-13	-26	-32	5	-11	-31
	MW 8	-37	-39	-41	-35	-40	-41	-39	-40	-40	-9	-29	-40
	MW 9	-27	-34	-36	-21	-30	-37	-21	-29	-33	-6	-20	-31
Cross Section 4	MW 10	-34	-36	-37	-14	-29	-37	-15	-19	-23	6	-5	-19
	MW 11	-38	-38	-38	-22	-35	-38	-22	-25	-30	5	-12	-27
	MW 12	-37	-37	-37	-37	-37	-37	-37	-37	-37	-12	-31	-37
Cross Section 5	MW 13	-38	-39	-39	-38	-39	-39	-38	-38	-39	-16	-31	-38
	MW 14	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	MW 15	-35	-35	-35	-28	-34	-35	-28	-31	-33	2	-17	-30
Reference 1	MW 16	-30	-31	-31	-24	-30	-31	-24	-28	-31	1	-13	-27
Reference 2	MW 17	-2	-6	-8	-1	-4	-6	-1	-3	-4	1	-2	-4
Reference 3	MW 18	-37	-39	-40	-31	-34	-37	-17	-28	-32	2	-9	-24

Shaded area indicates groundwater is within 12 inches of ground surface.

Monitoring well locations are provided on Sheet 3 - Post Construction Conditions

**Appendix 4. Groundwater Monitoring Summary**  
**Depth to Water from Ground Surface (inches)**  
**UT to Pembroke Creek**

Well Cross Section	Well	Mar-08			Apr-08			May-08			Jun-08		
		High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.
Cross Section 1	MW 1	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	MW 2	-18	-26	-31	-18	-26	-30	-22	-28	-33	-32	-36	-37
	MW 3	-18	-22	-24	-18	-22	-24	-22	-26	-33	-31	-36	-37
Cross Section 2	MW 4	-43	-43	-43	-43	-43	-43	-43	-43	-43	-43	-43	-43
	MW 5	-8	-12	-15	-8	-11	-15	-10	-15	-20	-18	-29	-36
	MW 6	-5	-9	-16	-4	-10	-16	-9	-17	-24	-18	-31	-37
Cross Section 3	MW 7	6	6	4	6	6	5	7	6	0	3	-18	-30
	MW 8	-8	-11	-16	-7	-11	-15	-10	-17	-24	-23	-31	-34
	MW 9	-5	-7	-11	-4	-6	-10	-7	-13	-21	-18	-29	-33
Cross Section 4	MW 10	7	7	6	8	7	7	9	8	8	10	10	9
	MW 11	6	5	5	7	6	5	7	6	6	8	0	-13
	MW 12	-2	-4	-13	-1	-3	-5	-4	-8	-13	-12	-26	-31
Cross Section 5	MW 13	-8	-15	-21	-6	-12	-18	-11	-18	-23	-21	-27	-32
	MW 14	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	MW 15	6	6	2	7	7	6	7	7	7	8	6	0
Reference 1	MW 16	5	5	1	6	6	5	6	6	6	7	3	-5
Reference 2	MW 17	1	-1	-3	2	0	-2	-2	-3	-3	No Data	No Data	No Data
Reference 3	MW 18	2	-2	-6	3	0	-3	-2	-6	-9	No Data	No Data	No Data

Shaded area indicates groundwater is within 12 inches of ground surface.

Monitoring well locations are provided on Sheet 3 - Post Construction Conditions

**Appendix 4. Groundwater Monitoring Summary**  
**Depth to Water from Ground Surface (inches)**  
**UT to Pembroke Creek**

Well Cross Section	Well	Jul-08			Aug-08			Sep-08			Oct-08		
		High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.
Cross Section 1	MW 1	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	MW 2	-19	-29	-37	-28	-34	-37	-21	-34	-36	-36	-36	-36
	MW 3	-18	-29	-37	-28	-35	-37	-32	-37	-37	-37	-37	-37
Cross Section 2	MW 4	-43	-43	-43	-43	-43	-43	-43	-43	-43	-43	-43	-43
	MW 5	-7	-15	-36	-10	-19	-31	-23	-34	-37	-36	-37	-37
	MW 6	-1	-15	-37	-11	-25	-36	-29	-37	-38	-37	-37	-38
Cross Section 3	MW 7	8	0	-32	8	-4	-21	-15	-26	-32	-32	-34	-35
	MW 8	-6	-16	-33	-13	-27	-34	-29	-33	-35	-35	-35	-36
	MW 9	-4	-12	-32	-11	-25	-33	-25	-33	-35	-35	-36	-36
Cross Section 4	MW 10	10	9	9	10	9	9	10	9	8	9	7	6
	MW 11	7	1	-16	7	5	-3	4	-7	-14	-14	-17	-19
	MW 12	-12	-27	-31	-26	-30	-31	-30	-31	-32	-32	-32	-32
Cross Section 5	MW 13	-5	-16	-33	-16	-30	-37	-36	-37	-37	-37	-38	-38
	MW 14	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
	MW 15	7	3	-2	6	1	-7	-7	-15	-21	-22	-25	-27
Reference 1	MW 16	5	-1	-18	3	-8	-27	-20	-28	-30	-30	-30	-30
Reference 2	MW 17	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Reference 3	MW 18	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data

Shaded area indicates groundwater is within 12 inches of ground surface.

Monitoring well locations are provided on Sheet 3 - Post Construction Conditions

Well Cross Section	Well	'06 to '08 Averages		
		High.	Avg.	Low.
Cross Section 1	MW 1	-14	-27	-35
	MW 2	-31	-37	-39
	MW 3	-28	-33	-35
Cross Section 2	MW 4	-29	-34	-36
	MW 5	-19	-25	-29
	MW 6	-16	-24	-30
Cross Section 3	MW 7	-10	-17	-23
	MW 8	-18	-26	-33
	MW 9	-18	-26	-32
Cross Section 4	MW 10	-8	-13	-17
	MW 11	-9	-15	-20
	MW 12	-19	-25	-29
Cross Section 5	MW 13	-24	-30	-34
	MW 14	-35	-39	-41
	MW 15	-12	-16	-20
Reference 1	MW 16	-7	-11	-15
Reference 2	MW 17	-3	-9	-13
Reference 3	MW 18	-12	-18	-22

**Appendix 5**  
**Cross Section Groundwater**  
**Elevations and Rainfall Data**

**Table 1. Groundwater Gauges Meeting 5% Success Criteria**

Well	Consecutive Days Above -12 Inches within Growing Season			GW Gauges meeting 5% Criteria		
	2006	2007	2008	2006	2007	2008
MW 1	7	1	0	---	---	---
MW 2	2	0	0	---	---	---
MW 3	1	0	0	---	---	---
MW 4	4	3	0	---	---	---
MW 5	6	3	11	---	---	---
MW 6	17	7	12	MW 6	---	---
MW 7	33	12	87	MW 7	---	MW 7
MW 8	5	7	11	---	---	---
MW 9	14	3	51	MW 9	---	MW 9
MW 10	15	7	207	MW 10	---	MW 10
MW 11	17	11	107	MW 11	---	MW 11
MW 12	9	8	77	---	---	MW 12
MW 13	5	0	10	---	---	---
MW 14	0	0	0	---	---	---
MW 15	61	23	174	MW 15	MW 15	MW 15
MW 16 - REF 1	66	67	112	MW 16	MW 16	MW 16
MW 17 - REF 2	37	77	54	MW 17	MW 17	MW 17
MW 18 - REF 3	10	68	54	---	MW 18	MW 18

**Table 2. Rainfall Data for Edenton, NC**

Station: 312635 - Edenton
Station type: COOP - TP
Date of first observation: January 1, 1933
City, State: Edenton, NC County: Chowan County
Latitude: 36.0622222222222°
Longitude: -76.6102777777778°
Elevation: 20 feet above sea level
Climate division: NC08 - Northern Coastal Plain
River basin: Albemarle
Supported by: NOAA National Weather Service

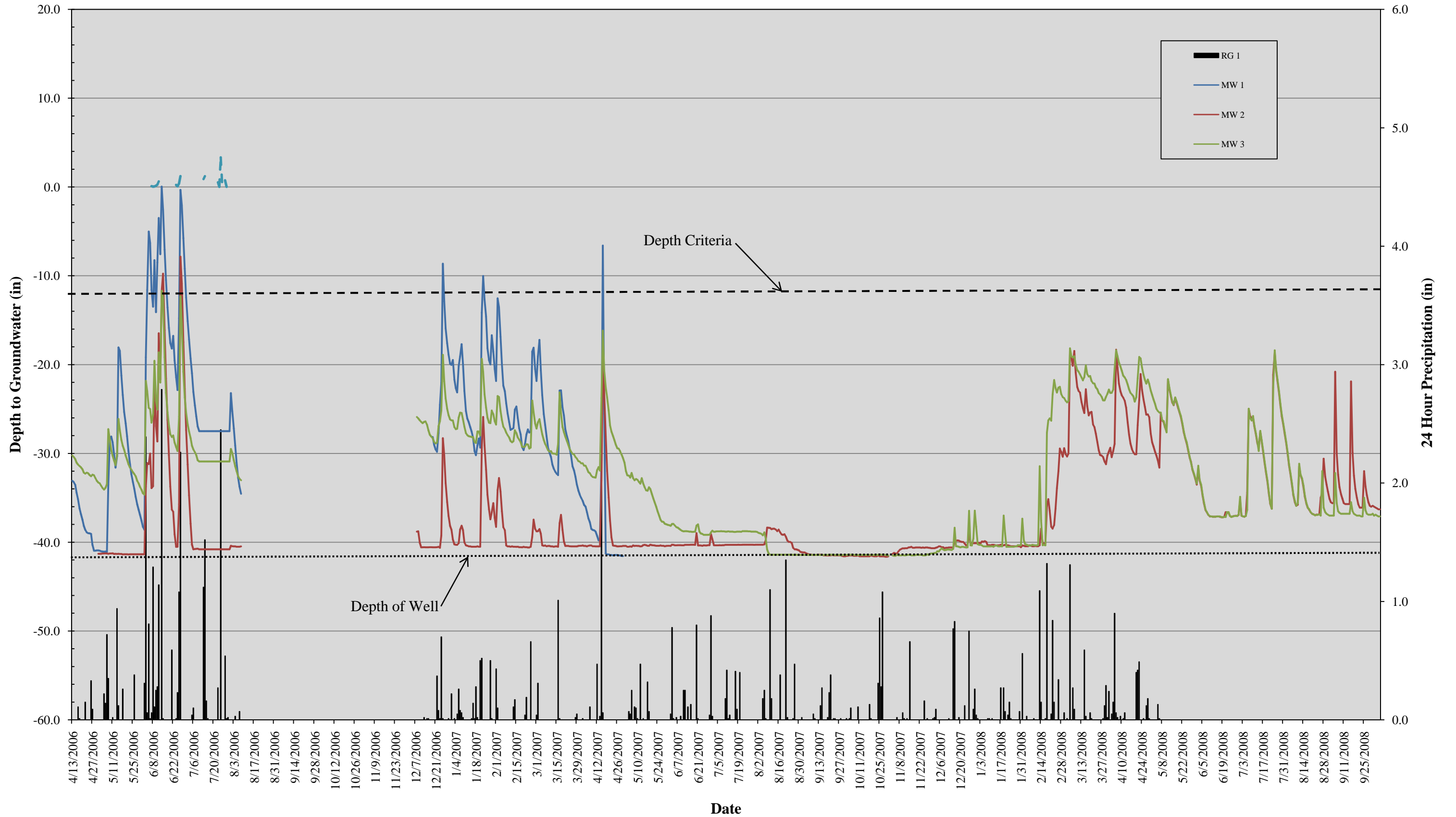
Month-Year	Days Recorded	Rainfall (inches)
Jan-06	31 (100%)	3.34
Feb-06	28 (100%)	1.11
Mar-06	31 (100%)	1.45
Apr-06	30 (100%)	3.2
May-06	31 (100%)	4.71
Jun-06	30 (100%)	12.68
Jul-06	31 (100%)	7.31
Aug-06	31 (100%)	2.66
Sep-06	30 (100%)	7.3
Oct-06	31 (100%)	3.07
Nov-06	30 (100%)	8
Dec-06	31 (100%)	1.83
Jan-07	31 (100%)	3.69
Feb-07	28 (100%)	1.83
Mar-07	31 (100%)	1.13
Apr-07	30 (100%)	1.97
May-07	31 (100%)	2.65
Jun-07	30 (100%)	4.37
Jul-07	31 (100%)	1.53
Aug-07	31 (100%)	4.08
Sep-07	30 (100%)	2.26
Oct-07	31 (100%)	0
Nov-07	30 (100%)	0.76
Dec-07	31 (100%)	5.68
Jan-08	31 (100%)	2.06
Feb-08	29 (100%)	7.97
Mar-08	31 (100%)	3.9
Apr-08	30 (100%)	8.91
May-08	31 (100%)	6.98
Jun-08	30 (100%)	3.25
Jul-08	31 (100%)	13.97
Aug-08	31 (100%)	4.98
Sep-08	30 (100%)	6.32
Oct-08	31 (100%)	3.34
Nov-08	30 (100%)	11.49
Dec-08	9 (29%)	0.79

**Table 3. Recorded On-Site Rainfall Data (inches)**

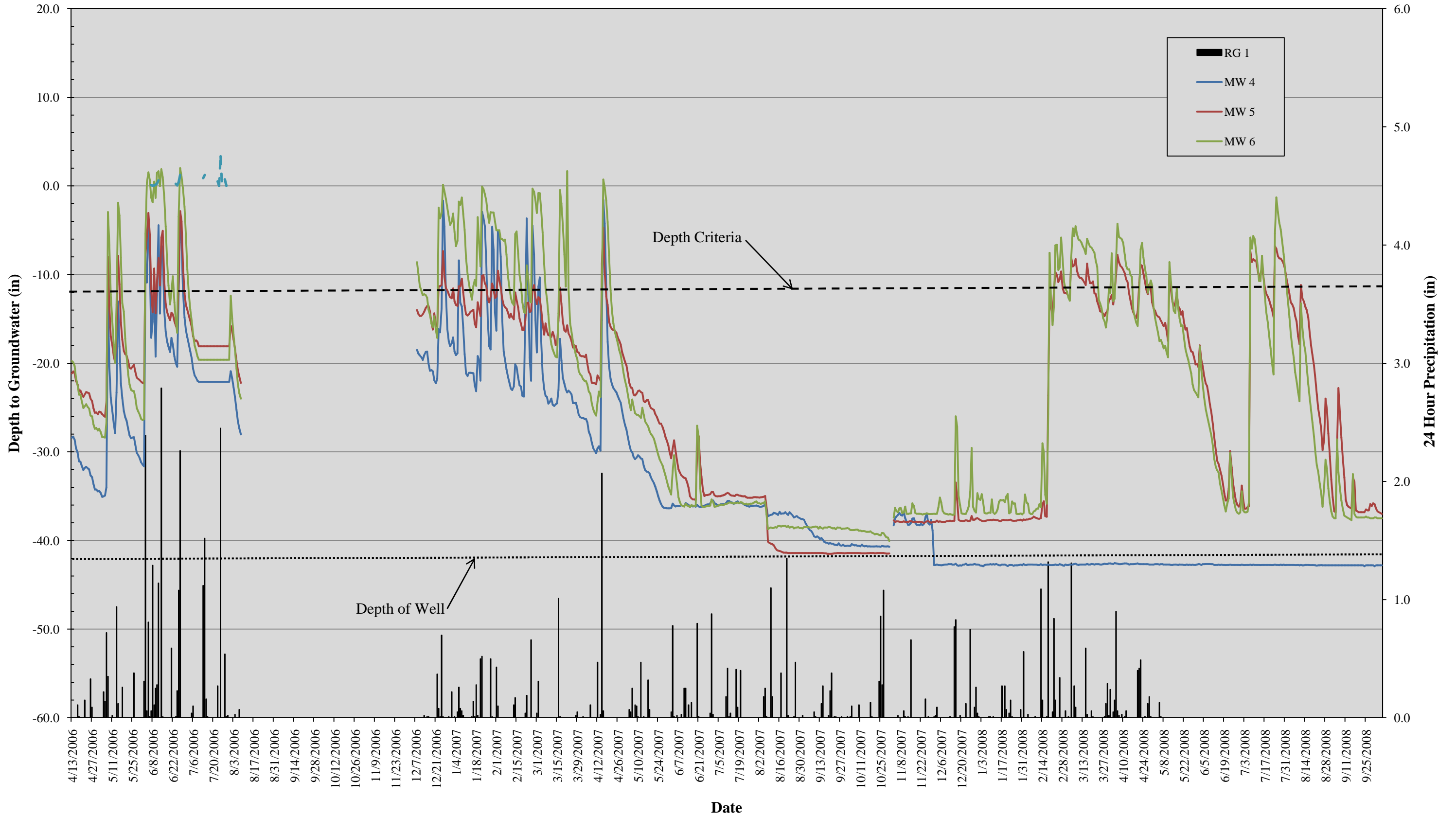
Date	RG 1	Date	RG 1	Date	RG 1	Date	RG 1	Date	RG 1
4/17/2006	0.11	12/13/2006	0.02	5/5/2007	0.05	9/19/2007	0.02	1/30/2008	0.07
4/18/2006	0.01	12/15/2006	0.01	5/6/2007	0.25	9/20/2007	0.23	2/1/2008	0.56
4/22/2006	0.15	12/16/2006	0.01	5/8/2007	0.11	9/21/2007	0.38	2/4/2008	0.03
4/26/2006	0.33	12/22/2006	0.37	5/9/2007	0.1	9/23/2007	0.01	2/9/2008	0.01
4/27/2006	0.09	12/23/2006	0.08	5/10/2007	0.01	9/24/2007	0.01	2/13/2008	1.09
5/5/2006	0.22	12/24/2006	0.01	5/12/2007	0.47	9/28/2007	0.01	2/14/2008	0.15
5/6/2006	0.14	12/25/2006	0.7	5/14/2007	0.01	10/2/2007	0.01	2/17/2008	0.01
5/7/2006	0.72	12/26/2006	0.01	5/17/2007	0.32	10/4/2007	0.01	2/18/2008	1.32
5/8/2006	0.35	12/30/2006	0.01	5/18/2007	0.07	10/5/2007	0.1	2/21/2008	0.05
5/11/2006	0.02	1/1/2007	0.22	6/2/2007	0.05	10/10/2007	0.11	2/22/2008	0.84
5/14/2006	0.94	1/3/2007	0.01	6/3/2007	0.78	10/18/2007	0.13	2/23/2008	0.15
5/15/2006	0.12	1/5/2007	0.05	6/4/2007	0.01	10/19/2007	0.01	2/26/2008	0.34
5/18/2006	0.26	1/6/2007	0.26	6/6/2007	0.02	10/24/2007	0.31	3/1/2008	0.06
5/26/2006	0.38	1/7/2007	0.08	6/9/2007	0.03	10/25/2007	0.86	3/3/2008	0.01
6/2/2006	0.31	1/8/2007	0.06	6/11/2007	0.25	10/26/2007	0.28	3/5/2008	1.31
6/3/2006	2.39	1/9/2007	0.02	6/12/2007	0.25	10/27/2007	1.08	3/7/2008	0.27
6/4/2006	0.06	1/15/2007	0.01	6/14/2007	0.11	11/6/2007	0.02	3/8/2008	0.09
6/5/2006	0.81	1/16/2007	0.14	6/16/2007	0.13	11/10/2007	0.06	3/15/2008	0.59
6/6/2006	0.01	1/17/2007	0.01	6/20/2007	0.8	11/11/2007	0.01	3/16/2008	0.03
6/7/2006	0.06	1/18/2007	0.28	6/21/2007	0.01	11/13/2007	0.01	3/19/2008	0.06
6/8/2006	1.29	1/19/2007	0.02	6/29/2007	0.04	11/15/2007	0.66	3/20/2008	0.01
6/9/2006	0.11	1/21/2007	0.5	6/30/2007	0.88	11/25/2007	0.16	3/28/2008	0.01
6/10/2006	0.25	1/22/2007	0.52	7/1/2007	0.03	11/27/2007	0.01	3/29/2008	0.12
6/11/2006	0.28	1/28/2007	0.5	7/10/2007	0.18	12/1/2007	0.01	3/30/2008	0.29
6/12/2006	1.14	1/29/2007	0.01	7/11/2007	0.42	12/2/2007	0.02	3/31/2008	0.02
6/14/2006	2.79	2/1/2007	0.43	7/12/2007	0.01	12/3/2007	0.09	4/1/2008	0.24
6/15/2006	0.01	2/2/2007	0.1	7/13/2007	0.04	12/12/2007	0.01	4/3/2008	0.05
6/21/2006	0.59	2/13/2007	0.11	7/17/2007	0.41	12/15/2007	0.77	4/4/2008	0.15
6/24/2006	0.01	2/14/2007	0.17	7/18/2007	0.09	12/16/2007	0.83	4/5/2008	0.9
6/25/2006	0.23	2/21/2007	0.04	7/20/2007	0.4	12/19/2007	0.02	4/6/2008	0.06
6/26/2006	1.08	2/22/2007	0.19	8/5/2007	0.18	12/23/2007	0.12	4/7/2008	0.02
6/27/2006	2.26	2/25/2007	0.66	8/6/2007	0.25	12/26/2007	0.75	4/9/2008	0.03
7/5/2006	0.04	3/1/2007	0.04	8/7/2007	0.01	12/29/2007	0.09	4/11/2008	0.01
7/6/2006	0.1	3/2/2007	0.31	8/10/2007	1.1	12/30/2007	0.26	4/12/2008	0.06
7/13/2006	1.12	3/16/2007	1.01	8/11/2007	0.18	12/31/2007	0.04	4/20/2008	0.4
7/14/2006	1.52	3/17/2007	0.01	8/17/2007	0.38	1/1/2008	0.01	4/21/2008	0.42
7/15/2006	0.16	3/28/2007	0.02	8/21/2007	1.35	1/8/2008	0.01	4/22/2008	0.49
7/16/2006	0.01	3/29/2007	0.05	8/22/2007	0.02	1/9/2008	0.01	4/25/2008	0.01
7/23/2006	0.27	4/2/2007	0.01	8/26/2007	0.01	1/11/2008	0.01	4/27/2008	0.12
7/25/2006	2.45	4/7/2007	0.11	8/27/2007	0.47	1/17/2008	0.27	4/28/2008	0.18
7/28/2006	0.54	4/12/2007	0.47	9/1/2007	0.02	1/19/2008	0.27	4/29/2008	0.01
7/29/2006	0.01	4/14/2007	0.03	9/9/2007	0.05	1/20/2008	0.07	5/5/2008	0.13
7/30/2006	0.02	4/15/2007	2.07	9/10/2007	0.01	1/22/2008	0.04	5/6/2008	0.01
8/4/2006	0.03	4/16/2007	0.06	9/14/2007	0.12	1/23/2008	0.15		
8/7/2006	0.07	5/4/2007	0.07	9/15/2007	0.27	1/24/2008	0.01		



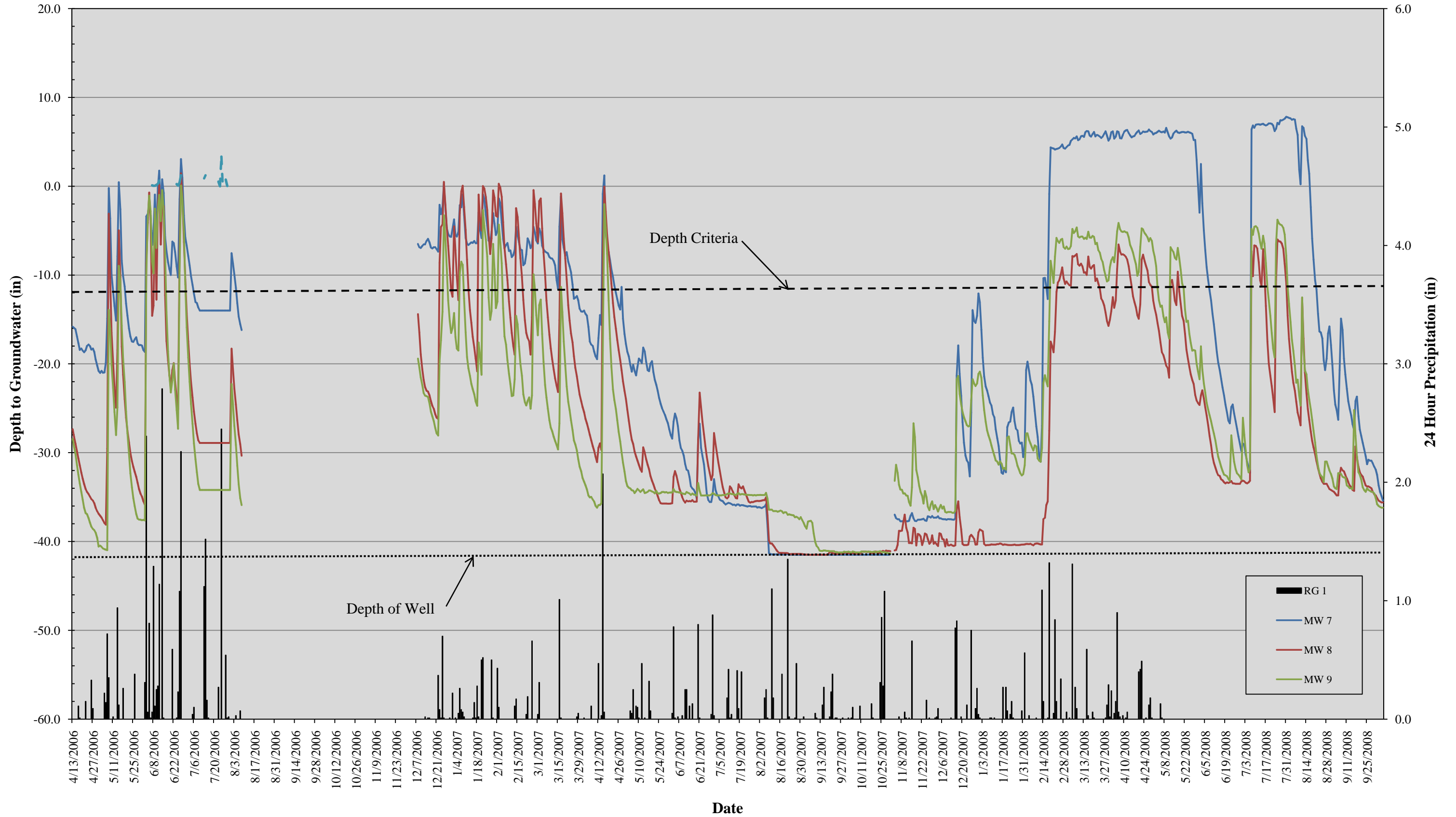
### Well Cross Section 1 Groundwater Elevations and Rainfall Data



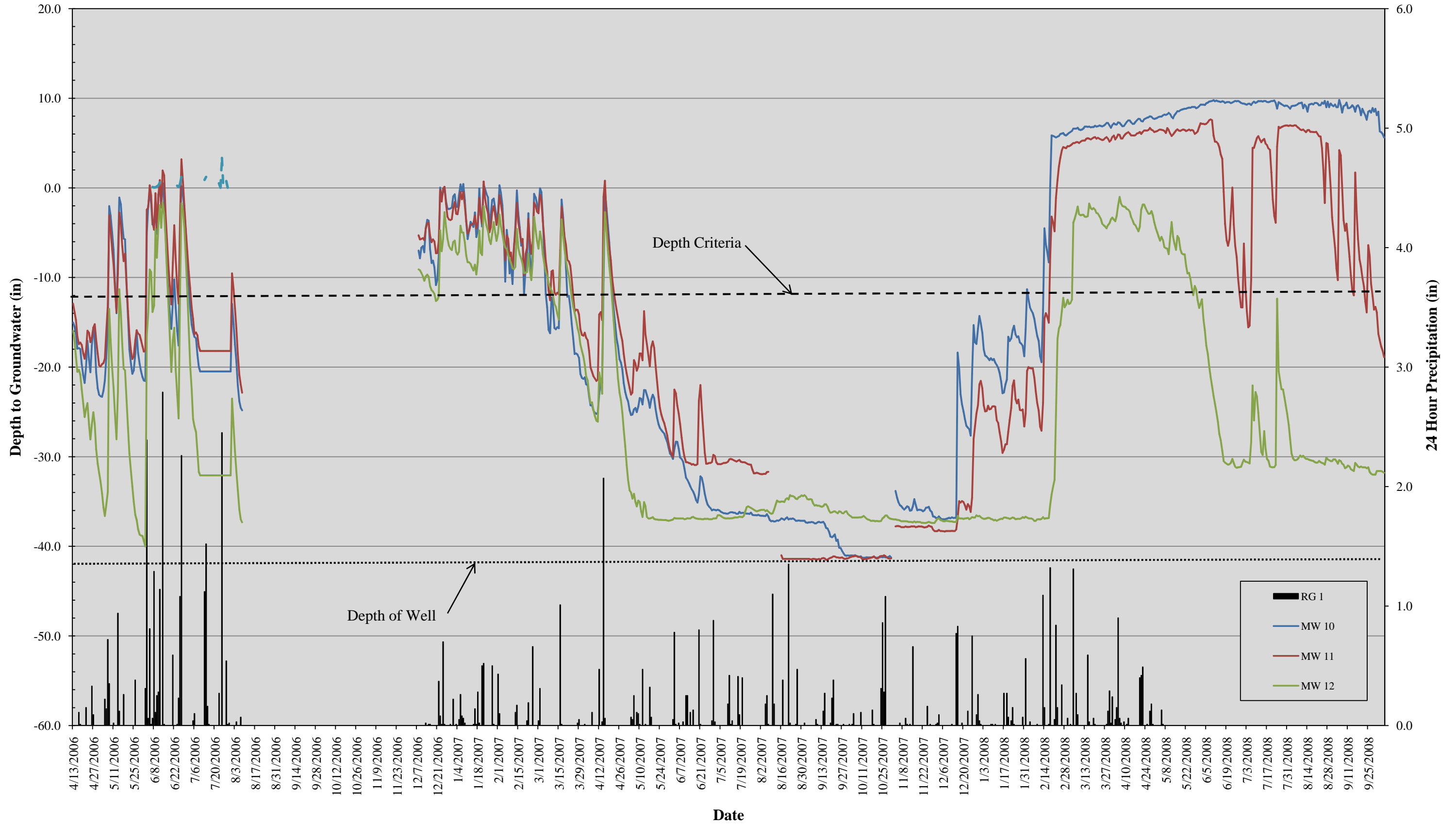
### Well Cross Section 2 Groundwater Elevations and Rainfall Data



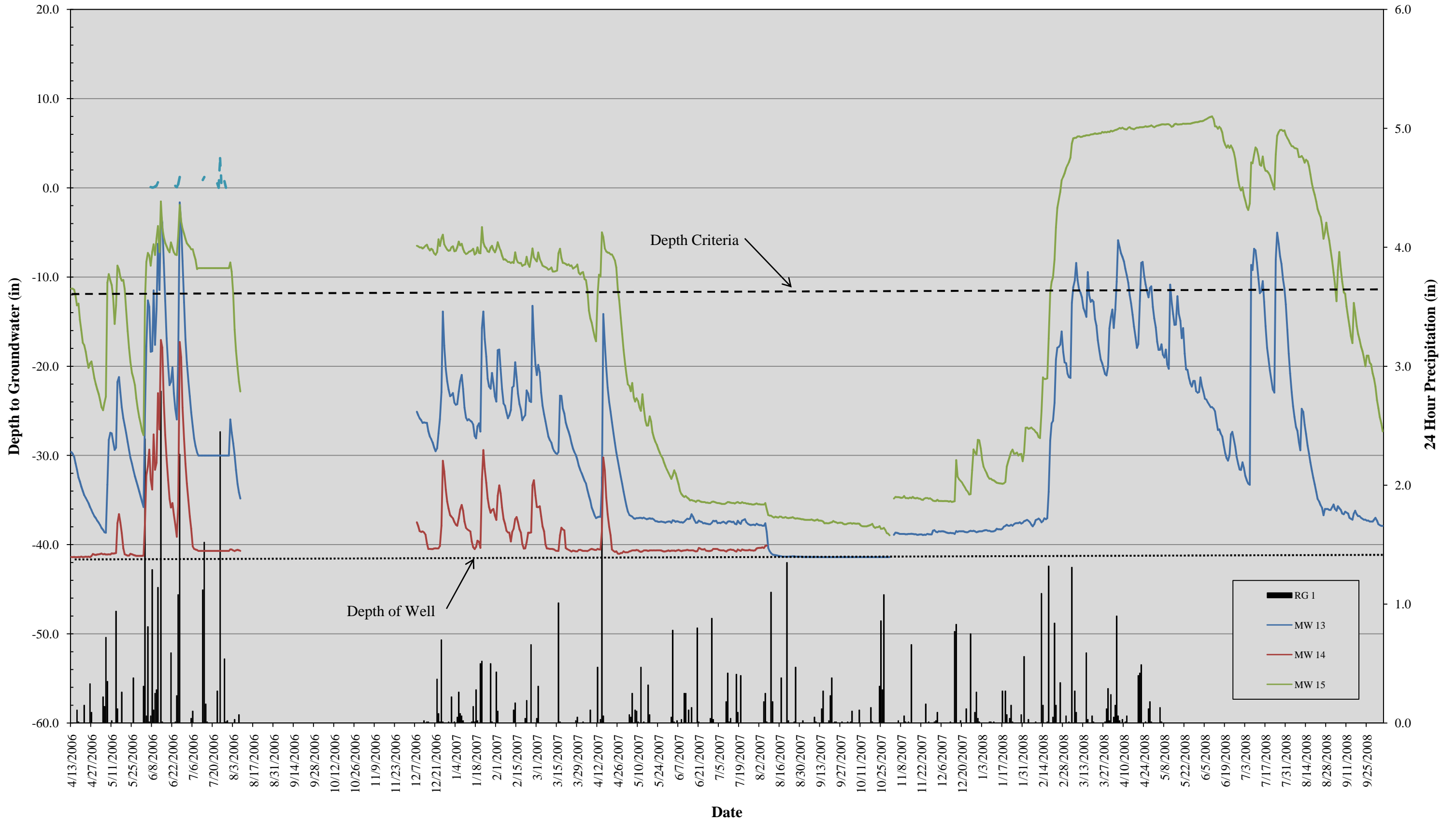
### Well Cross Section 3 Groundwater Elevations and Rainfall Data



### Well Cross Section 4 Groundwater Elevations and Rainfall Data



### Well Cross Section 5 Groundwater Elevations and Rainfall Data



### Reference Sites Groundwater Elevations and Rainfall Data

