Carteret-Craven Electrical Cooperative
Wetland Restoration
Morehead City, Onslow County, North Carolina

Year 4 of 5 Annual Monitoring Report
2005

Prepared for: NCDEHNR/Ecosystem Enhancement Program
1619 Mail Service Center
Raleigh, NC 27699-1619

Site Design: Soil and Environmental Consultants, PA.
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Raleigh, NC 27614

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December 2005

Ecosystem Enhancement PROGRAM

NCDENR

NC STATE UNIVERSITY

Carteret-Craven Electrical Cooperative (CCEC)
Wetlands Restoration Site (Jumping Run Creek)
Fall 2005 Monitoring Summary

A wetland restoration project was funded through the North Carolina Wetlands Restoration Program (NCWRP). The goals of the project are to:

1) Reduce nutrient inputs to estuarine system.
2) Contribute to effort to reopen closed shellfish waters.
3) Provide educational opportunities to show the importance of wetlands for water quality.

This is the 4th year of the 5-year monitoring plan for the completed CCEC Site.

Table 1. Background Information

Project Name	Carteret-Craven Electrical Cooperative Wetlands Restoration Site (Jumping Run Creek)
Designer's Name	Soil and Environmental Consultants, PA. 11010 Raven Ridge Rd. Raleigh, NC 27614
Contractor's Name	East Cell – NC Department of Transportation West Cell - unreported
Directions to Project Site	The site is located at the Carteret-Craven Electrical Cooperative offices. The offices are located on the north side of NC-24, near Morehead City, NC.
Drainage Area	1.25 square miles
USGS Hydro Unit	03020106
NCDWQ Subbasin	03-05-03
Project Size	2.64 acres freshwater wetland restoration
Restoration Approach	Expand existing road ditches. Grade areas to improve hydrology. Utilize water control structure to improve storage in upper West Cell.
Date of Completion	East Cell - Fall 2000, West Cell – Winter 2001
Monitoring Dates	November 2002, 2003, 2004, 2005

Results Summary

Overall, this site is currently meeting the proposed mitigation success criteria for vegetation and hydrology. There is some concern over invasive species in the East Cell, but not enough to recommend treatment or removal. Monitoring should continue to assess the impact of invasives on the desired tree species. An additional planting was completed in the spring of 2004 that has improved stem counts in the West Cell. However, growth of desired tree species in the West Cell appears slow.

Table 2. Summary Table of Results

Carteret-Craven Electrical Coop. Wetland
Morehead City, Onslow County, NC
Fall 2005 Monitoring Data Summary
11/9/2005

East Cell Quad 1

Tree Stratum				
Species	**Stems**	**Height (cm)**	**Density**	**Rel. Density (%)**
Nyssa aquatica	8	135.625	8	57.1
Nyssa biflora	1	152.5	1	7.1
Taxodium distichum	5	114	5.0	35.7

Planted Trees per acre	560

East Cell Quad 2

Tree Stratum				
Species		**Height (cm)**	**Density**	**Rel. Density (%)**
Nyssa aquatica	10	158.3	10.0	34.5
Pinus serotina	6	34.0	6.0	20.7
Taxodium distichum	13	116.0	13.0	44.8

Planted Trees per acre	1080

West Cell Quad 1

Tree Stratum				
Species		**Height (cm)**	**Density**	**Rel. Density (%)**
Nyssa aquatica	3	87.7	3.0	7.3
Pinus taeda	30	34.2	30.0	73.2
Taxodium distichum	7	106.0	7.0	17.1
Fraxinus sp.	1	20.0	1.0	2.4

Total Trees per acre	1640
Planted trees per acre	440
Nat. regen. trees per acre	1200

West Cell Quad 2

Tree Stratum				
Species		**Height (cm)**	**Density**	**Rel. Density (%)**
Nyssa aquatica	1	83.0	1.0	7.1
Pinus taeda	3	39.3	3.0	21.4
Taxodium distichum	10	99.8	10.0	71.4

Planted trees per acre	560
Trees per acre	480
Nat. regen. trees per acre	80

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1. 0 PROJECT BACKGROUND

1.1 Location and Setting

The project site is located on the grounds of the Carteret Craven Electrical Cooperative offices. The offices are located on the north side of NC-24, near Morehead City, NC. There are two main areas of the site. One is located on the east side of the building and a larger area is to the west of the building. Background data provided in this report was provided in a report entitled "Monitoring Report for Carteret-Craven Electrical Cooperative Wetlands". The report was prepared by Soil and Environmental Consultants, PA (S&EC) and submitted on January 2, 2003.

1.2 Structure and Objectives

The primary goals of the project, as included in the report, were to restore freshwater wetlands on the site that had been destroyed by filling and drainage activities. The wetlands would provide water quality improvements and augment habitat in the area. The goals of the project as listed by the NCWRP on their website include:

1) Reduce nutrient inputs to estuarine system.
2) Contribute to effort to reopen closed shellfish waters.
3) Provide educational opportunities to show the importance of wetlands for water quality.

Site design services were provided by S&EC. The site was constructed in two phases. The first phase consisted of construction on the eastern portion of the site. Grading for phase I was done by the North Carolina Department of Transportation (NCDOT). Construction at the site began in February of 2000 and planting was completed that summer. The second phase of construction on the site began in December of 2000. This phase of the construction was completed by a private contractor. This phase included the construction of a low head weir/bulkhead structure to control hydrology in the upper area of the site. The weir was installed during February of 2001. The west cell was planted in March and April of 2001. Some additional work was undertaken to improve conditions in the western cell in December of 2001. This work included plugging portions of the ditch, repair of erosion near the weir, and repair of damage caused by surface water flow down the banks of the wetland.

Table 3. Project Structure Table

Project: Carteret-Craven Electrical Cooperative

Segment/Reach ID	Acreage
Wetland Restoration Area	2.64 acres

Table 4. Project Objectives Table

Project: Carteret-Craven Electrical Cooperative

Segment/Reach ID	Objectives	Acreage	Comment
Wetland Restoration Area	Restoration	2.64	Reduce nutrient inputs to estuarine system. Contribute to effort to reopen closed shellfish waters. Provide educational opportunities to show the importance of wetlands for water quality.

1.3 Project History and Background

Table 5. Project Activity and Reporting History Project: Carteret-Craven Electrical Cooperative		
Activity or Report	**Calendar Year of Completion or Planned Completion**	**Actual Completion Date**
Restoration Plan	Oct 2001	Oct 2001
Mitigation Plan	Oct 2001	Oct 2001
Construction East Cell	2000	2000
Construction West Cell	2001	2001
As-Built report	2002	2002
Final Planting	2001	2001
Initial – Year 1 monitoring	2002	2002
Year 2 Monitoring	2003	2003
Year 3 Monitoring	2004	2004
Year 4 Monitoring	2005	2005

Table 6. Project Contact Table Project: Carteret-Craven Electrical Cooperative	
Designer	Soil and Environmental Consultants, PA. 11010 Raven Ridge Rd. Raleigh, NC 27614
Construction Contractor	NCDOT
Monitoring Performers	Biological and Agricultural Engineering North Carolina State University Campus Box 7625 Raleigh, NC 27695
Vegetation Monitoring POC	Karen Hall 919.515.8242
Wetland Monitoring POC	Kris Bass 919.515.8245

Table 7. Project Background Table Project: Carteret-Craven Electrical Cooperative	
Project County	Carteret
Drainage Area	1.25 sq miles
Drainage impervious cover estimate (%)	<10%
Stream Order	NA
Physiographic Region	Coastal Plain
Ecoregion	Carolina Flatwoods
Cowardin Classification	PFO2
USGS HUC for Project and Reference	03020106
NCDWQ Sub-basin for Project and Reference	03-05-03
NCDWQ classification for Project and Reference	C, NSW
% of project easement fenced	0

1.4 Monitoring Plan

The first monitoring trip made to the site was on November 21, 2002 by S&EC. Three 10 meter X 10 meter plots were set up for vegetative sampling. One plot was set up in the eastern cell and two were installed in the west cell. In the west cell, one of the plots was set up above the weir and one between the weir and the road. Woody vegetation was identified and counted in each of the cells. No effort was made to distinguish between planted and volunteer vegetation. The presence and percent coverage of herbaceous vegetation was also noted in the plots. The results presented in the monitoring report indicate an average density of 946 stems/acre. This number reflects the total of all of the plots. The results of this vegetative survey indicate survival well above the required minimums.

Three groundwater gages had been installed to monitor hydrology at the site. The report determined that groundwater levels during the growing season of 2002 were within 12 inches of the surface for sufficient continuous periods. The report also states that drought conditions occurred in this year, indicating that longer periods of saturation should be expected in years with normal rainfall.

NCSU staff made our initial monitoring visit on October 2, 2003. Our staff implemented a revised monitoring procedure developed based on the document "Draft Vegetation Monitoring Plan for NCWRP Riparian Buffer and Wetland Restoration Projects" provided by the North Carolina Wetlands Restoration Program. The plan involved vegetative plots, analysis of hydrologic data, and revised success criteria. Photographs and observations were also a part of the new monitoring agenda. The full monitoring plan is explained in detail in this report.

NCSU has continued monitoring through 2004 and 2005. The monitoring methodology was kept the same as in 2003.

Location Map

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CCEC
Jumping Run Creek
Wetlands Restoration

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Quality Group
Campus Box 7637
Raleigh, NC 27695
Phone: 919.515.7637

WRRI
Water Resources
Research Institue
Box 7012, Jordan Hall
Raleigh, NC 27695
Phone: 919.515.2815

2.0 PROJECT CONDITION AND MONITORING RESULTS

2.1 Vegetation Monitoring Set up

As described in the "Draft Vegetation Monitoring Plan for NCWRP Riparian Buffer and Wetland Restoration Projects" document, the monitoring set up for this site was a series of nested plots. Two 1 meter X 1 meter plots were set up in each of the wetland cells. The plots were permanently marked with pipe so measurements can be replicated in subsequent years. Smaller nested plots were set up to record shrub and herbaceous cover. The attached Vegetation Monitoring map shows the locations of the vegetation transects and plots.

Table 8. Vegetation Plots

Community Type	***Total Area (acres)***	***Setup***	***Plots***	***Size (sq. meters)***
East Cell	0.82	Nested Plots	2	10m, 5m, 1m
West Cell	1.82	Nested Plots	2	10m, 5m, 1m

2.2 Vegetation Monitoring Results

2.2.1 East Cell

Vegetation throughout the East Cell was healthy and consists of a combination of both planted trees and shrubs and volunteer shrubs and herbaceous plants. The herbaceous plants were widely diverse and thick throughout. A variety of algae was found in areas of standing water. Microtopography was heterogeneous in most areas.

Herbaceous vegetation consists of a variety of emergent and terrestrial plants. *Hydrocotyle* spp. (Pennywort) and *Diodia virginiana* are dominant emergents. Rushes and sedges are common, but nowhere dominant. Few shrubs existed and those that were noted were small species of *Myrica cerifera* (wax myrtle)*, Rosa palustris* (swamp rose) and *Cephalanthus occidentalis* (button bush).

Planted trees are prevalent on this site. *Taxodium distichum* (bald cypress) and *Nyssa aquatica* (water tupelo) are the dominant trees. Planted trees were largely healthy. *Pinus serotina* (pond pine) was present, although unhealthy in appearance. Some tree mortality was noticed. Extrapolation from two plots in the East Cell resulted in an average of 900 trees per acre for this area. This number is generated from planted trees only with no naturally regenerated trees noted.

Natural regeneration included only herbaceous and shrub species. Planted wax myrtles along the wetland boundary appeared to be an abundant seed source of these species.

Invasive plant species on the site included *Mikania scandens* (climbing hempweed) and *Typha* spp. (cattails). Although not exotic, these plants can reduce diversity and growth of other plants. The climbing hempweed covered nearly every shrub and tree in this cell. This vine appeared to strangle smaller shrubs and cause irregular growth in the trees. Cattails appeared to be spreading into the east cell. An isolated patch was observed in 2004, along an outfall area near the road, which now seems to be expanding. The climbing hempweed does not seem to be currently prohibiting growth of trees so far and cattails are not endangering tree populations.

The east cell is currently meeting the requirements of vegetative success at this site. Recommendations for this site are to monitor the invasive plants over time and treat or remove them if needed. Overall, this portion of the site has a healthy, diverse vegetative population.

2.2.2 West Cell

Vegetation throughout this wetland area consists of a combination of both planted and volunteer trees, shrubs and herbaceous plants. Trees and shrubs were planted within this cell during the spring of 2004.

Herbaceous vegetation consists of a variety of emergent and terrestrial plants. *Hydrocotyle* spp. and *Diodia virginiana* were dominant emergents in the area below the weir. The plot above the weir was sparser in herbaceous vegetation. Compared to the East Cell, however, diversity of herbs is low in the West Cell. Only small specimens of wax myrtle represent the shrub layer. These appeared to be volunteers from a nearby hedgerow. In both areas, the shrub and herb layers are more abundant in the drier areas than the wetter areas. The herbs in the drier areas represent commonly occurring early successional species such as *Andropogon* spp. and *Panicum* spp.

Planted trees on this site included predominantly bald cypress, water tupelo, and *Fraxinus pennsylvanica* (green ash). The recently planted trees appear to be in good shape, however, older trees are struggling. Mortality of older trees was noted. Some trees, planted in dryer areas are growing very well (Photo 4).

The area below the weir was abundant in *Pinus* spp. volunteers. Extrapolation from two plots in the West Cell resulted in an average of 460 planted trees per acre for this area. Planted trees and volunteer trees resulted in an extrapolated average of 1100 trees per acre.

Invasive plant species on the site include climbing hempweed. These plants are present in the drier areas of this wetland. This vine appeared to strangle smaller shrubs and cause irregular growth in the trees in the drier areas. It is not nearly as prevalent as it is in the East Cell and does not appear to need treatment.

Recommendations for this site are to monitor the invasive plants over time and treat or remove them if needed. Secondly, a soil fertility test is recommended. The substrate appeared to be quite sandy with no nutrients; a possible explanation for poor health of the planted trees, particularly in the area above the weir.

Table 9. Vegetative Problem Areas

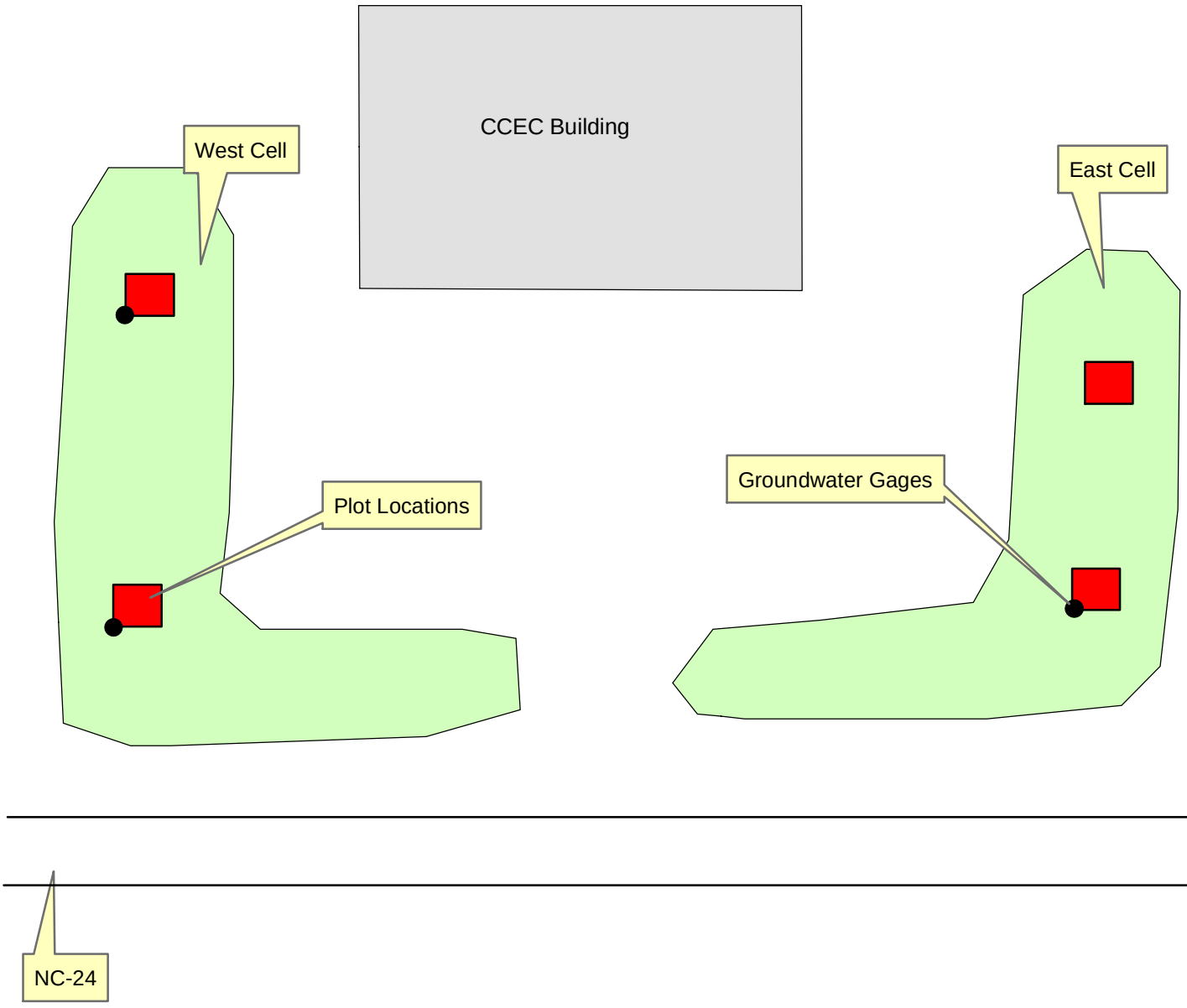
Location/Issue	Location	Probable Causes	Photo #
Invasive populations	East Cell	Hempweed intrusion	None available
		Cattail intrusion	
Bare areas	West Cell	Tree mortality	3
		Sandy soil	
		Excessive saturation	

The survival of various species at the site is shown in Table 10. The data should be viewed with caution as the results are influenced by several factors. The initial quantities of Cephalanthus and Nyssa biflora should be noted along with the low survival percentage. The supplemental planting in 2004 also effects the survival of the noted species.

Table 10. Species Survival.

Carteret Craven Electrical Cooperative Species Survival Table - 2005								
	Plot							
Species	East 1	East 2	West 1	West 2	**2003 total**	**2005 total**	**Survival %**	
Shrubs								
Cephalanthus occidentalis	0	0	0	0	2	0	0%	
Trees								*
Nyssa aquatica	8	10	3	1	30	22	73%	*
Nyssa biflora	1	0	0	0	2	1	50%	*
Pinus serotina	0	6	0	0	5	6	120%	
Taxodium distichum	5	13	7	10	30	35	117%	
Fraxinus pennsylvanica	0	0	1	0	0	1	n/a	
* Survival percentages are affected by supplementary planting in 2004								

Monitoring Map



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2.3 Hydrologic Monitoring Setup

Three ground water gages were set up at the site for the purposes of hydrologic monitoring after the project construction was completed. No revisions to the current hydrologic monitoring plan were proposed for this site. The data from each of the devices was downloaded during the monitoring visit. Analysis and overlay of the data showed that saturation levels well exceeded the mitigation requirements. Water levels in each area were recorded within 12 inches of the surface for a large portion of the growing season (Appendix A).

2.4 Results Discussion

The Carteret-Craven Electrical Cooperative is currently meeting the vegetative and hydrologic success criteria for the project. Stem counts and saturation levels are well above the proposed criteria. Continued monitoring is recommended to further assess whether actions will be needed to ensure that invasives will not negatively impact the area.

An additional planting has increased stem counts in the West Cell of the site. However, tree growth appears limited. A soil fertility test could help determine if nutrient deficiencies are a problem. The continued level of surface inundation may also be causing stress and contributing to the poor growth. Trees in dryer areas of this cell are growing well (Photo 4). If maximizing water quality benefits is a primary goal of the project, it may be recommended to supplement the Western Cell with an herbaceous planting.

3.0 PHOTOGRAPHS

Photo 1. East Cell and Plot

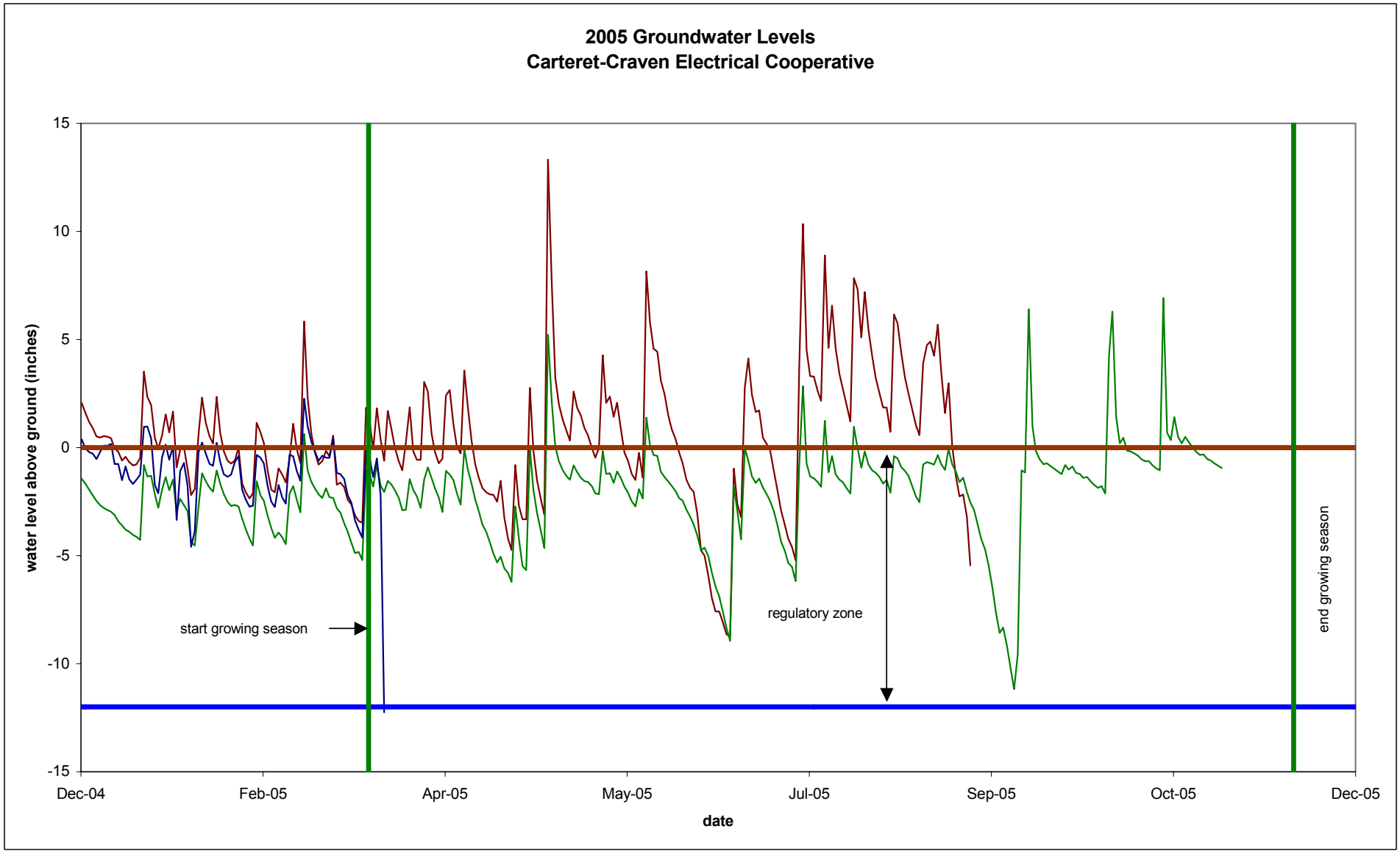
Photo 2. Upper West Cell and Plot

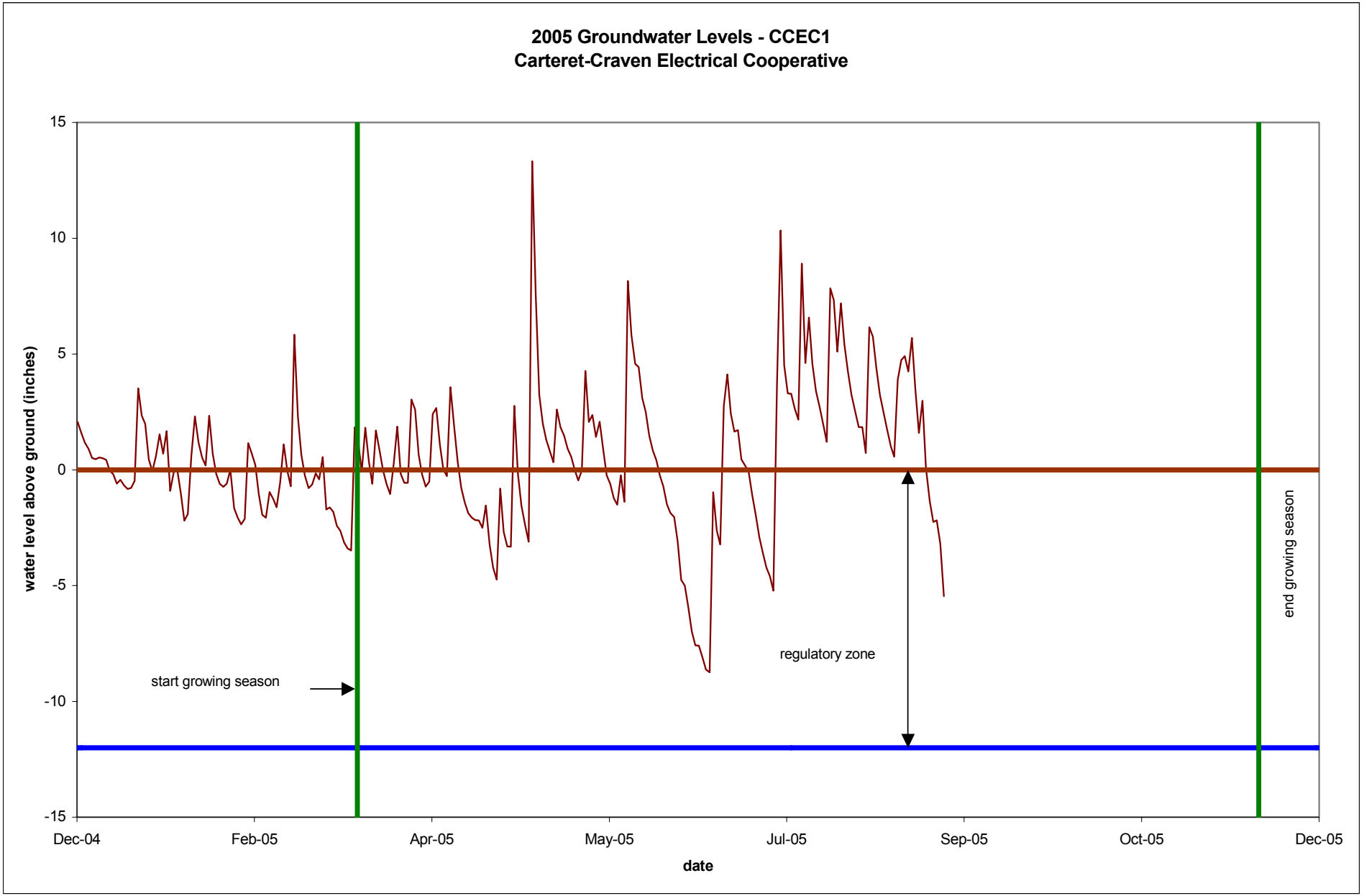
Photo 3. West Cell - above weir

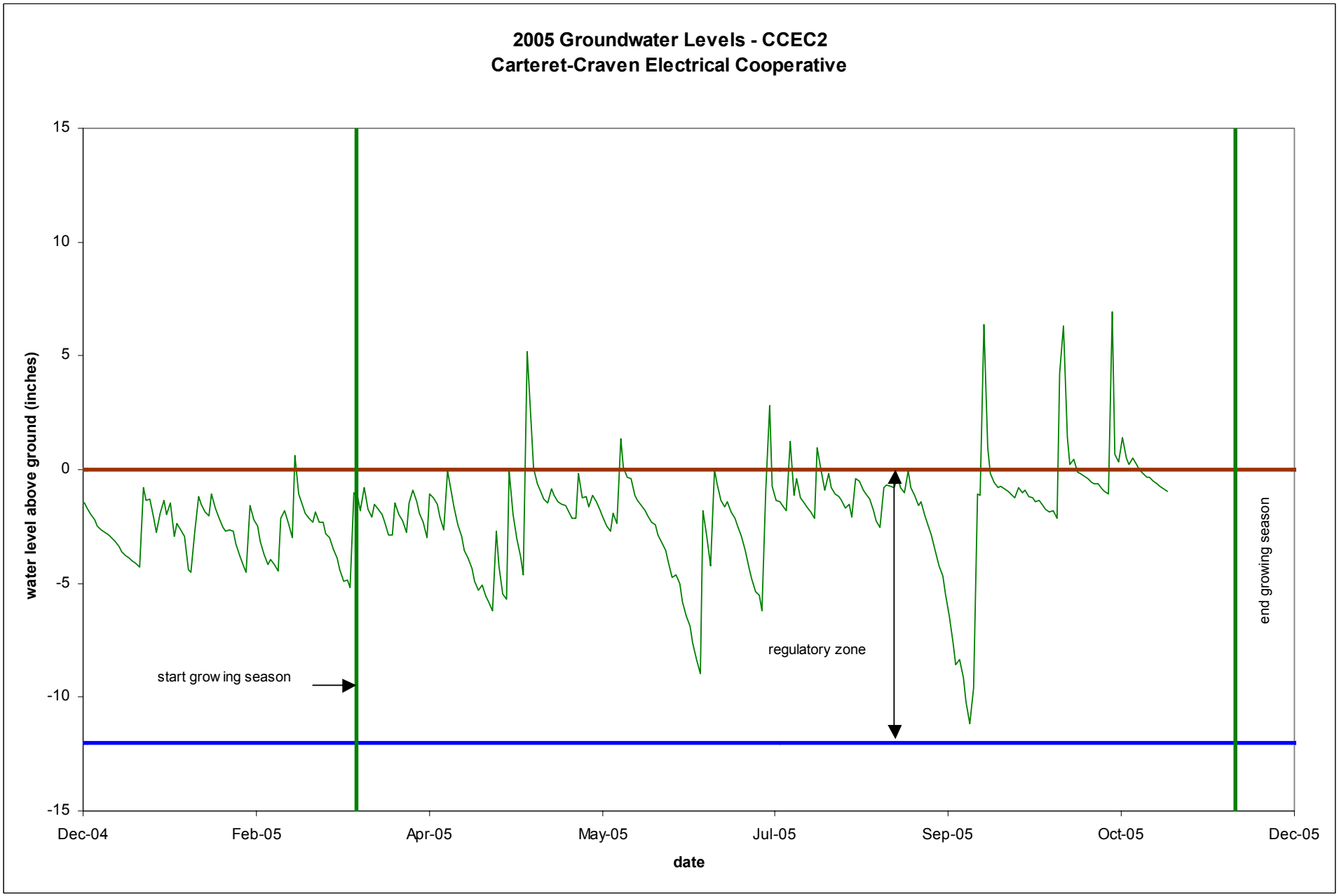
Photo 4. West Cell – Good trees in a high area.

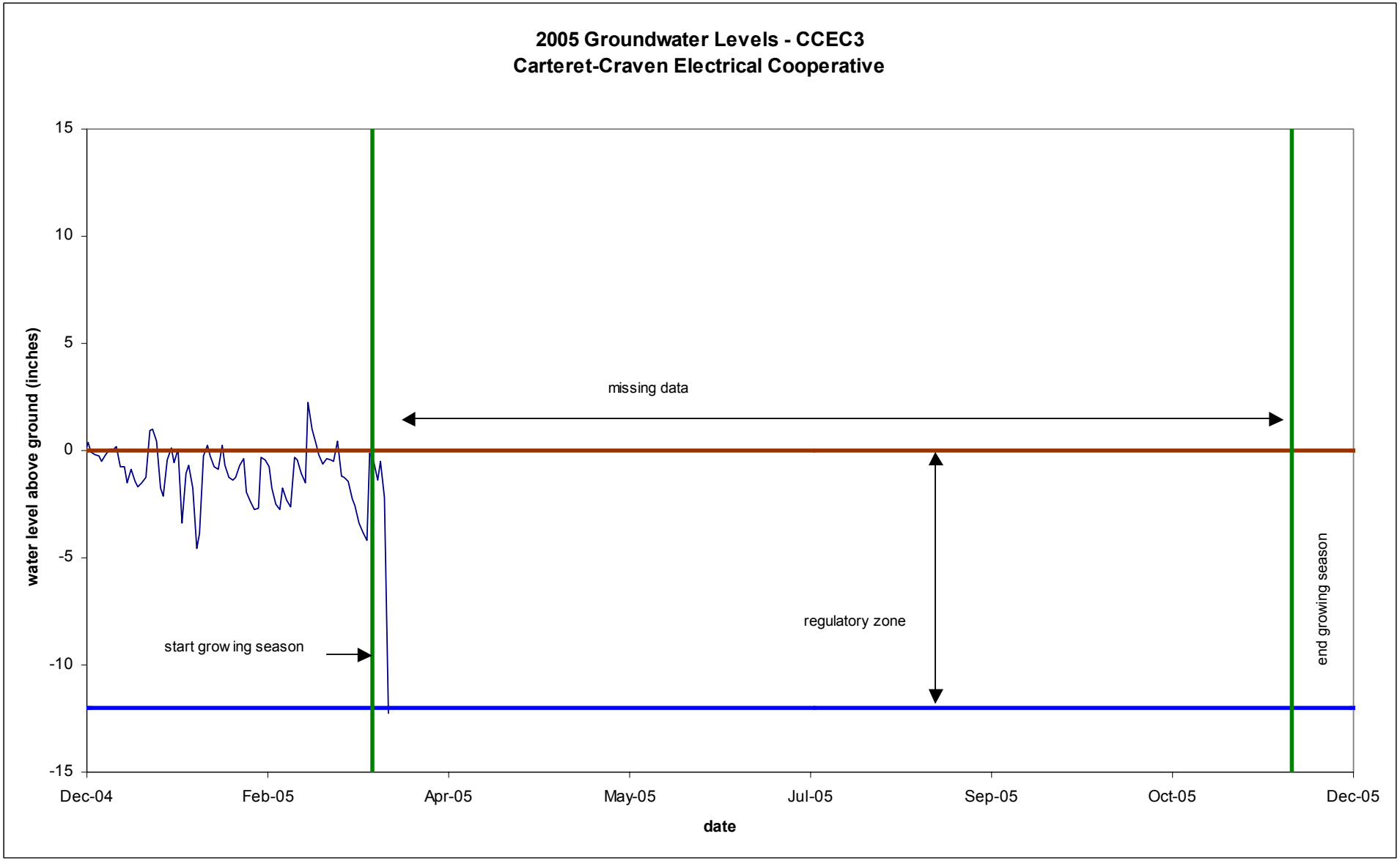
Appendix A.

Water Table Data


2005 Groundwater Levels
Carteret-Craven Electrical Cooperative
water level above ground (inches)
15
10
5
0
-5
-10
-15
Dec-04
Feb-05
Apr-05
May-05
Jul-05
Sep-05
Oct-05
Dec-05
date
start growing season
regulatory zone
end growing season


2005 Groundwater Levels - CCEC1
Carteret-Craven Electrical Cooperative
water level above ground (inches)
15
10
5
0
-5
-10
-15
Dec-04
Feb-05
Apr-05
May-05
Jul-05
Sep-05
Oct-05
Dec-05
date
start growing season
regulatory zone
end growing season


2005 Groundwater Levels - CCEC2
Carteret-Craven Electrical Cooperative
water level above ground (inches)
15
10
5
0
-5
-10
-15
Dec-04
Feb-05
Apr-05
May-05
Jul-05
Sep-05
Oct-05
Dec-05
date
start grow ing season
regulatory zone
end growing season


2005 Groundwater Levels - CCEC3
Carteret-Craven Electrical Cooperative
water level above ground (inches)
15
10
5
0
-5
-10
-15
missing data
regulatory zone
start grow ing season
end growing season
Dec-04
Feb-05
Apr-05
May-05
Jul-05
Sep-05
Oct-05
Dec-05
date