YEAR 4 (2012)
ANNUAL MONITORING REPORT
COLUMBUS SWAMP WETLAND RESTORATION SITE
ROBESON/COLUMBUS COUNTIES, NORTH CAROLINA
(Contract 000619)

FULL DELIVERY PROJECT
TO PROVIDE RIPARIAN WETLAND MITIGATION
IN THE LUMBER RIVER BASIN
CATALOGING UNIT 03040203

Prepared for:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
RALEIGH, NORTH CAROLINA

Prepared by:

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1101 Haynes Street, Suite 211
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And

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Raleigh, North Carolina 27603

November 2012

EXECUTIVE SUMMARY

Restoration Systems, L.L.C. has completed restoration of riparian wetlands at the Columbus Swamp Wetland Restoration Site (hereafter referred to as the "Site") to assist the North Carolina Ecosystem Enhancement Program in fulfilling wetland mitigation goals. The Site, located approximately 11 miles southeast of Lumberton (34.4597°N, 78.9002°W NAD 83/WGS84), on the Robeson and Columbus County line, provides 32 riparian wetland mitigation units as outlined in the April 2007 Technical Proposal and calculated as stipulated in RFP #16-D07033. The Site is located in United States Geological Survey (USGS) Hydrologic Unit 03040203170020 (North Carolina Division of Water Quality Subbasin 03-07-53) of the Lumber River Basin. This report serves as the year 4 (2012) annual monitoring report.

Primary activities at the Site included 1) wetland restoration, 2) wetland enhancement, 3) soil scarification, and 4) plant community restoration. Project restoration efforts will provide a minimum of 32 riparian Wetland Mitigation Units.

Ten vegetation plots (10 meters by 10 meters in size) were established and permanently monumented. These plots were surveyed in June 2012 for the year 4 (2012) monitoring season. Although vegetation sampling was conducted in June of 2012, vegetation plots were revisited in October of 2012 to see if plant mortality occurred since June. Based on the number of stems present, the average density of all plots was 1028 planted stems per acre surviving in year 4 (2012). The dominant species identified at the Site were planted stems of bald cypress (*Taxodium distichum*), water oak (*Q. nigra*), and swamp tupelo (*Nyssa biflora*). One of the ten vegetation plots (Plot 3) contained no planted stems in Year 1 (2009) due to extreme wetness in that portion of the Site. Supplemental planting in approximately four acres occurred in late 2009 with species tolerant of long periods of soil saturation and/or surface inundation (*Nyssa biflora, Taxodium distichum,* and *Betula nigra*); these areas are doing well. No vegetation problem areas were noted during the year 4 (2012) monitoring season.

Seven Restoration Site and one reference groundwater monitoring gauges were operated for the Year 4 (2012) monitoring season. All monitored gauges within restoration areas were inundated/saturated within 12 inches of the surface for greater than 10 percent of the growing season. No wetland problem areas were noted during Year 4 (2012) monitoring.

In summary, the Restoration Site achieved success criteria for vegetation and hydrology attributes in the fourth monitoring year (2012).

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1.0 PROJECT BACKGROUND

1.1 Location and Setting

Restoration Systems, L.L.C. (Restoration Systems) has completed restoration of riparian wetlands at the Columbus Swamp Wetland Restoration Site (hereafter referred to as the "Site") to assist the North Carolina Ecosystem Enhancement Program (NCEEP) in fulfilling wetland mitigation goals. The Site, located approximately 11 miles southeast of Lumberton (34.4597°N, 78.9002°W NAD 83/WGS84) on the Robeson and Columbus County line, provides 32 riparian wetland mitigation units as outlined in the April 2007 Technical Proposal and calculated as stipulated in RFP #16-D07033 (Figure 1, Appendix A). The Site is located in United States Geological Survey (USGS) Hydrologic Unit 03040203170020 (North Carolina Division of Water Quality Subbasin 03-07-53) of the Lumber River Basin.

Directions to the Site:

- From Raleigh, take I-40 east to I-95 south
- Take exit 13A from I-95 and travel east on US-74
- Take the first left on Old Boardman Road
- After approximately 2.5 miles, turn left on Paul Willoughby Road
- Travel approximately 0.5 mile, the Site is on the left
- Latitude, Longitude of Site: 34.4597°N, 78.9002°W (NAD83/WGS84)

1.2 Project Objectives

The primary components of the restoration project included 1) enhancement of water quality functions within, upstream, and downstream of the Site; 2) restoration/enhancement of jurisdictional riparian wetlands in the Site; 3) reforestation of the Site with native vegetation; 4) improvement of aquatic habitat and species diversity by removing nonpoint and point sources of pollution; and 5) restoration of wildlife functions associated with a riparian wetland system.

1.3 Project Structure, Restoration Type, and Approach

An approximately 40-acre conservation easement was placed on the Site to incorporate all restoration activities. The Site is situated at the outer floodplain edge of Big Swamp at the confluence of Big Swamp and a smaller tributary, Brier Creek. Big Swamp serves as the primary hydrologic feature at the Site. The Big Swamp floodplain is approximately three quarters of a mile in width, extending to timber tracts on the northern rim of the drainage feature. Prior to construction, an extensive ditch system had been excavated to drain the Site for agricultural land uses. Interfield ditches had been excavated to a depth of approximately 4 to 5 feet and resulting spoil was used to construct a berm/road that bordered Site agricultural fields. The berm hindered surface water from Big Swamp from accessing agricultural fields during wetter periods of the year.

Restoration of Site wetlands will result in positive benefits for water quality and biological diversity in the watershed. Targeted mitigation efforts, which focused on improving water quality, enhancing flood attenuation, restoring aquatic and riparian habitat, and improving biological diversity in the Lumber River watershed were accomplished by:

1. Removing nonpoint and point sources of pollution associated with agricultural practices including a) cessation of broadcasting fertilizer, pesticides, and other agricultural chemicals into and adjacent to the Site and b) provide a forested riparian buffer to treat surface runoff.
2. Restoring Site hydrology by filling approximately 8000 linear feet of existing drainage ditches, thereby promoting flood storage, nutrient cycling, and aquatic wildlife habitat.

3. Restoring soil structure through appropriate soil modifications and physical alteration (grading, ripping, etc.).
4. Reforesting a native wetland community, thereby reestablishing habitat diversity and functional continuity.
5. Enhancing and protecting the Site's full potential of wetland functions and values in perpetuity.
6. Providing a terrestrial wildlife corridor and refuge in an area segmented for agricultural production.

As constructed, the Site restored historic wetland functions, which existed onsite prior to ditching, agricultural impacts, and vegetation removal. The Site restoration design mimicked a nearby reference wetland. Site construction resulted in 33.5 acres of riparian wetland restoration and 2.5 acres of riparian wetland enhancement (Table 1).

Table 1. Site Restoration Structures and Objectives

Restoration Segment/ Reach ID	Station Range	Mitigation Type	Priority Approach	Existing Linear Footage/ Acreage	Designed Linear Footage/ Acreage	Comment
Riparian/ Riverine Wetlands	--	Restoration	--	--	33.5	Filling agricultural ditches, removing a berm and spoil castings, eliminating row crop production, rehydrating floodplain soils, and planting with native forest vegetation.
	--	Enhancement	--	2.5	2.5	Eliminating row crop production and planting with native forest vegetation.

1.4 Project History and Background

Completed project activities, reporting history, completion dates, project contacts, and background information are summarized in Tables 2-4.

Table 2. Project Activity and Reporting History

Activity or Report	Data Collection Completion	Actual Completion or Delivery
Restoration Plan	April 2008	April 2008
Construction Completion	NA	December 2008
Site Planting	NA	January 2009
Mitigation Plan/As-builts	February 2009	February 2009
Year 1 (2009) Monitoring	November 2009	September 2009
Supplemental Planting of 4 acres	NA	Late 2009
Year 2 (2010) Monitoring	November 2010	August 2010
Year 3 (2011) Monitoring	November 2011	August 2011
Year 4 (2012) Monitoring	October 2012	November 2012

Table 3. Project Contacts

Full Delivery Provider	Restoration Systems 1101 Haynes Street, Suite 211 Raleigh, North Carolina 27604 George Howard and John Preyer (919) 755-9490
Designer and Monitoring Performer	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, North Carolina 27603 Grant Lewis (919) 215-1693
Construction Contractor	Land Mechanics Designs, Inc. 126 Circle G Lane Willow Spring, North Carolina 27592 Lloyd Glover (919) 422-3392
Planting Contractor	Carolina Silvics 908 Indian Trail Road Edenton, North Carolina 27932 Dwight McKinney (252) 482-8491

Table 4. Project Background

Project County	Columbus/Robeson County, North Carolina
Drainage impervious cover estimate (%)	< 1
Physiographic Region	Coastal Plain
Ecoregion	Southeastern Plains
Dominant Soil Types	Johnston
Reference Site ID	Big Swamp
USGS HUC	03040203170020
NCDWQ Subbasin	03-07-53
NCDWQ Classification	C Sw (Stream Index # 14-22-17)
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	Not Applicable
% of project easement fenced	0%

1.5 Monitoring Plan View

Monitoring activities for the Site, including relevant structures and utilities, project features, specific project structures, and monitoring features are detailed in the monitoring plan (Figure 2, Appendix A). Site features including vegetation, wetland hydrology, and photographic documentation were monitored in year 4 (2012).

2.0 PROJECT CONDITION AND MONITORING RESULTS

2.1 Vegetation Assessment

Following Site construction, ten plots (10 meters by 10 meters in size) were established and monumented with metal fence posts at all plot corners and PVC at each plot origin. Sampling was conducted as outlined in the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee et al. 2006) (http://cvs.bio.unc.edu/methods.htm); results are included in Appendix B. The taxonomic standard for

vegetation used for this document was *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas* (Weakley 2007). The locations of vegetation monitoring plots were placed to accurately represent the entire Site and are depicted on the monitoring plan (Figure 2, Appendix A).

2.1.1 Vegetation Success Criteria

Success criteria have been established to verify that the vegetation component supports community elements necessary for forest development. Success criteria are dependent upon the density and growth of characteristic forest species. Additional success criteria are dependent upon density and growth of "Characteristic Tree Species." Characteristic Tree Species include planted species, species identified through inventory of a reference (relatively undisturbed) forest community used to orient the planting plan, and appropriate Schafale and Weakley (1990) community descriptions. All species planted and identified in the reference forest will be utilized to define "Characteristic Tree Species" as termed in the success criteria (Table 5).

Table 5. Characteristic Tree Species

Planted Species	**Reference Species**
River birch (*Betula nigra*)	Red maple (*Acer rubrum*)
Ironwood (*Carpinus caroliniana*)	American holly (*Ilex opaca*)
Atlantic white cedar (*Chamaecyparis thyoides*)	Sweetbay magnolia (*Magnolia virginiana*)
Laurel oak (*Quercus laurifolia*)	Swamp blackgum (*Nyssa biflora*)
Overcup oak (*Quercus lyrata*)	Red bay (*Persea borbonia*)
Swamp chestnut oak (*Quercus michauxii*)	Laurel oak (*Quercus laurifolia*)
Water oak (*Quercus nigra*)	Swamp chestnut oak (*Quercus michauxii*)
Willow oak (*Quercus phellos*)	Willow oak (*Quercus phellos*)
Shumard oak (*Quercus shumardii*)	Bald cypress (*Taxodium distichum*)
Bald cypress (*Taxodium distichum*)	

An average density of 320 stems per acre of Characteristic Tree Species must be surviving at the end of the third monitoring year. Subsequently, 290 Characteristic Tree Species per acre must be surviving at the end of Year 4 and 260 Characteristic Tree Species per acre at the end of Year 5.

2.1.2 Vegetative Problem Areas

Vegetation sampling across the Site was above the required average density with an overall average of 1028 planted stems per acre. In Year 1 (2009), one of the ten vegetation plots (Plot 3) contained no planted stems due to extreme wetness in that portion of the Site. Groundwater Gauge 3, immediately adjacent to this plot, indicated the longest hydroperiod (108 consecutive days or 44.6% of the growing season) of all gauges on the Site for the same year. Ground observations indicated that approximately four acres around Plot 3 were vegetated by heavy stands of obligate wetland plants with evidence of standing water. Supplemental planting in this area occurred in late 2009 with species tolerant of long periods of soil saturation or surface inundation (*Nyssa biflora, Taxodium distichum,* and *Betula nigra*). This area appears to be doing well and no vegetation problem areas were noted during the year 4 (2012) monitoring season.

2.2 Wetland Assessment

Seven Restoration Site and one reference groundwater monitoring gauges were maintained and monitored throughout the year 4 (2012) growing season. Graphs of groundwater hydrology and precipitation from a nearby rain station are included in Appendix C.

2.2.1 Wetland Success Criteria

Target hydrological characteristics include a minimum regulatory wetland hydrology criteria based upon reference groundwater modeling. Evaluation of success criteria will also be supplemented by sampling and data comparison between restoration areas and the reference wetland site. Hydrology success criteria for the five-year monitoring period will include a minimum regulatory criterion, comprising saturation (free water) within one foot of the soil surface for 10 percent of the growing season, which extends from March 16 to November 12 (242 days).

Wetland hydroperiods measured by a groundwater gauge located within the reference area will be compared to the hydroperiods exhibited by groundwater gauges in the restoration area to further evaluate restoration success. Success criteria outlined by the groundwater model indicates that the wetland restoration area should maintain saturation within one foot of the soil surface for at least 75 percent of the hydroperiod exhibited by the reference wetland gauges in any given year.

2.2.2 Wetland Problem Areas

No wetland problem areas were identified within the Site during year 4 (2012) monitoring.

2.2.3 Wetland Criteria Attainment

All monitored gauges within restoration areas were inundated/saturated within 12 inches of the surface for greater than 10 percent of the growing season (Table 6). Hydrographs containing groundwater and precipitation data for each gauge can be found in Appendix C.

Table 6. Wetland Criteria Attainment for Year 4 (2012)

Gauge ID	Hydrology Threshold Met?	Hydrophytic Vegetation Criteria Met?	Site Mean	Vegetation Plot ID	Vegetation Survival Threshold Met?	Site Mean
1	Yes	Yes	100 %	1	Yes	100 %
2	Yes	Yes		2	Yes	
3	Yes	Yes		3	Yes	
4	Yes	Yes		4	Yes	
5	Yes	Yes		5	Yes	
6	Yes	Yes		6	Yes	
7	Yes	Yes		7	Yes	
				8	Yes	
				9	Yes	
				10	Yes	

3.0 CONCLUSIONS

The Site achieved the defined (or targeted) success criteria, with saturation (free water) within one foot of the soil surface for a minimum of 10 percent of the growing season, for all Site groundwater gauges in the Fourth Monitoring Year (Year 2012). A summary of groundwater gauge data is included in Table 7. Also, vegetation plots across the Site were above the required 320 stems per acre with an average of 1028 planted tree stems per acre in the fourth monitoring year (Year 2012) (Table 8).

Table 7. Summary of Groundwater Gauge Results

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (%)				
	Year 1 (2009)	Year 2 (2010)	Year 3 (2011)	Year 4 (2012)	Year 5 (2013)
1	Yes/47 days (19 percent)	Yes/33 days (14 percent)	Yes/55 days (23 percent)	Yes/105 days (43 percent)	
2	Yes/54 days (22 percent)	Yes/34 days (14 percent)	Yes/48 days (20 percent)	Yes/40 days (17 percent)	
3	Yes/108 days (45 percent)	Yes/45 days (19 percent)	Yes/79 days (33 percent)	Yes/86 days (36 percent)	
4	Yes/39 days (16 percent)	Yes/25 days (10 percent)	Yes/43 days (18 percent)	Yes/29 days (13 percent)	
5	Yes/38 days (16 percent)	Yes/23 days (10 percent)	Yes/36 days (15 percent)	Yes/33 days (14 percent)	
6	Yes/100 days (41 percent)	Yes/65 days (27 percent)	Yes/81 days (33 percent)	Yes/125 days (52 percent)	
7	Yes/45 days (19 percent)	Yes/26 days (11 percent)	Yes/48 days (20 percent)	Yes/39 days (16 percent)	
Ref 1	Yes/47 days (19 percent)	Yes/32 days (13 percent)	Yes/21 days (9 percent)	Yes/48 days (20 percent)	

Table 8. Summary of Planted Vegetation Plot Results

Plot	Planted Stems/Acre Counting Towards Success Criteria				
	Year 1 (2009)	Year 2 (2010)	Year 3 (2011)	Year 4 (2012)	Year 5 (2013)
1	769	890	1375	1214	
2	728	850	890	890	
3	0	405	526	486	
4	647	890	971	931	
5	769	769	647	809	
6	890	1457	1456	1457	
7	809	1133	1133	1052	
8	971	1416	1619	1619	
9	647	809	890	809	
10	405	809	930	1012	
Average 10 Plots	**664**	**943**	**1044**	**1028**	

4.0 REFERENCES

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. United States Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Lee, Michael T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0. (online). Available: http://cvs.bio.unc.edu/methods.htm

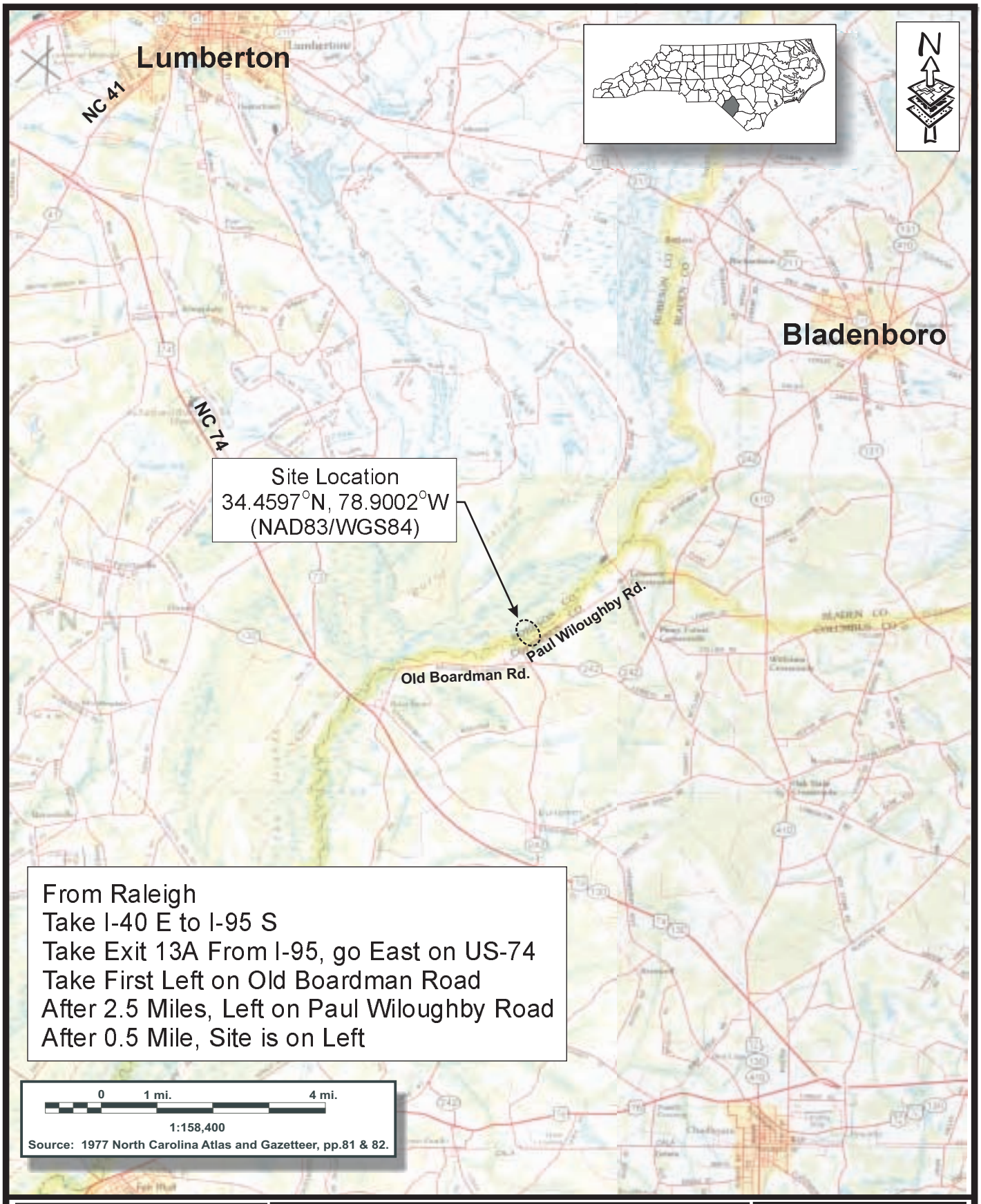
Schafale, M. P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation, NC Natural Heritage Program, Division of Parks and Recreation, NC DEM, Raleigh NC.

Weakley, Alan S. 2007. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas (online). Available: http://www.herbarium.unc.edu/WeakleysFlora.pdf [February 1, 2008]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.

Weather Underground. 2009. Station in Lumberton, North Carolina. (online). Available: http://www.wunderground.com/history/airport/KLBT/2009/9/8/DailyHistory.html?req_ [September 8, 2009]. Weather Underground.

APPENDIX A
FIGURES

1. **Site Location**
2. **Monitoring Plan**

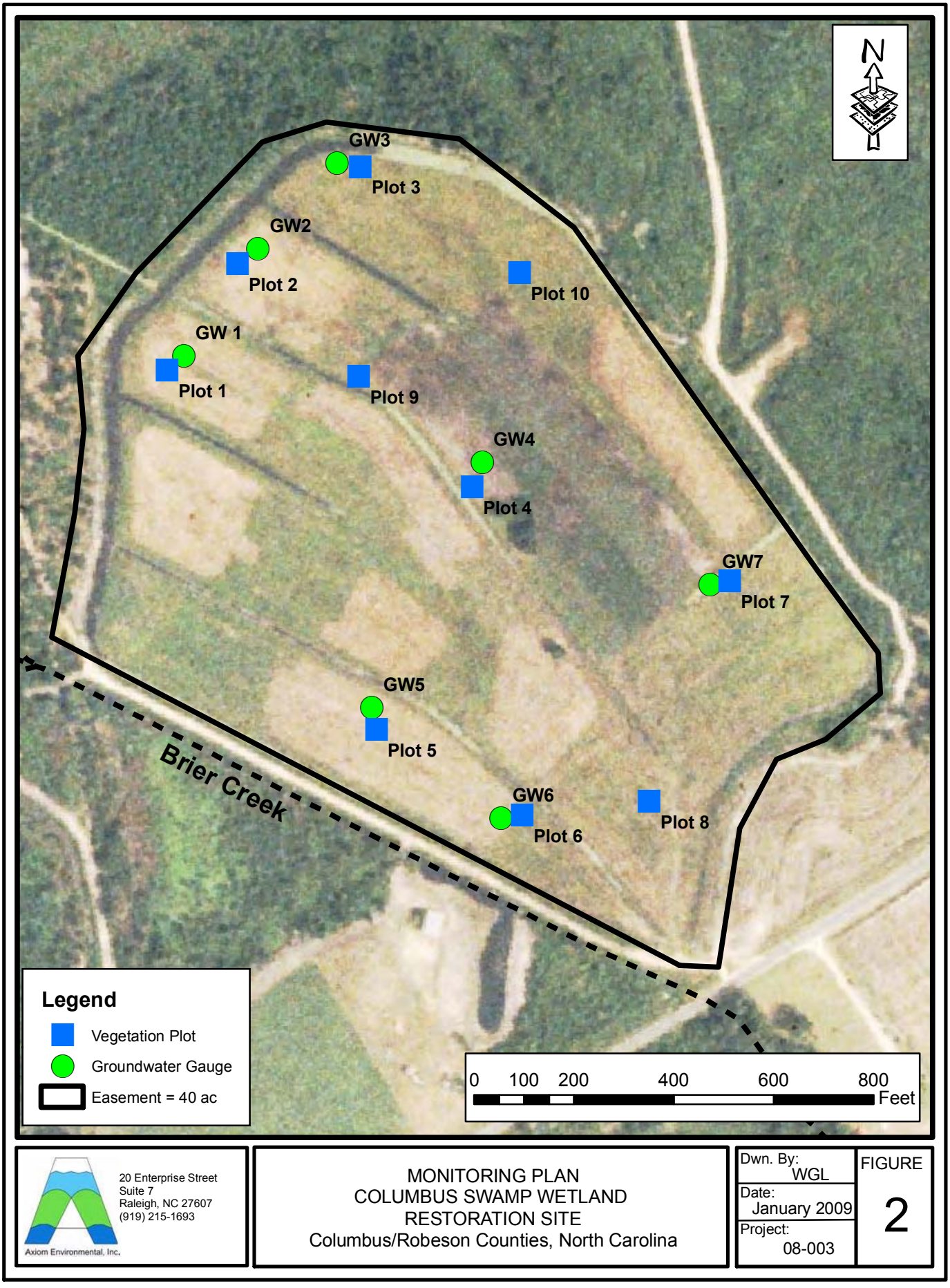


Axiom Environmental
20 Enterprise St. #7
Raleigh, NC 27607
(919) 215-1693

SITE LOCATION
COLUMBUS SWAMP WETLAND RESTORATION SITE
Robeson County, North Carolina

Dwn. by:	CLF
Ckd by:	WGL
Date:	August 2010
Project:	10-001

FIGURE
1



Axiom Environmental, Inc.
20 Enterprise Street
Suite 7
Raleigh, NC 27607
(919) 215-1693

MONITORING PLAN
COLUMBUS SWAMP WETLAND
RESTORATION SITE
Columbus/Robeson Counties, North Carolina

Dwn. By:	WGL
Date:	January 2009
Project:	08-003

FIGURE
2

APPENDIX B
VEGETATION DATA

1. **Vegetation Survey Data Tables**
2. **Vegetation Monitoring Plot Photos**

Report Prepared By	Corri Faquin
Date Prepared	6/26/2012 14:24
database name	RestorationSystems-2012-A.mdb
database location	C:\Axiom\Business\CVS
computer name	CORRI-PC
file size	65286144
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	Columbus
project Name	Columbus Swamp Restoration Site
Description	Wetland Restoration in Columbus County
Sampled Plots	10

Living planted stems, excluding live stakes, per acre: Negative (red) numbers indicate the project failed to reach requirements in a particular year.

Project Code	Project Name	River Basin	Year 4
Columbus	Columbus Swamp Restoration Site	Lumber	1027.90

Total stems, including planted stems of all kinds (including live stakes) and natural/volunteer stems:

Project Code	Project Name	River Basin	Year 4
Columbus	Columbus Swamp Restoration Site	Lumber	2132.69

Plot Data

plot	Plot Level	Year	Date Sampled	Planted Living Stems	Planted Living Stems EXCLUDING Live Stakes	Dead/Missing Stems	Natural (Volunteer) Stems	Total Living Stems	Total Living Stems EXCLUDING Live Stakes	Planted Living Stems per ACRE	Planted Living Stems EXCLUDING Live Stakes PER ACRE	Natural (Volunteer) Stems PER ACRE	Total Living Stems PER ACRE	Total Living Stems EXCLUDING Live Stakes PER ACRE	# species
Columbus-AXE-0001-year:4	2	4	6/20/2012	30	30	5	26	56	56	1214.056929	1214.056929	1052.182672	2266.239601	2266.239601	5
Columbus-AXE-0002-year:4	2	4	6/20/2012	22	22	0	10	32	32	890.3084146	890.3084146	404.685643	1294.994058	1294.994058	5
Columbus-AXE-0003-year:4	2	4	6/20/2012	12	12	1	33	45	45	485.6227716	485.6227716	1335.462622	1821.085394	1821.085394	3
Columbus-AXE-0004-year:4	2	4	6/20/2012	23	23	1	17	40	40	930.7769789	930.7769789	687.9655931	1618.742572	1618.742572	7
Columbus-AXE-0005-year:4	2	4	6/20/2012	20	20	3	17	37	37	809.371286	809.371286	687.9655931	1497.336879	1497.336879	3
Columbus-AXE-0006-year:4	2	4	6/20/2012	36	36	4	41	77	77	1456.868315	1456.868315	1659.211136	3116.079451	3116.079451	6
Columbus-AXE-0007-year:4	2	4	6/20/2012	26	26	3	13	39	39	1052.182672	1052.182672	526.0913359	1578.274008	1578.274008	5
Columbus-AXE-0008-year:4	2	4	6/20/2012	40	40	4	31	71	71	1618.742572	1618.742572	1254.525493	2873.268065	2873.268065	7
Columbus-AXE-0009-year:4	2	4	6/20/2012	20	20	5	26	46	46	809.371286	809.371286	1052.182672	1861.553958	1861.553958	4
Columbus-AXE-0010-year:4	2	4	6/20/2012	25	25	0	59	84	84	1011.714108	1011.714108	2387.645294	3399.359401	3399.359401	4

Vigor

vigor	Count	Percent
0	11	3.9
2	4	1.4
3	114	40.7
4	136	48.6
Missing	15	5.4

Vigor by Species

	Species	CommonName	4	3	2	1	0	Missing	Unknown
	Betula nigra	river birch	18	5			1		
	Chamaecyparis thyoides	Atlantic white cedar	5	2				1	
	Nyssa biflora	swamp tupelo	10	53	1		2	6	
	Quercus lyrata	overcup oak	14	10			1	4	
	Quercus michauxii	swamp chestnut oak	3	9	2			2	
	Quercus nigra	water oak	30	17	1		7	1	
	Quercus phellos	willow oak	14	5				1	
	Taxodium distichum	bald cypress	41	12					
	Carpinus caroliniana	American hornbeam	1						
	Unknown			1					
TOT:	**10**	**9**	**136**	**114**	**4**		**11**	**15**	

Damage

Damage	Count	Percent Of Stems
(no damage)	258	92.1
Deer	19	6.8
Unknown	2	0.7
Insects	1	0.4

Damage by Species

	Species	CommonName	Count of Damage Categories	(no damage)	Deer	Insects	Unknown
	Betula nigra	river birch	0	24			
	Carpinus caroliniana	American hornbeam	0	1			
	Chamaecyparis thyoides	Atlantic white cedar	1	7	1		
	Nyssa biflora	swamp tupelo	8	64	8		
	Quercus lyrata	overcup oak	7	22	7		
	Quercus michauxii	swamp chestnut oak	4	12	1	1	2
	Quercus nigra	water oak	1	55	1		
	Quercus phellos	willow oak	0	20			
	Taxodium distichum	bald cypress	0	53			
	Unknown		1		1		
TOT:	**10**	**9**	**22**	**258**	**19**	**1**	**2**

Damage by Plot

	Plot	Count of Damage Categories	(no damage)	Deer	Insects	Unknown
	Columbus-AXE-0001-year:4	3	32	2		1
	Columbus-AXE-0002-year:4	6	16	6		
	Columbus-AXE-0003-year:4	1	12	1		
	Columbus-AXE-0004-year:4	0	24			
	Columbus-AXE-0005-year:4	0	23			
	Columbus-AXE-0006-year:4	3	37	1	1	1
	Columbus-AXE-0007-year:4	0	29			
	Columbus-AXE-0008-year:4	3	41	3		
	Columbus-AXE-0009-year:4	3	22	3		
	Columbus-AXE-0010-year:4	3	22	3		
TOT:	**10**	**22**	**258**	**19**	**1**	**2**

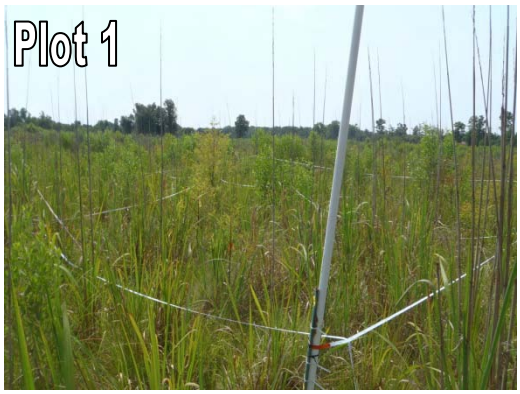
Planted Stems by Plot and Species

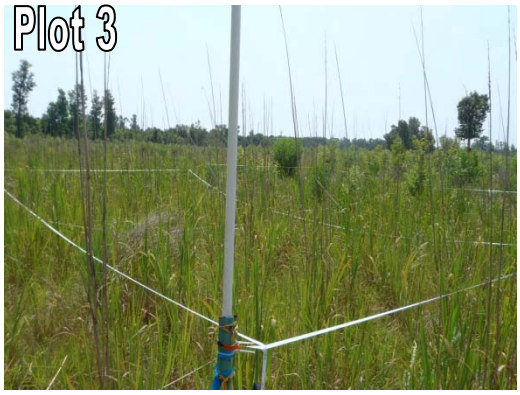
	Comment	Species	CommonName	Total Planted Stems	# plots	avg # stems	1	2	3	4	5	6	7	8	9	10
		Betula nigra	river birch	23	4	5.75			6			4		4		9
		Carpinus caroliniana	American hornbeam	1	1	1		1								
		Chamaecyparis thyoides	Atlantic white cedar	7	4	1.75			2	1		2		2		
		Nyssa biflora	swamp tupelo	64	10	6.4	9	1	4	2	6	15	1	12	7	7
		Quercus lyrata	overcup oak	24	5	4.8	1	7		1			14	1		
		Quercus michauxii	swamp chestnut oak	14	4	3.5	7			3		2		2		
		Quercus nigra	water oak	48	8	6	2	7		1	9	4	1	15	9	
		Quercus phellos	willow oak	19	3	6.33				12			4		3	
		Taxodium distichum	bald cypress	53	9	5.89	11	6		3	5	9	6	4	1	8
		Unknown		1	1	1										1
TOT:	**0**	**10**	**9**	**254**	**10**		**30**	**22**	**12**	**23**	**20**	**36**	**26**	**40**	**20**	**25**

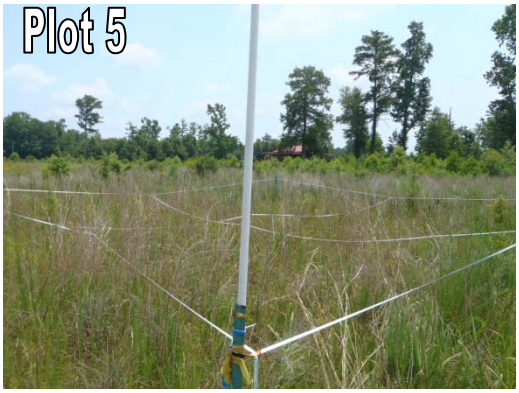
All Stems by Plot and Species (Planted and Natural Recruits)

	Comment	Species	CommonName	Total Planted Stems	# plots	avg# stems	1	2	3	4	5	6	7	8	9	10
		Acer rubrum	red maple	25	7	3.57	5	3	1	2		12		1	1	
		Baccharis halimifolia	eastern baccharis	108	9	12	17		1	2	4	14	10	28	18	14
		Betula nigra	river birch	24	4	6			7			4		4		9
		Carpinus caroliniana	American hornbeam	1	1	1		1								
		Chamaecyparis thyoides	Atlantic white cedar	7	4	1.75			2	1		2		2		
		Liquidambar styraciflua	sweetgum	105	9	11.67	3	7	28	4	11	14		2	2	34
		Magnolia virginiana	sweetbay	3	3	1	1		1						1	
		Morella cerifera	wax myrtle	2	2	1									1	1
		Nyssa biflora	swamp tupelo	66	10	6.6	10	1	4	2	6	16	1	12	7	7
		Pinus taeda	loblolly pine	2	2	1					1	1				
		Quercus lyrata	overcup oak	25	5	5	2	7		1			14	1		
		Quercus michauxii	swamp chestnut oak	14	4	3.5	7			3		2		2		
		Quercus nigra	water oak	55	8	6.88	2	7		1	10	5	1	15	14	
		Quercus phellos	willow oak	19	3	6.33				12			4		3	
		Rhus sp.	Unknown sumac	2	1	2			2							
		Rhus copallinum	flameleaf sumac	26	5	5.2				9	1		3		3	10
		Taxodium distichum	bald cypress	53	9	5.89	11	6		3	5	9	6	4	1	8
		Unknown		1	1	1										1
TOT:	**0**	**18**	**17**	**538**	**18**		**58**	**32**	**46**	**40**	**38**	**79**	**39**	**71**	**51**	**84**

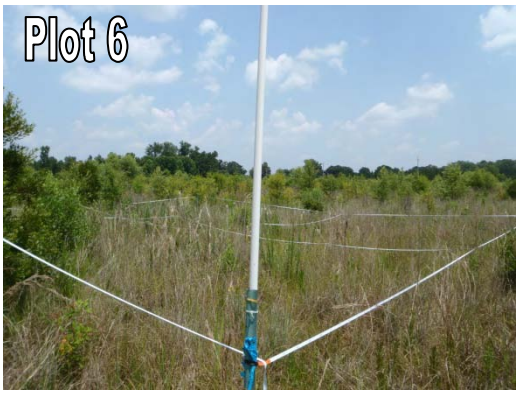
Columbus Swamp Wetland Restoration Site
Year 4 (2012) Annual Monitoring
Vegetation Plot Photos
Taken June 2012



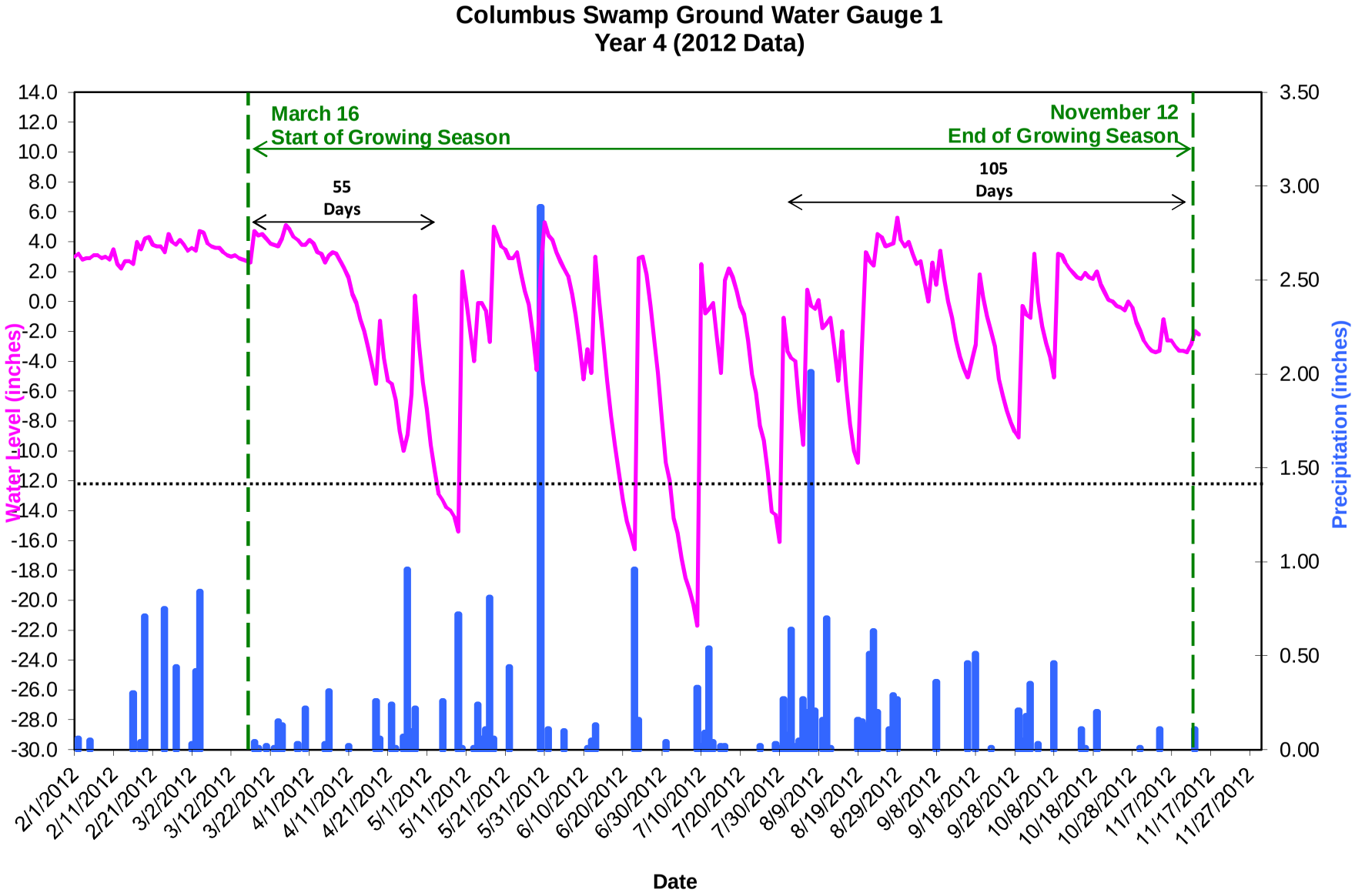


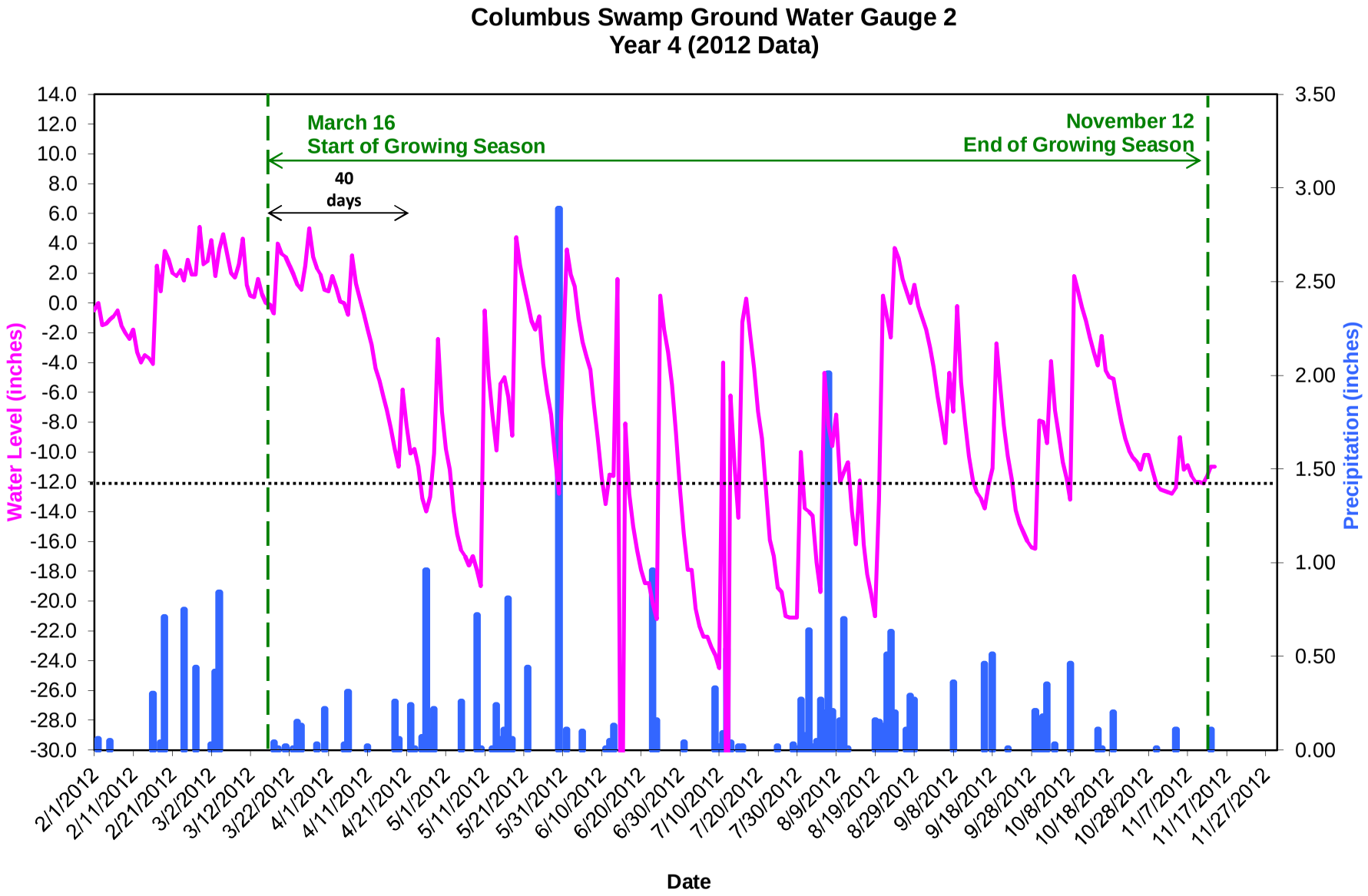


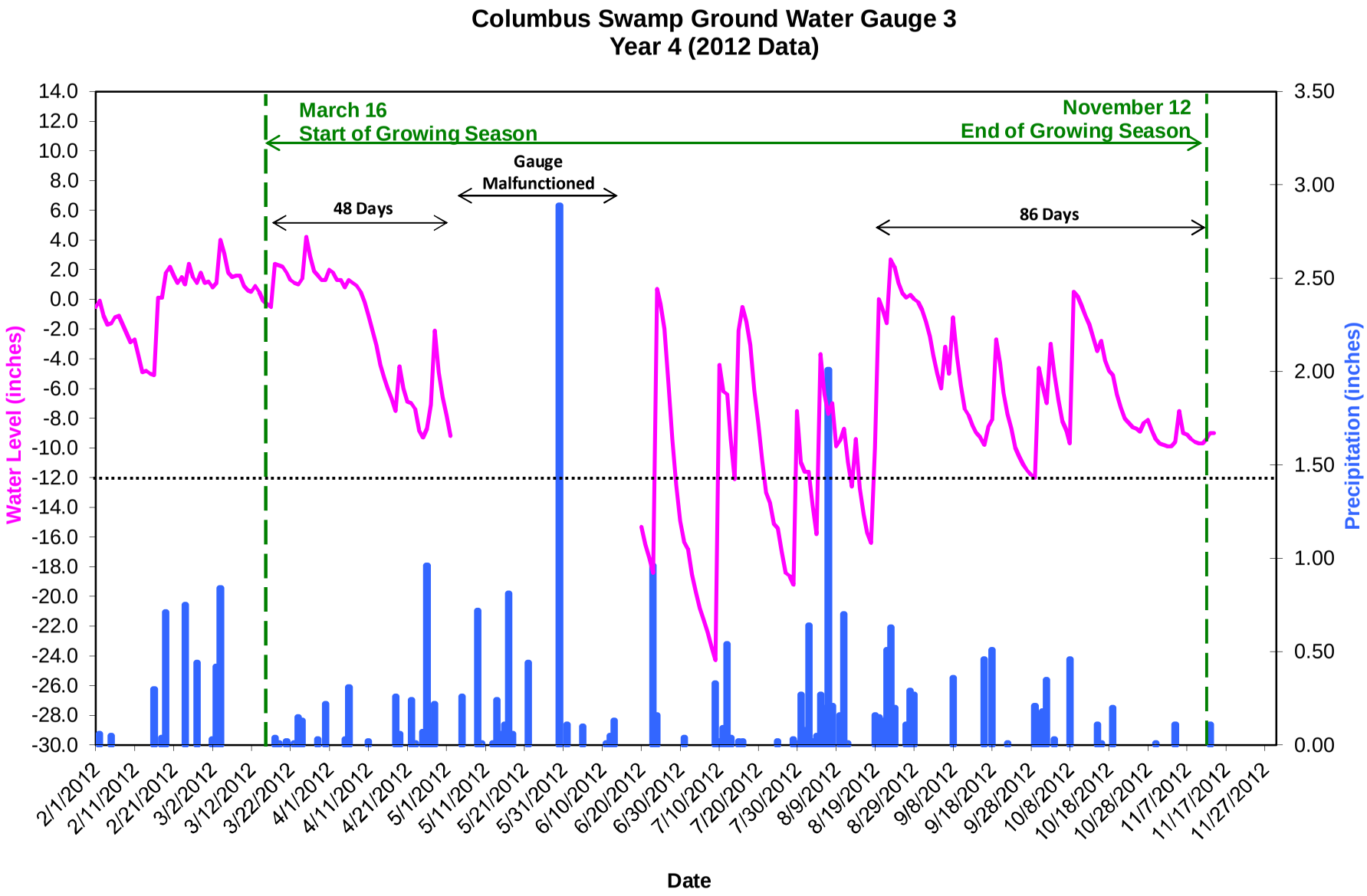
Columbus Swamp Wetland Restoration Site
Year 4 (2012) Annual Monitoring
Vegetation Plot Photos
Taken June 2012
(continued)

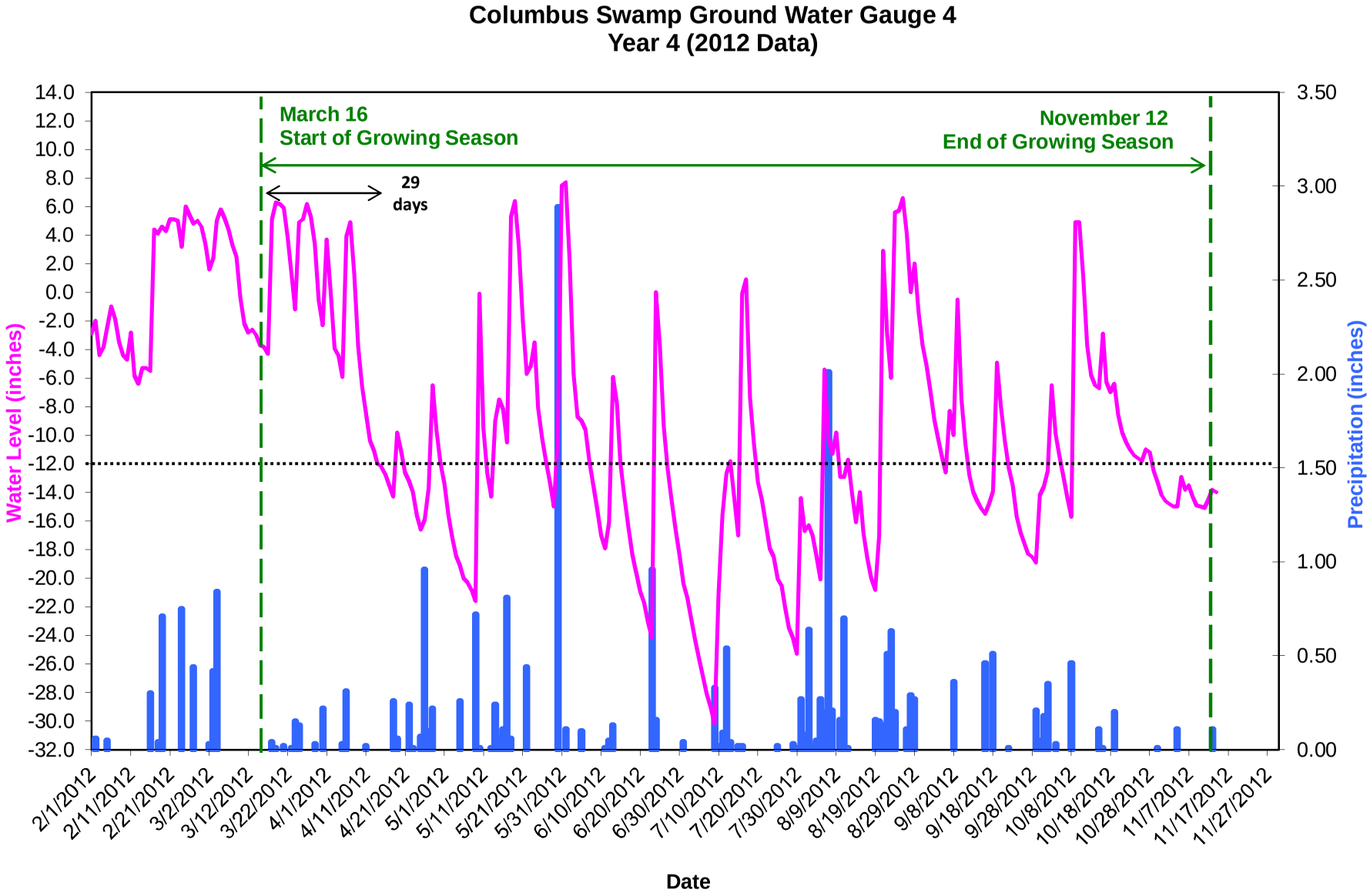


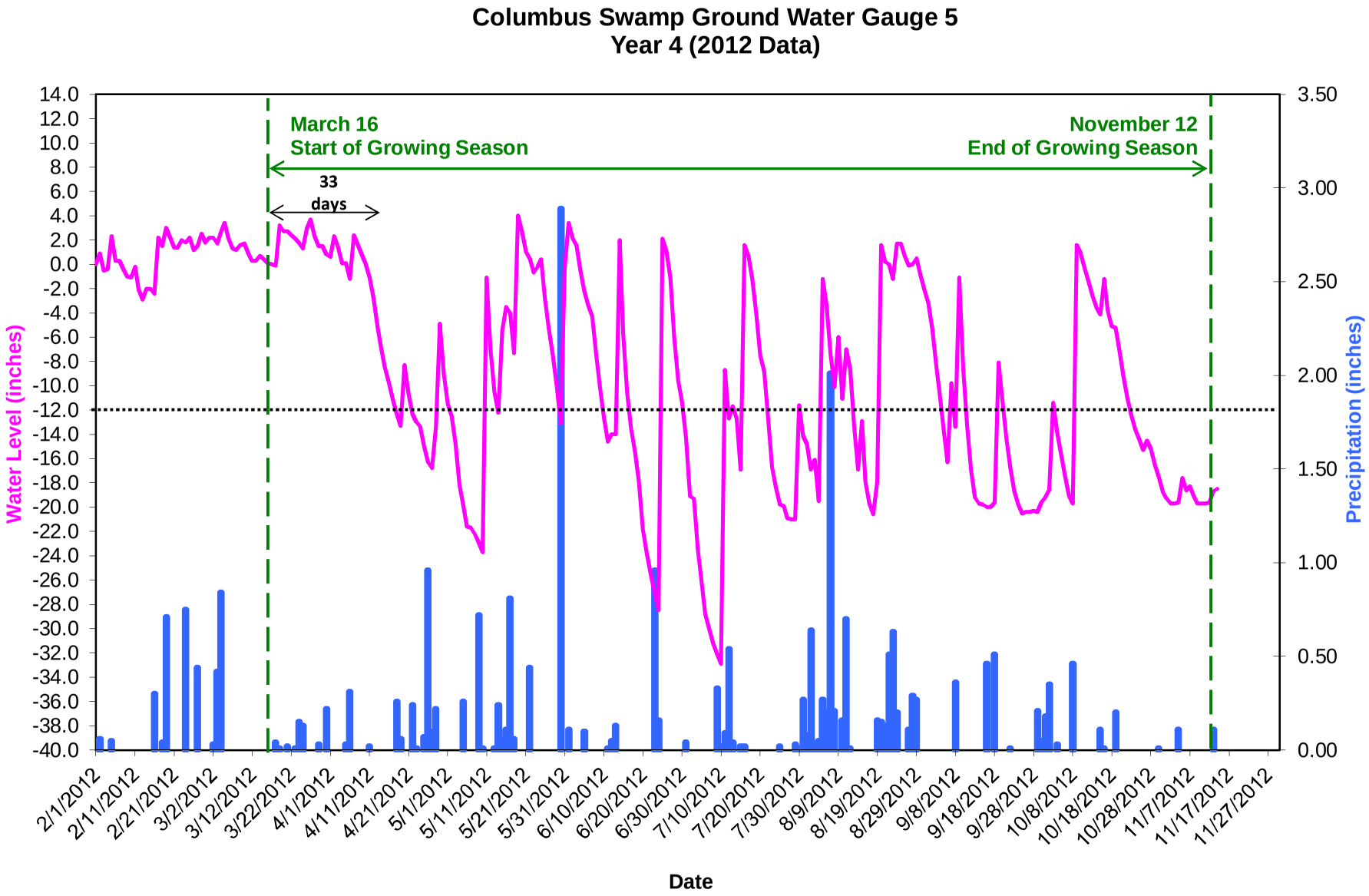
APPENDIX C
HYDROLOGY DATA
2012 Groundwater Gauge Graphs

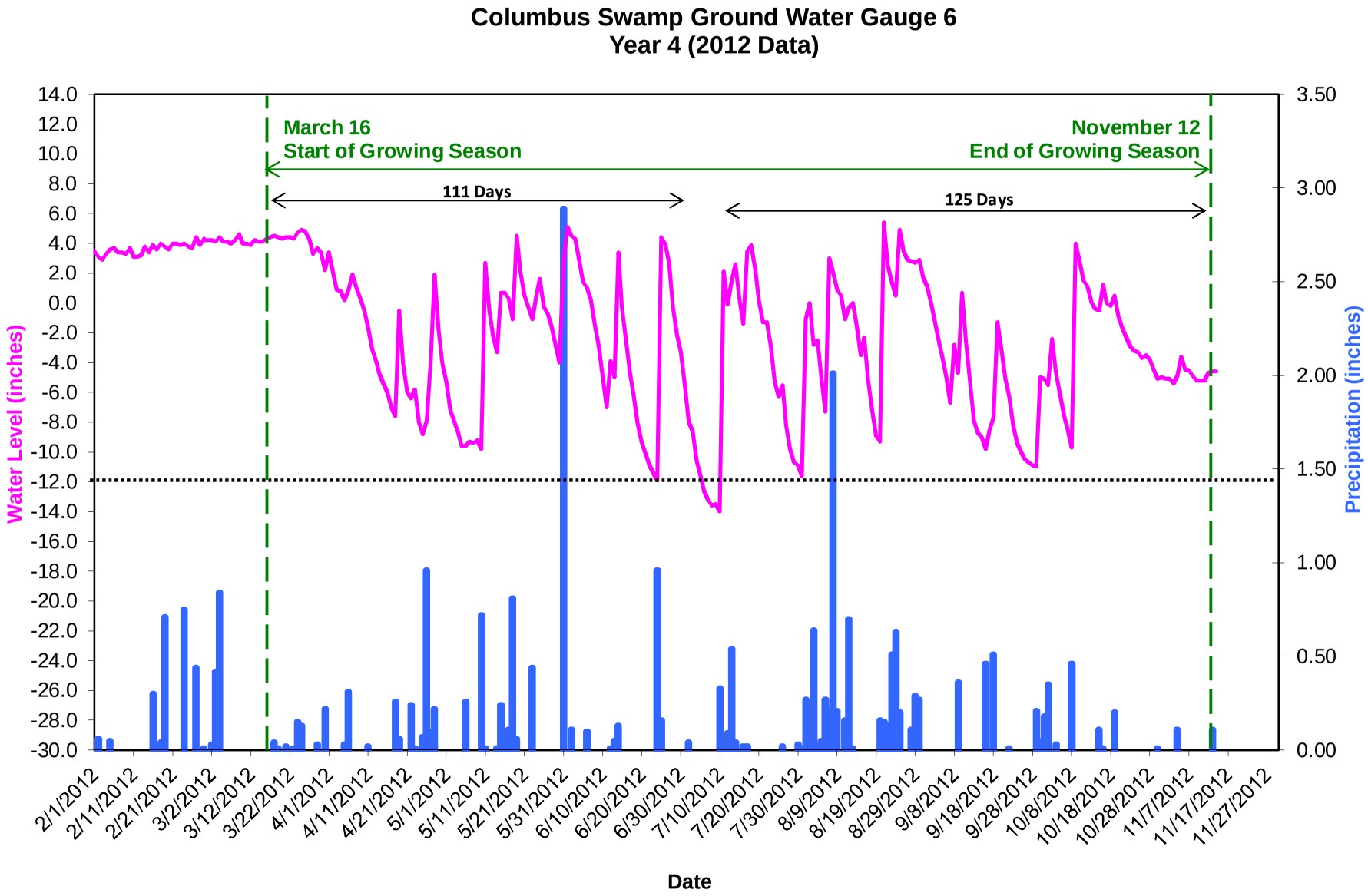

Columbus Swamp Ground Water Gauge 1
Year 4 (2012 Data)
March 16
Start of Growing Season
November 12
End of Growing Season
55
Days
105
Days
Water Level (inches)
Precipitation (inches)
Date
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2/1/2012
2/11/2012
2/21/2012
3/2/2012
3/12/2012
3/22/2012
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
7/30/2012
8/9/2012
8/19/2012
8/29/2012
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012


Columbus Swamp Ground Water Gauge 2
Year 4 (2012 Data)
March 16
Start of Growing Season
November 12
End of Growing Season
40
days
Water Level (inches)
Precipitation (inches)
Date
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2/1/2012
2/11/2012
2/21/2012
3/2/2012
3/12/2012
3/22/2012
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
7/30/2012
8/9/2012
8/19/2012
8/29/2012
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012


Columbus Swamp Ground Water Gauge 3
Year 4 (2012 Data)
March 16
Start of Growing Season
November 12
End of Growing Season
Gauge
Malfunctioned
48 Days
86 Days
Water Level (inches)
Precipitation (inches)
Date
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2/1/2012
2/11/2012
2/21/2012
3/2/2012
3/12/2012
3/22/2012
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
7/30/2012
8/9/2012
8/19/2012
8/29/2012
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012


Columbus Swamp Ground Water Gauge 4
Year 4 (2012 Data)
March 16
Start of Growing Season
November 12
End of Growing Season
29
days
Water Level (inches)
Precipitation (inches)
Date
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
-32.0
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2/1/2012
2/11/2012
2/21/2012
3/2/2012
3/12/2012
3/22/2012
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
7/30/2012
8/9/2012
8/19/2012
8/29/2012
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012


Columbus Swamp Ground Water Gauge 5
Year 4 (2012 Data)
March 16
Start of Growing Season
November 12
End of Growing Season
33
days
Water Level (inches)
Precipitation (inches)
Date
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
-32.0
-34.0
-36.0
-38.0
-40.0
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2/1/2012
2/11/2012
2/21/2012
3/2/2012
3/12/2012
3/22/2012
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
7/30/2012
8/9/2012
8/19/2012
8/29/2012
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012


Columbus Swamp Ground Water Gauge 6
Year 4 (2012 Data)
March 16
Start of Growing Season
November 12
End of Growing Season
111 Days
125 Days
Water Level (inches)
Precipitation (inches)
Date
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2/1/2012
2/11/2012
2/21/2012
3/2/2012
3/12/2012
3/22/2012
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
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8/29/2012
9/8/2012
9/18/2012
9/28/2012
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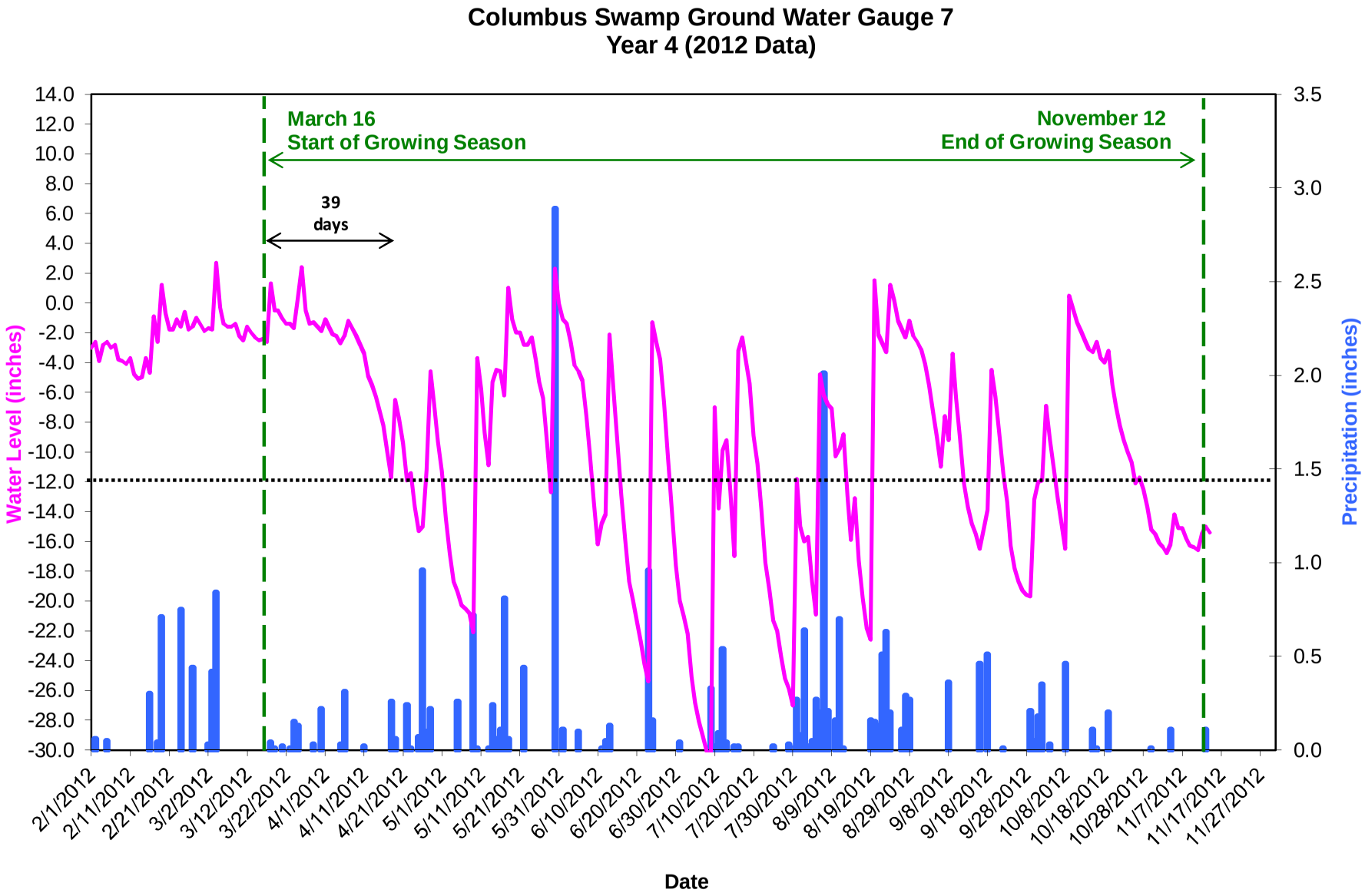
10/18/2012
10/28/2012
11/7/2012
11/17/2012
11/27/2012


Columbus Swamp Ground Water Gauge 7
Year 4 (2012 Data)
March 16
Start of Growing Season
November 12
End of Growing Season
39
days
Water Level (inches)
Precipitation (inches)
Date
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
-16.0
-18.0
-20.0
-22.0
-24.0
-26.0
-28.0
-30.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/1/2012
2/11/2012
2/21/2012
3/2/2012
3/12/2012
3/22/2012
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
7/30/2012
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8/29/2012
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
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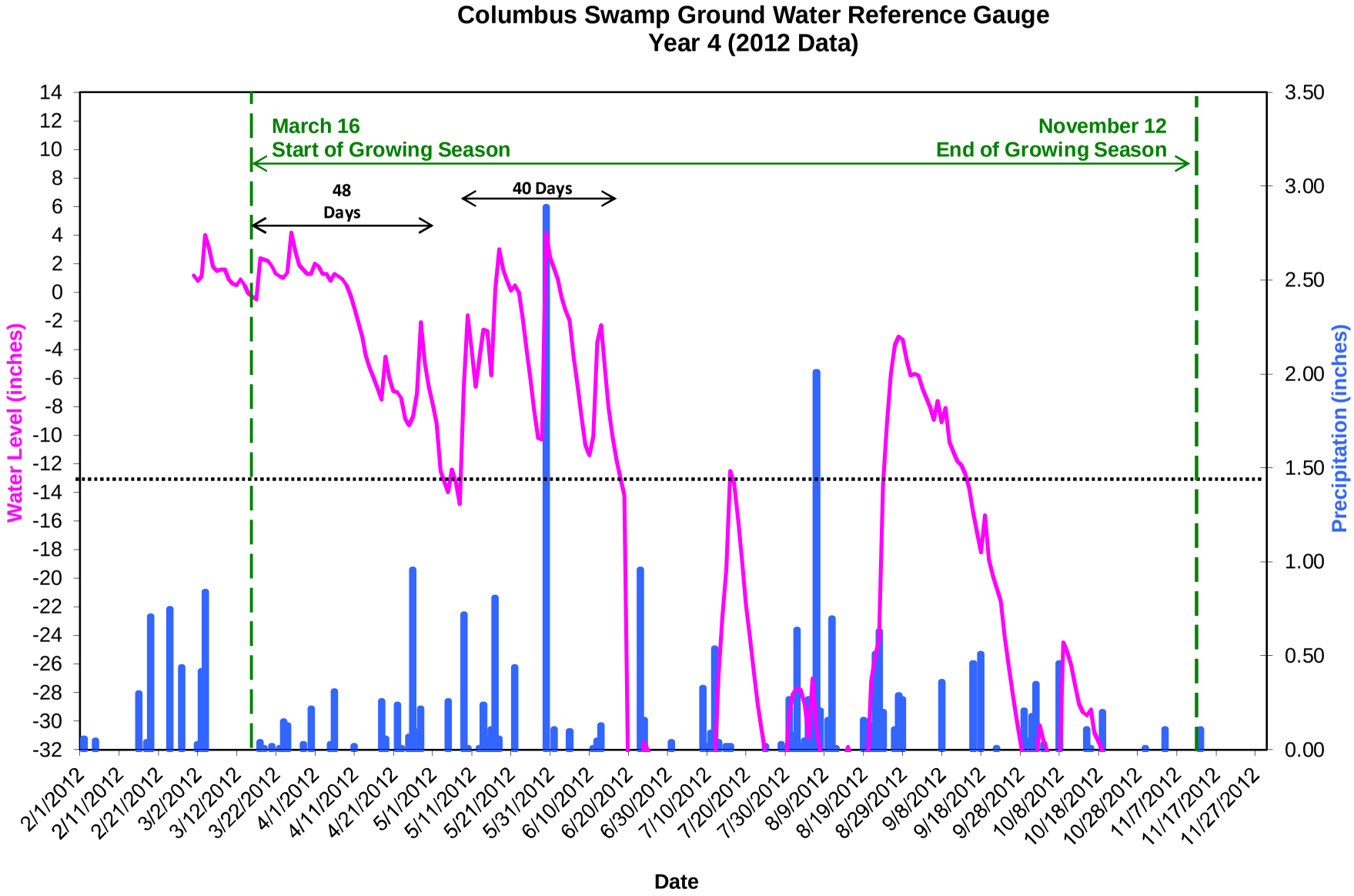
11/27/2012


Columbus Swamp Ground Water Reference Gauge
Year 4 (2012 Data)
March 16
Start of Growing Season
November 12
End of Growing Season
48
Days
40 Days
Water Level (inches)
Precipitation (inches)
Date
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
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2/11/2012
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11/27/2012