

**ANNUAL MONITORING REPORT  
HOWELL WOODS**

**WETLAND RESTORATION  
JOHNSTON COUNTY, NORTH CAROLINA  
(EEP Project Number 183)**

Monitoring Year 8 of 8 (2009)



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

November 2009

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## **WETLAND RESTORATION JOHNSTON COUNTY, NORTH CAROLINA (EEP Project Number 183)**

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Submitted to:  
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Ecosystem Enhancement Program  
Raleigh, North Carolina

Prepared by/Monitoring Performer:  
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20 Enterprise St. Suite 7  
Raleigh, North Carolina 27607

Design Firm:  
EcoScience Corporation  
1101 Haynes Street, Suite 101  
Raleigh, North Carolina 27592



November 2009

## 1.0 EXECUTIVE SUMMARY

The Howell Woods Wetland Restoration Site (Site) is located within United States Geological Survey (USGS) Hydrologic Unit 03020201 (North Carolina Division of Water Quality [NCDWQ] subbasin 03-04-04) of the Neuse River Basin. The Site includes an approximately 140-acre tract, located 8.5 miles southeast of the Town of Smithfield in southern Johnston County (Figure 1). The Site is contained within an approximately 2000-acre tract of land managed by Johnston County Community College as part of the Howell Woods Environmental Learning Center.

The primary goals of the project included the following.

1. Enhance water quality functions in the Gar Gut Creek and Mill Creek watersheds.
2. Reestablish a functioning backwater slough system, which extends through developing bottomland hardwood forests.
3. Provide educational opportunities to show the importance of wetlands for water quality.
4. Maximize the area returned to historic wetland function.

Success criteria dictate an average density of 320 stems per acre must be surviving in the first three monitoring years. Subsequently, 290 Character Tree Species per acre must be surviving in year 4 and 260 Character Tree Species per acre in year 5. Five vegetation plots had been previously established by North Carolina State University. The plots are 10 meters square and are located randomly within the Site. Results from vegetation surveys exceeded success criteria with 346, 1806, 1401, and 1101 planted stems per acre present in years 2 through 5, respectively; with an increase in species diversity over the monitoring period. Vegetation surveys were completed in year 5 and no data was collected in subsequent years. No data was available for year 1 monitoring.

Success criteria based on the 2002 Monitoring Plan for wetland hydrology require inundation or saturation within 12 inches of the ground surface for a consecutive period of 12.5 percent of the growing season. The growing season in Johnston County begins March 21 and ends November 4 (229 days). Areas inundated less than 5 percent of the growing season (11 days) are classified as nonwetlands. Areas inundated between 5 percent and 12.5 percent of the growing season can be classified as wetlands depending upon factors such as the presence of hydrophytic vegetation and hydric soils. In order to attain hydrologic success, saturation within 12 inches of the ground surface is required for at least 11 consecutive days (5 percent of the growing season) or 29 consecutive days (12.5 percent of the growing season). All gauges are currently functioning and recorded groundwater hydrology within 12 inches of the ground surface for at least 5 percent of the growing season with a presence of hydric soils and hydrophytic vegetation.

In summary, the Site achieved success criteria for hydrology and vegetation in the Eighth Monitoring Year (2009). Based on available data, the Site achieved success criteria for hydrology and vegetation over the entire 8-year monitoring period. Summary information and data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in table and figures within this report's appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on EEPs website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.

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- Figure 3. Monitoring Plans

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- Table 5. Vegetation Plot Mitigation Success Summary  
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- Table 7. Summary of Groundwater Gauge Results for Years 1 through 8  
Year 8 (2009) Groundwater Gauge Graphs

### APPENDIX E. YEAR 8 (2009) GAUGE VEGETATION LISTS



## 2.0 METHODOLOGY

### 2.1 Vegetation Assessment

In the fall of 2001, vegetation monitoring plots were randomly established within the Site. Each sample plot was composed of two-300-foot transects extending from a central point, usually a groundwater monitoring gauge. The Site was monitored for the as-built and the 2002 (year 1) growing season utilizing this methodology with vegetation success achieved.

During the 2003 (year 2) monitoring period, North Carolina State University implemented a revised vegetation monitoring procedure based on the *Draft Vegetation Monitoring Plan for NCWRP Riparian Buffer and Wetland Restoration Projects* document (undated). Five-10 meter by 10 meter plots were established and permanently marked with pipe. The location of each vegetation monitoring plot is depicted on Figure 3 (Appendix A). These plots were surveyed for five monitoring seasons; results for years 2 through 5 (2003 through 2006) are included in Table 7. No reference area was studied; therefore no comparisons could be made to reference conditions.

Due to the revised monitoring protocol during the second year of vegetation surveys, no comparisons of as-built or 2002 (year 1) can be made to the subsequent monitoring years. Therefore, planted species have been based upon previous annual monitoring reports and percent survival is based on a comparison of 2003 (year 2) totals where possible. The phased planting schedule made it difficult to determine planted trees from naturally recruited trees; therefore, the number of “planted” species was based on the experience and judgment of the monitoring team, and counts for planted species may be influenced by naturally recruited stems. During preparation of this monitoring report, no as-built mitigation plan or data for 2002 (year 1) totals were available.

Results from vegetation surveys exceeded success criteria with 346, 1806, 1401, and 1101 planted stems per acre present in years 2 through 5, respectively with an increase in species diversity over the 5-year monitoring period. Vegetation surveys were completed in year 5 and no data was collected in subsequent years with the exception of photographs, which are included in Appendix C. No data was available for year 1 monitoring. Based on these results, Site vegetation should be considered successful.

### 2.2 Wetland Assessment

Fourteen groundwater monitoring gauges have been maintained and monitored throughout the year 8 (2009) growing season (Appendix D). Twelve are located within the restoration areas and two are located within the reference wetlands immediately northwest of the Site. The groundwater gauges record daily readings of groundwater depth. Daily rainfall data was acquired from the Moore Farm Weather Station in Four Oaks, North Carolina (Weather Underground 2009). Table 7 summarizes success criteria for groundwater gauges over the 8-year monitoring period.

Success criteria based on the 2002 Monitoring Plan for wetland hydrology require that the area be inundated or saturated within 12 inches of the ground surface for a consecutive period of 12.5 percent of the growing season. The growing season in Johnston County begins March 21 and ends November 4 (229 days). Areas inundated less than 5 percent of the growing season (11 days) are classified as nonwetlands. Areas inundated between 5 percent and 12.5 percent of the growing season can be classified as wetlands depending upon factors such as the presence of hydrophytic vegetation and hydric soils. In order to attain hydrologic success, saturation within 12 inches of the ground surface is required for at least 11 consecutive days (5 percent of the growing season) or 29 consecutive days (12.5 percent of the growing season).

All groundwater gauges had a presence of hydrophytic wetland vegetation and hydric soils based on criteria set forth in the *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratories 1987). Vegetation lists for each gauge can be found in Appendix E.

Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season for the year 8 (2009) growing season at Gauges 2 and 4-12 and greater than 5 percent of the growing season at Gauges 1 and 3.

### **3.0 EIGHT-YEAR MONITORING ASSESSMENT**

In summary, the Site achieved success criteria for vegetation and hydrology for over the eight-year monitoring period.

Results from vegetation surveys exceeded success criteria with 346, 1806, 1401, and 1101 planted stems per acre present in years 2 through 5, respectively; with an increase in species diversity over the monitoring period.

Previous vegetative problem areas within the Site have resolved naturally and no vegetation or wetland problem areas were present within the Site during year 8 (2009) monitoring.

Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season for the year 8 (2009) growing season at Gauges 2 and 4-12 and for at least 5 percent of the growing season at Gauges 1 and 3. Vegetation documented in the vicinity of each of the twelve restoration area groundwater gauges was considered hydrophytic wetland vegetation. In addition, wetland criteria set forth in the *Corps of Engineers Wetland Delineation Manual* were met with the presence of the three criteria, 1) hydric soils, 2) hydrophytic vegetation, and 3) wetland hydrology at all gauges.

In summary, the Site achieved success criteria for hydrology and vegetation in the Eighth Monitoring Year (2009). Based on available data, the Site achieved success criteria for hydrology and vegetation over the entire 8-year monitoring period.

#### 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.

North Carolina Wetlands Restoration Program (NCWRP). Undated. Draft Internal Guidance for Vegetation Monitoring Plans for NCWRP Riparian Buffer and Wetland Restoration Projects. North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina.

United States. Department of Agriculture (USDA). 1994. Soil Survey of Johnston County, North Carolina. United States Department of Agriculture.

Weather Underground. 2009. Station at Moore Farm (KNCFOURO2) in Four Oaks, North Carolina. (online). Available:  
<http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KNCFOURO2>  
[November 10, 2009]. Weather Underground.

APPENDIX A  
FIGURES AND PLAN VIEWS

Figure 1. Site Location

Figure 2. DRAINMOD Revised Mitigation Unit Calculations

Figure 3. Monitoring Plans

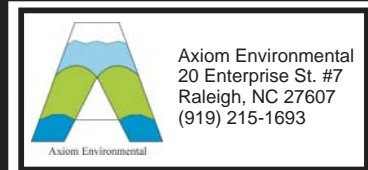
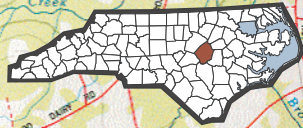




**Directions to the Site:**  
 From Highway 70 Business in Smithfield  
 Travel south on Route 701 for approximately 15 miles  
 Turn left/southeast on Devil's Racetrack Road  
 for approximately 10 miles  
 Turn left into the Howell Woods Environmental  
 Learning Center  
 See Jaime Sasser or Kinchon Taylor at the Center office  
 for a gate key and directions into the Site

**APPROX.  
 SITE  
 LOCATION**

0 1 mi. 4 mi.  
 1:158,400  
 Source: 1977 North Carolina Atlas and Gazetteer, p.63.



**SITE LOCATION**  
**HOWELL WOODS RESTORATION SITE**  
**Project Number 183**  
**Year 8 (2009) Monitoring Report**  
 Johnston County, North Carolina

Dwn. by: CLF  
 Ckd by: WGL  
 Date: Nov 2009  
 Project: 08-001

**FIGURE**  
**1**





Axiom Environmental, Inc.

REVISIONS


Client:

WETLANDS RESTORATION PROGRAM

Raleigh, North Carolina

Project:

HOWELL WOODS RESTORATION SITE

Project Number 183  
Year 8 (2009 Monitoring Report)

JOHNSTON COUNTY, NORTH CAROLINA

Title:

DRAINMOD

REVISED MITIGATION UNIT CALCULATIONS

Dwn By:

WGL

Date:

Sept 2009

Ckd By:

WGL

Scale:

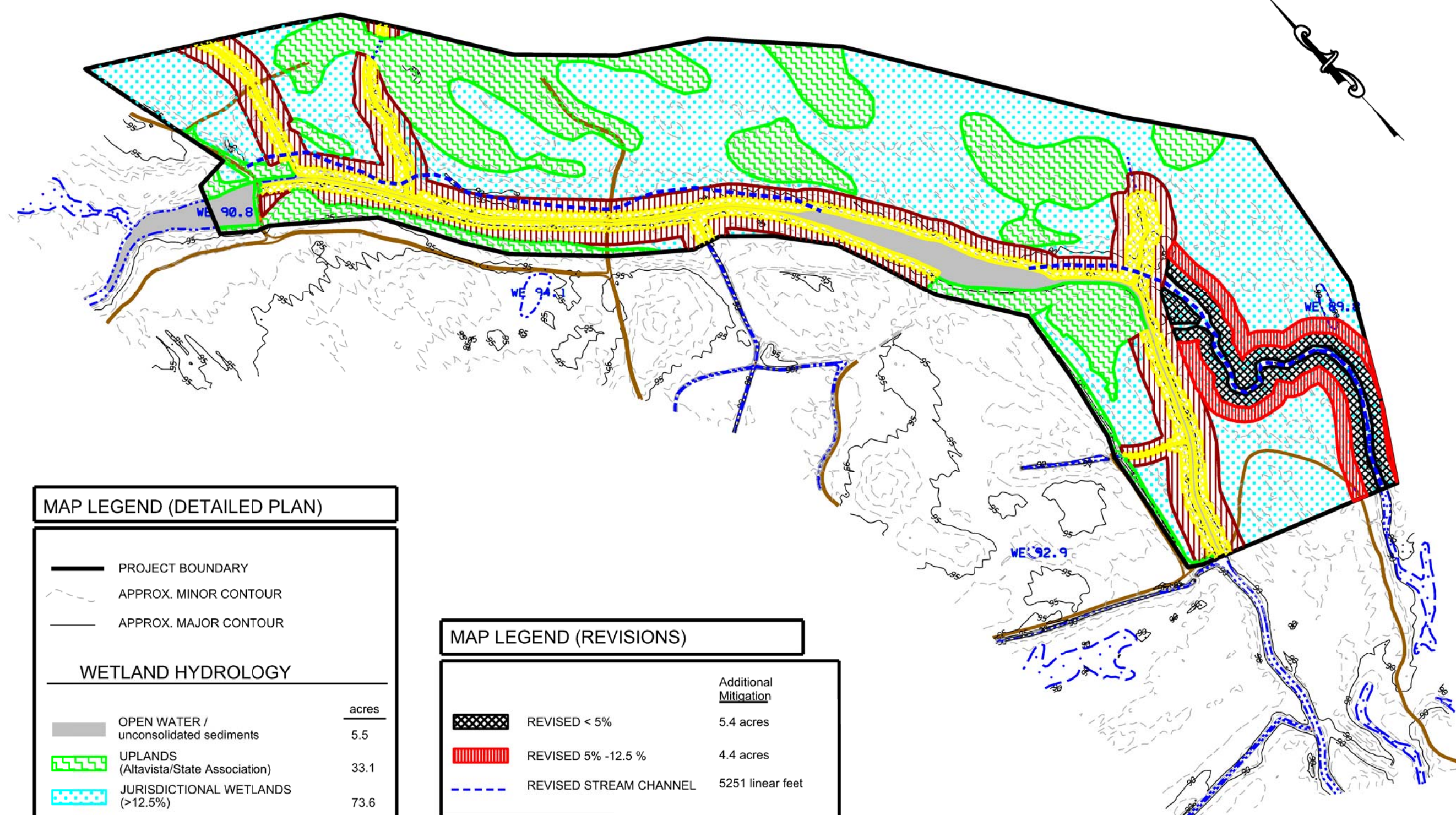
1" = 500'

AXE Project No.:

08-001

FIGURE

2



MAP LEGEND (DETAILED PLAN)

	PROJECT BOUNDARY	
	APPROX. MINOR CONTOUR	
	APPROX. MAJOR CONTOUR	
<b>WETLAND HYDROLOGY</b>		
	OPEN WATER / unconsolidated sediments	5.5
	UPLANDS (Altavista/State Association)	33.1
	JURISDICTIONAL WETLANDS (>12.5%)	73.6
	< 5%	11.3
	5%-12.5%	16.5
	Total	140.0

MAP LEGEND (REVISIONS)

		Additional Mitigation
	REVISED < 5%	5.4 acres
	REVISED 5% -12.5 %	4.4 acres
	REVISED STREAM CHANNEL	5251 linear feet

MAP COMPILED BY PHOTOGRAMMETRIC METHODS.



SCALE IN FEET





REVISIONS	

Client:  
**WETLANDS RESTORATION PROGRAM**  
 Raleigh, North Carolina

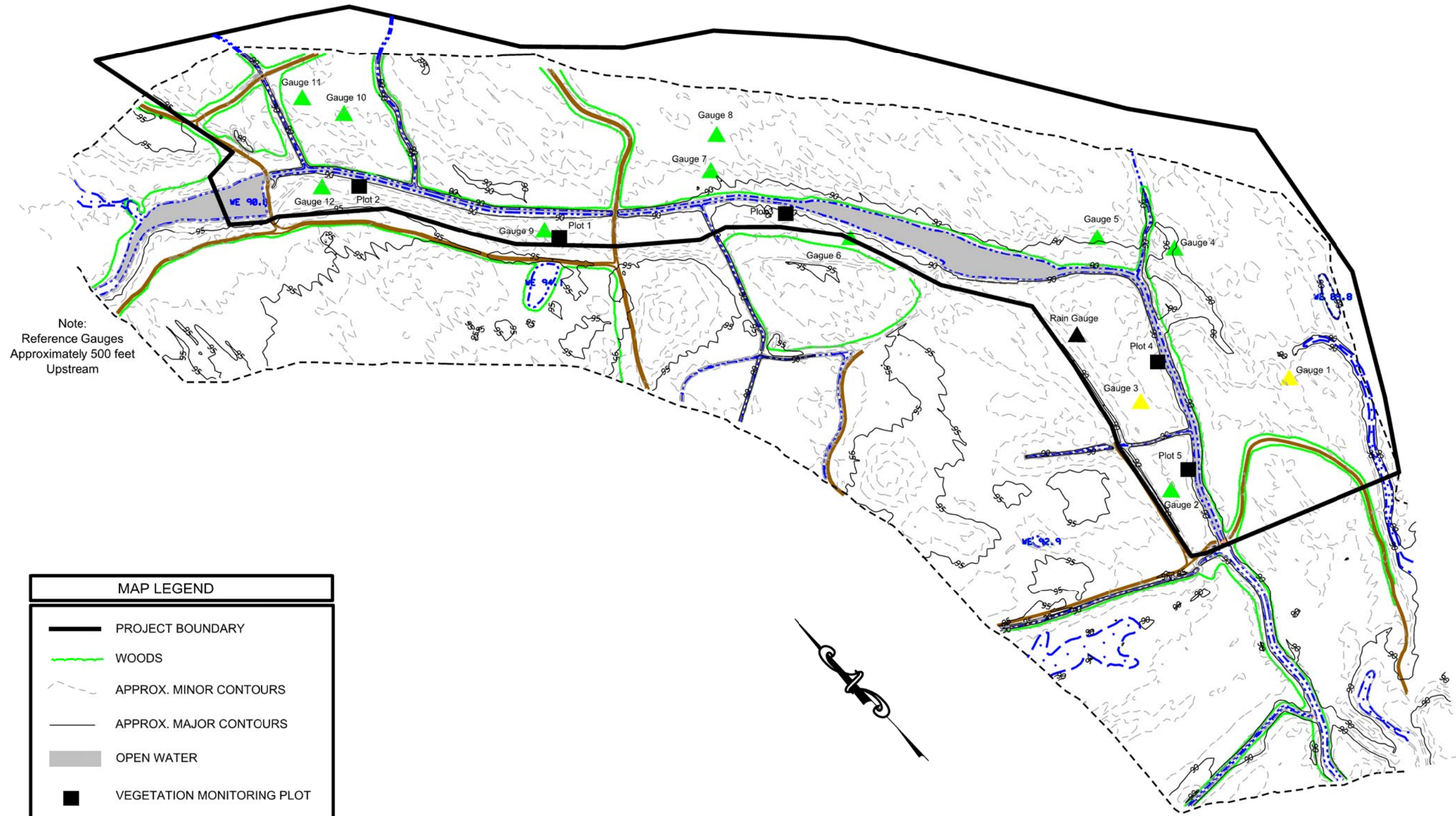
Project:  
**HOWELL WOODS RESTORATION SITE**  
 Project Number 183  
 Year 8 (2009 Monitoring Report)  
 JOHNSTON COUNTY, NORTH CAROLINA

Title:  
**MONITORING PLAN**

Dwn By: WGL	Date: Sept 2009
Ckd By: WGL	Scale: 1" = 500'

AXE Project No.:  
 08-001

FIGURE  
**3**



Note:  
 Reference Gauges  
 Approximately 500 feet  
 Upstream

MAP LEGEND	
	PROJECT BOUNDARY
	WOODS
	APPROX. MINOR CONTOURS
	APPROX. MAJOR CONTOURS
	OPEN WATER
	VEGETATION MONITORING PLOT
	MONITORING GAUGE (>12.5 %)
	MONITORING GAUGE (5 - 12.5 %)
	MONITORING GAUGE (<5 %)

MAP COMPILED BY PHOTOGRAMMETRIC METHODS.



APPENDIX B  
GENERAL PROJECT TABLES

Table 1. Site Restoration Structures and Objectives

Table 2. Project Activity and Reporting History

Table 3. Project Contacts Table

Table 4. Project Attributes Table



<b>Table 1. Project Mitigation Structures and Objectives</b>						
<b>Project Name/Number: Howell Woods (EEP Project Number 183)</b>						
<b>Project Segment or Reach ID</b>	<b>Mitigation Type**</b>	<b>Approach</b>	<b>Linear Footage or Acreage</b>	<b>Revised Linear Footage or Acreage</b>	<b>Stationing</b>	<b>Comment</b>
Howell Woods	R	---	24 acres	34 acres	---	Areas Effectively Drained by Historic Ditch/Canal
Howell Woods	E	---	74 acres	64 acres	---	Areas with Hydrology Effected by Ditches/Canal, but not Drained Below Jurisdictional Threshold
Howell Woods	C	---	4 acres	4 acres	---	Littoral Shelf Excavation
Howell Woods	R	---	--	5251 feet	*	Passive Backwater Slough Restoration

\* No stationing along the reach, linear footage is based on down valley distance of the braided stream channel, as based on inter agency guidance (USACE et. al. 2005)

\*\*R = Restoration

E = Enhancement

C = Creation

<b>Table 2. Project Activity and Reporting History</b>			
<b>Project Name/Number: Howell Woods (EEP Project Number 183)</b>			
<b>Activity or Report</b>	<b>Scheduled Completion</b>	<b>Data Collection Completion</b>	<b>Actual Completion or Delivery</b>
Initial Feasibility Report	---	---	Apr 1999
Mitigation Alternatives Analysis	Spring 2000	---	Spring 2000
Initial Site Planting (approximately 19 acres)	Mar 2000	---	Mar 2000
Year 1 Monitoring (2001)	Fall 2002	---	Nov 2002
<b>Additional Property Acquisition</b>	---	---	*
Compensatory Wetland Mitigation Design Plan	Oct 2001	---	Oct 2001
Site Implementation (Wetland/Backwater Slough)	Fall 2002	---	Jul 2002
Site Planting (approximately 12 acres)	Dec 2002	---	Dec 2002
Year 2 Monitoring (2003)	Dec 2003	---	Dec 2003
Year 3 Monitoring (2004)	Dec 2004	---	Dec 2004
Year 4 Monitoring (2005)	Dec 2005	---	Dec 2005
Year 5 Monitoring (2006)	Dec 2006	Nov 2006	Nov 2006
Year 6 Monitoring (2007) (Groundwater Gauges Only)	Dec 2007	Nov 2007	Nov 2007
Year 7 Monitoring (2008) (Groundwater Gauges Only)	Dec 2008	Nov 2008	Dec 2008
Year 8 Monitoring (2009) (Groundwater Gauges Only)	Dec 2009	Nov 2008	Nov 2009

<b>Table 3. Project Contact Table</b>	
<b>Project Name/Number: Howell Woods (EEP Project Number 183)</b>	
<b>Designer</b>	EcoScience Corporation 1101 Haynes Street, Suite 101 Raleigh, North Carolina 27604 Jerry McCrain (919) 828-3433
<b>Construction Contractor</b>	Backwater Environmental PO Box 1654 Pittsboro, North Carolina 27312 Wes Newell (919) 523-4375
<b>Planting Contractor</b>	Carolina Silvics 908 Indian Trail Road Edenton, North Carolina 27932 Dwight McKinney
<b>Monitoring Performers</b> Years 5-8 (2006-2008)	Axiom Environmental, Inc. 20 Enterprise Street, Suite 7 Raleigh, North Carolina 27607
<b>Monitoring Point of Contact</b>	Grant Lewis 919-215-1693

<b>Table 4. Project Background Table</b>	
<b>Project Name/Number: Howell Woods (EEP Project Number 183)</b>	
Project County	Johnston County, North Carolina
Drainage Area	Primary Neuse River - 1870 square miles Secondary Gar Gut - 9.8 square miles
Drainage impervious cover estimate (%)	< 5
Stream Order	second
Physiographic Region	Coastal Plain
Ecoregion	Southeastern Floodplains and Low Terraces
Rosgen Classification of As-built	D-type
Cowardin Classification	PF01
Dominant Soil Types	Altavista, State, Wehadkee, and Chastain
Reference Site ID	Onsite
USGS HUC for Project and Reference	Project and Reference – 03020201
NCDWQ Subbasin for Project and Reference	Project and Reference – 03-04-04
Any portion of any project segment 303d listed?	No (Stream Index #27-52-7)
Any portion of any project segment upstream of a 303d listed segment?	Yes, reach of the Neuse River in Subbasin 03-04-05 – Stream Index # 27-(56b)
Reasons for 303d listing or stressor	Mercury Level in Fish
% of project easement fenced	0

APPENDIX C

VEGETATION ASSESSMENT DATA

Table 5. Vegetation Plot Mitigation Success Summary

Vegetation Monitoring Plot Photos

Table 6. Wetland Criteria Attainment

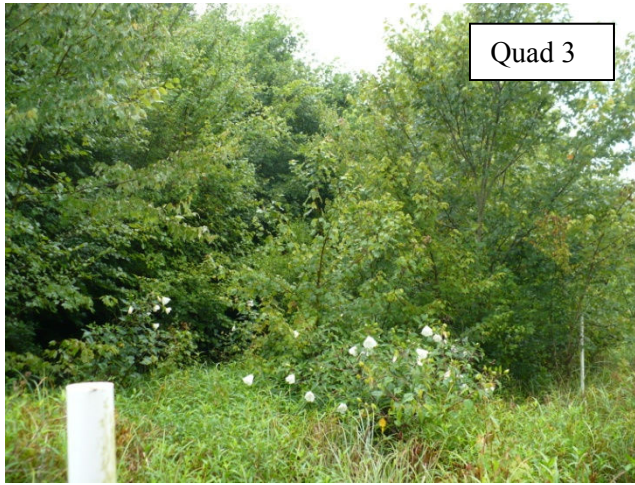
<b>Table 5. Vegetation Plot Mitigation Success Summary</b>						
<b>Project Name/Number: Howell Woods (EEP Project Number 183)</b>						
<b>Species</b>	<b>Year 1 (2002) Totals*</b>	<b>Year 2 (2003) Totals</b>	<b>Year 3 (2004) Totals</b>	<b>Year 4 (2005) Totals</b>	<b>Year 5 (2006) Totals</b>	<b>% Survival</b>
<i>Cephalanthus occidentalis</i>	No Data Available	6	0	0	0	0
<i>Crataegus</i> sp.		*	0	0	8	*
<i>Diospyros virginiana</i>		*	0	0	2	*
<i>Fraxinus pennsylvanica</i>		22	21	28	19	86
<i>Ilex deciduas</i>		*	0	0	1	*
<i>Platanus occidentalis</i>		4	3	3	5	125
<i>Populus heterophylla</i>		*	0	0	1	*
<i>Quercus lyrata</i>		0	0	0	1	--
<i>Quercus nigra</i>		1	1	1	0	0
<i>Quercus pagoda</i>		4	5	4	2	50
<i>Quercus phellos</i>		7	7	6	8	114
<i>Quercus</i> sp.		0	0	0	2	--
<i>Taxodium distichum</i>		1	1	1	2	200
<i>Ulmus americana</i>		*	0	0	1	*
<i>Ulmus rubra</i>		*	0	0	4	*
<i>Ulmus</i> sp.		*	185	130	80	*
<b>Total Stems Per Plot</b>			<b>45*</b>	<b>223</b>	<b>173</b>	<b>136</b>
<b>Stems Per Acre</b>		<b>364</b>	<b>1806</b>	<b>1401</b>	<b>1101</b>	*

\* - Historical project documents necessary to provide this data were unavailable at the time of this report submission.

### Vegetation Plot Photographs

Taken July 2009





Quad 3



Quad 4



Quad 5

**Table 6. Wetland Criteria Attainment**

**Project Name/Number: Howell Woods (EEP Project Number 183)**

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				
7	Yes	Yes				
8	Yes	Yes				
9	Yes	Yes				
10	Yes	Yes				
11	Yes	Yes				
12	Yes	Yes				

APPENDIX D  
GROUNDWATER ASSESSMENT DATA

Table 7. Summary of Groundwater Gauge Results for Years 1 through 8  
Year 8 (2009) Groundwater Gauge Graphs



**Project Name/Number: Howell Woods (EEP Project Number 183)**

**Table 7. Summary of Groundwater Gauge Results for Years 1 through 8**

Gauging	Historic Description	Serial Number	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)							
			Year 1 (2002)^	Year 2 (2003)*	Year 3 (2004)**	Year 4 (2005)	Year 5 (2006)	Year 6 (2007)	Year 7 (2008)	Year 8 (2009)
1	RDSA	S2C9894	Yes/>12.5%	No Data	No Data	No Data	Yes/34 days (14.8 %)	Yes/43 days (18.8 %)	Yes/64 days (27.9%)	Yes/22 days (9.6%)
2	RDSB	B6522D1	Yes/>12.5%	No Data	No Data	Malfunctioned***	Yes/25 days (11.0 %)	No/10 days (4.4 %)	Yes/11 days (5 %)	Yes/28 days (12.2%)
3	RDSC	B6B6E09	No/<5%	No Data	No Data	Malfunctioned***	No/8 days (3.9 %)	No/8 days (3.9 %)	Yes/11 days (5 %)	Yes/22 days (9.6%)
4	INF6	A279A59	Malfunctioned	No Data	No Data	No Data	Yes/76 days (33.2%)	Yes/66 days (28.8%)	Yes/80 days (34.9%)	Yes/109 days (47.6%)
5	INF5	A28984F	Malfunctioned/<5%	No Data	No Data	No Data	Yes/229 days (100 %)	Yes/80 days (34.9 %)	Yes/96 days (41.9%)	Yes/217 days (94.8%)
6	RDSD	B6B4FB9	Malfunctioned/<5%	No Data	No Data	Malfunctioned***	Yes/33 days (14.4 %)	Yes/47 days (20.5 %)	Yes/35 days (15.3%)	Yes/82 days (35.8%)
7	INF1/JG6	EBD85C9	Yes/5-12.5%	Yes/73 days (31.9%)	No Data	Yes/36 days (15.7 %)	Yes/168 days (73.4 %)	Yes/68 days (29.7 %)	Yes/82 days (35.8%)	Yes/201 days (87.8%)
8	INF2	A3C095A	Malfunctioned	Mal-functioned	No Data	No Data	Yes/19 days (8.3 %)	Yes/15 days (6.6 %)	Yes/18 days (7.9%)	Yes/35 days (15.3%)
9	RDSE	B652374	No/<5%	No Data	No Data	Malfunctioned/4 days (1.7 %)**	Yes/29 days (12.7 %)	Yes/44 days (19.2 %)	Yes/37 days (16.2%)	Yes/34 days (14.8%)
10	INF4	A286A2D	Malfunctioned/<5%	Yes/54 days (23.6%)	No Data	No Data	Yes/68 days (29.7 %)	Yes/43 days (18.8 %)	Yes/63 days (27.5%)	Yes/40 days (17.5%)
11	INF3	AB36608	Malfunctioned/<5%	Yes/54 days (23.6%)	No Data	No Data	Yes/32 days (14.0 %)	Yes/41 days (17.9 %)	Yes/51 days (22.3%)	Yes/38 days (16.7%)
12	RDSF	B652408	No/<5%	No Data	No Data	Malfunctioned/4 days (1.7 %)**	Yes/52 days (22.7 %)	Yes/43 days (18.8 %)	Yes/51 days (22.2%)	Yes/73 days (31.9%)
Ref1	REF1	N386A9F1	Yes/>12.5%	Yes/70 days (30.6%)	No Data	No Data	Yes/34 days (14.8 %)	Yes/56 days (24.4 %)	Yes/64 days (27.9%)	Yes/74 days (32.3%)
Ref2	REF2	N3B6AA64	Yes/>12.5%	Yes/74 days (32.3%)	No Data	No Data	Yes/72 days (31.4 %)	Yes/55 days (24.0 %)	Yes/63 days (27.5%)	Yes/61 days (26.6%)

^ - Gauges malfunctioned for the majority of the growing season. Site construction did not occur until mid-growing season; therefore, gauges will be monitored for a sixth growing season.

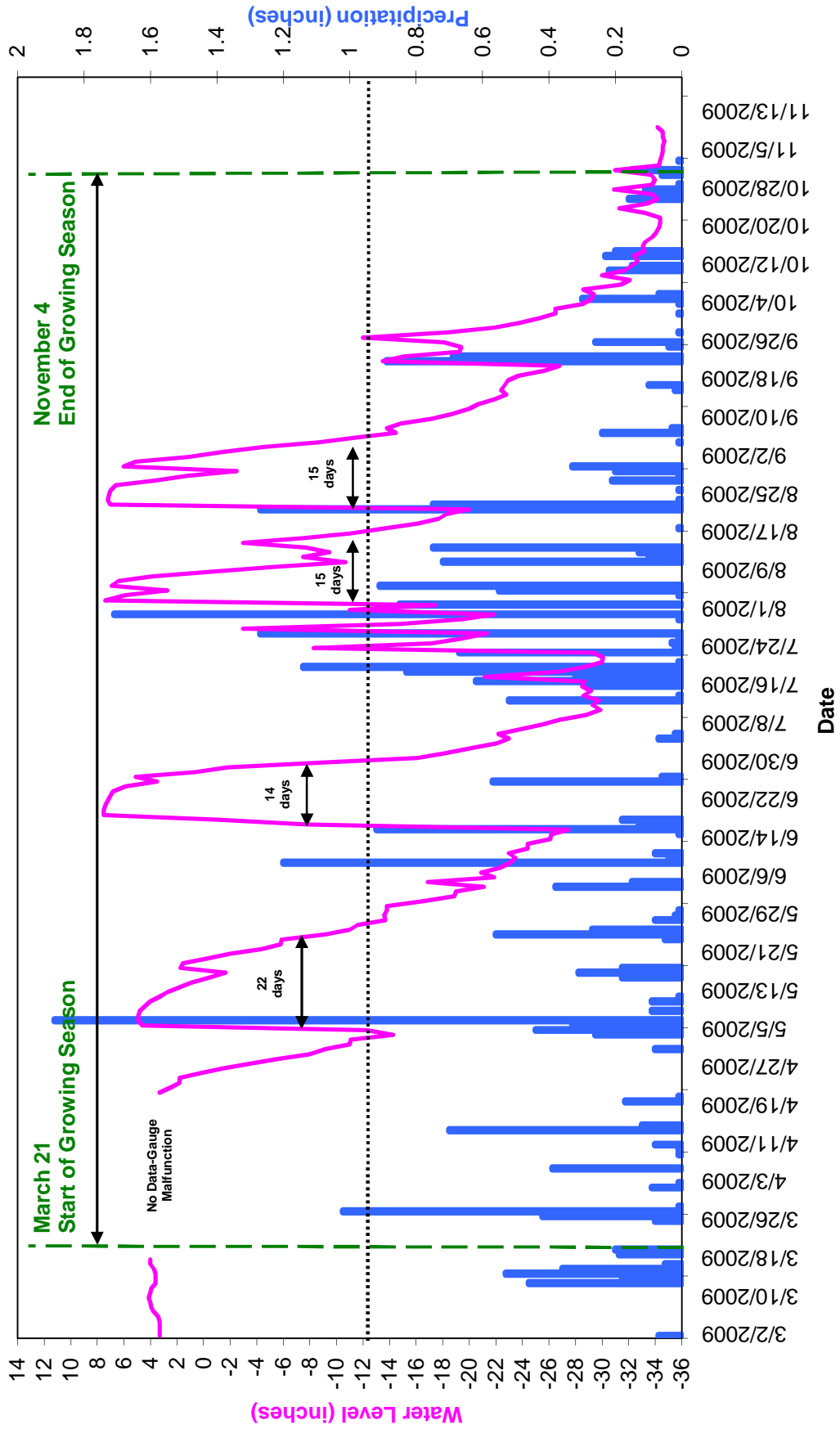
\* - Data for most of the end of the growing season was unavailable.

\*\* - Graph is included in the year 3 (2004) report for one of the Infinities gauges; however, it does not indicate which one.

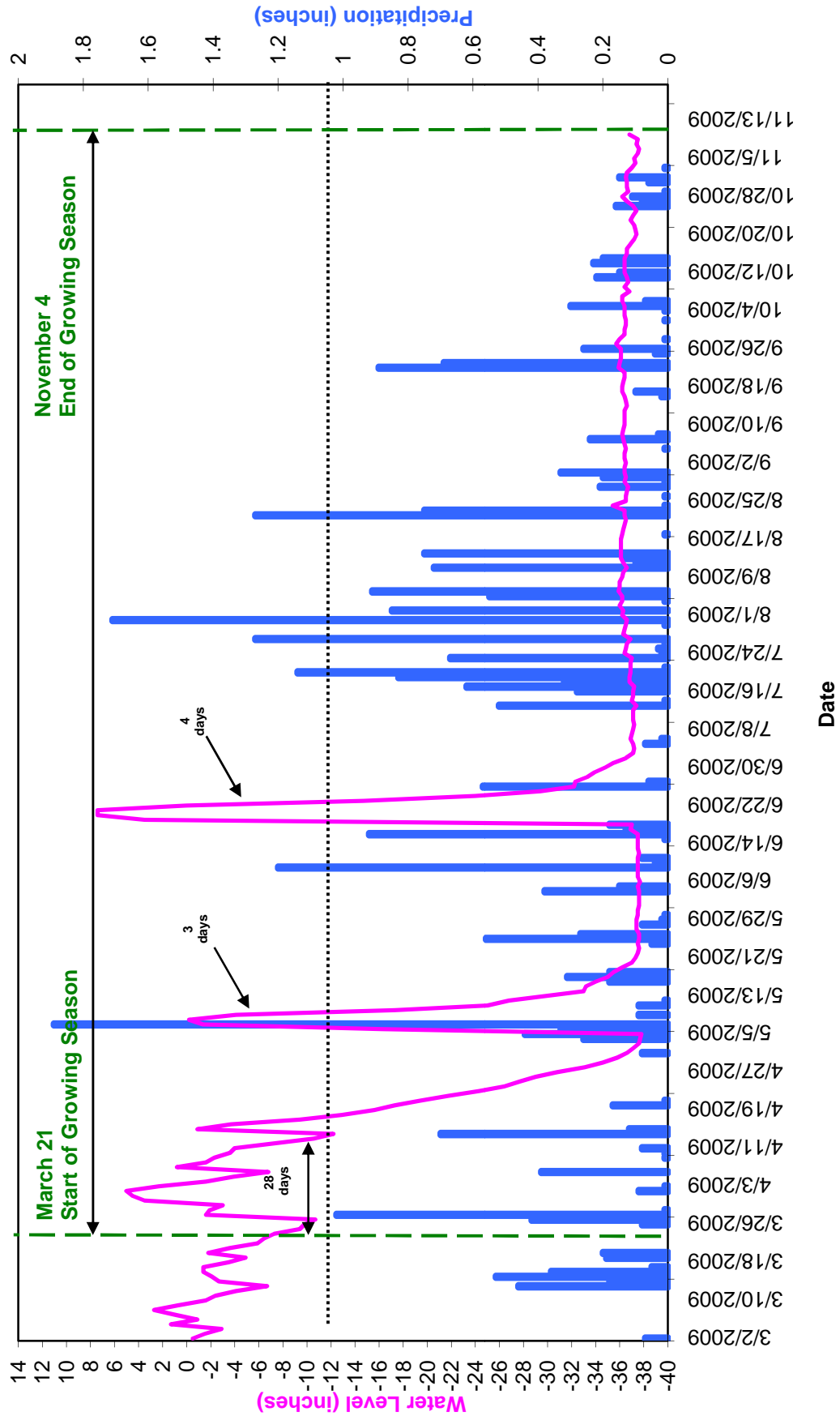
\*\*\* - Gauges malfunctioned for the first several months of the growing season.



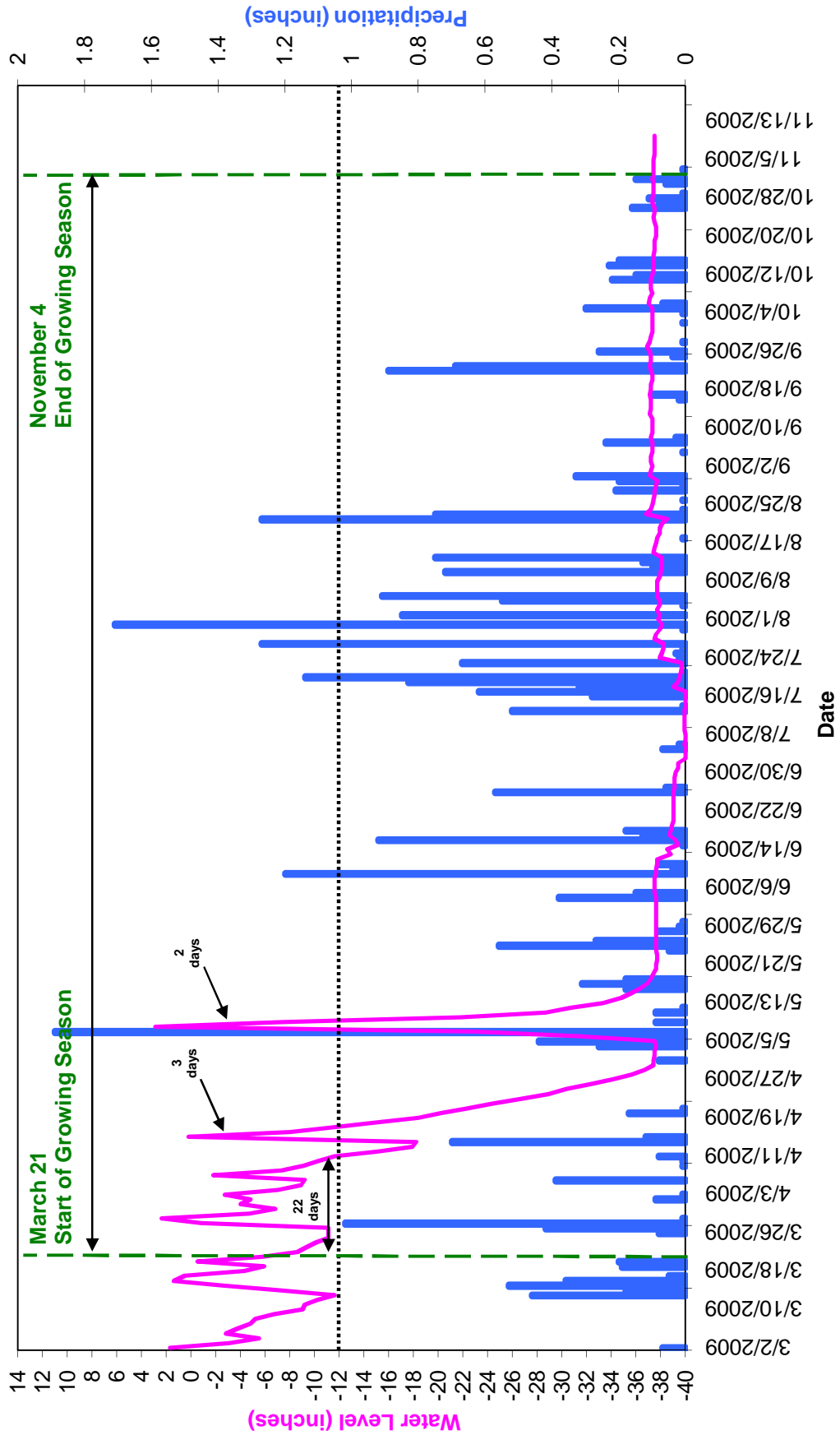
# Gauge 1 Howell Woods Year 8 (2009 Gauge Data)



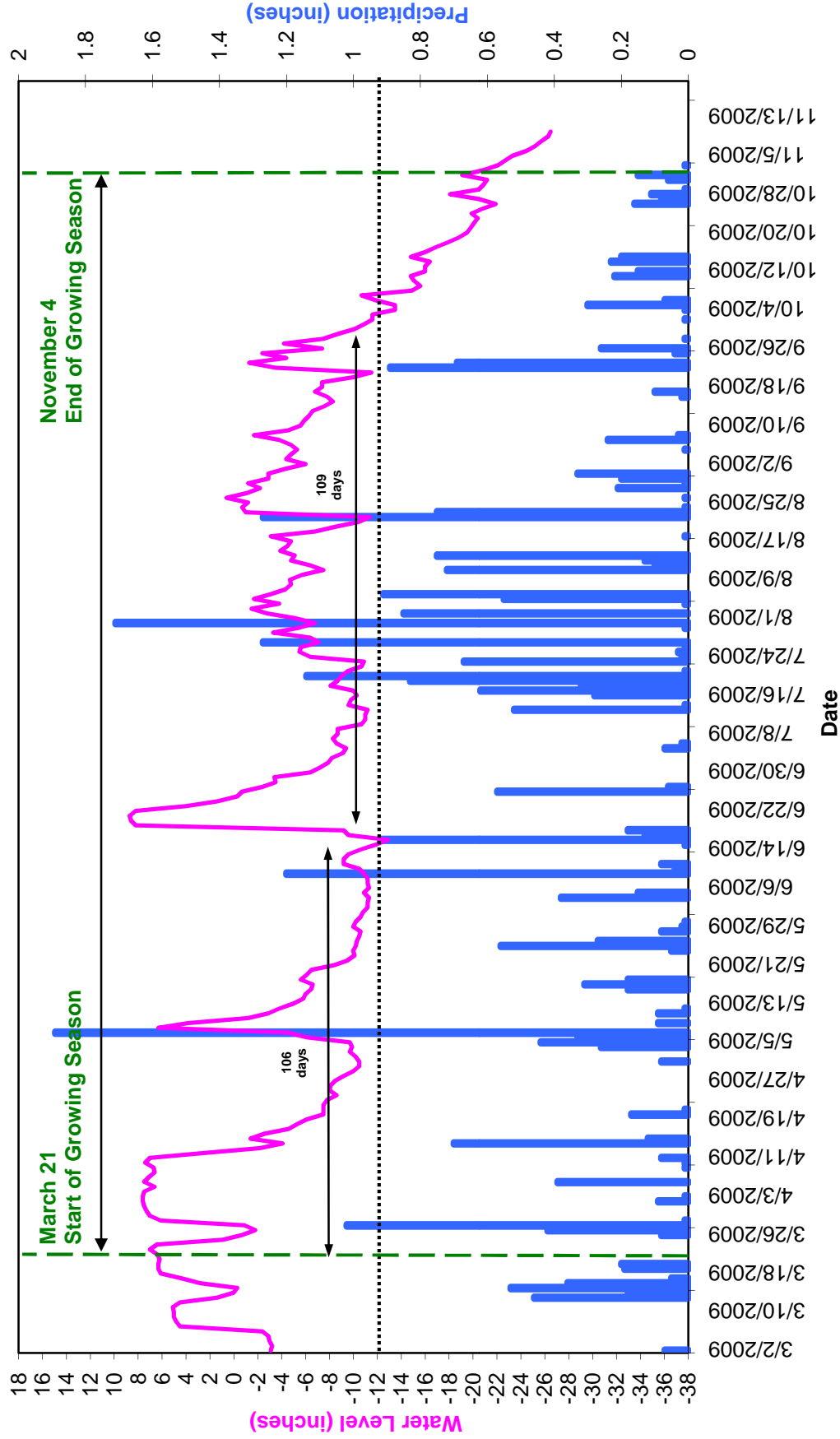
# Gauge 2 Howell Woods Year 8 (2009 Gauge Data)



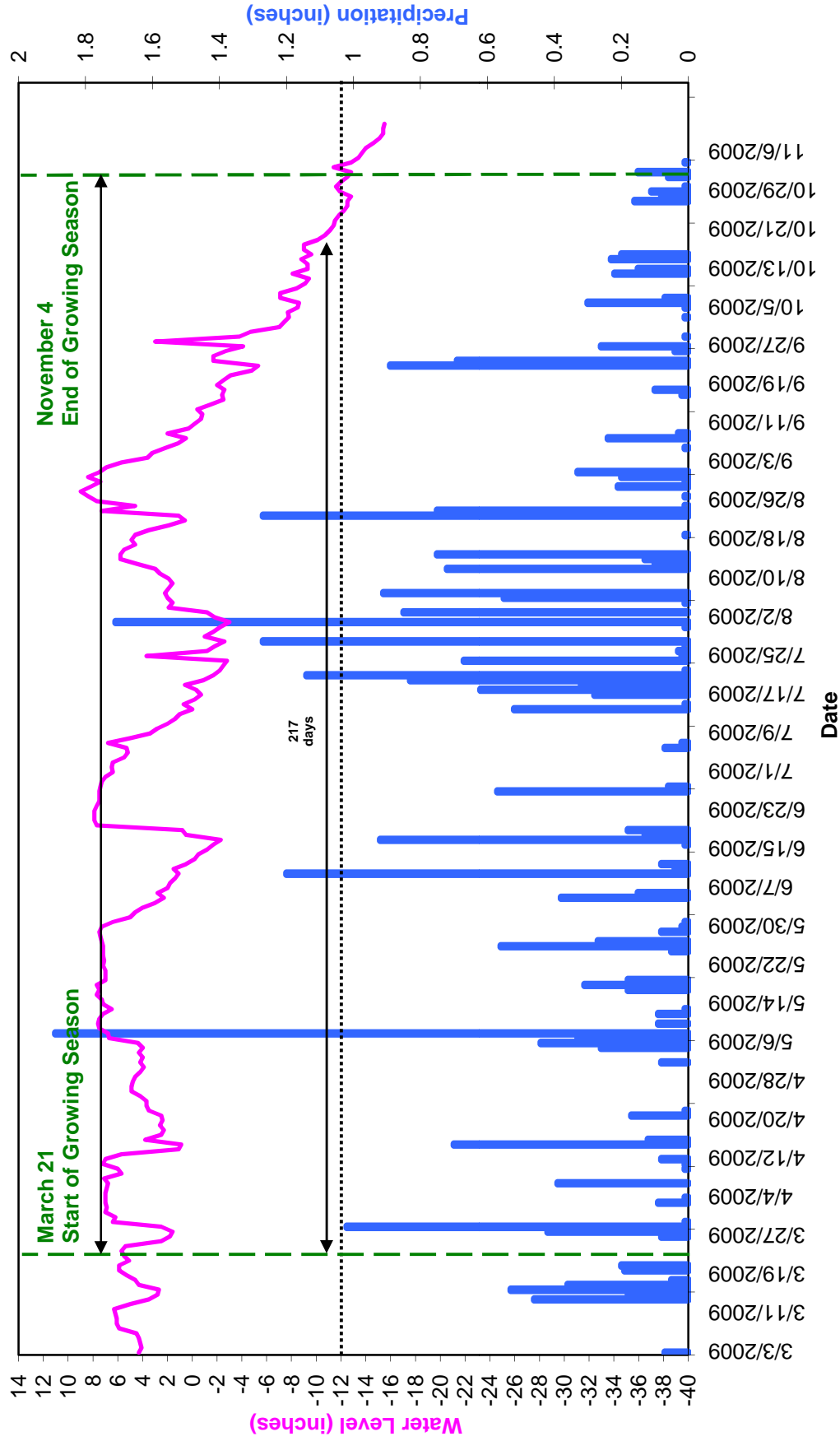
# Gauge 3 Howell Woods Year 8 (2009 Gauge Data)



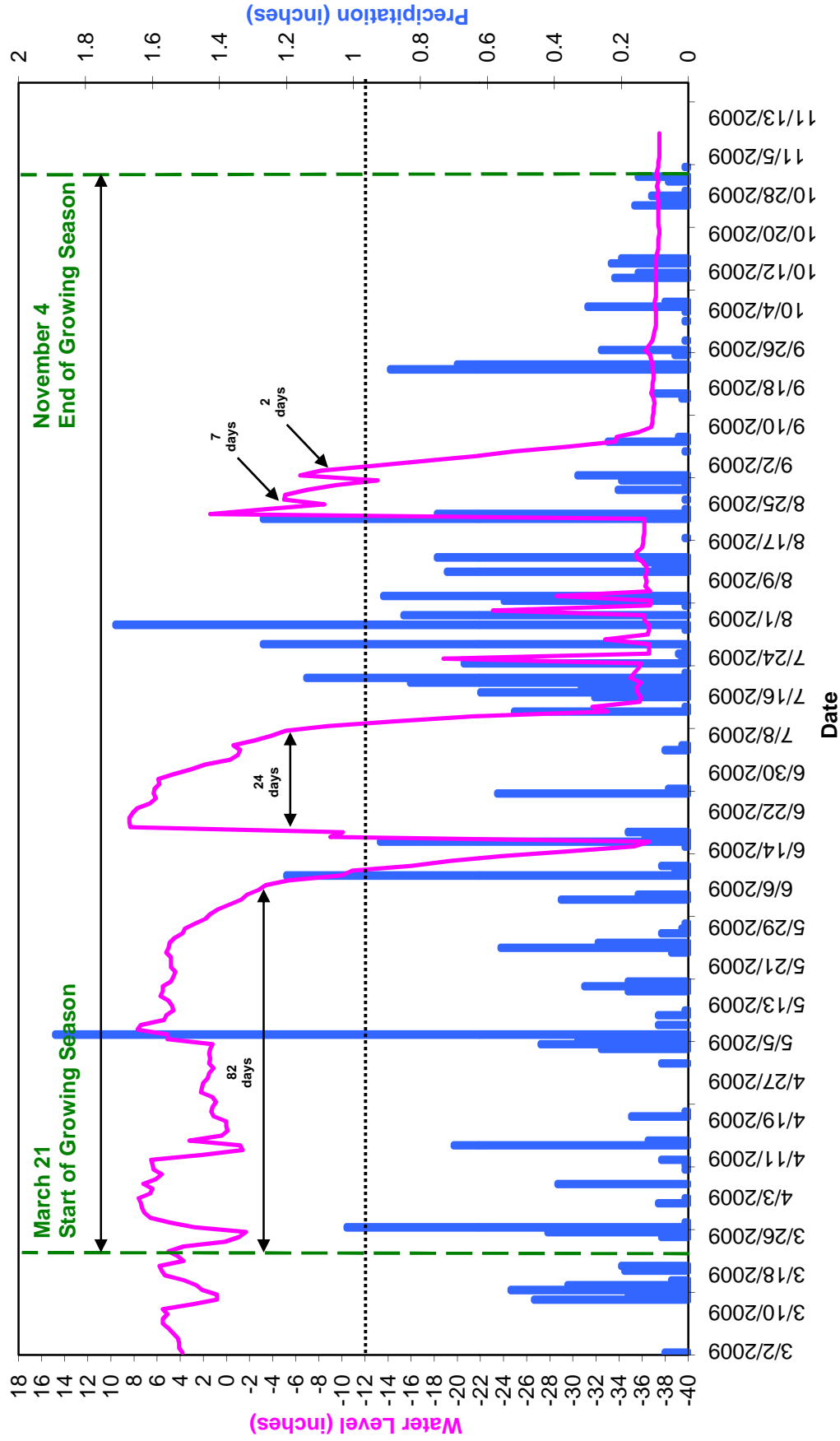
# Gauge 4 Howell Woods Year 8 (2009 Gauge Data)



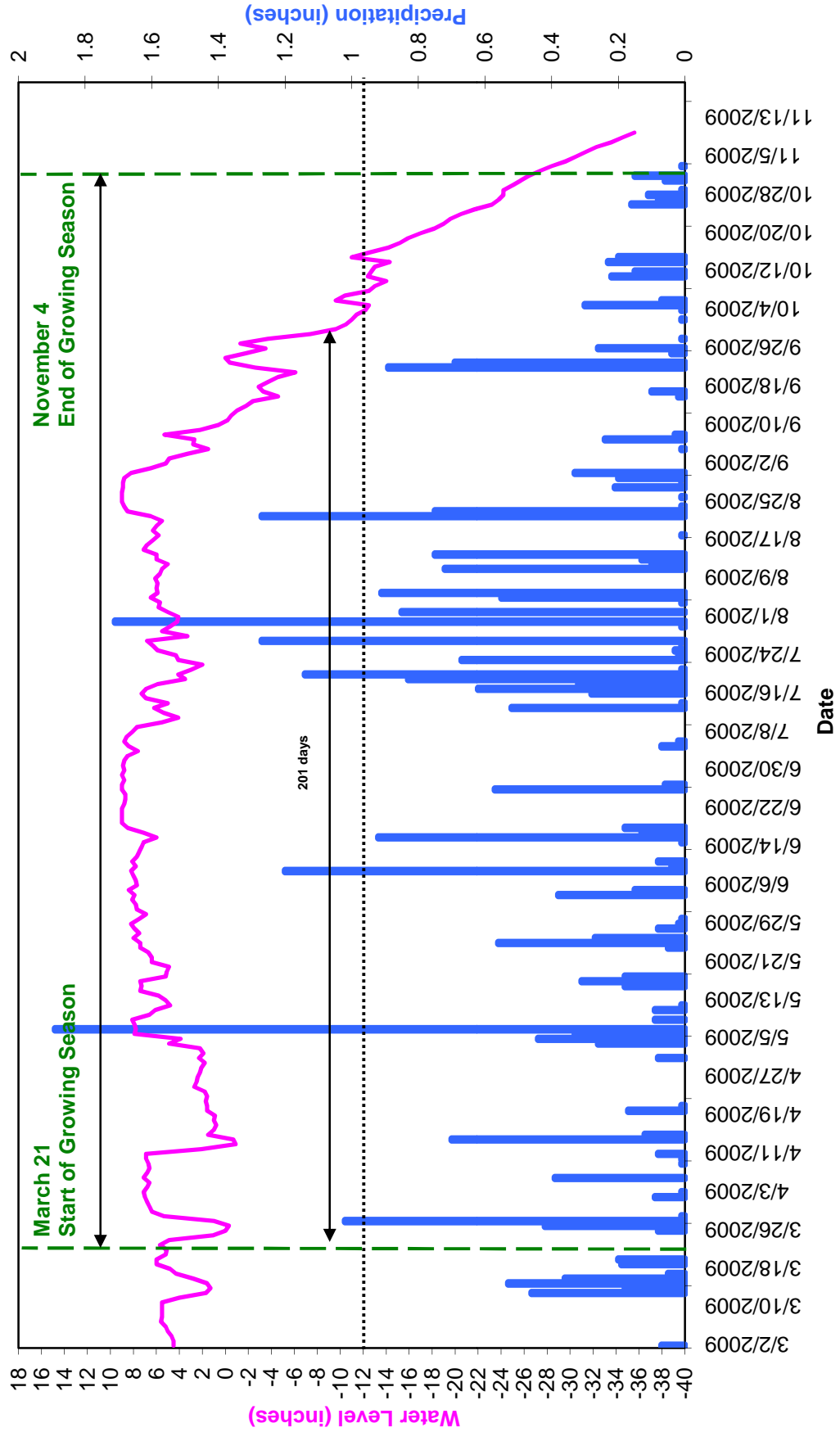
# Gauge 5 Howell Woods Year 8 (2009 Gauge Data)



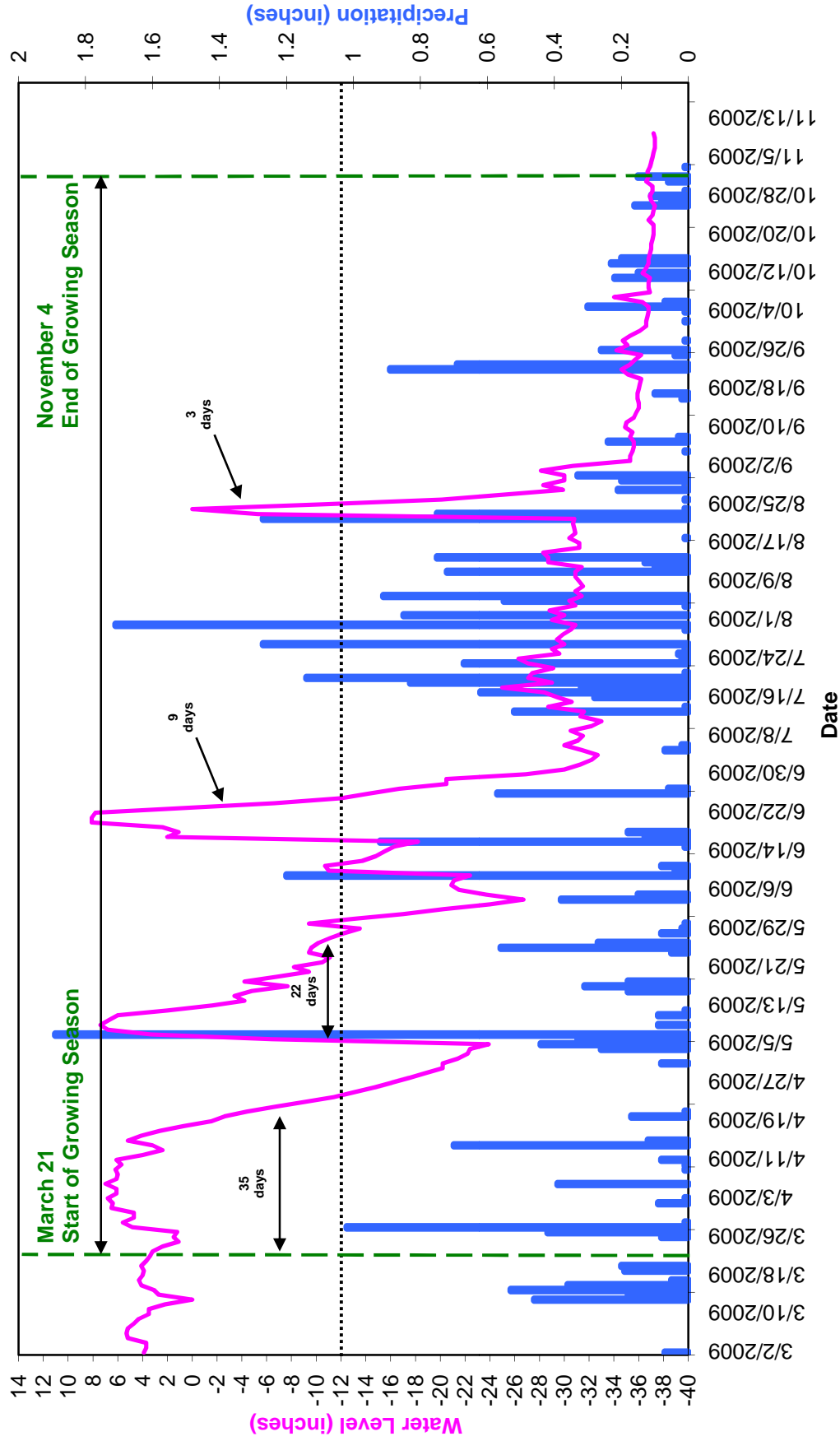
# Gauge 6 Howell Woods Year 8 (2009 Gauge Data)



# Gauge 7 Howell Woods Year 8 (2009 Gauge Data)

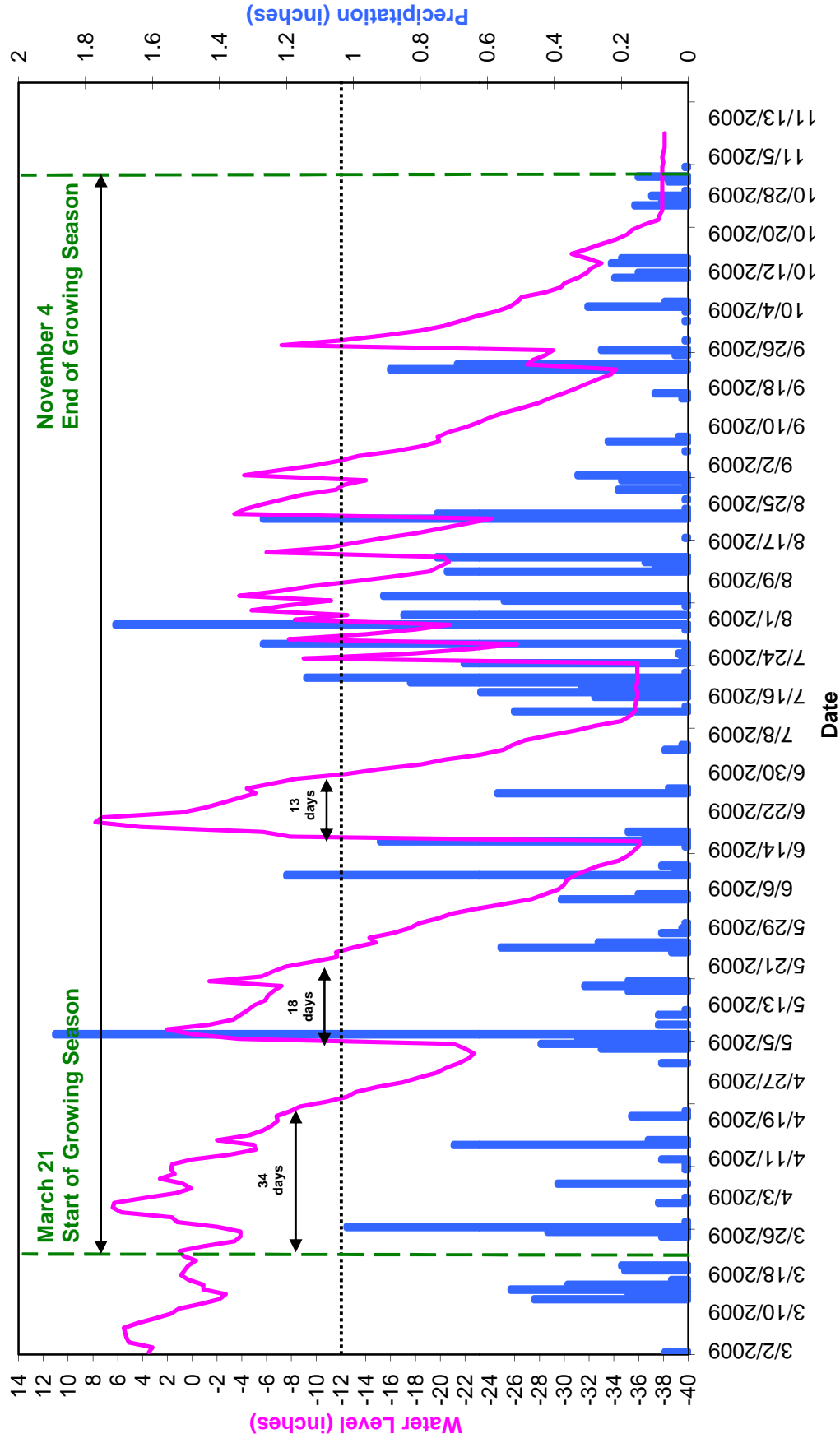


# Gauge 8 Howell Woods Year 8 (2009 Gauge Data)

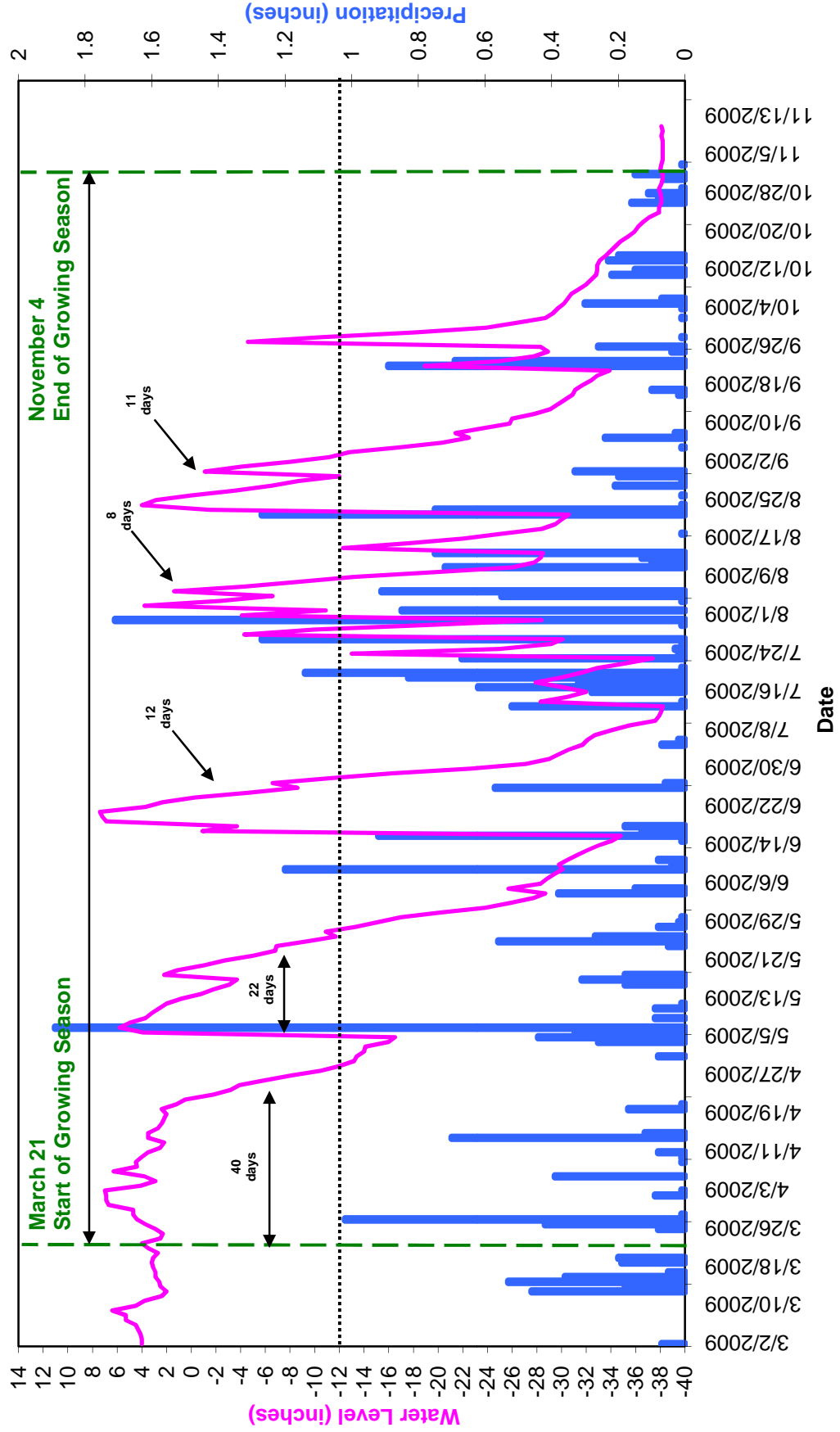




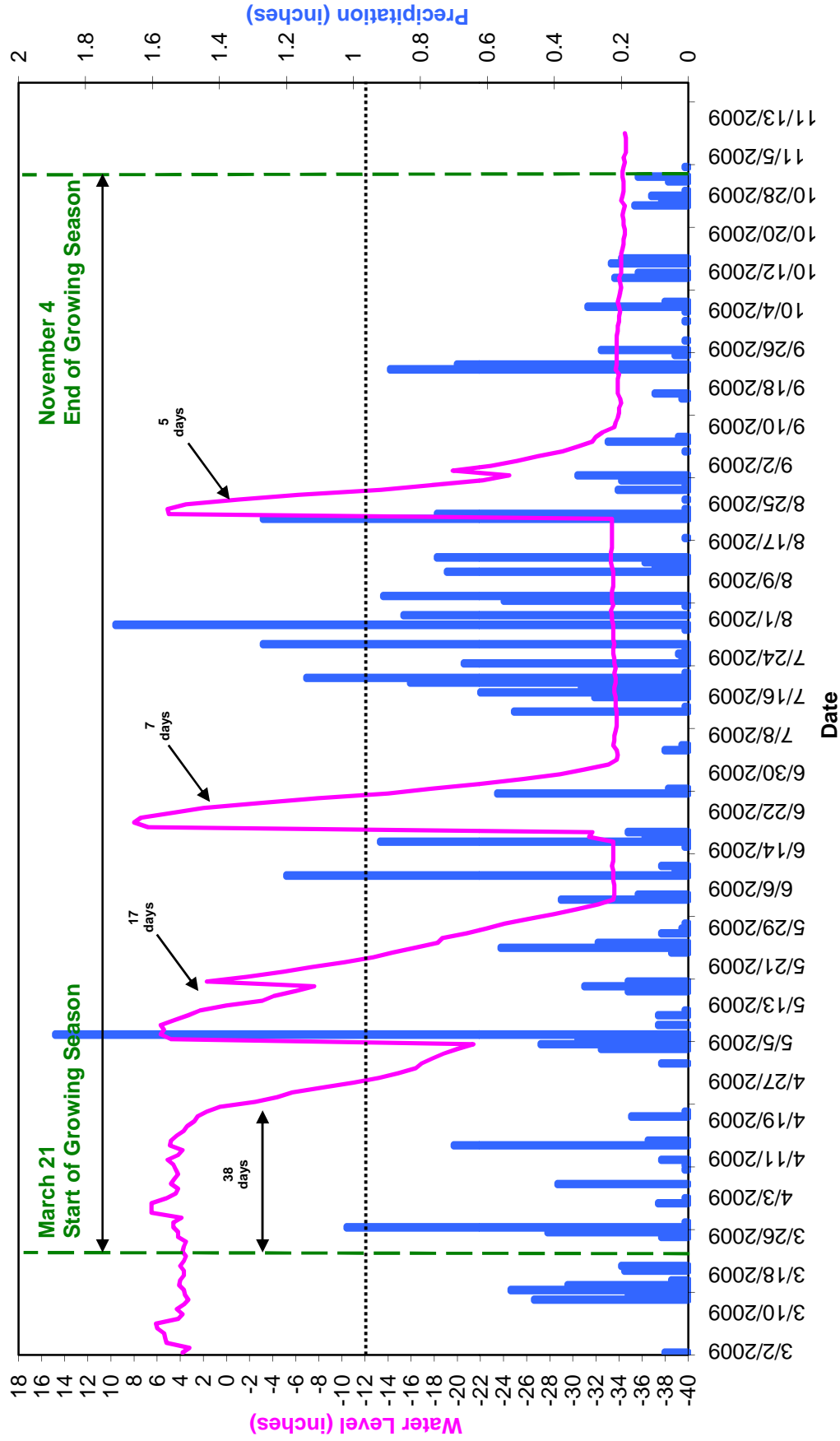
### Gauge 9 Howell Woods Year 8 (2009 Gauge Data)



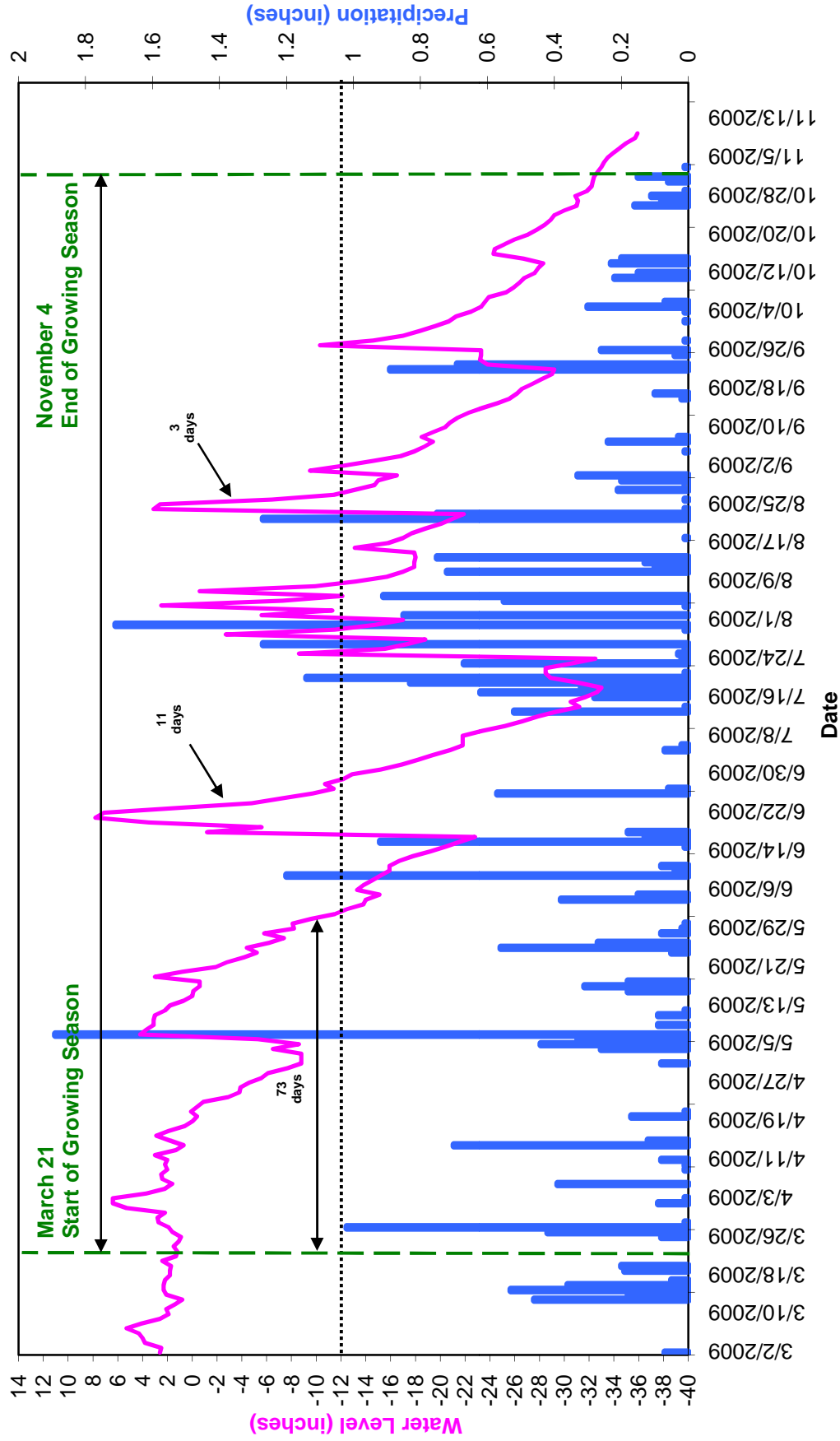
# Gauge 10 Howell Woods Year 8 (2009 Gauge Data)



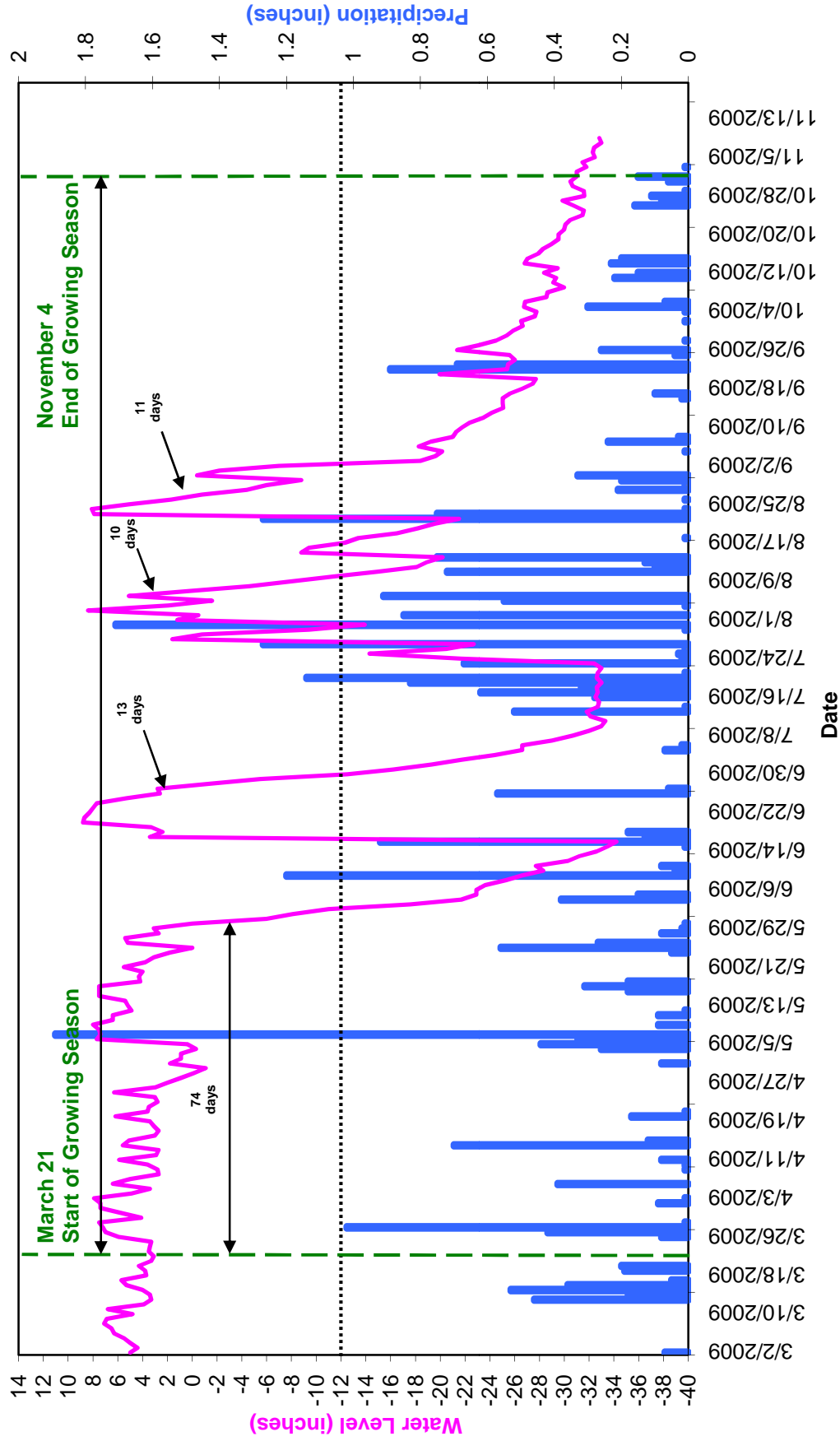
# Gauge 11 Howell Woods Year 8 (2009 Gauge Data)



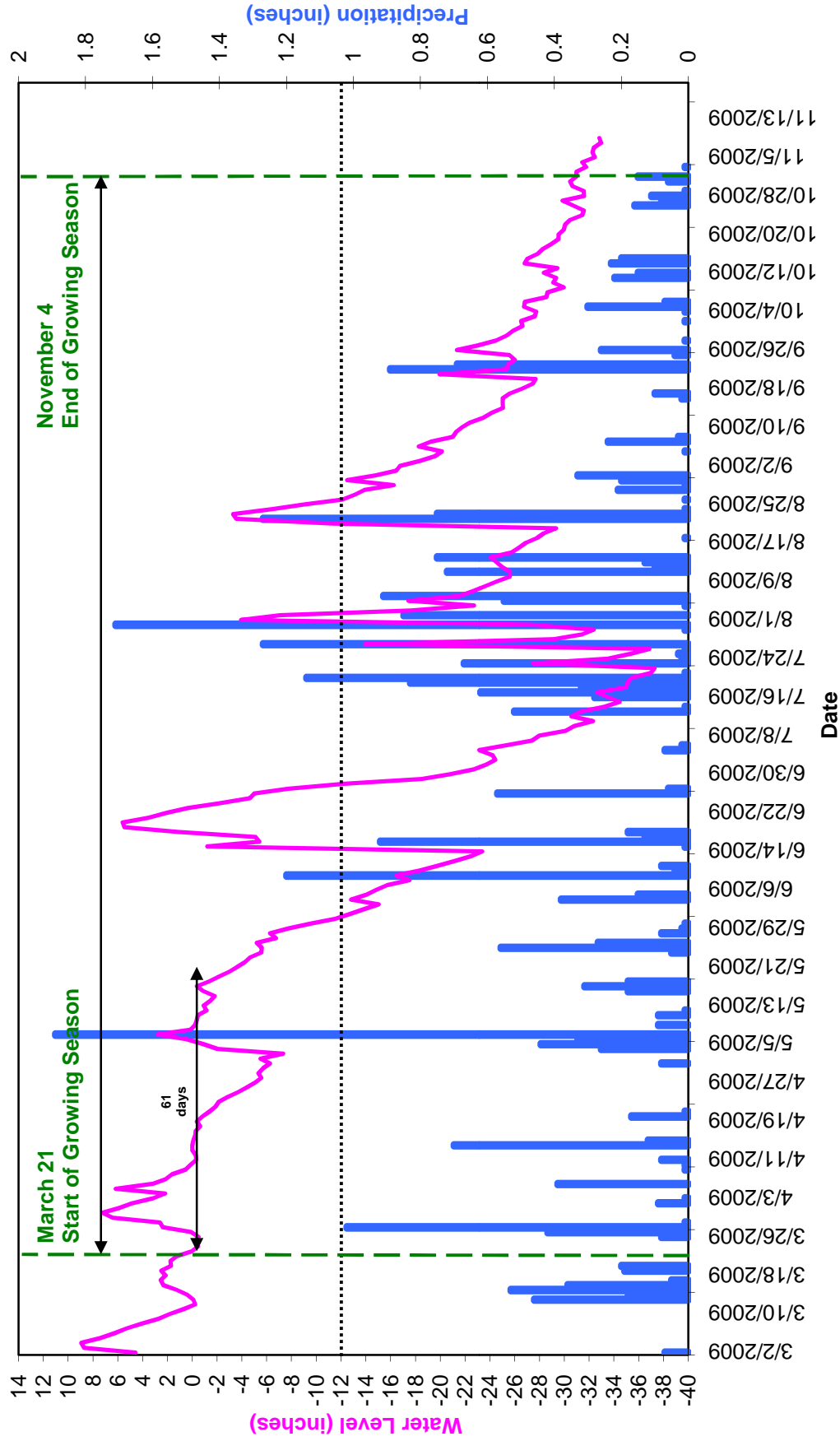
## Gauge 12 Howell Woods Year 8 (2009 Gauge Data)



# Reference Gauge 1 Howell Woods Year 8 (2009 Gauge Data)



# Reference Gauge 2 Howell Woods Year 8 (2009 Gauge Data)



APPENDIX E  
YEAR 8 (2009) GAUGE VEGETATION LISTS

**YEAR 8 (2009) GAUGE VEGETATION LISTS  
HOWELL WOODS RESTORATION SITE  
July 13, 2009**

**GAUGE 1**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Quercus phellos</i></u>	Canopy	FACW-
2.	<u><i>Fraxinus pennsylvanica</i></u>	Canopy	FACW
3.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
4.	<u><i>Ulmus americana</i></u>	Canopy	FACW
5.	<u><i>Celtis laevigata</i></u>	Canopy	FACW
6.	<u><i>Ulmus alata</i></u>	Sapling	FACU+
7.	<u><i>Carpinus caroliniana</i></u>	Sapling	FAC
8.	<u><i>Quercus lyrata</i></u>	Sapling	OBL
9.	<u><i>Ilex decidua</i></u>	Shrub	FACW-
10.	<u><i>Carya cordiformis</i></u>	Shrub	FAC
11.	<u><i>Carex</i> spp.</u>	Herb	FAC to OBL
12.	<u><i>Commelina virginica</i></u>	Herb	FACW
13.	<u><i>Leersia lenticularis</i></u>	Herb	OBL
14.	<u><i>Arundinaria gigantea</i></u>	Herb	FACW
15.	<u><i>Smilax rotundifolia</i></u>	Herb	OBL

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **93%**

**GAUGE 2**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Ulmus alata</i></u>	Canopy	FACU+
2.	<u><i>Fraxinus pennsylvanica</i></u>	Canopy	FACW
3.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
4.	<u><i>Ulmus</i> sp.</u>	Canopy	FAC to FACW
5.	<u><i>Platanus occidentalis</i></u>	Canopy	FACW-
6.	<u><i>Quercus pagoda</i></u>	Canopy	FACW-
7.	<u><i>Crataegus</i> sp.</u>	Canopy	FAC to OBL
8.	<u><i>Dulchium arundinaceum</i></u>	Herb	OBL
9.	<u><i>Juncus effusus</i></u>	Herb	FACW+
10.	<u><i>Carex lurida/comosa</i></u>	Herb	OBL
11.	<u><i>Campsis radicans</i></u>	Herb	FAC
12.	<u><i>Toxicodendron radicans</i></u>	Herb	FAC

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **92%**

**GAUGE 3**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Ulmus alata</i></u>	Canopy	FACU+
2.	<u><i>Fraxinus pennsylvanica</i></u>	Canopy	FACW
3.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
4.	<u><i>Acer rubrum</i></u>	Canopy	FAC
5.	<u><i>Carex</i> spp.</u>	Herb	FAC to OBL
6.	<u><i>Parthenocissus quinquefolia</i></u>	Herb	FAC
7..	<u><i>Toxicodendron radicans</i></u>	Herb	FAC

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **86%**



**YEAR 8 (2009) HOWELL WOODS (continued)**  
**July 13, 2009**

**GAUGE 4**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Nyssa biflora</i></u>	Canopy	OBL
2.	<u><i>Ulmus americana</i></u>	Canopy	FACW
3.	<u><i>Acer rubrum</i></u>	Canopy	FAC
4.	<u><i>Quercus lyrata</i></u>	Canopy	OBL
5.	<u><i>Ilex decidua</i></u>	Shrub	FAC-
6.	<u><i>Carex</i> spp.</u>	Herb	FAC to OBL
7.	<u><i>Leersia lenticularis</i></u>	Herb	OBL
8.	<u><i>Boehmeria cylindrica</i></u>	Herb	FACW+
9.	<u><i>Saururus cernuus</i></u>	Herb	OBL
10.	<u><i>Commelina virginica</i></u>	Herb	FACW
11.	<u><i>Smilax bona-nox</i></u>	Herb	FAC

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **91%**

**GAUGE 5**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Ulmus americana</i></u>	Canopy	FACW
2.	<u><i>Nyssa biflora</i></u>	Canopy	OBL
3.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
4.	<u><i>Celtis laevigata</i></u>	Sapling	FACW
5.	<u><i>Crataegus</i> sp.</u>	Sapling	FAC to OBL
6.	<u><i>Carpinus caroliniana</i></u>	Sapling	FAC
7.	<u><i>Fraxinus pennsylvanica</i></u>	Shrub	FACW
8.	<u><i>Ilex decidua</i></u>	Shrub	FACW-
9.	<u><i>Boehmeria cylindrica</i></u>	Herb	FACW+
10.	<u><i>Carex</i> spp.</u>	Herb	FAC to OBL
11.	<u><i>Populus deltoides</i></u>	Herb	FAC+
12.	<u><i>Acer rubrum</i></u>	Herb	FAC
13.	<u><i>Commelina virginica</i></u>	Herb	FACW
14.	<u><i>Arundinaria gigantea</i></u>	Herb	FACW
15.	<u><i>Leersia lenticularis</i></u>	Herb	OBL
16.	<u><i>Saururus cernuus</i></u>	Herb	OBL
17.	<u><i>Taxodium distichum</i></u>	Herb	OBL
18.	<u><i>Toxicodendron radicans</i></u>	Herb	FAC

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **100%**

**GAUGE 6**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Ulmus alata</i></u>	Canopy	FACU+
2.	<u><i>Ulmus rubra</i></u>	Canopy	FAC
3.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
4.	<u><i>Acer rubrum</i></u>	Canopy	FAC
5.	<u><i>Fraxinus pennsylvanica</i></u>	Canopy	FACW
6.	<u><i>Betula nigra</i></u>	Canopy	FACW
7.	<u><i>Carex</i> spp.</u>	Herb	FAC to OBL
8.	<u><i>Campsis radicans</i></u>	Herb	FAC
9.	<u><i>Boehmeria cylindrica</i></u>	Herb	FACW+
10.	<u><i>Commelina virginica</i></u>	Herb	FACW

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **90%**

**YEAR 8 (2009) HOWELL WOODS (continued)**  
**July 13, 2009**

**GAUGE 7**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Nyssa biflora</i></u>	Canopy	OBL
2.	<u><i>Celtis laevigata</i></u>	Canopy	FACW
3.	<u><i>Acer rubrum</i></u>	Canopy	FAC
4.	<u><i>Fraxinus pennsylvanica</i></u>	Canopy	FACW
5.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
6.	<u><i>Ulmus rubra</i></u>	Sapling	FAC
7.	<u><i>Ilex decidua</i></u>	Shrub	FACW-
8.	<u><i>Celtis laevigata</i></u>	Shrub	FACW
9.	<u><i>Carex</i> spp.</u>	Herb	FAC to OBL
10.	<u><i>Smilax rotundifolia</i></u>	Herb	FAC
11.	<u><i>Microstegium vimeneum</i></u>	Herb	FAC+
12.	<u><i>Commelina virginica</i></u>	Herb	FACW
13.	<u><i>Boehmeria cylindrical</i></u>	Herb	FACW+
14.	<u><i>Smilax bona-nox</i></u>	Herb	FAC

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **100%**

**GAUGE 8**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Quercus phellos</i></u>	Canopy	FACW-
2.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
3.	<u><i>Ulmus americana</i></u>	Canopy	FACW
4.	<u><i>Acer rubrum</i></u>	Canopy	FAC
5.	<u><i>Diospyros virginiana</i></u>	Sapling	FAC
6.	<u><i>Carpinus caroliniana</i></u>	Sapling	FAC
7.	<u><i>Celtis laevigata</i></u>	Sapling	FACW
8.	<u><i>Fraxinus pennsylvanica</i></u>	Shrub	FACW
9.	<u><i>Campsis radicans</i></u>	Herb	FAC
10.	<u><i>Carex</i> spp.</u>	Herb	FAC to OBL
11.	<u><i>Commelina virginica</i></u>	Herb	FACW
12.	<u><i>Boehmeria cylindrical</i></u>	Herb	FACW+
13.	<u><i>Smilax rotundifolia</i></u>	Herb	FAC
14.	<u><i>Toxicodendron radicans</i></u>	Herb	FAC

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **100%**

**GAUGE 9**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
2.	<u><i>Diospyros virginiana</i></u>	Canopy	FAC
3.	<u><i>Populus deltoids</i></u>	Canopy	FAC+
4.	<u><i>Ulmus americana</i></u>	Canopy	FACW
5.	<u><i>Acer rubrum</i></u>	Shrub	FAC
6.	<u><i>Salix nigra</i></u>	Shrub	OBL
7.	<u><i>Cephalanthus occidentalis</i></u>	Shrub	OBL
8.	<u><i>Hibiscus moscheutos</i></u>	Herb	OBL
9.	<u><i>Aster vimineus</i></u>	Herb	FAC
10.	<u><i>Andropogon virginicus</i></u>	Herb	FACU
11.	<u><i>Carex</i> spp.</u>	Herb	FAC to OBL
12.	<u><i>Polygonum punctatum</i></u>	Herb	FACW+
13.	<u><i>Juncus effusus</i></u>	Herb	FACW+
14.	<u><i>Scirpus cyperinus</i></u>	Herb	OBL
15.	<u><i>Rhynchospora corniculata</i></u>	Herb	OBL
16.	<u><i>Diodia virginiana</i></u>	Herb	FACW
17.	<u><i>Rubus argutus</i></u>	Herb	FACU+

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **88%**

YEAR 8 (2009) HOWELL WOODS (continued) July 13, 2009

GAUGE 10

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Nyssa biflora</i></u>	Canopy	OBL
2.	<u><i>Acer rubrum</i></u>	Canopy	FAC
3.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
4.	<u><i>Fraxinus pennsylvanica</i></u>	Canopy	FAC+
5.	<u><i>Ulmus americana</i></u>	Canopy	FACW
6.	<u><i>Carpinus caroliniana</i></u>	Sapling	FAC
7.	<u><i>Ilex deciduas</i></u>	Sapling	FACW-
8.	<u><i>Quercus pagoda</i></u>	Shrub	FAC+
9.	<u><i>Diospyros virginiana</i></u>	Shrub	FAC
10.	<u><i>Smilax rotundifolia</i></u>	Shrub	FAC
11.	<u><i>Carex spp.</i></u>	Herb	FAC to OBL
12.	<u><i>Commelina virginica</i></u>	Herb	FACW
13.	<u><i>Bignonia capreolata</i></u>	Herb	FAC
14.	<u><i>Leersia lenticularis</i></u>	Herb	OBL
15.	<u><i>Toxicodendron radicans</i></u>	Herb	FAC
16.	<u><i>Boehmeria cylindrical</i></u>	Herb	FACW+
17.	<u><i>Campsis radicans</i></u>	Herb	FAC
18.	<u><i>Cretagus sp.</i></u>	Herb	FAC to OBL
19.	<u><i>Microstegium vimeneum</i></u>	Herb	FAC

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **100%**

GAUGE 11

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Carpinus caroliniana</i></u>	Canopy	FAC
2.	<u><i>Fraxinus pennsylvanica</i></u>	Canopy	FACW
3.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
4.	<u><i>Acer rubrum</i></u>	Canopy	FAC
5.	<u><i>Diospyros virginiana</i></u>	Canopy	FAC
6.	<u><i>Ilex decidua</i></u>	Sapling	FACW-
7.	<u><i>Carex spp.</i></u>	Herb	FAC to OBL
8.	<u><i>Microstegium vimineum</i></u>	Herb	FAC
9.	<u><i>Leersia lenticularis</i></u>	Herb	OBL
10.	<u><i>Smilax rotundifolia</i></u>	Herb	FAC
11.	<u><i>Campsis radicans</i></u>	Herb	FAC
12.	<u><i>Saururus cernuus</i></u>	Herb	OBL
13.	<u><i>Boehmeria cylindrical</i></u>	Herb	FACW+

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **100%**

GAUGE 12

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Quercus lyrata</i></u>	Canopy	OBL
2.	<u><i>Quercus pagoda</i></u>	Canopy	FAC
3.	<u><i>Quercus phellos</i></u>	Canopy	FACW-
4.	<u><i>Crataegus sp.</i></u>	Sapling	FAC to OBL
5.	<u><i>Populus deltoids</i></u>	Sapling	FAC+
6.	<u><i>Fraxinus pennsylvanica</i></u>	Sapling	FACW
7.	<u><i>Platanus occidentalis</i></u>	Sapling	FACW-
8.	<u><i>Betula nigra</i></u>	Sapling	FACW
9.	<u><i>Taxodium distichum</i></u>	Sapling	OBL
10.	<u><i>Ulmus alata</i></u>	Sapling	FACU+
11.	<u><i>Hibiscus moscheutos</i></u>	Herb	OBL
12.	<u><i>Aster vimineus</i></u>	Herb	FAC
13.	<u><i>Acer rubrum</i></u>	Herb	FAC
14.	<u><i>Carex sp.</i></u>	Herb	FAC to OBL
15.	<u><i>Pluchea camphorata</i></u>	Herb	FACW
16.	<u><i>Andropogon virginicus</i></u>	Herb	FAC-
	<u><i>Ptilimnium capillaceum</i></u>	Herb	OBL

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **88%**

**YEAR 8 (2009) HOWELL WOODS (continued)**  
**July 13, 2009**

**REFERENCE GAUGE 1**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Quercus lyrata</i></u>	Canopy	OBL
2.	<u><i>Nyssa biflora</i></u>	Canopy	OBL
3.	<u><i>Ulmus americana</i></u>	Canopy	FACW
4.	<u><i>Acer rubrum</i></u>	Canopy	FAC
5.	<u><i>Fraxinus pennsylvanica</i></u>	Canopy	FACW
6.	<u><i>Quercus laurifolia</i></u>	Canopy	FACW
7.	<u><i>Carpinus caroliniana</i></u>	Sapling	FAC
8.	<u><i>Liquidambar styraciflua</i></u>	Sapling	FAC+
9.	<u><i>Ilex decidua</i></u>	Shrub	FACW-
10.	<u><i>Commelina virginica</i></u>	Herb	FACW
11.	<u><i>Carex</i> spp.</u>	Herb	FAC to OBL
12.	<u><i>Leersia lenticularis</i></u>	Herb	OBL
13.	<u><i>Boehmeria cylindrica</i></u>	Herb	FACW+
14.	<u><i>Campsis radicans</i></u>	Herb	FAC
15.	<u><i>Smilax rotundifolia</i></u>	FAC	FAC

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **100%**

**REFERENCE GAUGE 2**

	<u>Dominant Plant Species</u>	<u>Stratum</u>	<u>Indicator</u>
1.	<u><i>Quercus lyrata</i></u>	Canopy	OBL
2.	<u><i>Quercus phellos</i></u>	Canopy	FACW-
3.	<u><i>Acer rubrum</i></u>	Canopy	FAC
4.	<u><i>Liquidambar styraciflua</i></u>	Canopy	FAC+
5.	<u><i>Carpinus caroliniana</i></u>	Sapling	FAC
6.	<u><i>Ulmus rubra</i></u>	Sapling	FAC
7.	<u><i>Ilex decidua</i></u>	Shrub	FACW-
8.	<u><i>Crataegus</i> sp.</u>	Shrub	FAC to OBL
9.	<u><i>Carex</i> spp.</u>	Herb	FACW+
10.	<u><i>Fraxinus pennsylvanica</i></u>	Herb	FACW
11.	<u><i>Commelina virginica</i></u>	Herb	FACW
12.	<u><i>Leersia lenticularis</i></u>	Herb	OBL
13.	<u><i>Smilax rotundifolia</i></u>	Herb	FAC
14.	<u><i>Saururus cernuus</i></u>	Herb	OBL

Percent of Dominant Species that are OBL, FACW, or FAC (except FAC-) = **100%**