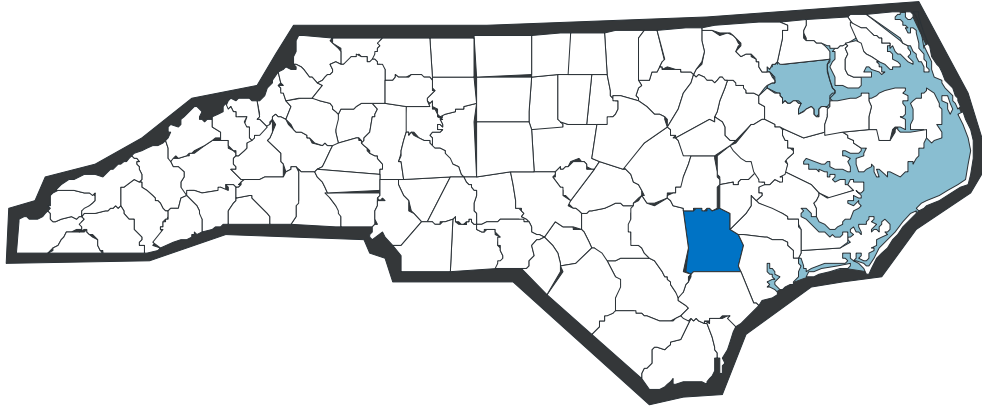


ANNUAL MONITORING REPORT FOR 2007 GROVE CREEK



GROVE CREEK MITIGATION SITE
DUPLIN COUNTY, NORTH CAROLINA
TIP No. R-2204 WM
NCDOT Project No. 8.1241801
(EEP Project Number .00038)
2007 Annual Monitoring Report (Year 2 of 5)

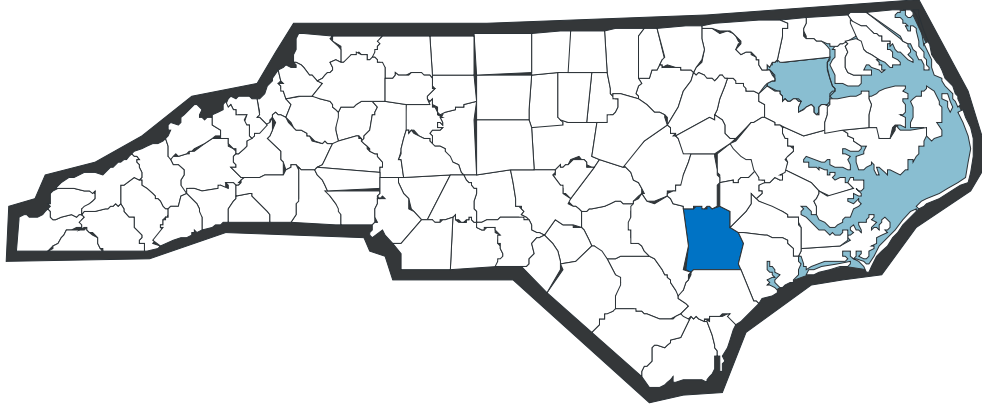
Submitted to:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

Prepared by:
Axiom Environmental, Inc.
2126 Rowland Pond Drive
Willow Spring, North Carolina 27592

Design Firm:
Office of Natural Environment & Roadside Environmental Unit
North Carolina Department of Transportation
Raleigh, North Carolina

February 2008

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February 2008

EXECUTIVE SUMMARY

The Grove Creek Wetland Mitigation Site (Site) is located within the United States Geological Survey (USGS) Hydrologic Unit 03030007 (North Carolina Division of Water Quality [NCDWQ] subbasin 03-06-22) of the Cape Fear River Basin. The Site includes an approximately 549-acre tract, located 5 miles east of Kenansville in central Duplin County. This document serves as the 2007 Second Year Annual Monitoring Report.

Eleven gauges were maintained and monitored for the year 2 (2007) growing season. Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season at all gauges except Gauge GW3, which is located along an upland margin, and Gauges GW4, GW5, and GW11. However, rainfall for the growing season was on average below normal. Based on the available gauge and rain data, the site should be considered successful for the year 2 (2007) monitoring.

Seven 10-meter square vegetation plots were monitoring for the year 2 (2007) monitoring season. Based on stem counts, the average plot density monitored at this Site is greater than 320 stems per acre for year 2 (2007) and is considered successful. The average plot density was measured at 560 stems per acre, or 15 stems per plot. The dominant species identified at the Site were bald cypress (*Taxodium distichum*) and water oak (*Quercus nigra*). Five out of the seven individual vegetation plots were well-above the success criteria with 688 to 891 planted stems per acre. Vegetation plot 7 was low with 243 planted stems per acre as the result of high water levels; the only surviving species was bald cypress. Plot 5 had no planted stem survival.

Vegetation problem areas within the Site included several areas of poor planted stem survival, especially near vegetation plot 5. Poor survival may have resulted from drought during planting followed by excessive inundation. These areas will continue to be monitored.

In summary, the mitigation site achieved success criteria for hydrology and vegetation in the Second Monitoring Year (2007).

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- APPENDIX B. YEAR 1 (2006) GROUNDWATER/SURFACEWATER GAUGE GRAPHS
- APPENDIX C. VEGETATION MONITORING PHOTOGRAPHS

1.0 PROJECT BACKGROUND

1.1 Project Description

The Grove Creek Wetland Mitigation Site (Site) is located within the United States Geological Survey (USGS) Hydrologic Unit 03030007 (North Carolina Division of Water Quality [NCDWQ] subbasin 03-06-22) of the Cape Fear River Basin. The Site includes an approximately 549-acre tract, located 5 miles east of Kenansville in central Duplin County (Figure 1).

Directions to the Site:

From Raleigh take Interstate 40 East to Exit 373

- Travel east on Highway 24 through Kenansville
- Travel approximately 6 miles further east on Highway 24 (if you reach the Cape Fear River, you have gone too far) to a left onto Dobson Chapel Road.
- Road surface becomes gravel and intersects another gravel road in about 0.3 mile. The Site is straight ahead.

1.2 Purpose

In order to demonstrate successful mitigation, hydrologic and vegetative monitoring must be conducted for five years or until success criteria are achieved. Success criteria are based on federal guidelines for wetland mitigation. These guidelines stipulate criteria for both hydrologic conditions and vegetation survival. The following report details the results of hydrologic and vegetative monitoring for the 2007 (year 2) growing season at the Grove Creek Mitigation Site.

1.3 Project History

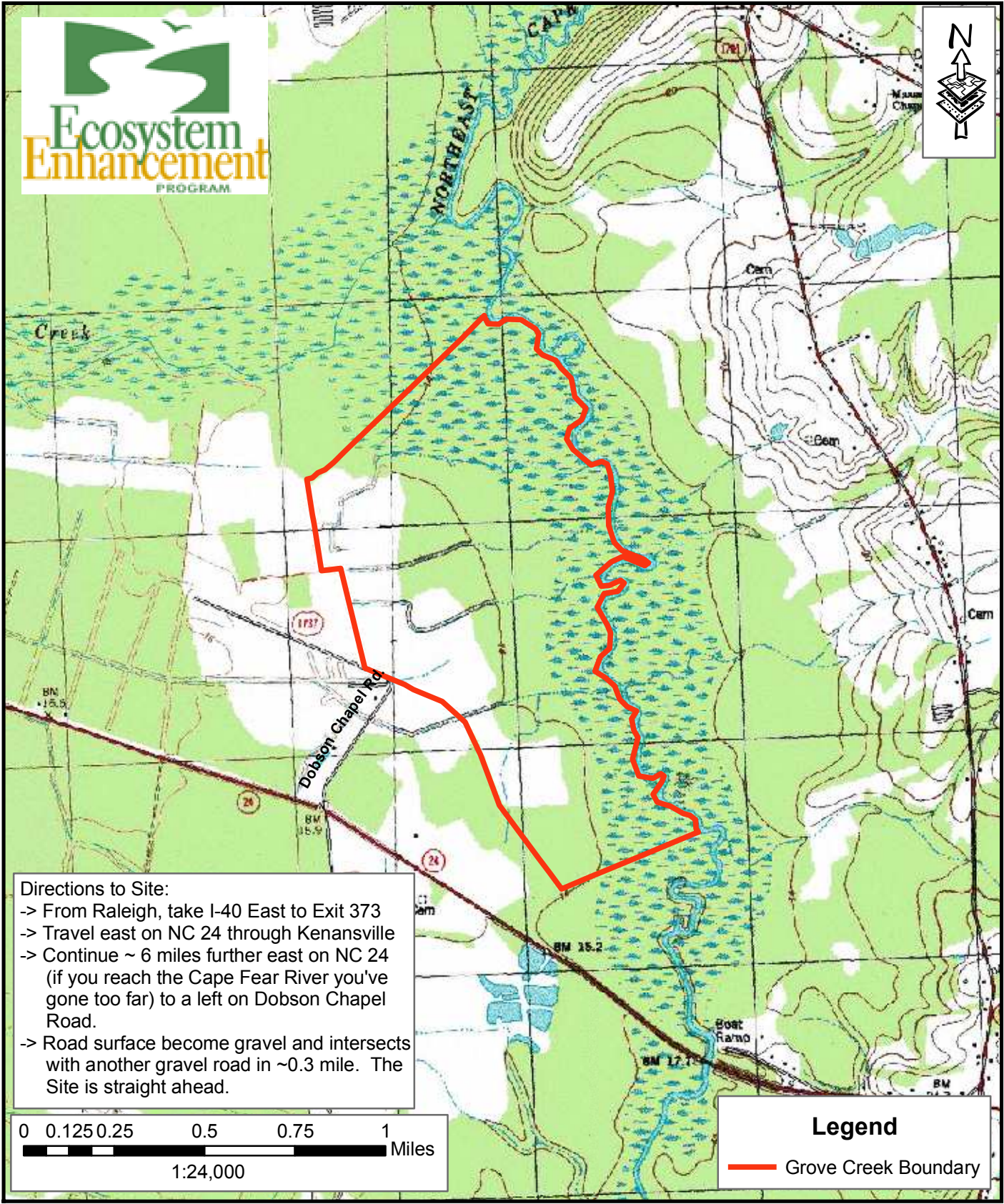
January 2004	Mitigation Plan
September 2004	Final Design (90%)
2005	Site Construction
2005	Planting
November 2006	Vegetation Monitoring (Year 1)
March-November 2006	Hydrologic Monitoring (Year 1)
July 2007	Vegetation Monitoring (Year 2)
March-November 2007	Hydrologic Monitoring (Year 2)

1.4 Mitigation Structure and Objectives

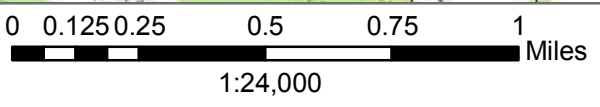
Prior to implementation of wetland restoration activities, the Site was characterized by active agricultural fields, mixed hardwood forests, and a large Bottomland Hardwood/Cypress-Gum Swamp wetland system located adjacent to the Northeast Cape Fear River. Historical land use activities included ditching within hydric soils and timber harvesting within wetlands.

The primary mitigation activities at the Site included restoration of previously ditched and filled riverine wetlands, creation of riverine wetlands within existing agricultural fields, hydrological enhancement of previously ditched riverine wetlands, preservation of the existing Coastal Plain Bottomland Hardwoods/Cypress-Gum Swamp Forest wetlands, restoration of a previously drained nonriverine wetland area, and preservation of existing upland hardwood forests.

Wetland restoration and creation at the Site entailed 1) ditch cleaning prior to backfill, 2) impervious ditch plug construction, 3) ditch/canal backfilling, and 4) removal of fill material from wetlands.



Directions to Site:
 -> From Raleigh, take I-40 East to Exit 373
 -> Travel east on NC 24 through Kenansville
 -> Continue ~ 6 miles further east on NC 24 (if you reach the Cape Fear River you've gone too far) to a left on Dobson Chapel Road.
 -> Road surface become gravel and intersects with another gravel road in ~0.3 mile. The Site is straight ahead.



Legend

— Grove Creek Boundary

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Axiom Environmental, Inc.

SITE LOCATION
GROVE CREEK WETLAND RESTORATION SITE
 EEP Project Number .00038
 Year 2 (2007) Annual Monitoring Report
 Duplin County, North Carolina

CLF
Date: July 2007
Project: 07-002

FIGURE
1

According to the January 2004 Mitigation Plan, the primary goals of the project include 1) maximizing the area returned to historic wetland function; 2) expand, enhance, and preserve 549 acres of the Northeast Cape Fear River riparian ecosystem; 3) protect the Site within a conservation easement in perpetuity; 4) provide valuable habitat to a diverse assemblage of flora and fauna; 5) serve as a wildlife corridor along the Northeast Cape Fear river; and 6) provide numerous wetland values including water storage, shoreline stabilization, pollutant removal, aquatic/wildlife habitat, recreation, and education. Project structures and objectives are summarized in Table 1 and depicted in Figure 2.

Table 1. Project Mitigation Structures and Objectives					
Grove Creek (EEP Project Number .00038)					
Project Segment or Reach ID	Mitigation Type*	Approach	Acreage	Stationing	Comment
Bottomland Hardwood	R	---	3.0 acres	---	Previously ditched and filled riverine wetlands
Bottomland Hardwood	E	---	18.4 acres	---	Ditched riverine wetlands
Cypress-Gum Swamp/Bottomland Hardwood	P	---	375.9 acres	---	Existing riverine wetlands
Bottomland Hardwood	C	---	9.2 acres	---	Existing upland agricultural fields to be graded to riverine wetlands
Headwater Forest	E	---	1.9 acres	---	Existing agricultural fields to be converted to nonriverine wetlands
Headwater Forest	C	---	1.4 acres	---	Existing agricultural fields upland to be graded to nonriverine wetlands
Headwater Forest	R	---	7.3 acres	---	Previously drained nonriverine wetlands
TOTAL			417.1 acres		

* R = Restoration; E = Enhancement; C = Creation; P = Preservation

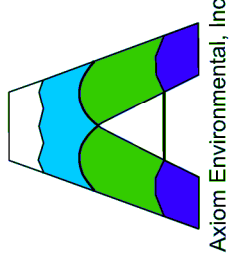
2.0 HYDROLOGY

2.1 Success Criteria

Success criteria for wetland hydrology at Grove Creek require inundation or saturation within 12 inches of the ground surface for a consecutive period of 12.5 percent of the growing season. The soil survey for Duplin County does not contain growing season data; therefore, due to its close proximity the Sampson County soil survey was used. The estimated growing season begins March 18 and ends November 4 (239 days). In order to attain hydrologic success, saturation within 12 inches of the ground surface is required for at least 30 consecutive days (12.5 percent of the growing season).

2.2 Hydrologic Description

Seven groundwater monitoring gauges and four surfacewater monitoring gauges have been maintained and monitored throughout the year 2 (2007) growing season (Figure 3).



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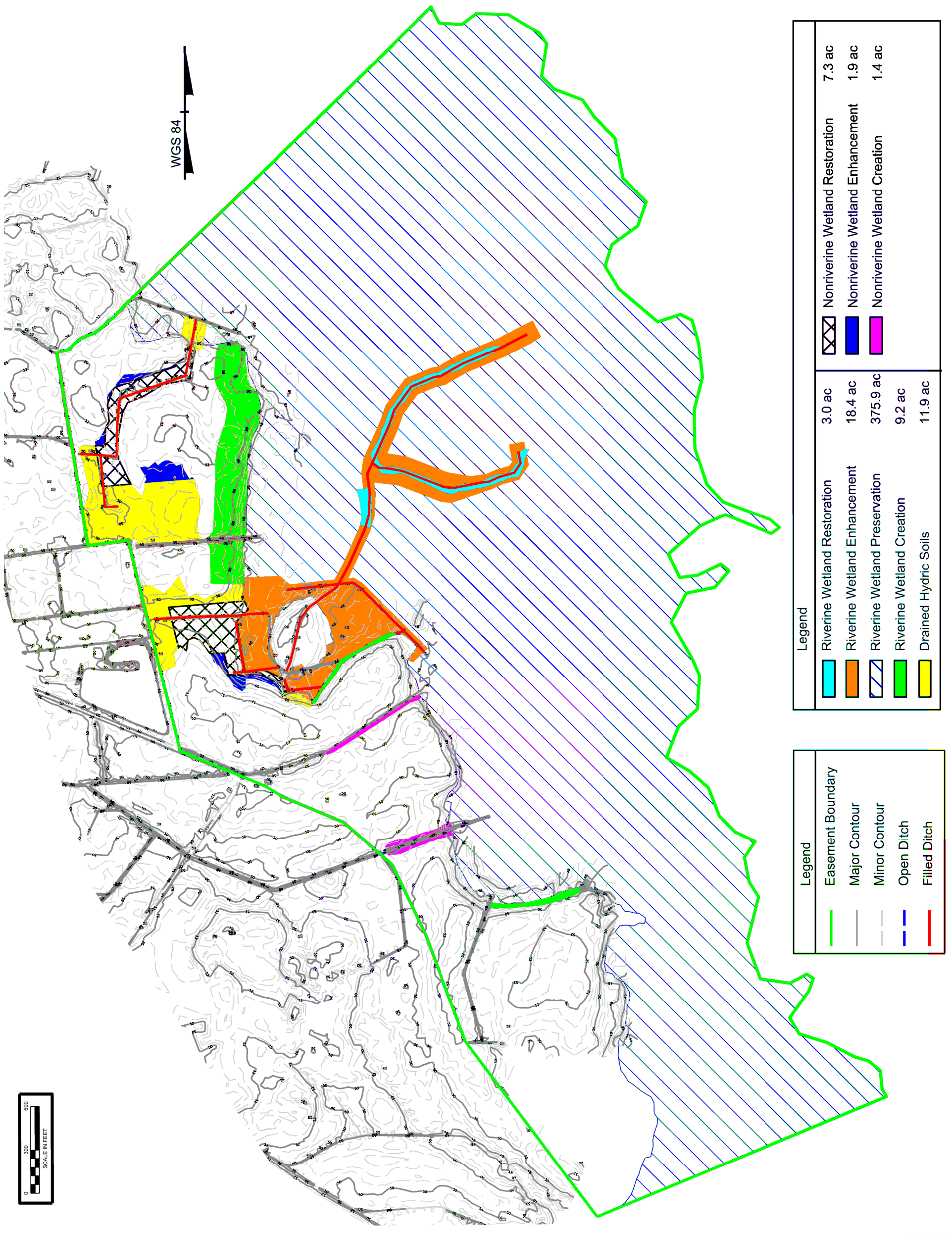
NOTES/REVISIONS

Project:
**Grove Creek
 Restoration Site**
 Project No. .00038
 Year 1 (2006) Monitoring Report
 Duplin County
 North Carolina

Title:
**As-Built
 Wetland Restoration
 Plan**

Scale: **1" = 655'**
 Date: **MAR 2007**
 Project No.: **06-021**

FIGURE NO.
2

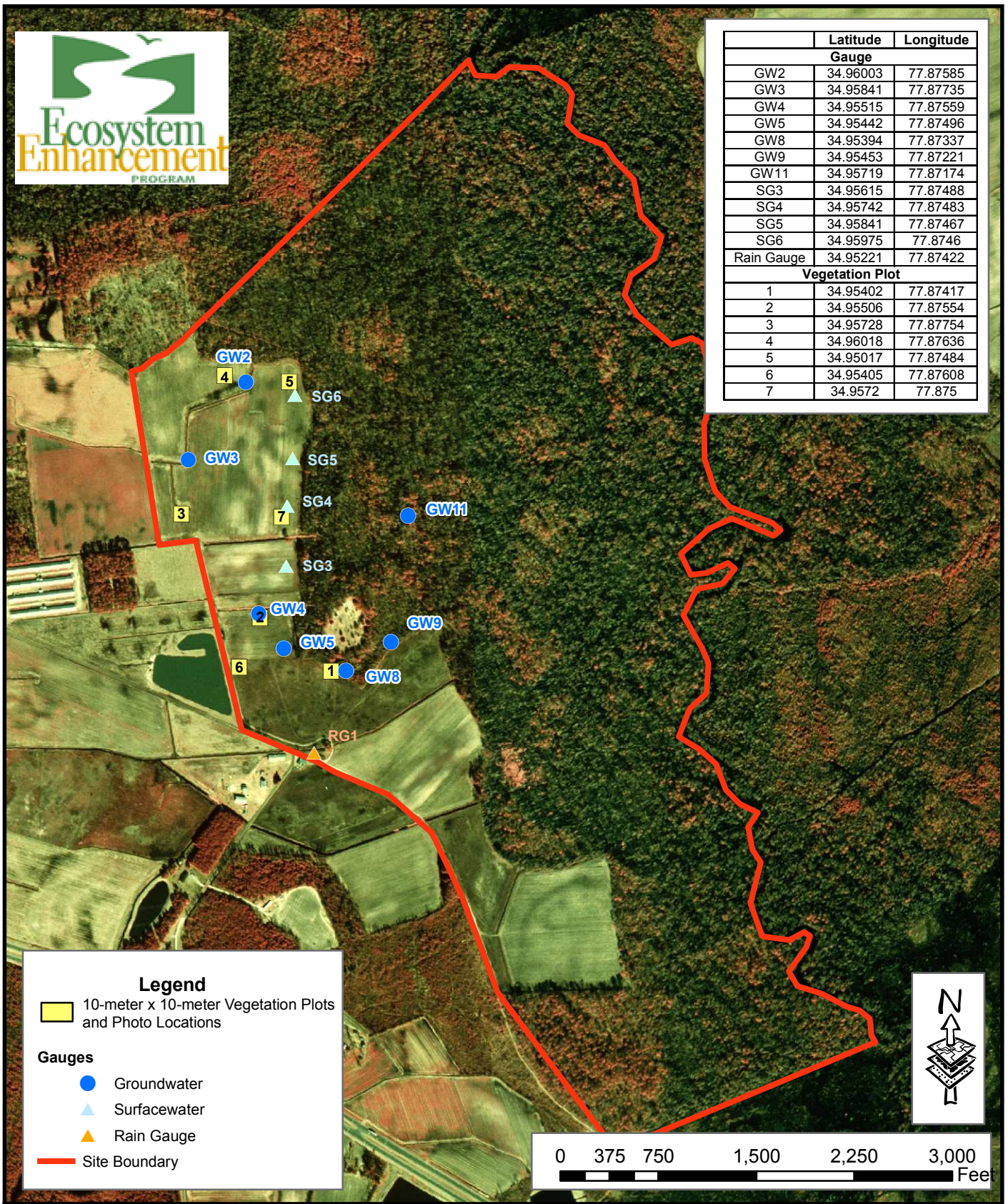


Legend	
	Nonriverine Wetland Restoration 7.3 ac
	Nonriverine Wetland Enhancement 1.9 ac
	Nonriverine Wetland Creation 1.4 ac
	Riverine Wetland Restoration 3.0 ac
	Riverine Wetland Enhancement 18.4 ac
	Riverine Wetland Preservation 375.9 ac
	Riverine Wetland Creation 9.2 ac
	Drained Hydric Soils 11.9 ac

Legend	
	Easement Boundary
	Major Contour
	Minor Contour
	Open Ditch
	Filled Ditch

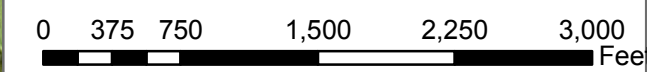


	Latitude	Longitude
Gauge		
GW2	34.96003	77.87585
GW3	34.95841	77.87735
GW4	34.95515	77.87559
GW5	34.95442	77.87496
GW8	34.95394	77.87337
GW9	34.95453	77.87221
GW11	34.95719	77.87174
SG3	34.95615	77.87488
SG4	34.95742	77.87483
SG5	34.95841	77.87467
SG6	34.95975	77.8746
Rain Gauge	34.95221	77.87422
Vegetation Plot		
1	34.95402	77.87417
2	34.95506	77.87554
3	34.95728	77.87754
4	34.96018	77.87636
5	34.95017	77.87484
6	34.95405	77.87608
7	34.9572	77.875



Legend

- 10-meter x 10-meter Vegetation Plots and Photo Locations
- Gauges**
- Groundwater
- Surfacewater
- Rain Gauge
- Site Boundary



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MONITORING PLAN
GROVE CREEK WETLAND RESTORATION SITE
 EEP Project Number .00038
 Year 2 of 5 (2007) Monitoring Report
 Duplin County, North Carolina

CLF
Date: July 2007
Project: 07-002

FIGURE
3

Graphs of groundwater/surfacewater hydrology and precipitation from an onsite rain gauge for year 2 (2007) are included in Appendix A. Data from 2006 (year 1) can be found in Appendix B.

2.3 Results of Hydrologic Monitoring

2.3.1 Site Data

Eleven gauges were maintained and monitored for the year 2 (2007) growing season. Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season at all gauges except Gauge GW3, which is located along an upland margin, and Gauges GW4, GW5, and GW11.

Table 2 summarizes success criteria achievement for Site gauges.

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)				
	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)
GW2	Yes/98 days (41 percent)	Yes/60 days (25 percent)			
GW3	No/14 days (5.9 percent)	No/8 days (3.3 percent)			
GW4	Yes/46 days (19.2 percent)	No/13 days (5.4 percent)			
GW5	Yes/98 days (41 percent)	No/18 days (7.5 percent)			
GW8	Yes/239 days (100 percent)	Yes/69 days (28.9 percent)			
GW9	Yes/239 days (100 percent)	Yes/89 days (37.2 percent)			
GW11	Yes/31 days (13.0 percent)	No/9 days (3.8 percent)			
SG3	Yes/239 days (100 percent)	Yes/239 days (100 percent)			
SG4	Yes/239 days (100 percent)	Yes/213 days (89.1 percent)			
SG5	Yes/239 days (100 percent)	Yes/239 days (100 percent)			
SG6	Yes/239 days (100 percent)	Not able to determine*			

*This gauge does not monitor groundwater levels below the soil surface; therefore, it is not possible to determine the number of days the groundwater level was within 12 inches of the soil surface. However, it is expected that the groundwater level remains near the soil surface.

2.3.2 Climatic Data

Climatic data for the year 2 (2007) growing season has been compared to 30-year historical data from the station in Clinton, North Carolina (Figure 4) (NOAA 2004). The Site experienced lower than average rainfall for the majority of the growing season with the exception of the months of April, July, and October 2007.

2.4 Hydrologic Conclusions

Eleven gauges were maintained and monitored for the year 2 (2007) growing season. Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season at all gauges except Gauge GW3, which is located along an upland margin, and Gauges GW4, GW5, and GW11. However, rainfall for the growing season was on average below normal. Based on the available gauge and rain data, the site should be considered successful for the year 2 (2007) monitoring.

3.0 VEGETATION

3.1 Success Criteria

Wetland vegetation success criteria at Grove Creek will require an average across the Site of 320 stems per acre of approved target species surviving for the first three years of monitoring, 290 stems per acre in year four, and 260 stems per acre in year five.

3.2 Description of Planted Areas

According to the 2004 *Grove Creek Mitigation Plan*, seedlings were to be planted at a minimum density of 680 stems per acre and included:

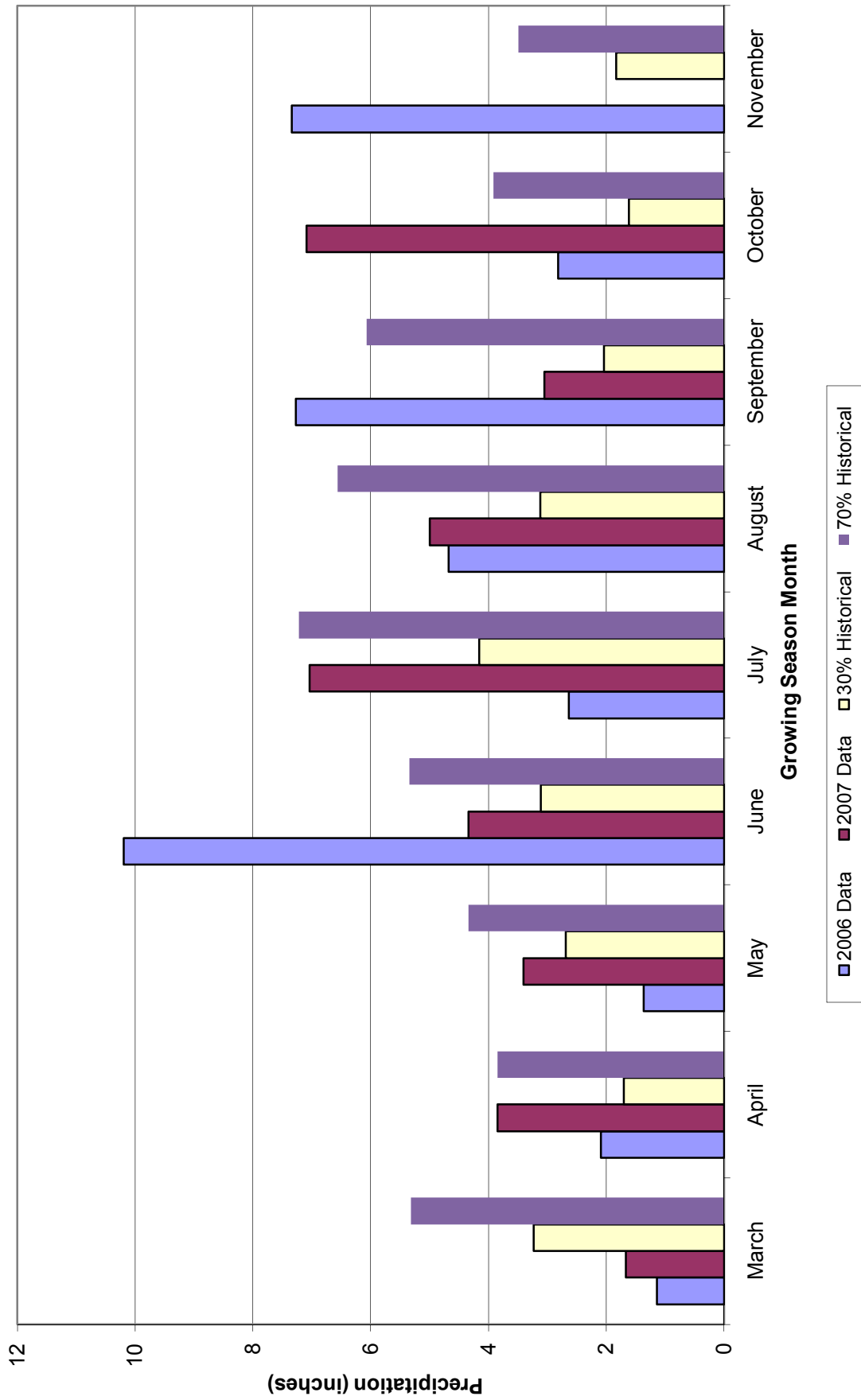
1. water oak (*Quercus nigra*)
2. willow oak (*Quercus phellos*)
3. laurel oak (*Quercus laurifolia*)
4. swamp chestnut oak (*Quercus michauxii*)
5. green ash (*Fraxinus pennsylvanica*)
6. river birch (*Betula nigra*)
7. bald cypress (*Taxodium distichum* var. *distichum*)
8. water tupelo (*Nyssa biflora*)

3.3 Results of Vegetation Monitoring

Seven 10-meter square vegetation plots were established as depicted in Figure 2 in November 2006. These plots were surveyed in July 2007 for the year 2 (2007) monitoring season using 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 Table 3 and pictures are included in Appendix C. The taxonomic standard for vegetation used for this document was *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas* (Weakley 2007). No reference area was studied; therefore, no comparisons could be made to reference conditions.

Based on the number of stems counted, the average plot density monitored at this Site is greater than 320 stems per acre and is considered successful. The average plot density has been measured at 560 stems per acre, or 15 stems per plot for 2007 (year 2) monitoring. The dominant species identified at the Site were bald cypress (*Taxodium distichum*), green ash (*Fraxinus pennsylvanica*), and water oak (*Quercus nigra*). Five out of the seven individual vegetation plots were well above the success criteria with 688 to 891 planted stems per acre. Vegetation plot 7 was low with 243 planted stems per acre as the result of high

Figure 4. Climatic Data vs. 30-year Historic Data



water levels; the only surviving species was bald cypress. Plot 5 had no planted stem survival and is located in deep water.

Table 3. Stem Counts for Planted Species Arranged by Plot

Grove Creek (EEP Project Number .00038)

Species	Year 2 (2007) Individual Plots (0.0247 acre each)							Year 2 (2007) Totals	Year 1 (2006) Totals	% Survival
	1	2	3	4	5*	6	7			
<i>Betula nigra</i>	-	-	-	5	-	5	-	10	9	111
<i>Fraxinus pennsylvanica</i>	-	4	8	-	-	7	-	19	11	172
<i>Quercus laurifolia</i>	-	-	-	2	-	-	-	2	2	100
<i>Quercus lyrata</i>	5	1	-	3	-	2	-	11	11	100
<i>Quercus michauxii</i>	2	1	2	3	-	-	-	8	7	114
<i>Quercus nigra</i>	6	2	1	3	-	2	-	14	14	100
<i>Quercus phellos</i>	4	-	-	1	-	-	-	5	5	100
<i>Taxodium distichum</i>	-	11	7	3	-	6	6	33	27	122
Total Stems Per Plot	17	19	18	20	0	22	6	102	86	119
Stems Per Acre	688	769	729	810	0	891	243	560	497	

*Plot 5 is located in deep water.

3.4 Conclusions

Based on the number of stems counted, the average plot density monitored at this Site is greater than 320 stems per acre and is considered successful for 2007 (year 2) monitoring. The average plot density was measured at 560 stems per acre, or 15 stems per plot.

Vegetation problem areas within the Site are depicted on Figure 5. Several areas of poor planted stem survival were observed throughout the Site during the year 2 (2007) monitoring, especially near vegetation plot 5. Poor survival in some areas may have resulted from drought during planting followed by excessive inundation.

Planted seedlings exhibited various degrees of vigor at the Site. Overall, vigor was noted as good.

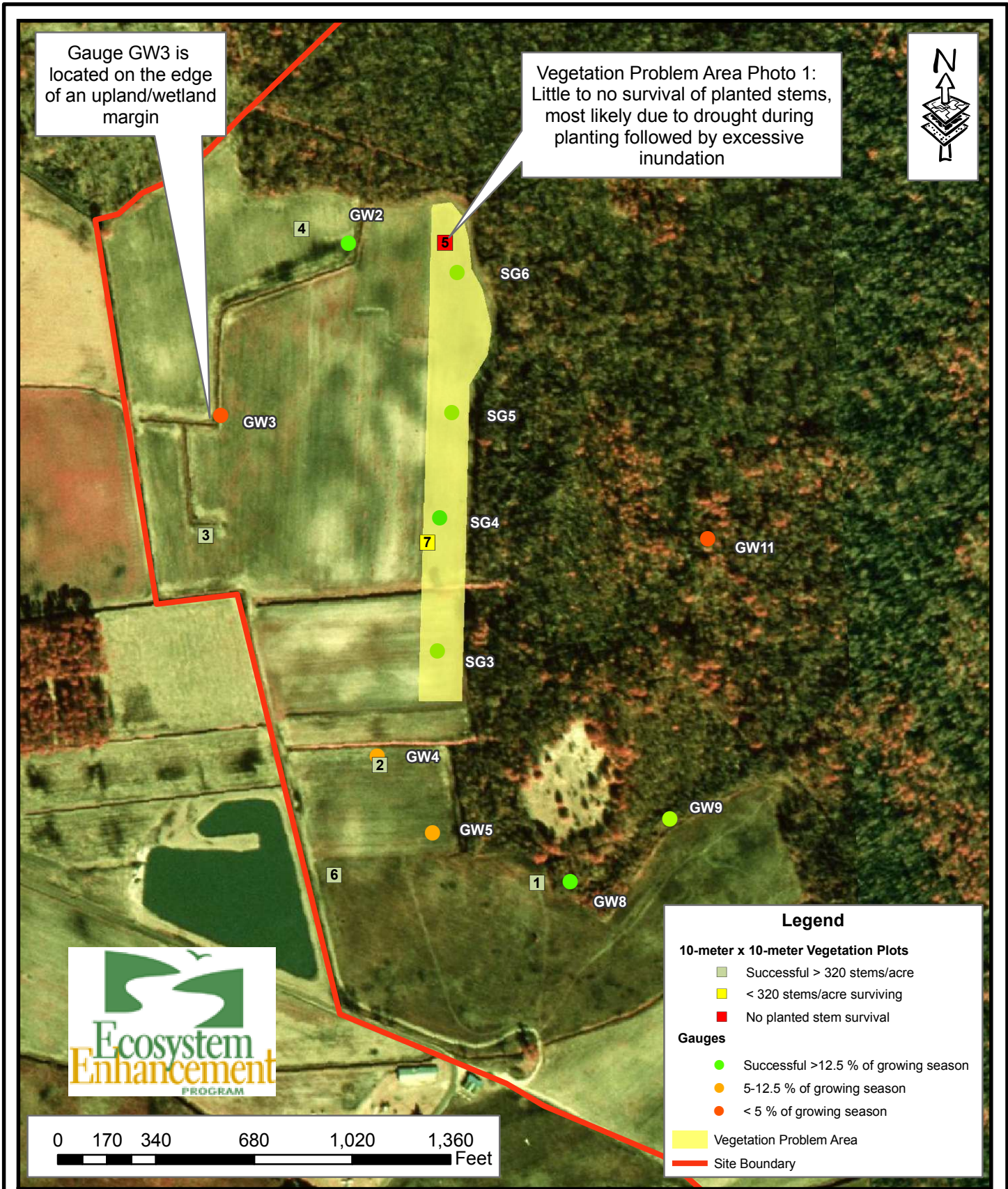
4.0 OVERALL CONCLUSIONS/RECOMMENDATIONS

Eleven gauges were maintained and monitored for the year 2 (2007) growing season. Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season at all gauges except Gauge GW3, which is located along an upland margin, and Gauges GW4, GW5, and GW11. However, rainfall for the growing season was on average below normal. Based on the available gauge and rain data, the site should be considered successful for the year 2 (2007) monitoring.

Based on the number of stems counted, the average plot density monitored at this Site is greater than 320 stems per acre and is considered successful for 2007 (year 2) monitoring. The average plot density was measured at 560 stems per acre, or 15 stems per plot.

Vegetation problem areas within the Site included several areas of poor planted stem survival, especially near vegetation plot 5 which is located in deep water. Poor survival may have resulted from drought during planting followed by excessive inundation. These areas will continue to be monitored.

In summary, Grove Creek Mitigation Site was successful for hydrology and vegetation for the Second Annual Monitoring Year (2007).



0 170 340 680 1,020 1,360 Feet

Legend

10-meter x 10-meter Vegetation Plots

- Successful > 320 stems/acre
- < 320 stems/acre surviving
- No planted stem survival

Gauges

- Successful >12.5 % of growing season
- 5-12.5 % of growing season
- < 5 % of growing season

■ Vegetation Problem Area

— Site Boundary

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YEAR 2 (2007) MONITORING RESULTS
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CLF
Date: Nov 2007
Project: 07-002

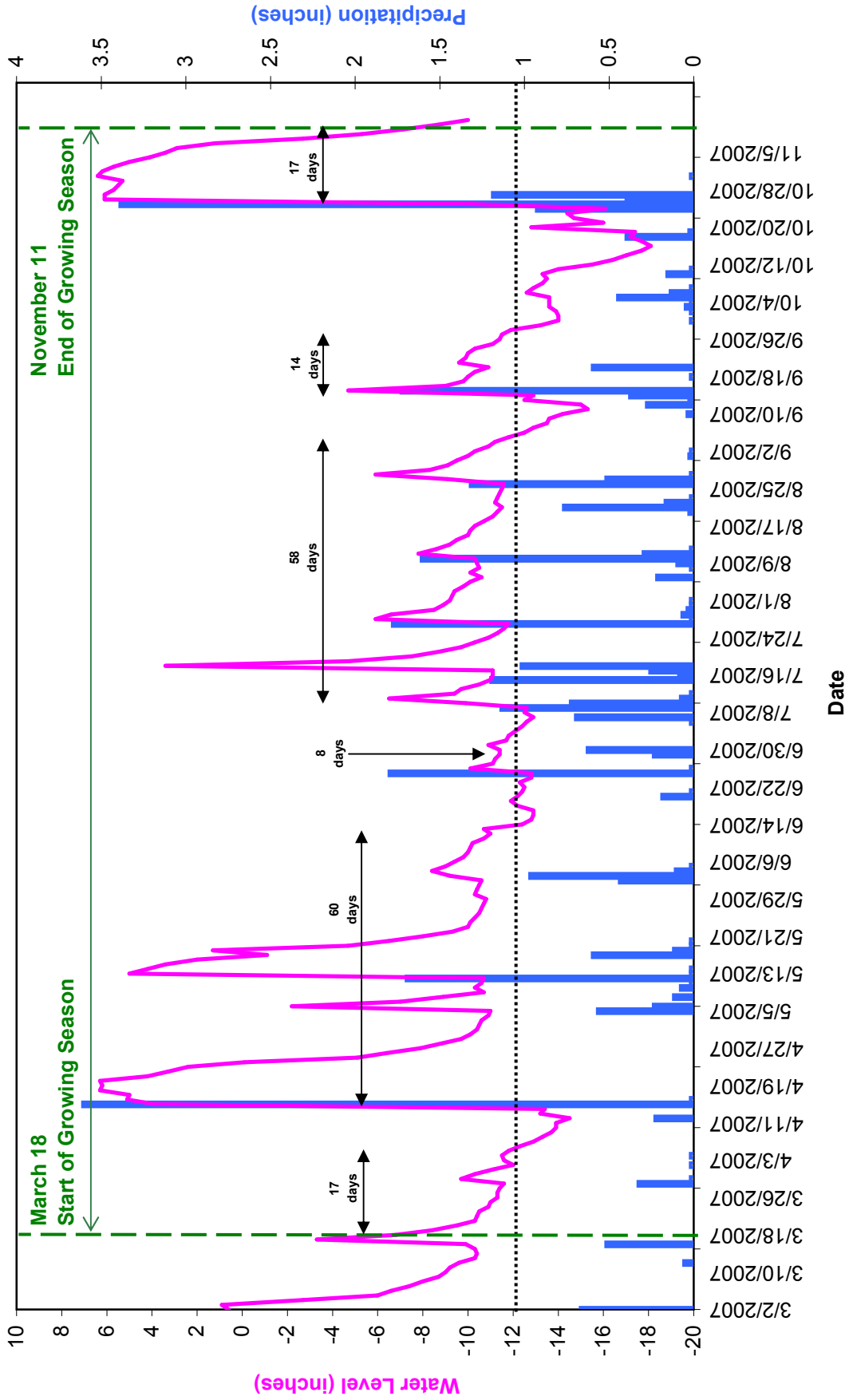
FIGURE
5

5.0. REFERENCES

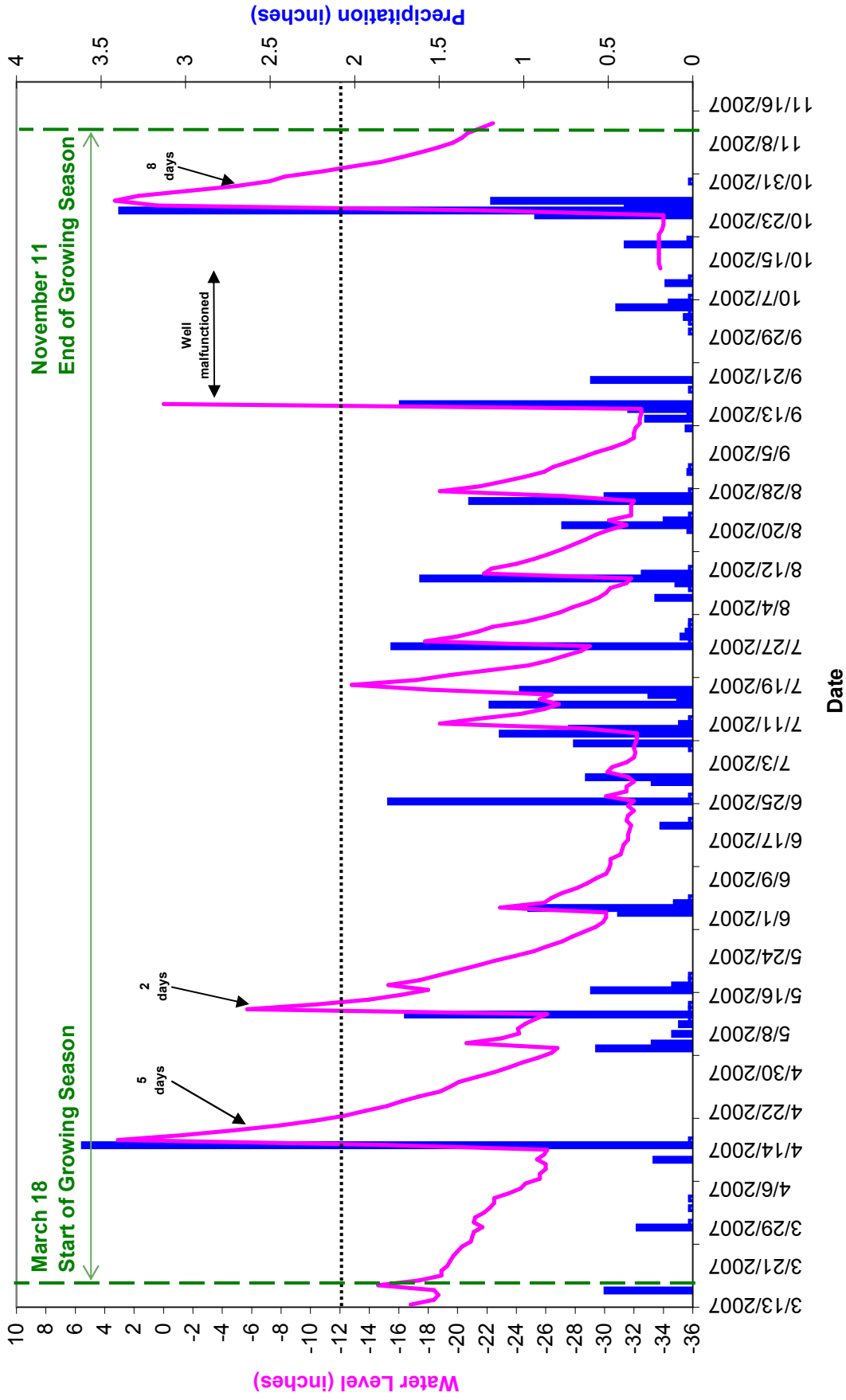
- Lee, Michael T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0. (online). Available: <http://cvs.bio.unc.edu/methods.htm>.
- National Oceanic and Atmospheric Administration (NOAA). 2004. Climatology of the United States No. 20; Monthly Station Climate Summaries, 1971-2000. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Asheville, North Carolina.
- North Carolina Department of Transportation (NCDOT). 2004. Grove Creek Mitigation Plan, Duplin County, North Carolina, TIP No. R-2204 WM. Office of Natural Environment & Roadside Environmental Unit.
- United States. Department of Agriculture (USDA). 1985. Soil Survey of Sampson County, North Carolina. United States Department of Agriculture.
- 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.

APPENDIX A
YEAR 2 (2007) GROUNDWATER/SURFACEWATER GAUGE GRAPHS

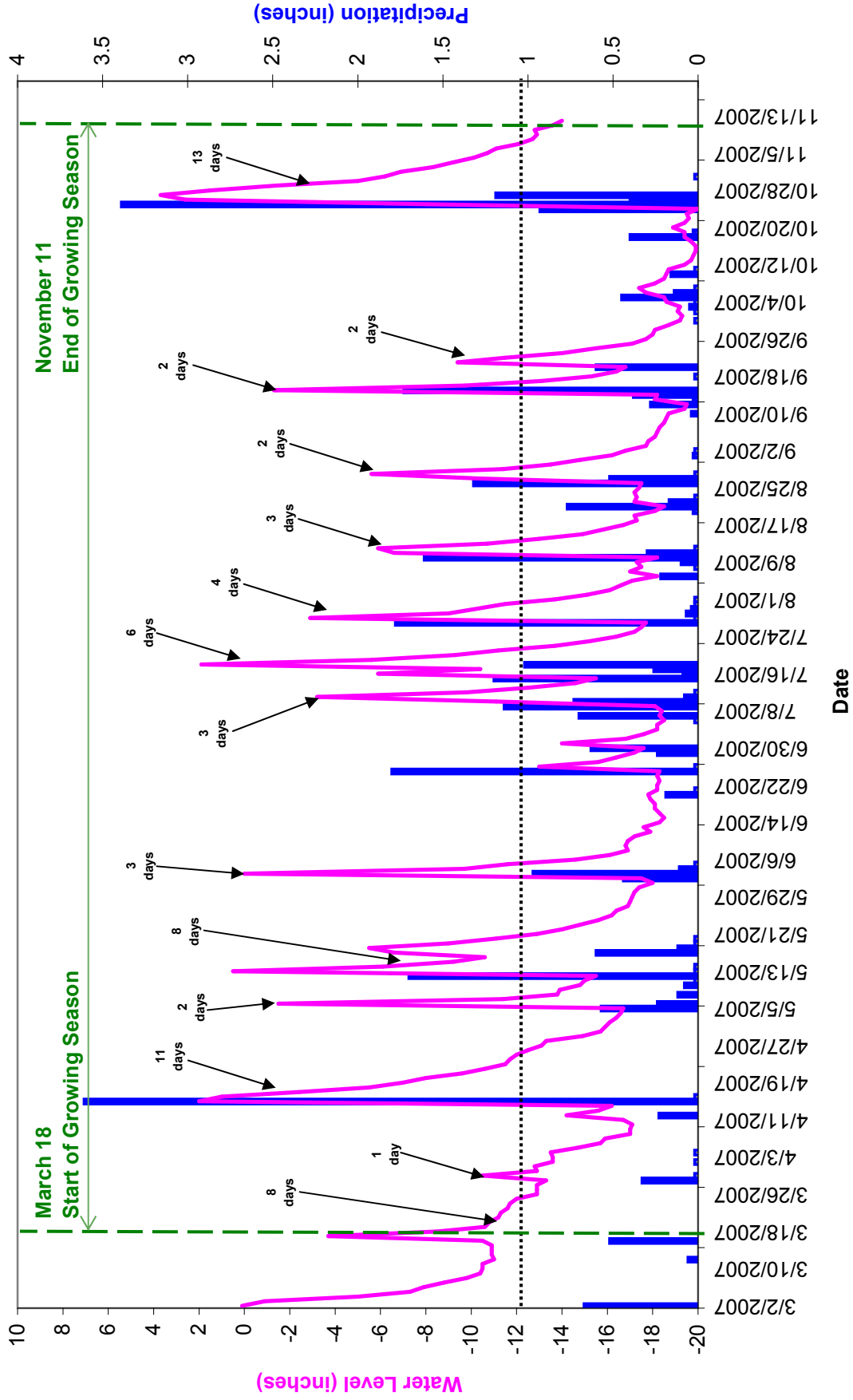
Grove Creek GW2 (2007 Gauge Data)



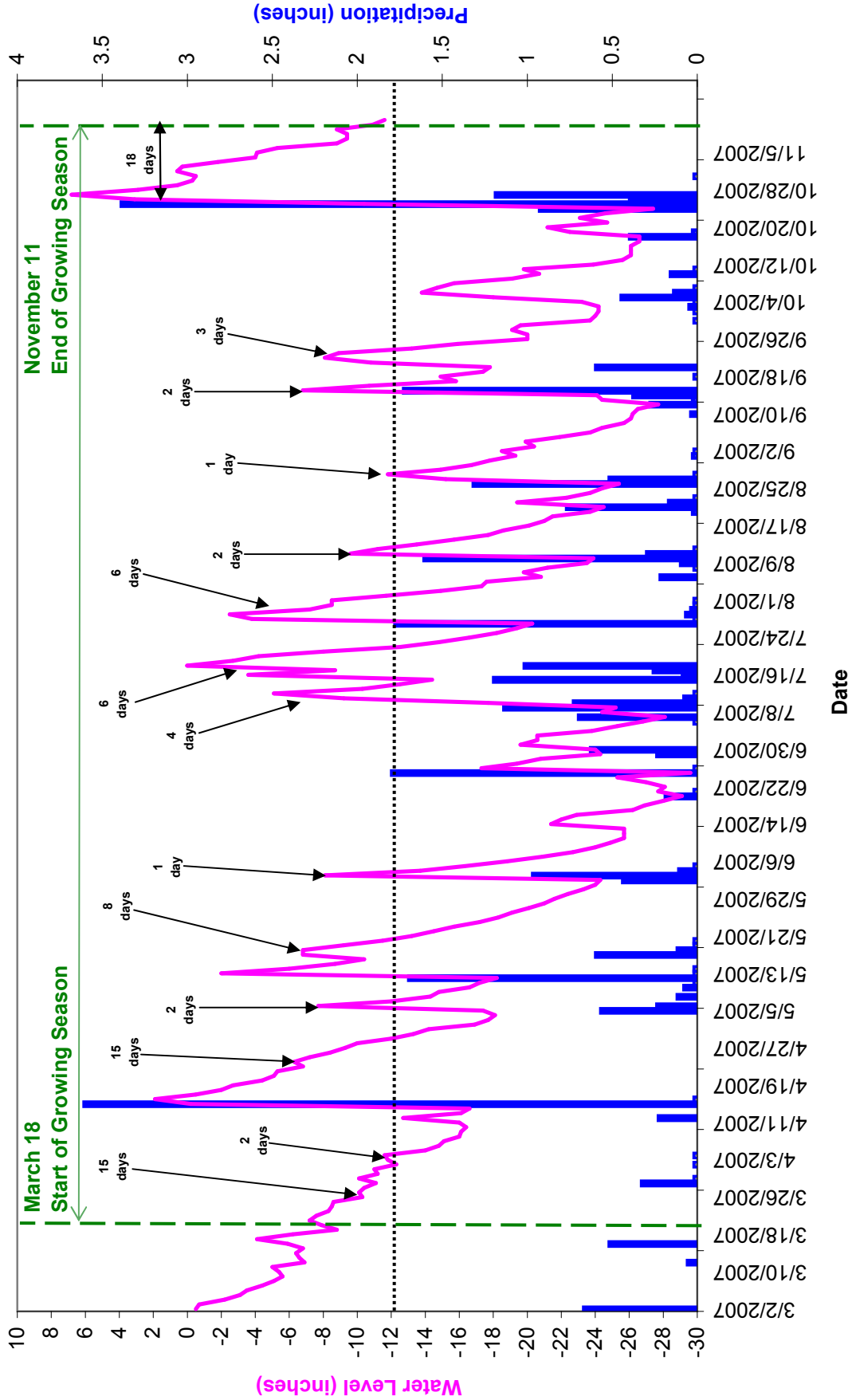
Grove Creek GW3 (2007 Gauge Data)



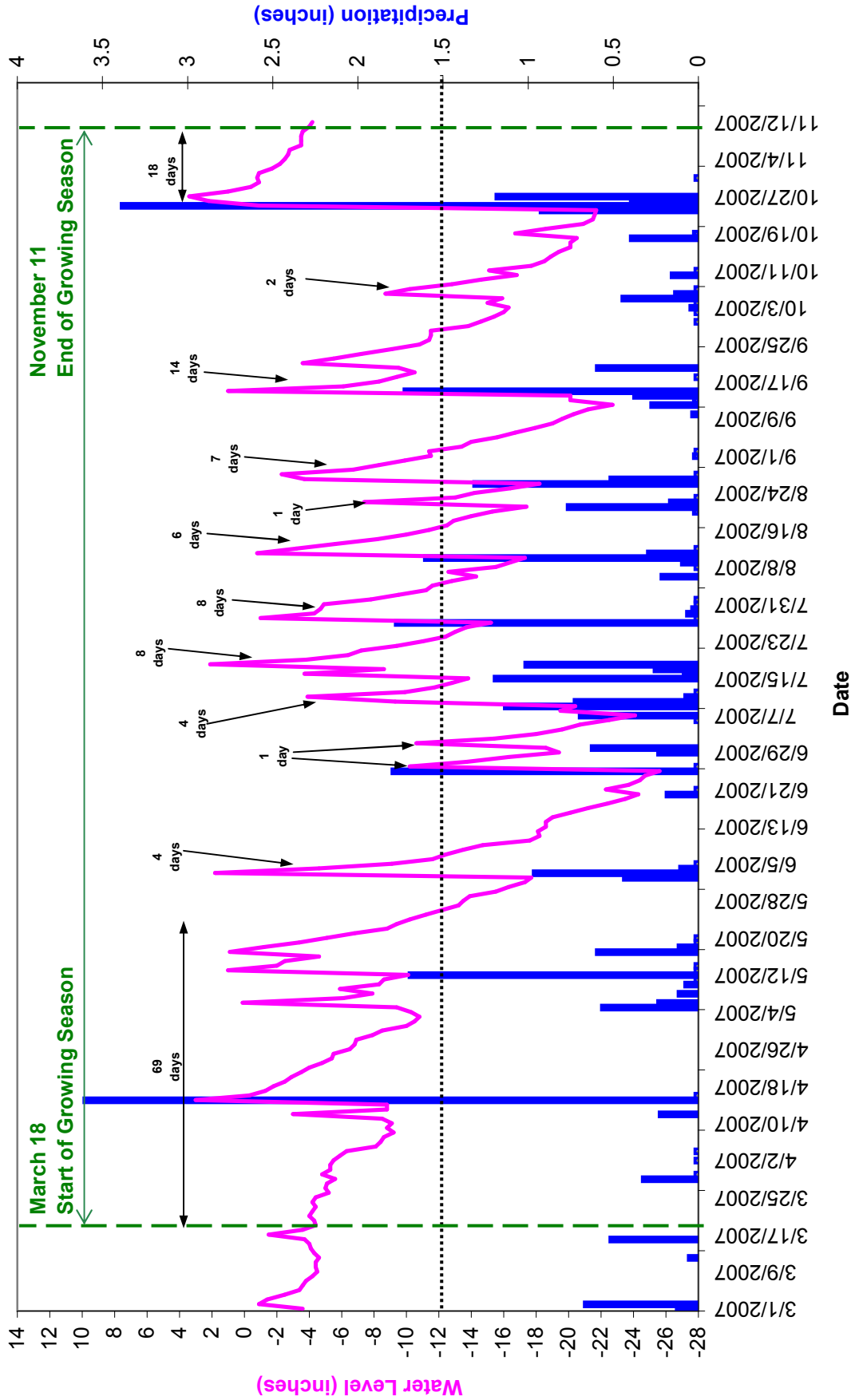
Grove Creek GW4 (2007 Gauge Data)



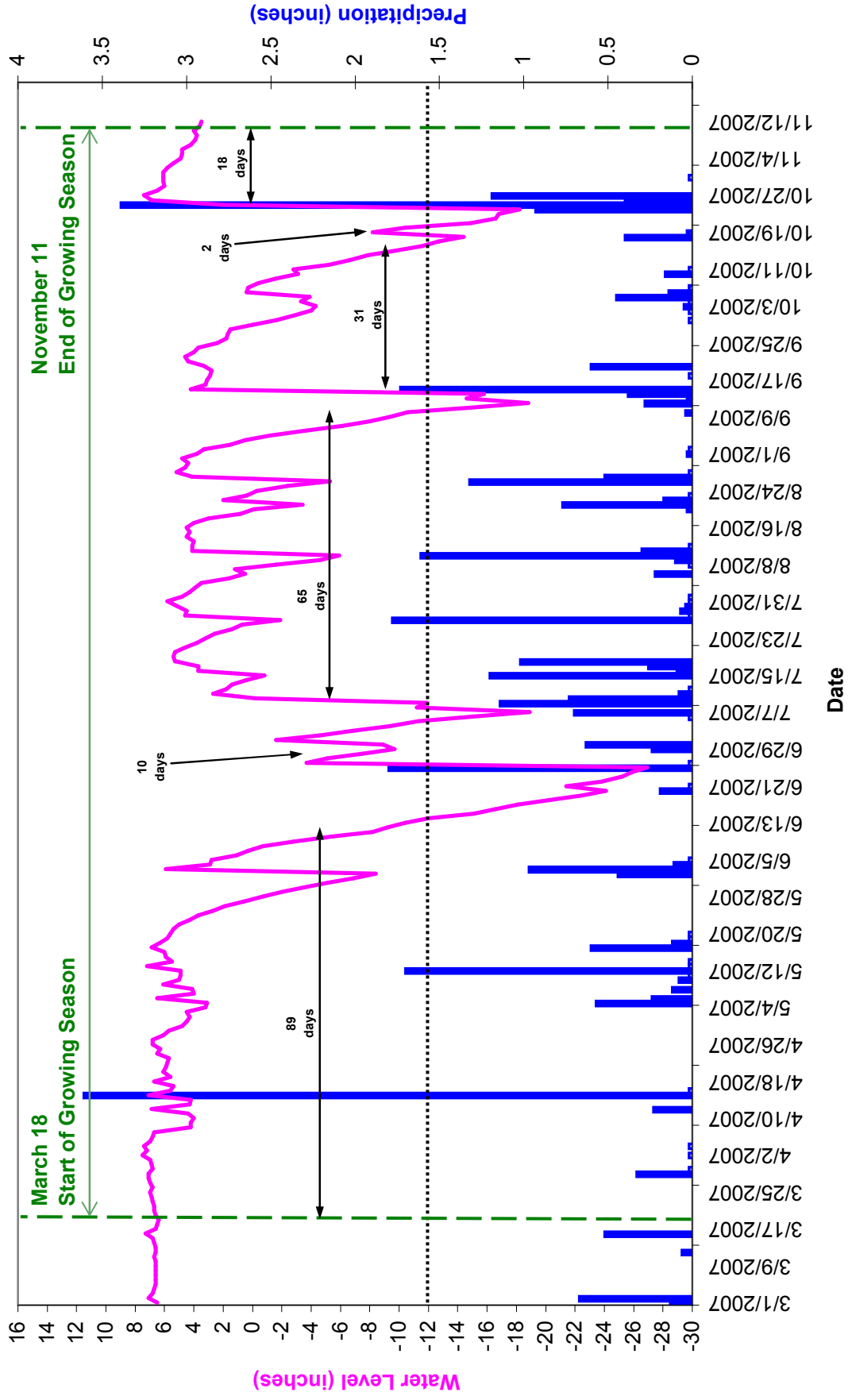
Grove Creek GW5 (2007 Gauge Data)



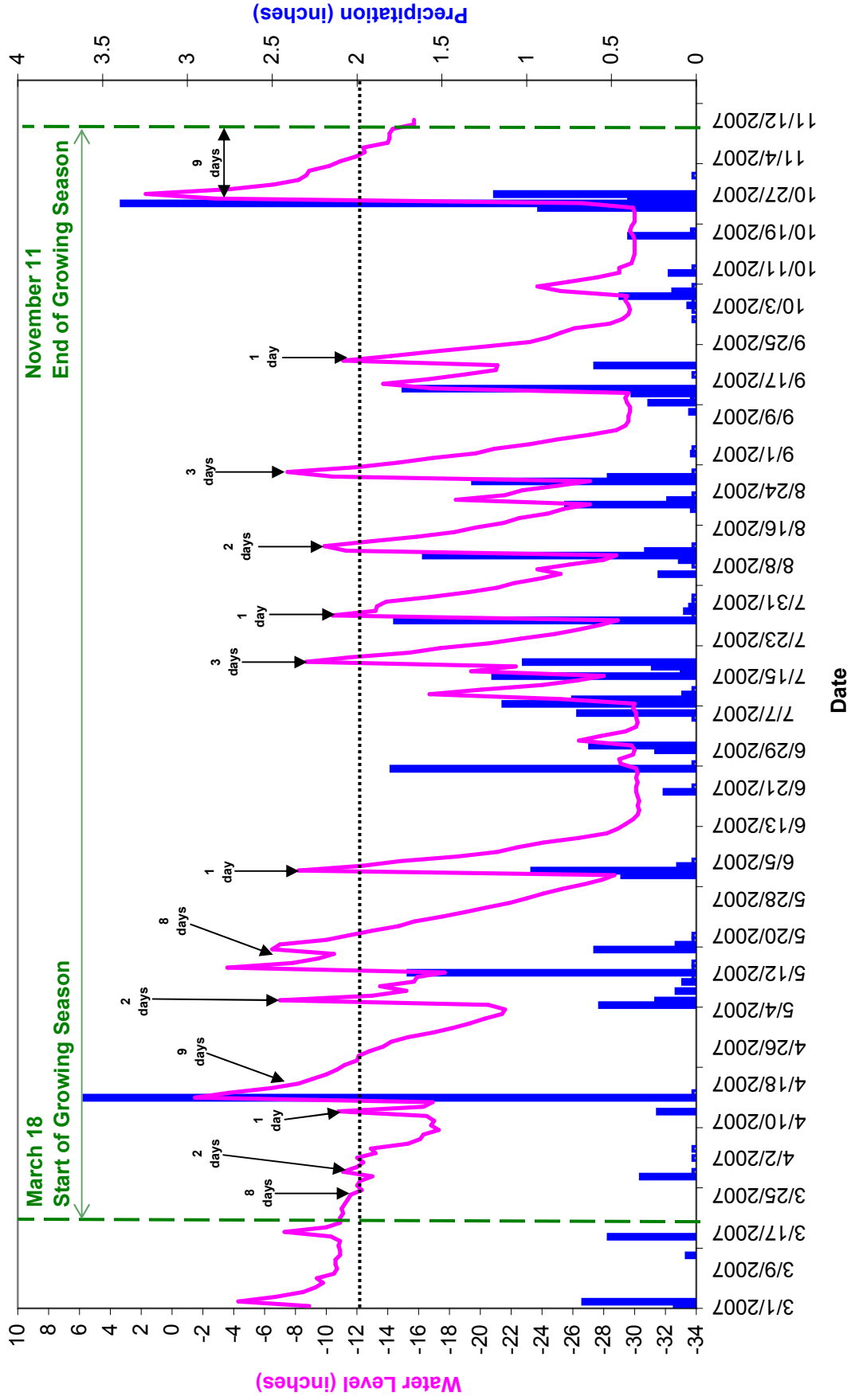
Grove Creek GW8 (2007 Gauge Data)



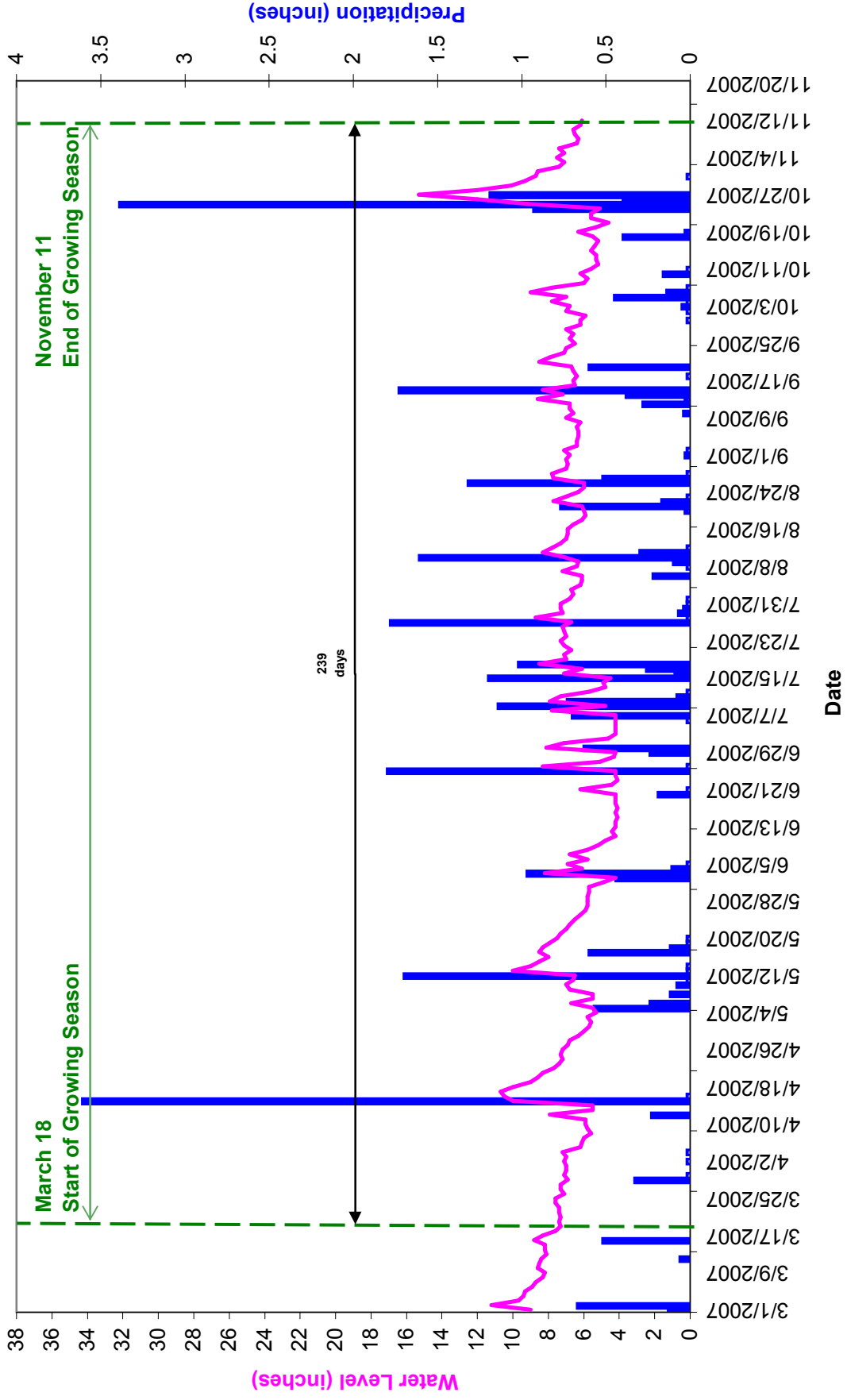
Grove Creek GW9 (2007 Gauge Data)



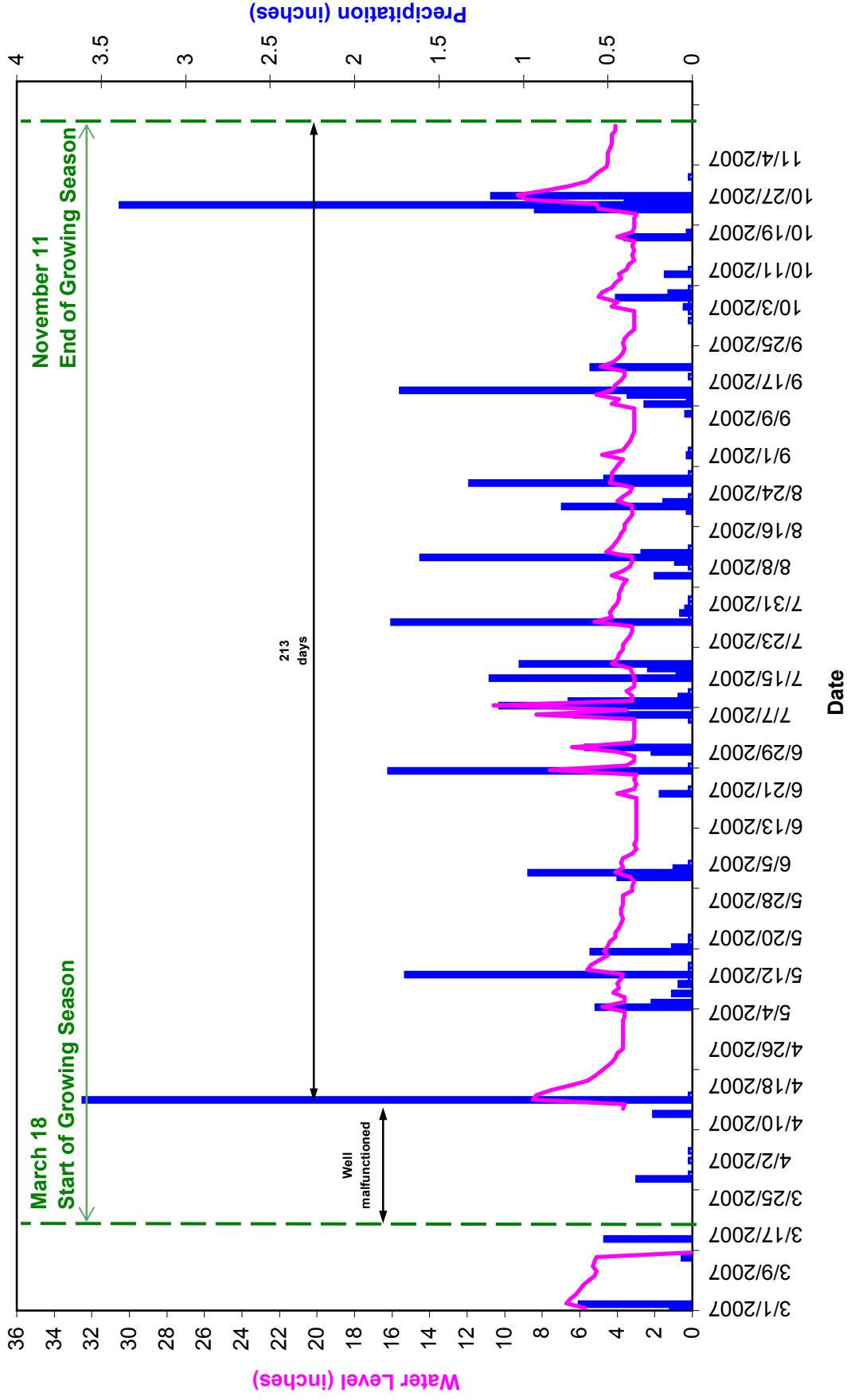
Grove Creek GW11 (2007 Gauge Data)



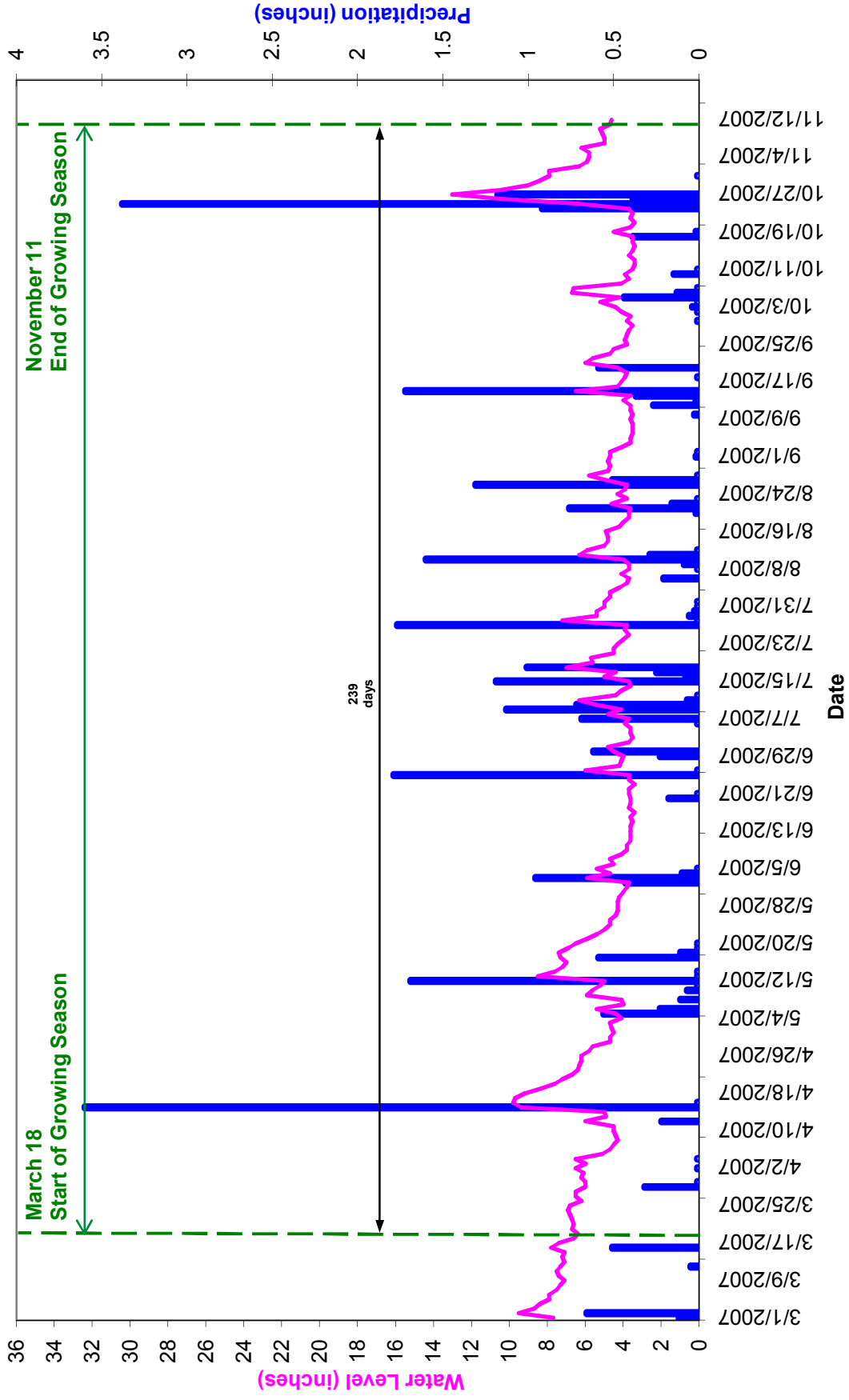
Grove Creek SG3 (2007 Gauge Data)



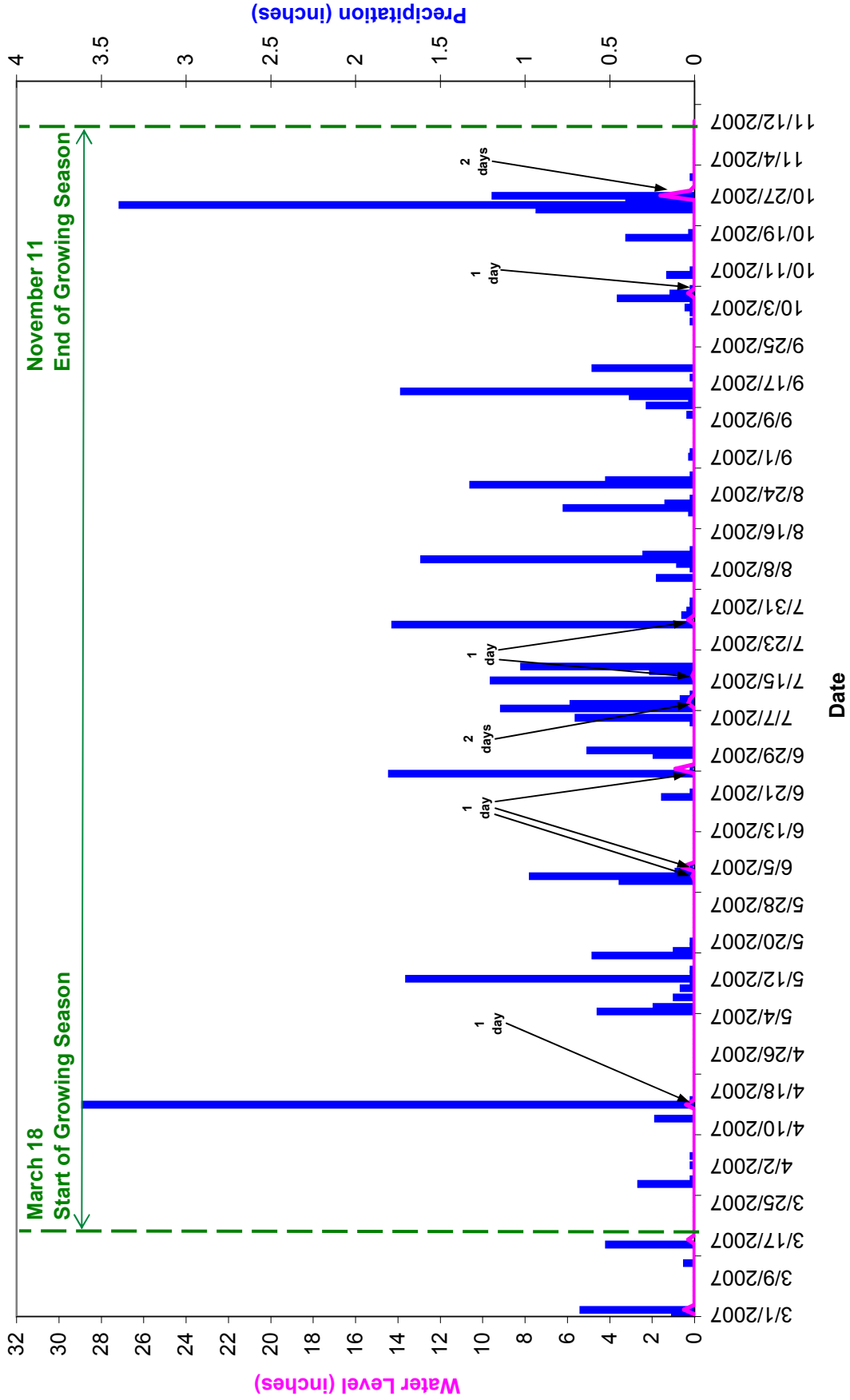
Grove Creek SG4 (2007 Gauge Data)



Grove Creek SG 5 (2007 Gauge Data)

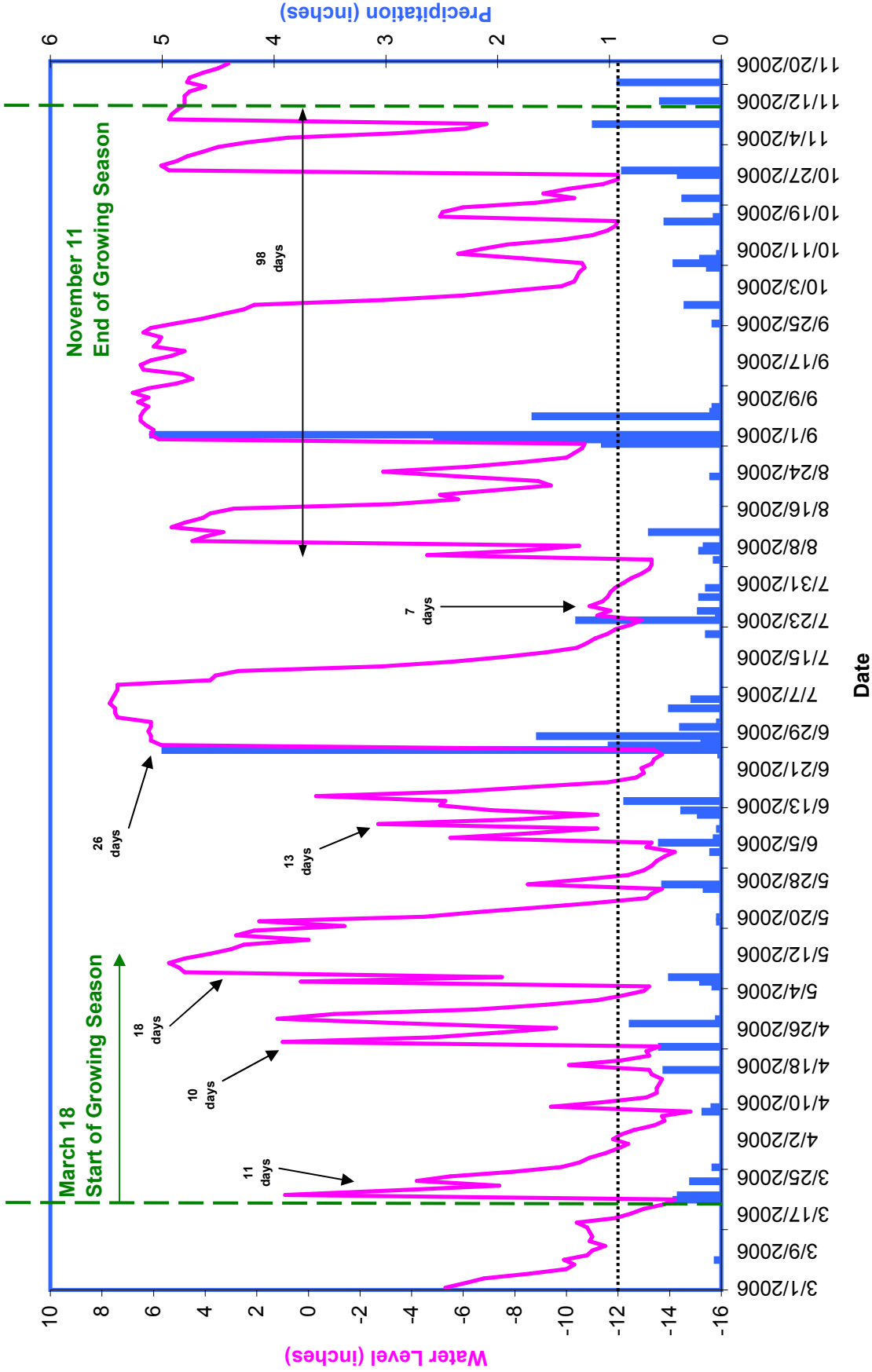


Grove Creek SG6 (2007 Gauge Data)

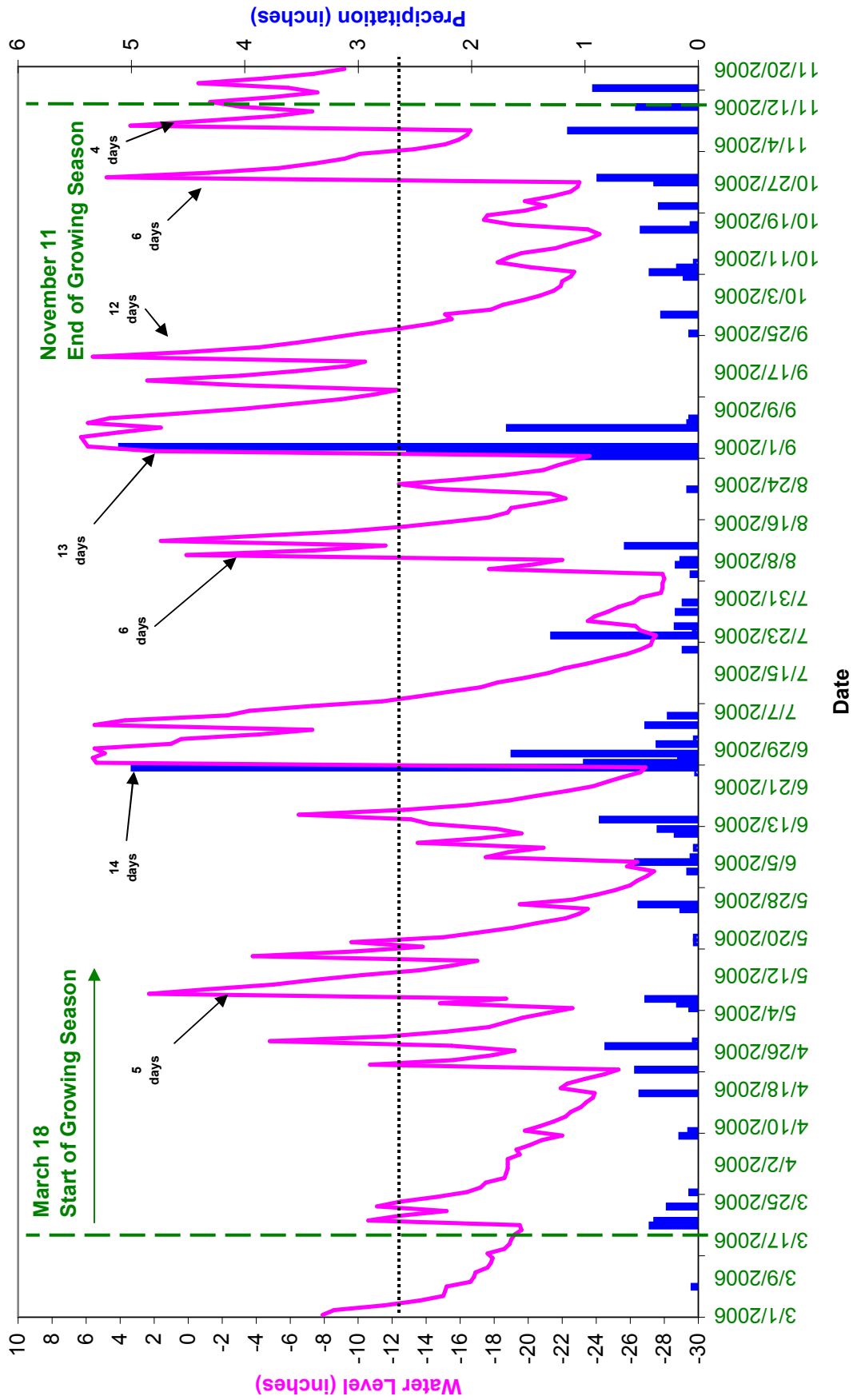


APPENDIX B
YEAR 1 (2006) GROUNDWATER/SURFACEWATER GAUGE GRAPHS

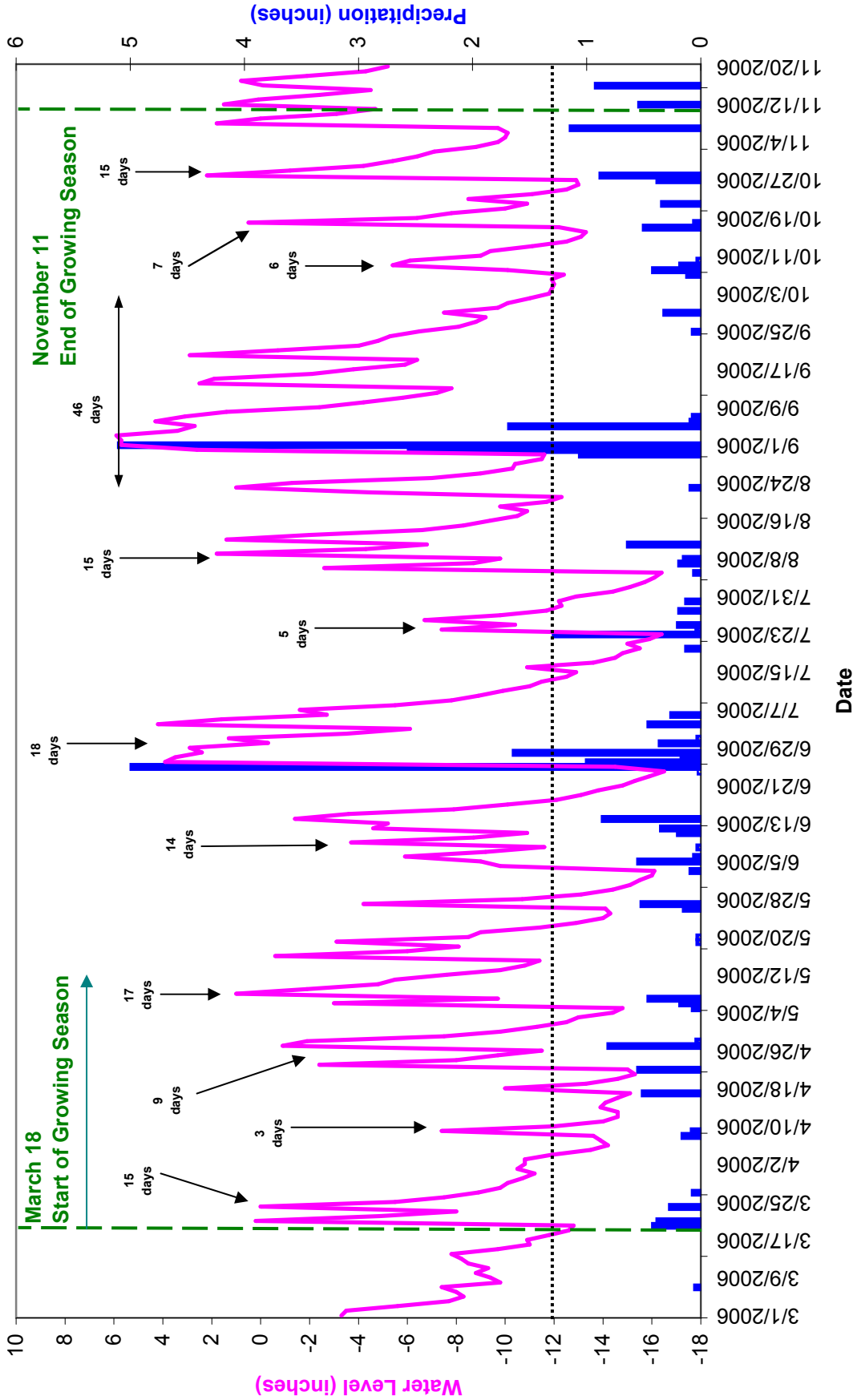
GW2 (2006 Gauge Data)



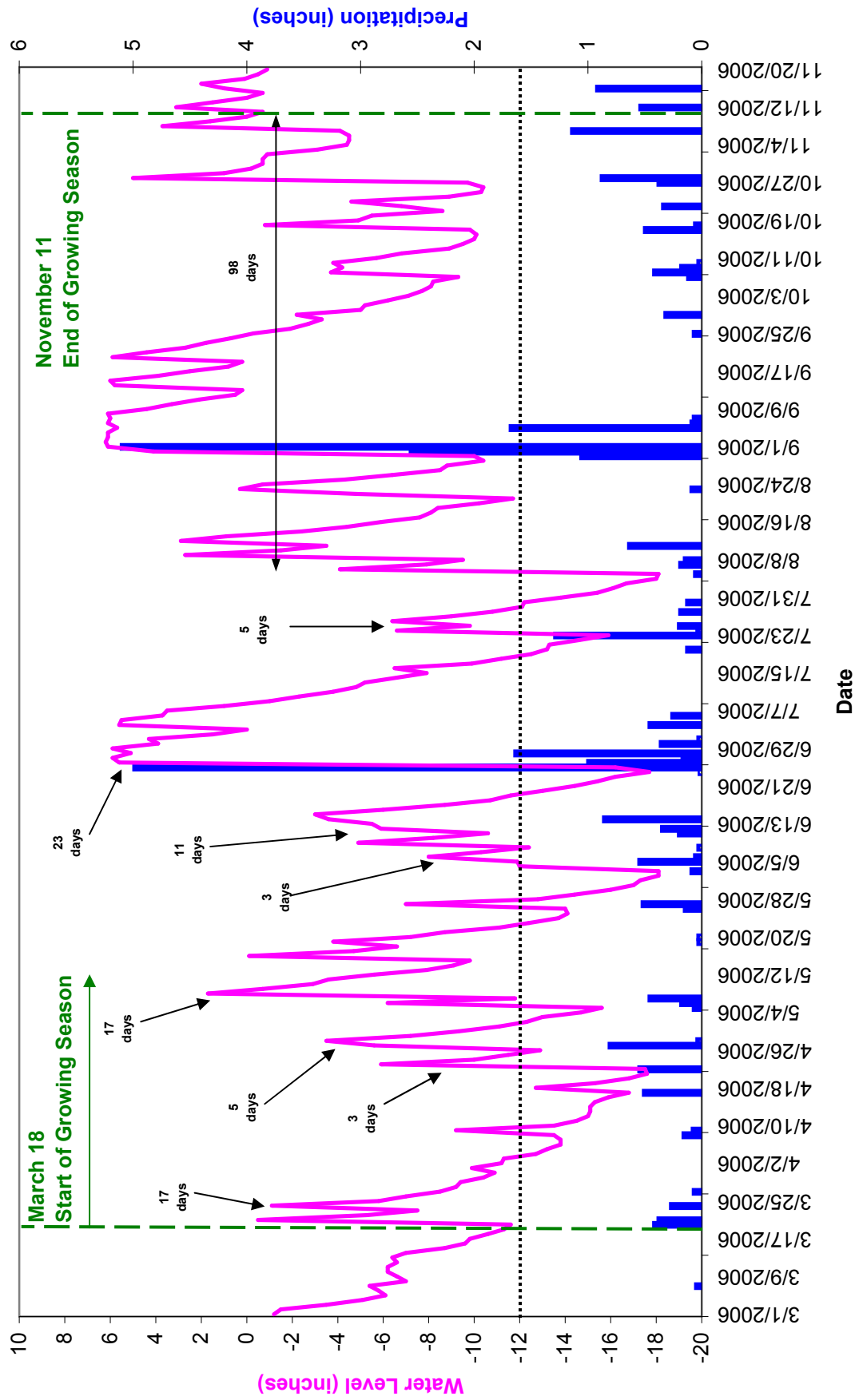
GW3 (2006 Gauge Data)



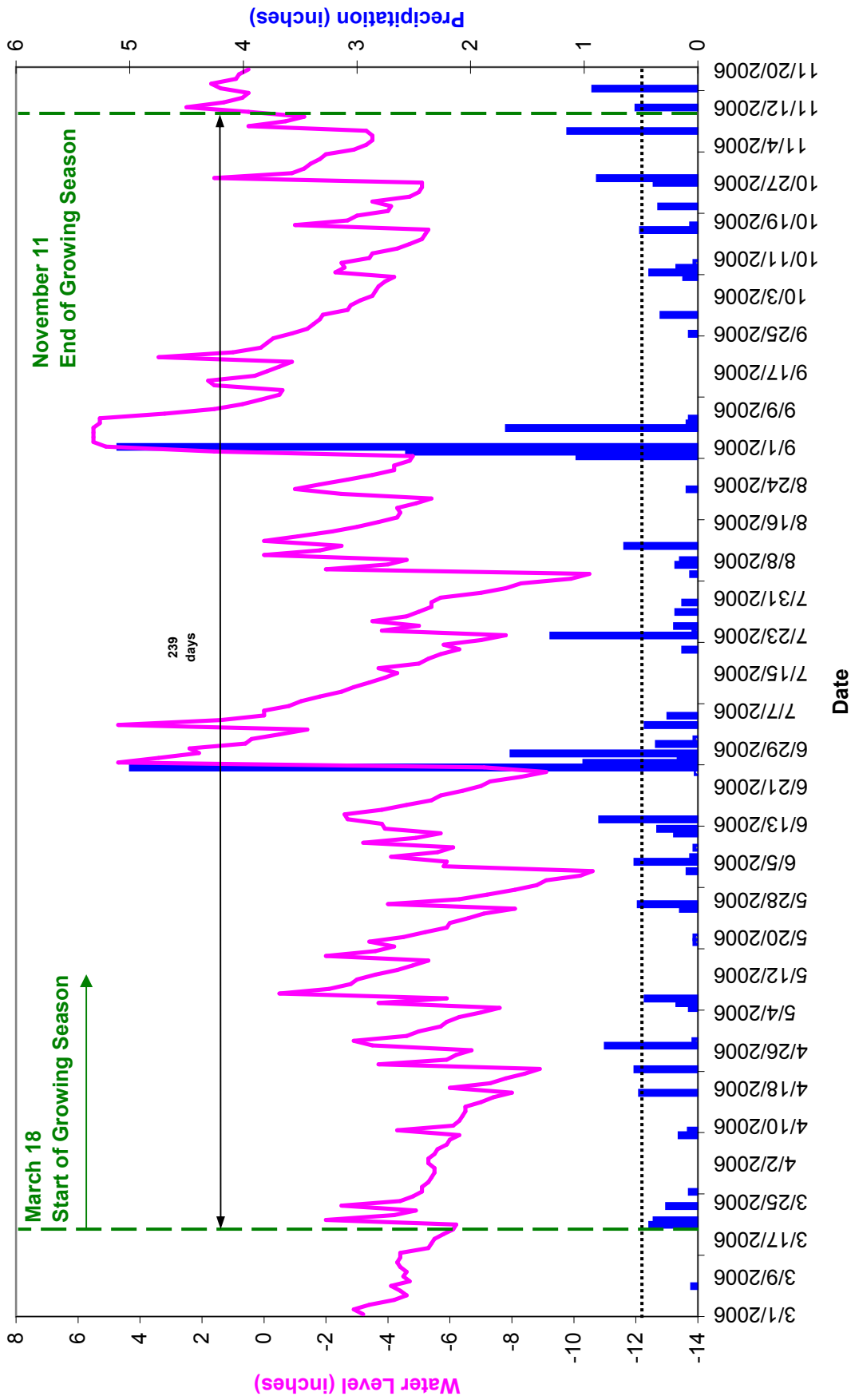
GW4 (2006 Gauge Data)



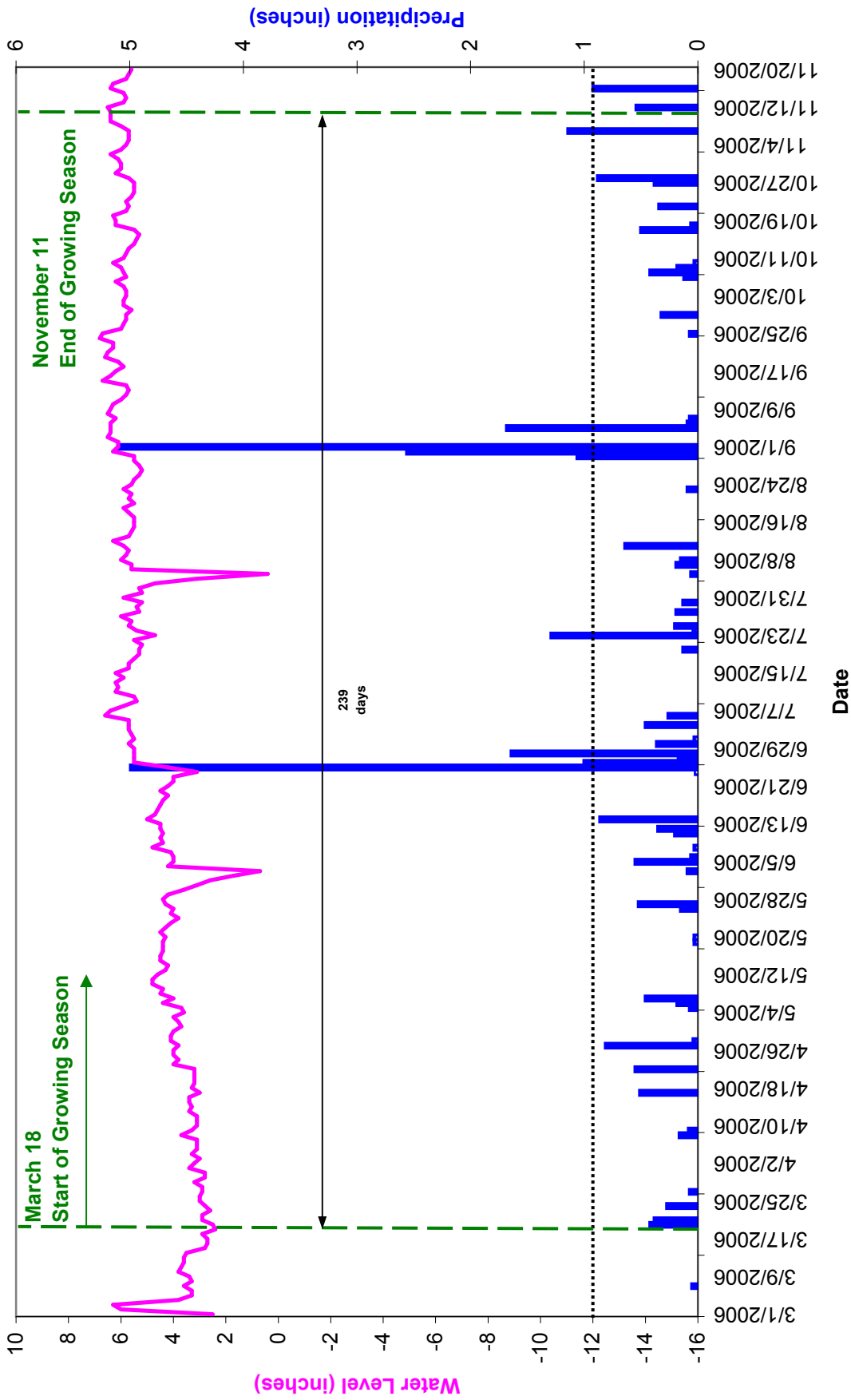
GW5 (2006 Gauge Data)



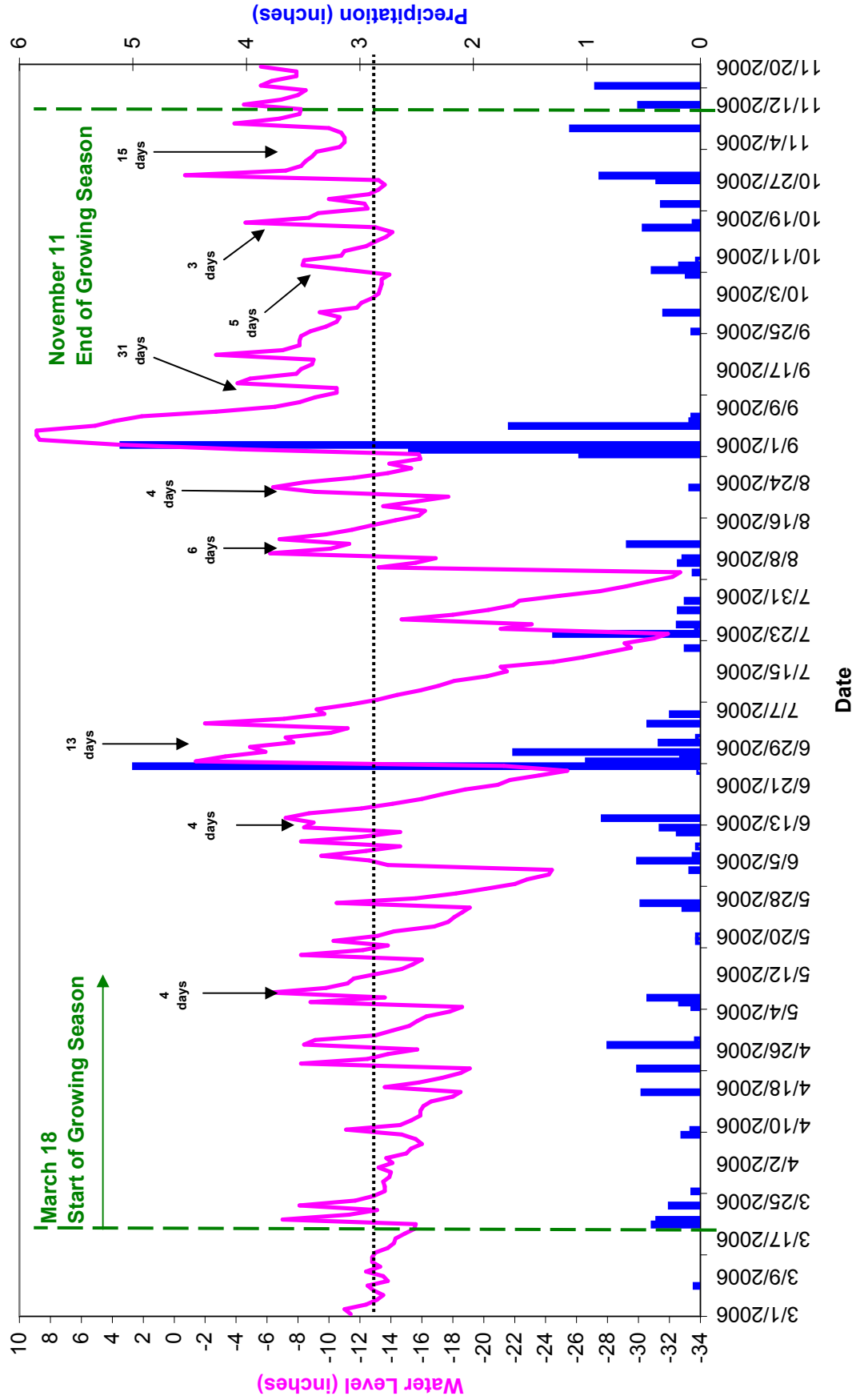
GW8 (2006 Gauge Data)



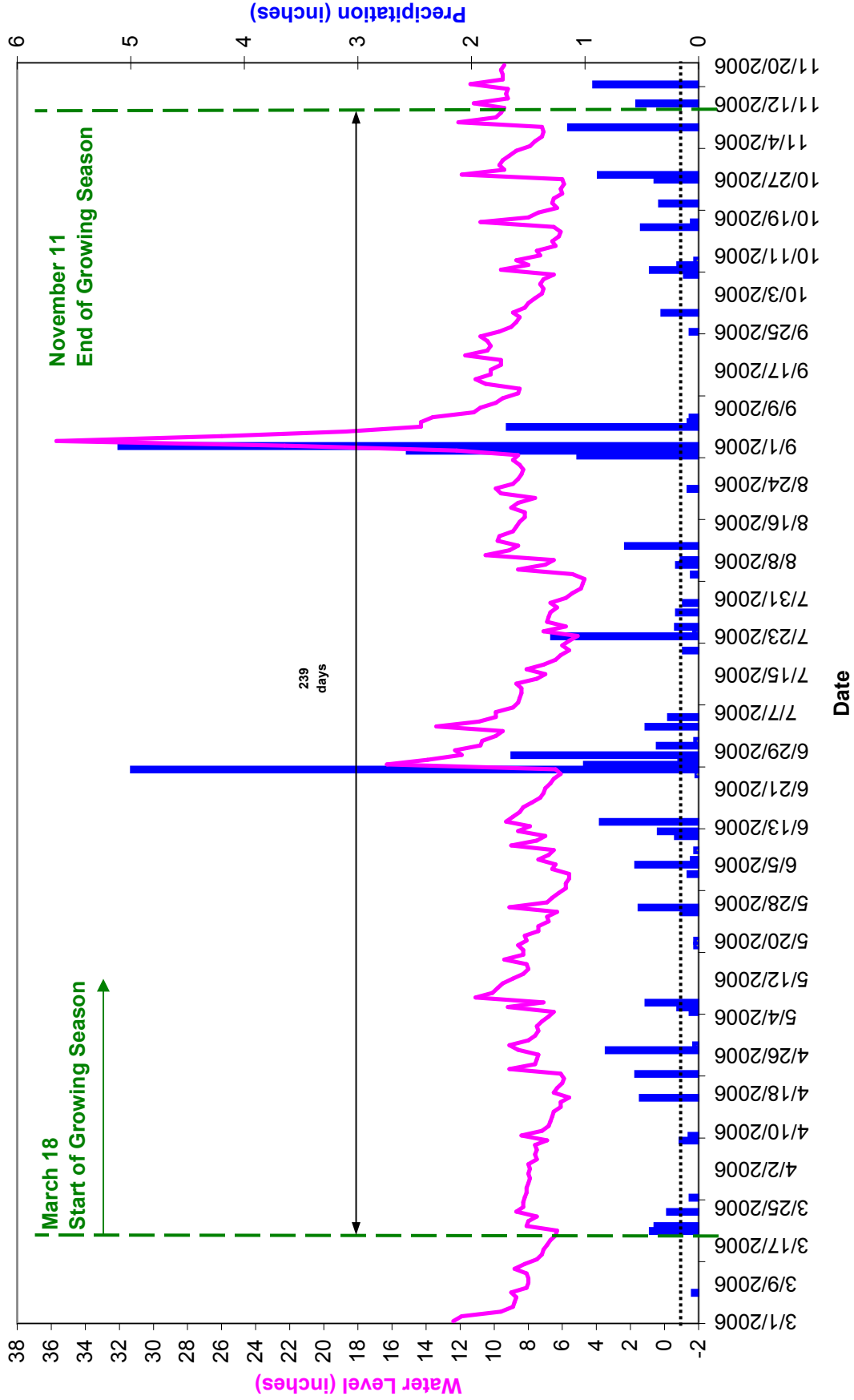
GW9 (2006 Gauge Data)



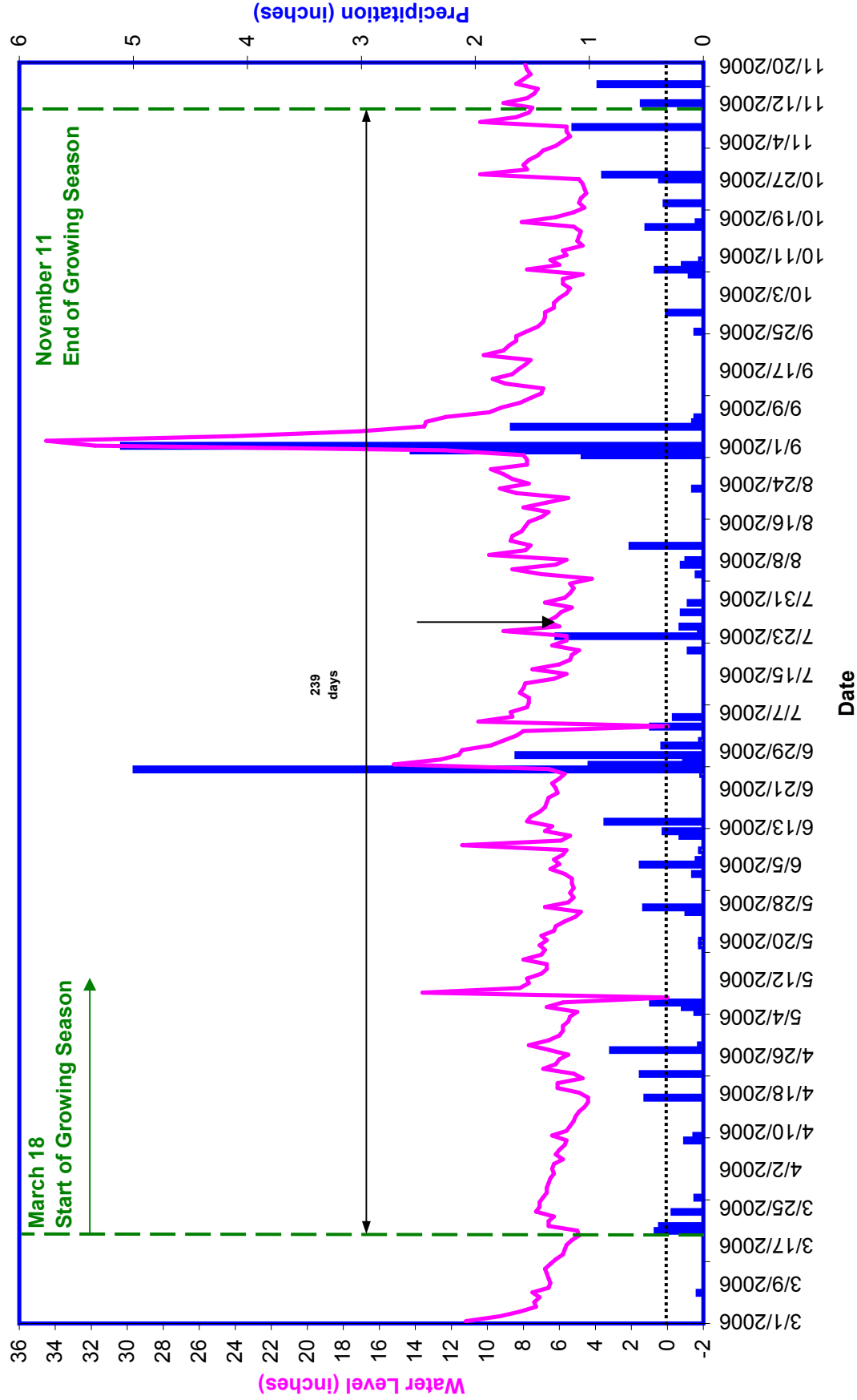
GW11 (2006 Gauge Data)



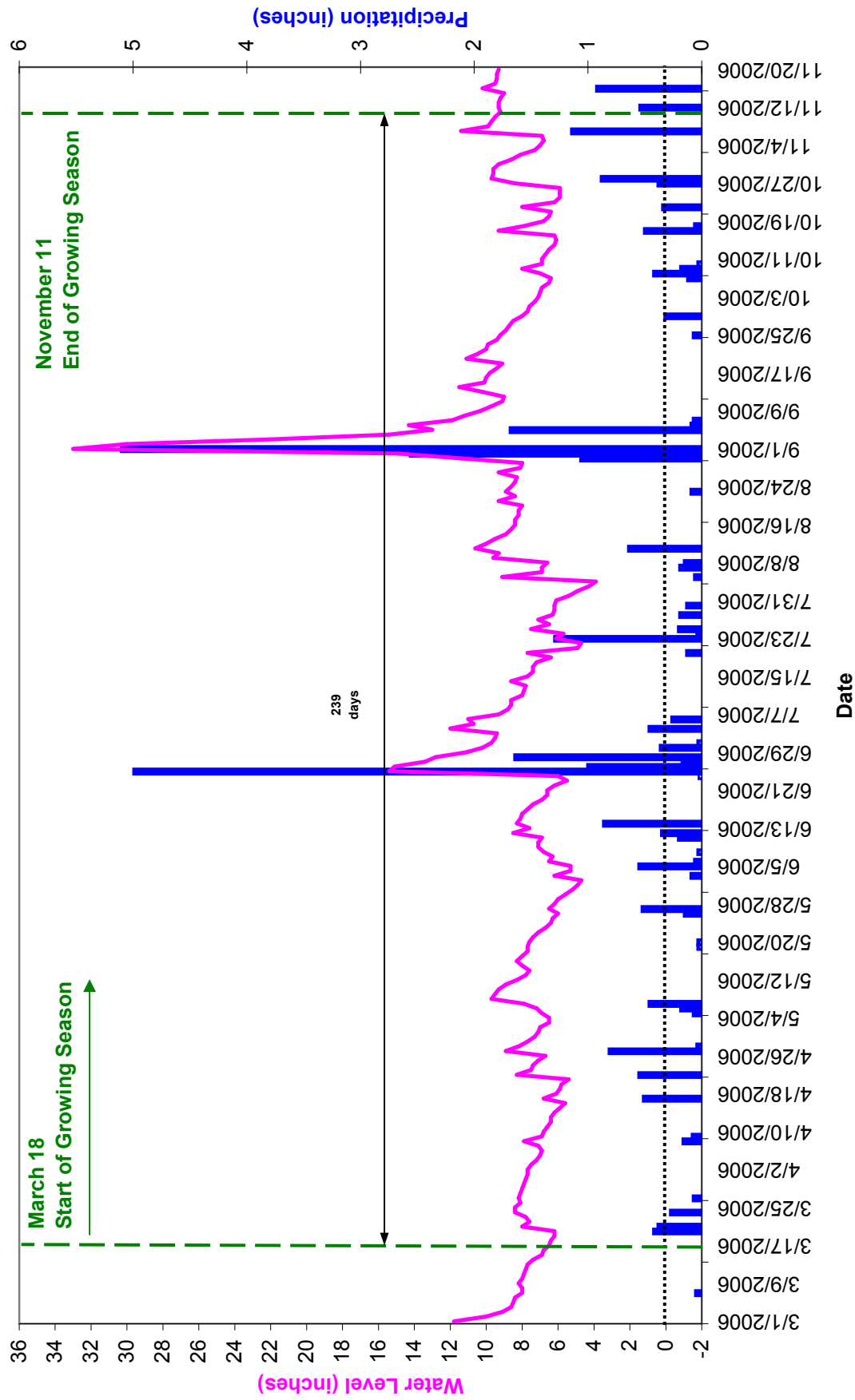
SG3 (2006 Gauge Data)



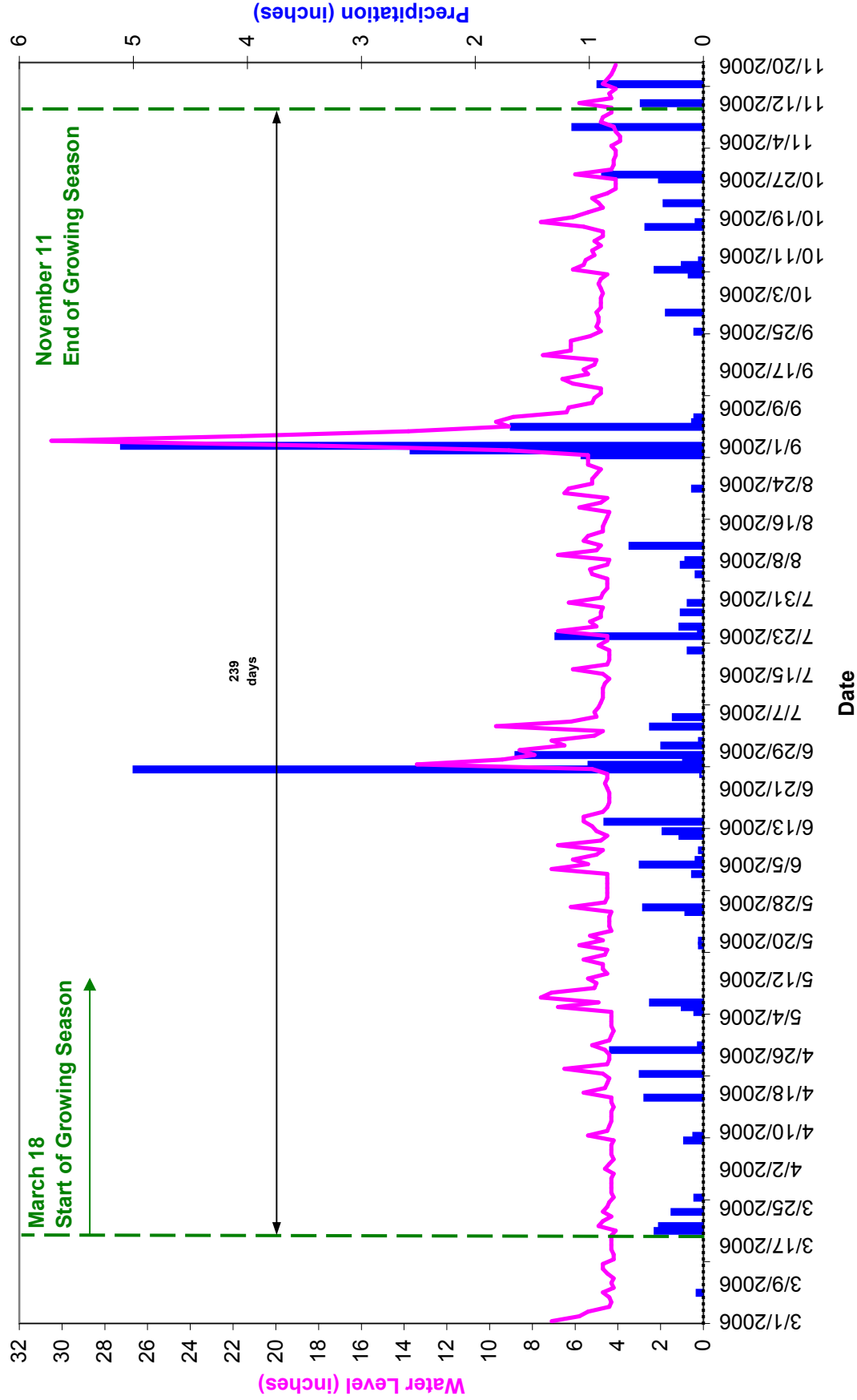
SG4 (2006 Gauge Data)



SG 5 (2006 Gauge Data)



SG6 (2006 Gauge Data)



APPENDIX C
VEGETATION MONITORING PHOTOGRAPHS

Appendix C
Vegetation Plot and Problem Area Photographs
Taken July 2007

