

**Brown Farm Wetland Restoration
Monitoring Report – MY03
Orange and Durham Counties, NC
Basin 03030002 – Contract # D050011-2**



Submitted to:



NCEEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

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Monitoring and Design Firm



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EXECUTIVE SUMMARY

The Brown Farm Wetland Restoration Project restored 24.6 acres and enhanced 3.3 acres of riparian wetland. New Hope Creek, which runs adjacent to the site, has a contributing drainage area of 33.3 square miles (21,331 acres) at the downstream limits of the site and is located within USGS 8-digit HUC 03030002 and NCDWQ Sub-basin 03-06-05 of the Cape Fear River Basin. The 46.1 acre project site is located on an active floodplain of New Hope Creek along the Orange-Durham County line. The restoration was completed to achieve the following objectives:

- Restore aquatic/terrestrial habitat
- Improve water quality
- Increase groundwater recharge
- Enhance nutrient cycling
- Restore a native bottomland hardwood community

Project construction occurred in November 2006. Construction involved plugging and filling ditches, installing level spreaders, and creating microtopography. The site was planted with native trees and shrubs common to Piedmont Bottomland Hardwood communities. Following construction and planting, baseline data collection occurred in February 2007. This report describes the third year of monitoring that took place in 2009.

Vegetation was planted at a density of approximately 436 and 100-200 stems per acre in the restored and enhanced wetlands, respectively. Twenty vegetation plots were monitored to assess planted vegetation survivability, growth, and vigor. The third year of monitoring counted an average of 308 planted stems per acre, which is slightly below the success criterion of 320 stems/acre. However, the site averages 878 total stems per acre, which includes woody volunteers in the monitoring plots except for red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*). An assessment of the site's vegetation found Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and multiflora rose (*Rosa multiflora*) on the outskirts of the site with Chinese lespedeza (*Lespedeza cuneata*) and thistle (*Cirsium* sp.) observed within the site. The thistle was sprayed with herbicide during the second monitoring year. These species will continue to be monitored to determine if other corrective action is necessary. Third year monitoring found the vegetation component of the project to be on track to meeting the success criteria.

During 2009, wetland hydrology was achieved at all seven wells in the restoration area and the well in the reference wetland. The hydrology success criterion states that groundwater must be within 12 inches of the soil surface in excess of 12 consecutive days (5% of the growing season) at each well.

The daily rainfall data depicted on the gauge data graphs were obtained from the on-site precipitation gauge. The precipitation gauge was installed in 2006 prior to project implementation. Daily rainfall data were obtained from the State Climate Office of North Carolina for Durham, North Carolina to confirm on-site precipitation data. The combined precipitation data show that the site experienced normal precipitation during the growing season in 2009.

Site photographs were taken from permanent photo points established throughout the site. Photo documentation facilitates the qualitative evaluation of wetland conditions. The photo point locations were selected in order to document representative site conditions.

The results of the third year of monitoring of the Brown Farm Wetland Restoration Project indicate that the site is on track to meeting the project's success criteria.

1.0 PROJECT BACKGROUND

1.1 Project Objectives

- Restore aquatic/terrestrial wildlife habitat
- Improve water quality
- Increase groundwater recharge
- Enhance nutrient cycling
- Restore to native bottomland hardwood communities

1.2 Project Structure, Restoration Type, and Approach

Before restoration, the land use was primarily agricultural for at least the past 50 years. The wetland was restored by plugging and filling drainage ditches throughout the site, removing ditch spoil from wooded areas to restore natural drainage patterns, placing water diversion features to redistribute the surface hydrology, recreating microtopography across the site to enhance surface water retention and storage, and planting the site with Piedmont Bottomland Hardwood Forest species.

1.3 Location and Setting

The Brown Farm Wetland Restoration Site is located within the 03030002 (Upper Cape Fear 02) Watershed Cataloging Unit (8-digit HUC) and North Carolina Division of Water Quality (NCDWQ) Sub-basin 03-06-05 (Figure 1). New Hope Creek, which runs adjacent to the site, has a contributing drainage area of 33.3 square miles (21,331 acres) at the downstream limits of the project. Jordan Lake is approximately 11 miles downstream of the site. The project watershed is located within the Piedmont physiographic province and is part of the Triassic Basins Level IV Ecoregion.

1.4 Project History and Background

Table 1. Project Restoration Components						
Project Name: Brown Farm Wetland Restoration						
Segment / Reach ID	Existing Feet/Acres	Type	Approach	Acreage	Mitigation Ratio	Mitigation Units
Brown Farm	24.6	R	-	24.6	1.0	24.6
Brown Farm	3.3	E	-	3.3	0.5	1.7
Mitigation Unit Summations						
Stream (If)	Riparian Wetland (Ac)	Nonriparian Wetland (Ac)	Total Wetland (Ac)	Buffer (Ac)	Comment	
	26.3					

R = Restoration E = Enhancement

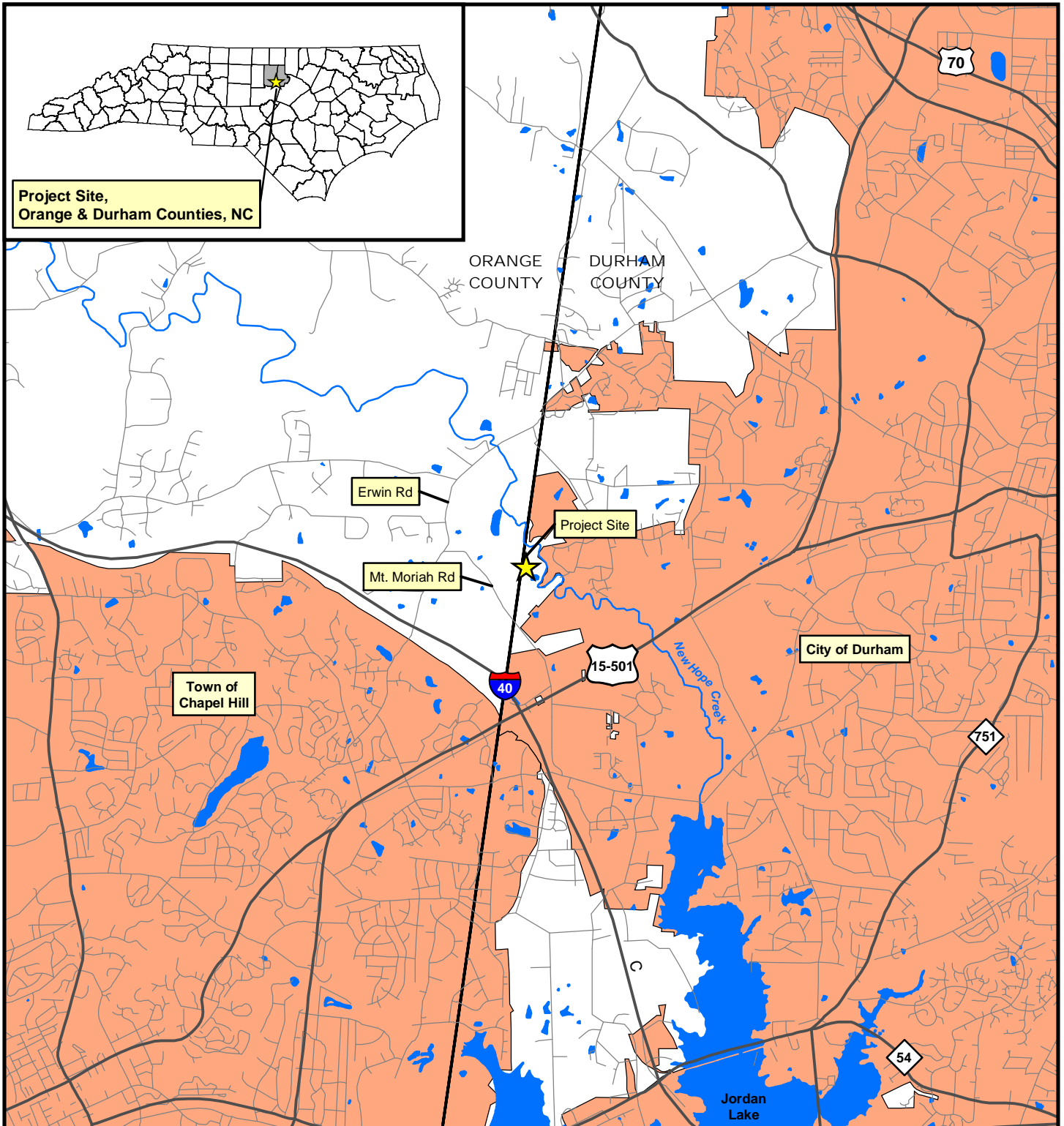









Figure 1. Vicinity Map

-  Project Location
-  Major Streams and Rivers
-  Lakes and Reservoirs
-  Municipalities
-  Counties
-  Major Roads
-  Other Roads



1:63,360
1 inch equals 1 miles

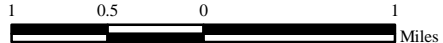
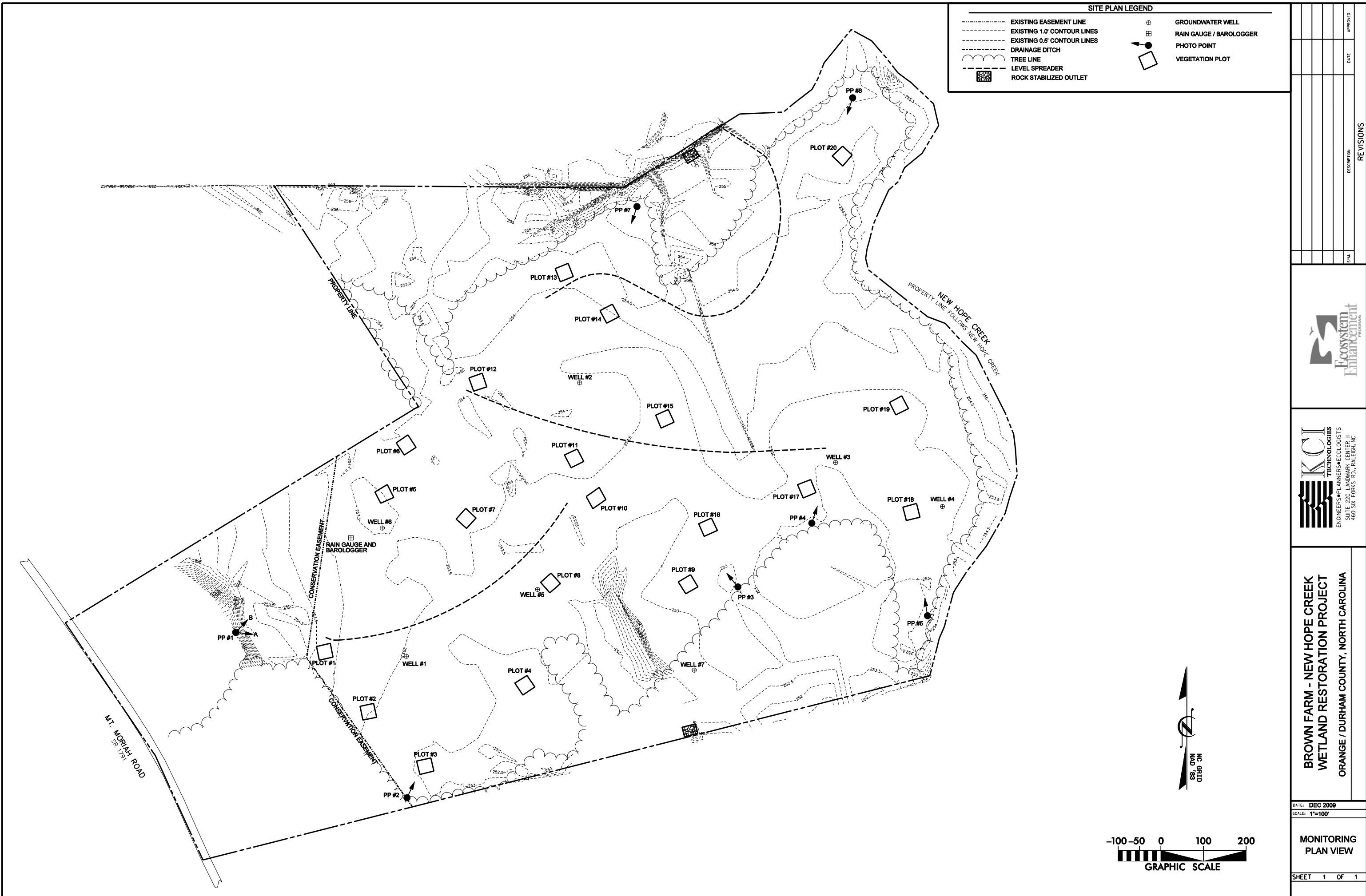


Table 2. Project Activity and Reporting History		
Project Name: Brown Farm Wetland Restoration		
Activity or Report	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	May 06	Jun 06
Construction	N/A	Nov 06
Mitigation Plan	Feb 07	Mar 07
Year 1 Monitoring	Sep 07	Nov 07
Herbicide Sprayed for Invasive Species Control	N/A	Jun 08
Year 2 Monitoring	Sep 08	Dec 08
Year 3 Monitoring	Nov 09	Dec 09

Table 3. Project Contact Table	
Project Name: Brown Farm Wetland Restoration	
Design, Monitoring, and Maintenance Firm	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Ms. Kristin Knight-Meng Phone: (919) 278-2509 Fax: (919) 783-9266
Construction Contractor	KCI Environmental Technologies and Construction, Inc. Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Ryan McDavitt Phone: (919) 783-9214 Fax: (919) 783-9266
Nursery	Cill Ide Native Plant Nursery 621 Starburst Lane Raleigh, North Carolina 27603 Contact: Mr. George T. Swearingen Phone: (919) 302-6900 Fax: (509) 351-5324

Table 4. Project Background Table	
Project Name: Brown Farm Wetland Restoration	
Project County	Durham and Orange Counties
Project Area	46.1 Acres
Drainage impervious cover	17%
Physiographic Region	Piedmont
Ecoregion	Triassic Basin
Dominant soil types	Wehadkee
USGS HUC for project and reference	03030002
NCDWQ Sub-basin for project and reference	03-06-05
% of project easement fenced	65%



SITE PLAN LEGEND

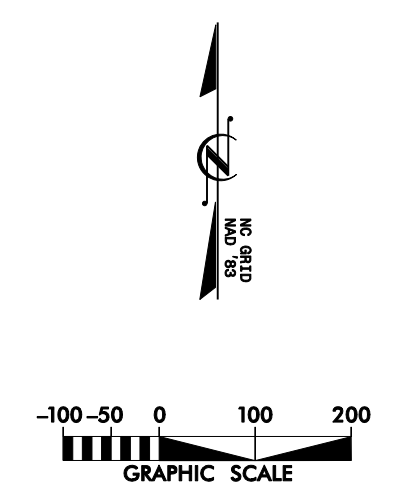
--- (dashed line)	EXISTING EASEMENT LINE	⊕ (circle with cross)	GROUNDWATER WELL
--- (dashed line)	EXISTING 1.0' CONTOUR LINES	⊞ (square with cross)	RAIN GAUGE / BAROLOGGER
--- (dashed line)	EXISTING 0.5' CONTOUR LINES	● (black dot)	PHOTO POINT
--- (dashed line)	DRAINAGE DITCH	□ (square)	VEGETATION PLOT
--- (dashed line)	TREE LINE		
--- (dashed line)	LEVEL SPREADER		
--- (dashed line)	ROCK STABILIZED OUTLET		

SYL	DESCRIPTION	DATE	APPROVED



**BROWN FARM - NEW HOPE CREEK
WETLAND RESTORATION PROJECT**
ORANGE / DURHAM COUNTY, NORTH CAROLINA

DATE: DEC 2009
SCALE: 1"=100'
MONITORING PLAN VIEW
SHEET 1 OF 1



2.0 PROJECT CONDITIONS AND MONITORING RESULTS

2.1 Vegetation Assessment

The 2009 vegetation monitoring included counting the volunteer stems. The site is immediately adjacent to well-developed wetlands within the New Hope Creek floodplain with extensive wetland vegetation. These surrounding areas have helped seed the site, contributing to a large number of volunteers in the monitoring plots. There was a decrease in the site average of planted stems/acre during the third monitoring year. The mortality of the planted stems is primarily related to deer browse and competition from dense herbaceous vegetation. The volunteer plants that were counted include: green ash (*Fraxinus pennsylvanica*), buttonbush (*Cephalanthus occidentalis*), laurel oak (*Quercus laurifolia*), willow oak (*Quercus phellos*), swamp chestnut oak (*Quercus michauxii*), cherrybark oak (*Quercus pagoda*), elderberry (*Sambucus canadensis*), sycamore (*Platanus occidentalis*), eastern baccharis (*Baccharis halmifolia*), and winged elm (*Ulmus alata*). Red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*) were also counted, but since they are not considered desirable species, they were not included in the density calculations for this report. The third year of monitoring found an average of 308 planted stems per acre and 878 total stems per acre for the site based on the monitored vegetation plots. Even though there has been some mortality of the planted stems, based on the average total stems per acre, the site is on track to meeting the success criteria set in the restoration plan of 320 stems per acre.

The qualitative vegetation assessment of the site found that there were many woody stems throughout the site and that there is a healthy mix of wetland herbaceous vegetation covering the site as well. Plot 1 was repositioned during the second monitoring year when it became apparent that the monitoring plot was on top of the line that separated the upland from the restored wetland. For additional data on the counted stems, volunteer stems, and photos of the vegetation plots, see Appendix A.

2.2 Wetland Criteria Attainment Tables

Table 5. Hydrologic Monitoring Results						
Project Name: Brown Farm Wetland Restoration						
Well #	Hydroperiod				Max. No. of Consecutive Days	Dates Meeting Success
	<5%	5% - 8%	8% - 12.5%	>12.5%		
1				X	34	3/24/09-4/26/09
2				X	99	3/24/09-6/30/09
3				X	97	3/24/09-6/28/09
4				X	41	3/24/09-5/3/09
5				X	100	3/24/09-7/1/09
6				X	59	3/24/09-5/21/09
7				X	65	3/24/09-5/27/09
Ref. Wetland				X	35	3/24/09-4/27/09

Table 6. Hydroperiod History						
Project Name: Brown Farm Wetland Restoration						
Well #	Pre-Restoration	Year 1	Year 2	Year 3	Year 4	Year 5
1	<5%	>12.5%	>12.5%	>12.5%		
2	<5%	>12.5%	>12.5%	>12.5%		
3	<5%	5% - 8%	>12.5%	>12.5%		
4	<5%	5% - 8%	>12.5%	>12.5%		
5	<5%	8%-12.5%	>12.5%	>12.5%		
6	<5%	5% - 8%	>12.5%	>12.5%		
7	<5%	8%-12.5%	>12.5%	>12.5%		
Ref. Well	<5%	5% - 8%	>12.5%	>12.5%		

The wetland wells used to monitor site hydrology were installed in early 2007. The maximum number of consecutive days that the groundwater was within 12 inches of the surface was determined for each groundwater gauge. This number was converted into a percentage of the 223-day growing season. Wetland hydrology was achieved at all of the gauges on the site in 2009 (Table 5). Based on these data, the site has exceeded the minimum duration of 12 consecutive days with the water table within 12 inches of the soil surface for the 2009 growing season (Appendix B). In addition, all of the gauges exceeded 12.5% saturation. Table 5 presents the hydrological monitoring results for 2009. Climatic data for the 2009 growing season were analyzed in comparison to historical data to determine whether 2009 was a normal year in terms of climatic conditions as a precursor to validating the results of the wetland monitoring. The historical data were collected from the NRCS, Water and Climate Center, "Climate Analysis for Wetlands by County" website. This evaluation concluded that 2009 was a normal year for rainfall during the growing season. Rainfall was within the 30th to 70th percentiles for the months of April, May, July and September. Rainfall was less than the 30th percentile threshold in January, February, August and October and was greater than the 70th percentile threshold in March, June, and November (Appendix B).

To illustrate that the site is a riverine system, a stream gauge was installed on New Hope Creek to document overbank flooding. This gauge was installed in February 2008. Since installation, the gauge has recorded 26 overbank flooding events (over 253.8' elevation). Of these events, only 3 did not exceed 254 feet in elevation, at which approximately 75% of the site would be inundated.

Appendix A

Vegetation Data

Appendix A - Vegetation Data Tables

Table A1. Planted stem counts for each species arranged by plot														
Project Name: Brown Farm Wetland Restoration														
Species	Plots										Initial Totals	Year 3 Totals	Survival %	
	1*	2	3	4	5	6	7	8	9	10				
Trees														
<i>Diospyros virginiana</i>		1										1	1	100%
<i>Fraxinus pennsylvanica</i>	6	4			5	3	1		3	2		23	24	104%
<i>Liriodendron tulipifera</i>												6	0	0%
<i>Quercus laurifolia</i>							2		1	2		7	5	71%
<i>Quercus lyrata</i>	1	4	2		2							9	9	100%
<i>Quercus michauxii</i>	1	5	4	1		1	4					23	16	70%
<i>Quercus pagoda</i>	1	1	3	2	2		3		2	2		23	16	70%
<i>Quercus phellos</i>			2				1			2		9	5	56%
Unknown												44	0	0%

*Plot 1 was moved in MY02

Table A1 cont. Planted stem counts for each species arranged by plot														
Project Name: Brown Farm Wetland Restoration														
Species	Plots										Initial Totals	Year 3 Totals	Survival %	
	11	12	13	14	15	16	17	18	19	20				
Trees														
<i>Fraxinus pennsylvanica</i>	1	2	1			1	8	1	2	5		25	21	84%
<i>Liriodendron tulipifera</i>												5	0	0%
<i>Nyssa sylvatica</i>												1	0	0%
<i>Quercus laurifolia</i>	1					1	3		1			7	6	86%
<i>Quercus lyrata</i>	6	2	4	4	3		1			4		28	24	86%
<i>Quercus michauxii</i>	1		2			1		2		1		8	7	88%
<i>Quercus pagoda</i>	3	1	5		1	1	1	1	2	1		22	16	73%
<i>Quercus phellos</i>						4			1			8	5	63%
Unknown												30	0	0%

Table A2. Stem Density By Plot
Project Name: Brown Farm Wetland Restoration
Date : 6/8/09 to 6/10/09
Crew : B. Roberts, C. Carter

Plot #	Persimmon <i>Diospyros virginiana</i>	Green Ash <i>Fraxinus pennsylvanica</i>	Tulip Poplar <i>Liriodendron tulipifera</i>	Water Tupelo <i>Nyssa sylvatica</i>	Laurel Oak <i>Quercus laurifolia</i>	Overcup Oak <i>Quercus lyrata</i>	Swamp Chestnut Oak <i>Quercus michauxii</i>	Cherrybark Oak <i>Quercus pagoda</i>	Willow Oak <i>Quercus phellos</i>	Total	Density
1		6				1	1	1		9	360
2	1	4				4	5	1		15	600
3						2	4	3	2	11	440
4							1	2		3	120
5		5				2		2		9	360
6		3					1			4	160
7		1			1		4	3	1	10	400
8										0	0
9		3			1			2		6	240
10		2			2			2	2	8	320
11		1			1	6	1	3		12	480
12		2				2		1		5	200
13		1				4	2	5		12	480
14						4				4	160
15						3		1		4	160
16		1			1		1	1	4	8	320
17		8			3	1		1		13	520
18		1					2	1		4	160
19		2			1			2	1	6	240
20		5				4	1	1		11	440
Total Average Density										308	

Table A3. Vegetation History Stems/Acre Planted and Total with Volunteers							
Project Name: Brown Farm Wetland Restoration							
Plot #	Year 0	Year 1	Year 2	Year 3		Year 4	Year 5
	planted	planted	planted	planted	total		
1	640	560	360	360	400		
2	760	720	600	600	800		
3	680	560	520	440	1,040		
4	520	240	240	120	1,120		
5	640	520	360	360	560		
6	400	320	160	160	800		
7	680	680	480	400	960		
8	560	280	80	0	840		
9	440	360	280	240	840		
10	480	480	320	320	520		
11	640	520	480	480	680		
12	520	240	200	200	240		
13	640	560	480	480	1,200		
14	720	480	400	160	720		
15	320	320	200	160	360		
16	480	440	320	320	480		
17	600	560	520	520	1,760		
18	320	280	160	160	2,000		
19	480	480	260	240	320		
20	640	600	520	440	1,920		
Site Average	558	460	347	308	878		

- Notes: -Plot 1 was moved in monitoring year 02.
 -Total stems includes all volunteer woody stems except for red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*).
 -Volunteer woody stems were not counted in MY 01 and 02.

Species	Percent of Total
Green Ash (<i>Fraxinus pennsylvanica</i>)	66.7%
Overcup Oak (<i>Quercus lyrata</i>)	11.1%
Southern Red Oak (<i>Quercus falcata</i>)	11.1%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	11.1%

Density:

Total Number of Planted Stems 9 / 0.025 acres = 360 stems / acre

Total Number of Desirable Stems* 10 / 0.025 acres = 400 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 9 / 9 trees x 100 = 100 % survivability



2nd Year Monitoring



3rd Year Monitoring

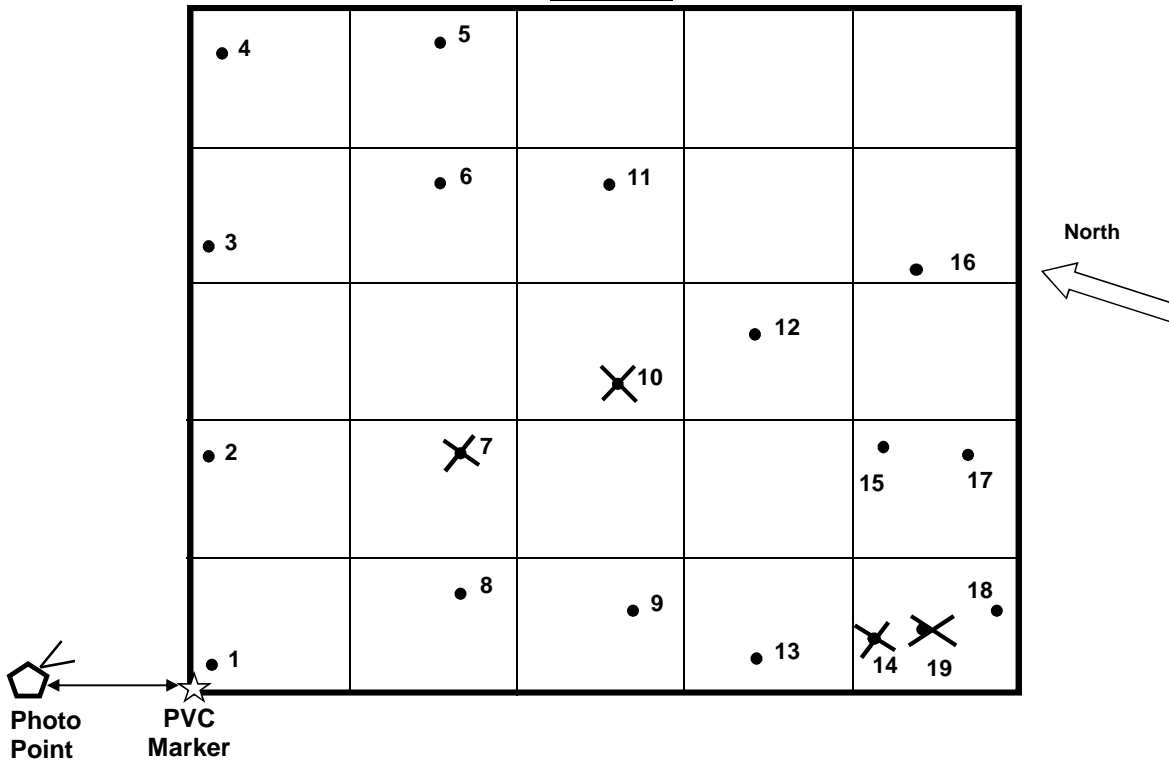
Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Red Maple (<i>Acer rubrum</i>)	1			
Cherrybark Oak (<i>Quercus pagoda</i>)	1			
Total	2			

Vegetation Monitoring Worksheet

Site: Brown Plot: 2 Date: 6/8/2009

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Green Ash (<i>Fraxinus pennsylvanica</i>)	0.55	2	Browsed
2	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.82	2	Heavily Browse
3	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.94	3	Moderately Browsed
4	Overcup Oak (<i>Quercus lyrata</i>)	0.84	3	Heavily Browse
5	Overcup Oak (<i>Quercus lyrata</i>)	0.71	2	Moderately Browsed
6	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.39	3	
7	Swamp Chestnut Oak (<i>Quercus michauxii</i>)			Dead (Browsing)
8	Green Ash (<i>Fraxinus pennsylvanica</i>)	0.56	3	Browsed
9	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	2.40	4	
10	Unknown			Dead
11	Green Ash (<i>Fraxinus pennsylvanica</i>)	0.60	2	Heavily Browse
12	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.60	2	Heavily Browse
13	Overcup Oak (<i>Quercus lyrata</i>)	0.84	2	Heavily Browse
14	Unknown			Dead
15	Green Ash (<i>Fraxinus pennsylvanica</i>)	0.51	2	Heavily Browse
16	Cherrybark Oak (<i>Quercus pagoda</i>)	0.93	3	Moderately Browsed
17	Persimmon (<i>Diospyros virginiana</i>)	1.27	4	
18	Overcup Oak (<i>Quercus lyrata</i>)	0.51	3	Browsed
19	Unknown			Dead (Browsing)

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Green Ash (<i>Fraxinus pennsylvanica</i>)	26.7%
Overcup Oak (<i>Quercus lyrata</i>)	26.7%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	33.3%
Persimmon (<i>Diospyros virginiana</i>)	6.7%
Cherrybark Oak (<i>Quercus pagoda</i>)	6.7%

Density:

Total Number of Planted Stems 15 / 0.025 acres = 600 stems / acre

Total Number of Desirable Stems* 20 / 0.025 acres = 800 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 15 / 19 trees x 100 = 79 % survivability



2nd Year Monitoring



3rd Year Monitoring

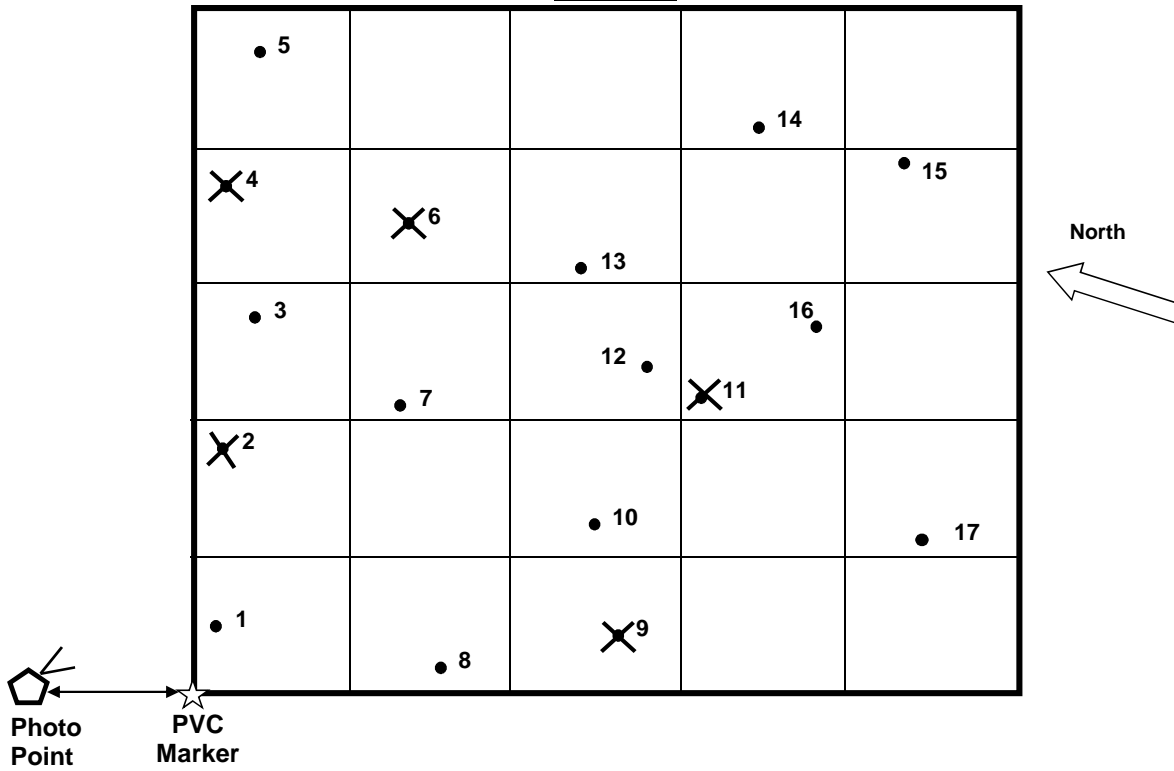
Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Buttonbush (<i>Cephalanthus occidentalis</i>)	3			
Green Ash (<i>Fraxinus pennsylvanica</i>)		2		
Total	3	2		

Vegetation Monitoring Worksheet

Site: Brown Plot: 3 Date: 6/8/2009

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Cherrybark Oak (<i>Quercus pagoda</i>)	0.78	3	
2	Unknown			Dead
3	Overcup Oak (<i>Quercus lyrata</i>)	0.57	3	Heavily Browsed
4	Unknown			Dead
5	Willow Oak (<i>Quercus phellos</i>)	0.52	3	
6	Swamp Chestnut Oak (<i>Quercus michauxii</i>)			Dead
7	Cherrybark Oak (<i>Quercus pagoda</i>)	0.51	3	
8	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.47	3	Top died back
9	Unknown			Dead
10	Overcup Oak (<i>Quercus lyrata</i>)	0.72	3	Browsed
11	Unknown			Dead
12	Willow Oak (<i>Quercus phellos</i>)	0.90	4	
13	Swamp Chestnut Oak (<i>Quercus michauxii</i>)			Missing
14	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.62	3	Browsed
15	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.31	2	Resprout
16	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.55	3	
17	Cherrybark Oak (<i>Quercus pagoda</i>)	0.63	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Willow Oak (<i>Quercus phellos</i>)	18.2%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	36.4%
Cherrybark Oak (<i>Quercus pagoda</i>)	27.3%
Overcup Oak (<i>Quercus lyrata</i>)	18.2%

Density:

Total Number of Planted Stems 11 / 0.025 acres = 440 stems / acre

Total Number of Desirable Stems* 26 / 0.025 acres = 1,040 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 11 / 17 trees x 100 = 65 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Buttonbush (<i>Cephalanthus occidentalis</i>)	5	8		
Green Ash (<i>Fraxinus pennsylvanica</i>)	1	1		
Total	6	9		

Species	Percent of Total
Cherrybark Oak (<i>Quercus pagoda</i>)	66.7%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	33.3%

Density:

Total Number of Planted Stems 3 / 0.025 acres = 120 stems / acre

Total Number of Desirable Stems* 28 / 0.025 acres = 1,120 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 3 / 13 trees x 100 = 23 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Buttonbush (<i>Cephalanthus occidentalis</i>)	7	15	2	
Green Ash (<i>Fraxinus pennsylvanica</i>)		1		
Total	7	16	2	

Species	Percent of Total
Overcup Oak (<i>Quercus lyrata</i>)	22.2%
Green Ash (<i>Fraxinus pennsylvanica</i>)	55.6%
Cherrybark Oak (<i>Quercus pagoda</i>)	22.2%

Density:

Total Number of Planted Stems 9 / 0.025 acres = 360 stems / acre

Total Number of Desirable Stems* 14 / 0.025 acres = 560 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 9 / 16 trees x 100 = 56 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Green Ash (<i>Fraxinus pennsylvanica</i>)	5			
Total	5			

Species	Percent of Total
Green Ash (<i>Fraxinus pennsylvanica</i>)	75.0%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	25.0%

Density:

Total Number of Planted Stems 4 / 0.025 acres = 160 stems / acre

Total Number of Desirable Stems* 20 / 0.025 acres = 800 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 4 / 10 trees x 100 = 40 % survivability



2nd Year Monitoring



3rd Year Monitoring

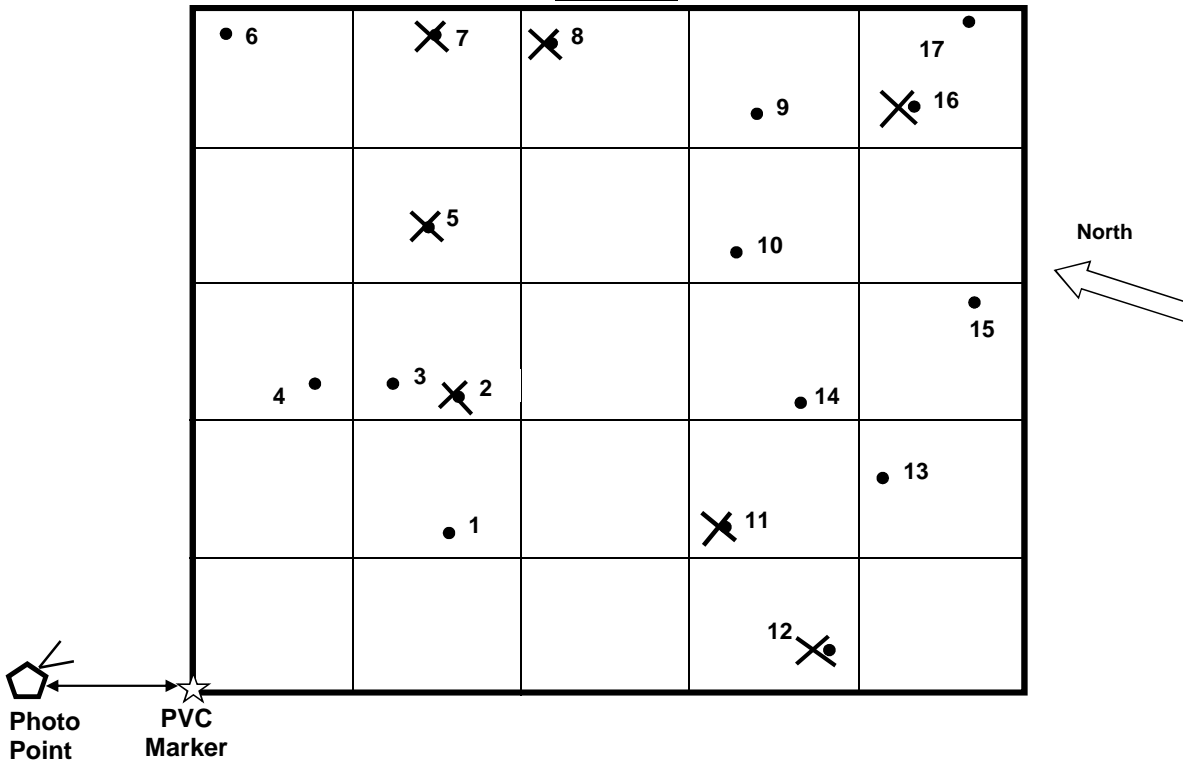
Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Buttonbush (<i>Cephalanthus occidentalis</i>)	1			
Green Ash (<i>Fraxinus pennsylvanica</i>)	7	6		
Swamp Chestnut Oak (<i>Quercus michauxii</i>)		1		
Elderberry (<i>Sambucus canadensis</i>)	1			
Total	9	7		

Vegetation Monitoring Worksheet

Site: Brown Plot: 7 Date: 6/9/2009

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Cherrybark Oak (<i>Quercus pagoda</i>)	0.50	3	Top died back
2	Willow Oak (<i>Quercus phellos</i>)			Dead
3	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.46	2	
4	Laurel Oak (<i>Quercus laurifolia</i>)	0.81	3	
5	Swamp Chestnut Oak (<i>Quercus michauxii</i>)			Dead
6	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.98	3	Moderately browsed
7	Willow Oak (<i>Quercus phellos</i>)			Missing
8	Laurel Oak (<i>Quercus laurifolia</i>)			Missing
9	Willow Oak (<i>Quercus phellos</i>)	0.90	3	
10	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.77	3	
11	Unknown			Dead
12	Green Ash (<i>Fraxinus pennsylvanica</i>)			Dead
13	Swamp Chestnut Oak (<i>Quercus michauxii</i>)	0.42	2	
14	Cherrybark Oak (<i>Quercus pagoda</i>)	0.83	3	
15	Cherrybark Oak (<i>Quercus pagoda</i>)	0.46	3	
16	Unknown			Dead
17	Green Ash (<i>Fraxinus pennsylvanica</i>)	0.64	2	Moderately browsed

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Willow Oak (<i>Quercus phellos</i>)	10.0%
Green Ash (<i>Fraxinus pennsylvanica</i>)	10.0%
Cherrybark Oak (<i>Quercus pagoda</i>)	30.0%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	40.0%
Laurel Oak (<i>Quercus laurifolia</i>)	10.0%

Density:

Total Number of Planted Stems 10 / 0.025 acres = 400 stems / acre

Total Number of Desirable Stems* 24 / 0.025 acres = 960 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 10 / 17 trees x 100 = 59 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Buttonbush (<i>Cephalanthus occidentalis</i>)	2	9		
Green Ash (<i>Fraxinus pennsylvanica</i>)	2			
Sycamore (<i>Platanus Occidentalis</i>)		1		
Total	4	10		

Species	Percent of Total

Density:

Total Number of Planted Stems 0 / 0.025 acres = 0 stems / acre

Total Number of DesirableStems* 21 / 0.025 acres = 840 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 0 / 14 trees x 100 = 0 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Buttonbush (<i>Cephalanthus occidentalis</i>)	1	12	1	
Green Ash (<i>Fraxinus pennsylvanica</i>)	2	4		
Unknown		1		
Total	3	17	1	

Species	Percent of Total
Green Ash (<i>Fraxinus pennsylvanica</i>)	50.0%
Laurel Oak (<i>Quercus laurifolia</i>)	16.7%
Cherrybark Oak (<i>Quercus pagoda</i>)	33.3%

Density:

Total Number of Planted Stems 6 / 0.025 acres = 240 stems / acre

Total Number of Desirable Stems* 21 / 0.025 acres = 840 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 6 / 11 trees x 100 = 55 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Buttonbush (<i>Cephalanthus occidentalis</i>)	5	5		
Green Ash (<i>Fraxinus pennsylvanica</i>)	3	2		
Total	8	7		

Species	Percent of Total
Willow Oak (<i>Quercus phellos</i>)	25.0%
Green Ash (<i>Fraxinus pennsylvanica</i>)	25.0%
Cherrybark Oak (<i>Quercus pagoda</i>)	25.0%
Laurel Oak (<i>Quercus laurifolia</i>)	25.0%

Density:

Total Number of Planted Stems 8 / 0.025 acres = 320 stems / acre

Total Number of Desirable Stems* 13 / 0.025 acres = 520 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 8 / 12 trees x 100 = 67 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Green Ash (<i>Fraxinus pennsylvanica</i>)	1	2		
Sweet Gum (<i>Liquidambar styraciflua</i>)	1			
Cherrybark Oak (<i>Quercus pagoda</i>)	1			
Winged Elm (<i>Ulmus alata</i>)		1		
Total	3	3		

Species	Percent of Total
Overcup Oak (<i>Quercus lyrata</i>)	50.0%
Green Ash (<i>Fraxinus pennsylvanica</i>)	8.3%
Laurel Oak (<i>Quercus laurifolia</i>)	8.3%
Cherrybark Oak (<i>Quercus pagoda</i>)	25.0%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	8.3%

Density:

Total Number of Planted Stems 12 / 0.025 acres = 480 stems / acre

Total Number of Desirable Stems* 17 / 0.025 acres = 680 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 12 / 16 trees x 100 = 75 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Sycamore (<i>Platanus occidentalis</i>)	2	2		
Willow Oak (<i>Quercus phellos</i>)		1		
Total	2	3		

Species	Percent of Total
Green Ash (<i>Fraxinus pennsylvanica</i>)	40.0%
Overcup Oak (<i>Quercus lyrata</i>)	40.0%
Cherrybark Oak (<i>Quercus pagoda</i>)	20.0%

Density:

Total Number of Planted Stems 5 / 0.025 acres = 200 stems / acre

Total Number of Desirable Stems* 6 / 0.025 acres = 240 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 5 / 13 x 100 = 38 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Laurel Oak (<i>Quercus laurifolia</i>)	1			
Total	1			

Species	Percent of Total
Green Ash (<i>Fraxinus pennsylvanica</i>)	8.3%
Overcup Oak (<i>Quercus lyrata</i>)	33.3%
Cherrybark Oak (<i>Quercus pagoda</i>)	41.7%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	16.7%

Density:

Total Number of Planted Stems 12 / 0.025 acres = 480 stems / acre

Total Number of Desirable Stems* 30 / 0.025 acres = 1,200 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 12 / 16 x 100 = 75 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Eastern Baccharis (<i>Baccharis halimifolia</i>)			3	
Green Ash (<i>Fraxinus pennsylvanica</i>)		2	1	
Sweetgum (<i>Liquidambar styraciflua</i>)			1	
Sycamore (<i>Platanus occidentalis</i>)	2	6	4	
Total	2	8	9	

Species	Percent of Total
Overcup Oak (<i>Quercus lyrata</i>)	100.0%

Density:

Total Number of Planted Stems 4 / 0.025 acres = 160 stems / acre

Total Number of DesirableStems* 18 / 0.025 acres = 720 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 4 / 18 x 100 = 22 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Eastern Baccharis (<i>Baccharis halimifolia</i>)		4		
Sweetgum (<i>Liquidambar styraciflua</i>)		1		
Sycamore (<i>Platanus occidentalis</i>)	3	1	6	
Total	3	6	6	

Species	Percent of Total
Overcup Oak (<i>Quercus lyrata</i>)	75.0%
Cherrybark Oak (<i>Quercus pagoda</i>)	25.0%

Density:

Total Number of Planted Stems 4 / 0.025 acres = 160 stems / acre

Total Number of DesirableStems* 9 / 0.025 acres = 360 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 4 / 8 x 100 = 50 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Green Ash (<i>Fraxinus pennsylvanica</i>)	1	3	1	
Total	1	3	1	

Species	Percent of Total
Willow Oak (<i>Quercus phellos</i>)	50.0%
Green Ash (<i>Fraxinus pennsylvanica</i>)	12.5%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	12.5%
Laurel Oak (<i>Quercus laurifolia</i>)	12.5%
Cherrybark Oak (<i>Quercus pagoda</i>)	12.5%

Density:

Total Number of Planted Stems 8 / 0.025 acres = 320 stems / acre

Total Number of Desirable Stems* 12 / 0.025 acres = 480 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 8 / 12 x 100 = 67 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Buttonbush (<i>Cephalanthus occidentalis</i>)		1		
Green Ash (<i>Fraxinus pennsylvanica</i>)	2	1		
Total	2	2		

Species	Percent of Total
Green Ash (<i>Fraxinus pennsylvanica</i>)	61.5%
Cherrybark Oak (<i>Quercus pagoda</i>)	7.7%
Laurel Oak (<i>Quercus laurifolia</i>)	23.1%
Overcup Oak (<i>Quercus lyrata</i>)	7.7%

Density:

Total Number of Planted Stems 13 / 0.025 acres = 520 stems / acre

Total Number of Desirable Stems* 44 / 0.025 acres = 1,760 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 13 / 15 x 100 = 87 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Red Maple (<i>Acer rubrum</i>)	2	3		
Green Ash (<i>Fraxinus pennsylvanica</i>)	7	21	3	
Total	2	24	3	

Species	Percent of Total
Green Ash (<i>Fraxinus pennsylvanica</i>)	25.0%
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	50.0%
Cherrybark Oak (<i>Quercus pagoda</i>)	25.0%

Density:

Total Number of Planted Stems 4 / 0.025 acres = 160 stems / acre

Total Number of Desirable Stems* 50 / 0.025 acres = 2,000 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 4 / 8 x 100 = 50 % survivability



2nd Year Monitoring

3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Red Maple (<i>Acer rubrum</i>)	3	2	1	
Green Ash (<i>Fraxinus pennsylvanica</i>)	5	32	9	
Sweetgum (<i>Liquidambar styraciflua</i>)	1	1		
Total	9	35	10	

Species	Percent of Total
Green Ash (<i>Fraxinus pennsylvanica</i>)	33.3%
Willow Oak (<i>Quercus phellos</i>)	16.7%
Cherrybark Oak (<i>Quercus pagoda</i>)	33.3%
Laurel Oak (<i>Quercus laurifolia</i>)	16.7%

Density:

Total Number of Planted Stems 6 / 0.025 acres = 240 stems / acre

Total Number of Desirable Stems* 8 / 0.025 acres = 320 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 6 / 12 x 100 = 50 % survivability



2nd Year Monitoring



3rd Year Monitoring

Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Green Ash (<i>Fraxinus pennsylvanica</i>)		1		
Sweet Gum (<i>Liquidambar styraciflua</i>)	11	12	18	9
Laurel Oak (<i>Quercus laurifolia</i>)	1			
Total	12	13	18	9

Species	Percent of Total
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	9.1%
Cherrybark Oak (<i>Quercus pagoda</i>)	9.1%
Green Ash (<i>Fraxinus pennsylvanica</i>)	45.5%
Overcup Oak (<i>Quercus lyrata</i>)	36.4%

Density:

Total Number of Planted Stems 11 / 0.025 acres = 440 stems / acre

Total Number of Desirable Stems* 48 / 0.025 acres = 1,920 stems / acre

* This includes all volunteers listed below except Red Maple (*Acer rubrum*) and Sweetgum (*Liquidambar styraciflua*)

Survivability:

Total Number of Planted Stems 11 / 16 x 100 = 69 % survivability



2nd Year Monitoring



3rd Year Monitoring

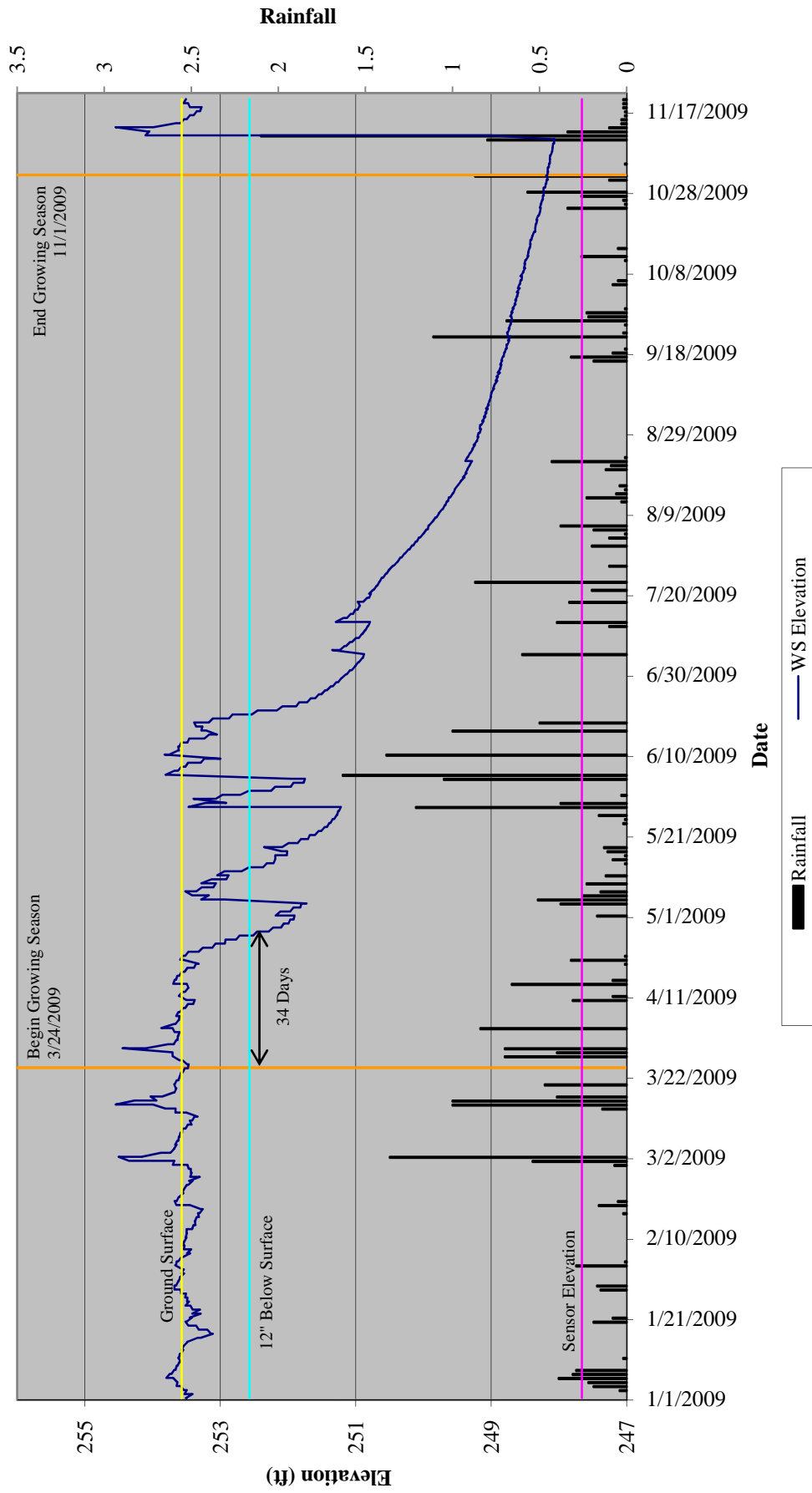
Volunteers:

Species	10-50 cm	50-100 cm	100-150 cm	>150 cm
Green Ash (<i>Fraxinus pennsylvanica</i>)	14	23		
Total	14	23		

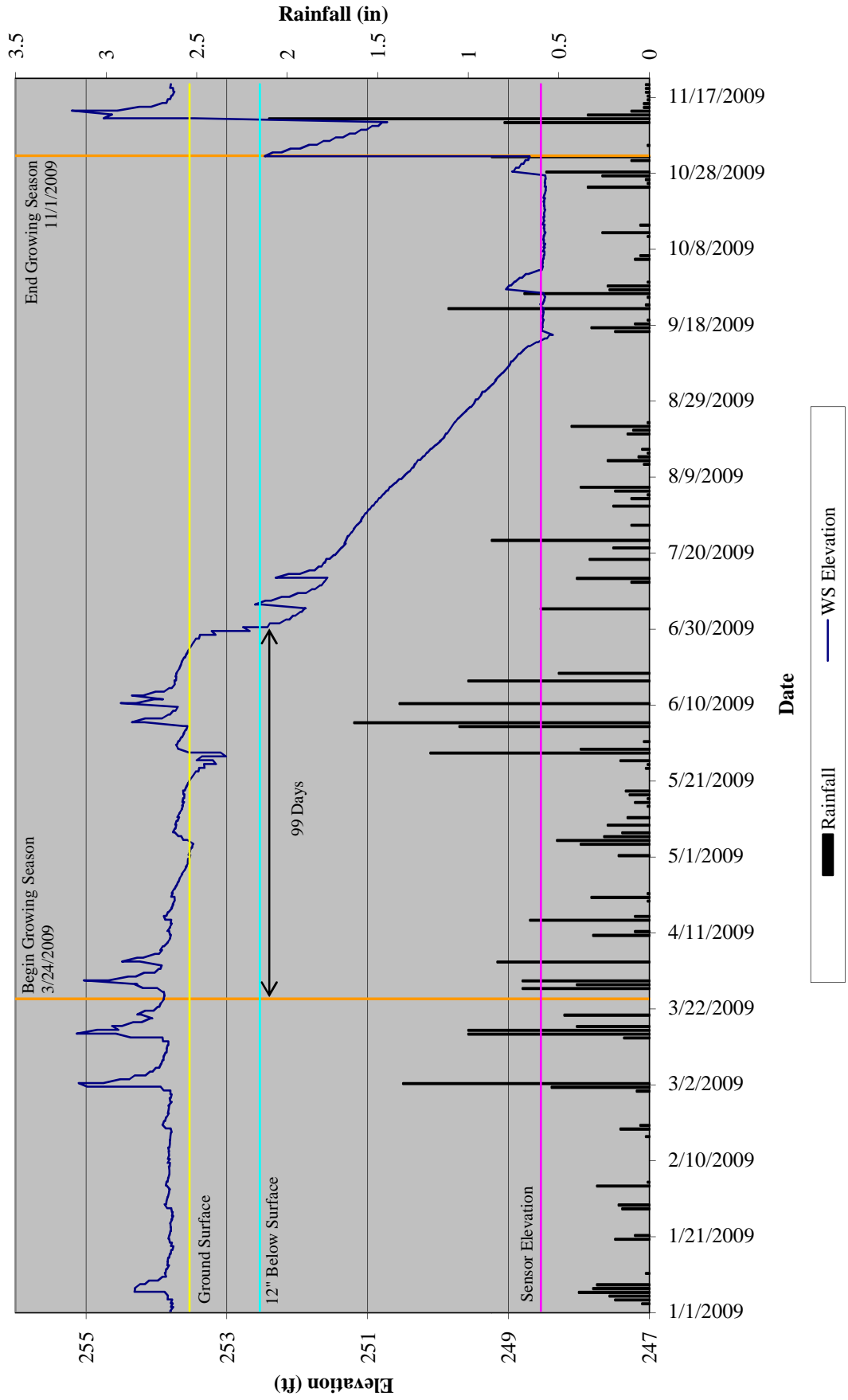
Appendix B

Hydrologic Monitoring and Hydroperiod

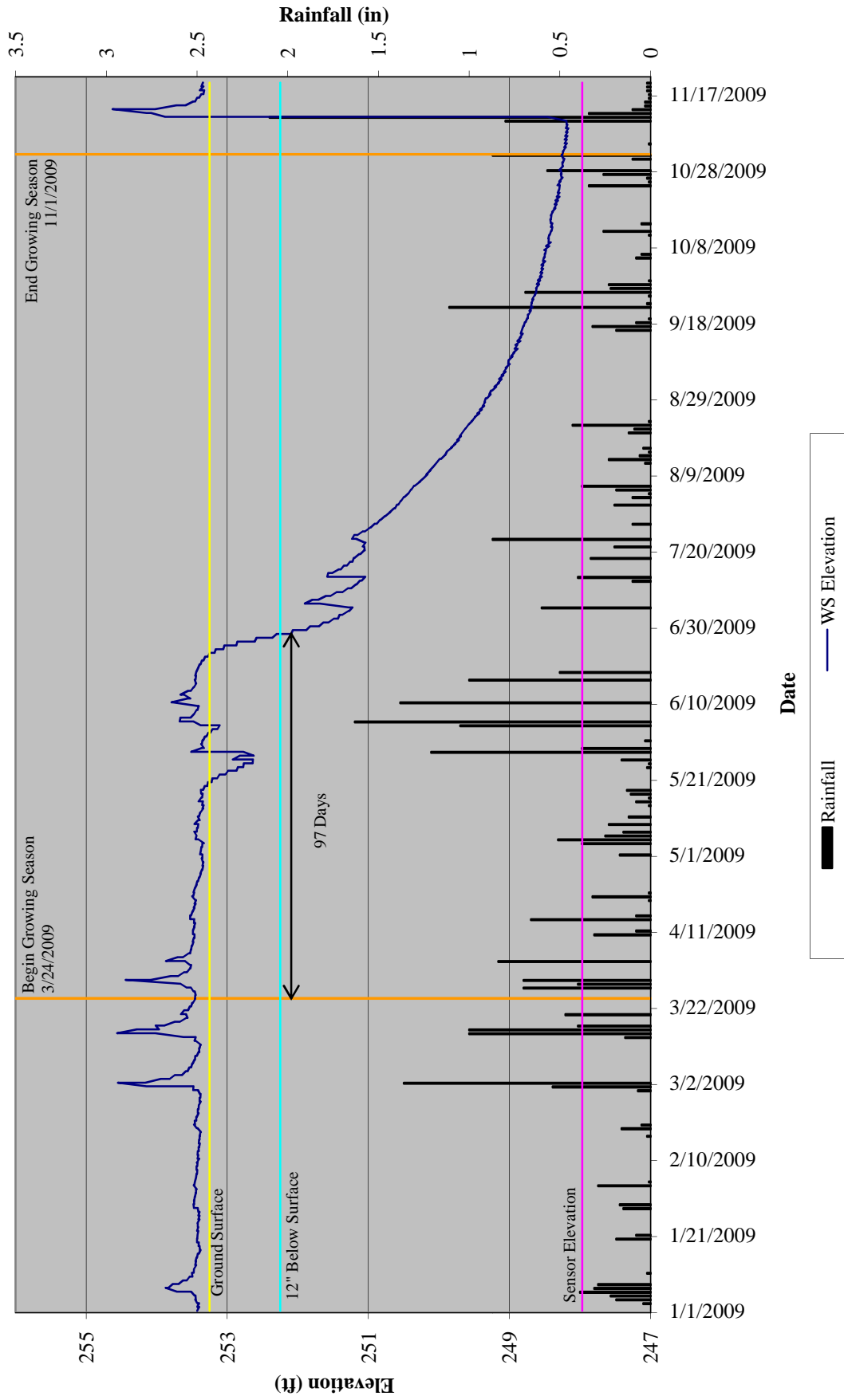
Brown Farm Gauge 1 Hydrograph 1/1/09 to 11/20/09



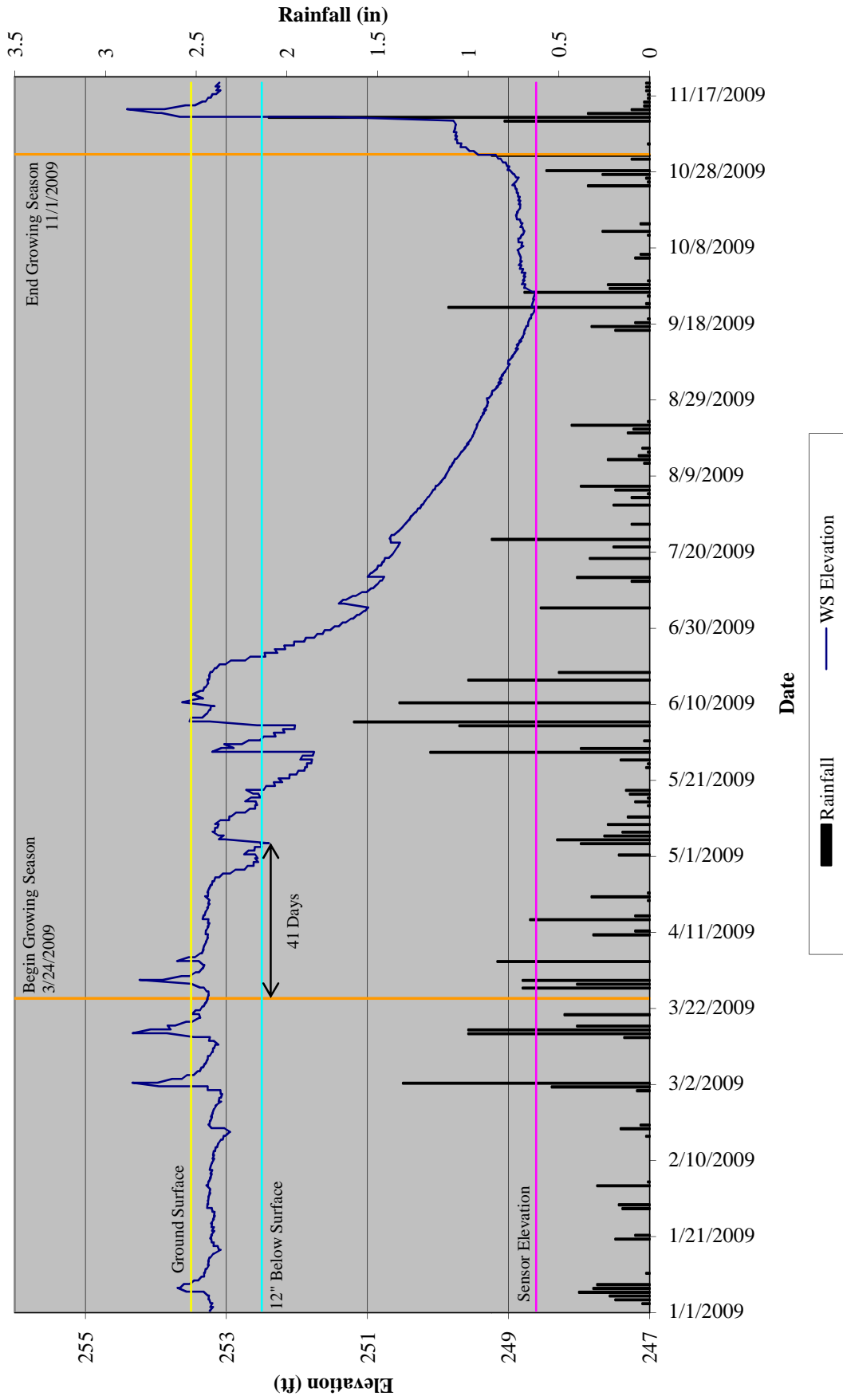
Brown Farm Gauge 2 Hydrograph 1/1/09 to 11/20/09



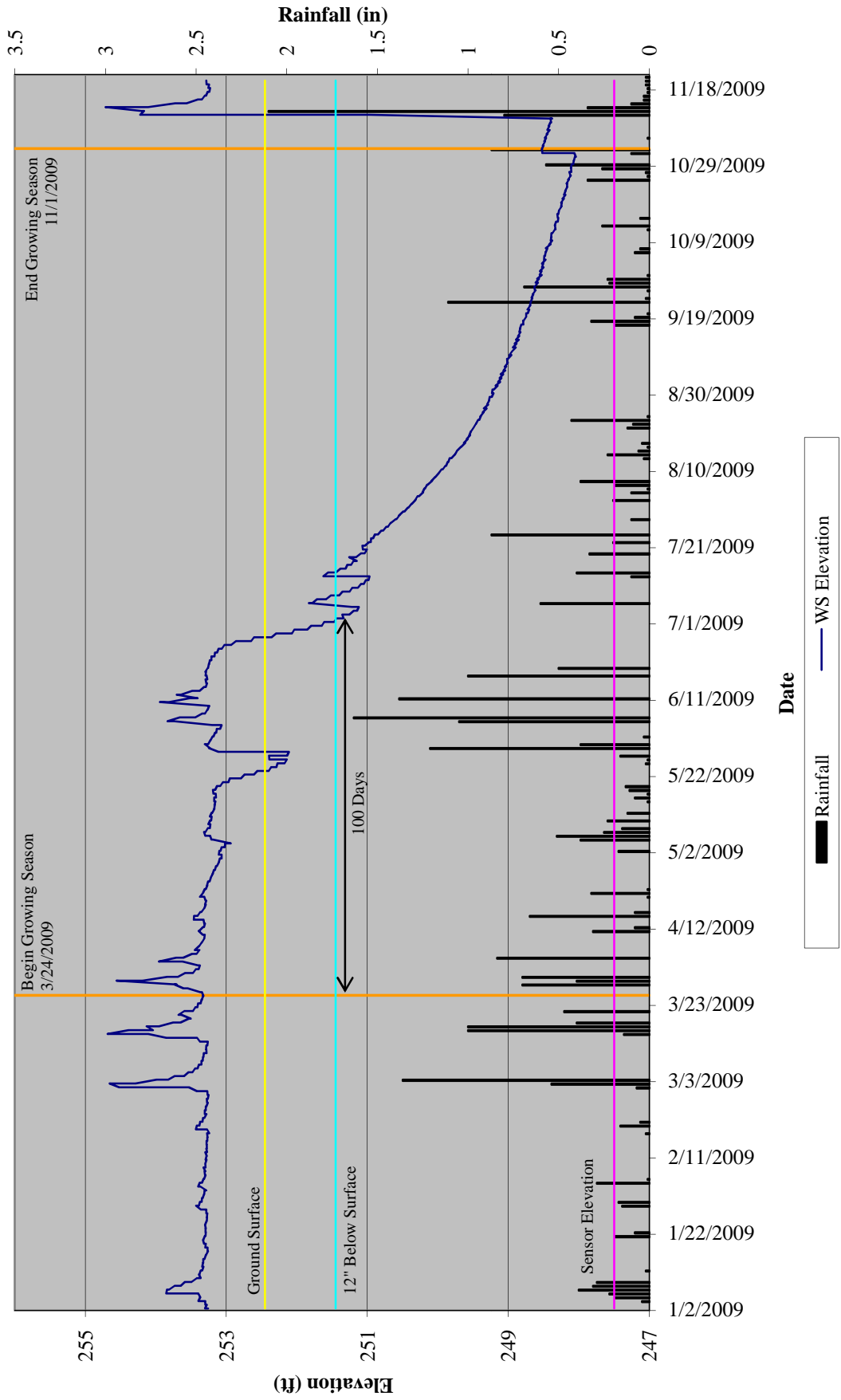
Brown Farm Gauge 3 Hydrograph 1/1/09 to 11/20/09



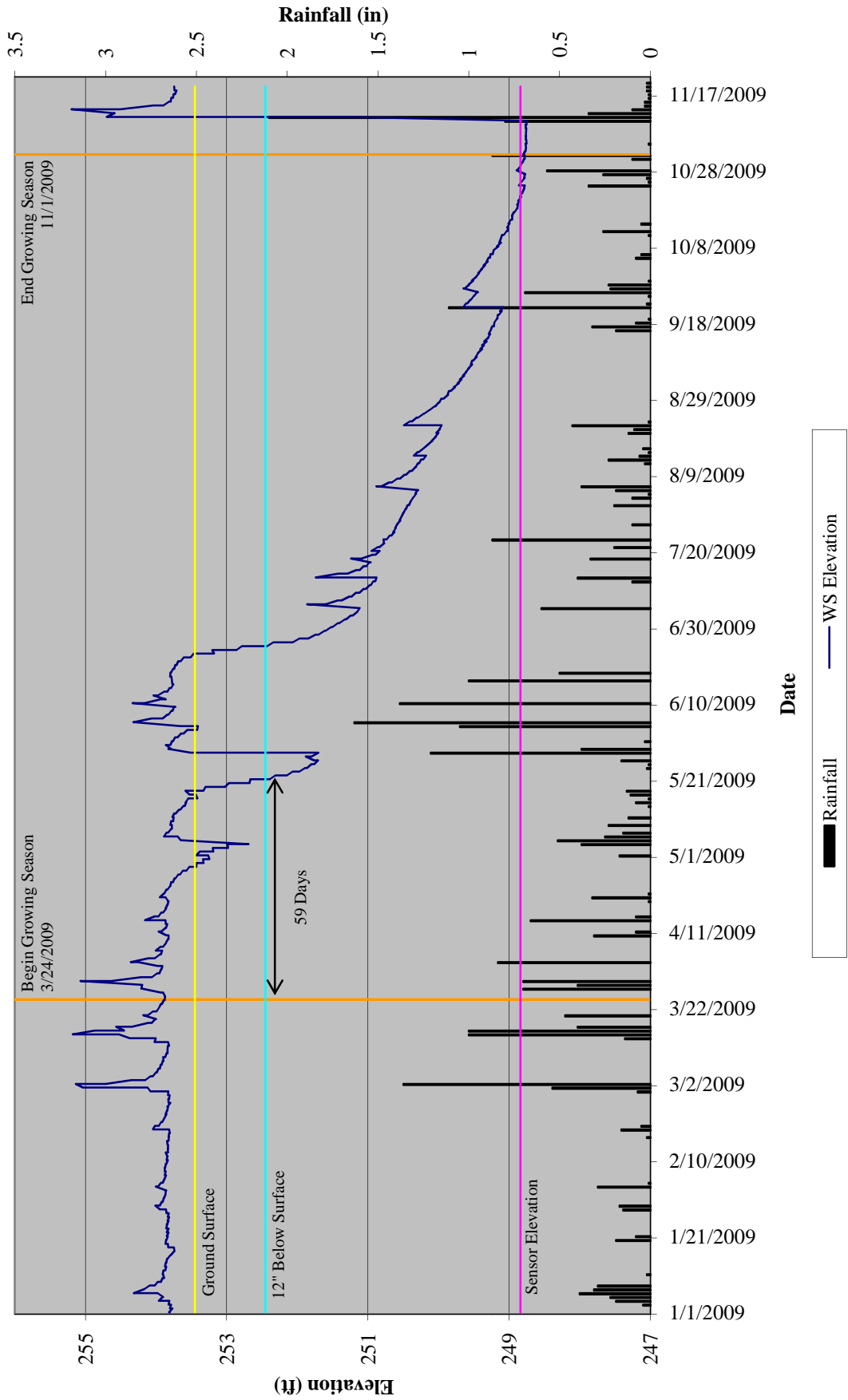
Brown Farm Gauge 4 Hydrograph 1/1/09 to 11/20/09



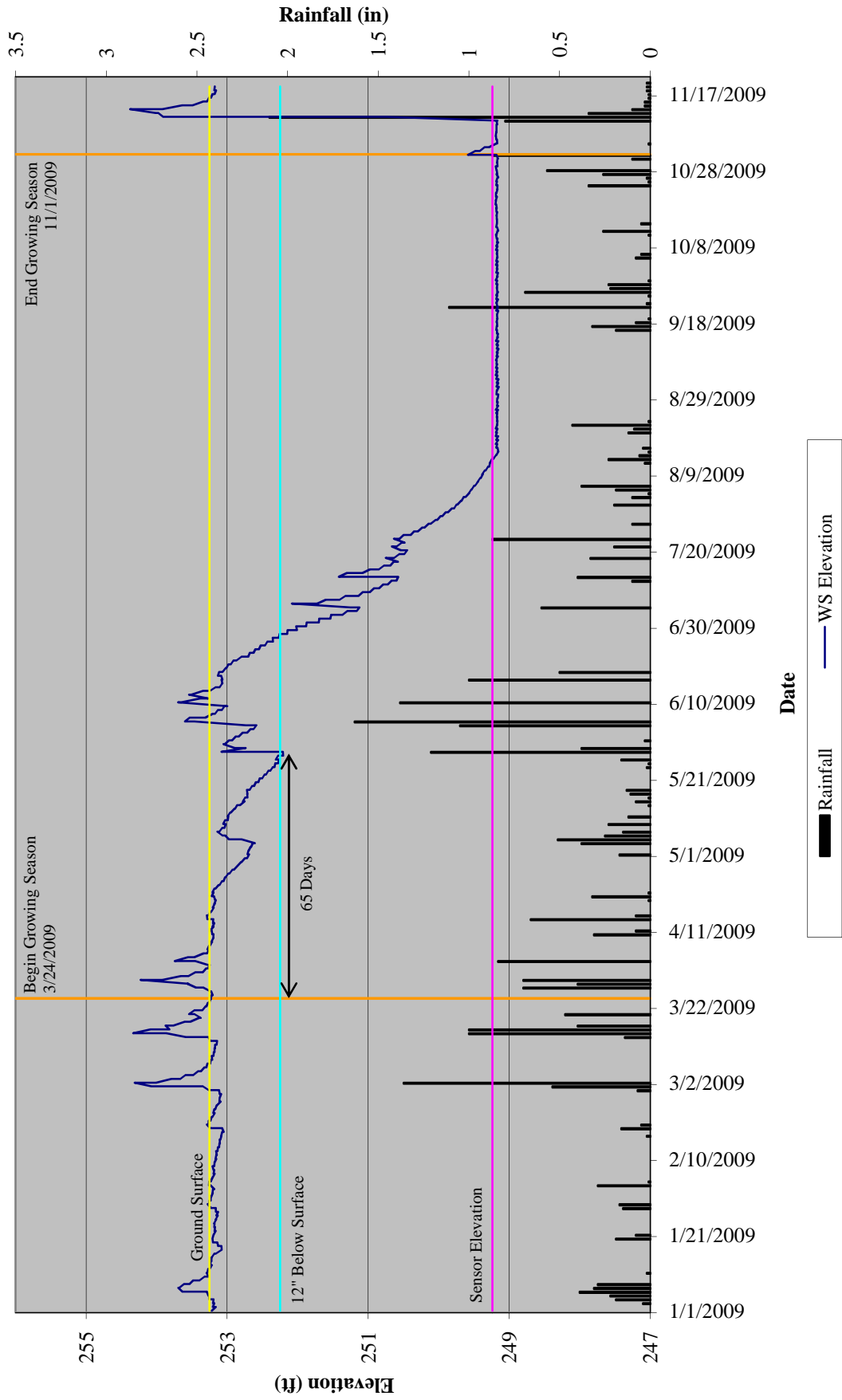
Brown Farm Gauge 5 Hydrograph 1/1/09 to 11/20/09



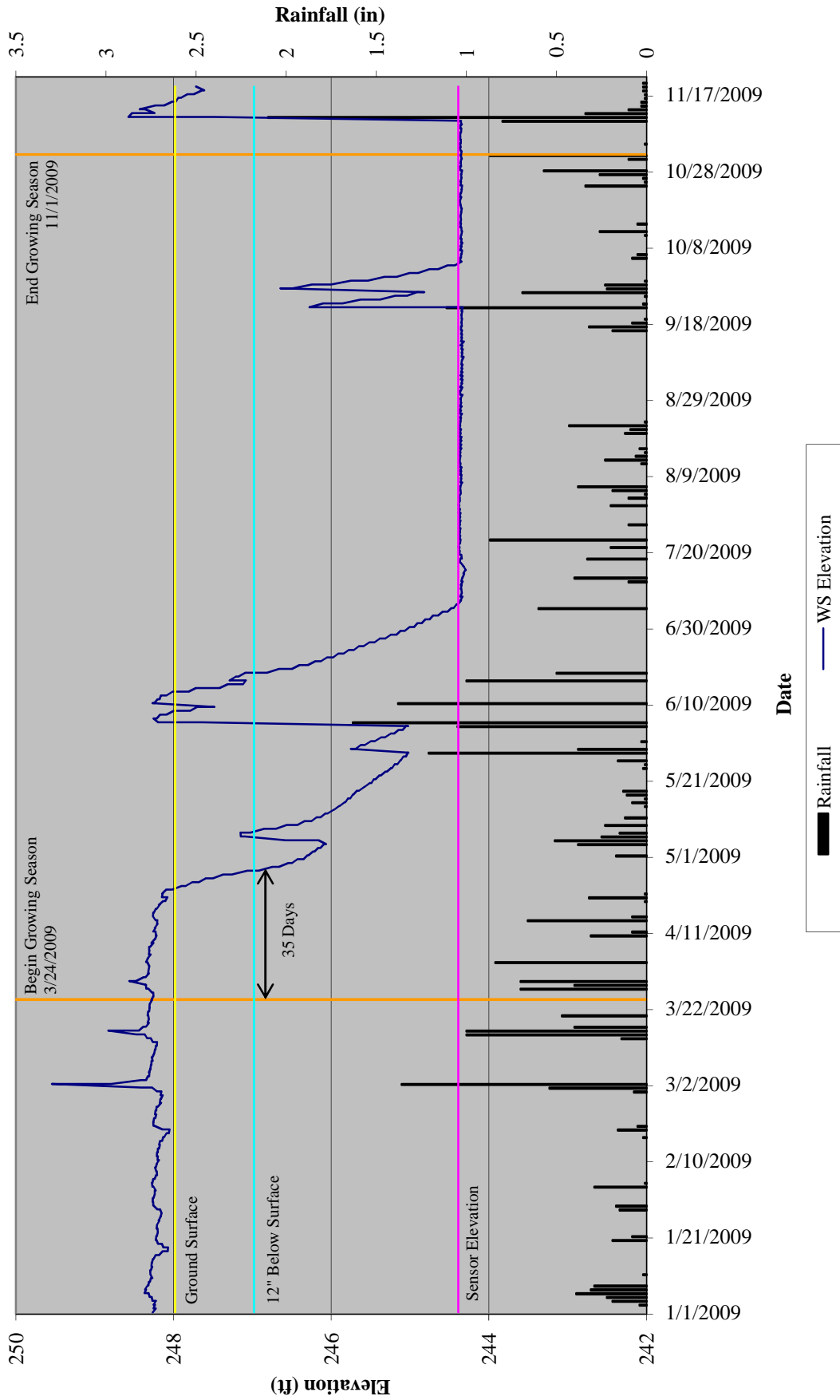
Brown Farm Gauge 6 Hydrograph 1/1/09 to 11/20/09



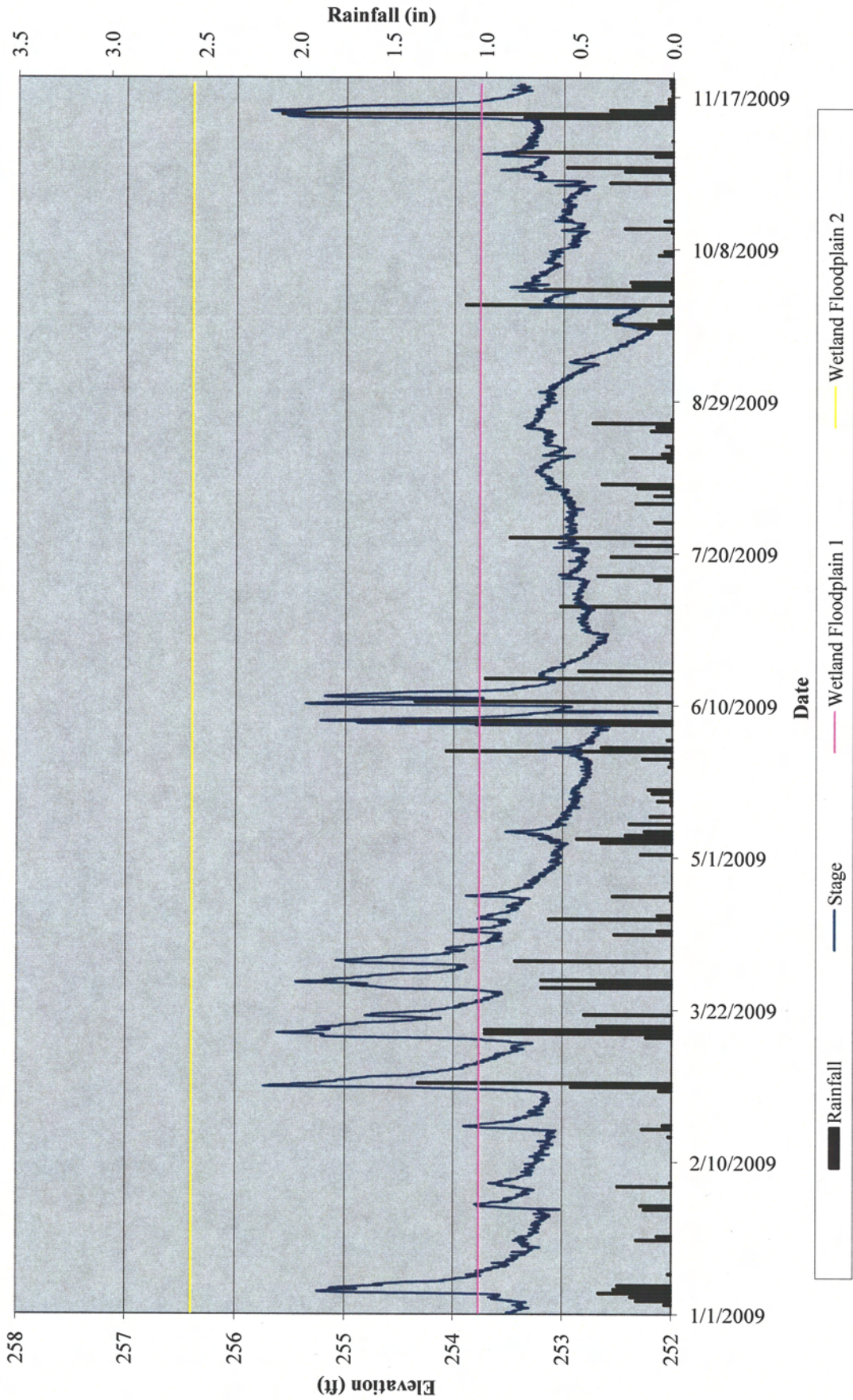
Brown Farm Gauge 7 Hydrograph 1/1/09 to 11/20/09



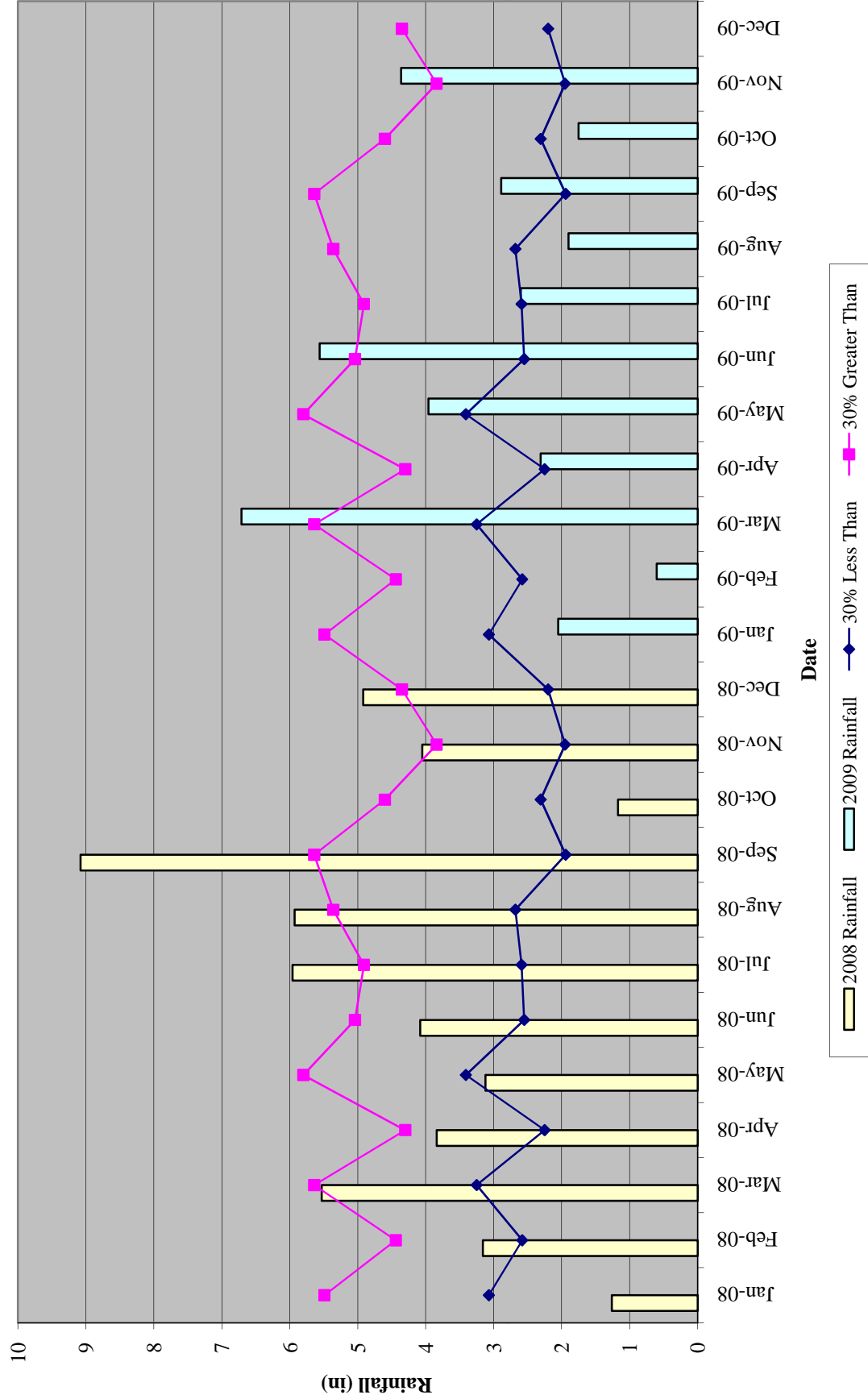
Brown Farm Reference Gauge Hydrograph 1/1/09 to 11/20/09



**Brown Farm Wetland Restoration Site
New Hope Creek Stage
1/1/09 to 11/20/09**



**Brown Farm 30-70 Percentile Graph 2008-2009
Durham, NC Monthly Rainfall**



Appendix C

Photo Log



Photo Point 1A: View looking east towards Vegetation Plot #1. 6/9/09 – MY-03



Photo Point 1B: View looking northeast toward Vegetation Plot #5. 6/9/09 – MY-03



Photo Point 1 Supplemental: View looking northeast towards Wetland Gauge #6. 6/9/09 – MY-03



Photo Point 2: View looking north toward Vegetation Plot # 3. 6/8/09 – MY-03



Photo Point 3: View looking north with Vegetation Plot #10 on left. 6/10/09 – MY-03



Photo Point 4: View looking north toward Vegetation Plot #17. 6/10/09 – MY-03



Photo Point 5: View looking north from the far eastern part of the project site. 6/10/09 – MY-03



Photo Point 6: View looking south toward Vegetation Plot #20. 6/10/09 – MY-03



Photo Point 7: View looking south. 6/10/09 – MY-03