Armstrong Property Wetland and Stream Mitigation Project
Hyde County, NC

2010 Annual Monitoring Report
Year 3

NCEEP Project Number D06012-A
Tar-Pamlico River Basin

Submitted to
NCDENR/Ecosystem Enhancement Program
2728 Capital Blvd.
Raleigh, NC 27604

Date: November, 2010

Monitoring:
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P. O. Box 176
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Executive Summary

The Armstrong Property Wetland Mitigation Site is a headwater riverine wetland and stream mitigation project located just east of State Route 45 near its intersection with State Route 264, in Hyde County, North Carolina. It was constructed by Albemarle Restorations, LLC, under contract with EEP to provide compensatory wetland mitigation credits in the Tar-Pamlico River Basin. Construction activities, in accordance with the approved restoration plan, began October 1, 2007, and were completed on November 30, 2007. Tree and shrub planting on the project site occurred on January 28 and 29, 2008. An emergent wetland seed mixture was sown shortly afterward. With the exception of increased planting density, all planting was done in accordance with the approved restoration plan.

Five water level monitoring gauges are located at varying elevations throughout riverine wetland areas of the site to measure subsurface water elevations. Two additional gauges are located in the headwater stream (swamp run) to help monitor flow and water level within the stream. Two more gauges are installed at the reference site. Two of the five gauges in the riverine wetland area met the stated hydrologic success criterion of maintained groundwater levels within 12 inches of the soil surface for 21 consecutive days during the growing season (Four of the five gauges met success at 13 days - 5% of the growing season). The cumulative rainfall deficit during the 2010 growing season was 11.23 inches.

Corrective action to improve hydrologic performance was taken in September, 2010 in the form of subsoiling on 11 acres with the intent of improving water penetration and retention. It appears as if the treatment has had a positive effect by enhancing infiltration and groundwater recharge.

One flow event, resulting from a three-day period of rain in September and October was video documented during the 2010 growing season. The data from the water level monitoring gauges coincides with and confirms the flow of water through and off the site via the outlet pipe.

Four vegetative monitoring plots are installed in the riverine wetland areas and permanently monumented, one coincident with monitoring gauges 1 through 4. There are also two plots installed within the swamp run, each similarly situated and referenced at the two swamp run monitoring gauges. Each plot is a 10m X 10m square, as recommended by the CVS-EEP protocol for recording vegetation sampling. Three of the four plots in the riverine wetland area met the third year survival success criteria of 320 stems per acre. Both the plots in the swamp run met the same vegetation survival criteria.

Table ES-1 shows the levels of success attained by each of the water level monitoring gauges and the vegetation plots since monitoring began. Success criterion for hydrology is 8% of the growing season (21 days). Table C-1 in Appendix C has a detailed breakdown of hydrologic success. Success criterion for the vegetation plots is the third year level of survival (320 stems per acre).

Table ES-1. Project Success Summary (longest hydro-period as a percent of the growing season)																	
	Gauge									Percent	Vegetation Plot						Percent
	1	2	3	4	5	R1	R2	6*	7*	Success	1	2	3	4	R1	R2	Success
Year 1 (2008)	3.4	1.5	4.6	3.1	6.9	13.4	53.6	38.3	5.4	29%	Y	Y	N	N	N	N	33%
Year 2 (2009)	7.3	6.5	6.5	5	10.5	47.5	100	37.5	6.5	43%	Y	Y	Y	Y	Y	N	100%
Year 3 (2010)	5.4	3.4	5	11.5	19.5	18.8	35.2	37.9	10.7	57%	Y	Y	Y	Y	Y	Y	100%

Percentage of the growing season that gauge showed continuous hydrology. **Green: met 8% level**, **Red: did not.**

* Gauges 6 and 7 are reference gauges and are not included in the Percent Success

I. Project Background

1.0 Project Objectives

The goal of the Armstrong Property Mitigation Project was to create a riverine wetland system typically found in the middle to upper reaches of first or zero order tributary systems. The project is to serve as compensation for wetland loss in the Tar-Pamlico River Basin. The restoration plan was developed and implemented to eliminate pattern drainage and restore topography and hydrology that more closely resembled that of similar undisturbed land. Construction resulted in the development of a broad, frequently flooded swamp run following a historical path as evidenced by archived aerial photographs and signature topography. Subsequent planting was designed to restore a wetland forest ecosystem that is typically found in the immediate area characteristic of similar soils, topography and hydrology.

Ecological benefits of the restored riparian headwater system and its associated riverine wetlands are the following:

1. Water quality improvements, including nutrient, toxicant and sediment retention and reduction, increasing dissolved oxygen levels, as well as reducing excessive algae growth, and reducing surface water temperatures in receiving waters by providing permanent shading in the form of a shrub/scrub and forested headwater wetland system.
2. Wildlife habitat enhancement by adding to the existing adjacent forested areas creating a continuous travel corridor between habitat blocks and providing a wide range of habitat areas (open water, emergent, shrub/scrub and forested) for amphibians, reptiles, birds, insects and mammals.
3. Flood flow attenuation during storm events which reduces sedimentation and erosion downstream, and improves long term water quality within the Pungo River.
4. Passive outdoor recreation and educational opportunities for the landowner and the surrounding community.

2.0 Project Structure, Restoration Type, and Approach

Table I lists the estimated wetland acreage to be restored on the Armstrong Property. The mitigation plan provides for the restoration of 20.0 acres of riverine wetlands and 2,200 linear feet of stream (swamp run) restoration. Prior to construction, the easement area was used entirely for row crop agriculture, primarily soy beans, corn and cotton. The agricultural fields were drained by several ditches that traversed the site with outfall into Clark Mill Creek. Construction activities, in accordance with the approved restoration plan, began in October, 2007 and were completed in November of 2007. Native tree and shrub species were planted in January of 2008. The resulting riverine system is designed to emulate natural swamp run systems found within the Pungo River Basin.

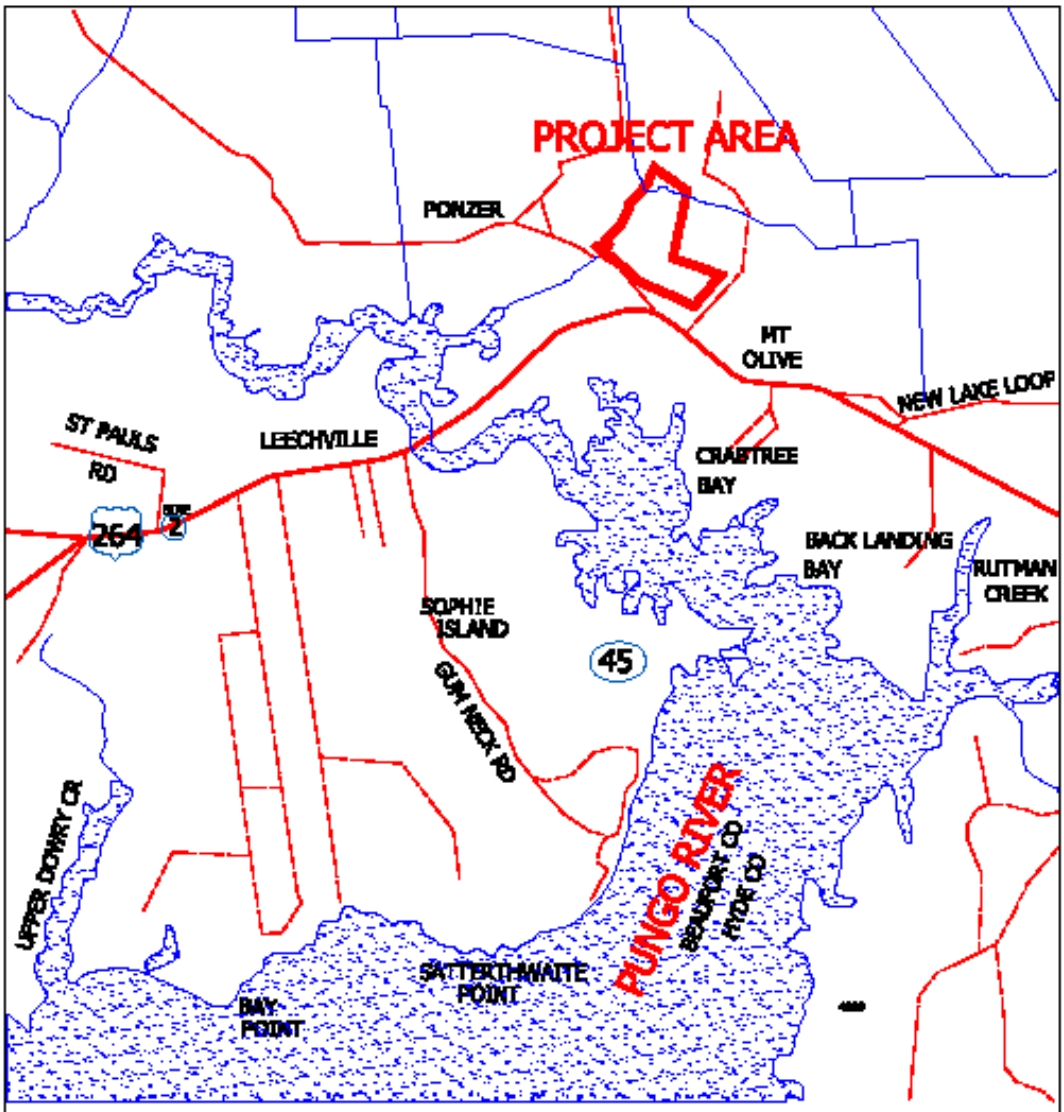
Table 1. Project Restoration Components

Restoration Type	Pre-Existing Acres/Linear Feet	Post Construction Acres/ Linear Feet	Credit Ratio (Restoration : WMU)	Total WMUs/ SMUs
Riverine Wetland	0.0 acres	20.0 acres	1:1	20.0 WMUs
Stream (Swamp Run)	0.0 linear feet	2,200 linear feet	1:1	2,200 SMUs

3.0 Location and Setting

The Armstrong Property Mitigation Site is located in Hyde County, between Ponzer and Mt. Olive on the north side of State Route 45 near its intersection with US Hwy 264. The easement area is situated in the middle of the Armstrong property and adds contiguous swamp run and forested wetlands to those of Clark Mill Creek, a tributary of the Pungo River which is less than a mile to the south. The surrounding area is primarily forest and agricultural land with residential properties as a minor component.

Figure 1 is a location map for the project site. Directions to the site are as follows: from Belhaven, travel east on US Hwy 264 approximately 10 miles and turn left (north) on State Route 45. Access to the site is approximately .25 miles north of the intersection on right.


PROJECT AREA
PONZER
MT OLIVE
NEW LAKE LOOP
ST PAULS RD
LEECHVILLE
CRABTREE BAY
264
BUS 2
BACK LANDING BAY
RUTMAN CREEK
SOPHIE ISLAND
45
GUM NECK RD
UPPER DOWRY CR
PUNGO RIVER
BEAUFORT CO
HYDE CO
SATTERTHWAITE POINT
BAY POINT
FIGURE 1
SCALE
ECOTONE, INC.
Environmental Consulting, Permitting & Design.
Forest & Wetland Creation &
Stream Restoration.
Vicinity Map
ARMSTRONG PROPERTY
RIVERINE WETLAND & STREAM RESTORATION
MITIGATION MONITORING
Scale: 1" = 4000'
11/2008
Drawn By: LMS

4.0 Project History and Background

Table II provides the history of data collection and actual completion of various milestones of the Armstrong Property Wetland Mitigation Site.

Table II. Project Activity and Reporting History Armstrong Property Wetland Mitigation Project/EEP #D06012-A		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	June 2007	July 2007
Final Design -90%	June 2007	July 2007
Construction	N/A	November 2007
Temporary S & E mix applied to entire project area	N/A	February 2008
Permanent seed mix applied to entire project area	N/A	February 2008
Containerized and Bare Root Planting	N/A	January 2008
Mitigation Plan/As-built (Year 1 monitoring - baseline)	March 2008	December 2008
Year 2 monitoring	September 2009	January 2010
Year 3 monitoring	September 2010	November 2010
Year 4 monitoring		
Year 5 monitoring		

Points of contact for the various phases of the APWMS are provided in Table III.

Table III. Project Contacts Armstrong Property Wetland Mitigation Site/EEP #D06012-A	
Designer Primary Project design POC	Ecotone, Inc. 1204 Baldwin Mill Road Jarrettsville, MD 21804 Scott McGill (410-692-7500)
Construction Contractor Construction contractor POC	Armstrong, Inc. P. O. Box 96 25852 US Hwy 64 Pantego, NC 27860 Tink Armstrong (252-943-2082)
Planting Contractor Planting contractor POC	Carolina Silvics, Inc. 908 Indian Trail Road Edenton, NC 27932 Mary-Margaret McKinney (252-482-8491)
Seeding Contractor Seed planting contractor POC	Armstrong, Inc. P. O. Box 96 Pantego, NC 27860 Tink Armstrong (252-943-2082)
Seed mix sources	Ernst Conservation Seeds, LLP, Meadville, PA
Nursery stock suppliers	International Paper, Inc., et. al.
Monitoring Consultants Wetland and Vegetation POC	Woods, Water and Wildlife, Inc. P. O. Box 176 Fairfield, NC 27826 Ashby Brown (800-509-0190)

Project background information for the APWMS is provided in Table IV.

Table IV. Project Background Armstrong Property Wetland Mitigation Site/EEP #D06012-A	
Project County	Hyde County
Drainage Area	25.0 acres within easement boundary
Drainage impervious cover estimate (%)	0
Physiographic Region	Coastal Plain
Ecoregion	8.5.1 Middle Atlantic Coastal Plain
Rosgen Classification of As-built	N/A
Cowardin Classification	PEM, PSS, PFO
Dominant Soil Types	Acredale Silt Loam
Reference site ID	Clark Mill Creek, Hyde County, NC
USGS HUC for Project and Reference	03020104
NCDWQ Sub-basin for Project and Reference	03-03-07
NCDWQ classification for Project and Reference	C
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	Yes, Pungo River
Reasons for 303d listing or stressor?	WWTP, ag, urban runoff, marinas
% of project easement fenced	0

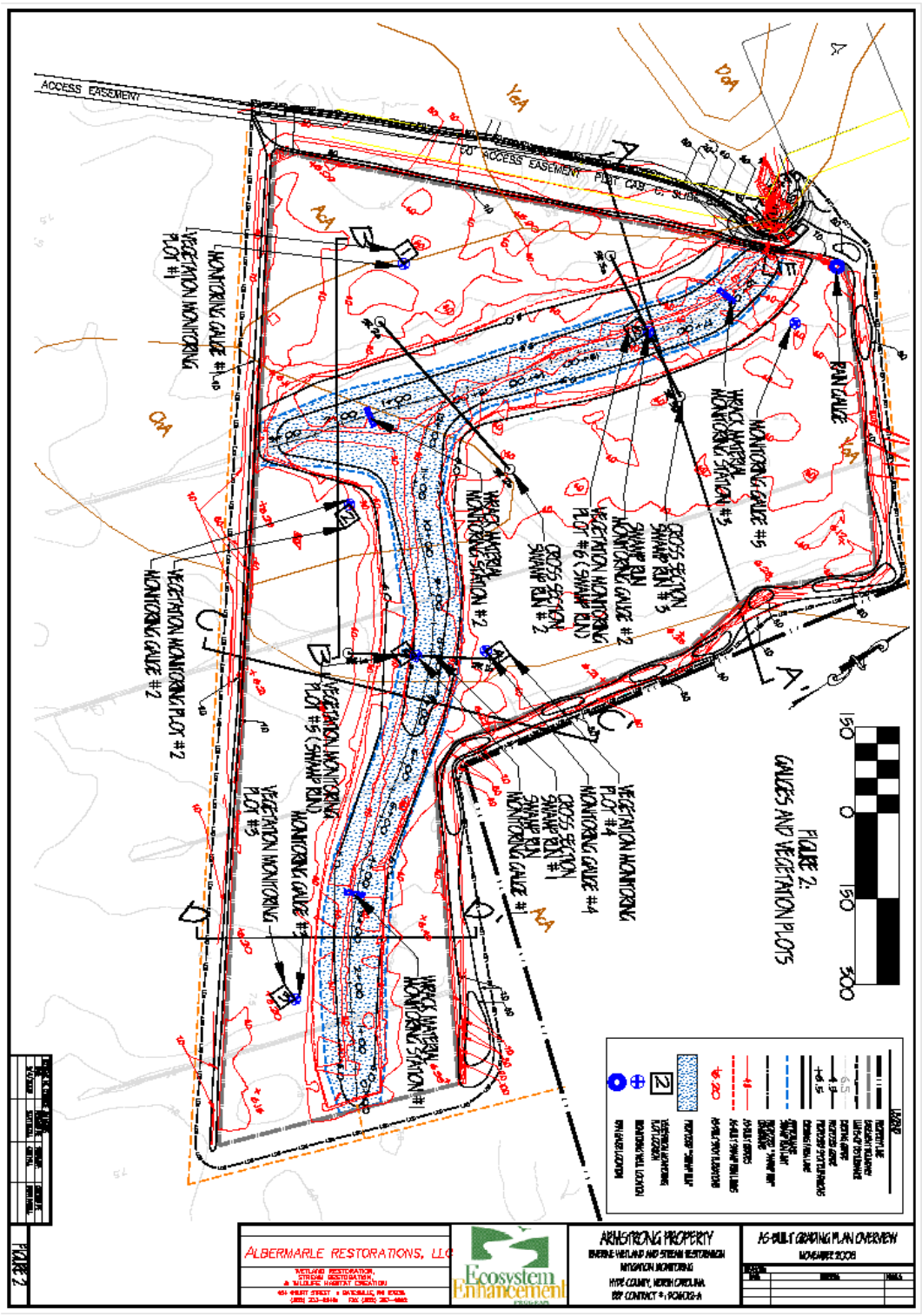
5.0 Monitoring Plan View

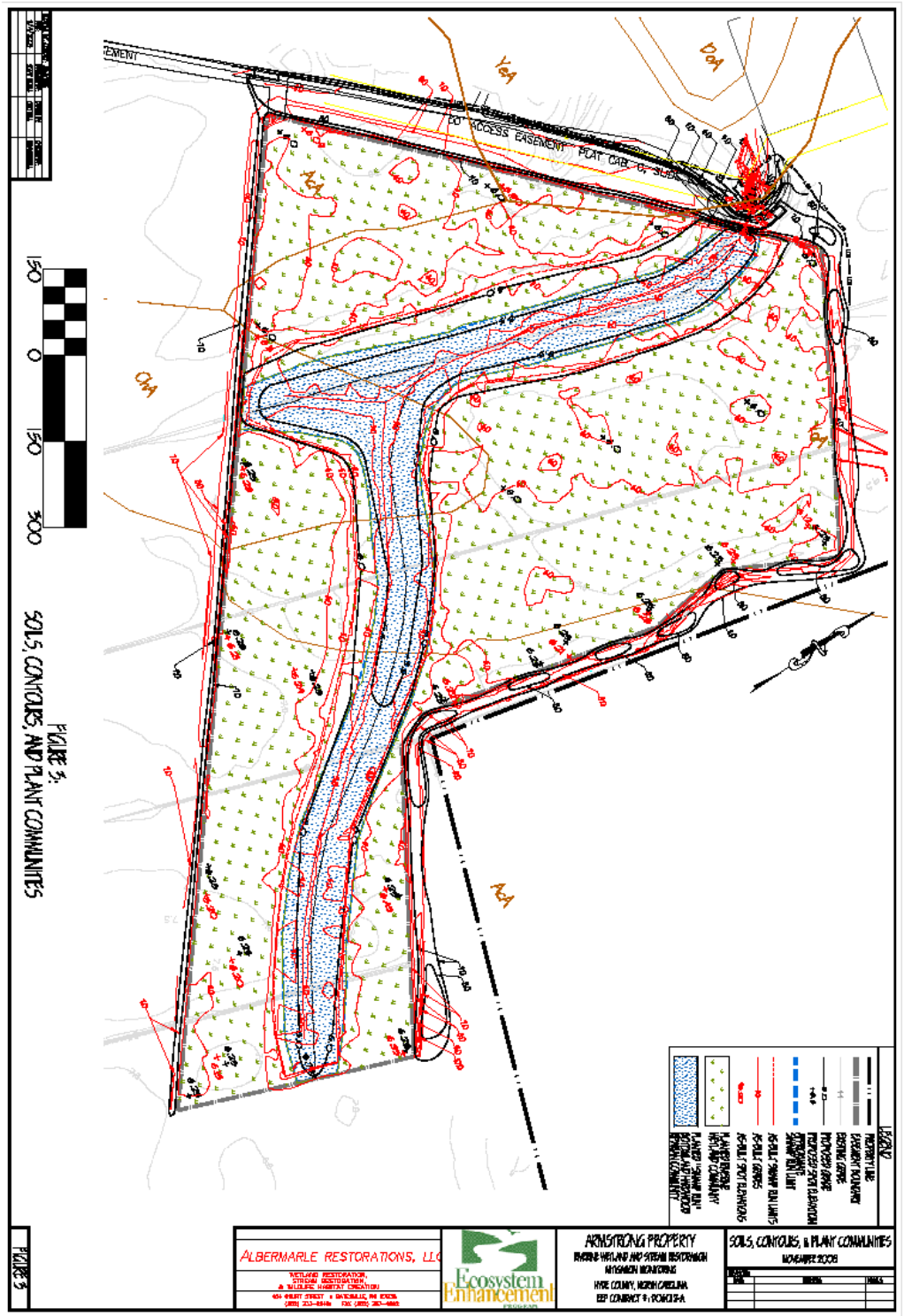
There are five water level monitoring gauges installed in the riverine wetland areas of the site. These gauges are suspended in two-inch pvc pipe that is set approximately four feet vertically into the ground. The gauges have been located to assess the groundwater levels throughout the year at various elevations and topographies within the site. Two gauges are also installed in the swamp runs to help verify flow. Two more gauges are installed in an offsite wetland area to serve as references for a naturally functioning riverine wetland and headwater swamp run. In addition, there is a rain gauge onsite to capture and record precipitation.

Vegetation monitoring is accomplished by surveying the six permanent sampling plots. Each plot is referenced by a monitoring gauge which serves as the plot origin and as a photo station for that plot. The plots are ten meters square and are situated to give an accurate sample of the planted and natural woody vegetation. For each site, the data recorded matches that required of the *CVS-EEP Protocol for Recording Vegetation, v 4.0, 2006,* level 1-2.

Three wrack lines were also installed as an aid in monitoring flow in the swamp run. They were designed and located to capture debris during periods of high water as evidence of water movement within the site.

Figures 2 and 3 provide plan views of the site showing the location of all monitoring features including gauges, sampling plots and the rain gauge as well as the vegetative communities.


ACCESS EASEMENT
VEGETATION MONITORING PLOT #1
VEGETATION MONITORING GAUGE #1
VEGETATION MONITORING PLOT #2
VEGETATION MONITORING PLOT #5 (SWAMP RUN)
VEGETATION MONITORING PLOT #3
VEGETATION MONITORING PLOT #4
CROSS SECTION SWAMP RUN #1
CROSS SECTION SWAMP RUN #2
CROSS SECTION SWAMP RUN #3
SWAMP RUN MONITORING GAUGE #2
SWAMP RUN MONITORING GAUGE #3
WRACK MATERIAL MONITORING STATION #1
WRACK MATERIAL MONITORING STATION #2
WRACK MATERIAL MONITORING STATION #3
RAIN GAUGE
FIGURE 2:
GAUGES AND VEGETATION PLOTS
150
0
150
300
ALBEMARLE RESTORATIONS, LLC
Ecosystem Enhancement
ARMSTRONG PROPERTY
AS-BUILT GRADING PLAN OVERVIEW
NOVEMBER 2008


SOILS, CONTOURS, AND PLANT COMMUNITIES
FIGURE 3:
ALBEMARLE RESTORATIONS, LLC
Ecosystem Enhancement
ARMSTRONG PROPERTY
SOILS, CONTOURS, & PLANT COMMUNITIES
NOVEMBER 2008
FIGURE 3

II. Project Condition and Monitoring Results

1.0 Vegetation Assessment

The vegetation success criterion was developed in accordance with the CVS-EEP protocol. The Armstrong project was designed to include both riverine and bottomland hardwood plant communities. The project was planted with a mixture of tree and shrub species that would resemble that of naturally occurring swamp runs and adjacent riverine wetlands in the local area. The run and area immediately adjacent were planted heavily with cypress, oaks and tupelo. The riverine wetland zone beyond the swamp run is populated by a broader mix of native hydrophytic tree and shrub species. The photos in Appendix A show the colonization of the project area by hydrophytic vegetation. The species mix was based on the vegetation noted at the reference site and all species are classified from FAC to OBL (Table V).

Table V. Species by Community Type		
Armstrong Property Wetland Mitigation Project/EEP #D06012-A		
Tree/Shrub Planting Schedule - 25.0 acres		
Common Name	**Scientific Name**	**Wetland Indicator Status**
Bald Cypress	Taxodium distichum	OBL
Water Tupelo	Nyssa aquatica	OBL
Swamp Black Gum	Nyssa biflora	FAC
Swamp Chestnut Oak	Quercus michauxii	FACW-
Pin Oak	Quercus palustris	FACW
Willow Oak	Quercus phellos	FACW-
Swamp White Oak	Quercus bicolor	FACW+
Water Oak	Quercus nigra	FAC
Sweetgum	Liquidambar styraciflua	FAC+
Swamp Cyrilla	Cyrilla racemiflora	FACW
Sweet Pepperbush	Clethera alnifolia	FACW
Virginia Sweetspire	Itea virginica	FACW+
Button Bush	Cephalanthus occidentalis	OBL
Wax Myrtle	Myrica cerifera	FAC+
Highbush Blueberry	Vaccinium corymbosum	FACW
Sweetbay	Magnolia virginiana	FACW+
Swamp Bay	Persea palustris	FACW

1.1 Vegetation Discussion and Problem Areas

Three of the four plots in the riverine community met the Year 3 success criterion of a minimum of 320 stems per acre after the third growing season. Plot 4 supported 289 stems per acre. Both stream plots met the success criterion due to the supplemental planting that was done in 2009. Over the entire project, the survival rate averaged 419 live stems per acre.

During the 2010 growing season, there was a cumulative rainfall deficit of 11.23 inches (according to the normal averages per the WETS table for Belhaven, NC). Also, as can be seen in site photos in Appendix A, the project area continues to have a complete and heavy ground

cover of herbaceous material. The soil in parts of the project was suspected to be moderately to severely compacted which, along with heavy herbaceous cover and droughty conditions during the peak of the growing season probably contributed to the mortality seen around Plot 4.

1.2 Vegetation Monitoring Plan View (Integrated)

See Wetland Assessment for discussion of the Monitoring Plan View.

2.0 Wetland Assessment

The hydrologic success criterion is to achieve a minimum of 21 consecutive days where the groundwater level is within 12 inches of the soil surface during the growing season. The growing season for this site is from March 11 to November 27, a period of 261 days (WETS Table for Belhaven, NC). Success for any particular monitoring location is to show soil saturation to within 12 inches of the surface for 21 consecutive days during that period.

There are five continuous water level monitoring gauges deployed across the site (Gauges 1 through 5) to monitor fluctuations in the water table and to determine if wetland hydrology is present. A rain gauge is also kept onsite and its data are compared to that collected at the NOAA cooperator site in Belhaven, NC. To further monitor the affect of seasonal and annual variations in precipitation in restored wetlands, hydrologic success of the site was assessed in relation to the reference wetland site where two more monitoring gauges are installed (Gauge 6 as a Swamp Run reference & Gauge 7 as a Riverine reference).

2.1 Wetland Discussion and Problem Areas

Through the end of June, 2010, the site experienced a cumulative rainfall deficit of 11.37" which no doubt contributed to poor hydrologic performance. Despite the lack of rainfall, and given the generally non-compliant hydrology at certain areas within the project, soil compaction was suspected to be a considerable component of the problem. The decision was made to subsoil approximately 11 acres to improve water penetration and retention. Figure 4 in Appendix D shows the three areas that were treated in September, 2010 and the photos in Appendix A show the effects.

A bulldozer with ripper shanks set approximately 30" apart and 24" deep did an excellent job of fracturing and lifting the clay layers. The heavy rainfall in late September helped resettle the soil. Replanting of the three areas will be done in November 2010 with species from the original planting schedule.

The hydrographs in Appendix C indicate potential improvements in the hydrology around gauges 1-4 which has been problematic. For the first time, gauge 4 was successful at 8% in the spring of 2010. Gauge 2 showed a hydroperiod of 9 days after the subsoiling which equaled its longest hydroperiod in the spring of 2010.

Further comparison of the hydrographs for gauges 1-4 to the one for Reference gauge 7 show that since the subsoiling was done, the hydrology at gauges 1-4 more closely tracks that at the reference site and even appears to be more responsive to minor rainfall events than at gauge 7. In addition, the hydrology at gauges 1-4 after subsoiling compared to the general hydrology during 2009, appears to be more sensitive to rainfall, indicating faster recharge rates. Most of these observations are based on a single, extended rainfall event, but gauges 1-4 now appear to be behaving more in line with the reference gauge 7. Given the droughty conditions during the past three growing seasons, mirroring the reference site may be best indication of developing wetland hydrology.

Both of the swamp run gauges, R1 and R2, met hydrology success. The hydrologic patterns they recorded closely correlate to that of Reference Gauge 6, which is in a similar landscape position. Comparison of the hydrographs for gauges R1, R2 and Reference 6 indicate that these three gauges are measuring very similar patterns for both above and below ground water levels which is further proof that the site is behaving like a naturally functioning headwater system.

2.15 Flow

The rainfall deficit in 2010 allowed for only one verifiable flow event during the growing season. Video files included with this report corroborate the data shown in the following figure that is discussed below.

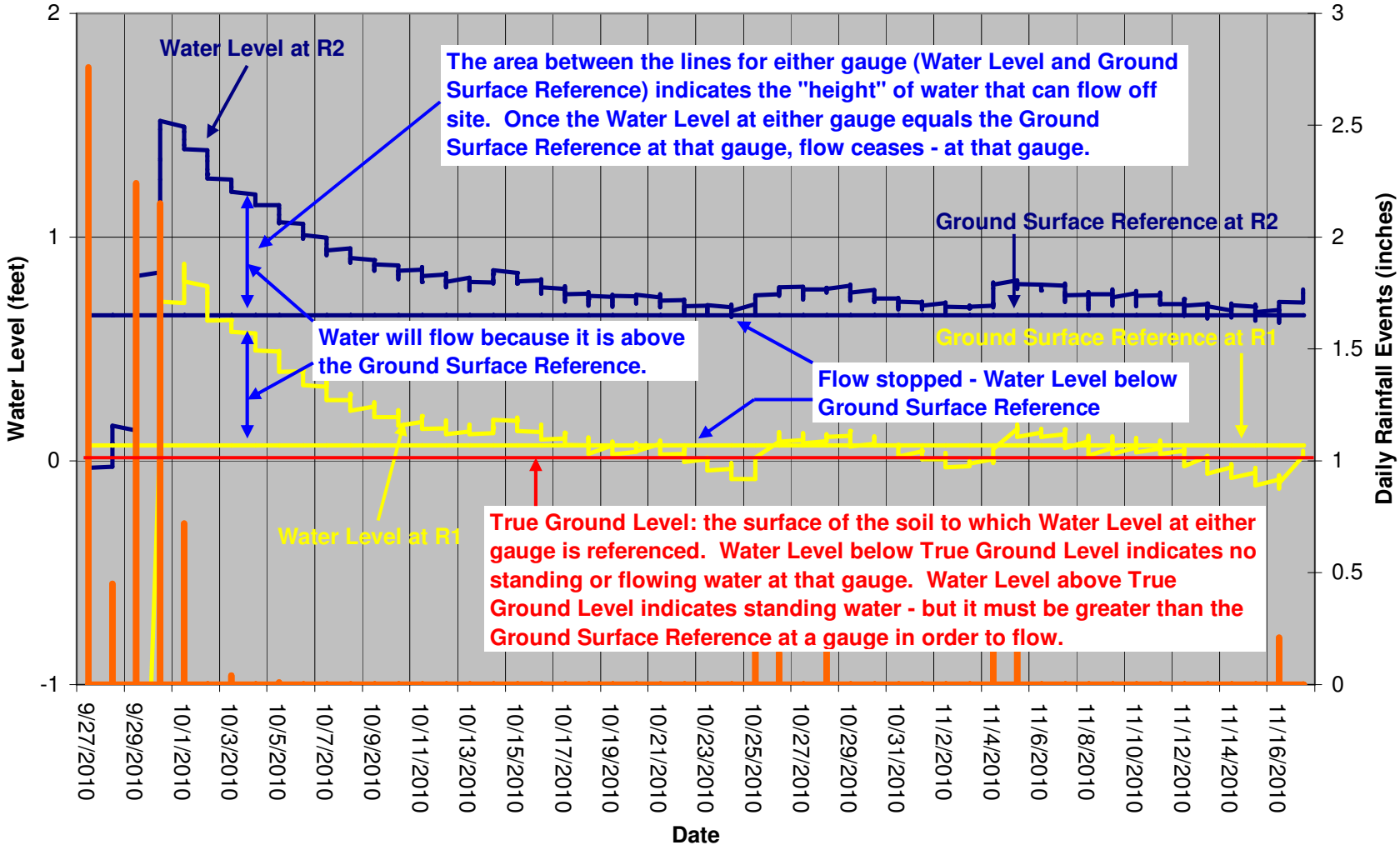
Refer to Figure F1 for the following discussion of evidence of flow within the swamp runs. Figure F1 is a composite chart showing the water level at both run gauges during a period when flow in the swamp runs was visually confirmed and recorded on video. From 9/28/2010 through 10/1/2010 the site received 8.32" of rain causing the water levels to rise rapidly and gradually drain through and off the site. The ground level at gauge R1 is .07 feet above the inlet level of the outfall pipe at the downstream end of the project. The ground level at gauge R2 is .65 feet *below* the inlet level of the pipe. Gauge R2 is situated in a depression which means the area immediately surrounding gauge R2 will never completely drain offsite. These relative ground surface levels are indicated in Figure 1 as Ground Surface References.

Figure F1 illustrates the "height" of water at gauges R1 and R2 that can flow offsite. Gauge R2 is shown in blue. The difference between the Water Level at R2 and the Ground Surface Reference at R2 at any point between those lines represents the level of water that can flow offsite. Once the Water Level falls to or below the Ground Surface Reference, flow can no longer occur because it will have reached equilibrium with the level of the outlet pipe, even though the water level may still be above the True Ground Level (shown in red). The same is not quite true for gauge R1. Its Ground Surface Reference is .07 feet above the outlet pipe, but flow at this gauge can continue until the water level falls to the True Ground Level because it will be collected in the area around gauge R2.

The video documentation included with this report is from the remnants of a tropical storm at the end of September, 2010. Water level measurements over a three-day period after the rain event ended not only confirm the flow pattern described above but also illustrate how the site is capturing run-off from the field above as water levels in the project continued to rise for a day

after rain had ended. The water level at gauge R1 eventually dropped as water flowed through the site, but for two days after the rain ended, the level at gauge R2 increased as the water from the fields above the project drained into the site.

Figure F1.
Armstrong Run Monitoring Gauges 1 and 2 (R1 and R2)
Correlated to Video Evidence of Flow Across Site



2.2 Wetland Monitoring Plan View (Integrated)

Figure 4 in Appendix D provides an overview of the areas where hydrology was deemed poor enough to warrant corrective action. Much of the riverine wetland zone was flooded for a short length of time early and late in the growing season as evidenced by the site photos in Appendix A. For most of the summer however, the site suffered droughty conditions due to continued below-average rainfall.

Table VI. Hydrology and Vegetation Criteria Success by Plot
Armstrong Property Wetland Mitigation Project/EEP #D06012-A

Gauge	Hydrology Success Met	Hydrology Mean	Vegetation Plot	Vegetation Success Met	Vegetation Mean
1	N	57%	1	Y	83%
2	N		2	Y	
3	N		3	Y	
4	Y		4	N	
5	Y		No Plot	No Plot	
R-1	Y		R-1	Y	
R-2	Y		R-1	Y	
6 (Ref)*	Y		No Plot	No Plot	
7 (Ref)*	Y		No Plot	No Plot	

* Gauges 6 & 7 are reference gauges on the reference site and are not included in the success percentages

3.0 Project Success Discussion

Particularly droughty conditions persisted in 2010, so in order to remove all impediments to success, severe and highly invasive corrective action was taken in the form of improvements to the soil structure. The subsoiling that was done in September, 2010 appears to have had a positive effect on the hydrology. However, as indicated by Reference gauge 7, without a more normal rainfall pattern during the growing season, successful hydrology may only be possible during the cooler months when rainfall is more consistent.

Unfortunately, where it was done, subsoiling damaged much of the tree stock; replanting is scheduled to be done in November, 2010.

III. Methodology Section

Year 3 monitoring for the Armstrong project occurred in 2010. Monitoring and vegetation sampling procedures were established in the mitigation plan for this project and no deviations were made.

Appendix A

Vegetation Data Tables

Site Photos

1. Vegetation Data Tables

Table 1. Vegetation Metadata

Report Prepared By	Ashby B. Brown
Date Prepared	9/23/2010 16:40
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	D06012A
project Name	Armstrong Wetland Mitigation project
River Basin	Tar-Pamlico
Sampled Plots	6

Table 2. Vigor by Species

	Species	4	3	2	1	0	Missing	Unknown
	Cephalanthus occidentalis	5	2	1			1	
	Itea virginica			1				
	Liquidambar styraciflua	2	2					
	Nyssa biflora			1				
	Quercus bicolor		2	3			2	
	Quercus phellos	1	7	7			2	
	Taxodium distichum	11	7		1			
	Myrica cerifera	8				1	2	
TOT:	**8**	**27**	**20**	**13**	**1**	**1**	**7**	

Table 3. Damage by Species

	Species	All Damage Categories	(no damage)
	Cephalanthus occidentalis	9	9
	Itea virginica	1	1
	Liquidambar styraciflua	4	4
	Myrica cerifera	11	11
	Nyssa biflora	1	1
	Quercus bicolor	7	7
	Quercus phellos	17	17
	Taxodium distichum	19	19
TOT:	**8**	**69**	**69**

Table 4. Damage by Plot

	plot	All Damage Categories	(no damage)
	D06012A-ABET-0001-year:1	12	12
	D06012A-ABET-0002-year:1	14	14
	D06012A-ABET-0003-year:1	13	13
	D06012A-ABET-0004-year:1	9	9
	D06012A-ABET-R1-year:1	9	9
	D06012A-ABET-R2-year:1	12	12
TOT:	**6**	**69**	**69**

Table 5. Stem count by plot and species

					plot D06012A-ABET-					
	Species	**Total Planted Stems**	**# plots**	**avg# stems**	**1**	**2**	**3**	**4**	**R1**	**R2**
	Cephalanthus occidentalis	8	2	4					3	5
	Itea virginica	1	1	1				1		
	Liquidambar styraciflua	4	1	4		4				
	Myrica cerifera	8	5	1.6	2	1	2	2	1	
	Nyssa biflora	1	1	1				1		
	Quercus bicolor	5	3	1.67		3	1		1	
	Quercus phellos	15	4	3.75	3	3	6	3		
	Taxodium distichum	19	4	4.75	5	3			4	7
TOT:	**8**	**61**	**8**		**10**	**14**	**9**	**7**	**9**	**12**
Average stems per acre					**412**	**577**	**371**	**289**	**371**	**495**
Project average stems per acre		**419**								

Table 6. Vegetation Problem Areas

Feature/Issue	Plot	Probable Cause	Photo #
Slow growth and development	Swamp run plots: heavy cattails, plots 1 and 3 herb. cover	Dense herbaceous cover droughty conditions	VPA 1, 2
Remedial action to soil structure	1, 2 and 4	Compacted Soil, corrected by subsoiling	3-5

VPA 1
Continued heavy cattail cover in swamp run

VPA 2
Continued heavy cattail coverage in swamp run

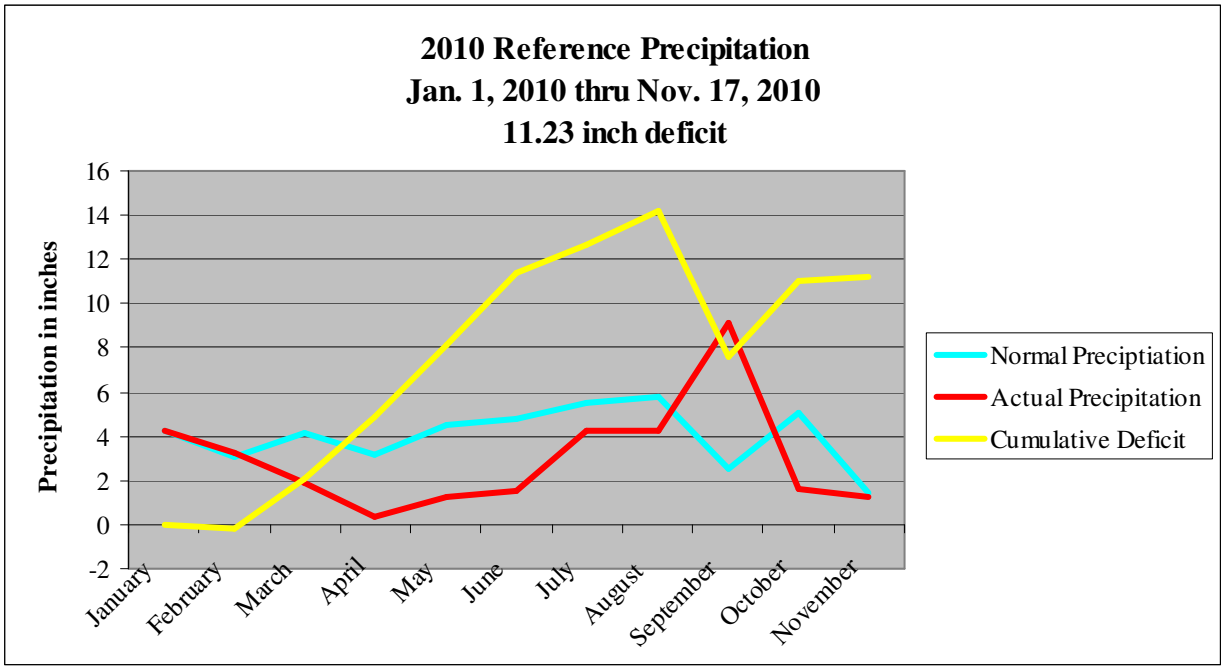
(Photo 3) Dry reference area in April 2010

(Photo 4) Effects of subsoiling near gauge 2 in September 2010

(Photo 5) Clay fracturing after subsoiling in Sept. 2010

Table C-1 Longest Consecutive Successful Hydrologic Period in Days and Success at 5% and 8% of Growing Season															
	Year 1			Year 2			Current Year			Year 4			Year 5		
Gauge	Days	5%	8%	Days	5%	8%	Days	5%	8%	Days	5%	8%	Days	5%	8%
1	9	N	N	19	Y	N	14	Y	N						
2	4	N	N	17	Y	N	9	N	N						
3	12	N	N	17	Y	N	13	Y	N						
4	8	N	N	13	Y	N	30	Y	Y						
5	18	Y	N	27	Y	Y	51	Y	Y						
6 (Ref)	100	Y	Y	98	Y	Y	99	Y	Y						
7 (Ref)	14	N	N	17	Y	N	28	Y	Y						
Run 1	35	Y	Y	124	Y	Y	49	Y	Y						
Run 2	140	Y	Y	261	Y	Y	92	Y	Y						

5% of growing season is 13 days, 8% is 21 days



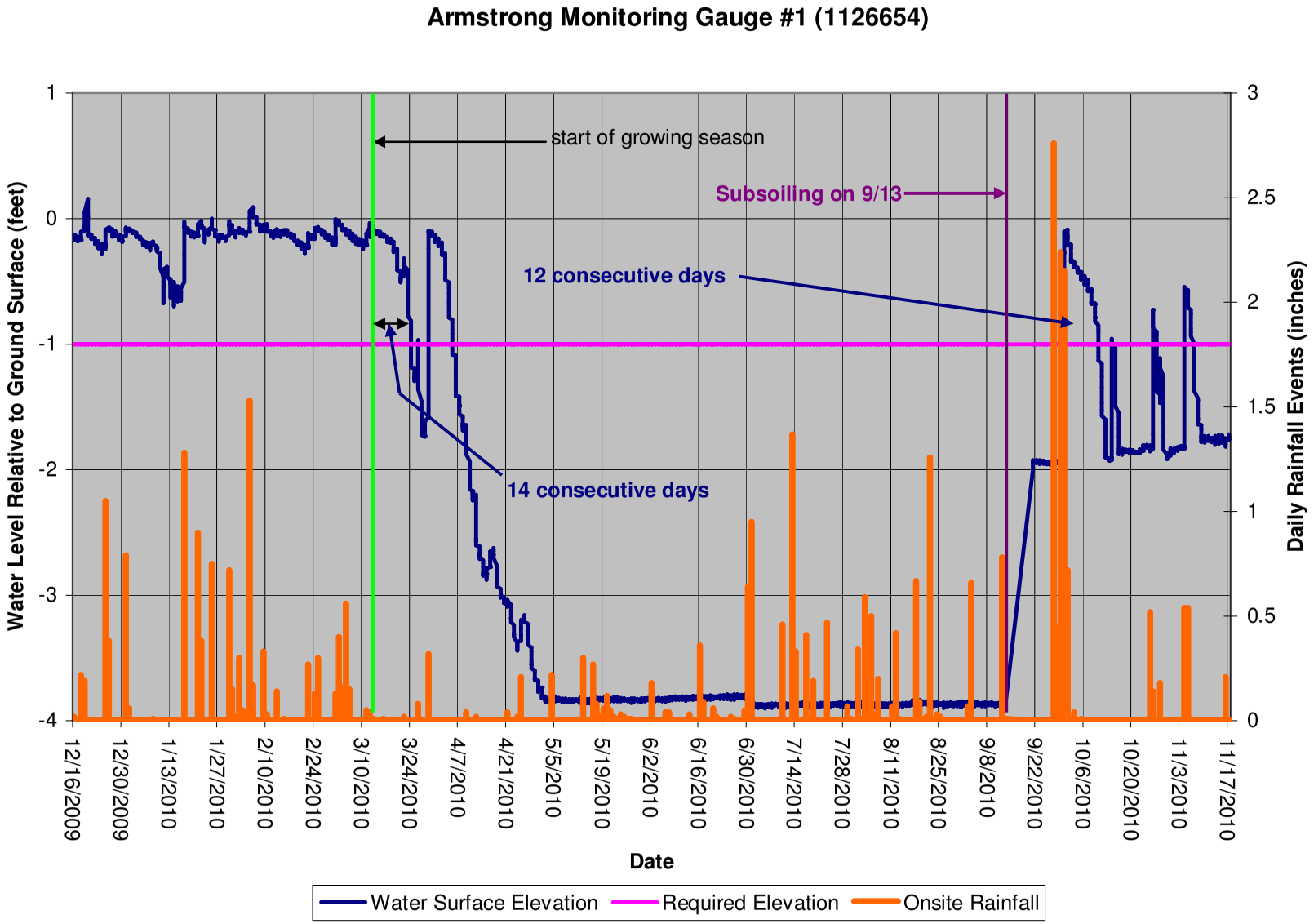
Appendix B

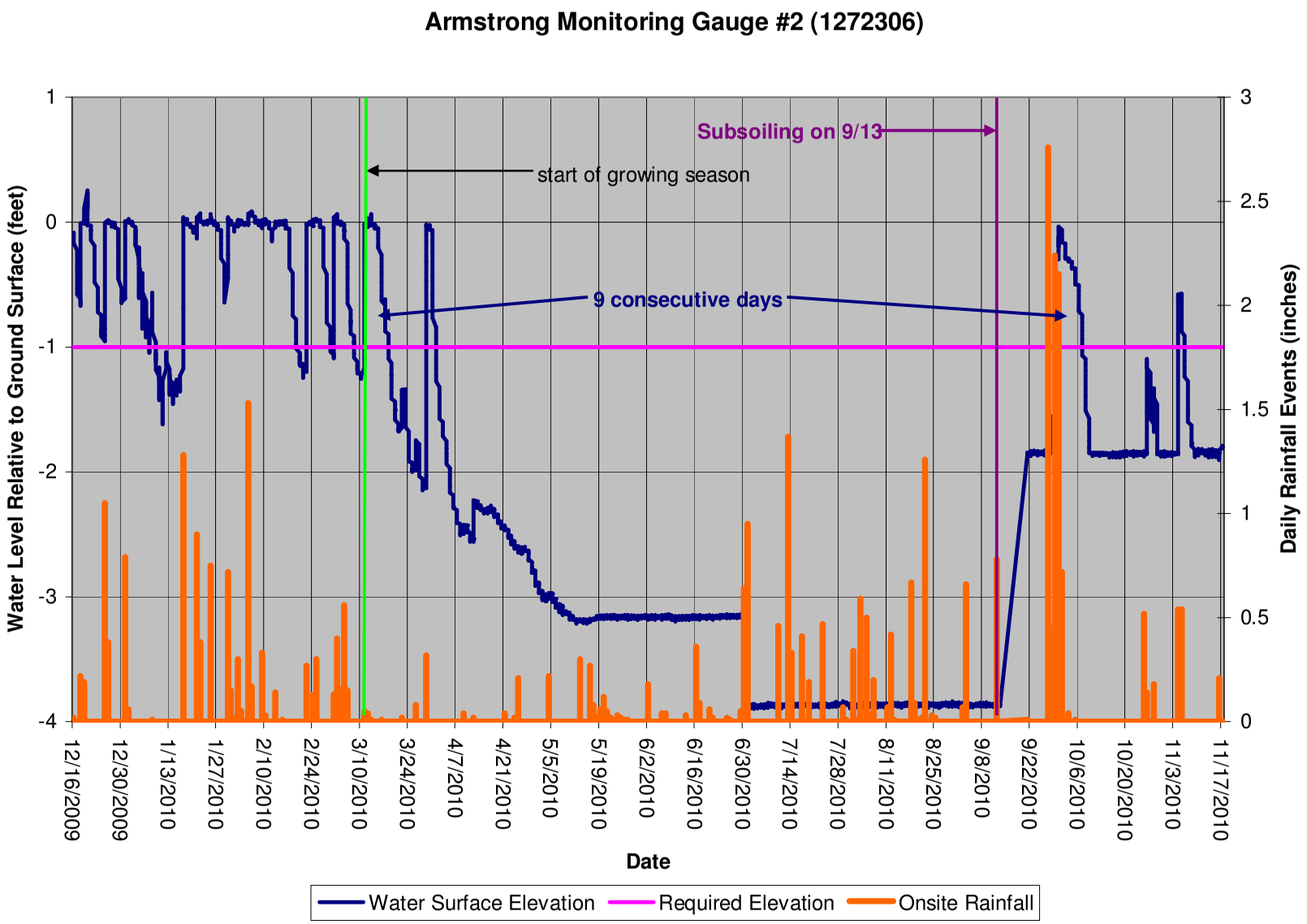
Geomorphologic Raw Data

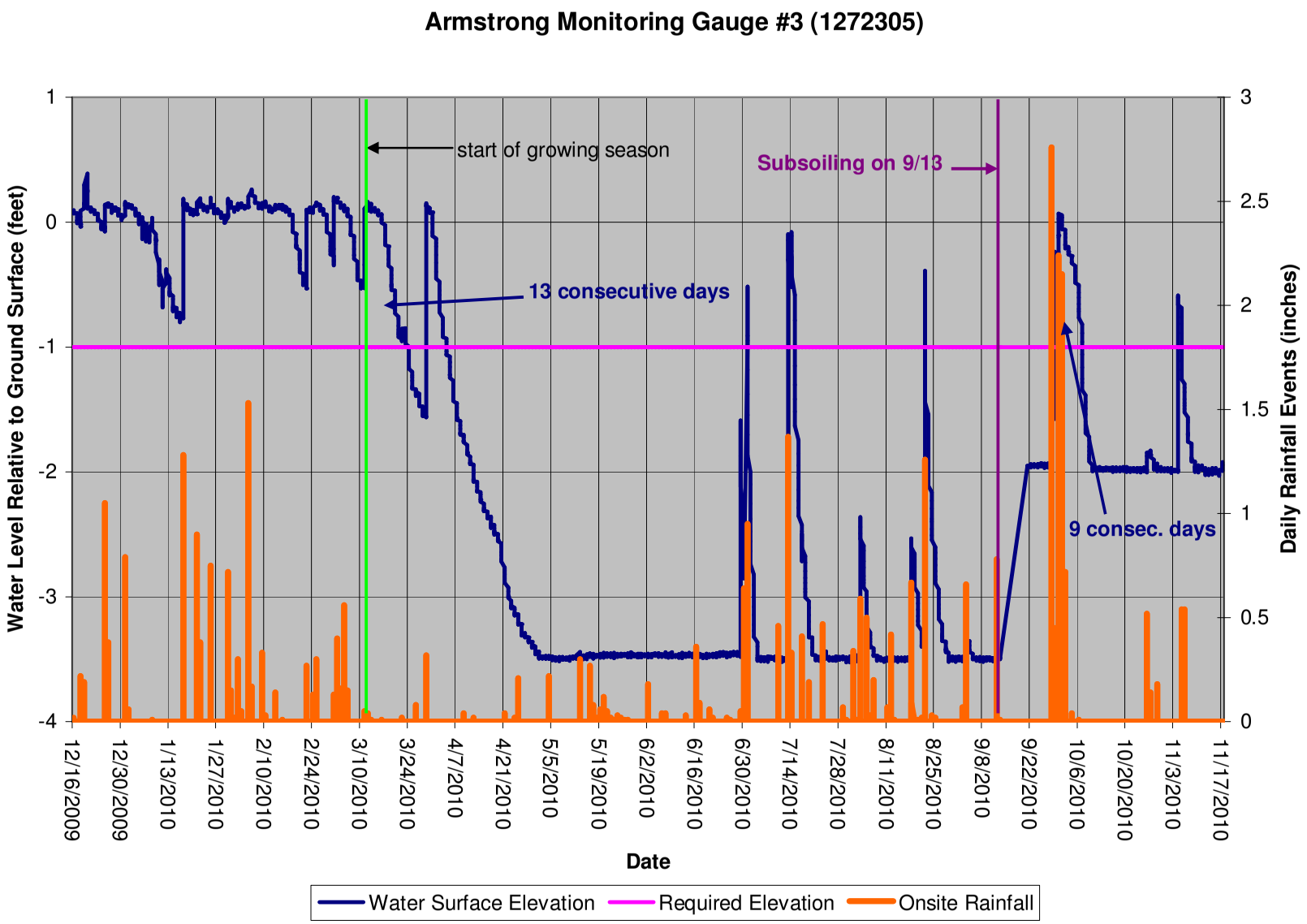
Not used in this report

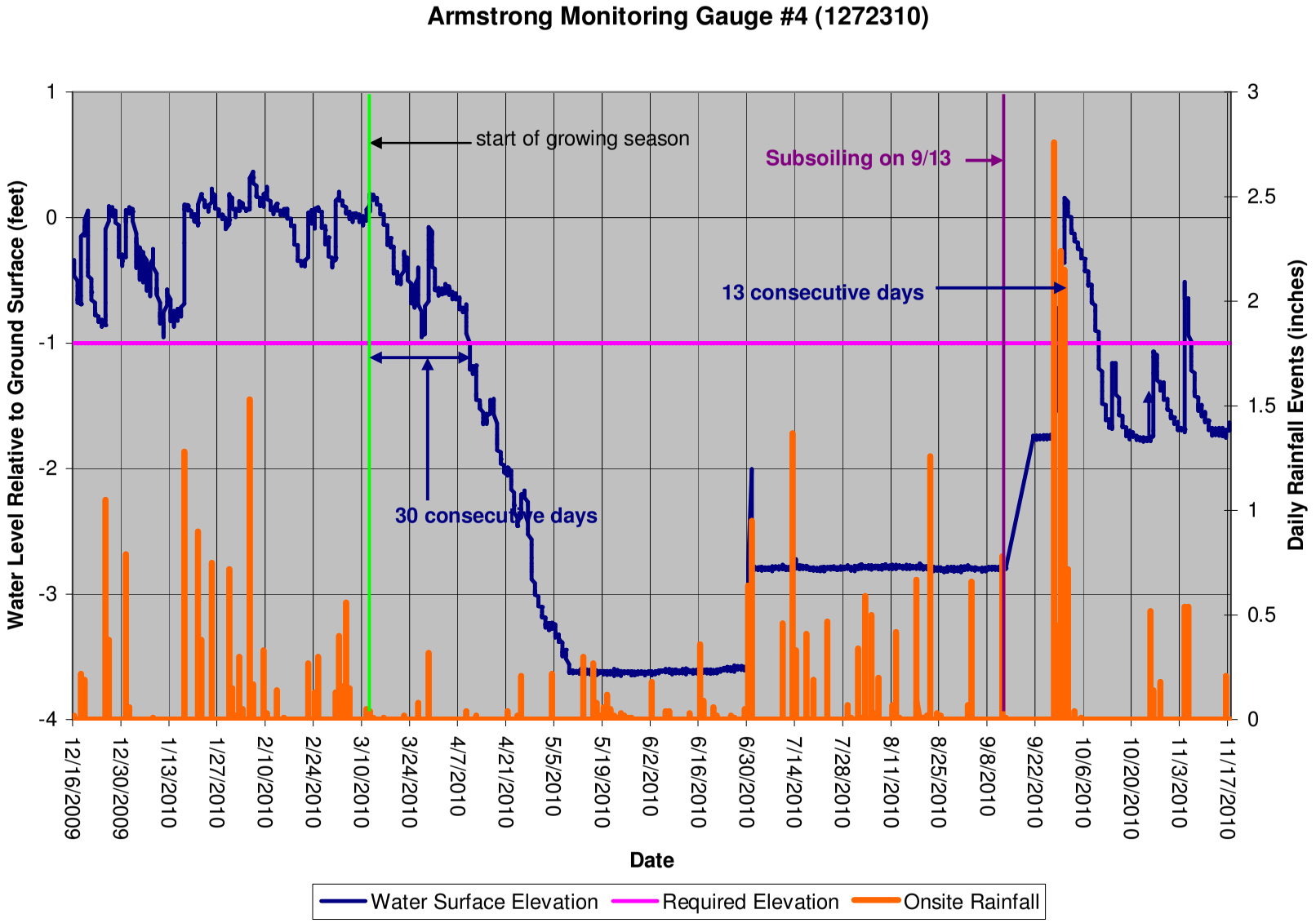
Appendix C

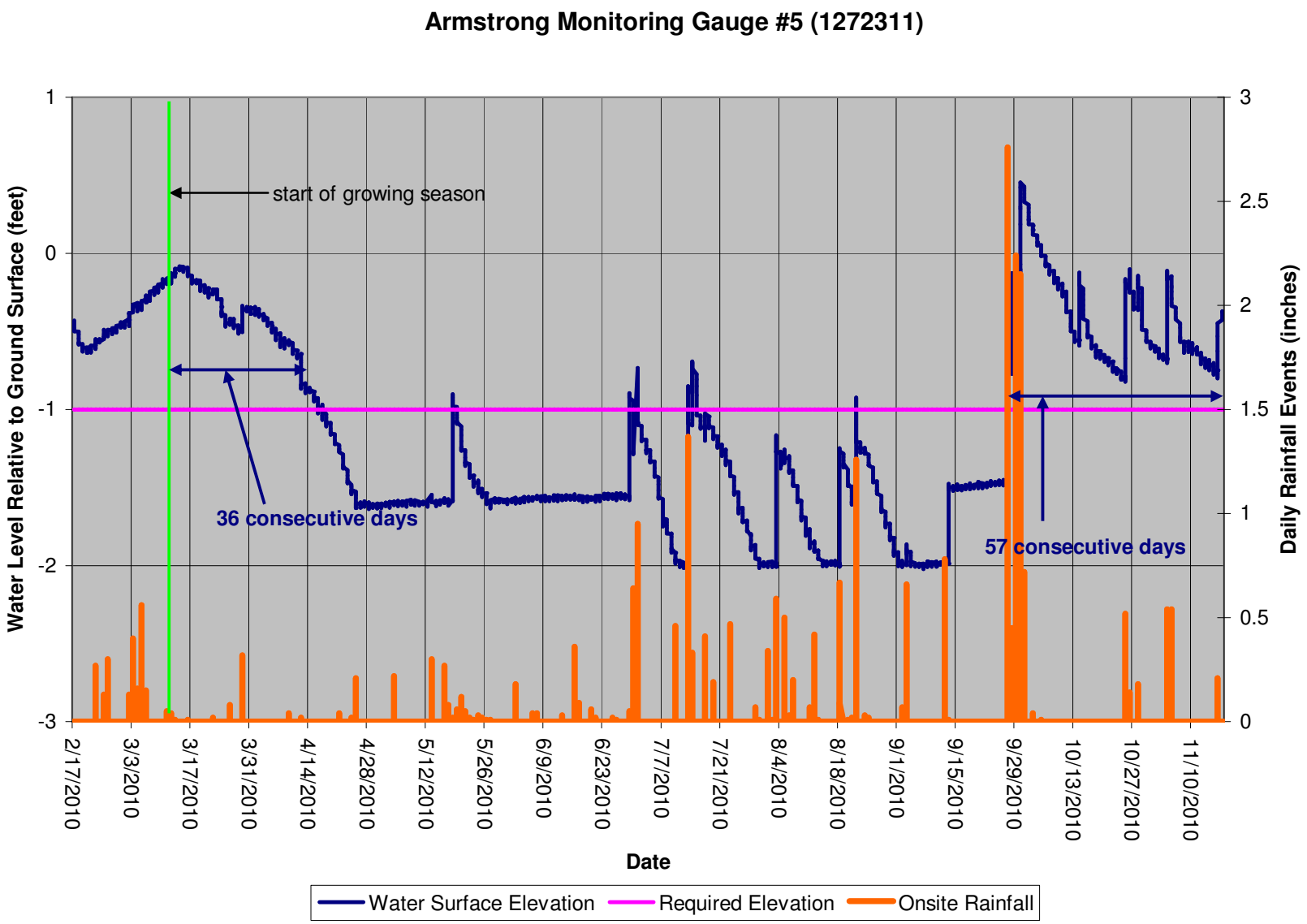
Hydrologic Data Tables

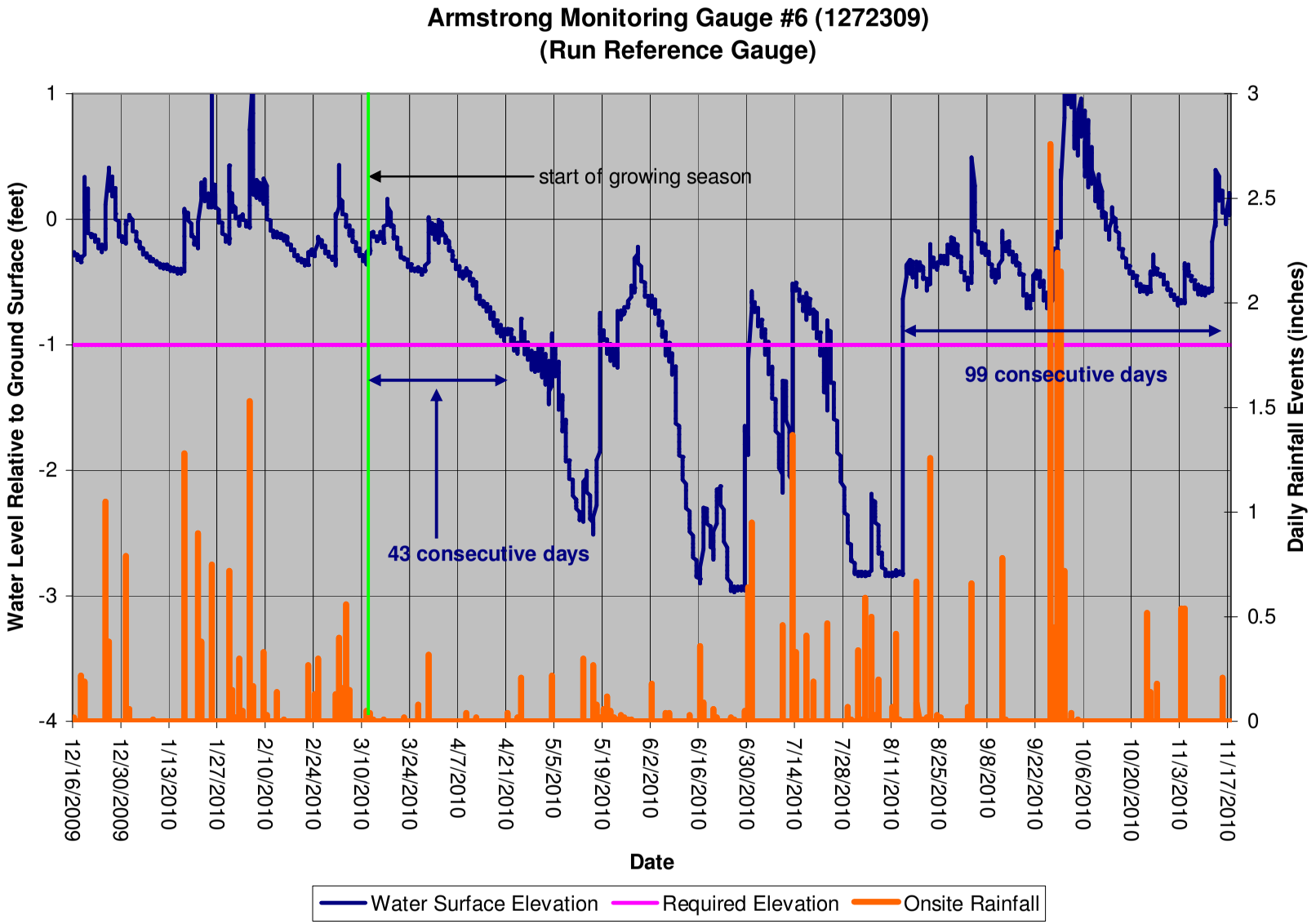

Armstrong Monitoring Gauge #1 (1126654)
start of growing season
Subsoiling on 9/13
12 consecutive days
14 consecutive days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
3
2.5
2
1.5
1
0.5
0
12/16/2009
12/30/2009
1/13/2010
1/27/2010
2/10/2010
2/24/2010
3/10/2010
3/24/2010
4/7/2010
4/21/2010
5/5/2010
5/19/2010
6/2/2010
6/16/2010
6/30/2010
7/14/2010
7/28/2010
8/11/2010
8/25/2010
9/8/2010
9/22/2010
10/6/2010
10/20/2010
11/3/2010
11/17/2010
Water Surface Elevation
Required Elevation
Onsite Rainfall

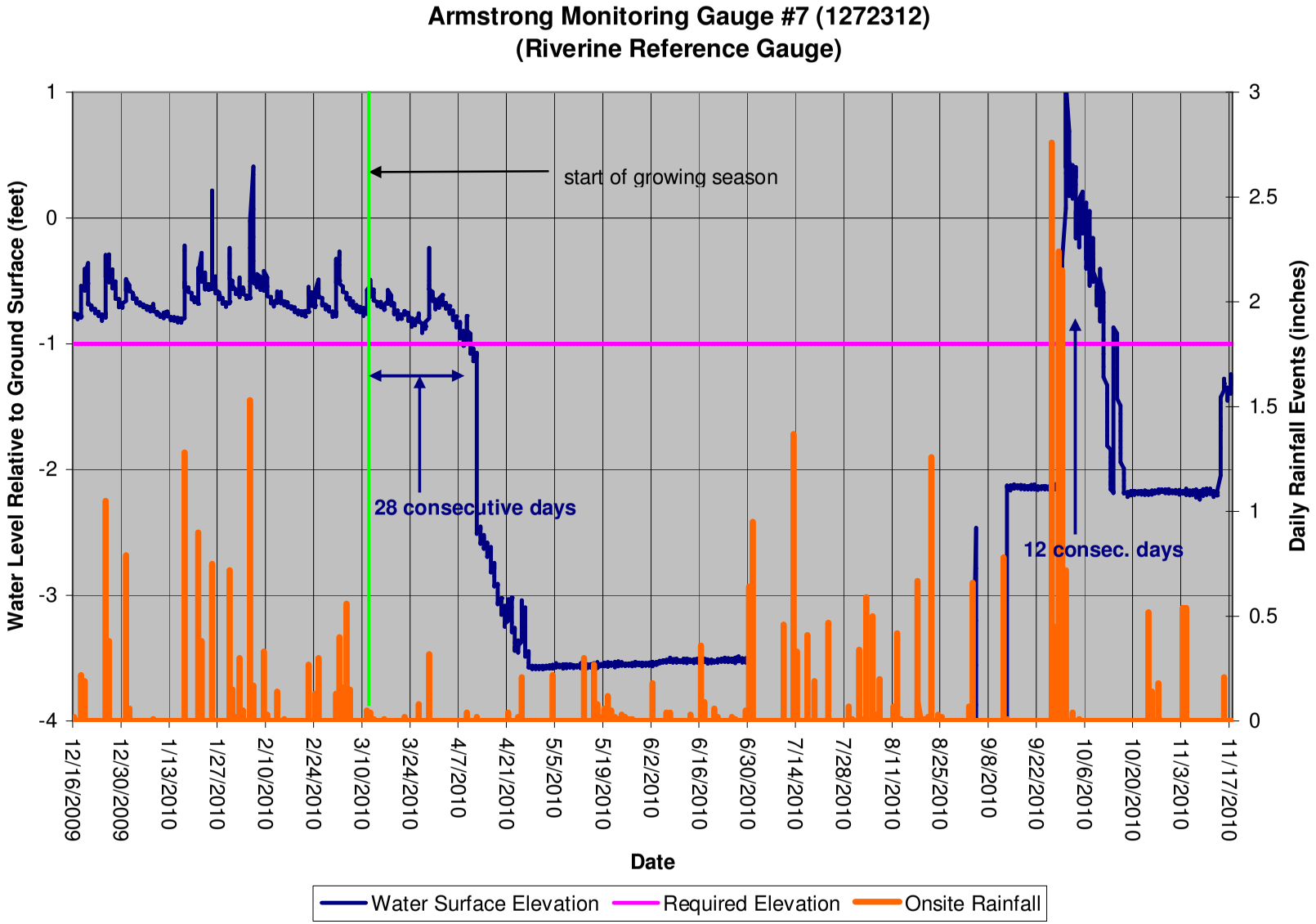

Armstrong Monitoring Gauge #2 (1272306)
Subsoiling on 9/13
start of growing season
9 consecutive days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
1
0
-1
-2
-3
-4
3
2.5
2
1.5
1
0.5
0
12/16/2009
12/30/2009
1/13/2010
1/27/2010
2/10/2010
2/24/2010
3/10/2010
3/24/2010
4/7/2010
4/21/2010
5/5/2010
5/19/2010
6/2/2010
6/16/2010
6/30/2010
7/14/2010
7/28/2010
8/11/2010
8/25/2010
9/8/2010
9/22/2010
10/6/2010
10/20/2010
11/3/2010
11/17/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall

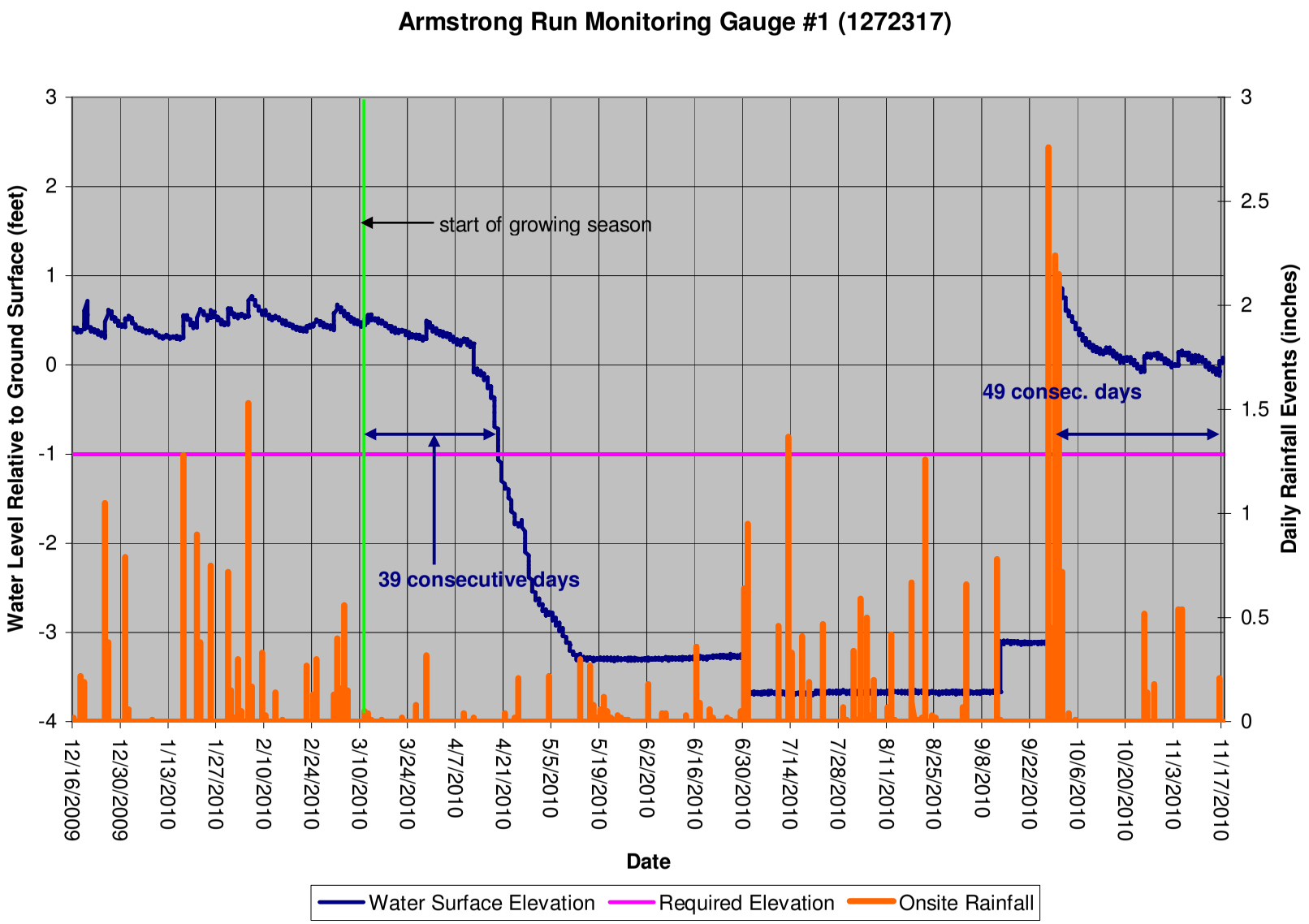

Armstrong Monitoring Gauge #3 (1272305)
start of growing season
Subsoiling on 9/13
13 consecutive days
9 consec. days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
3
2.5
2
1.5
1
0.5
0
12/16/2009
12/30/2009
1/13/2010
1/27/2010
2/10/2010
2/24/2010
3/10/2010
3/24/2010
4/7/2010
4/21/2010
5/5/2010
5/19/2010
6/2/2010
6/16/2010
6/30/2010
7/14/2010
7/28/2010
8/11/2010
8/25/2010
9/8/2010
9/22/2010
10/6/2010
10/20/2010
11/3/2010
11/17/2010
Water Surface Elevation
Required Elevation
Onsite Rainfall

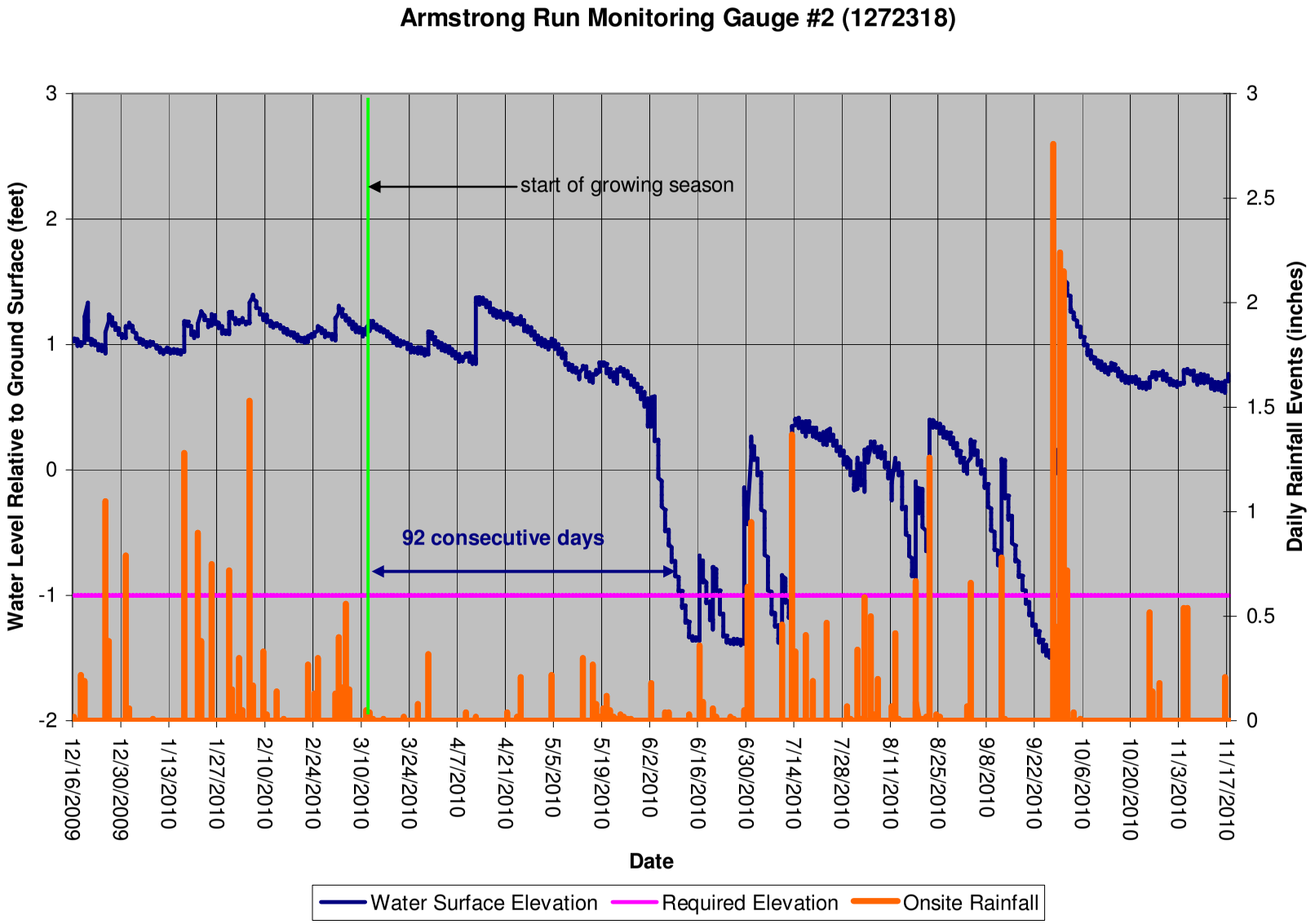

Armstrong Monitoring Gauge #4 (1272310)
start of growing season
Subsoiling on 9/13
13 consecutive days
30 consecutive days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
1
0
-1
-2
-3
-4
3
2.5
2
1.5
1
0.5
0
12/16/2009
12/30/2009
1/13/2010
1/27/2010
2/10/2010
2/24/2010
3/10/2010
3/24/2010
4/7/2010
4/21/2010
5/5/2010
5/19/2010
6/2/2010
6/16/2010
6/30/2010
7/14/2010
7/28/2010
8/11/2010
8/25/2010
9/8/2010
9/22/2010
10/6/2010
10/20/2010
11/3/2010
11/17/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall


Armstrong Monitoring Gauge #5 (1272311)
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
start of growing season
36 consecutive days
57 consecutive days
1
0
-1
-2
-3
3
2.5
2
1.5
1
0.5
0
2/17/2010
3/3/2010
3/17/2010
3/31/2010
4/14/2010
4/28/2010
5/12/2010
5/26/2010
6/9/2010
6/23/2010
7/7/2010
7/21/2010
8/4/2010
8/18/2010
9/1/2010
9/15/2010
9/29/2010
10/13/2010
10/27/2010
11/10/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall


Armstrong Monitoring Gauge #6 (1272309)
(Run Reference Gauge)
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
start of growing season
43 consecutive days
99 consecutive days
1
0
-1
-2
-3
-4
3
2.5
2
1.5
1
0.5
0
12/16/2009
12/30/2009
1/13/2010
1/27/2010
2/10/2010
2/24/2010
3/10/2010
3/24/2010
4/7/2010
4/21/2010
5/5/2010
5/19/2010
6/2/2010
6/16/2010
6/30/2010
7/14/2010
7/28/2010
8/11/2010
8/25/2010
9/8/2010
9/22/2010
10/6/2010
10/20/2010
11/3/2010
11/17/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall

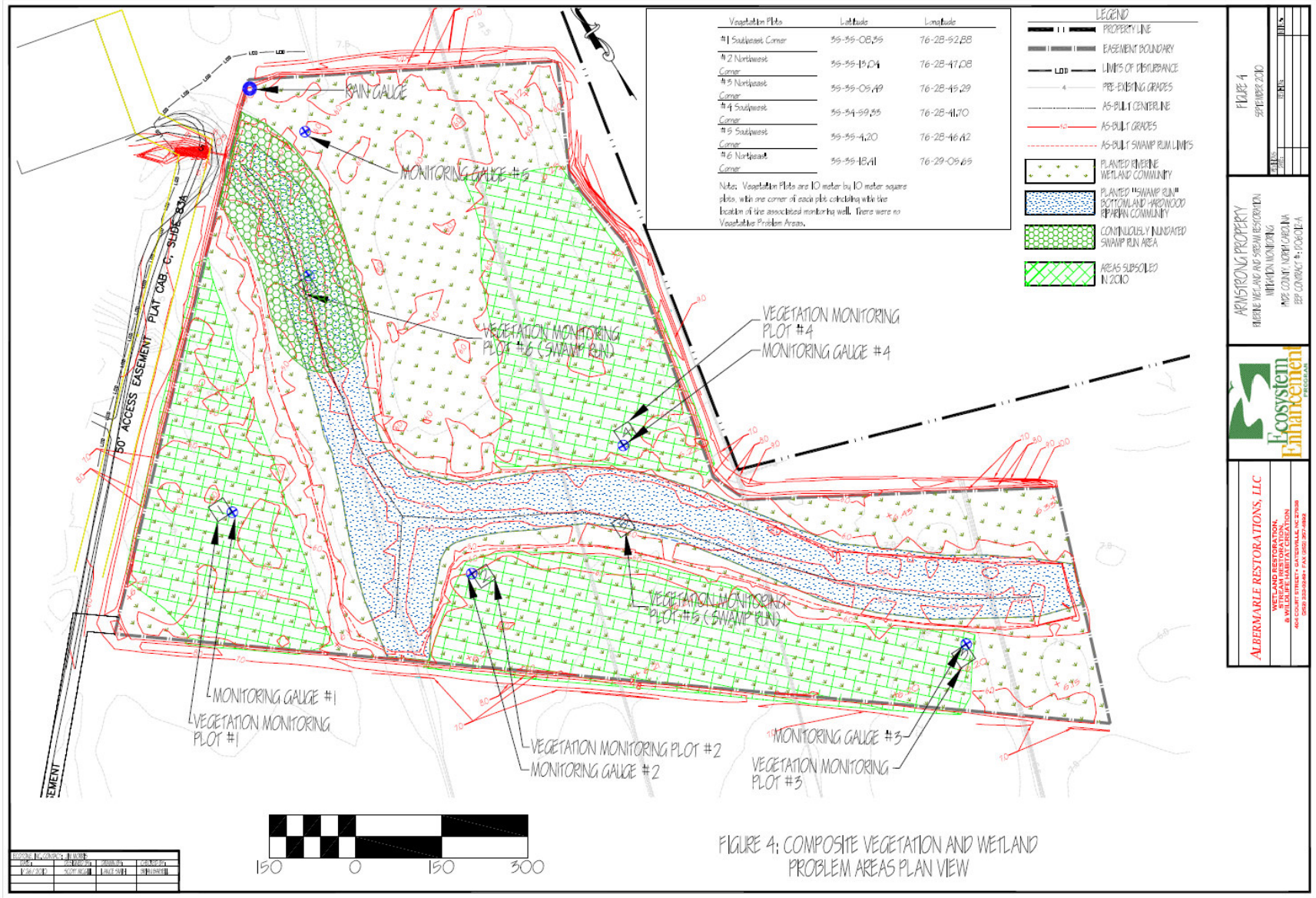

Armstrong Monitoring Gauge #7 (1272312)
(Riverine Reference Gauge)
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
start of growing season
28 consecutive days
12 consec. days
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall


Armstrong Run Monitoring Gauge #1 (1272317)
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
start of growing season
39 consecutive days
49 consec. days
Date
12/16/2009
12/30/2009
1/13/2010
1/27/2010
2/10/2010
2/24/2010
3/10/2010
3/24/2010
4/7/2010
4/21/2010
5/5/2010
5/19/2010
6/2/2010
6/16/2010
6/30/2010
7/14/2010
7/28/2010
8/11/2010
8/25/2010
9/8/2010
9/22/2010
10/6/2010
10/20/2010
11/3/2010
11/17/2010
Water Surface Elevation
Required Elevation
Onsite Rainfall


Armstrong Run Monitoring Gauge #2 (1272318)
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
start of growing season
92 consecutive days
3
2
1
0
-1
-2
2.5
1.5
0.5
12/16/2009
12/30/2009
1/13/2010
1/27/2010
2/10/2010
2/24/2010
3/10/2010
3/24/2010
4/7/2010
4/21/2010
5/5/2010
5/19/2010
6/2/2010
6/16/2010
6/30/2010
7/14/2010
7/28/2010
8/11/2010
8/25/2010
9/8/2010
9/22/2010
10/6/2010
10/20/2010
11/3/2010
11/17/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall

Appendix D

Problem Areas Plan View (Integrated)



Vegetation Plots	Latitude	Longitude
#1 Southeast Corner	35-35-08.35	76-28-52.88
#2 Northwest Corner	35-35-13.04	76-28-47.08
#3 Northeast Corner	35-35-09.49	76-28-43.29
#4 Southwest Corner	35-34-59.35	76-28-41.70
#5 Southwest Corner	35-35-4.20	76-28-46.62
#6 Northeast Corner	35-35-18.41	76-29-05.85

Notes: Vegetation Plots are 10 meter by 10 meter square plots, with one corner of each plot coinciding with the location of the associated monitoring well. There were no Vegetative Problem Areas.

FIGURE 4; COMPOSITE VEGETATION AND WETLAND PROBLEM AREAS PLAN VIEW

FIGURE 4
SEPTEMBER 2010

ARMSTRONG PROPERTY
RIVERINE WETLAND AND SWAMP RUN RESTORATION
WETLAND MONITORING
MOORE COUNTY, NORTH CAROLINA
EEP CONTRACT #: 92042-A

Ecosystem Enhancement Program

ALBEMARLE RESTORATIONS, LLC
WETLAND RESTORATION, & WETLAND MITIGATION
464 COURT STREET• OATESVILLE, NC 27958
(252) 333-3361 • FAX (252) 357-1882

ENGINEERING CONTRACTS JOB NUMBER

DATE	DESCRIPTION	DRAWN BY	CHECKED BY
10/26/2010	SCOPY RECEIVED	LANCE SMITH	BENJAMIN BELL