Armstrong Property Wetland and Stream Mitigation Project
Hyde County, NC

2011 Annual Monitoring Report
Year 4

NCEEP Project Number D06012-A
Tar-Pamlico River Basin

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

Date: December, 2011

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. Due to severe drought, only one 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 (three of the five gauges met success at 13 days - 5% of the growing season). The cumulative rainfall deficit during the 2011 growing season was 4.45 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. Again, the severe drought conditions in 2011 made it difficult to determine the efficacy of the treatment.

One flow event, resulting from Hurricane Irene in late August was video documented during the 2011 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. All six plots met the fourth year survival success criteria of 260 stems per acre.

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 260 stems per acre.

Table ES-1. Project Success Summary

Gauges show longest hydroperiod as % of growing season, Plots show Stems per Acre											Percent
Success		1	2	3	4	5	6	7	R1	R2	Success
Year 1 2009	Gauges %	3	2	5	3	7	38	5	13	54	29%
	Plot SPA	364	486	243	162	No Plot			162	243	33%
Year 2 2010	Gauges %	7	7	7	5	10	38	7	48	100	43%
	Plot SPA	454	577	536	371	No Plot			371	247	100%
Year 3 2011	Gauges %	5	3	5	12	20	38	11	19	35	57%
	Plot SPA	412	577	371	289	No Plot			371	495	100%
Year 4 2012	Gauges %	7	4	4	7	26	41	7	25	36	43%
	Plot SPA	784	907	454	330	No Plot			371	495	100%
Year 5 2013	Gauges %										
	Plot SPA					No Plot					

Gauge values shown in red did not meet minimum of 8% of the growing season

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.

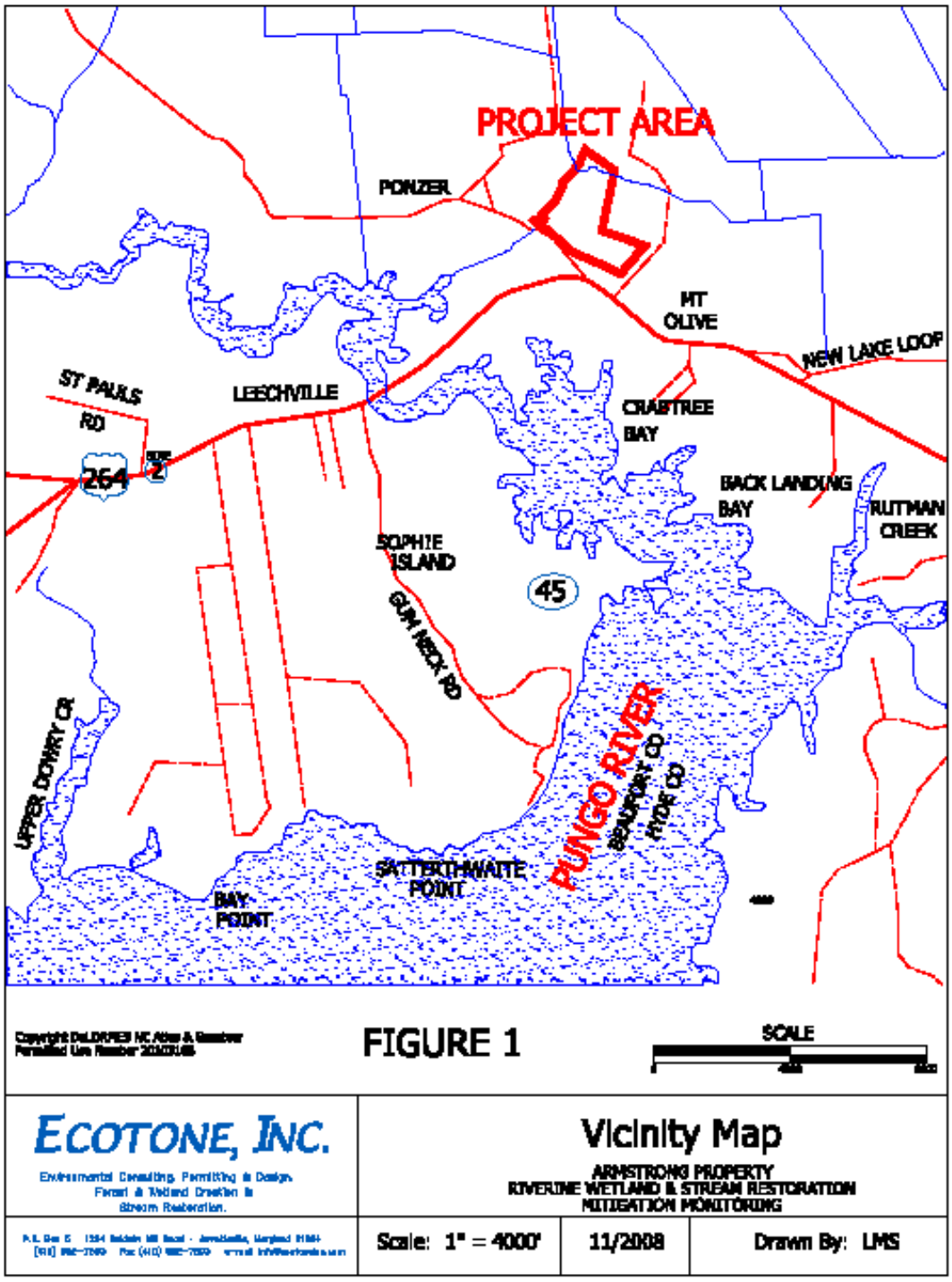
Table 1. Project Restoration Components

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
BACK LANDING BAY
RUTMAN CREEK
264
SOPHIE ISLAND
45
GUM NECK RD
UPPER DOWRY CR
PUNGO RIVER
BEAUFORT CR
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	September 2011	December 2010
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

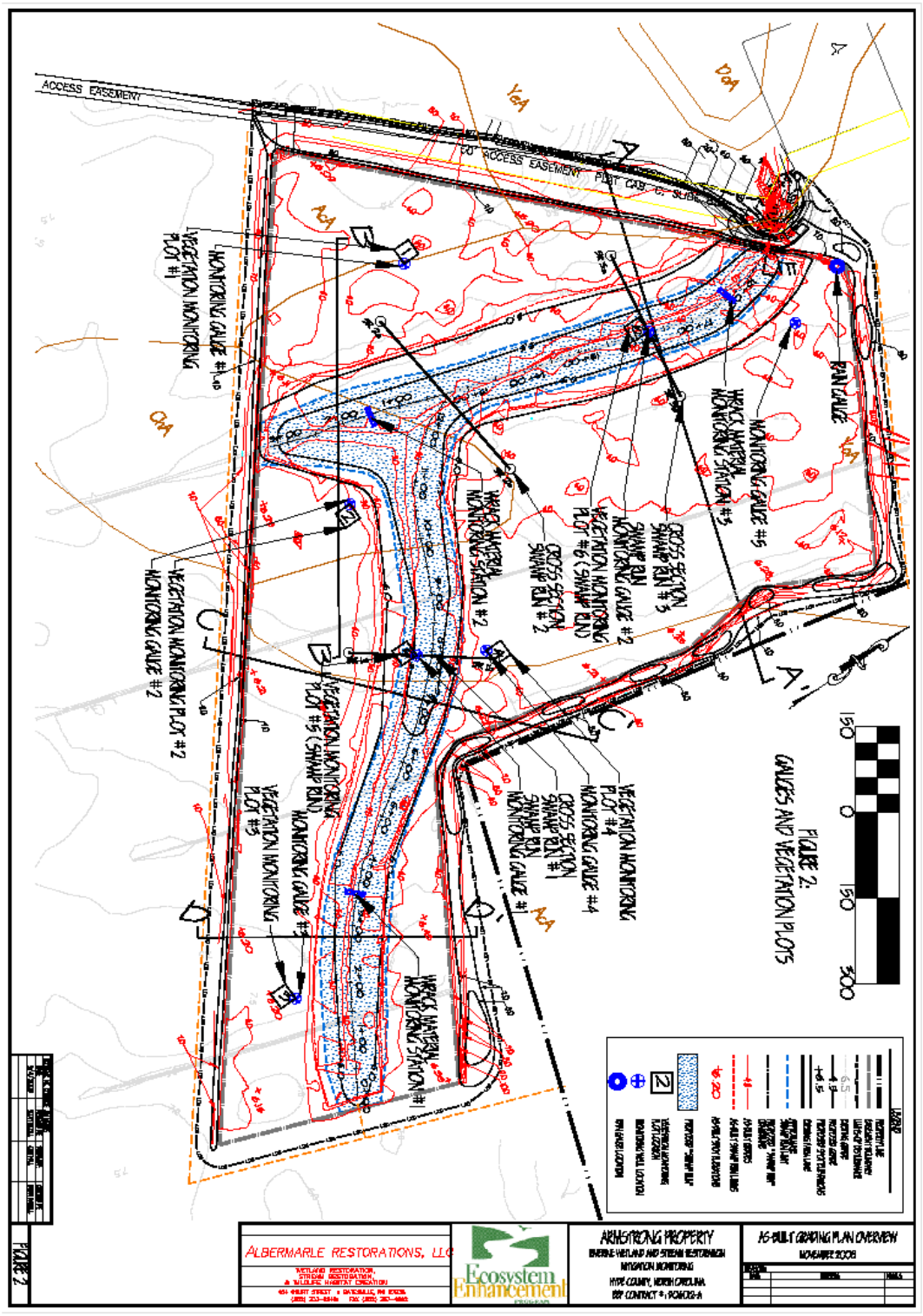
5.0 Monitoring Plan View

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
TO ACCESS EASEMENT
VEGETATION MONITORING PLOT #1
MONITORING GAUGE #1
VEGETATION MONITORING PLOT #2
MONITORING GAUGE #2
WRACK WATERLINE MONITORING STATION #1
WRACK WATERLINE MONITORING STATION #2
WRACK WATERLINE MONITORING STATION #3
MONITORING GAUGE #3
VEGETATION MONITORING PLOT #3
VEGETATION MONITORING PLOT #5 (SWAMP RUN)
CROSS SECTION #1 SWAMP RUN
MONITORING GAUGE #4
VEGETATION MONITORING PLOT #4
CROSS SECTION #2 SWAMP RUN
VEGETATION MONITORING PLOT #6 (SWAMP RUN)
CROSS SECTION #3 SWAMP RUN
MONITORING GAUGE #5
PLANT GAUGE
FIGURE 2:
GAUGES AND VEGETATION PLOTS
150
0
150
300
LEGEND
ALBEMARLE RESTORATIONS, LLC
Ecosystem Enhancement
ARMSTRONG PROPERTY
HYDE COUNTY, NORTH CAROLINA
AS-BUILT GRADING PLAN OVERVIEW
NOVEMBER 2008

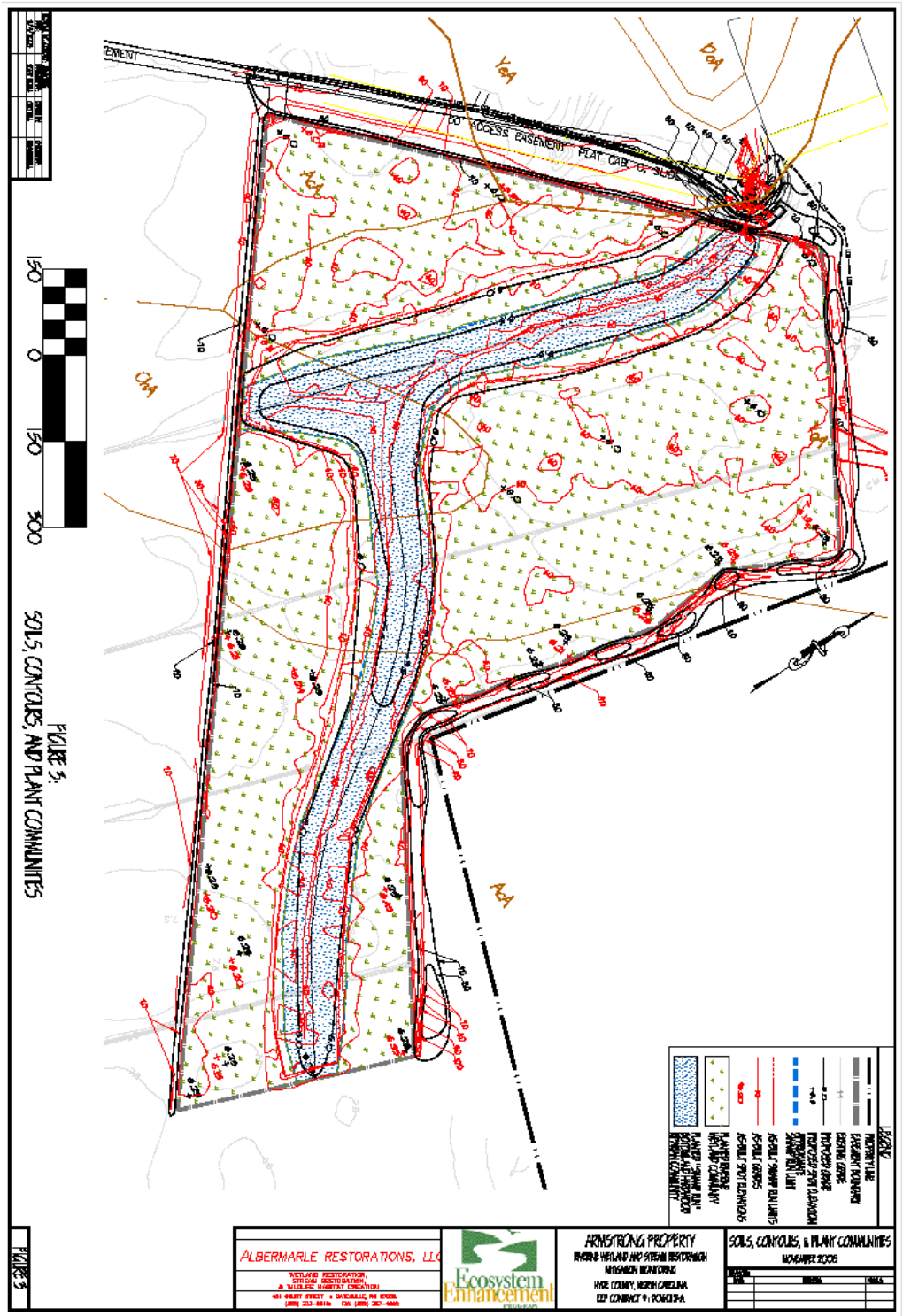


FIGURE 3:
SOILS, CONTOURS, AND PLANT COMMUNITIES
FIGURE 3
ALBEMARLE RESTORATIONS, LLC
Ecosystem Enhancement
ARMSTRONG PROPERTY
SOILS, CONTOURS, & PLANT COMMUNITIES
NOVEMBER 2008
LEGEND

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 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

All four plots in the riverine community met the Year 5 success criterion of a minimum of 260 stems per acre after the fourth growing season. Plots 1 and 2 supported 784 and 907 stems per acre respectively, the result of replanting after subsoiling in 2010. More of the original stems survived the treatment than was expected. Both stream plots also met the success criterion. Over the entire project, the survival rate averaged 557 live stems per acre.

During the 2011 growing season, there was a cumulative rainfall deficit of 15.08 inches through the end of July which had an impact on tree growth and development. As can be seen in the photos in Appendix A, the severe drought conditions caused top dieback, leaf burn and early leaf

fall. However, given current stocking levels, the project should have adequate stocking to see it through close out.

1.2 Vegetation Monitoring Plan View (Integrated)

See 2.2 Wetland Discussion and Problem Areas 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 riverine portion of 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).

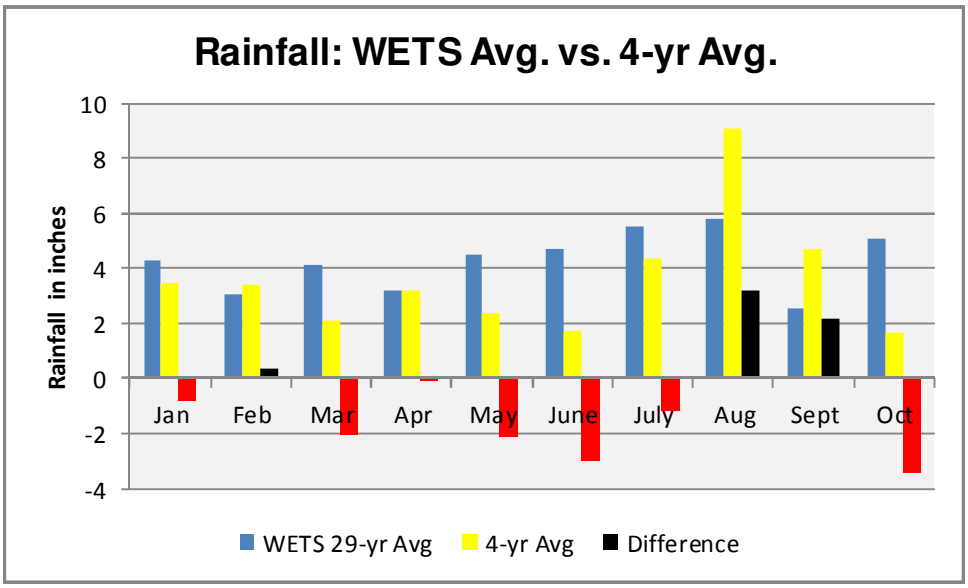
2.1 Wetland Discussion and Problem Areas

From January 1st, through the end of July, 2011 the site experienced a cumulative rainfall deficit of 15.08" which no doubt caused poor hydrologic performance. Of particular note is the fact that the longest hydroperiod measured by Reference Gauge 7 was 19 days, which is the same for Gauges 1 and 4. Reference Gauge 6 measured a hydroperiod very similar in length to that of Run Gauge 2. These two gauges are in similar positions in the landscape. It appears that hydrology on the project is performing similar to that in the reference area.

Of particular importance is the fact that from May 15 through August 18, Run Gauge 2 showed no standing water at all for the first time since the project was completed. A similar pattern occurs for Reference Gauge 6. The data, taken in their entirety, do not indicate a lack of wetland hydrology. Rather, they show the effects of inadequate rainfall. 2008 was the first year of monitoring and since its completion the project has been under moderate to severe rainfall drought. The hydrologic success of the project depends entirely on rainfall.

Subsoiling was done in 2010 in an attempt to offer every possible enhancement and give the project the best chance for success. Refer to Figure 4 in Appendix D for a description of those areas. It was thought that soil compaction was a possible cause for poor hydrology, and that certainly may have contributed to the problem, but the following charts summarize the lack of rainfall which is clearly having a detrimental effect on success. Despite the remedial efforts, and

because of the lack of rainfall, those areas shown as subsoiled in Figure 4 continued to suffer poor hydrology.



Month	4-year Avg Difference
Jan	-0.80
Feb	0.33
Mar	-2.05
Apr	-0.01
May	-2.12
June	-2.99
July	-1.16
Aug	3.23
Sept	2.21
Oct	-3.42
Total	-6.77

Rainfall during the period of January through March is critical for hydrologic success on this project. As can be summarized from the information above, since 2008, the site has suffered a cumulative average rainfall deficit during that 3-month period of 2.52 inches. The average rainfall deficit of 6.77 inches through October means the project site is going into the fall season drier than normal. If the site is drier than normal going into the upcoming wet season, which also produces below-normal rainfall, the chances of hydrologic success (and flow) are severely handicapped.

There are essentially two times during the growing season when successful hydrology can normally be expected and they are from March to mid-May and from October to the end of the growing season in November. Typically, once leaf-out occurs in the spring, the herbaceous layer regenerates and evaporation increases, the water table will normally begin to drop. If successful hydrology hasn't been measured by then, it isn't likely to be seen until very late in the growing season when evapotranspiration is much lower. But with the site experiencing an average 6.77 inch rainfall deficit as of the end of October for the last four years, the second chance at successful hydrology is greatly reduced.

All of this, taken in conjunction with the fact that the reference gauges show similar performance to the on-site gauges, it would be presumptuous at this point to say that the site isn't successful. Some semblance of normal rainfall pattern must exist in order to accurately judge the hydrologic performance.

2.15 Flow

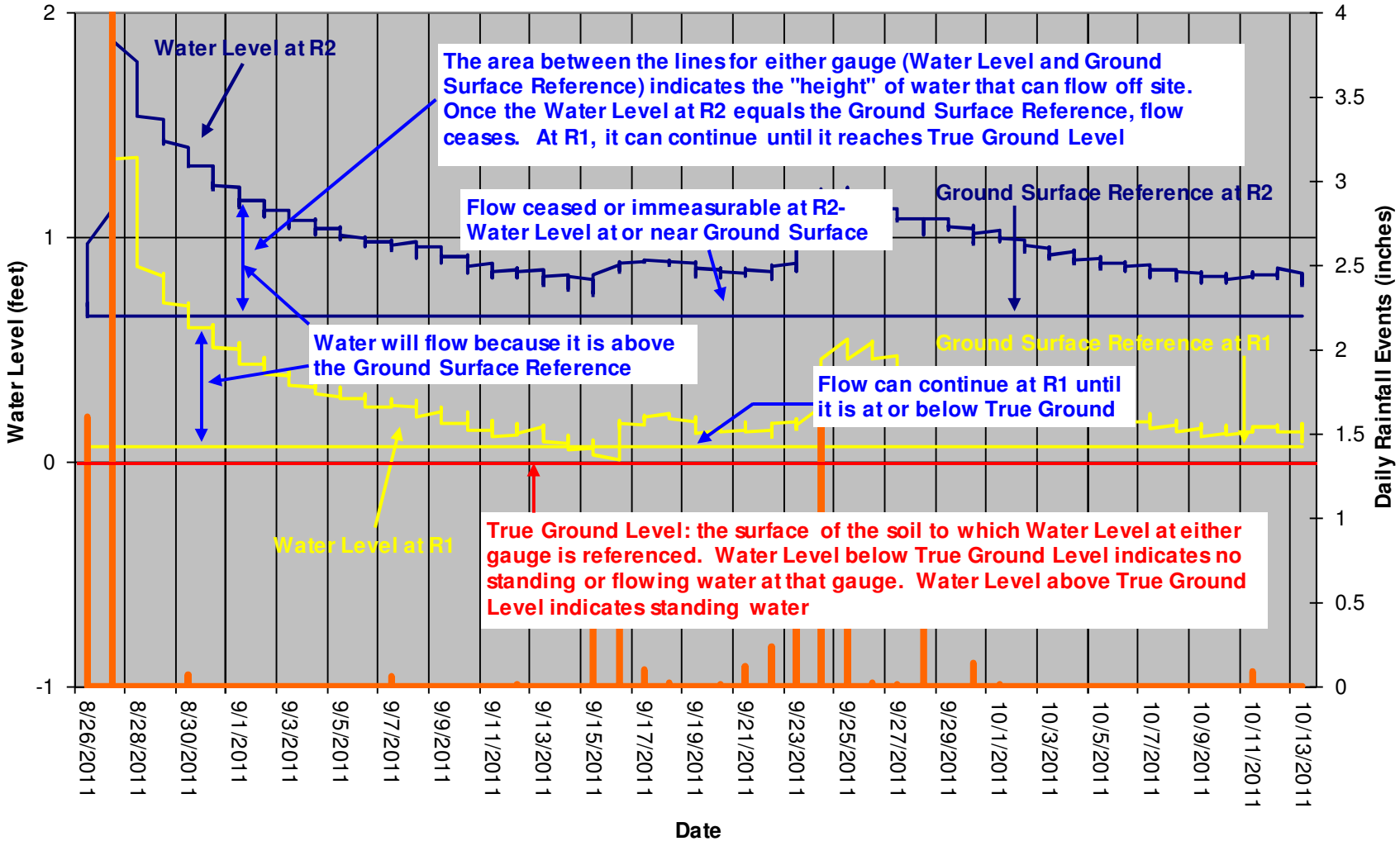
The same cause and effect circumstances regarding hydrology pertain to flow of water through the site. During 2011, only one flow event was captured and that was after approximately ten inches of rain produced at the end of August by Hurricane Irene.

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 8/26/2011 through 10/13/2011 the site received nearly 15 inches 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 was shot after Hurricane Irene passed though at the end of August, 2011. Water level measurements over a two-day period after the rain event ended confirm the flow pattern described above. The water level at gauge R1 eventually dropped as water flowed through the site and probably ceased sometime between September 5th and 9th. Flow at the downstream gauge R2 continued a few days longer.

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 which was undertaken in 2010. In previous years, much of the site was flooded at least immediately prior to the beginning of the growing season, but that was not the case in 2011 due to insufficient rainfall as evidenced by the hydrographs in Appendix C. Despite the subsoiling treatment to correct hydrologic problems, inadequate rainfall still caused poor performance. Compare the results of Gauges 1-4 to those of Gauge 7 in Table VI below. The project site is performing in a similar fashion to that of the reference site.

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 (7%)	43%	1	Yes (784)	100%
2	N (4%)		2	Yes (907)	
3	N (4%)		3	Yes (454)	
4	N (7%)		4	Yes (330)	
5	Y (26%)		No Plot		
R-1	Y (25%)		R-1	Yes (371)	
R-2	Y (36%)		R-1	Yes (495)	
6 (Ref)*	Y (41%)		No Plot		
7 (Ref)*	N (7%)		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

The severely droughty conditions experienced in 2010 persisted through 2011 and made it impossible to determine if the corrective actions taken in 2010 have had the desired effect. The same subsoiling procedure was done on two other projects (Modlin and Powell) and has dramatically improved hydrologic performance of previously compacted soils. But without some reasonably normal rainfall, the efficacy of the procedure cannot be assessed on the Armstrong project.

Due to the replanting after subsoiling in 2010 and better than expected survival of the original trees in the areas where the treatment was done, stocking levels are more than adequate to see the project to completion.

III. Methodology Section

Year 4 monitoring for the Armstrong project occurred in 2011. 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. Project Metadata

Report Prepared By	Ashby B. Brown
Date Prepared	12/6/2011
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
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
Description	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	7	4					
	Liquidambar styraciflua	1	1					
	Quercus bicolor		2					
	Quercus michauxii	1	2	1				
	Quercus phellos	3	4	1				
	Taxodium distichum	14	24	5				
	Unknown			1				
	Myrica cerifera	10						
TOT:	**8**	**36**	**37**	**8**				

Table 3. Damage by Species

	Species	All Damage Categories	(no damage)	Drought
	Cephalanthus occidentalis	11	11	
	Liquidambar styraciflua	2	2	
	Myrica cerifera	10	10	
	Quercus bicolor	2	2	
	Quercus michauxii	4	4	
	Quercus phellos	8	8	
	Taxodium distichum	43	38	5
	Unknown	1	1	
TOT:	**8**	**81**	**76**	**5**

Table 4. Damage by Plot

	Plot	All Damage Categories	(no damage)	Drought
	D06012A-ABET-0001-year:4	19	17	2
	D06012A-ABET-0002-year:4	22	21	1
	D06012A-ABET-0003-year:4	11	11	
	D06012A-ABET-0004-year:4	8	6	2
	D06012A-ABET-R1-year:4	9	9	
	D06012A-ABET-R2-year:4	12	12	
TOT:	**6**	**81**	**76**	**5**

Table 5. Project Planted Stems by Plot and Species Year 4

					Plot					
	Species	**Total Planted Stems**	**# plots**	**avg# stems**	**1**	**2**	**3**	**4**	**R1**	**R2**
	Cephalanthus occidentalis	11	4	2.75	2	1			3	5
	Liquidambar styraciflua	2	1	2		2				
	Myrica cerifera	10	5	2	3	4	1	1	1	
	Quercus bicolor	2	2	1		1			1	
	Quercus michauxii	4	4	1	1	1	1	1		
	Quercus phellos	8	4	2	1	5	1	1		
	Taxodium distichum	43	6	7.17	11	8	8	5	4	7
	Unknown	1	1	1	1					
TOT:	**8**	**81**	**8**		**19**	**22**	**11**	**8**	**9**	**12**
Average Stems per Acre					**784**	**907**	**454**	**330**	**371**	**495**
Project Average Stems per Acre		**557**								

Table 6. Vegetation Problem Areas

Feature/Issue	Plot	Probable Cause	Photo #
Severely droughty conditions	2, 3 and 4	Lack of rainfall	VPA 1, 2, 3 and 4

VPA 1
Very dry conditions near Gauge 2 in March 2011

VPA 2
Dry conditions between Ga. 2 and 3, March 2011. Also shows effects of subsoiling in 2010

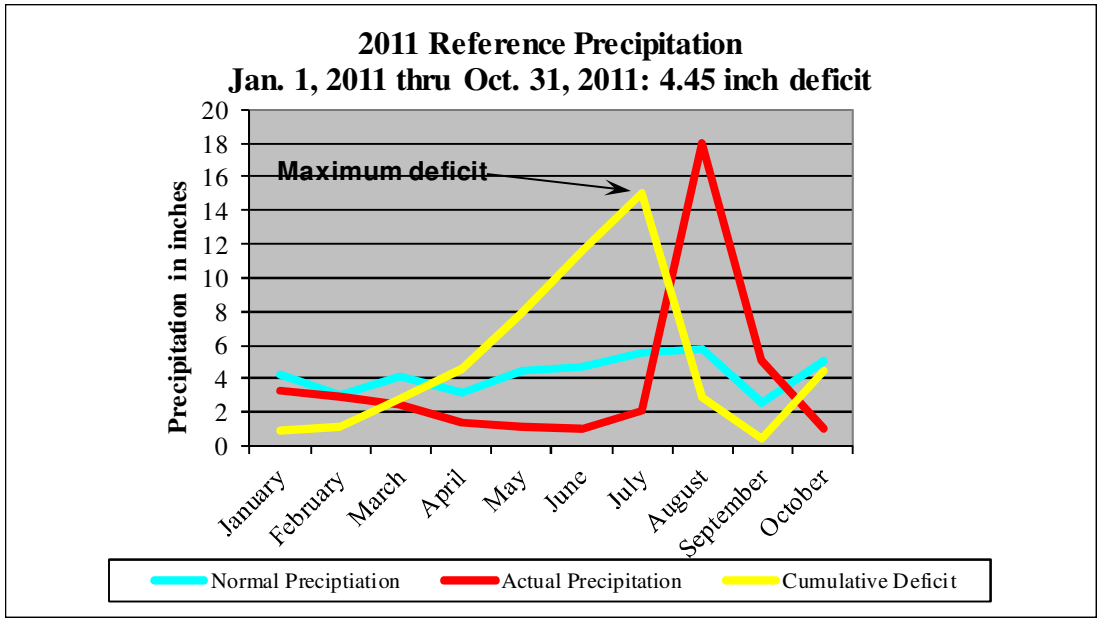
VPA 3
Newly planted trees after subsoiling in 2010 suffering from droughty conditions in July.

VPA 4
Effects of droughty conditions in July.

Stems closer to or in the swamp run fared better in 2011.

Table C-1																									
Longest consecutive successful hydrologic period in days (and % of Growing Season) and success at 5% and 8% of the growing season Living Stems Per Acre at the end of the growing season for plots 1-4																									
Gauge	Year 1					Year 2					Year 3					Year 4					Year 5				
(Plot)	Days	%	5%	8%	SPA	Days	%	5%	8%	SPA	Days	%	5%	8%	SPA	Days	%	5%	8%	SPA	Days	%	5%	8%	SPA
1	9	3	N	N	364	19	7	Y	N	454	14	5	Y	N	412	19	7	Y	N	784					
2	4	2	N	N	486	17	7	Y	N	577	9	3	N	N	577	12	4	N	N	907					
3	12	5	Y	N	243	17	7	Y	N	536	13	5	Y	N	371	12	4	N	N	454					
4	8	3	N	N	162	13	5	Y	N	371	30	12	Y	Y	289	18	7	Y	N	330					
5	18	7	Y	N		27	10	Y	Y		51	20	Y	Y		67	26	Y	Y						
6 (Ref)	100	38	Y	Y		98	38	Y	N		99	38	Y	Y		108	41	Y	Y						
7 (Ref)	14	5	Y	N		17	7	Y	N		28	11	Y	Y		19	7	N	Y						
Run 1	35	13	Y	Y	162	124	48	Y	Y	371	49	19	Y	Y	371	65	25	Y	Y	371					
Run 2	140	54	Y	Y	243	261	100	Y	Y	247	92	35	Y	Y	495	93	36	Y	Y	495					

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



Through July, 2011, the project site suffered from a cumulative rainfall deficit of 15.08". The ten inches of rain produced by Hurricane Irene in late August were not enough to eliminate the total deficit and as of the end of October, the cumulative deficit was still 4.45". The project suffered a similar problem in 2010 when the cumulative deficit through the month of August was 14.17" and ended the growing season in November at 11.23". Despite the severely droughty conditions, Gauges 1-4 showed their best hydroperiods during the early part of the growing season, a characteristic mirrored by the reference gauge #7. This trend would suggest properly performing hydrology during times of adequate rainfall.

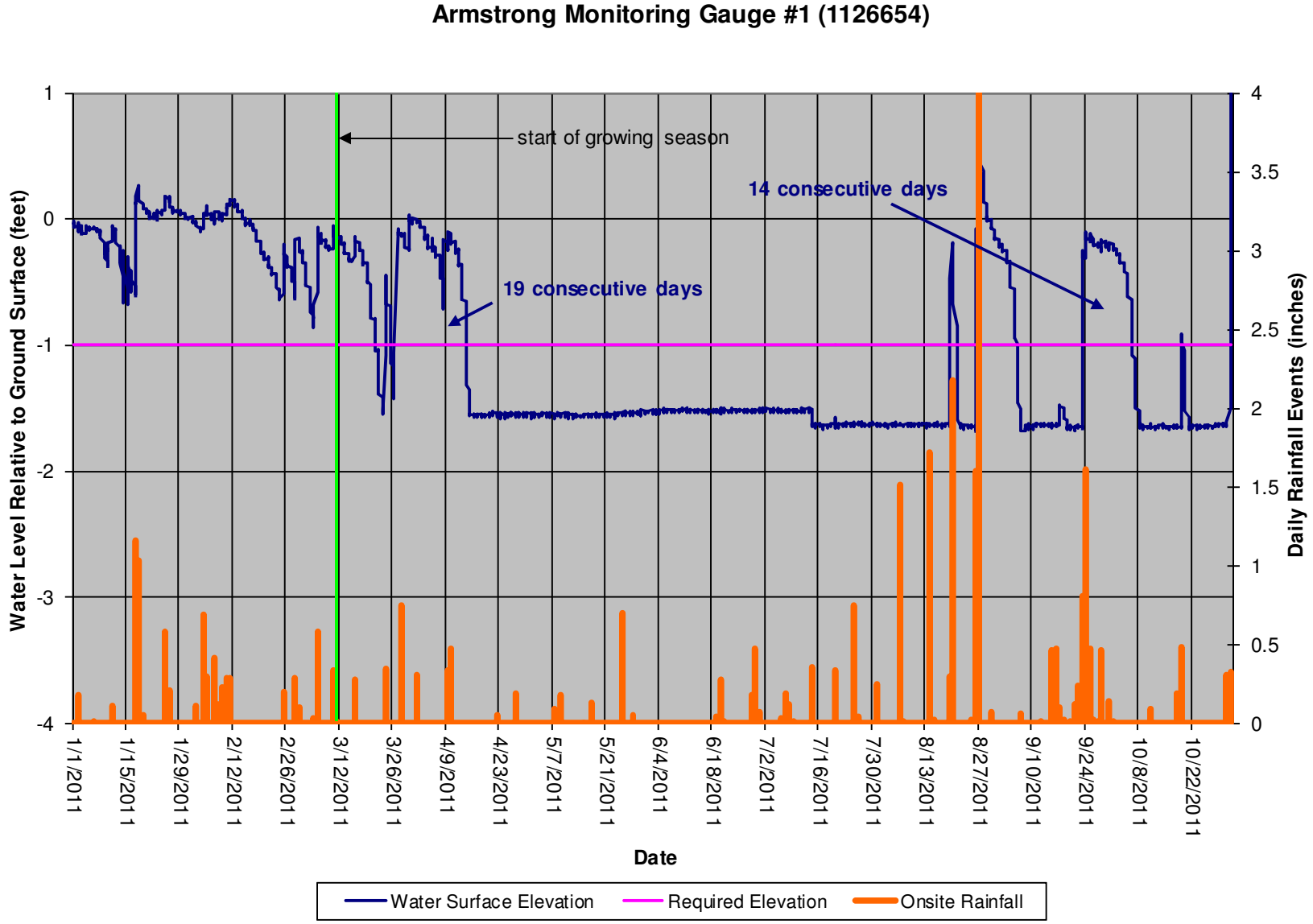
Appendix B

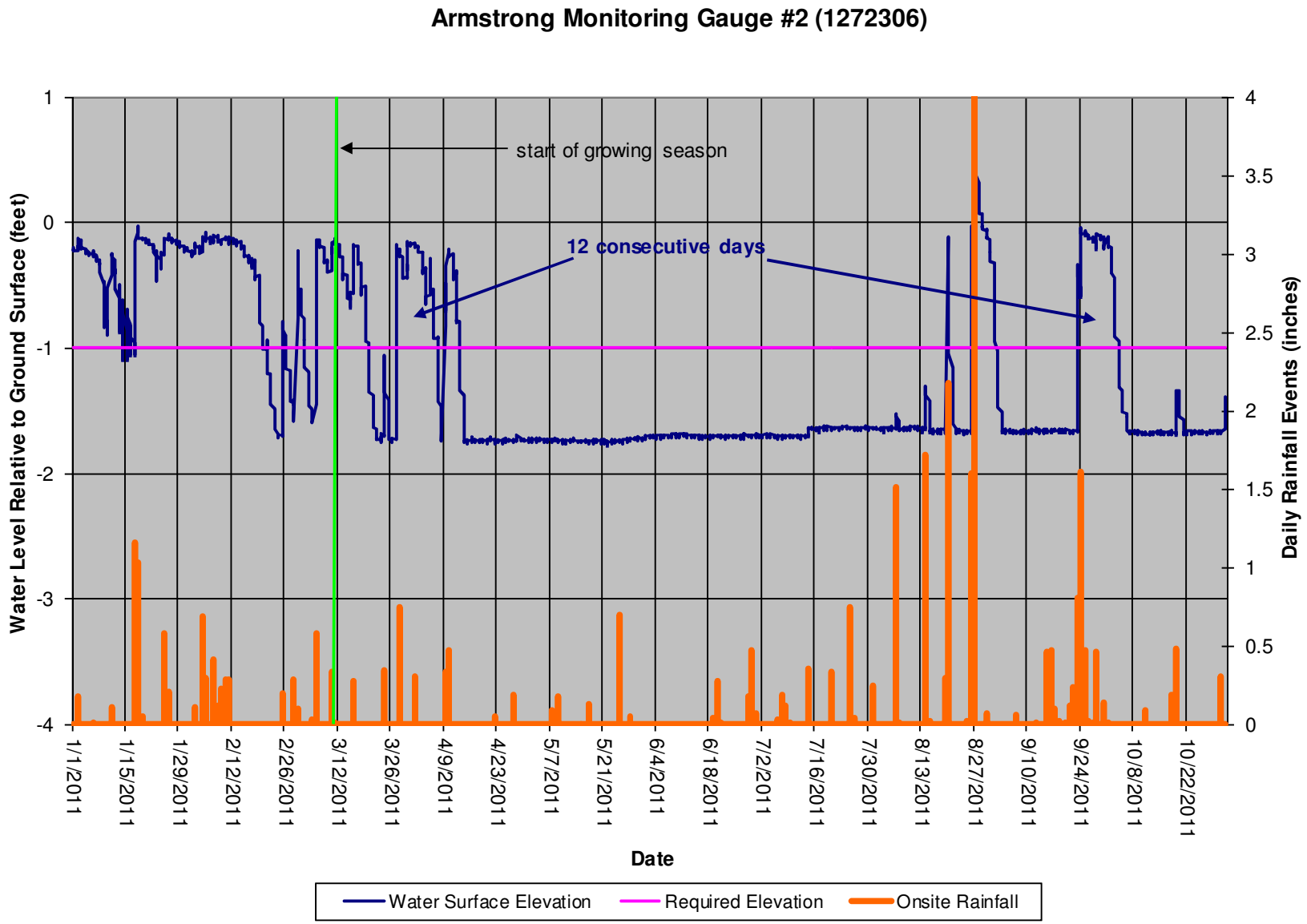
Geomorphologic Raw Data

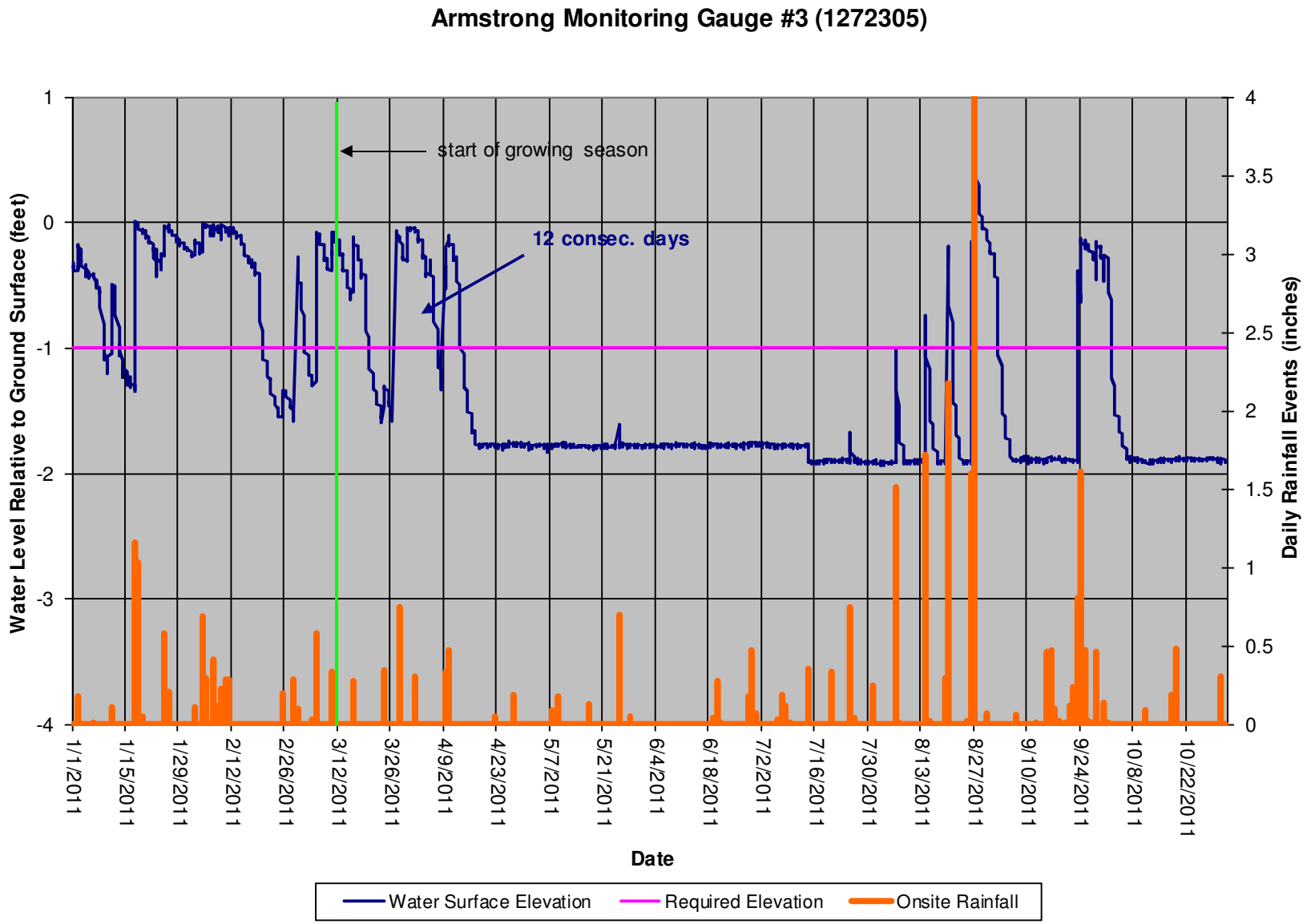
Not used in this report

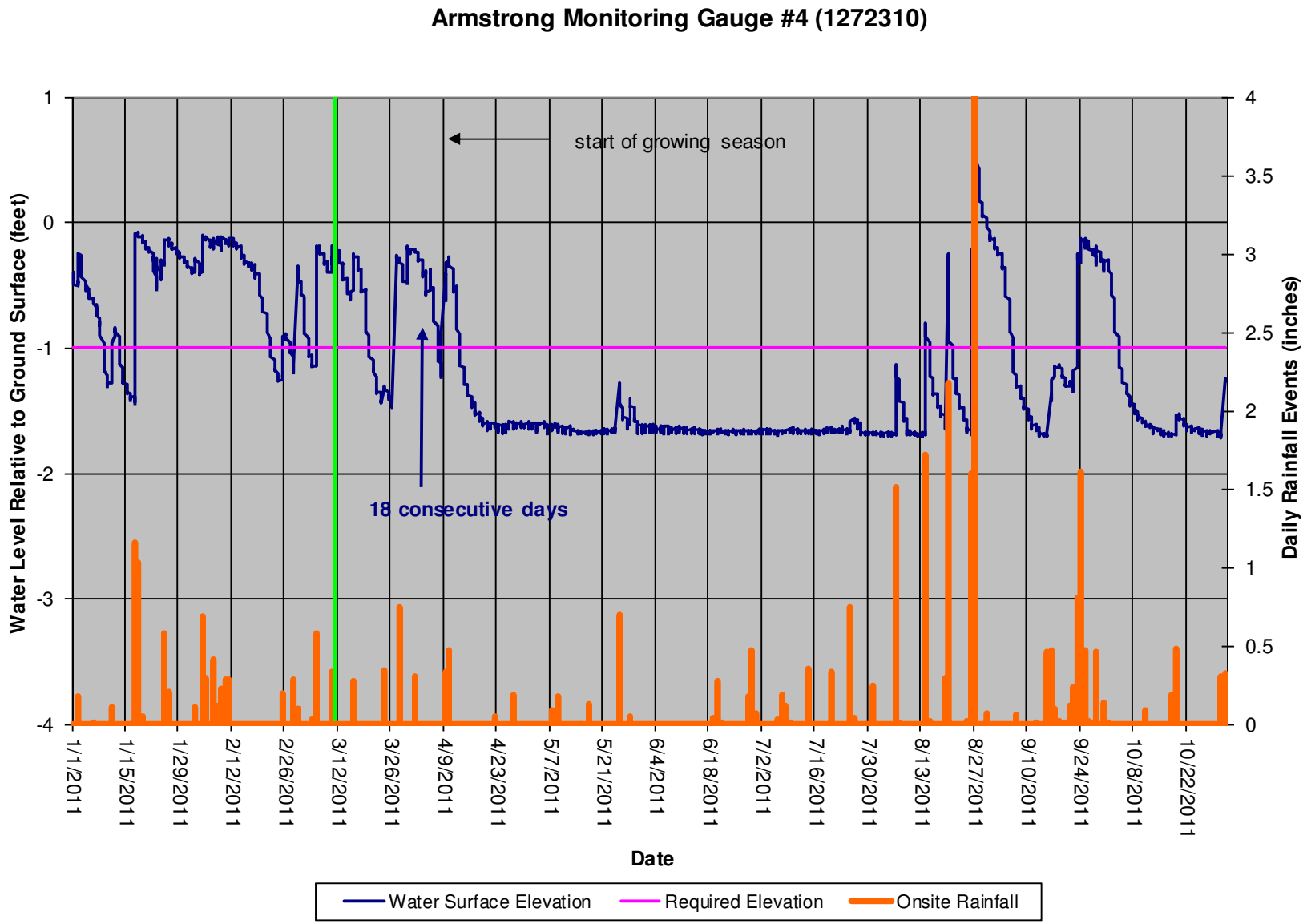
Appendix C

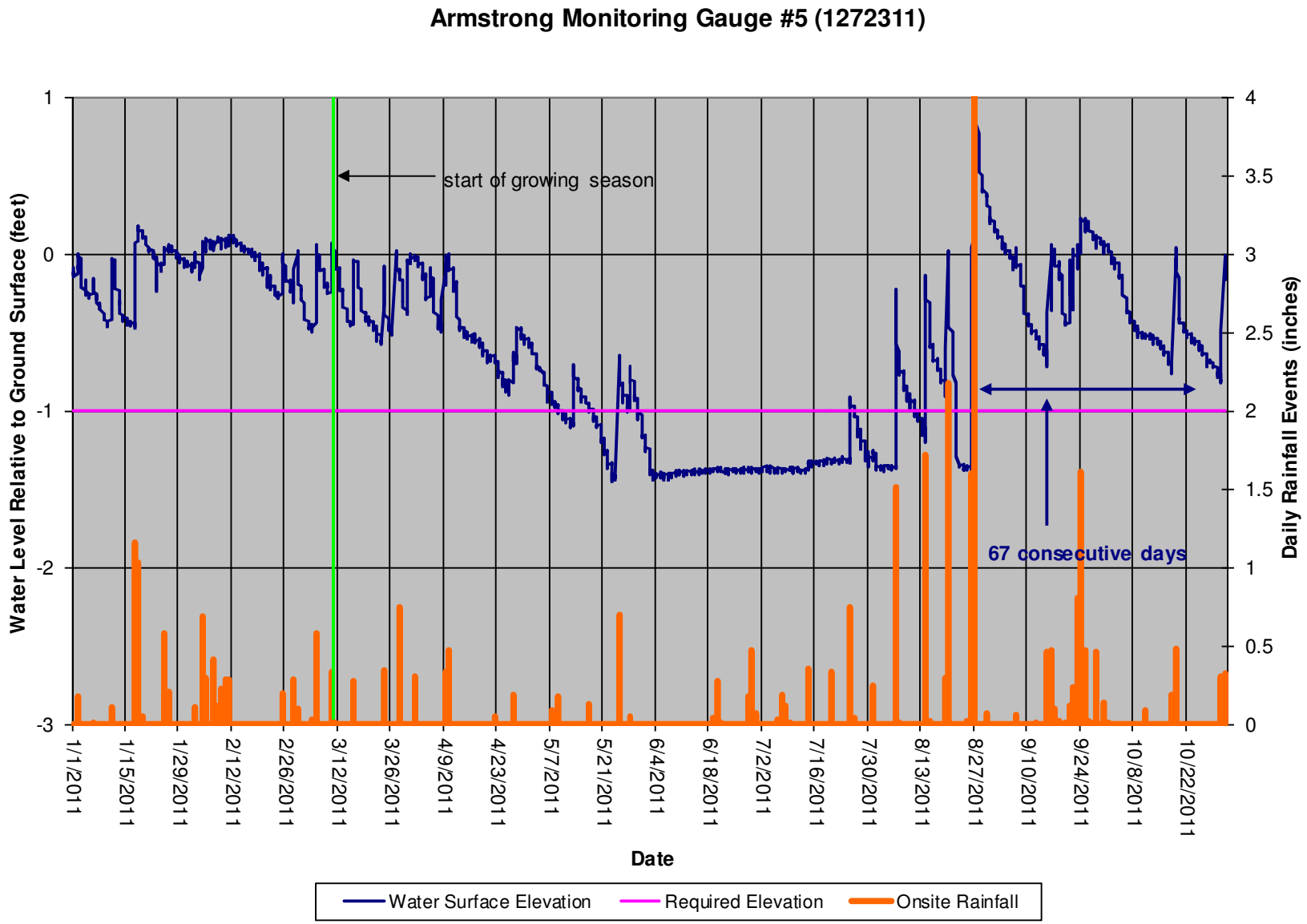
Hydrologic Data Tables

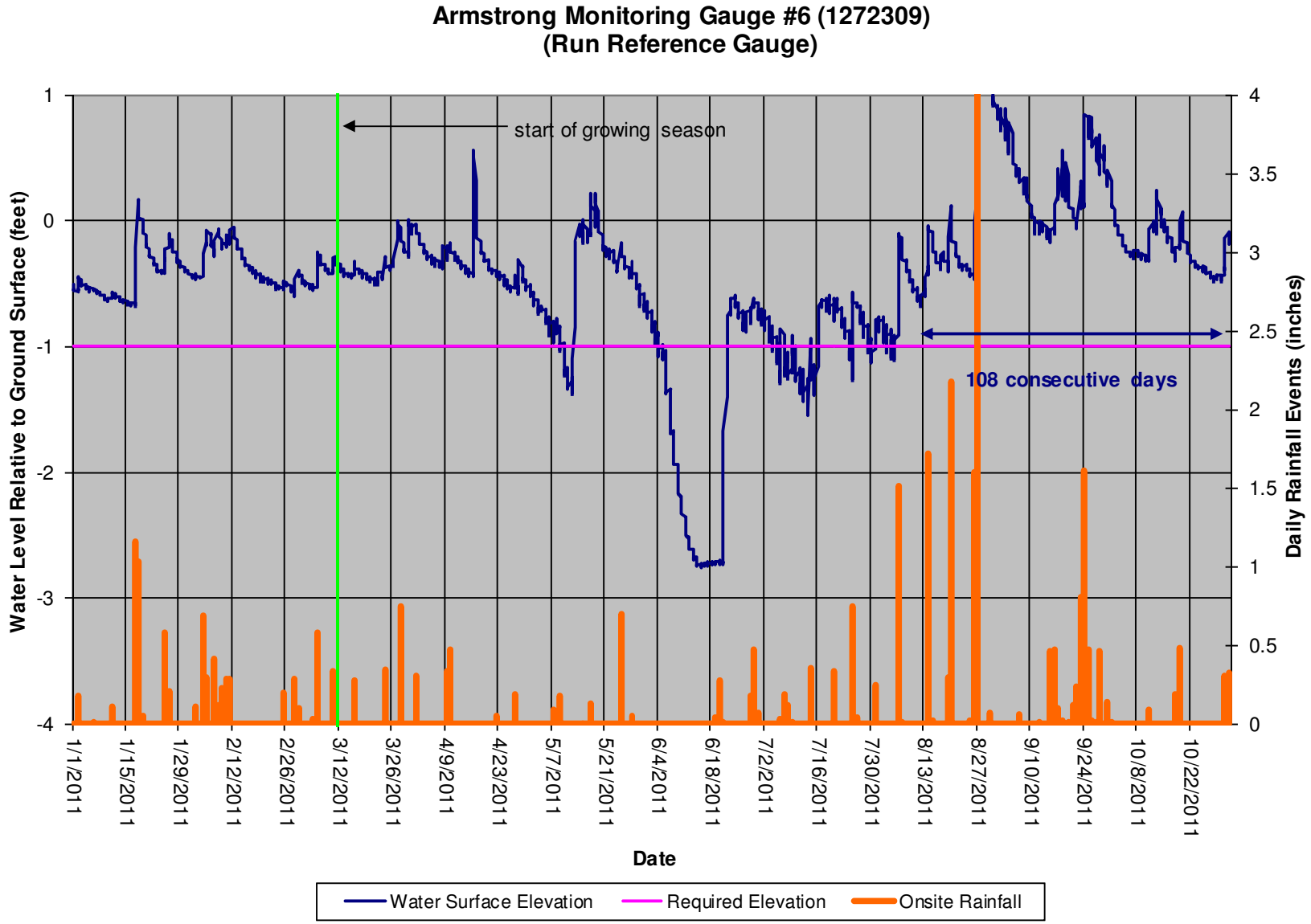

Armstrong Monitoring Gauge #1 (1126654)
start of growing season
14 consecutive days
19 consecutive days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2011
1/15/2011
1/29/2011
2/12/2011
2/26/2011
3/12/2011
3/26/2011
4/9/2011
4/23/2011
5/7/2011
5/21/2011
6/4/2011
6/18/2011
7/2/2011
7/16/2011
7/30/2011
8/13/2011
8/27/2011
9/10/2011
9/24/2011
10/8/2011
10/22/2011
Water Surface Elevation
Required Elevation
Onsite Rainfall

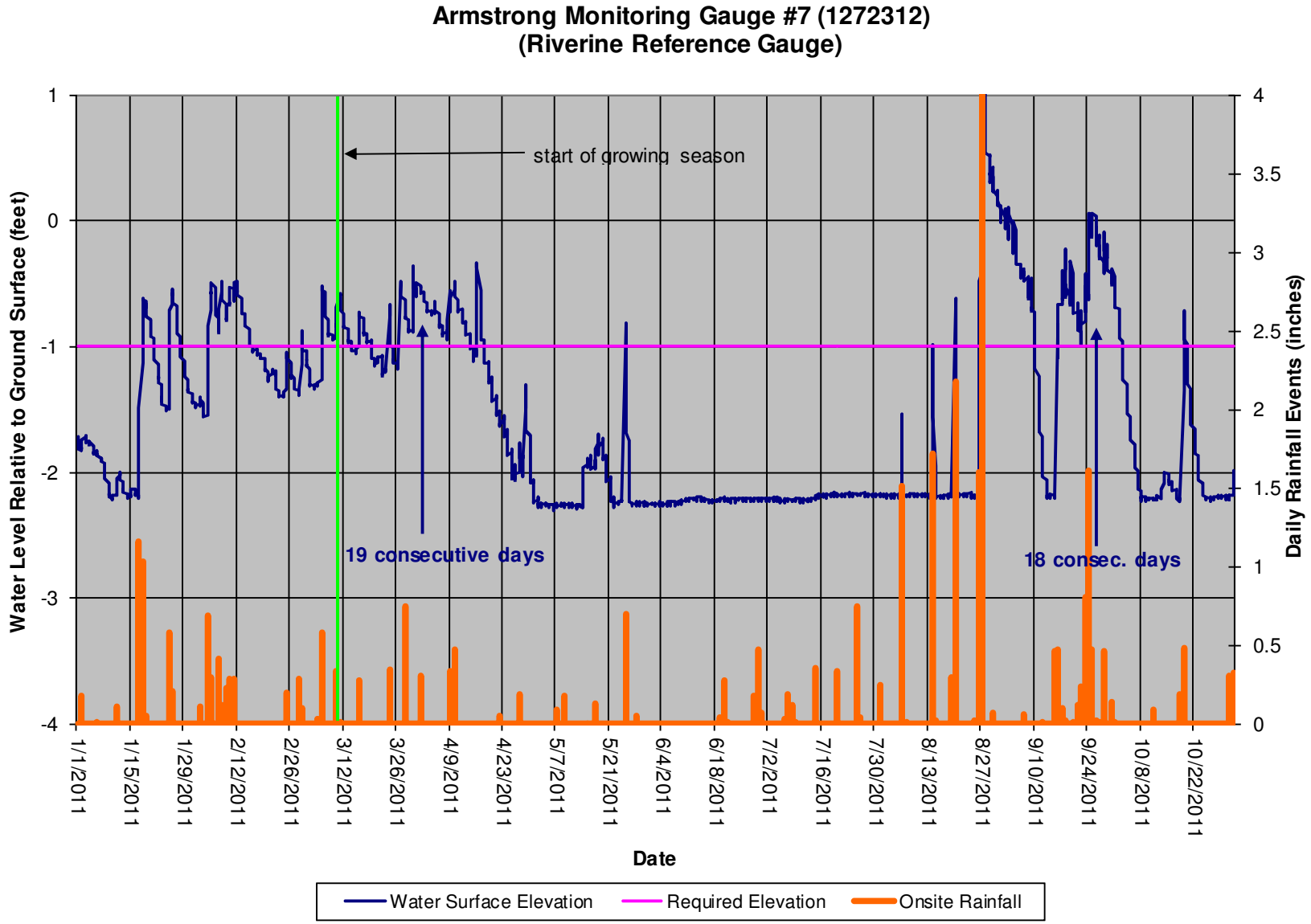

Armstrong Monitoring Gauge #2 (1272306)
start of growing season
12 consecutive days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2011
1/15/2011
1/29/2011
2/12/2011
2/26/2011
3/12/2011
3/26/2011
4/9/2011
4/23/2011
5/7/2011
5/21/2011
6/4/2011
6/18/2011
7/2/2011
7/16/2011
7/30/2011
8/13/2011
8/27/2011
9/10/2011
9/24/2011
10/8/2011
10/22/2011
Water Surface Elevation
Required Elevation
Onsite Rainfall

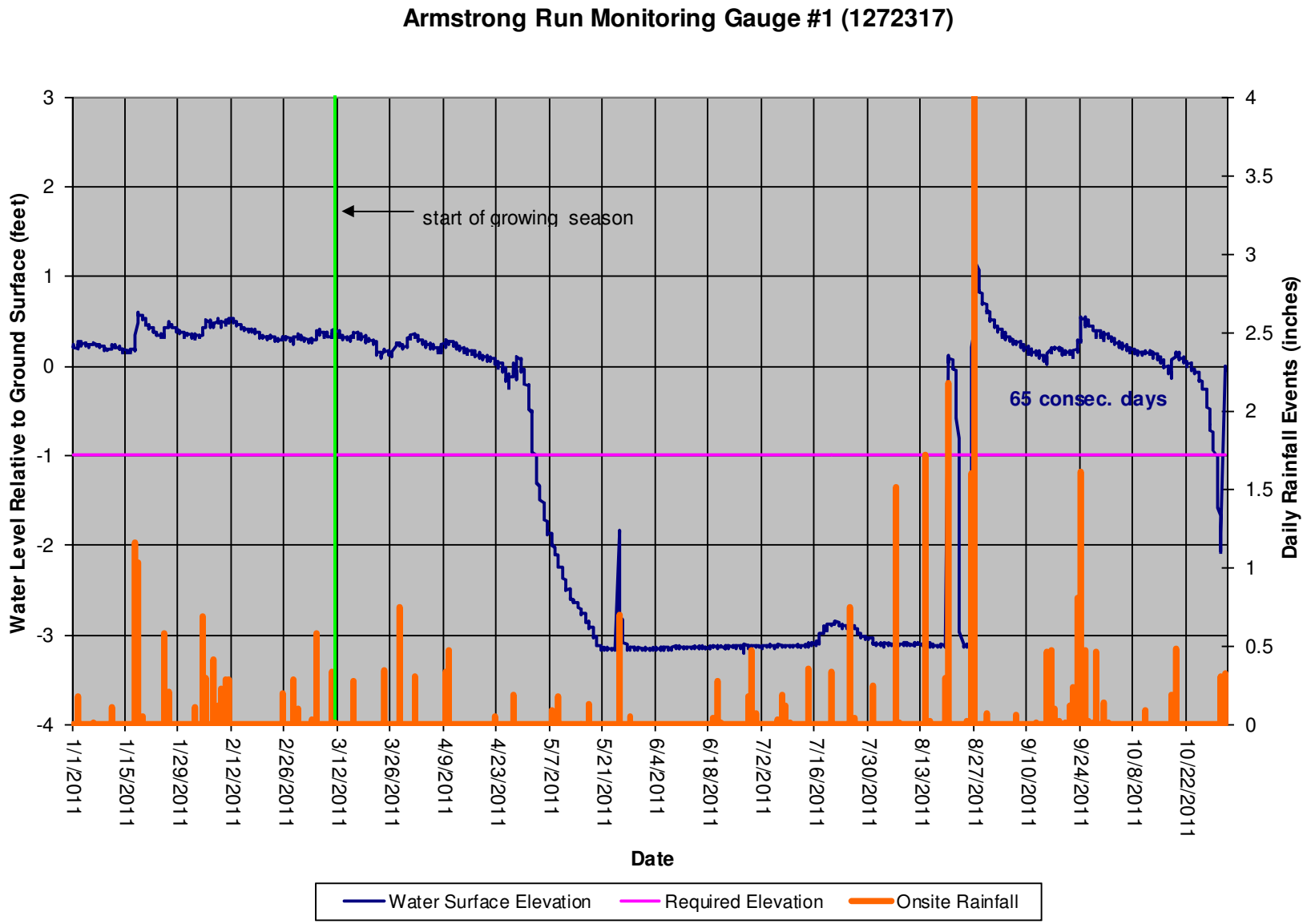

Armstrong Monitoring Gauge #3 (1272305)
start of growing season
12 consec. days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2011
1/15/2011
1/29/2011
2/12/2011
2/26/2011
3/12/2011
3/26/2011
4/9/2011
4/23/2011
5/7/2011
5/21/2011
6/4/2011
6/18/2011
7/2/2011
7/16/2011
7/30/2011
8/13/2011
8/27/2011
9/10/2011
9/24/2011
10/8/2011
10/22/2011
Water Surface Elevation
Required Elevation
Onsite Rainfall

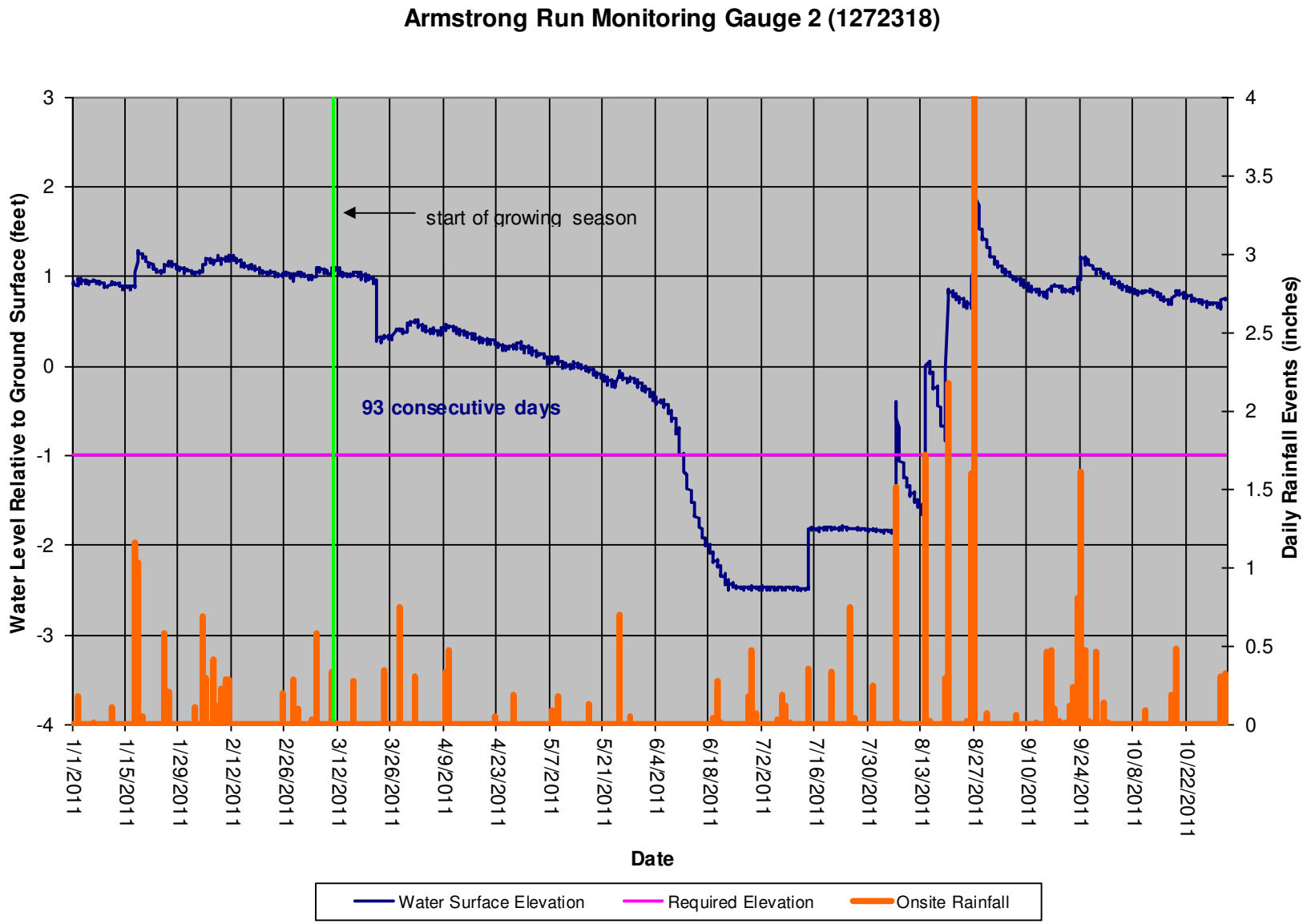

Armstrong Monitoring Gauge #4 (1272310)
start of growing season
18 consecutive days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2011
1/15/2011
1/29/2011
2/12/2011
2/26/2011
3/12/2011
3/26/2011
4/9/2011
4/23/2011
5/7/2011
5/21/2011
6/4/2011
6/18/2011
7/2/2011
7/16/2011
7/30/2011
8/13/2011
8/27/2011
9/10/2011
9/24/2011
10/8/2011
10/22/2011
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
67 consecutive days
1
0
-1
-2
-3
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2011
1/15/2011
1/29/2011
2/12/2011
2/26/2011
3/12/2011
3/26/2011
4/9/2011
4/23/2011
5/7/2011
5/21/2011
6/4/2011
6/18/2011
7/2/2011
7/16/2011
7/30/2011
8/13/2011
8/27/2011
9/10/2011
9/24/2011
10/8/2011
10/22/2011
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall


Armstrong Monitoring Gauge #6 (1272309)
(Run Reference Gauge)
start of growing season
108 consecutive days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2011
1/15/2011
1/29/2011
2/12/2011
2/26/2011
3/12/2011
3/26/2011
4/9/2011
4/23/2011
5/7/2011
5/21/2011
6/4/2011
6/18/2011
7/2/2011
7/16/2011
7/30/2011
8/13/2011
8/27/2011
9/10/2011
9/24/2011
10/8/2011
10/22/2011
Water Surface Elevation
Required Elevation
Onsite Rainfall

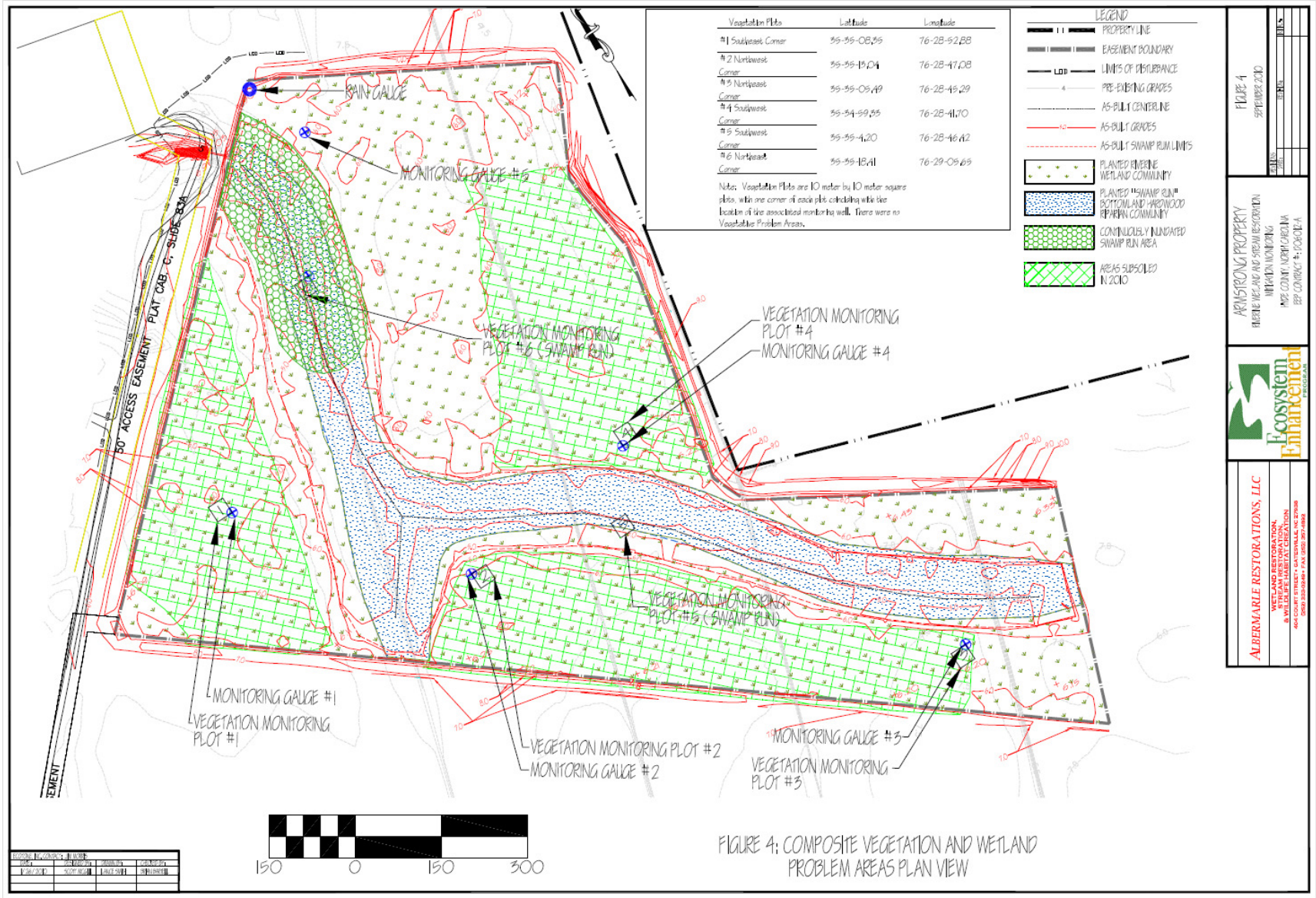

Armstrong Monitoring Gauge #7 (1272312)
(Riverine Reference Gauge)
start of growing season
19 consecutive days
18 consec. days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2011
1/15/2011
1/29/2011
2/12/2011
2/26/2011
3/12/2011
3/26/2011
4/9/2011
4/23/2011
5/7/2011
5/21/2011
6/4/2011
6/18/2011
7/2/2011
7/16/2011
7/30/2011
8/13/2011
8/27/2011
9/10/2011
9/24/2011
10/8/2011
10/22/2011
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
65 consec. days
Date
1/1/2011
1/15/2011
1/29/2011
2/12/2011
2/26/2011
3/12/2011
3/26/2011
4/9/2011
4/23/2011
5/7/2011
5/21/2011
6/4/2011
6/18/2011
7/2/2011
7/16/2011
7/30/2011
8/13/2011
8/27/2011
9/10/2011
9/24/2011
10/8/2011
10/22/2011
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
93 consecutive days
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall
3
2
1
0
-1
-2
-3
-4
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2011
1/15/2011
1/29/2011
2/12/2011
2/26/2011
3/12/2011
3/26/2011
4/9/2011
4/23/2011
5/7/2011
5/21/2011
6/4/2011
6/18/2011
7/2/2011
7/16/2011
7/30/2011
8/13/2011
8/27/2011
9/10/2011
9/24/2011
10/8/2011
10/22/2011

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	35-35-05.49	76-28-48.29
#4 Southwest Corner	35-34-59.35	76-28-41.70
#5 Southwest Corner	35-35-4.20	76-28-46.42
#6 Northeast Corner	35-35-18.41	76-29-05.65

Note: 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 STREAM RESTORATION
MITIGATION MONITORING
MOORE COUNTY, NORTH CAROLINA
EEP CONTRACT #: 003012-A

Ecosystem Enhancement PROGRAM

ALBERMARLE RESTORATIONS, LLC
WETLAND RESTORATION
STREAM RESTORATION
& WILDLIFE HABITAT CREATION
404 COURT STREET • GATESVILLE, NC 27938
(252) 357-0391 • FAX (252) 357-0392

ENGINEERING CONSTRUCTION NOTICE			
DATE	DESCRIPTION	DRAWN BY	CHECKED BY
9/24/2010	SCOPE MODIFICATION	LANCE SMITH	BEN HARRELL