Tarlton Stream and Wetland Restoration Project

Contract #:	D05013-1
County:	Cumberland
Cataloging Unit:	Cape Fear 03030004
Monitoring Firm POC:	Mid-Atlantic Mitigation, LLC Rich Mogensen (704) 782-4133 Kimley-Horn Associates, Inc. Will Wilhelm (704) 333-5131
Prepared For:	EEP Project Manager, Guy Pearce

Year 2 (2007) Monitoring Report

Kimley-Horn
and Associates, Inc.

Mid-Atlantic
Mitigation, LLC
AN EARTHMARK COMPANY

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1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

On behalf of the North Carolina Ecosystem Enhancement Program (NCEEP), Mid-Atlantic Mitigation, LLC (MAM) with technical assistance from Kimley-Horn and Associates (KHA) restored, enhanced and preserved 4,402 linear feet of stream, restored 6.6 acres of riverine wetlands and enhanced 2.7 acres of riverine wetlands. Construction of the project began in November 2005 with beaver dam removal and grade-control structure installation, continued into March 2006 with final planting completed in June 2006. The Tarlton Stream and Wetland Restoration Project (Project) will provide NCEEP with 3,930 Stream Mitigation Units (SMUs) and 8.0 Wetland Mitigation Units (WMUs).

The objective of the restoration approach is to plan, design, and construct a dynamically stable stream/riparian floodplain and bottomland hardwood riverine wetland community providing an ecological improvement for the entire site and watershed. This project is designed to provide a stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport the surface water and sediment load. Also, the Project aims to reestablish the primary stream and wetland functions associated with nutrient removal and transport, sediment retention, wildlife (both aquatic and terrestrial) habitat, and to provide restoration of riparian zones that have been historically an impounded lakebed. The restoration approach, due to the existing condition (fluctuating open water levels caused by Beaver activity) and varied historical conditions of the site (lake, dry lake bed, beaver impoundments, etc.), involved an “adaptive” management phased process.

The project was constructed in two phases. The restoration approach established a stable grade control stream section, which maintains the elevation of the entire stream thalweg and the floodplain by controlling the downstream end of the project area. The floodplain elevation below the dam was set by installing several rock-cross vanes and a constructed riffle to hold the grade of the existing lake bottom area which is now the floodplain area above the dam. This design provides both secondary water quality and primary flood storage benefits. The Project (both streams and wetlands) underwent a natural adjustment to a more stable aquatic ecosystem. The streams continued to re-establish natural channel function. This adaptive management approach allowed the streams to naturally seek equilibrium and appropriate dimension, pattern, and profile as the Project stabilizes. The primary restoration approach is to determine whether the stream adjustments trend towards the design criteria and restoration goals based on up-stream reference morphology and vegetation communities.

The riverine wetland and buffer vegetation community will transition as the system seeks hydrologic and biologic equilibrium. The sediments were unconsolidated and mucky with saturation. It was anticipated that settling and subsidence would occur throughout the initial growing season, first through evaporation and then through transpiration as the herbaceous cover (seeded and natural propagation) established. This did occur and continues to progress. Areas that were not saturated/ponded (i.e. fringe areas and/or

headwater wetlands) were intially planted with bare root seedlings and containerized plants to establish a bottomland hardwood riparian wetland community. Later as the site dewatered, thousands of containerized, bottomland hardwood trees & shrubs were planted throughout the stream and wetland areas.

The stream(s) will be monitored for stability of dimension, pattern, and profile using standard practices including permanent cross sections, riffle-run-pool analysis, and pebble counts. Wetland hydrology and vegetation success will be monitored using self-reading ground water monitoring gages and standardized, randomly placed permanent vegetation plots which will be monitored for species diversity and survival. Monitoring data will be analyzed to determine what remedial actions if any are required and any remedial actions proposed will be detailed in the annual monitoring reports.

The second year monitoring was performed on October 16th, 2007, and completed on November 19th and 20th. There is some active channel evolution and adjustment occurring in the mid to upper reaches on both stream channels. This will be monitored closely and MAM has done some low-intrusive hand channel work. This minor channel work is documented in this monitoring report. The vegetation in all of the plots currently meets and/or exceeds the requirements.

2.0 PROJECT BACKGROUND

2.1 LOCATION AND SETTING

The Project is located in the City of Fayetteville, Cumberland County, North Carolina on the corner of Clearwater Drive and US 401 Bypass (Country Club Drive). A location map is included in Figure 1. The project site is located in the Upper Cape Fear River Watershed (USGS 8-digit Hydrologic Unit 03030004, and NCDWQ River Basin 03-06-15), and is within the NC Ecosystem Enhancement Program (EEP) Cross Creek Targeted Local Watershed (00050). The project site was historically impounded by a dam built in the 1970s, creating Country Club Lake by impounding about 4,500 feet of two perennial prongs of a tributary to Cross Creek. The project drainage area is approximately 2.6 sq. mi. flowing into Cross Creek, a 303(d)-listed stream for impaired biological activity. The eastern prong of the project which is named UT to Cross Creek East has a drainage area of 1.0 square miles. The western prong named UT to Cross Creek West has a drainage area of 1.6 square miles. The project area conservation easement consists of 17.8 acres. The restoration project is being managed and monitored by Mid-Atlantic Mitigation, LLC but the property is owned by the Greg and Patricia Tarlton and the conservation easement is held by the State of North Carolina.

2.2 STRUCTURE AND OBJECTIVES

The goals and objectives of the Project are to restore a naturally stable stream and riparian wetland community; to restore a bottomland hardwood wetland community; and to provide stormwater management for downstream development. In addition, water quality will be improved, flood storage will be increased, wildlife and aquatic habitat will be restored and the threat of flooding of downstream areas will be significantly reduced.

Phase I (completed Fall 2005): A beaver management plan was implemented to remove all the beavers from the project site. The removal of the old dam debris and spillway was completed in November and December 2005 making it more difficult for the beavers to re-establish a dam at its existing location. A beaver control program which includes regular site visits to the former dam area has been implemented and will continue throughout the monitoring period. In mid-November 2005, the lake water level was lowered over a 3-5 day period slowly releasing the water downstream to prevent flooding and erosion. In conjunction with removing the beaver dams, the stream section through the area of the historical dam and beaver dams was restored. The channel in this section (approximately 175 feet) was restored using a Priority I (Rosgen) restoration approach. The stream restoration included establishing a bankfull channel and active floodway through the relic spillway/dam and providing a variety of in-stream structures (rock vanes, constructed riffle, and step pool structures) to provide grade control, stability, and improve aquatic habitat diversity. The natural channel design was based on the upstream reference reach. The restoration project was transitioned through and under an existing aerial sanitary sewer crossing that is just beyond the easement limit. In addition to the stream restoration, a BMP (level spreader / pre-formed scour hole) was constructed in this area at the outlet of a stormwater drainage pipe. This restoration establishes a stable grade control, which maintains the elevation of the entire stream thalweg and the floodplain by controlling downstream end of the project area. The floodplain elevation below the dam was set to hold the grade of the existing lake bottom which is now the floodplain area above the dam. This also prevented any sediment that was in the old lake from being washed downstream and to provide a natural “pinch-point” corresponding with existing topography. This pinch-point will help re-establish and control natural hydrology in the proposed riparian wetland during events above bankfull and act as a large detention area.

Phase II (completed in July 2006): Once the beavers, beaver dams, and impounded water were removed, and the downstream grade control established, the Project (both streams and wetlands) underwent a natural adjustment to a more stable aquatic ecosystem. The stream segments found their hydrologic equilibrium and re-established bed and bank features. In addition, the site soils gradually dewatered allowing the deposited sediments to consolidate and subside. During the first growing season the Project soils stabilized through evapotranspiration and subsidence processes. The streams continued to re-establish natural channel function, and were evaluated for necessary adjustments. This adaptive management approach allowed the streams to naturally seek equilibrium and appropriate dimension, pattern, and profile as compared to the upstream reference reach. The primary restoration approach is to determine whether the stream adjustments trend

towards the design criteria and restoration goals based on reference morphology and vegetation communities. The eastern and western prongs are designed as Rosgen C5->E5 channels. During each monitoring year, where the channel slope and/or dimension are found to be unstable, structures such as rock cross vanes, log cross vanes, log vanes, log sills, and constructed riffles may be utilized to help maintain the channel compared to the reference morphology.

The riparian wetland and buffer vegetation community will transition and stabilize as the system seeks hydrologic equilibrium. The initial planting/seeding of the site was completed in March-April 2006 to establish herbaceous cover of exposed bare soils with the expectation that the initial growing season would allow for evapotranspiration to dewater lake bottom sediments. These sediments were initially unconsolidated and mucky with saturation. It was anticipated that settling and subsidence would occur throughout the initial growing season, first through evaporation and then through transpiration as the herbaceous cover (seeded and natural propagation) established. This has occurred as proposed. Areas that are not saturated/ponded (i.e. fringe areas and/or headwater wetlands) were planted with bare root seedlings and containerized plants to establish a bottomland hardwood riparian wetland community. Additional plantings may occur as needed, as the site continues to consolidate and settle.

In order to stabilize the newly constructed stream channel and flood plain areas both temporary and permanent grass seed as well as wetland herbaceous seed were applied to all restored areas. The types of seeds used were: *Leersia oryzoides* (Rice Cut grass); *Panicum clandestinum* (Deertongue grass); *Panicum virgatum* (Switchgrass): *Trisacum dactyloides* (Gama grass), and *Secale cereale* (Annual rye). Also, a Southeast Wildflower mix was applied throughout the project. Five hardwood planting zones were established as follows: Zone 1 – Stream Channel, Zone 2- Stream Bank, Zone 3 – Bottomland Hardwood wetland, Zone 4 – Swamp Wetland, and Zone 5- Upland fringe. Livestakes were installed along the newly constructed channel (approx. 175') within Zone 2. They were planted randomly spaced approximately 3 feet apart and differed in sizes ranging from .25" to 2" in diameter and 2' to 3' in length. Further livestaking may be necessary as the new stream channels stabilize. Zone 3 –5 consists of bareroot seedlings and 1 gallon containerized plants, which were planted randomly 3' to 12' apart throughout the project.

Table I. Project Mitigation Structure and Objectives Table

Project Segment	Mitigation Type	Approach	Linear Footage or Acerage	Stationing	Comment
Stream W Prong	P	-	341	10 + 00 - 14 + 00	Western Prong as it enters the site
Stream W Prong	E1		596	14 + 00 - 19 + 00	Western Prong between Preservation Area and Restoration Area
Stream	R	P1	3465		Remainder of Site is Restoration (88%)
Wetland	R	-	6.6		Project is 83% restoration
Wetland	E	-	2.7		Stream Enhancement Area is bordered by Wetland Enhancement, Several other enhancement areas exist

Table II. Project Activity and Reporting History

Activity or Report	Calendar Year of Completion or Planned Completion	Actual Completion Date
Restoration Plan	October 2005	March 2006
Construction	October 2006	March 2006
Temporary /Permanent seeding	October 2006	March 2006
Bareroot Plantings	November 2006	March 2006
Containerized Plantings	November 2006	June 2006
Mitigation Plan	December 2006	August 2006
Year 1 Monitoring	December 2007	October 2006
Year 2 Monitoring	December 2008	December 2007
Year 3 Monitoring	December 2009	
Year 4 Monitoring	December 2010	
Year 5 Monitoring	December 2011	

Table III. Project Contacts

Project Manager Mid-Atlantic Mitigation, LLC	1960 Derita Road Concord, NC 28027 Rich Mogensen (704) 782-4133
Designer Kimley-Horn and Associates Inc.	4651 Charlotte Park Dr Suite 300 Charlotte, NC 28217 Will Wilhelm (704) 333-5131
Construction Contractor Earthwork Inc.	343 Chapman Drive Sanford, NC 27330 Dan Wood (919) 718-6812
Planting & Seeding Contractor Carolina Silvics Seed mixes provided by IKEX Nursery Stock provided by Native Roots Nursery (Formerly Southern Shade)	908 Indian Trail Road Edenton, North Carolina 27932 Dwight McKinney (252) 482-8491
Monitoring Performers Mid-Atlantic Mitigation, LLC	1960 Derita Road Concord, North Carolina 28027 Christine Cook (704) 782-4140

Table IV. Project Background

Project Background Table	
Project County	Cumberland
Drainage Area	2.6 square miles
Drainage Cover Estimate (%)	10%
Physiographic Region	Coastal Plain
Ecoregion	45a Southern Inner Piedmont
Wetland Type	Palustrine, Forested, Broad-leaved Deciduous
Cowardin Classification	PFO1Fh
Dominant soil types	Johnston Loam
Reference site ID	UT to Cross Creek
USGS HUC for Project and Reference	03030004
NCDWQ Sub-basin for Project and Reference	03-06-15
% of project easement fenced	0 – Urban site surrounded by private residence

3.0 PROJECT CONDITION AND MONITORING RESULTS

3.1 VEGETATION ASSESSMENT

3.1.1 Soil Data

Table V. Preliminary Soil Data

Series	Max Depth (in)	% Clay on Surface	K	T	OM %
Johnston Loam	80	25 - 49	.20 - .17	5	3 - 8

3.1.2 Vegetative Problem Areas

At this time, no vegetative problem areas have been noted or invasive species problems. The site has been stabilized and vegetated with native woody and herbaceous species.

3.1.3 Stem Counts

Zones 1 – 3 of the five planting zones were sampled in three 75 ft by 75 ft plots. The prevalent vegetation should consist of macrophytes that typically are adapted for life in saturated soil conditions. These species should have the ability to grow, compete, reproduce, and persist in anaerobic soil conditions. A reduction in the percentage of nuisance vegetation in wetlands areas with existing vegetation to less than 15% will indicate enhancement of wetland vegetation. For the restoration areas, study plots showing that the composition and density of vegetation in the restoration areas that compares closely to the reference areas will indicate restoration success for vegetation. The initial success of riparian and wetland vegetation planting will be evaluated based on herbaceous cover as the site is stabilized in the initial growing season. After the year-two growing season, success will be gauged by stem counts of planted species and desirable volunteer species. Stem counts of over 320 trees per acre after 3 years, 288 trees per acre after 4 years, and 260 trees per acre after 5 year will be considered successful. Photos taken at established photo points should indicate maturation of riparian vegetation community.

On October 16, 2007, the second year-vegetative monitoring was performed on the established vegetative plots.

Exhibit Table VI: Stem Counts for Each Species Arranged by Plot							
Species	Plots			Initial Totals	Year 1 Totals	Year 2 Totals	Survival %
	1	2	3				
Betula nigra	3	12		18	18	15	83
Chamaecyparis thyoides				8	2		
Cornus ammomum		1	1	10	9	2	20
Fraxinus pennsylvanica	27		16	35	35	43	100
Liriodendron tulipifera				1			
Nyssa aquatica	5	3		6	6	8	100
Nyssa biflora	6			8	8	6	75
Nyssa slyvantica	5	4	1	10	10	10	100
Quercus nigra				2			
Quercus phellos			1	1	1	1	100
Quercus shumardii				1	1		
Taxodium distichium	8	10	6	25	21	24	96
Totals	**54**	**30**	**25**	**125**	**111**	**109**	**87%**

3.1.4 Vegetation Assessment Summary

Vegetation success will be defined as tree survival to meet 320 stems per acre after 3 years and 260 stems per acre after 5 years inside the permanent vegetative plots and herbaceous cover evaluated with photos showing 75% coverage, after 5 years.

All three plots showed excellent survival. There was really no significant change in counts from Year 1, except for a large colony of Alders taking root in Plot 3, this dense community is typical of Alders and will be managed and thinned to a manageable number of individuals, approximately 10 to 15. Based on sampling, the site as a whole shows an average of 281 stems per acre of planted stems and 319 stems per acre when healthy, desirable volunteers are included, only 5 Alder individuals were used in this calculation. The site demonstrates 87 percent survival of planted stems. The community is diverse and rich with healthy volunteers. Using the adaptive management approach for this site; the contribution of healthy, desirable volunteers will be considered before any decisions are made on additional plantings. This site was not over planted during initial planting as would typically be done due to a predicted high rate of colonization of desirable volunteer species. Due to the planted stem count being below the 3 year goal of 320 stems and the contribution of desirable volunteers being barely enough to meet this goal with year 3 sampling yet to be done, MAM plans to do a small supplemental planting of 100 to 200 bare roots this winter.

In Appendix A, the vegetative survey data tables show the actual counts of each species found per plot, severely stressed but not dead plants were noted. The herbaceous cover plant community was monitored in a 1 m by 1 m square at one corner of each plot. Each herbaceous quadrant showed at least 75% cover and all were or at close to 100%.

3.2 CHANNEL STABILITY ASSESSMENT

3.2.1 Cross Sections

The site has shown no significant change since as-built documents were submitted. The Cross Section plots are located in Appendix B. A small problem area where there appears to be some minor settling occurring on the left bank of the run between Cross Sections 1 and 2 continues to exist. This area was smoothed back and live staked however the patch work did not survive the subsequent bank full events. This area comprises less then 1% of the total length of the project and MAM may attempt to repair this area again, however for this monitoring year the area will be monitored to insure that it doesn't get worse. This area is documented in the Problem Areas Photo Log in Appendix D. This cross section was built as a constructed riffle using stone debris from the removal of the dam. The stream bank sub-surfaces and stream bed were formed with some stone debris. The banks were graded to the typical designed cross sections. The stream bed is made of stone to stabilize the riffle and to increase bed form diversity/ habitat of the riffle for this section as well as acting as grade control. The stream channels at Cross Sections 3 through 10 are less defined then Cross Sections 1 and 2. MAM and KHA tried to select deep still areas for pools and chose shallower areas of swift running water for the riffle cross sections.

3.2.2 Bank Full Events

The upstream reference gage recorded two major peaks during the period of February 6th to October 16th, 2007 these correspond with rain events in June and September. There was also a significant bank full event the week of Christmas 2006 however that data is not included due to a change in responsibility for the downloading of the gages from KHA to MAM, at which point the gages were reprogrammed, this data is also outside of the growing season. That bank full event was the first to produce true visual signs of a bank full event (vegetation damage, rack lines, waterlines) throughout the site and is well documented in the Bank Full Event Photo Log in Appendix E. The crest stage gage at the lower end of the site registered the two recorded events and photo documentation of these events is also included in the Bank Full Event Photo Log. Rain fall and stream gage data is presented in table form also in Appendix E.

3.2.3 Longitudinal Profiles

There is currently only one constructed riffle on the project, which is located at the site of the original dam and corresponds with Cross Section 2. This riffle was constructed with large cobbles and small boulders found on site. A pebble count was done in 2006 which demonstrates the substantial size of the bed material, and was not repeated in 2007. There is currently no smaller bed material present and only a small representative sample was taken in 2006. The site has shown no significant change since as-built documents were submitted. Currently, the site is in a very early stage of development and MAM will be watching and remediating the stream work as needed through out the next year. While several obvious pools (shown on the profile graphs in Appendix C) have formed, very

little definition in the riffle areas has been observed. Although in low-gradient coastal plain systems the current stream morphology is common and stable. During the 2007 monitoring year, two areas were observed where stream pattern and profile needed minor work as noted in the 2006 monitoring report these actions are documented in the Problem areas Photo Log in Appendix D. 1) A remnant beaver dam near Station 45+00 was removed to allow more natural stream flow through that area. 2) A log structure was installed at station 17+00 to divert water into the main channel and away from a small overflow channel to reduce the braided nature of the stream in the enhancement area. The main structure at the end of the site, station 36+00 has settled slightly but looks to be in good condition. Photos of this area and structure are also included in the Problem area Photo Log.

3.2.4 Wetland Assessment

Seven ground water gages are distributed around the project along with one reference gage off site, but not far upstream on the Western Prong. Graphs showing the 2007 data have been prepared and are included in AppendixE. Gage CC2 showed spotty, borderline hydrology and was the only gage on site not to indicate unquestionable jurisdictional hydrology this spring prior to onset of drought conditions. It was predicted that some areas of the site would become dryer as the site reaches hydrologic equilibrium. Gage CC2 is the southern most gage situated near the confluence of the Western and Eastern Prongs and where the slope of the site increases as it flows offsite and is therefore the most well drained of all the gages.

3.2.5 Site Stability Assessment Summary

Overall, the stream channel has developed and stabilized well. The herbaceous vegetative cover has also developed a healthy and diverse community. The planted trees and shrubs have also done very well and are supplemented by a robust existing buffer community which provides seed source for volunteers well suited to the current site conditions. Ground water wells demonstrate favorable trends and jurisdictional wetland hydrology. There are two areas that have been repaired in 2007 that will be monitored closely in 2008, between cross sections 1 and 2, and in the enhancement area at station 17+00. Some beaver activity has also been observed above cross section 2 and in this general area. A small beaver dam was removed in October and was not rebuilt. If beaver become a problem on site they will be relocated appropriately.

APPENDIX A: Vegetation Raw Data

Species	Plots			Initial Totals	Year 1 Totals	Year 2 Totals	Survival %
	1	2	3				
Betula nigra	3	12		18	18	15	83
Chamaecyparis thyoides				8	2		
Cornus ammomum		1	1	10	9	2	20
Fraxinus pennsylvanica	27		16	35	35	43	100
Liriodendron tulipifera				1			
Nyssa aquatica	5	3		6	6	8	100
Nyssa biflora	6			8	8	6	75
Nyssa slyvantica	5	4	1	10	10	10	100
Quercus nigra				2			
Quercus phellos			1	1	1	1	100
Quercus shumardii				1	1		
Taxodium distichium	8	10	6	25	21	24	96
Totals	**54**	**30**	**25**	**125**	**111**	**109**	**87%**

Stems per Acre

109 / 16875 = 281 / 43560

Plot 1	54	418	spa
Plot 2	30	232	spa
Plot 3	25	194	spa
	109	844	
		3	= 281

Stems per Acre w/ Voluteers

Plot 1	55	425	spa
Plot 2	36	278	spa
Plot 3	33	255	spa
	124	958	
		3	= 319

Tarlton- Vegetation plot #1						
	Number of Planted Species/Number of Volunteers					
Trees/ Shrubs	**2006**	**2007**	**2008**	**2009**	**2010**	
Alnus serrulata	/3	/1				100 % Volunteers
Betula nigra	5	3				
Cephalanthus occidentalis	/1					100% Volunteers
Chamaecyparis thyoides	1					
Cornus amomum	4					
Fraxinus pennsylvanica	20	27				
Liriodendron tulipifera						
Nyssa aquatica	5	5				
Nyssa biflora	6	6				
Nyssa slyvantica	5	5				
Quercus falcata var. pagodafolia						
Quercus michauxii						
Quercus nigra						
Quercus phellos						
Quercus shumardii						
Taxodium distichium	7	8				
Total Planted	**53**	**54**				
Voluteers	**4**	**1**				

Plot Size: 5625 ft²

Herbacous Vegetation	**2006**	**2007**	**2008**	**2009**	**2010**
Juncus spp.	Dominant	Dominant			
Polygonum* spp. *(tearthumb)	Sub dominant				
Eupatorium capillifolium	Common				

Stems/plot	=	Stems/ac
Sq ft/plot		Sq ft/acre
54		418
5625		43560

Tarlton- Vegetation plot # 2					
Trees/ Shrubs	**Number of Species planted/Number of Volunteers**				
	2006	**2007**	**2008**	**2009**	**2010**
Alnus serrulata					
Betula nigra	12	12/4			
Cephalanthus occidentalis	/2				
Chamaecyparis thyoides	1				
Cornus amomum	1	1/2			
Fraxinus pennsylvanica	1				
Liriodendron tulipifera					
Nyssa aquatica	1	3			
Nyssa biflora					
Nyssa slyvantica	4	4			
Quercus falcata var. pagodafolia					
Quercus michauxii					
Quercus nigra					
Quercus phellos					
Quercus shumardii					
Taxodium distichium	8	10			
Total Planted	**28**	**30**			
Volunteers	**2**	**6**			

100 % Volunteers

Plot Size: 5625 ft²

Herbacous Vegetation	**2006**	**2007**	**2008**	**2009**	**2010**
Eupatorium capillifolium	Sparse				
***Juncus* spp.**	Dominant				
panicum clandestinum	Common				
polygonum pensylvanicum	Dominant				
polygonum spp. (smartweed)	Common	Common			
Polygonum* spp. *(tearthumb)	Common	Common			
sedge sp.	Sparse				

Stems/plot	=	Stems/ac
Sq ft/plot		Sq ft/acre
30		232
5625		43560

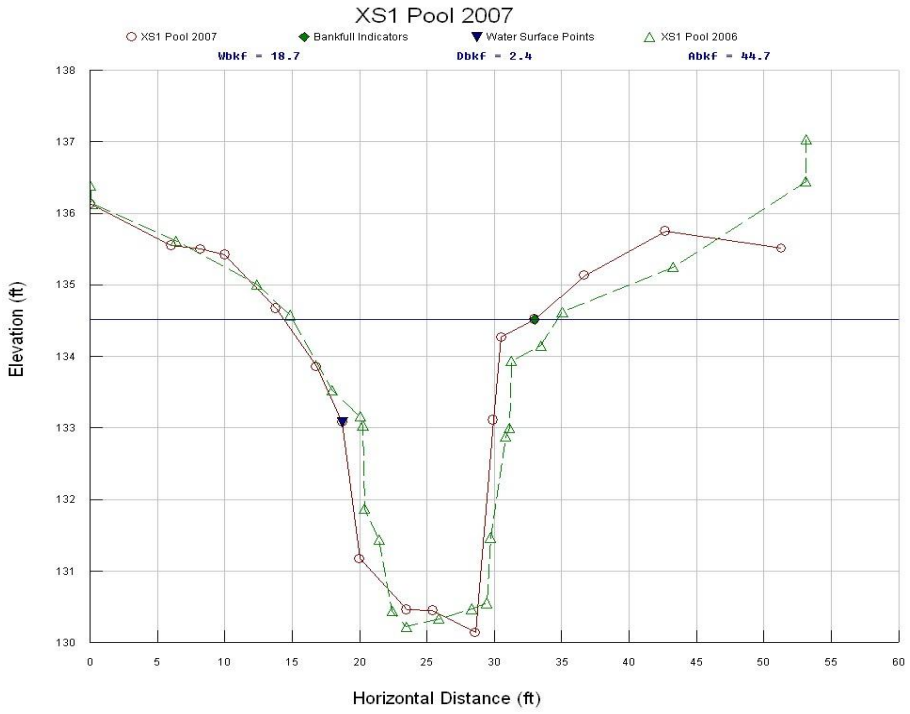
Tarlton- Vegetation plot # 3						
Trees/ Shrubs	**Number of Species planted/Number of Volunteers**					
	2006	**2007**	**2008**	**2009**	**2010**	
Alnus serrulata	/5	/5				100 % Volunteers
Betula nigra	1					
Cephalanthus occidentalis		/1				100 % Volunteers
Chamaecyparis thyoides						
Cornus amomum	4	1				
Fraxinus pennsylvanica	14- (2 Stressed)	16				
Liriodendron tulipifera						
Nyssa aquatica						
Nyssa biflora	2					
Nyssa slyvantica	1	1				
Platanus occidentalis		/1				100 % Volunteers
Quercus falcata var. pagodafolia						
Quercus michauxii						
Quercus nigra						
Quercus phellos	1	1				
Quercus shumardii	1					
Salix nigra	/1	/1				100 % Volunteers
Taxodium distichium	6	6				
Total Planted	**30**	**25**				
Volunteers	**6**	**8**				

Plot Size: 5625 ft²

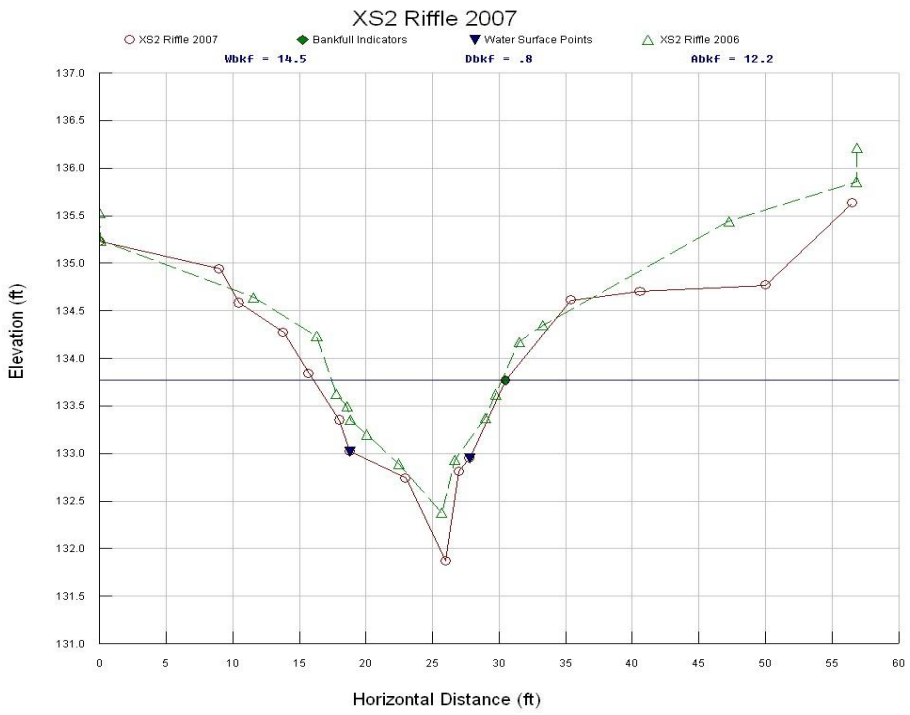
Herbacous Vegetation	**2006**	**2007**	**2008**	**2009**	**2010**
Eupatorium capillifolium	Dominant				
Juncus spp.	Dominant	Dominant			
Lycopus virginicus	Sparse				
Mikania scandens	Sparse				
Polygonum spp. (tearthumb)	Dominant	Dominant			
unidentified	Sparse				

Stems/plot	=	Stems/ac
Sq ft/plot		Sq ft/acre
25		194
5625		43560
109		281
16875		43560

APPENDIX B: Cross Sections



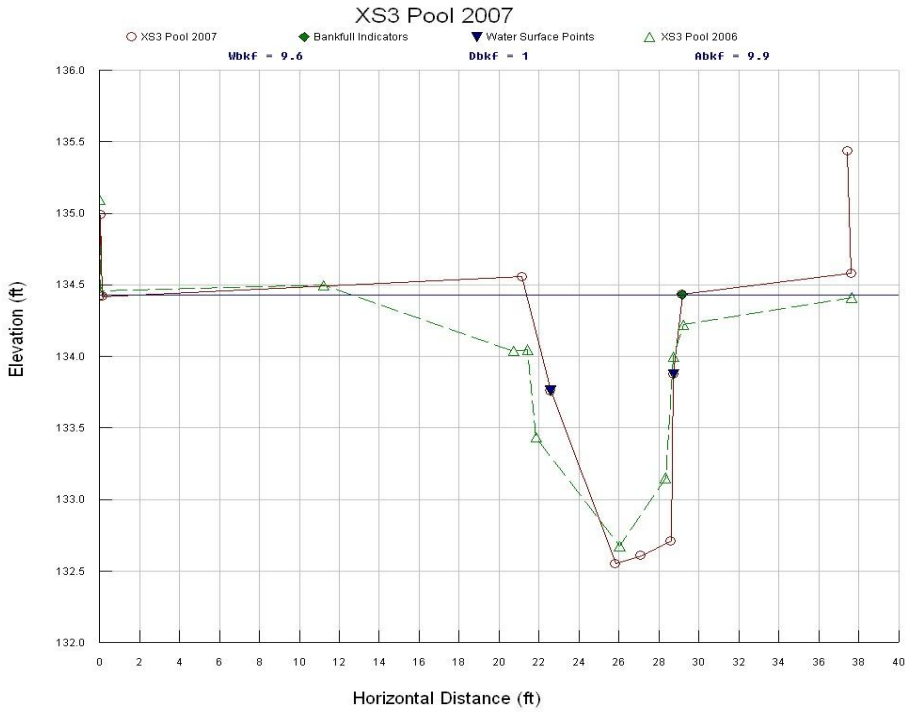
Graph 1: Cross Section 1 Pool



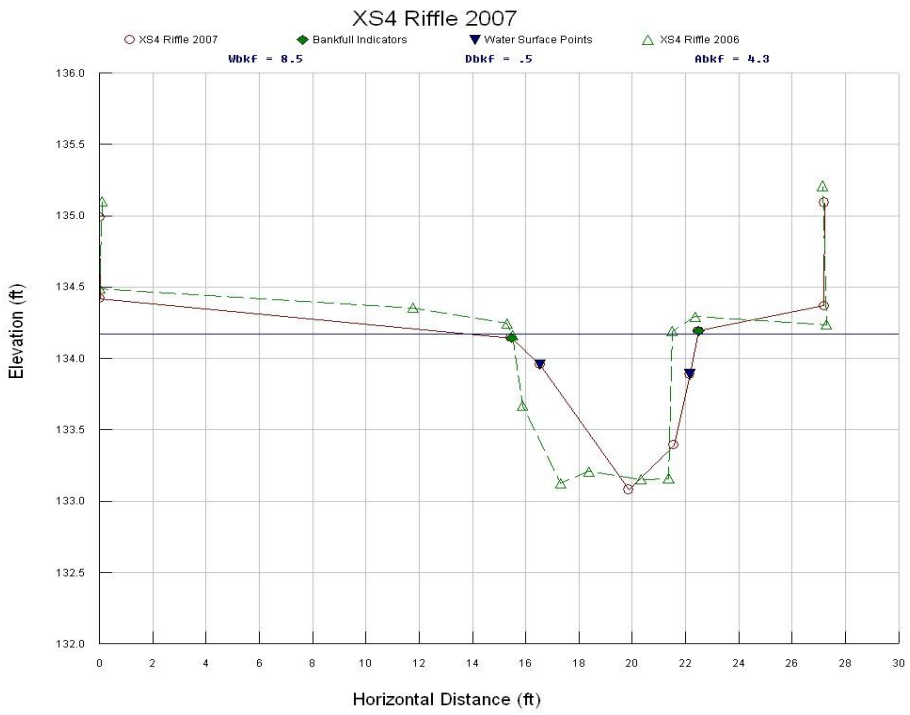
Graph 2: Cross Section 2 Riffle

Title	Cross Section Survey Graphs

Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Project Cumberland County, North Carolina		
	Date	**Project Number**	**Figure**	
	1/10/08	012857003	4	



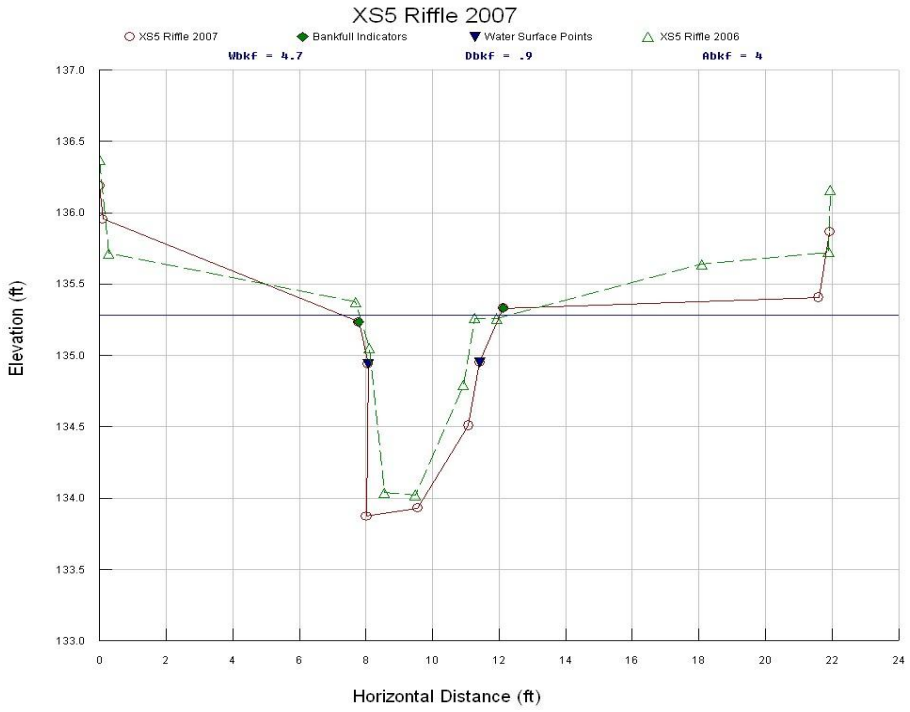
Graph 3: Cross Section 3 Pool



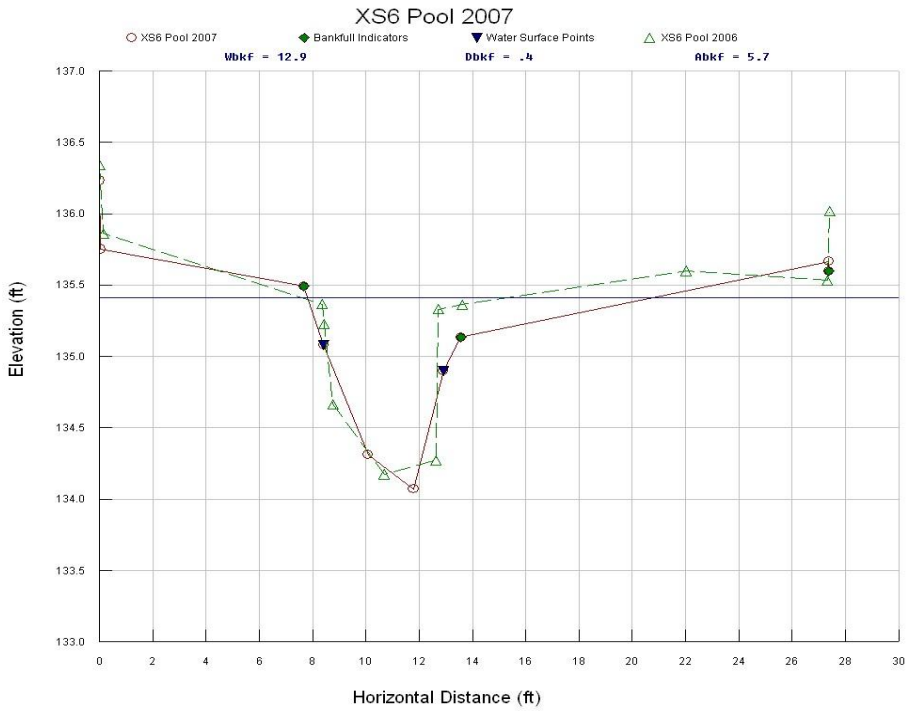
Graph 4: Cross Section 4 Riffle

Title	Cross Section Survey Graphs

Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Project Cumberland County, North Carolina	
	Date 1/10/08	**Project Number** 012857003	**Figure** 4a



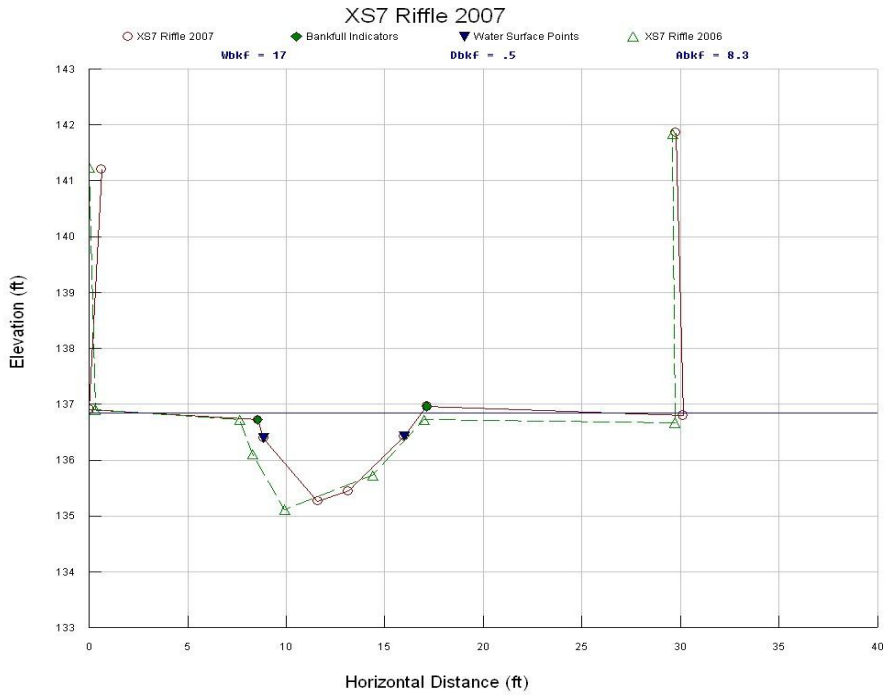
Graph 5: Cross Section 5 Riffle



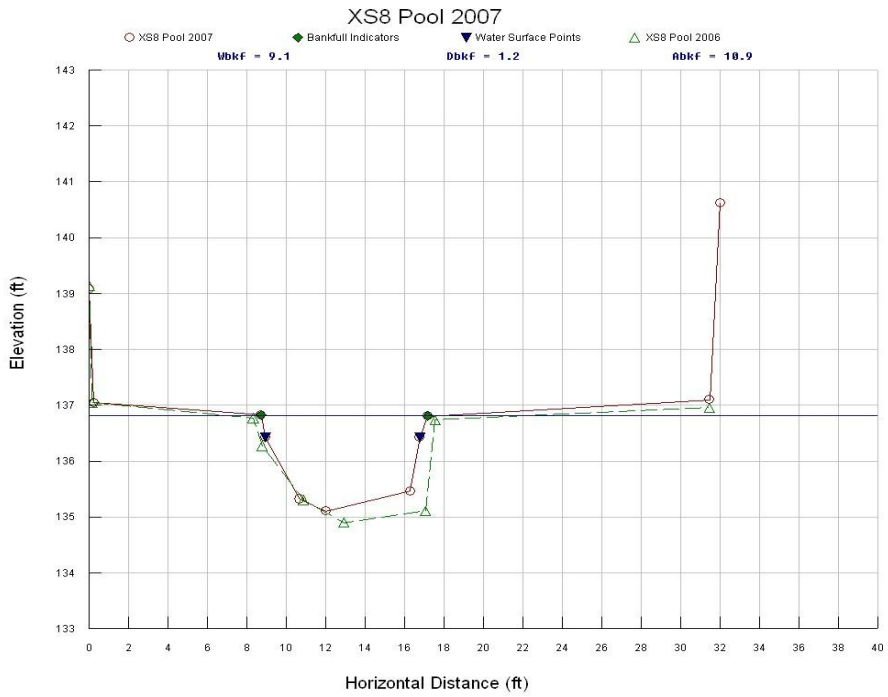
Graph 6: Cross Section 6 Pool

Title	Cross Section Survey Graphs

Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Project Cumberland County, North Carolina	
	Date 1/10/08	**Project Number** 012857003	**Figure** 4b



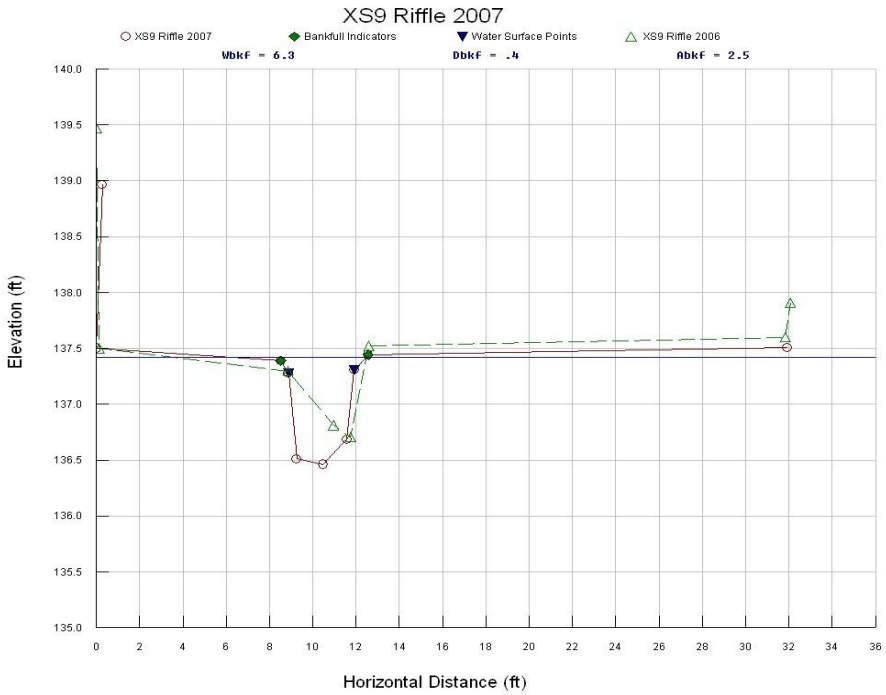
Graph 7: Cross Section 7 Riffle



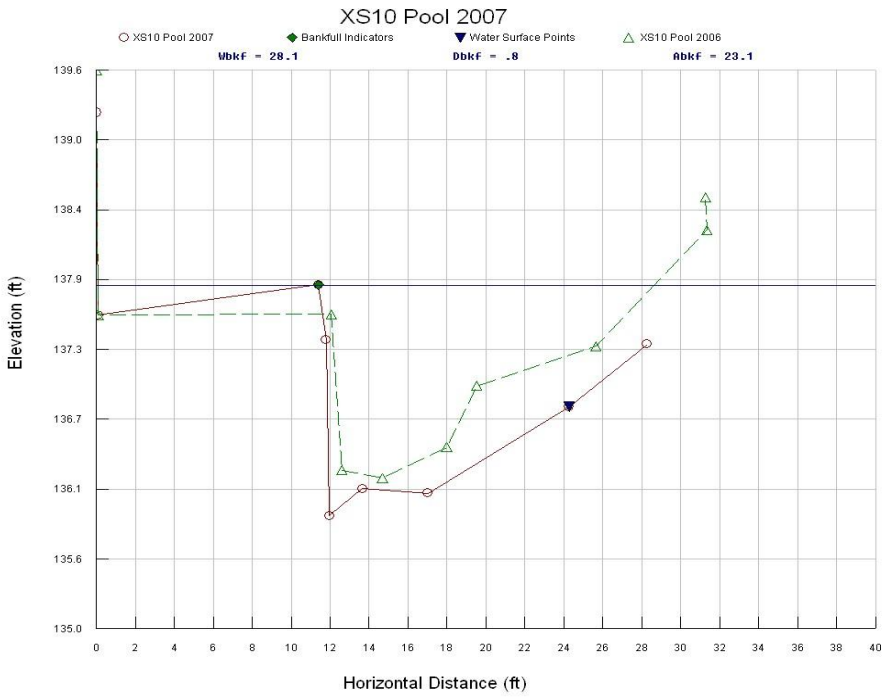
Graph 8: Cross Section 8 Pool

Title	Cross Section Survey Graphs

Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Project Cumberland County, North Carolina	
	Date	**Project Number**	**Figure**
	1/10/08	012857003	4c

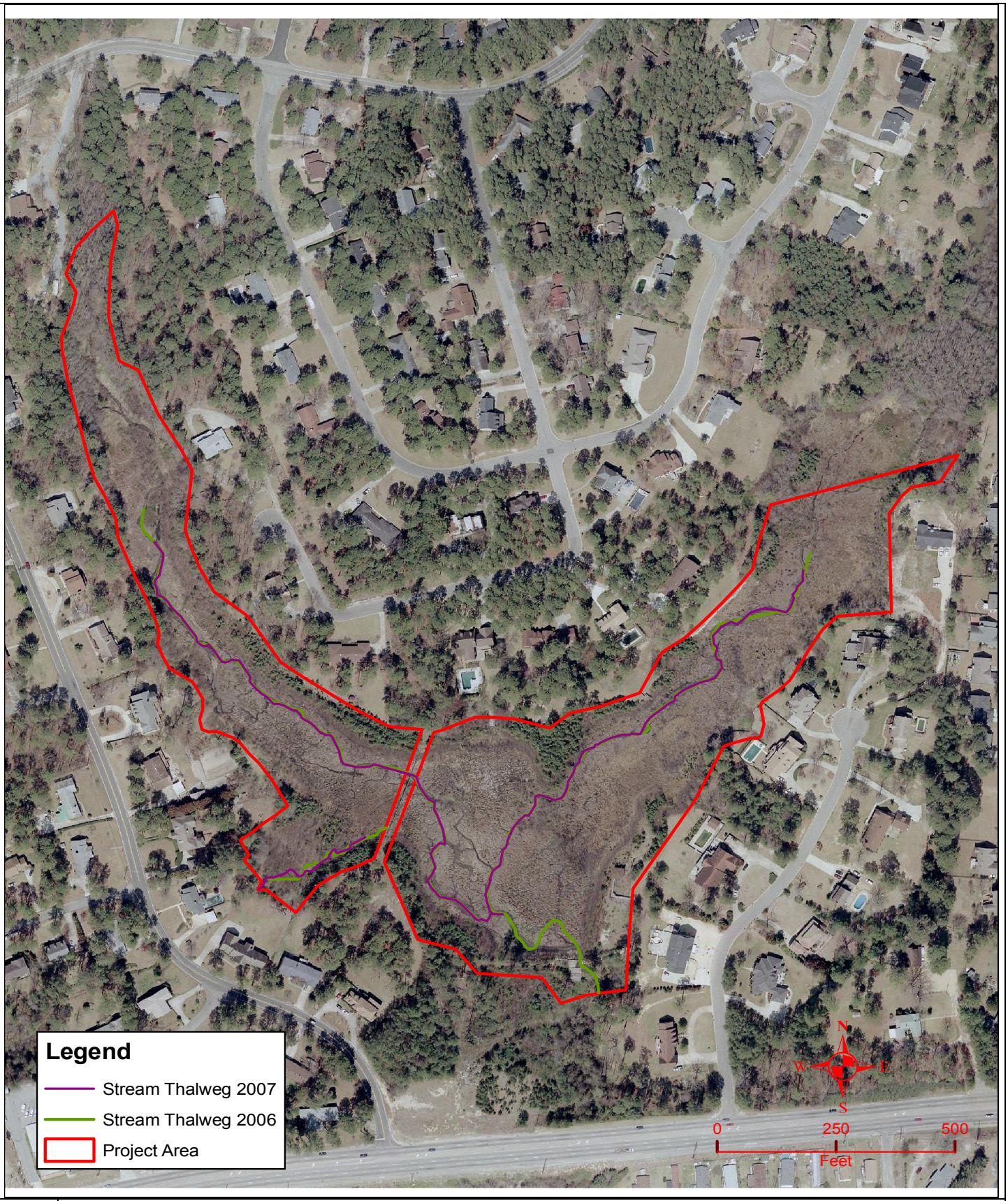


Graph 9: Cross Section 9 Riffle



Graph 10: Cross Section 10 Pool

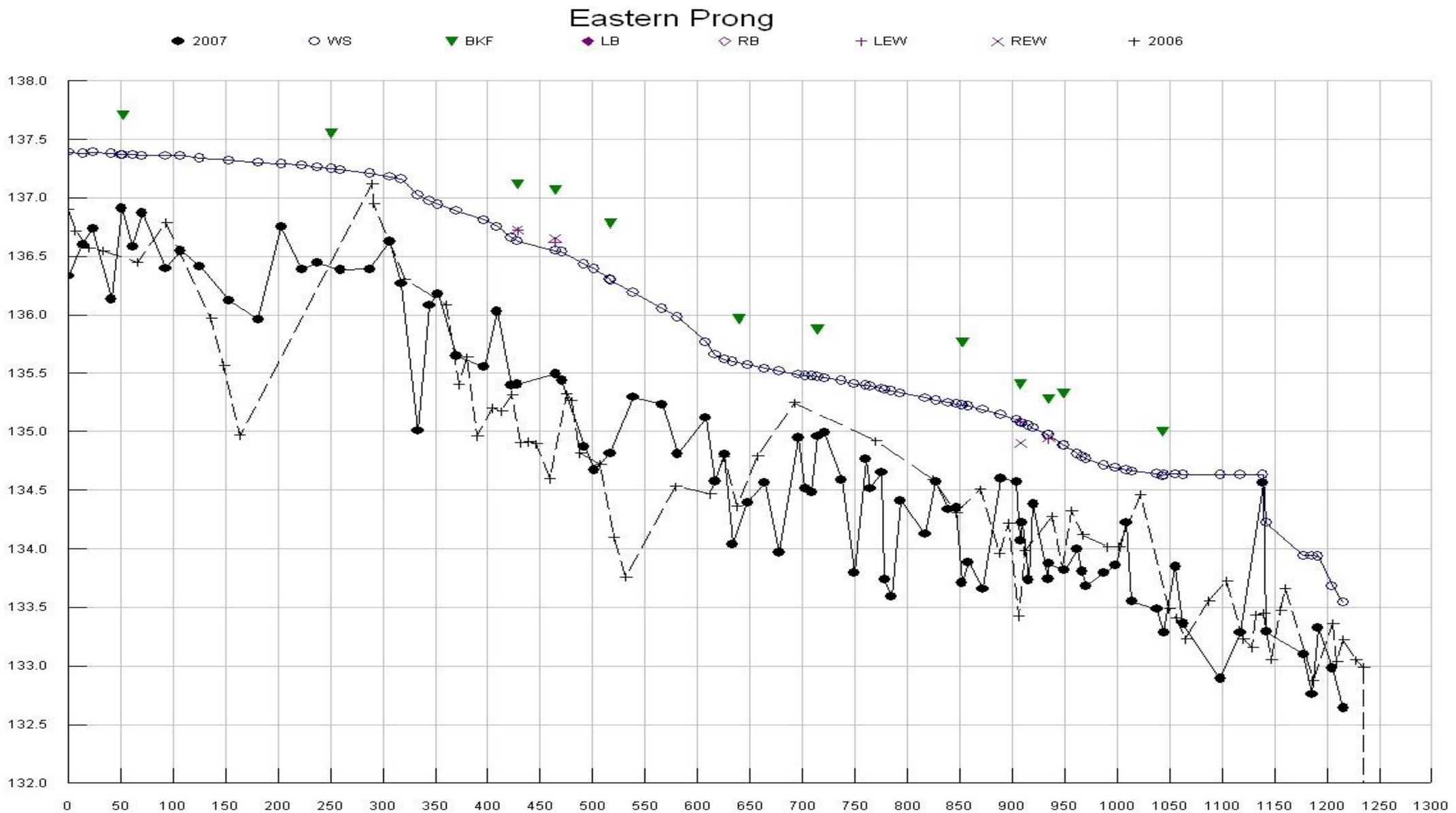
Title	Cross Section Survey Graphs		
Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Project Cumberland County, North Carolina	
	Date 1/10/08	**Project Number** 012857003	**Figure** 4d



Title	Survey Site Thalweg Map

Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Project Cumberland County, North Carolina	
	Date	**Project Number**	**Figure**
	1/10/08	012857003	3

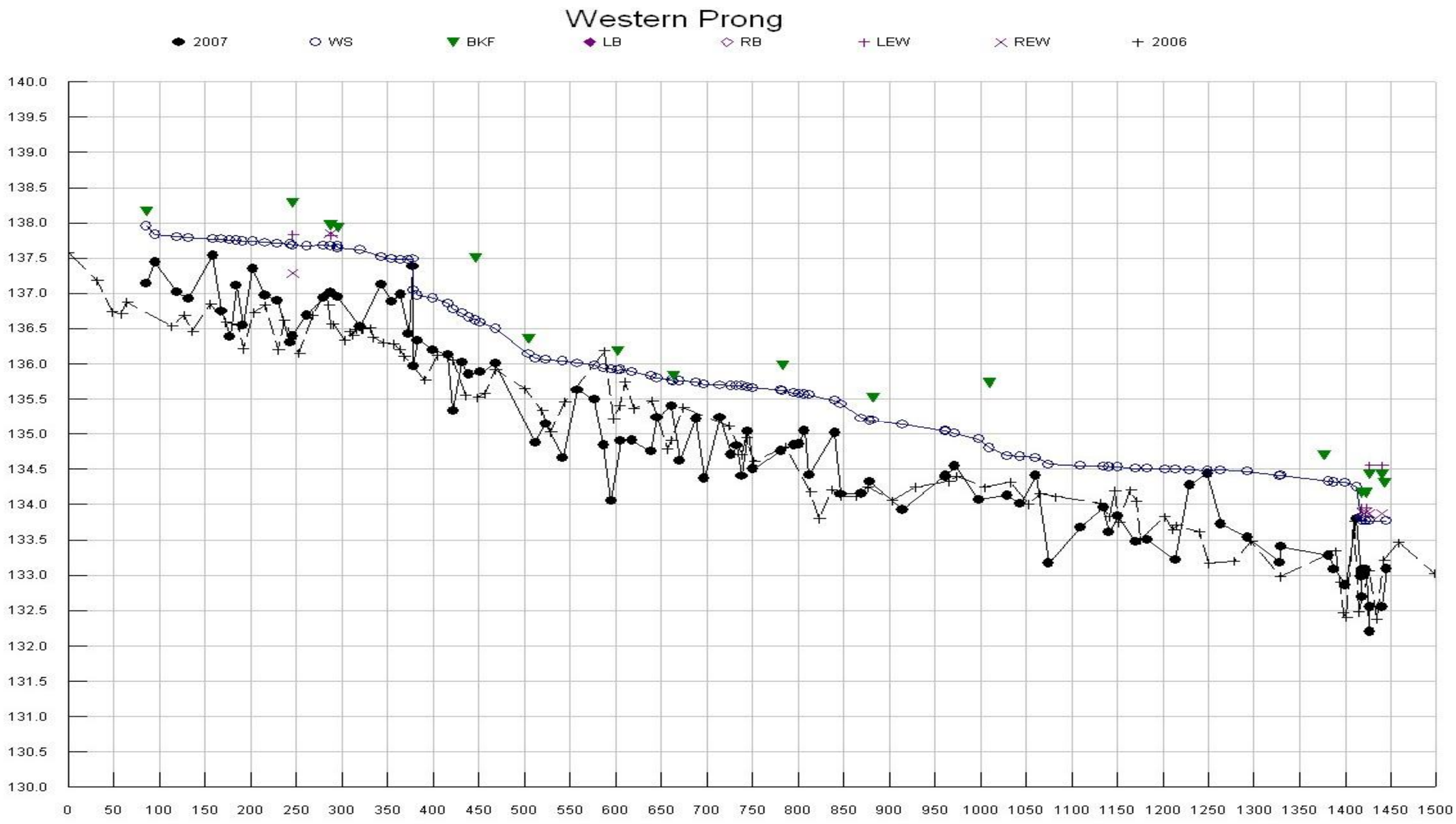
APPENDIX C: Profile Survey



Title	Survey Profile Graphs

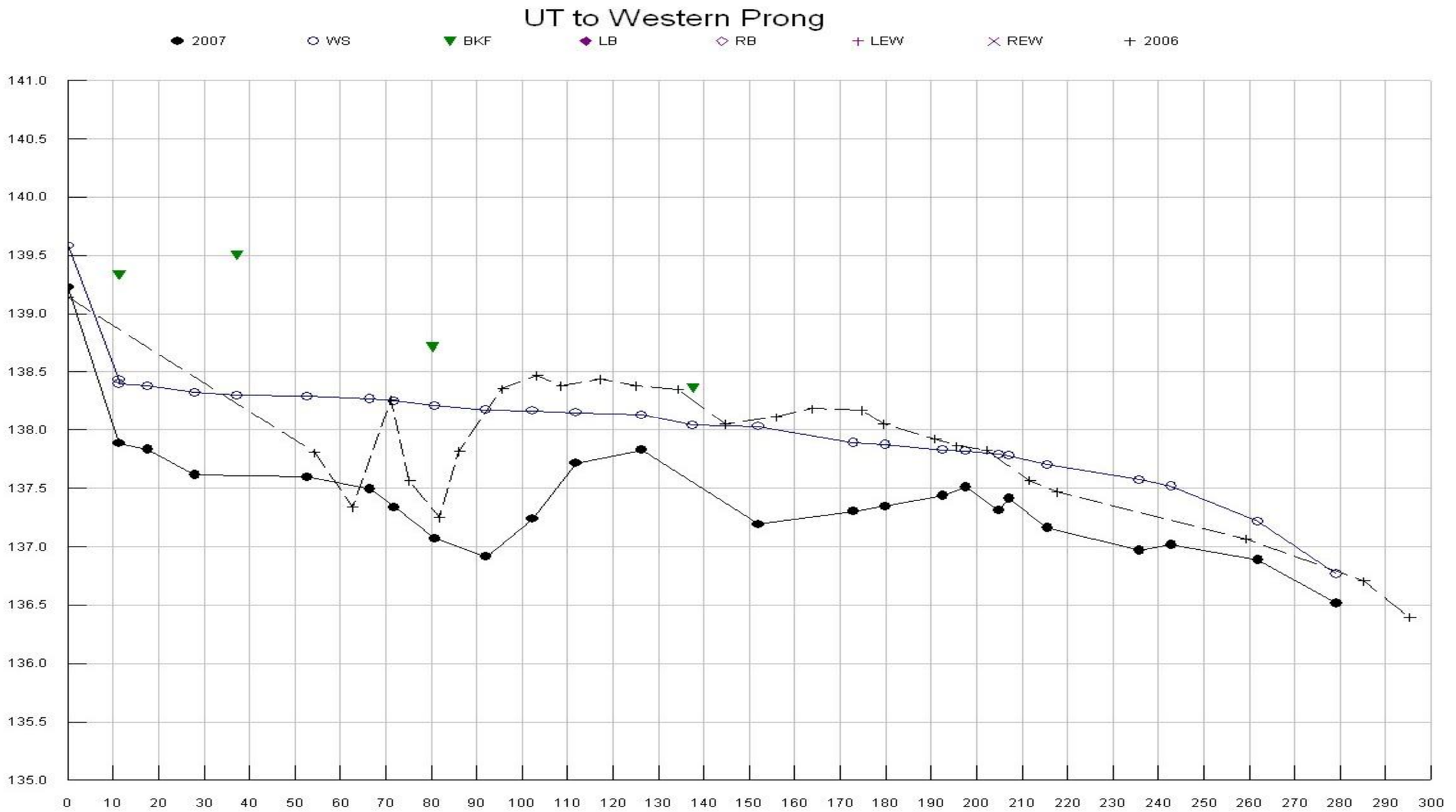
Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Project Cumberland County, North Carolina

Date	**Project Number**	**Figure**
1/10/08	012857003	5



Title	Survey Profile Graphs

Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Project Cumberland County, North Carolina		
	Date 1/10/08	**Project Number** 012857003	**Figure** 5a	



Title	Survey Profile Graphs		
Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Project Cumberland County, North Carolina	
	Date 1/10/08	**Project Number** 012857003	**Figure** 5b

APPENDIX D: Photo Log

Photo Points
Storm Water Outfalls
Problem Areas

Photo Point Log 2007

Photo Point 1 – Storm Water BMP

Photo Point 2 –

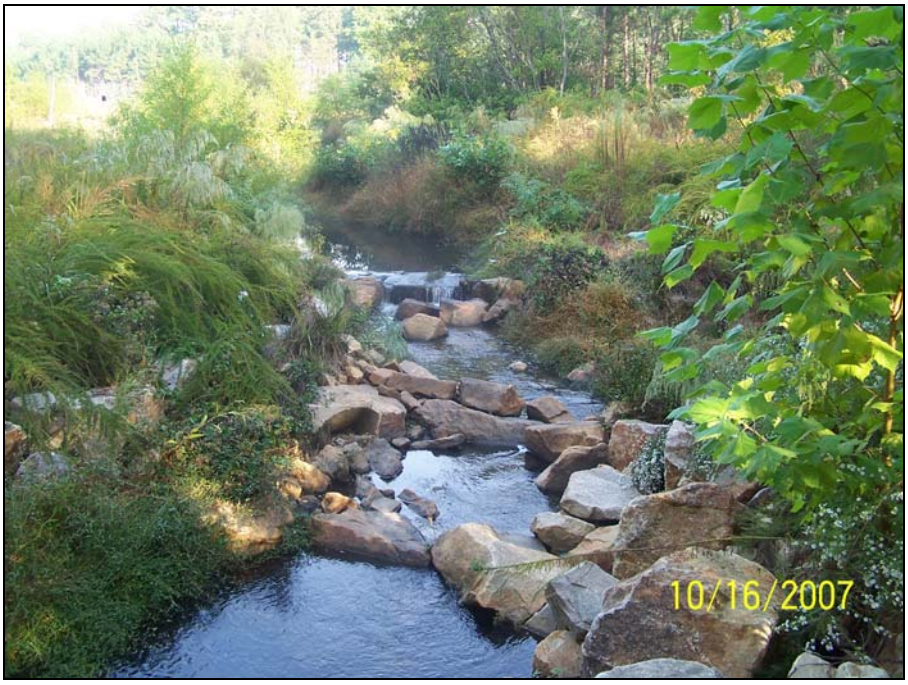


Photo Point 3 – Structures 1 & 2

Photo Point 4- Cross-section 1 facing right bank

Photo Point 5- Cross-section 1 facing left bank

Photo Point 6- Cross-section 2 facing right bank

Photo Point 7- Cross-section 2 facing left bank

Photo Point 8 – Site overview from Monument

Photo Point 9 – Eastern Prong from top of dam

Photo Point 10-Cross-section 3 facing left bank.

Photo Point 26a-Cross section 3 facing right bank.

Photo Point 11-Cross-section 4 facing left bank.

Photo Point 26-Cross-section 4 facing right bank.

Photo Point 17-Cross-section 5 facing left bank.

Photo Point 19-Cross-section 5 facing right bank.

Photo Point 16-Cross-section 6 facing left bank.

Photo Point 18-Cross-section 6 facing right bank.

Photo Point 22-Cross section 7 facing right bank.

Photo Point 24-Cross-section 7 facing left bank.

Photo Point 23-Cross-section 8 facing right bank.

Photo Point 25-Cross-section 8 facing left bank.

Photo Point 27-Cross-section 9 facing left bank.

Photo Point 29-Cross-section 8 facing right bank/

Photo Point 30-Cross-section 10 facing right bank.

Photo Point 28-Cross section 10 facing left bank.

Photo Point 12 – VP2

VP 2 Herbaceous Plot

Photo Point 14 – VP 1

VP 1 Herbaceous Plot

Photo Point 20 – VP3

VP 3 Herbaceous Plot

Photo Point 13 – Western Prong from Utility Line, downstream

Photo Point 15 – Western Prong from Utility Line, upstream

Photo Point 21- Eastern Prong facing cross-sections 7 and 8.

Photo Point 31 – Enhancement Area

Storm Water Outfalls

Storm water outfall 1, located in western prong in stream enhancement section (near well CE2).

Storm water outfall 2, located in western prong in stream restoration section (near cross-section 10).

Storm water outfall 3, located in the western prong in stream restoration section (near well Tarlton4).

Storm water outfall 4, located in eastern prong in stream restoration section (near cross-section 1, also photo point 1).

Storm water outfall 5, located in eastern prong in the stream restoration section.

Storm water outfall 6, located in the eastern prong in the stream restoration section.

Storm water outfall 7, located in the eastern prong in the stream restoration section (near well CEC10).

Storm water outfall 7 has debris blocking it from the landowner doing construction.

PROBLEM AREAS PHOTO LOG

Remnant Beaver dam was removed from main channel to allow proper stream flow at station 45+00.

Problem area at end of project between Cross Sections 1 and 2.
This area was smoothed out and live staked.

This area did not weather the September Bank full event very well and will be repaired and monitored.

Structure at Station 36+00 has settled in a few areas but appears to be in good condition.


11/20/2007


11/20/2007


11/20/2007

Riffle in Cross section 1 is stable.


11/20/2007

Log Diversion structure in enhancement area. In order to confine flow to the main channel and limit the braided nature of the channel the flowing log structure was installed.

Structure weathered September storms moderately well and will be repaired and monitored as needed.

APPENDIX E: Ground and Surface Water Data

Ground Water Gage Graphs
Bank Full Events Photo Log
Rainfall and Stream Gage Graphs

Bank Full Events

Vegetation flattend by bank full event, Photos taken January 9th, 2007. Several significant storms came through the Fayetteville area the week of Christmas 2006.

Main Structure after bank full event , January 2007

Areas of inundation during bank full event, January 2007

Vegetation flattened and rack lines along banks in center of project, January 2007

High water mark still visible in some areas, January 2007

Crest Stage Gage location

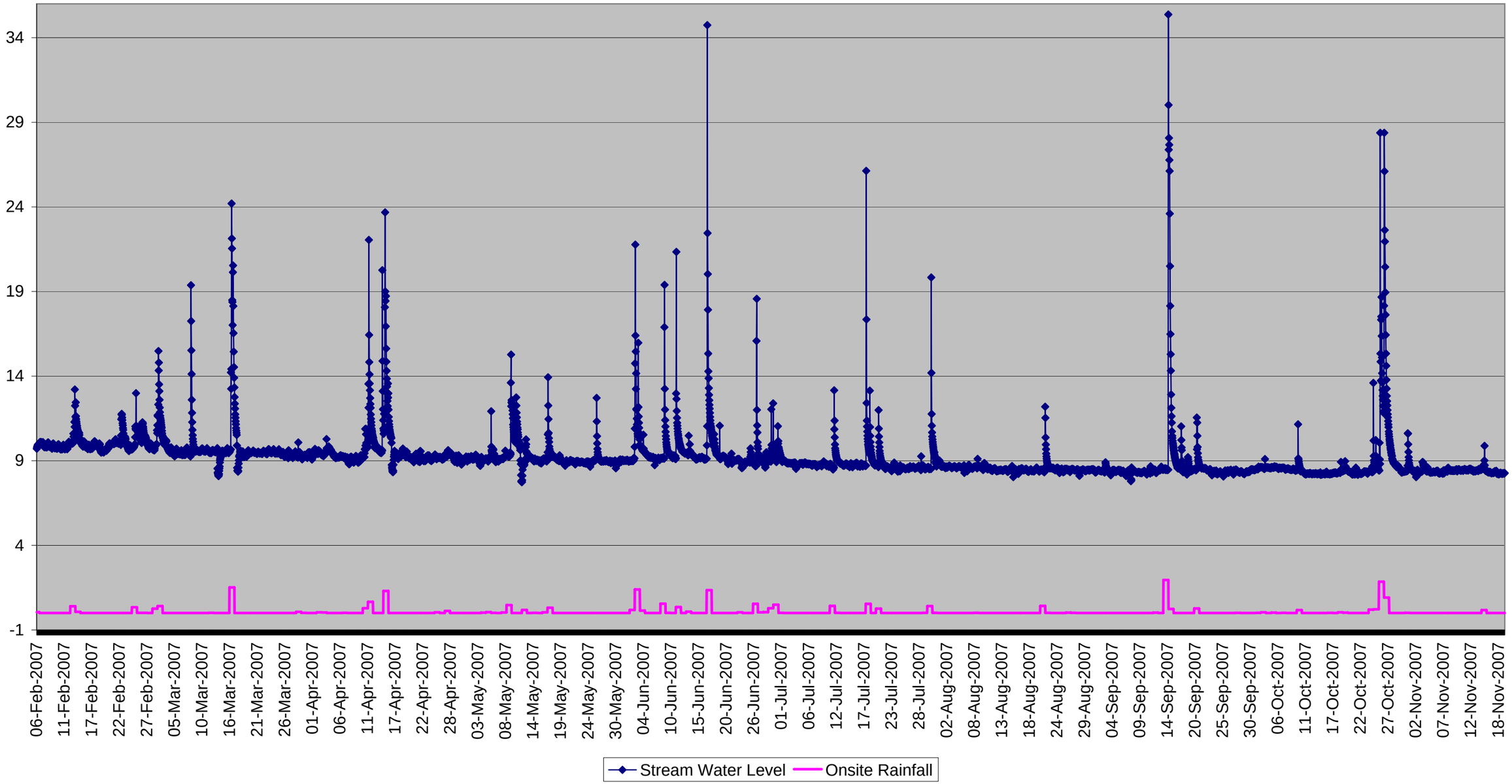
Leaf litter rack line along banks close to enhancement area, January 2007

Summer 2007 Bank full event:

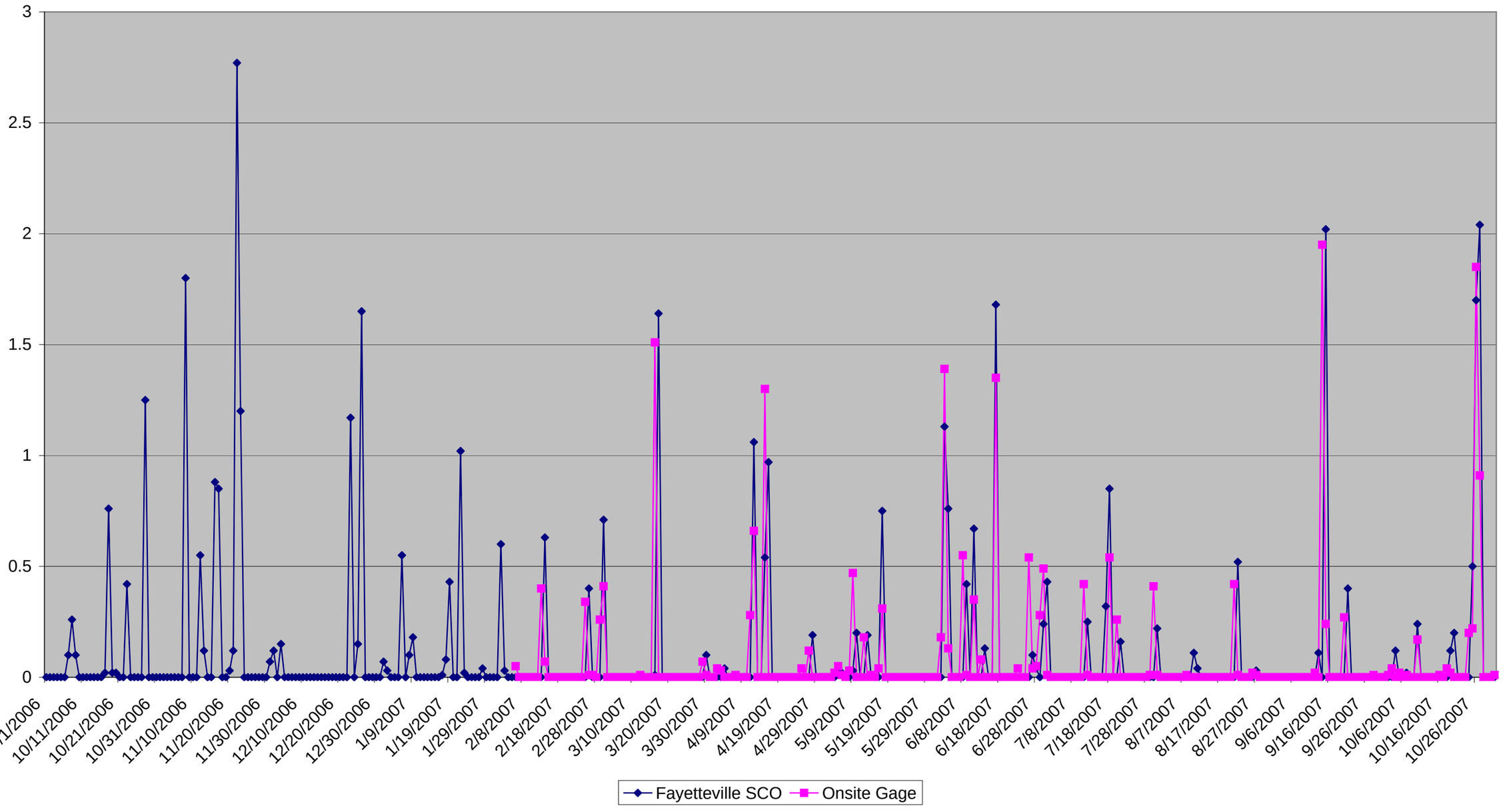
Crest stage gage was checked 7/12/2007 and showed indications of a bank full event. Several rainfall events of greater than an inch in 24 hours were recorded in June in the Fayetteville area and by the onsite rain gage.

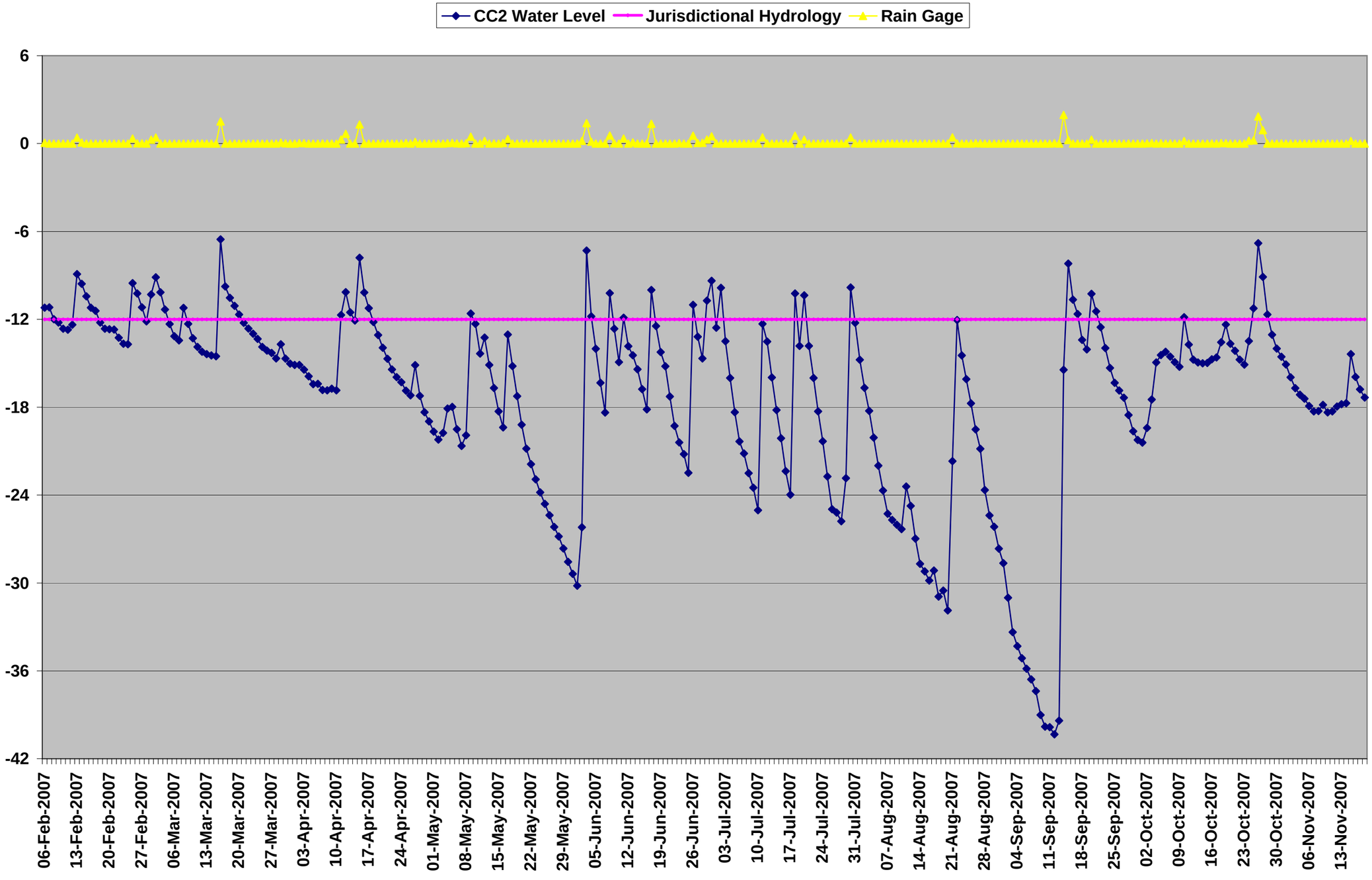
Crest Stage gage checked above 10/16/2007 showing bank full event from September 2007.

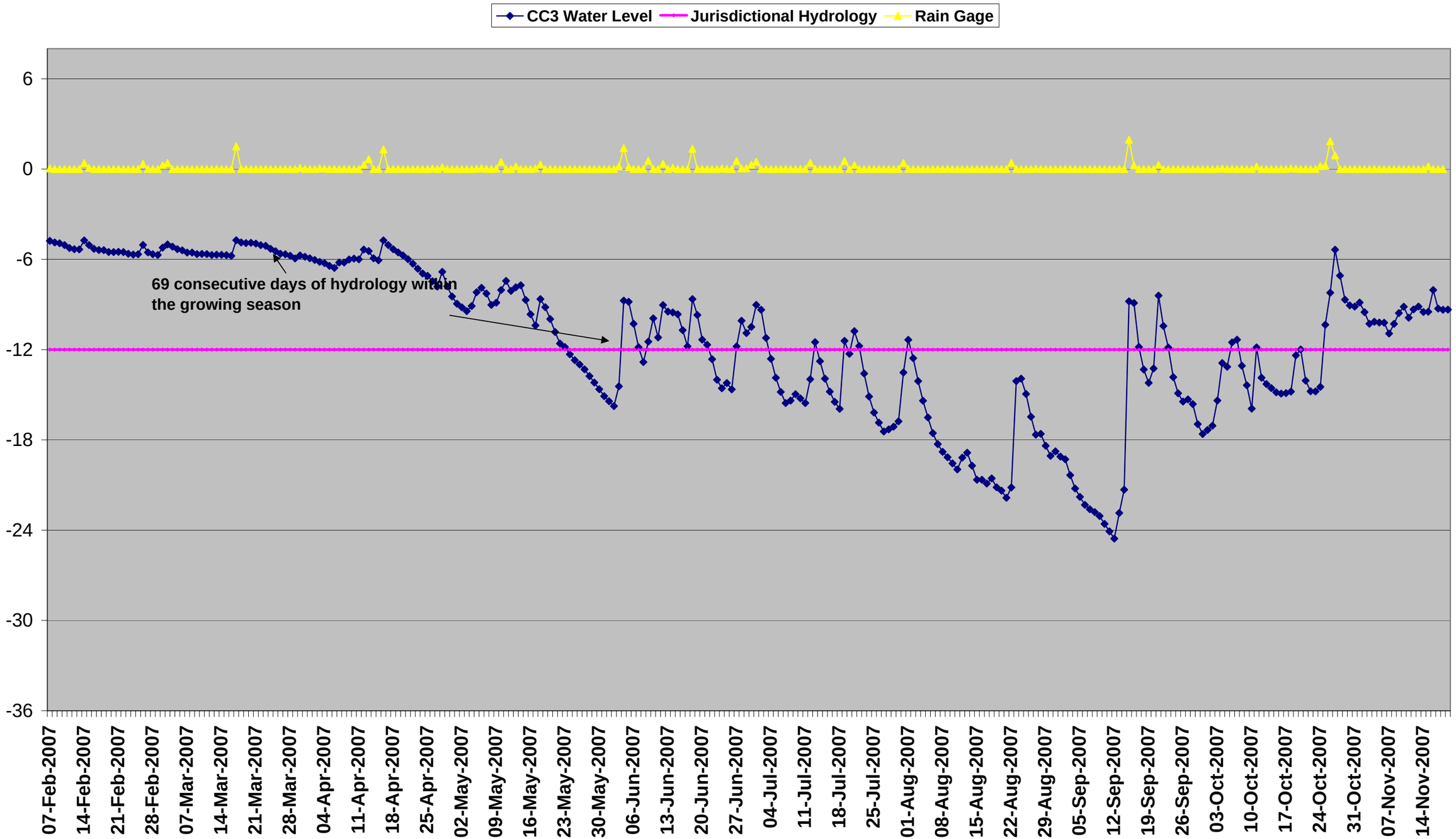
Stream Water Level Vs. Rainfall

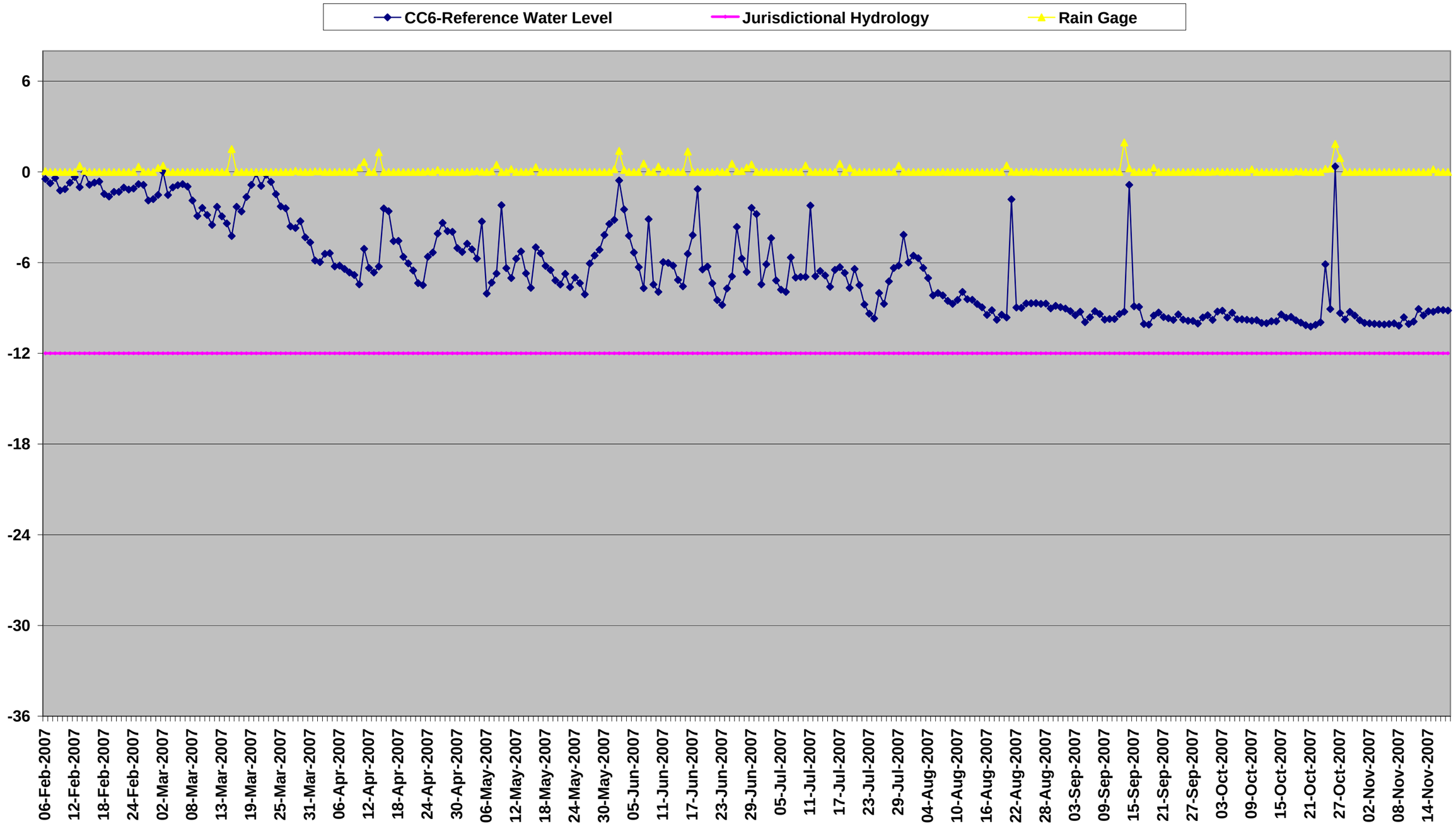


Tarlton Site Rainfall




CC2 Water Level
Jurisdictional Hydrology
Rain Gage
6
0
-6
-12
-18
-24
-30
-36
-42
06-Feb-2007
13-Feb-2007
20-Feb-2007
27-Feb-2007
06-Mar-2007
13-Mar-2007
20-Mar-2007
27-Mar-2007
03-Apr-2007
10-Apr-2007
17-Apr-2007
24-Apr-2007
01-May-2007
08-May-2007
15-May-2007
22-May-2007
29-May-2007
05-Jun-2007
12-Jun-2007
19-Jun-2007
26-Jun-2007
03-Jul-2007
10-Jul-2007
17-Jul-2007
24-Jul-2007
31-Jul-2007
07-Aug-2007
14-Aug-2007
21-Aug-2007
28-Aug-2007
04-Sep-2007
11-Sep-2007
18-Sep-2007
25-Sep-2007
02-Oct-2007
09-Oct-2007
16-Oct-2007
23-Oct-2007
30-Oct-2007
06-Nov-2007
13-Nov-2007


CC3 Water Level
Jurisdictional Hydrology
Rain Gage
6
0
-6
-12
-18
-24
-30
-36
69 consecutive days of hydrology within the growing season
07-Feb-2007
14-Feb-2007
21-Feb-2007
28-Feb-2007
07-Mar-2007
14-Mar-2007
21-Mar-2007
28-Mar-2007
04-Apr-2007
11-Apr-2007
18-Apr-2007
25-Apr-2007
02-May-2007
09-May-2007
16-May-2007
23-May-2007
30-May-2007
06-Jun-2007
13-Jun-2007
20-Jun-2007
27-Jun-2007
04-Jul-2007
11-Jul-2007
18-Jul-2007
25-Jul-2007
01-Aug-2007
08-Aug-2007
15-Aug-2007
22-Aug-2007
29-Aug-2007
05-Sep-2007
12-Sep-2007
19-Sep-2007
26-Sep-2007
03-Oct-2007
10-Oct-2007
17-Oct-2007
24-Oct-2007
31-Oct-2007
07-Nov-2007
14-Nov-2007


CC6-Reference Water Level
Jurisdictional Hydrology
Rain Gage
6
0
-6
-12
-18
-24
-30
-36
06-Feb-2007
12-Feb-2007
18-Feb-2007
24-Feb-2007
02-Mar-2007
08-Mar-2007
13-Mar-2007
19-Mar-2007
25-Mar-2007
31-Mar-2007
06-Apr-2007
12-Apr-2007
18-Apr-2007
24-Apr-2007
30-Apr-2007
06-May-2007
12-May-2007
18-May-2007
24-May-2007
30-May-2007
05-Jun-2007
11-Jun-2007
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04-Aug-2007
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16-Aug-2007
22-Aug-2007
28-Aug-2007
03-Sep-2007
09-Sep-2007
15-Sep-2007
21-Sep-2007
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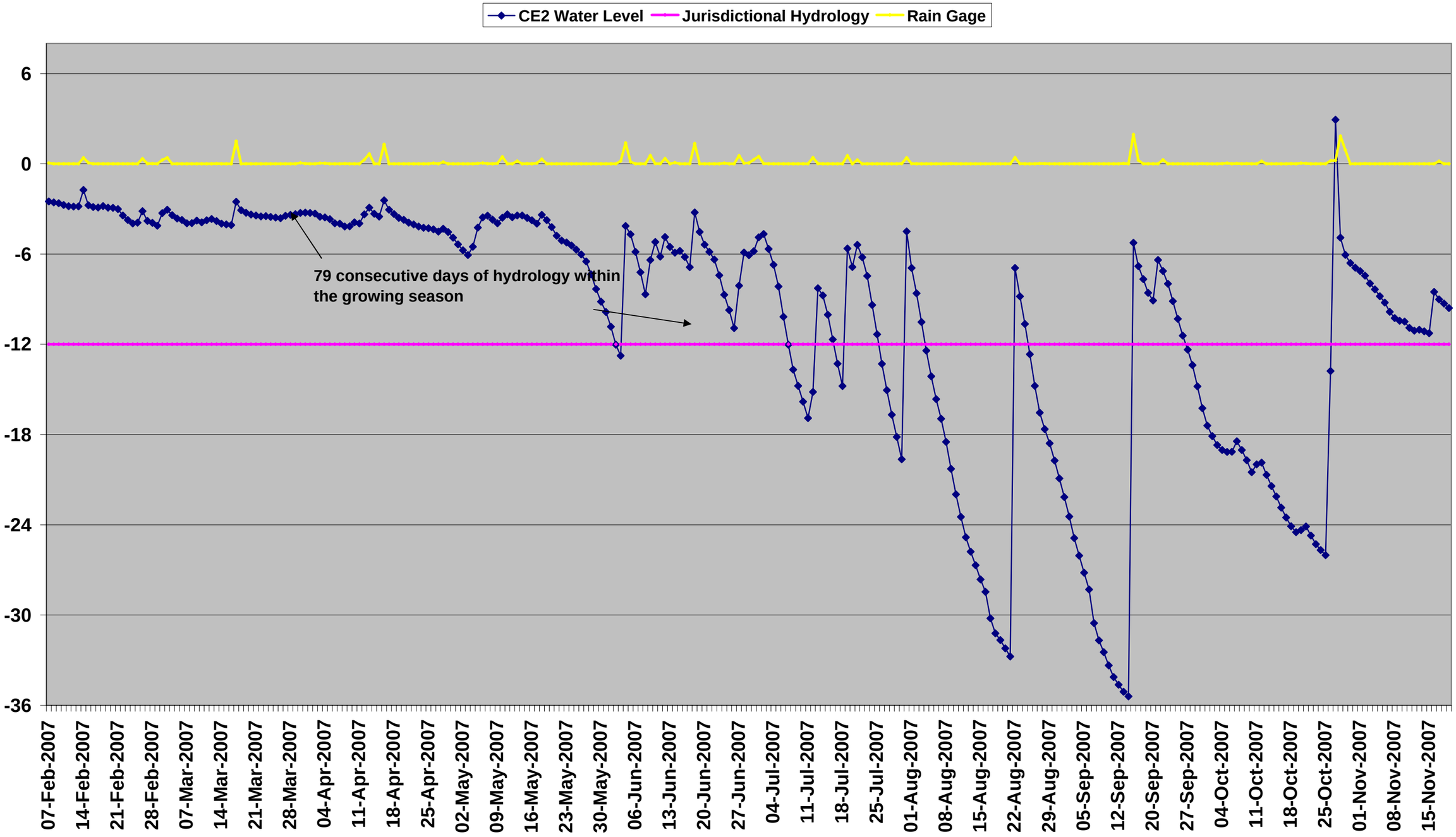
02-Nov-2007
08-Nov-2007
14-Nov-2007


CE2 Water Level
Jurisdictional Hydrology
Rain Gage
6
0
-6
-12
-18
-24
-30
-36
79 consecutive days of hydrology within the growing season
07-Feb-2007
14-Feb-2007
21-Feb-2007
28-Feb-2007
07-Mar-2007
14-Mar-2007
21-Mar-2007
28-Mar-2007
04-Apr-2007
11-Apr-2007
18-Apr-2007
25-Apr-2007
02-May-2007
09-May-2007
16-May-2007
23-May-2007
30-May-2007
06-Jun-2007
13-Jun-2007
20-Jun-2007
27-Jun-2007
04-Jul-2007
11-Jul-2007
18-Jul-2007
25-Jul-2007
01-Aug-2007
08-Aug-2007
15-Aug-2007
22-Aug-2007
29-Aug-2007
05-Sep-2007
12-Sep-2007
20-Sep-2007
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04-Oct-2007
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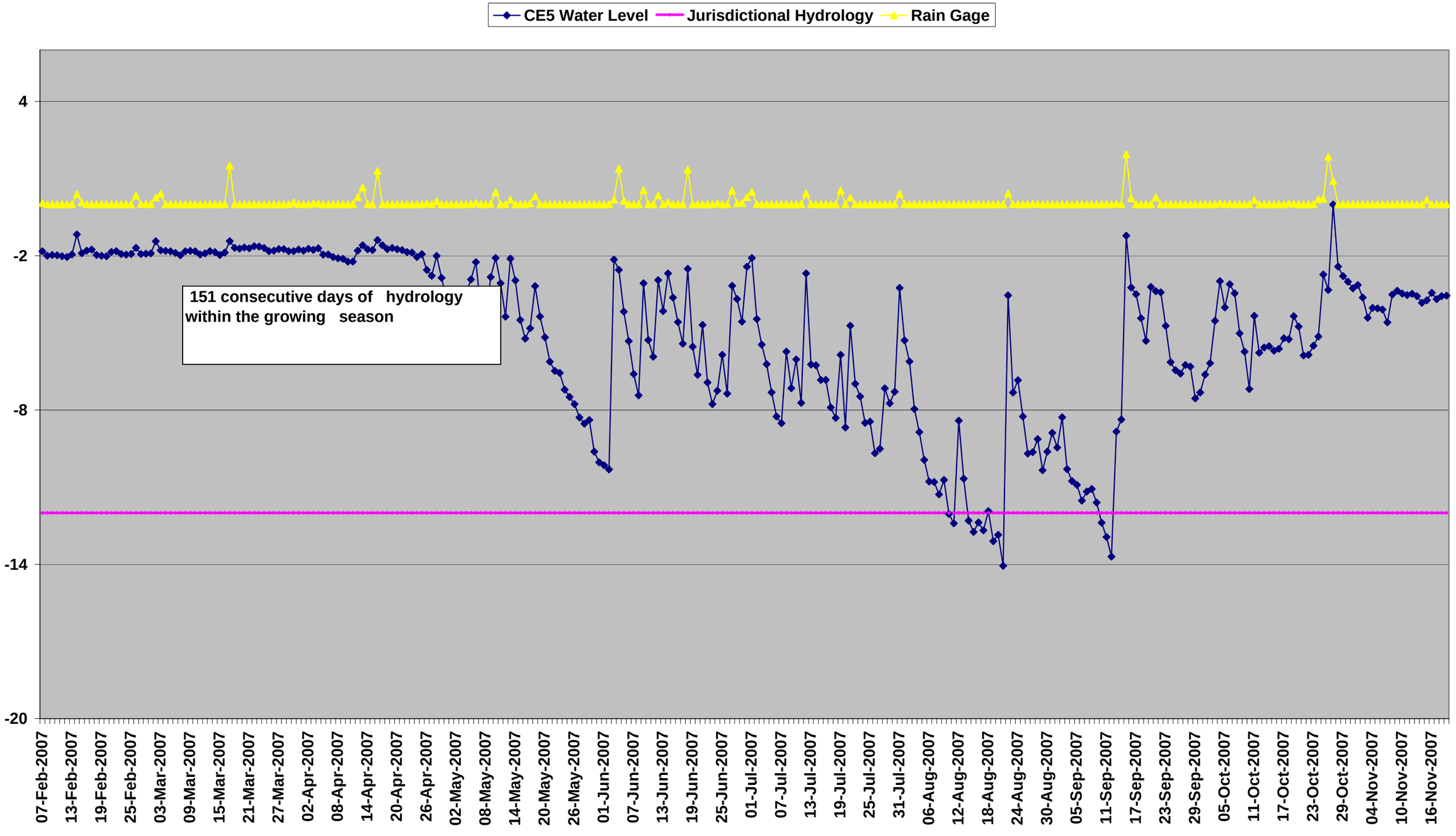
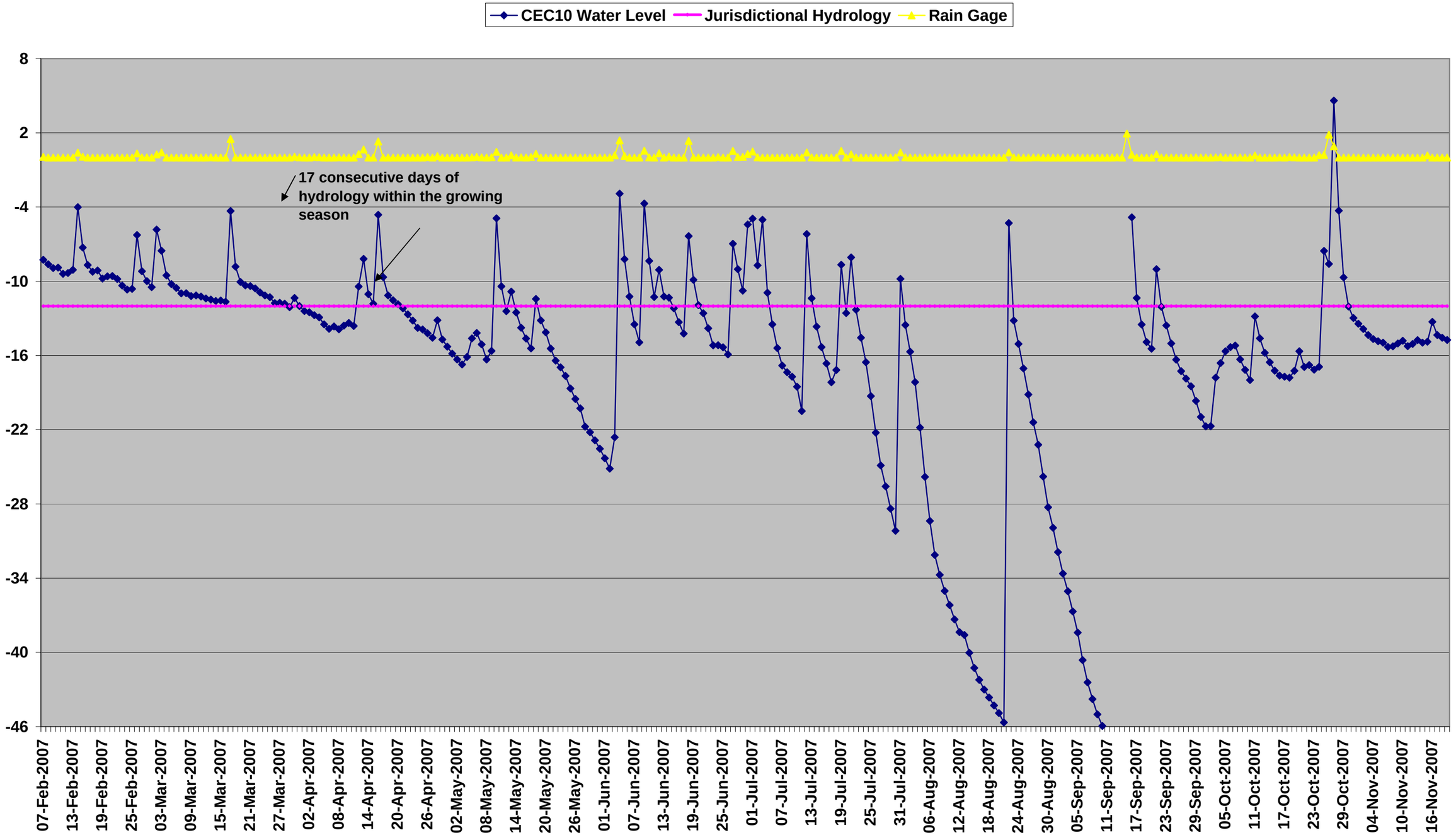
25-Oct-2007
01-Nov-2007
08-Nov-2007
15-Nov-2007


CE5 Water Level
Jurisdictional Hydrology
Rain Gage
4
-2
-8
-14
-20
151 consecutive days of hydrology within the growing season
07-Feb-2007
13-Feb-2007
19-Feb-2007
25-Feb-2007
03-Mar-2007
09-Mar-2007
15-Mar-2007
21-Mar-2007
27-Mar-2007
02-Apr-2007
08-Apr-2007
14-Apr-2007
20-Apr-2007
26-Apr-2007
02-May-2007
08-May-2007
14-May-2007
20-May-2007
26-May-2007
01-Jun-2007
07-Jun-2007
13-Jun-2007
19-Jun-2007
25-Jun-2007
01-Jul-2007
07-Jul-2007
13-Jul-2007
19-Jul-2007
25-Jul-2007
31-Jul-2007
06-Aug-2007
12-Aug-2007
18-Aug-2007
24-Aug-2007
30-Aug-2007
05-Sep-2007
11-Sep-2007
17-Sep-2007
23-Sep-2007
29-Sep-2007
05-Oct-2007
11-Oct-2007
17-Oct-2007
23-Oct-2007
29-Oct-2007
04-Nov-2007
10-Nov-2007
16-Nov-2007


CEC10 Water Level
Jurisdictional Hydrology
Rain Gage
17 consecutive days of hydrology within the growing season
8
2
-4
-10
-16
-22
-28
-34
-40
-46
07-Feb-2007
13-Feb-2007
19-Feb-2007
25-Feb-2007
03-Mar-2007
09-Mar-2007
15-Mar-2007
21-Mar-2007
27-Mar-2007
02-Apr-2007
08-Apr-2007
14-Apr-2007
20-Apr-2007
26-Apr-2007
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14-May-2007
20-May-2007
26-May-2007
01-Jun-2007
07-Jun-2007
13-Jun-2007
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25-Jul-2007
31-Jul-2007
06-Aug-2007
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17-Sep-2007
23-Sep-2007
29-Sep-2007
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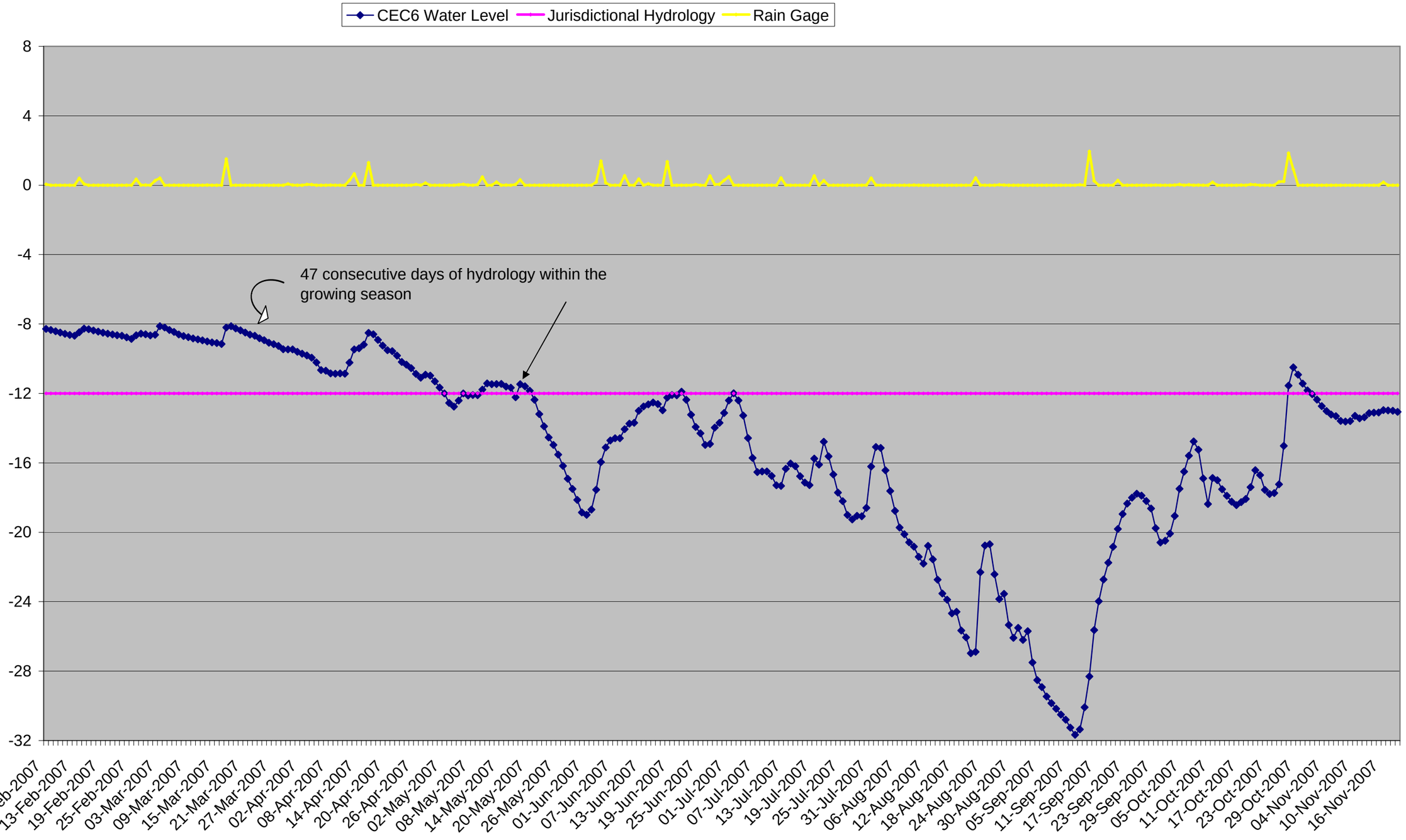
23-Oct-2007
29-Oct-2007
04-Nov-2007
10-Nov-2007
16-Nov-2007


CEC6 Water Level
Jurisdictional Hydrology
Rain Gage
8
4
0
-4
-8
-12
-16
-20
-24
-28
-32
47 consecutive days of hydrology within the growing season
07-Feb-2007
13-Feb-2007
19-Feb-2007
25-Feb-2007
03-Mar-2007
09-Mar-2007
15-Mar-2007
21-Mar-2007
27-Mar-2007
02-Apr-2007
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08-May-2007
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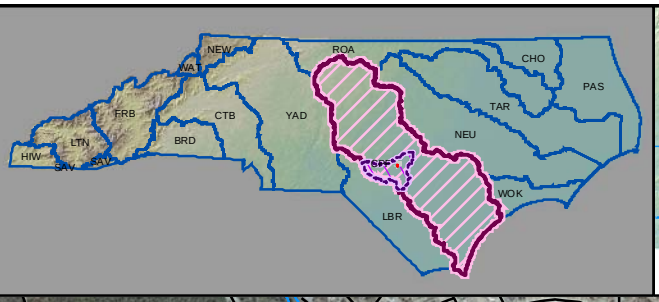
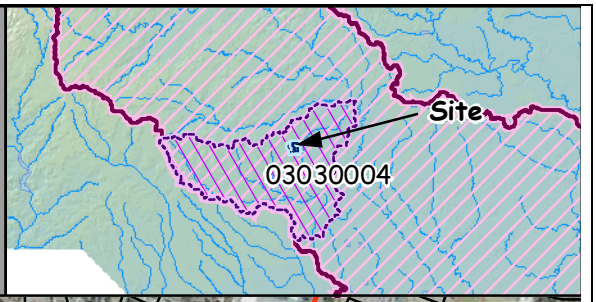
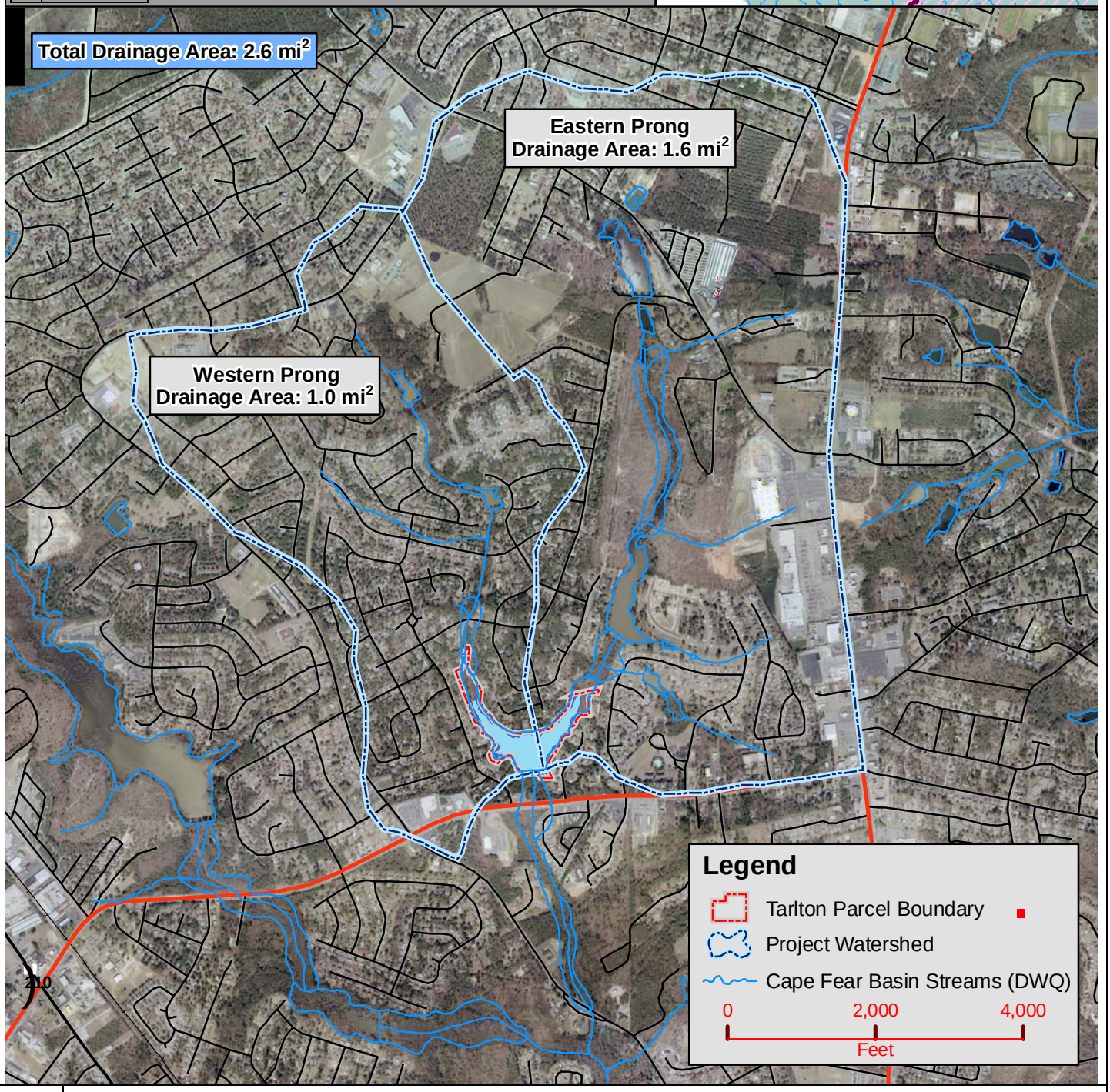
12-Aug-2007
18-Aug-2007
24-Aug-2007
30-Aug-2007
05-Sep-2007
11-Sep-2007
17-Sep-2007
23-Sep-2007
29-Sep-2007
05-Oct-2007
11-Oct-2007
17-Oct-2007
23-Oct-2007
29-Oct-2007
04-Nov-2007
10-Nov-2007
16-Nov-2007

FIGURES

NEW	NEW
PAS	PASQUOTANK
YAD	YADKIN
CHO	CHOWAN
ROA	ROANOKE
TAR	TAR-PAMLICO
NEU	NEUSE
WAT	WATAUGA
CPF	CAPE FEAR
FRB	FRENCH BROAD
CTB	CATAWBA
LTN	LITTLE TENNESSEE
BRD	BROAD
HIW	HIWASSEE
LBR	LUMBER
SAV	SAVANNAH
WOK	WHITE OAK







Title	Project Site Watershed Map (Cumberland County 2001 Aerial)

Prepared For: Mid-Atlantic Mitigation, LLC	**Project**	Tarlton Stream and Wetland Restoration Cumberland County, North Carolina	
	Date	**Project Number**	**Figure**
	11/28/07	012857003	1

CU: 03030004

35.10975 N
-78.89638 W

REFERENCE STREAM AND WETLAND GAGES

CONSERVATION EASEMENT BOUNDARY

CE2

35.10808 N
-78.89136 W

CEC10

CEC6

CC3

ORIGINAL POND BOUNDARY

35.10555 N
-78.89530 W

REEDS4

CC2

PHASE I ACTIVE PRIORITY I RESTORATION
(COMPLETED FALL 2005)

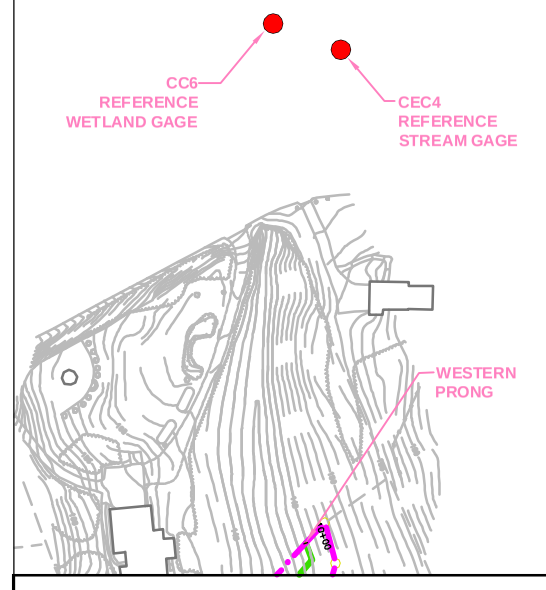
CE5

RIVERBEND ROAD

PERMANENT ACCESS

REMNANT DOCK EASEMENT ENCROACHMENT (REMOVED IN PHASE I)

35.10489 N
-78.89292 W



SITE LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- PROPERTY BOUNDARY
- WETLAND ENHANCEMENT
- WETLAND RESTORATION
- STREAM RESTORATION
- STREAM ENHANCEMENT
- STREAM PRESERVATION
- PERMANENT RIFFLE CROSS SECTION
- PERMANENT POOL CROSS SECTION
- VEGETATION MONITORING QUAD
- MONITORING GAGE
- STORM WATER OUTFALL
- 20 PHOTOGRAPH LOCATIONS

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)
1 inch = 200 ft.

REV. No.:	REVISION:	DATE:	DRAWN BY:	CHECKED BY:

PREPARED IN THE OFFICE OF:
Kimley-Horn and Associates, Inc.
P.O. BOX 33068 – RALEIGH, NORTH CAROLINA 27636-3068
PHONE: (919) 677-2000 FAX: (919) 677-2050

CLIENT: MID-ATLANTIC MITIGATION

TITLE: MONITORING PLAN MAP

SEAL:

DATE:	02/02/07
HORIZONTAL SCALE:	1": 200'
VERTICAL SCALE:	1": 200'
DRAWN BY:	JCD
DESIGNED BY:	JCD
CHECKED BY:	WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

ATTACHED REFERENCE FILES:

S.C.O. NUMBER: D05013-1

FIGURE NUMBER: 2