

**CUTAWHISKIE CREEK STREAM AND WETLAND RESTORATION SITE
2011 ANNUAL MONITORING REPORT (YEAR 4)**

**HERTFORD COUNTY, NORTH CAROLINA
NCEEP CONTRACT NO. D06066-A**



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1.0 EXECUTIVE SUMMARY

The Cutawhiskie Creek Restoration Site (hereafter referred to as the “Site”) was constructed for the North Carolina Ecosystem Enhancement Program (NCEEP) to provide compensatory stream and wetland mitigation in the Chowan River Basin. This restoration project is located on an unnamed tributary (UT) to Cutawhiskie Creek on a 22.9 acre Site located in Hertford County (Figure 1). The project includes stream restoration (Priority 1) and preservation, as well as riparian wetland restoration and enhancement.

The following report summarizes the monitoring activities that have occurred in the fourth year of project monitoring (2011) at the Site. Site construction began and was completed in November 2007. As-built surveys for the Site were performed in February 2008, and first year monitoring was conducted in 2008. To be deemed successful the Site must satisfy vegetative and hydrologic success criteria; and verify restored stream channel stability for a minimum of five years or until the success criteria is achieved. The following report summarizes the results of the 2011 monitoring.

Vegetation Assessment

Vegetation monitoring for Year 4 was performed based on the Carolina Vegetation Survey (CVS) Levels 1 and 2 (Lee et al. 2006). CVS methodology determines density and survival of planted species, and individuals resulting from natural regeneration. Plot locations are shown in Figures 2A and 2b (Appendix D). The taxonomic standard for vegetation follows *Flora of the Southern and Mid-Atlantic States* (Weakley 2010).

Vegetative monitoring success will be achieved if plot data indicates the average number of planted stems exceeds 320 stems per acre after the third year of monitoring and 260 stems per acre after the fifth and final year of project monitoring. Based on Year 4 surveys, the average count of the surviving planted species is 461 stems per acre. If volunteer species are included, the total number of stems increases to 5,771 stems per acre. The Site has met the 4th year criterion and is on target to exceed the established success criteria for vegetation based on the survival of the planted species.

Stream Assessment

Success criteria for the restored stream reach has been established to confirm that no significant changes have occurred to the dimension, pattern, profile, and bed material over the 5-year monitoring period. Location surveys of the constructed features were conducted to verify the performance of the stream. A total station survey was performed to describe the stream longitudinal profile and six permanent stream cross-sections (3 riffles and 3 pools). Overall, the stream channel bed form and banks are stable. Based on the cross-sections, longitudinal profile and visual observations, the channel dimensions have not changed significantly compared to as-built conditions.

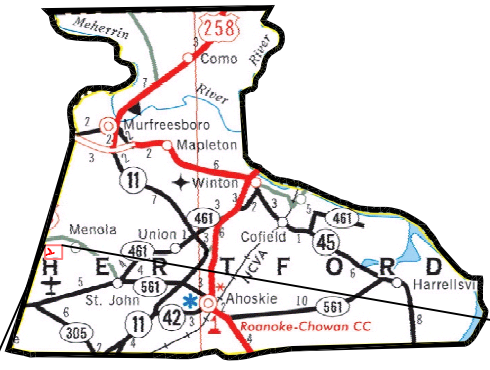
Wetland Hydrology Assessment

Success criteria for wetland hydrology require that restored wetland areas be inundated or saturated by groundwater within 12 inches of the ground surface for a period of time during the growing season

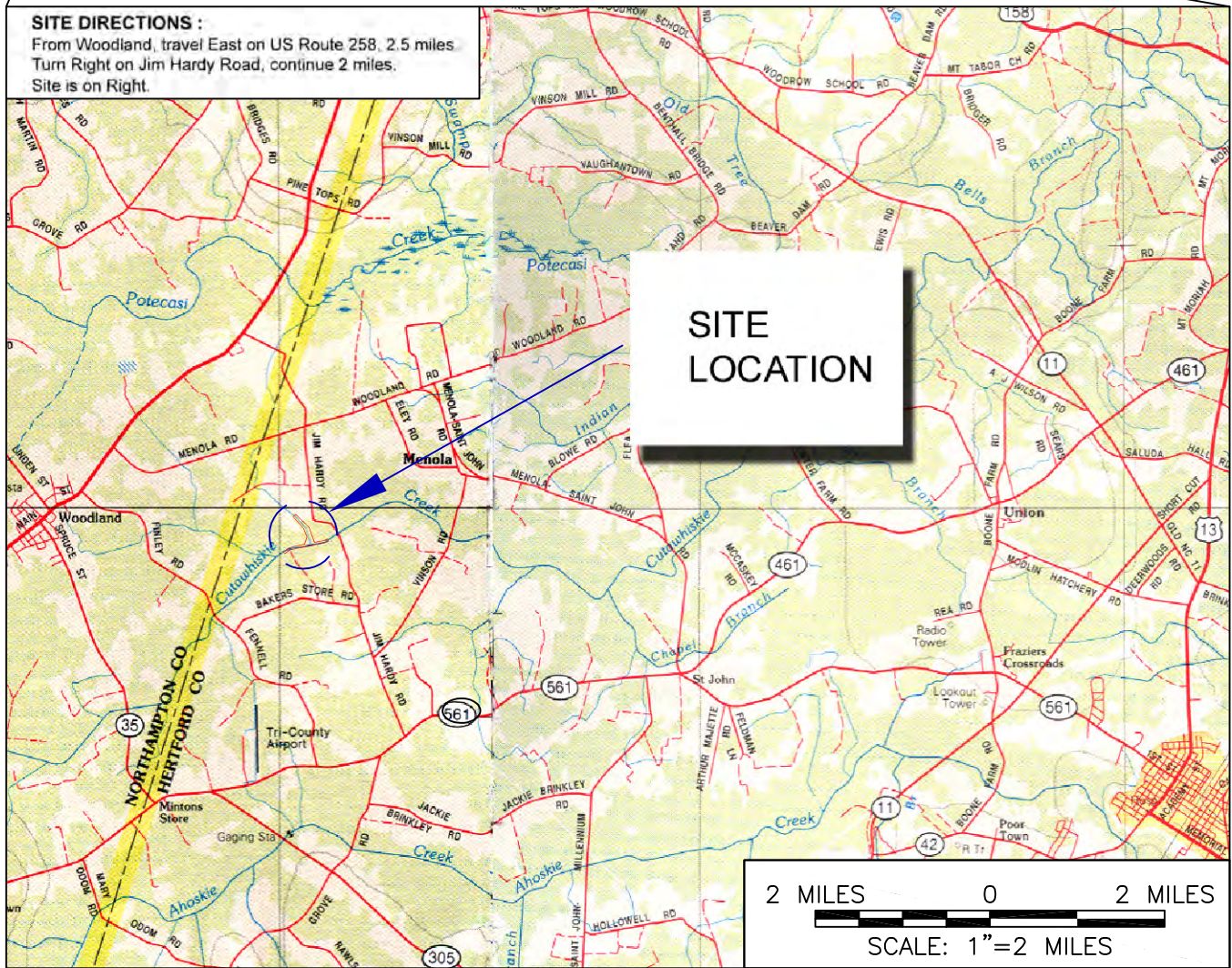
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CHOWAN RIVER BASIN
(CU03010204)

HERTFORD COUNTY



SITE DIRECTIONS :
 From Woodland, travel East on US Route 258, 2.5 miles
 Turn Right on Jim Hardy Road, continue 2 miles.
 Site is on Right.



Prepared by:

Project:

SITE LOCATION

**CUTAWHISKIE CREEK
 RESTORATION SITE
 MONITORING REPORT**

Hertford County, North Carolina

Dwn. By:	Ckd By:
RLG	JWG
Date:	OCT 2011
Scale:	AS SHOWN
ESC Project No.:	100004926

FIGURE

1

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consistent with other wetlands located in similar settings. The growing season in Hertford County begins on March 28 and ends on November 7 (225 days). In order to achieve hydrologic success, saturation within 12 inches of the ground surface is required for between 12 and 28 consecutive days (5 to 12.5 percent). The results of the Year 4 hydrologic monitoring indicate that all gauges exhibited saturation within 12 inches of the ground surface for at least 7.6 percent of the growing season. The period of saturation ranges from 17 to 44 days or (7.6 and 19.6%) with an average of 29.8 days (13.2%) of the growing season.

2.0 PROJECT BACKGROUND

2.1 Project Objectives

Site restoration activities included the excavation of a new stream channel, limited floodplain excavation, removal of stumps and debris, existing channel backfilling, on-site drainage ditch removal, and final grading and soil preparation within the adjacent floodplain. These activities were proposed in order to reintroduce surface water flood hydrodynamics from a 0.9-square mile watershed along the newly restored length of stream and floodplain. The new channel was constructed to reflect regional stream characteristics and accommodate bankfull flows. Characteristic wetland soil features, groundwater wetland hydrology, and hydrophytic vegetation communities are expected develop in areas adjacent to the constructed channel. Wetland and adjacent slope soil surfaces were restored and the Site reforested to promote riparian and upland slope hardwood communities. Plant community associations were designed to mimic various indigenous communities described by Schafale and Weakley (1990), including Coastal Plain Levee Forest, Cypress-Gum Swamp, Mesic-Mixed Hardwood Forest, and Coastal Plain Small Stream Swamp.

Specific ecological benefits anticipated as a result of on-Site restoration activities are as follows:

- Stream channel restoration will reintroduce stable bankfull dimension, pattern, and profile along restored stream reaches, which is expected to enhance lotic habitat quality and stream function.
- Floodplain excavation adjacent to restored streams will restore the characteristic flood regime, as well as provide a lateral hydrologic input to restored wetland areas adjacent to the UT and within the greater Cutawhiskie Creek floodplain.
- Restored and enhanced wetland areas will help to improve water quality via nutrient removal, increase local vegetative biodiversity, provide wildlife habitat, and serve as a forested corridor, linking the Site with adjacent forested areas.

2.2 Project Structure, Restoration Type, and Approach

The primary restoration features within the Site include the UT to Cutawhiskie Creek and approximately 11.9 acres of drained, hydric soils. The UT had been dredged and straightened, such that it did not exhibit stable dimension, pattern, and profile features. Side-cast material (spoil piles) from dredging was deposited along the west bank of the former channel. A moderate headcut (approximately 2 foot drop in elevation over 20 linear feet of stream channel) was observed near the upstream (north) extent of the Site boundary, indicating vertical instability. Due to its high level of entrenchment caused by dredging, large flooding events were confined within the former channel.

On-site restoration activities provide the following project mitigation units:

Table I: Project Restoration Components Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A					
Project Segment or Reach ID	Mitigation Type	Approach	Mitigation Units Linear Footage (LF) or Acreage (AC)	Stationing	Comment
UT to Cutawhiskie Creek (active restoration)	R	P1	2,540 LF	0+00 – 25+40	
UT to Cutawhiskie Creek (passive restoration)	R	NA	359 LF	NA	Passive restoration through floodplain not stationed. Braided reach measured as straight line distance to outfall
Stream Preservation (Cutawhiskie Creek)	P	NA	519 LF	NA	2593 LF actual design units, however only 20 percent is available for SMU
Riparian Wetland Restoration	R	NA	11.9 AC	NA	
Riparian Wetland Enhancement	WE	NA	0.6 AC	NA	1.1 AC actual design units, however only 0.6 LF available as WMU
<i>R = Restoration</i>			<i>P1 = Priority 1</i>		
<i>P = Preservation</i>			<i>NA = Not applicable</i>		
<i>WE = Wetland Enhancement</i>					

2.3 Location and Setting

Land uses in the vicinity of the Site consist primarily of agriculture, forest, pastureland, roadside shoulders, and residential lots. Row crops including soybeans, cotton, and corn are actively cultivated on the Site and surrounding areas. The Site is immediately adjacent to active rowcrop agriculture and timberland. There is no livestock or poultry production in the vicinity. Timber is actively harvested from adjacent forested areas. A large, contiguous bottomland hardwood stand was harvested just west of the Site along the Cutawhiskie floodplain in the spring of 2006. The Site encompasses approximately 22.9 acres of primary and secondary floodplain associated with Cutawhiskie Creek. The Site includes a UT that flows into Cutawhiskie Creek from the north (Figure 1). Portions of the Site had been logged prior to restoration activities, while other areas within the Site were actively managed for timber or agricultural production. Prior to restoration, the Site vegetation was generally characterized by bottomland hardwood forests along un-logged areas on the Cutawhiskie Creek floodplain and low

terraces, row crops including soybeans and corn, and successional communities associated with cut-over timberland.

2.4 History and Background

Table II. Project Activity and Reporting History Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A			
Activity Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	N/A*	December 2007	January 2007
Final Design (90 percent)	N/A*	December 2007	January 2007
Construction	N/A*	N/A*	November 2007
Temporary S&E mix applied to entire project area	November 2007	N/A*	November 2007
Permanent seed mix applied to reach/segments	November 2007	N/A*	November 2007
Bare Root Seedling Installation	February 2008	N/A*	February 2008
Mitigation Plan	April 2008	February 2008	April 2008
Minor repairs made filling small washed out areas	N/A*	N/A*	N/A*
Final Report	N/A*	N/A*	N/A*
Year 1 Vegetation Monitoring	November 2008	August 2008	November 2008
Year 1 Stream Monitoring	November 2008	September 2008	November 2008
Year 2 Vegetation Monitoring	November 2009	September 2009	December 2009
Year 2 Stream Monitoring	November 2009	September 2009	December 2009
Year 3 Vegetation Monitoring	November 2010	September 2010	November 2010
Year 3 Stream Monitoring	November 2010	September 2010	November 2010
Year 4 Vegetation Monitoring	November 2011	September 2011	November 2011
Year 4 Stream Monitoring	November 2011	September 2011	November 2011

*N/A- Activities and reporting history for these items are not applicable to this restoration project

Table III. Project Contacts Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A	
Prime Contractor	Restoration Systems, LLC 1101 Haynes Street, Suite 211 Raleigh, NC 27604 (919) 755-9490
Designer	Atkins (previously EcoScience Corporation/PBS&J) 1616 East Millbrook Road, Suite 310 Raleigh, NC 27609 (919) 876-6888
Construction Contractor	Anderson Farms 179 NC 97 East Tarboro, NC 27886 (252) 823-4730
Planting Contractor	Carolina Silvics 908 Indian Trail Road Edenton, NC 27932 (919) 523-4375
Seeding Contactor	Anderson Farms 179 NC 97 East Tarboro, NC 27886 (252) 823-4730
Seed Mix Sources	Erosion Supply Company 8817 Midway West Rd Raleigh, NC 27617 (919) 787-0334
Nursery Stock Suppliers	South Carolina Super Tree Nursery Company 5594 Highway 38 South Blenheim, SC 29516 (800) 222-1290
Monitoring Performers	Atkins North America, Inc. 1616 East Millbrook Road, Suite 310 Raleigh, NC 27609 (919) 876-6888
Stream Monitoring POC	Jens Geratz
Vegetation Monitoring POC	Jens Geratz

Table IV. Project Background Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A	
Project County	Hertford
Drainage Area	0.9 square miles
Impervious cover estimate (%)	0
Stream Order (UT/ Cutawhiskie Creek)	1st order / 3rd order
Physiographic Region	Coastal Plain
Ecoregion (Griffith and Omernik)	Mid-Atlantic Flatwood
Rosgen Classification of As-built	E5
Cowardin Classification	Stream (R3UB2)
Dominant soil types	Craven fine sandy loam (<i>Aquic Hapludults</i>)
	Leaf loam (<i>Typic Albaquults</i>)
	Wilbanks silty clay loam (<i>Cumulic Humaquepts</i>)
Reference Site ID	Black Branch, Bullard Branch, UT to Town Creek
USGS HUC for Project	03010204
NCDWQ Sub-basin for Project	03-01-02
NCDWQ classification for Project	C-NSW
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	N/A
Percent of project easement fenced	N/A

3.0 PROJECT MONITORING AND RESULTS

3.1 Vegetation Assessment

Five vegetation monitoring (10 x 10 m²) plots were established to monitor planted vegetation within Site's restoration and enhancement areas. Site vegetation was monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey (CVS) (CVS-EEP Protocol for Recording Vegetation, Level 1-2 Plot Sampling Only, Version 4.0, 2006). Established vegetation monitoring plot locations are displayed on the Current Conditions Area Plan View (Appendix D). Vegetative monitoring success will be achieved by plot data indicating an average number of planted stems exceeding 320 stems per acre after the third year of monitoring and 260 stems per acre after the fifth and final year of project monitoring. During Year 4 monitoring, the Site exceeded the vegetation success criteria with an average of 461 planted stems per acre. If volunteer species are included, the total number of stems increases to 5,771 stems per acre. Table V summarizes vegetation plot density for the first four years of monitoring. Refer to Appendix A for CVS vegetation data collected during Year 4 monitoring.

Chinese privet (*Ligustrum sinense*), an exotic invasive, was found growing densely along the lower reach of the stream channel. During the winter of 2010, the Prime Contractor (Restoration Systems LLC) initiated their plan to manage exotic species Chinese privet on the Site. Dense thickets of Chinese privet

were sprayed along the southwestern Site boundary (Figure 2A and 2B, Appendix D) and solitary specimens located along Cutawhiskie Creek. Given the vigorous nature of Chinese privet, the Site will continue to be monitored in order to maintain control of the species.

Table V. Vegetation Plot Summary					
Planted Stems per Acre					
Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A					
Plot	MY-01	MY-02	MY-03	MY-04	MY-05
1	728	688	688	526	
2	688	647	647	567	
3	688	688	567	607	
4	688	486	324	243	
5	567	486	394	364	
MEAN	672	599	518	461	

3.2 Stream Assessment

In order to document stable bankfull dimension, pattern, and profile along the restored channel, annual stream assessment surveys (longitudinal profile and six channel cross-sections) were undertaken (locations shown on Figure 2A and 2B, Appendix D). The longitudinal profile and channel cross-section plots are located in Appendix C. Channel geomorphic data is summarized on Tables VIII and IX. Success criteria for stream restoration include 1) successful classification of the reach as a functioning system (Rosgen 1996) and 2) channel permanence indices indicative of a stable stream system. Overall the stream survey data indicates a stable channel with very little lateral or vertical movement; balanced aggradation/degradation processes; and a rapidly developing, diverse riparian buffer. One bankfull event documented on August 27, 2011 (Hurricane Irene) further demonstrates stream stability. This is the fourth bankfull event that has been documented during the past four years of monitoring. No stream problem areas were identified during Year 4 monitoring.

Table VI Hydrological (Bankfull) Verifications			
Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A			
Date of Data Collection	Date of Occurrence	Method	Photo Number
11-16-09	11-14-09	Photo documentation	See 2009 Monitoring Report
03-04-10	03-03-10	Photo documentation	See 2010 Monitoring Report
11-18-10	09-28-10	Photo documentation	See 2010 Monitoring Report
09-09-11	08-27-11	Photo documentation	Photo 1-2, Appendix B

**Table VII. Categorical Stream Feature Visual Stability Assessment
Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A**

Segment/Reach: 2,540 feet

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles	100%	100%	100%	100%	100%	
B. Pools	100%	100%	100%	100%	100%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	100%	100%	100%	100%	
E. Bed General	100%	100%	100%	100%	100%	
F. Bank Condition	100%	100%	100%	100%	100%	
G. Rock Vanes	N/A	N/A	N/A	N/A	N/A	
H. Root Wads	N/A	N/A	N/A	N/A	N/A	

**Table VIII. Baseline Morphology and Hydraulic Summary
Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A**

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Dimension																		
BF Width (ft)	N/A	N/A	N/A	N/A	N/A	9.0	8.4	9.6	9.1	7.2	9.8	8.7	6.0	8.0	7.0	6.4	7.5	7.0
Floodprone Width (ft)	N/A	N/A	N/A	N/A	N/A	N/A	12	13	12.5	175	225	200	150+	150+	150+	150+	150+	150+
BF Cross Sectional Area (ft ²)	N/A	N/A	N/A	N/A	N/A	9.5	64	137	100.5	9	11.5	10.2	7.0	11.0	9.0	6.6	10.4	8.7
BF Mean Depth (ft)	N/A	N/A	N/A	N/A	N/A	0.9	0.9	1.1	1.0	1.1	1.3	1.2	0.7	1.4	1.3	1.0	1.4	1.2
BF Max Depth (ft)	N/A	N/A	N/A	N/A	N/A	N/A	1.5	1.7	1.6	1.5	1.9	1.7	1.5	3.5	1.8	1.5	3.1	2.4
Width/Depth Ratio	N/A	N/A	N/A	N/A	N/A	10.0	8.7	9.3	9.0	5.5	8.4	7.4	4	5.7	5.4	6.4	5.4	5.8
Entrenchment Ratio	N/A	N/A	N/A	N/A	N/A	N/A	1.3	1.4	1.35	20.3	23.1	21.4	1.2	5.9	>18.0	1.2	5.9	4.3
Wetted Perimeter(ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.6	35.6	17.6
Bank Height Ratio	N/A	N/A	N/A	N/A	N/A	N/A	3.4	5.0	4.2	1.1	1.3	1.2	1.0	1.1	1.0	1.0	1.1	1.0
Hydraulic radius (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.7	1.2	0.9	0.7	1.2	0.9
Pattern																		
Channel Beltwidth (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A*	N/A*	N/A*	12.0	113.0	38.3	28.0	49.0	40.0	28.0	49.0	40.0
Radius of Curvature (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A*	N/A*	N/A*	7.0	58.0	19.4	9.0	14.0	11.0	9.0	14.0	11.0
Meander Wavelength (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A*	N/A*	N/A*	28.0	175.0	75.7	40.0	60.0	50.0	40.0	60.0	50.0
Meander Width ratio	N/A	N/A	N/A	N/A	N/A	N/A	N/A*	N/A*	N/A*	2.1	21.6	8.1	5.7	10	7.9	5.7	10	7.9
Profile																		
Riffle length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A*	N/A*	N/A*	N/A	N/A	N/A	3.0	25.0	12.0	3.2	21.3	11.1
Riffle slope (ft/ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A*	N/A*	N/A*	N/A	N/A	N/A	0.00	0.050	0.001	0.000	0.082	0.013
Pool length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A*	N/A*	N/A*	5.0	84.0	29.8	4.0	25.0	12.0	4.1	25.6	13.4
Pool spacing (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A*	N/A*	N/A*	19.0	113.0	52.6	8.0	30.0	20.0	10.4	36.3	20.0
Substrate																		
d50 (mm)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	1.5	1.5	1.5	N/A	N/A	N/A	NA	NA	NA
d84 (mm)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	1.9	1.9	1.9	N/A	N/A	N/A	NA	NA	NA
Additional Reach Parameters																		
Valley Length (ft)		N/A			N/A			2,200			N/A			1,775			1,775	
Channel Length (ft)		N/A			N/A			2,200			N/A			2,540			2,540	
Sinuosity		N/A			N/A			1.0			1.4-1.6			1.4			1.4	
Water Surface Slope (ft/ft)		N/A			N/A			0.0031			0.002			N/A			0.0004	
BF slope (ft/ft)		N/A			N/A			N/A			0.004			N/A			0.0005	
Rosgen Classification		N/A			N/A			G5			E5			E5			E5	
Habitat Index / Macroinvertebrates		NA			N/A			N/A			N/A			N/A			N/A	

* No Distinct Riffles and Pools or Repetitive Channel Pattern due to Dredging and Straightening

**Table IX. Morphology and Hydraulic Monitoring Summary
Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A**

Parameter	Cross-Section 1 Pool						Cross-Section 2 Riffle						Cross-Section 3 Pool						Cross-Section 4 Riffle					
	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY	MY1	MY2	MY3	MY4	MY5	MY
BF Width (ft)	17.4	9.2	22.5	24.7			9.1	6.8	6.7	6.2			26.9	15.5	20.1	23.3			7.9	7.7	7.1	6.3		
Floodprone Width (ft)	150+	150+	150+	150+			150+	150+	150+	150+			150+	150+	150+	150+			150+	150+	150+	150+		
BF Cross Sectional Area (ft ²)	18.9	9.2	20.1	21.9			9.0	8.2	8.1	7.7			26.4	11.5	18.0	22.8			9.4	9.4	8.2	7.3		
BF Mean Depth (ft)	1.1	1.3	0.9	0.9			1.0	1.2	1.2	1.2			1.0	0.7	0.9	1.0			1.2	1.2	1.2	1.2		
BF Max Depth (ft)	2.7	2.2	2.9	2.8			1.9	1.9	1.7	1.9			3.1	2.3	2.5	3.1			1.8	1.8	1.7	1.7		
Width/Depth Ratio							9.2	5.7	5.6	5.2									6.6	6.4	5.9	5.3		
Entrenchment Ratio							16.5	22.0	22.3	16.1									19.0	19.4	21.1	15.9		
Wetted Perimeter(ft)							10.7	8.1	8.0	7.9									9.0	8.9	9.2	9.0		
Hydraulic radius (ft)							0.8	0.8	1.0	1.0									1.0	1.0	0.9	0.8		
Substrate																								
d50 (mm)	Silt	Silt	Silt	Silt			Silt	Silt	Silt	Silt			Silt	Silt	Silt	Silt			Silt	Silt	Silt	Silt		
d84 (mm)	Silt	Silt	Silt	Silt			Silt	Silt	Silt	Silt			Silt	Silt	Silt	Silt			Silt	Silt	Silt	Silt		
Parameter	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)			MY+								
Pattern	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean						
Channel Beltwidth (ft)	28.0	49.0	40.0	28.0	49.0	40.0	28.0	49.0	40.0	28.0	49.0	40.0												
Radius of Curvature (ft)	9.0	14.0	11.0	9.0	14.0	11.0	9.0	14.0	11.0	9.0	14.0	11.0												
Meander Wavelength (ft)	40.0	60.0	50.0	40.0	60.0	50.0	40.0	60.0	50.0	40.0	60.0	50.0												
Meander Width ratio	5.7	10	7.9	5.7	10	7.9	5.7	10	7.9	5.7	10	7.9												
Profile																								
Riffle length (ft)	4.0	21.0	11.5	2.4	19.3	10.0	2.1	18.4	10.4	1.0	26.7	11.8												
Riffle slope (ft/ft)	0.000	0.074	0.007	0.000	0.094	0.013	0.000	0.072	0.011	0.000	0.079	0.004												
Pool length (ft)	1.0	23.8	12.5	2.6	22.7	13.4	3.7	23.2	14.0	3.2	25.1	14.2												
Pool spacing (ft)	9.6	36.0	20.6	7.7	28.7	18.3	9.3	32.1	18.9	8.9	36.7	18.2												
Additional Reach Parameters																								
Valley Length (ft)	1,775			1,775			1,775			1,775														
Channel Length (ft)	2,540			2,540			2,540			2,540														
Sinuosity	1.4			1.4			1.4			1.4														
Water Surface Slope (ft/ft)	0.0004			0.0004			N/A (dry channel)			0.0006														
BF slope (ft/ft)	0.0005			0.0005			0.0005			0.0006														
Rosgen Classification	E5			E5			E5			E5														

Table IX. cont. Morphology and Hydraulic Monitoring Summary Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A																								
Parameter	Cross Section 5 Riffle						Cross Section 6 Pool																	
	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	7.0	7.2	7.4	7.4			15.1	13.7	13.5	12.9														
Floodprone Width (ft)	150+	150+	150+	150+			150+	150+	150+	150+														
BF Cross Sectional Area (ft ²)	6.7	6.2	6.1	5.1			16.8	14.1	12.8	9.6														
BF Mean Depth (ft)	1.0	0.8	0.8	0.7			1.1	1.0	0.9	0.7														
BF Max Depth (ft)	1.4	1.4	1.4	1.1			2.7	2.5	2.7	2.7														
Width/Depth Ratio	7.4	5.1	9.3	10.6																				
Entrenchment Ratio	21.5	20.8	20.3	13.5																				
Wetted Perimeter(ft)	7.8	7.8	8.8	8.9																				
Hydraulic radius (ft)	0.9	0.9	0.7	0.6																				
Substrate																								
d50 (mm)	Silt	Silt	Silt	Silt			Silt	Silt	Silt	Silt														
d84 (mm)	Silt	Silt	Silt	Silt			Silt	Silt	Silt	Silt														

3.3 Wetland Hydrology Assessment

Success criteria for wetland hydrology require that restored areas be inundated or saturated by groundwater within 12 inches of the ground surface for a period of 5 to 12.5 percent of the growing season. The growing season in Hertford County begins on March 28 and ends on November 7 (225 days). In order to achieve hydrologic success, saturation within 12 inches of the ground surface is required for between 12 and 28 consecutive days during the growing season (5 to 12.5 percent). The results of the Year 4 hydrologic monitoring indicate that all gauges exhibited saturation within 12 inches of the ground surface for at least 7.6 percent of the growing season (Appendix C). The average saturation period for all gauges was 29.8 days (13.2%) ranging from 17 to 44 days (7.6 and 19.6%).

Figure 3 (Appendix C) shows a comparison of 2011 monthly rainfall to historical precipitation for Hertford County. The figure shows average rainfall data collected between 1948 and 2011 and compares 30 percent and 70 percent of all observations with the actual 2011 monthly rainfall amounts to determine average. Monthly rainfall amounts were below the 30th percentile during four months of the growing season. Table X summarizes wetland hydrology criteria for Year 4 monitoring.

4.0 METHODOLOGY

No unavoidable deviations from initially prescribed methodologies were implemented as part of Year 4 monitoring activities.

5.0 REFERENCES

- Lee, Michael T., R. K. Peet, S. D. Roberts, and T. R. Wentworth. 2006 CVS-EEP Protocol for Recording Vegetation, Version 4.0 (<http://cvs.bio.unc.edu/methods.htm>)
- Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology (Publisher). Pagosa Springs, Colorado.
- Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.
- Weakley, A.S. 2010. Flora of the Southern and Mid-Atlantic States. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina at Chapel Hill. 944pp.

**Table X. Wetland Criteria Attainment
Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A**

Hydrology						
Monitoring Year	Gauge ID	Wetland Criteria Met			Maximum Consecutive Saturated Days (% of growing season)	Total Number of Saturated Days (% of growing season)
		<5%	5-12.5%	>12.5%		
1	1		✓		17 (7.6)	67 (29.8)
	2*		✓		12 (5.3)	82 (36.4)
	3			✓	59 (26.2)	73 (32.4)
	4			✓	57 (25.3)	79 (35.1)
	5		✓		15 (6.7)	37 (16.4)
2	1		✓		26 (11.6)	54 (24.0)
	2**	✓			7 (3.1)	32 (14.2)
	3			✓	29 (12.9)	54 (24.0)
	4			✓	32 (14.2)	59 (26.2)
	5		✓		22 (9.8)	39 (17.3)
3	1		✓		14 (6.2)	45 (20.0)
	2		✓		23 (10.2)	63 (28.0)
	3		✓		19 (8.4)	58 (25.8)
	4*		✓		22 (9.8)	40 (17.8)
	5		✓		12 (5.3)	33 (14.7)
4	1		✓		23 (10.2)	67 (29.8)
	2			✓	44 (19.6)	98 (43.6)
	3		✓		26 (11.6)	77 (34.2)
	4			✓	39 (17.3)	78 (34.7)
	5		✓		17 (7.6)	48 (21.3)
Vegetation						
Monitoring Year	Vegetation Density Met					Tract Density (Planted Stems)
	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	
1	✓	✓	✓	✓	✓	672
2	✓	✓	✓	✓	✓	599
3	✓	✓	✓	✓	✓	518
4	✓	✓	✓	✓	✓	461

*Missing data due to gauge malfunction. In both cases, would have likely extended the maximum consecutive saturated days.

**Gauge moved after year 2 to avoid draining effects of the UT. Initial position was directly adjacent to stream.

APPENDIX A: VEGETATIVE DATA

Table A1: Vegetation Metadata

Report Prepared By	Adam Efird
Date Prepared	10/11/2011 15:28
Database name	Cutawhiskie_2008-2011_CVS Data.mdb
Database location	G:\Projects\Projects06\06-306 Cutawhiskie Creek\Mitigation Monitoring\2011 (Year 4) Monitoring\Veg
Computer name	RALH3TDXF1
File size	35229696
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp.	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
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	D04020
Project Name	Cutawhiskie Stream Restoration
Description	restoration monitoring
River Basin	Chowan
Length (ft)	2,540
Stream-to-edge width (ft)	6
Area (sq m)	8
Required Plots (calculated)	
Sampled Plots	5

Table A2 Vegetation Vigor by Species

	Species	4	3	2	1	0	Missing	Unknown
	<i>Liquidambar styraciflua</i>						1	
	<i>Nyssa biflora</i>	1	12	5	1		9	
	<i>Quercus lyrata</i>		10				3	
	<i>Quercus pagoda</i>	1	3					
	<i>Quercus phellos</i>	1	5	1			2	
	<i>Taxodium distichum</i>	9	8				2	
TOT:	6	12	38	6	1		17	

Table A3. Vegetation Damage by Species

	Species	All Damage Categories	(no damage)	Cut	Unknown
	<i>Liquidambar styraciflua</i>	0	1		
	<i>Nyssa biflora</i>	2	26		2
	<i>Quercus lyrata</i>	0	13		
	<i>Quercus pagoda</i>	0	4		
	<i>Quercus phellos</i>	2	7	1	1
	<i>Taxodium distichum</i>	0	19		
TOT:	6	4	64	1	3

Table A4. Vegetation Damage by Plot

	plot	All Damage Categories	(no damage)	Cut	Unknown
	D06066a-12345-0001-year:4	4	13	1	3
	D06066a-12345-0002-year:4	0	16		
	D06066a-12345-0003-year:4	0	17		
	D06066a-12345-0004-year:4	0	12		
	D06066a-12345-0005-year:4	0	12		
TOT:	5	4	70	1	3

Table A5. Stem Count by Plot and Species

	Species	Total Planted Stems	# plots	Avg # stems	D06066a-12345-0001-year:4	D06066a-12345-0002-year:4	D06066a-12345-0003-year:4	D06066a-12345-0004-year:4	D06066a-12345-0005-year:4
	<i>Nyssa biflora</i>	19	4	4.75	2	8	8	1	
	<i>Quercus lyrata</i>	10	4	2.5		1	3	3	3
	<i>Quercus pagoda</i>	4	2	2		2			2
	<i>Quercus phellos</i>	7	1	7	7				
	<i>Taxodium distichum</i>	17	5	3.4	4	3	4	2	4
TOT:	5	57	5	3.93	13	14	15	6	9

Table A6. All Stems by Plot and Species

	Species	Total Stems	# plots	Avg # stems	D06066a-12345-0001-year:4	D06066a-12345-0002-year:4	D06066a-12345-0003-year:4	D06066a-12345-0004-year:4	D06066a-12345-0005-year:4
	<i>Baccharis halimifolia</i>	3	1	3			4		
	<i>Fraxinus pennsylvanica</i>	214	5	42.8	65	34	7	94	14
	<i>Ligustrum sinense</i>	5	1	5	5				
	<i>Liquidambar styraciflua</i>	10	3	3.33	2	6			2
	<i>Nyssa biflora</i>	23	4	5.75	6	8	8	1	
	<i>Pinus taeda</i>	124	4	31	11	25	85		3
	<i>Quercus lyrata</i>	21	4	5.25		1	3	12	5
	<i>Quercus pagoda</i>	10	3	3.33	4	2			4
	<i>Quercus phellos</i>	9	1	9	9				
	<i>Taxodium distichum</i>	17	5	3.4	4	3	4	2	4
	<i>Ulmus alata</i>	21	4	5.25	2	6	8	5	
	<i>Rhus copallinum</i>	2	1	2	2				
	<i>Platanus occidentalis</i>	4	2	2				2	2
	<i>Acer rubrum</i>	250	5	50	11	126	28	38	47
TOT:	14	713	14	12.2	121	211	146	154	81

Photo Stations: Year 4 Monitoring



Photo Station 1



Photo Station 2



Photo Station 3

Vegetation Plots: Year 4 Monitoring



Vegetation Plot 1



Vegetation Plot 2



Vegetation Plot 3



Vegetation Plot 4



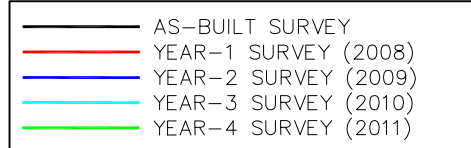
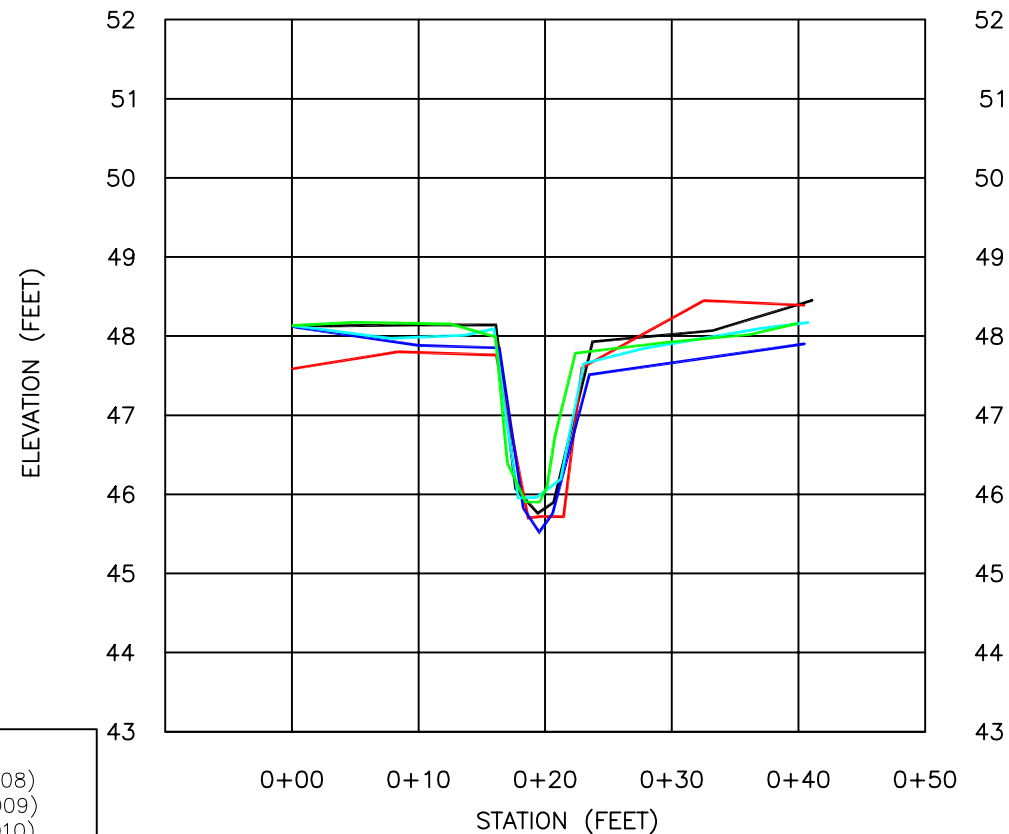
Vegetation Plot 5

APPENDIX B: GEOMORPHOLOGIC DATA

Table B2. Visual Morphological Stability Assessment
Cutawhiskie Creek Restoration Site – EEP Contract No. D06066-A
2,540 linear feet

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform Mean or Total
A. Riffles	1. Present?	77	77	N/A	100	
	2. Armor stable (e.g. no displacement)?	77	77	N/A	100	
	3. Facet grade appears stable?	77	77	N/A	100	
	4. Minimal evidence of embedding/fining?	77	77	N/A	100	
	5. Length appropriate?	77	77	N/A	100	100%
B. Pools	1. Present? (e.g not subject to severe aggrad. or migrat.?)	76	76	N/A	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	76	76	N/A	100	
	3. Length appropriate?	76	76	N/A	100	100%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	N/A	N/A	N/A	100	
	2. Downstream of meander (glide/inflection) centering?	N/A	N/A	N/A	100	100%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	N/A	N/A	N/A	100	
	2. Of those eroding, # w/concomitant point bar formation?	N/A	N/A	N/A	100	
	3. Apparent Rc within spec?	N/A	N/A	N/A	100	
	4. Sufficient floodplain access and relief?	N/A	N/A	N/A	100	100%
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/2540	100	
	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	N/A	N/A	0/2540	100	100%
F. Bank	1. Actively eroding, wasting, or slumping	N/A	N/A	0/2540	100	100%
G. Vanes	1. Free of back or arm scour?	N/A	N/A	N/A	N/A	
	2. Height appropriate?	N/A	N/A	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	N/A	N/A	N/A	
	4. Free of piping or other structural failures? ³	N/A	N/A	N/A	N/A	N/A
H. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	N/A

XS2 (Riffle)



SURVEY DATA					
STATION	ELEVATION	FEATURE	STATION	ELEVATION	FEATURE
0.00	48.13	LPIN			
5.17	48.17				
12.88	48.15				
16.46	47.99				
17.4	46.39				
18.85	45.9				
19.95	45.9				
20.53	46.1				
21.12	46.7				
22.75	47.78				
29.48	47.91				
36.63	48.02				
40.58	48.16	RPIN			

SUMMARY DATA	
BANKFULL CROSS SECTIONAL AREA	7.7 SQ. FT.
BANKFULL WIDTH	6.2 FT.
BANKFULL MEAN DEPTH	1.2 FT
BANKFULL MAX DEPTH	1.9 FT
WIDTH-DEPTH RATIO	5.2
ENTRENCHMENT RATIO	16.1
CLASSIFICATION	E5



REVISIONS



Project:
CUTAWHISKIE CREEK RESTORATION SITE

YEAR-4 MONITORING REPORT
 HERTFORD COUNTY, NC

Title:
CROSS SECTION XS2-RIFFLE

Dwn. By: _____ RLG
 Ckd. By: JWG Date: OCT 2011
 Scale: NO SCALE
 Project No.: 06-306

NOTES:
 1. All cross-sections facing the downstream direction

Survey Date	SEPT. 2011
Survey Weather	Sunny
Field Team	Schmid, Sicheloff
Location	XS2



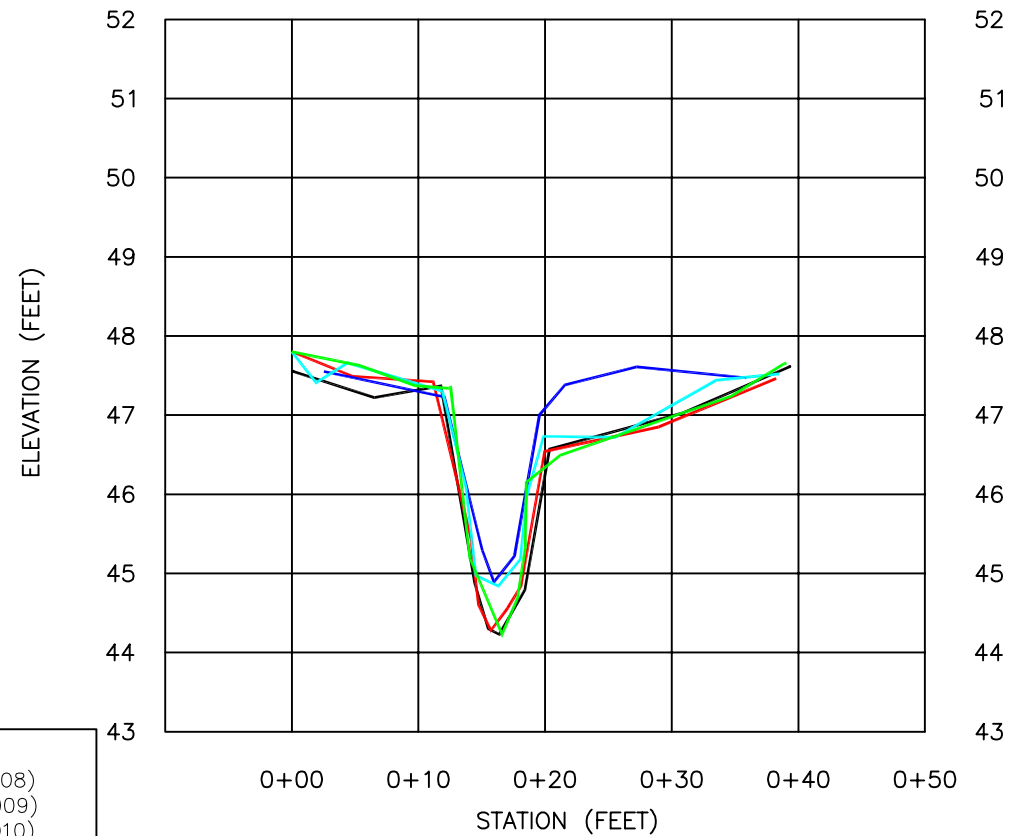
XS1 FROM LEFT BANK TO RIGHT BANK



XS2 LOOKING DOWNSTREAM

SHEET
B2

XS3 (Pool)



— AS-BUILT SURVEY
 — YEAR-1 SURVEY (2008)
 — YEAR-2 SURVEY (2009)
 — YEAR-3 SURVEY (2010)
 — YEAR-4 SURVEY (2011)

SURVEY DATA					
STATION	ELEVATION	FEATURE	STATION	ELEVATION	FEATURE
0.00	47.8	LPIN			
5.32	47.77				
9.8	47.51				
12.42	47.48				
12.57	47.49				
14.09	45.33				
16.64	44.37				
17.85	44.83				
18.47	45.47				
18.55	46.29				
21.21	46.63				
27.88	47.0				
34.74	47.38				
39.09	47.78	RPIN			



REVISIONS

Client:

SUMMARY DATA	
POOL CROSS SECTIONAL AREA	22.8 SQ. FT.
POOL WIDTH	23.3 FT.
POOL MEAN DEPTH	1.0 FT.
POOL MAX DEPTH	3.1 FT.
WIDTH-DEPTH RATIO	N/A
ENTRENCHMENT RATIO	N/A
CLASSIFICATION	N/A

Project:
CUTAWHISKIE CREEK RESTORATION SITE
 YEAR-4 MONITORING REPORT
 HERTFORD COUNTY, NC

Title:
CROSS SECTION XS3-POOL

Dwn. By: RLG
 Ckd. By: JWG Date: OCT 2011
 Scale: NO SCALE
 Project No.: 06-306

NOTES:
 1. All cross-sections facing the downstream direction

Survey Date	SEPT. 2011
Survey Weather	Sunny
Field Team	Schmid, Sicheloff
Location	XS3



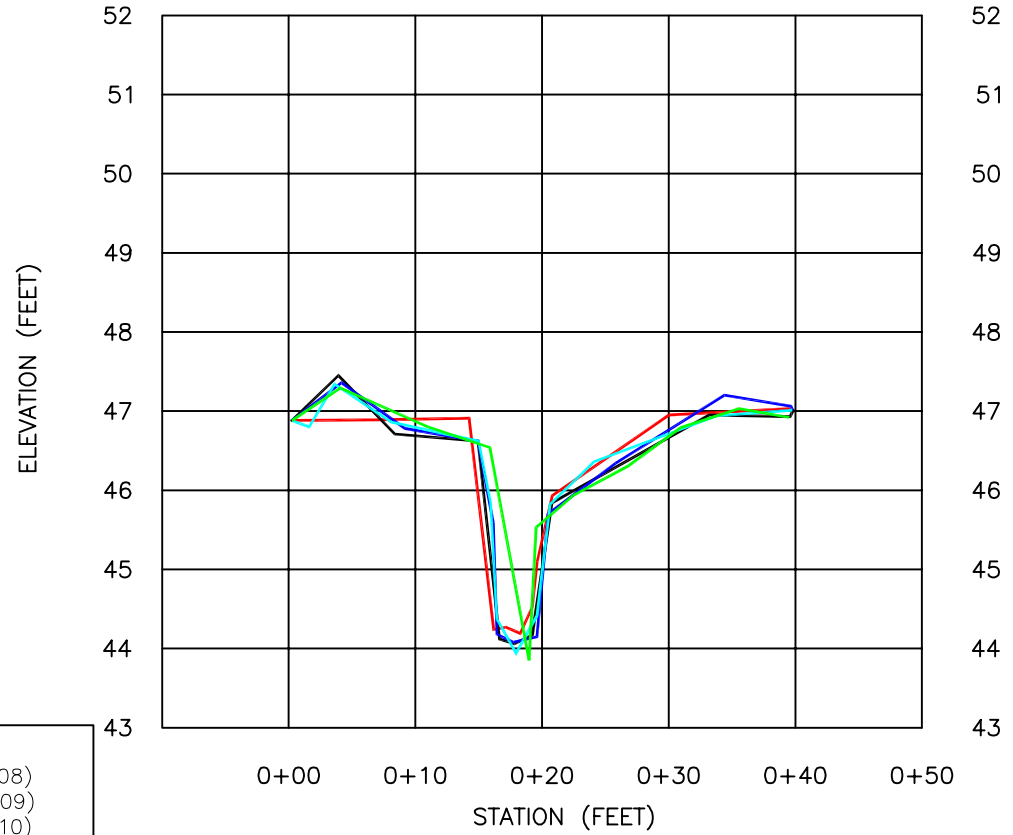
XS1 FROM LEFT BANK TO RIGHT BANK



XS3 LOOKING DOWNSTREAM

SHEET
B3

XS6 (Pool)



—	AS-BUILT SURVEY
—	YEAR-1 SURVEY (2008)
—	YEAR-2 SURVEY (2009)
—	YEAR-3 SURVEY (2010)
—	YEAR-4 SURVEY (2011)

SURVEY DATA					
STATION	ELEVATION	FEATURE	STATION	ELEVATION	FEATURE
0.00	46.88	LPIN			
3.81	47.29				
10.77	46.8				
15.64	46.54				
18.72	43.85				
19.29	45.53				
22.19	45.93				
26.58	46.31				
30.69	46.79				
35.29	47.03				
39.28	46.92	RPIN			

SUMMARY DATA	
POOL CROSS SECTIONAL AREA	9.6 SQ. FT.
POOL WIDTH	12.9 FT.
POOL MEAN DEPTH	0.7 FT.
POOL MAX DEPTH	2.7 FT.
WIDTH-DEPTH RATIO	N/A
ENTRENCHMENT RATIO	N/A
CLASSIFICATION	N/A



REVISIONS



Project:
CUTAWHISKIE CREEK RESTORATION SITE
 YEAR-4 MONITORING REPORT
 HERTFORD COUNTY, NC

Title:
CROSS SECTION XS6-POOL

Dwn. By: RLG
 Ckd. By: JWG Date: OCT 2011
 Scale: NO SCALE
 Project No.: 06-306

NOTES:
 1. All cross-sections facing the downstream direction

Survey Date	SEPT. 2011
Survey Weather	Sunny
Field Team	Schmid, Sicheloff
Location	XS6



XS1 FROM LEFT BANK TO RIGHT BANK



XS6 LOOKING DOWNSTREAM

REVISIONS

Client:



Project:

**CUTAWHISKIE
CREEK
RESTORATION
SITE**

**YEAR-4
MONITORING
REPORT**

HERTFORD COUNTY, NC

Title:

**LONGITUDINAL
PROFILE**

Dwn. By:

RLG

Ckd. By:

Date:

JWG OCT 2011

Scale:

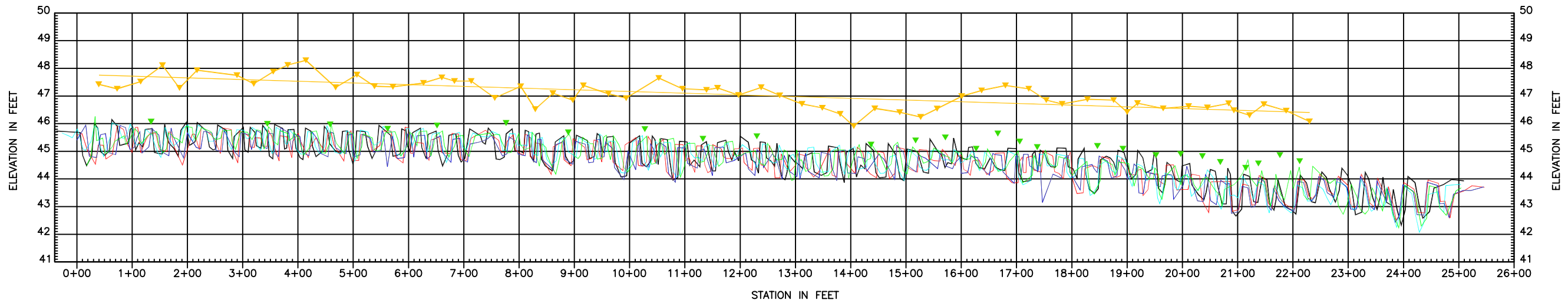
NO SCALE

Project No.:

06-306

SHEET

B7



—	AS-BUILT SURVEY
—	YEAR-1 SURVEY (2008)
—	YEAR-2 SURVEY (2009)
—	YEAR-3 SURVEY (2010)
—	YEAR-4 SURVEY (2011)
—▲	YEAR-4 BANKFULL
▼	YEAR-4 WATER SURFACE

Bankfull Event 08-27-11: Year 4 Monitoring



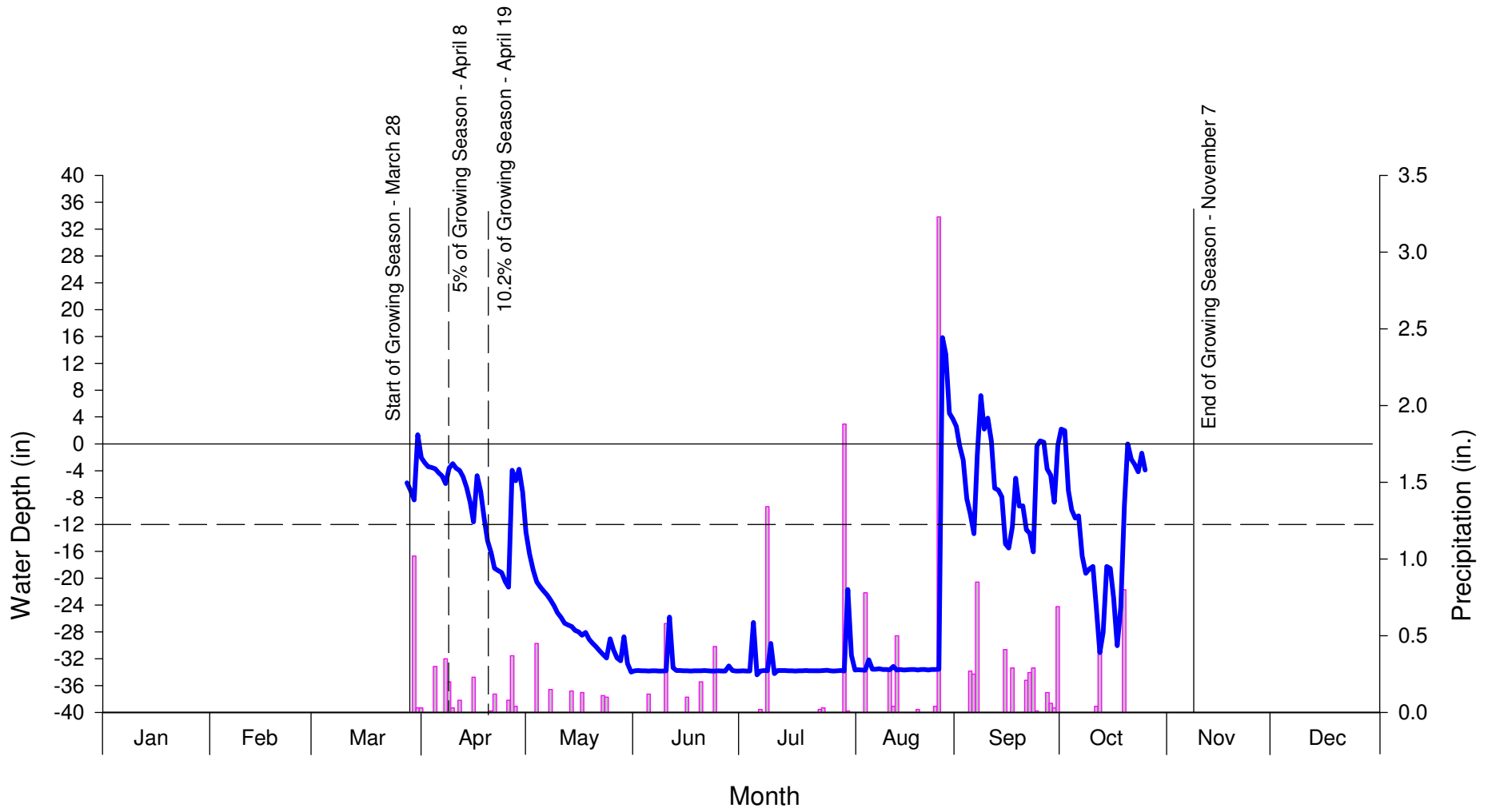
Photo 1. Hurricane Irene produced 5-7 inches of rain over the region during a 24 hour period. Evidence of a large bankfull event was seen while checking monitoring gauges. Herbaceous vegetation adjacent to the channel showed signs of being matted down from water flow. Wrack lines were found pressed against erosion matting stakes and woody vegetation.



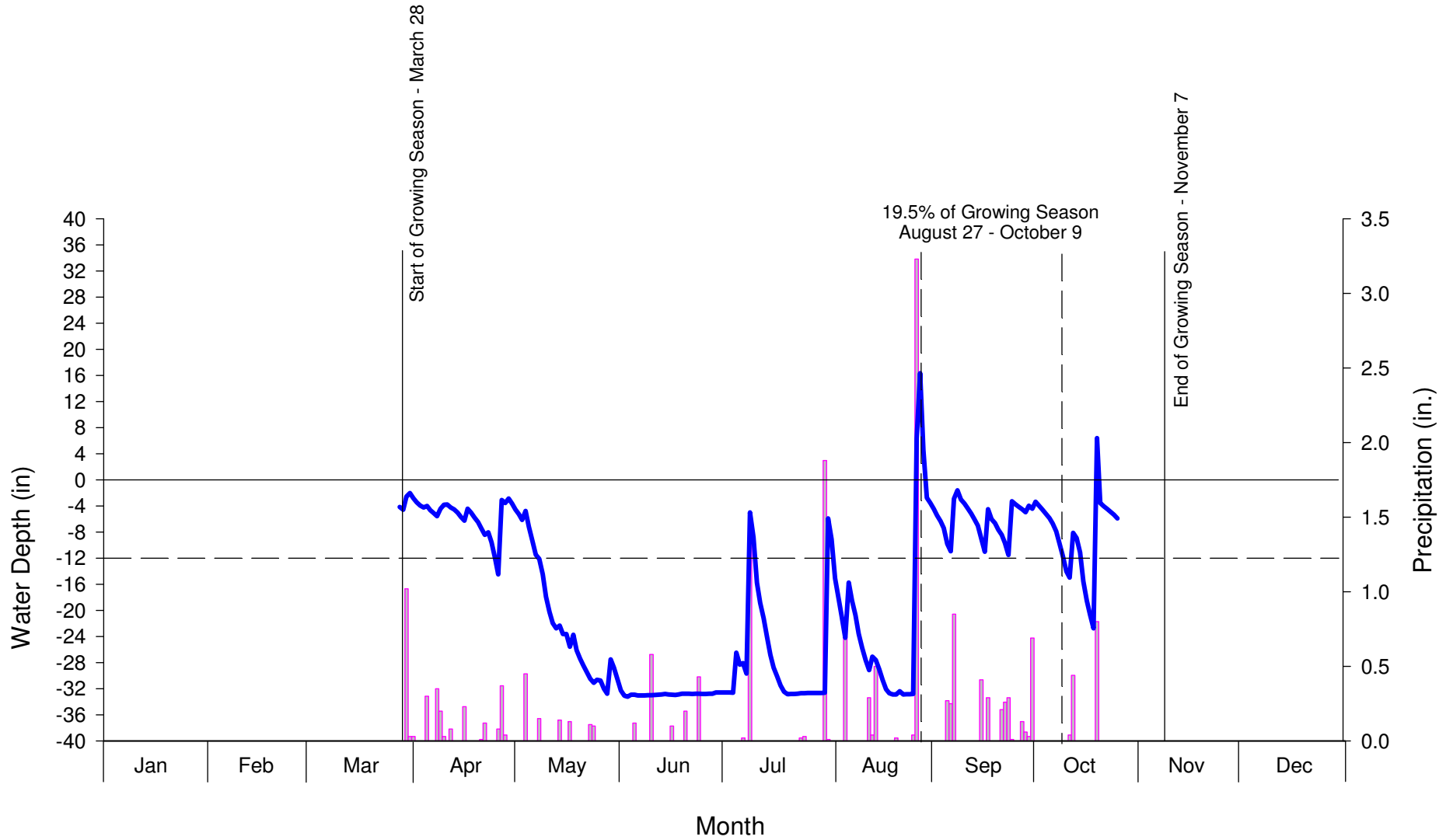
Photo 2. Floodplain wrack line looking from across channel.

APPENDIX C: WETLAND DATA HYDROGRAPHS

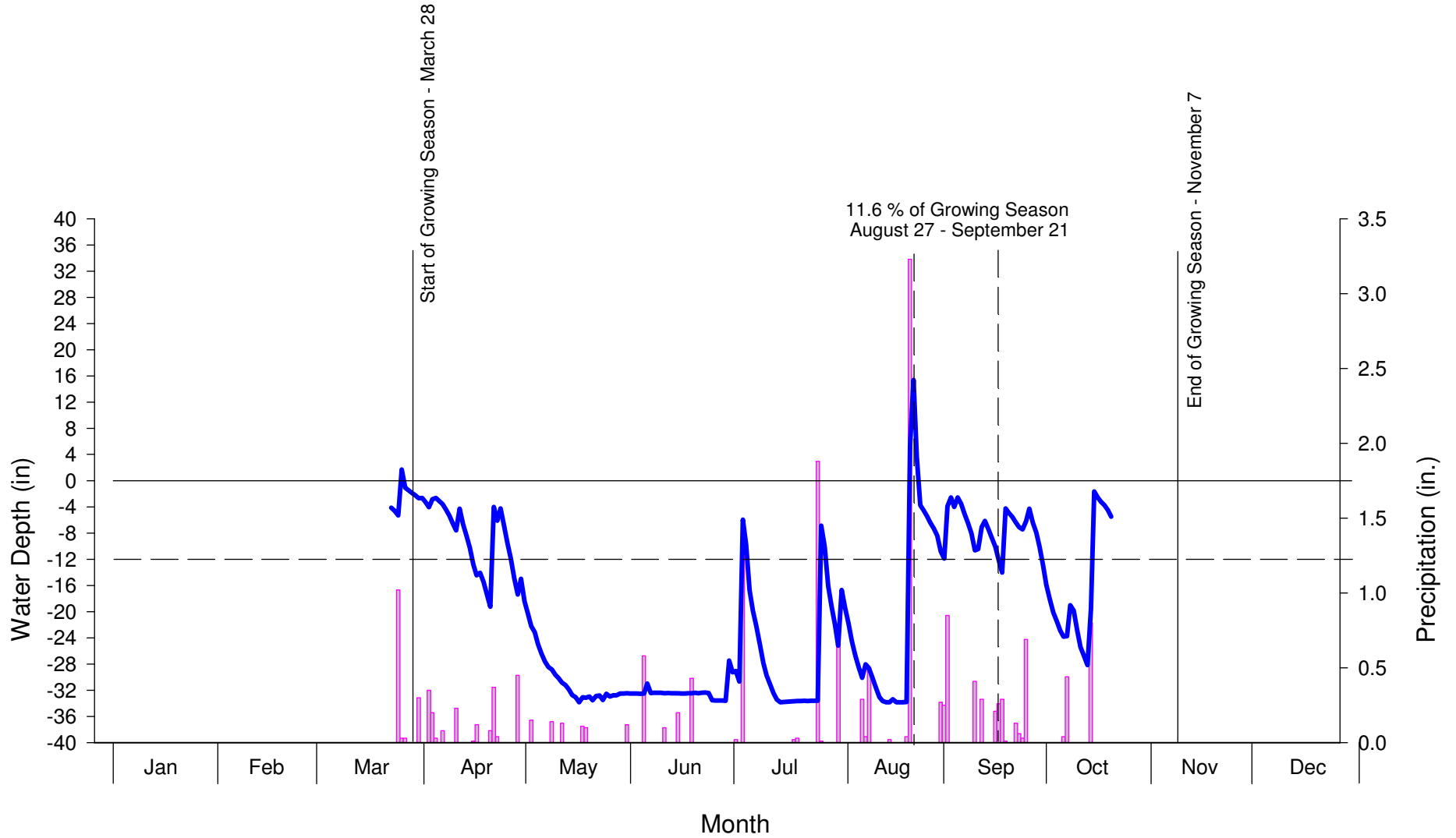
Cutawhiskie Creek Year-4 Monitoring - 2011 Monitoring Gauge 1: N47BAC28



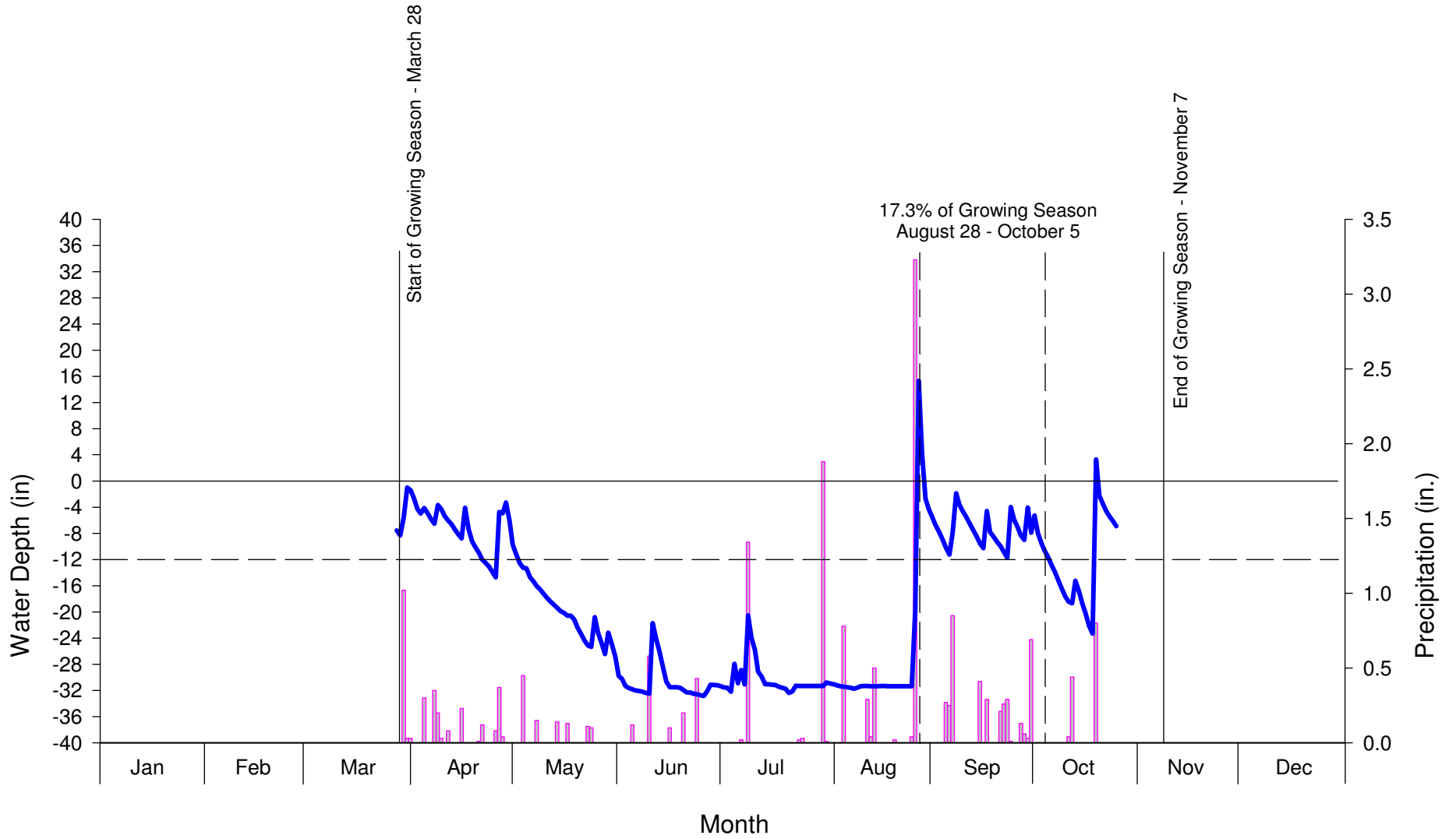
Cutawhiskie Creek Year-4 Monitoring - 2011 Monitoring Gauge 2: N47BAB81



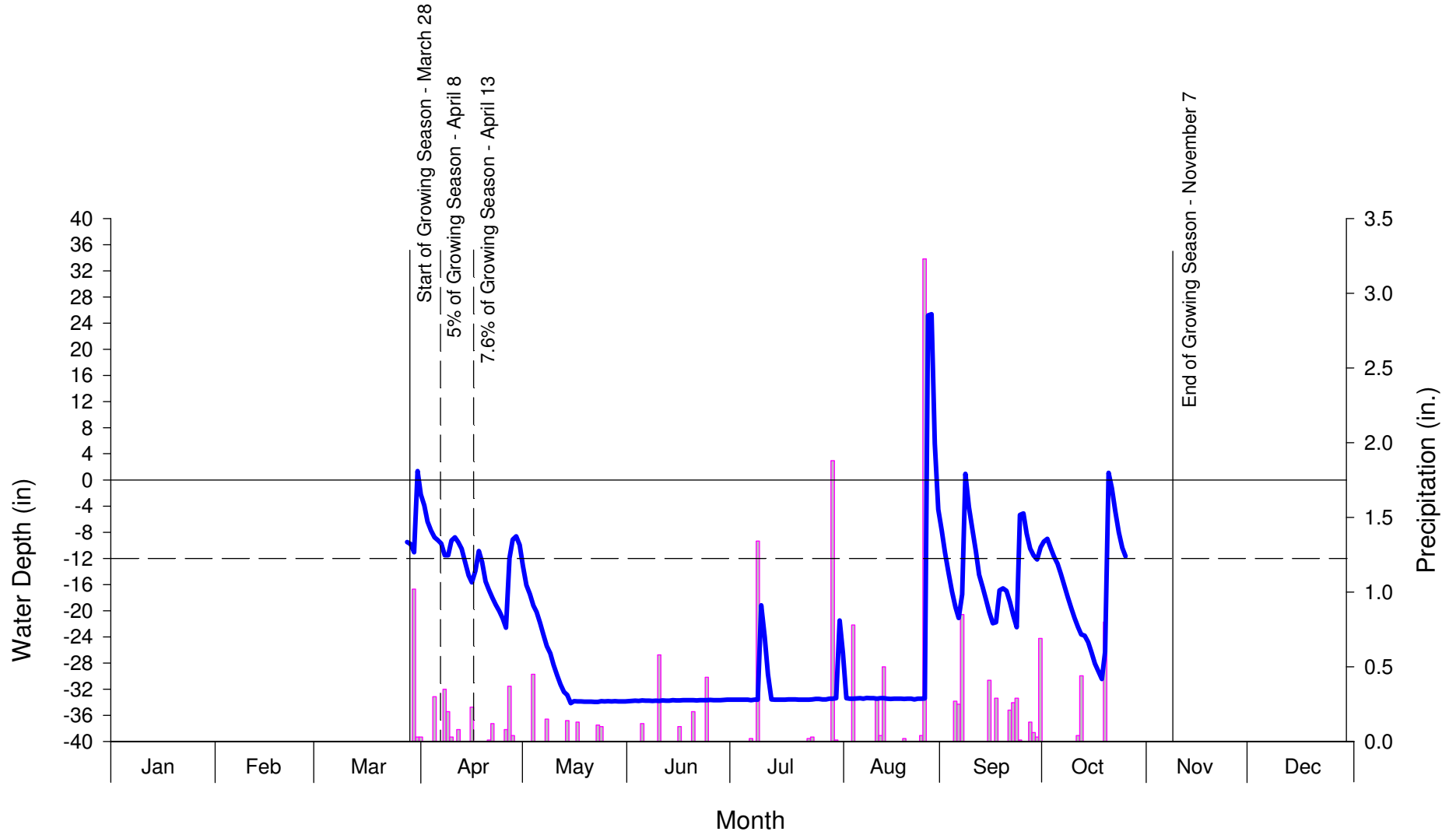
Cutawhiskie Creek Year-4 Monitoring - 2011 Monitoring Gauge 3: N47BABFE



Cutawhiskie Creek Year-4 Monitoring - 2011 Monitoring Gauge 4: N47BABD7



Cutawhiskie Creek Year-4 Monitoring - 2011 Monitoring Gauge 5: N47BABD7



APPENDIX D: CURRENT CONDITIONS PLAN VIEW

REVISIONS	

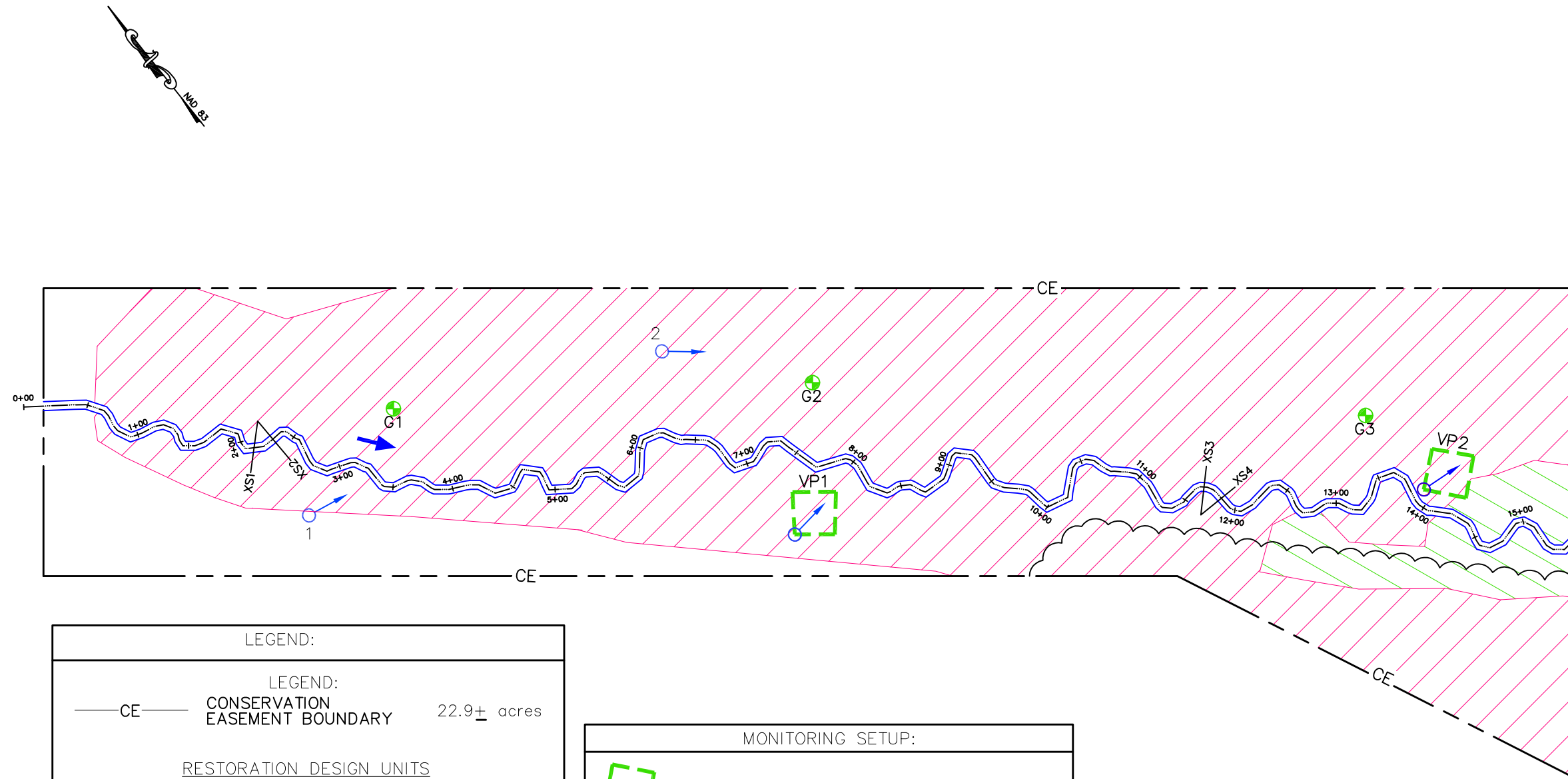


Project:
CUTAWHISKIE CREEK RESTORATION SITE
 YEAR-4 MONITORING REPORT
 HERTFORD COUNTY, NC

Title:
CURRENT CONDITIONS PLAN VIEW

Dwn. By: RLG	Ckd. By: JWG
Date: OCT 2011	Scale: AS SHOWN
ESC Project No.: 100004926	

FIGURE
 2A

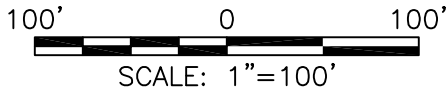


LEGEND:

— CE —	CONSERVATION EASEMENT BOUNDARY	22.9± acres
RESTORATION DESIGN UNITS		
	STREAM RESTORATION	2540 In. ft.
	BRAIDED STREAM RESTORATION	359 In. ft.
	THALWEG	
	STREAM PRESERVATION	2593 In. ft.
	WETLAND RESTORATION	11.9± acres
	WETLAND ENHANCEMENT	1.1± acres

MONITORING SETUP:

	VEGETATIVE MONITORING PLOT (5) (SUCCESS CRITERIA MET)
	GROUNDWATER MONITORING GAUGE (5) HYDROLOGY 5–12.5% OF GROWING SEASON
	PERMANENT CROSS-SECTIONS (6)
	PERMANENT PHOTO STATION (8)
	STREAM FLOW DIRECTION
	EXOTIC SPECIES MANAGEMENT (<i>Ligustrum sinense</i>)



NOTE:
 NO STREAM OR VEGETATION PROBLEM AREAS WERE IDENTIFIED DURING YEAR-4 MONITORING.

MATCHLINE (SEE SHEET 2B)

REVISIONS	

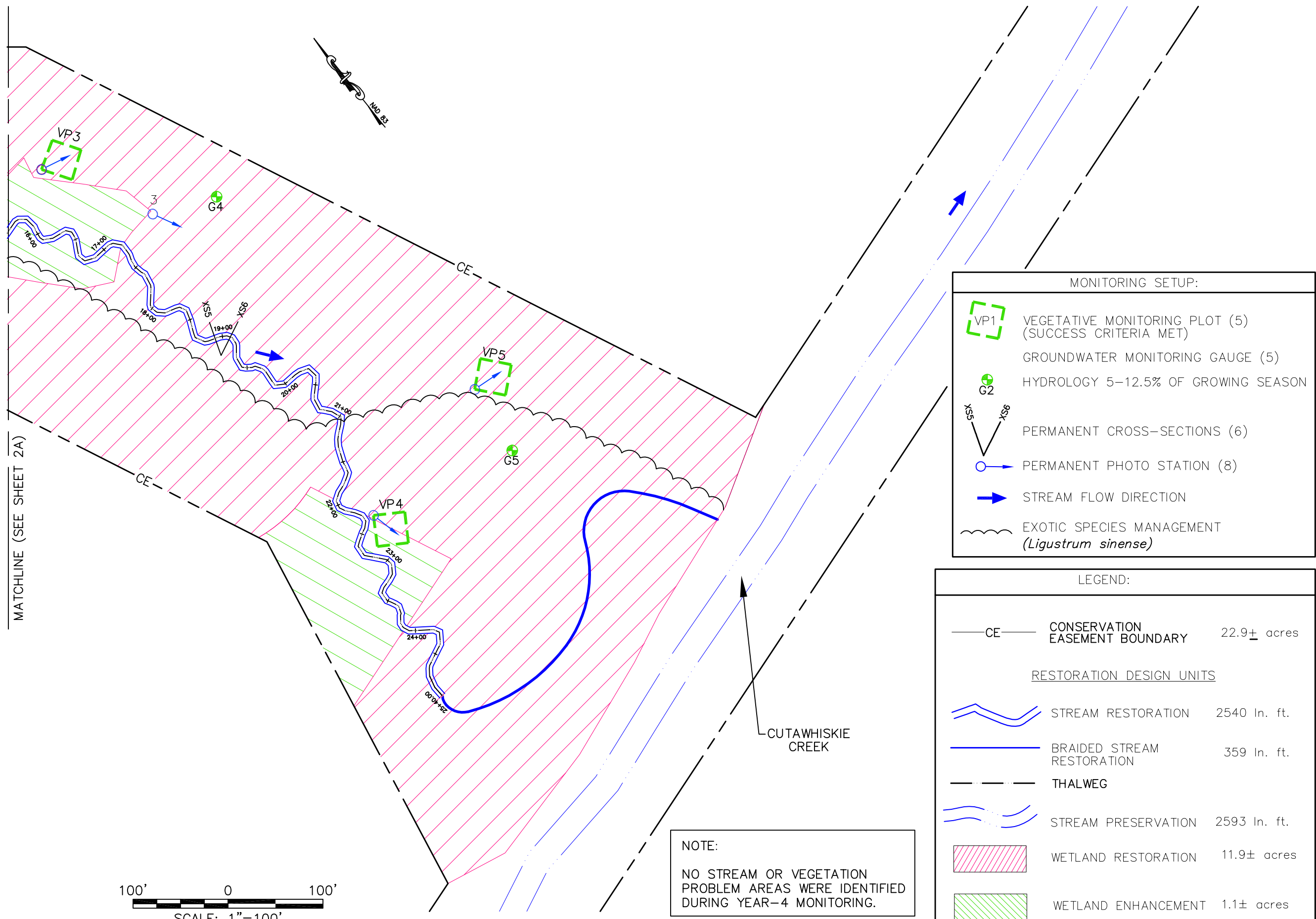


Project:
CUTAWHISKIE CREEK RESTORATION SITE
 YEAR-4 MONITORING REPORT
 HERTFORD COUNTY, NC

Title:
CURRENT CONDITIONS PLAN VIEW

Dwn. By: RLG	Ckd. By: JWG
Date: OCT 2011	Scale: AS SHOWN
ESC Project No.: 100004926	

FIGURE
2B



MONITORING SETUP:

- VP1 VEGETATIVE MONITORING PLOT (5) (SUCCESS CRITERIA MET)
- G2 GROUNDWATER MONITORING GAUGE (5) HYDROLOGY 5-12.5% OF GROWING SEASON
- XS5 XS6 PERMANENT CROSS-SECTIONS (6)
- PERMANENT PHOTO STATION (8)
- STREAM FLOW DIRECTION
- EXOTIC SPECIES MANAGEMENT (*Ligustrum sinense*)

LEGEND:

CE	CONSERVATION EASEMENT BOUNDARY	22.9± acres
RESTORATION DESIGN UNITS		
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