UT to Mill Swamp Restoration Project
Year 1 Monitoring Report

Onslow County, North Carolina

NCEEP Project ID Number - 95019

Project Info:	Monitoring Year: 1 of 7 Year of Data Collection: 2013 & 2014 Year of Completed Construction: 2013 Submission Date: June 2014
Submitted To:	NCDENR - Ecosystem Enhancement Program 1625 Mail Service Center Raleigh, NC 27699 NCDENR Contract ID No. 003992

Ecosystem Enhancement PROGRAM

UT to Mill Swamp Restoration Project
Year 1 Monitoring Report

Onslow County, North Carolina
NCEEP Project ID Number – 95019

Report Prepared and Submitted by Michael Baker Engineering, Inc.

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TABLE OF CONTENTS

APPENDICES

1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) restored 3,606 linear feet (LF) of perennial stream, 4.0 acres (AC) of riparian wetlands, and enhanced 600 LF of stream along an unnamed tributary (UT) to Mill Swamp in Onslow County, North Carolina (NC), (Figure 1). The UT to Mill Swamp Restoration Project (Site) is located in Onslow County, approximately three miles northwest of the Town of Richlands. The Site is located in the NC Division of Water Resources (NCDWR) sub-basin 03-05-02 and the Targeted Local Watershed (TLW) 03030001-010020 of the White Oak River Basin. The project involved the restoration and enhancement of a Coastal Plain Headwater Small Stream Swamp system (NC WAM 2010, Schafale and Weakley 1990) from impairments within the project area due to past agricultural conversion, cattle grazing, and draining of floodplain wetlands by ditching activities.

The project goals directly addressed stressors identified in the White Oak River Basin Restoration Priority Plan (RBRP) such as degraded riparian conditions, channel modification, and excess sediment and nutrient inputs. The primary restoration goals, as outlined in the approved mitigation plan, are described below:

- Create geomorphically stable conditions along the unnamed tributaries across the Site,
- Implement agricultural Best Management Practices (BMPs) to reduce nonpoint source inputs to receiving waters,
- Protect and improve water quality by reducing bank erosion, nutrient and sediment inputs,
- Restore stream and wetland hydrology by connecting historic flow paths and promoting natural flood processes, and
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement.

To accomplish these goals, the following objectives were identified:

- Restore existing incised, eroding, and channelized streams by providing access to their historic floodplains,
- Prevent cattle from accessing the riparian buffer, reducing excessive bank erosion,
- Increase aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated bank erosion,
- Plant native species riparian buffer vegetation along stream bank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve bank stability, and shade the stream to decrease water temperature,
- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature, and
- Control invasive species vegetation within the project area and if necessary, continue treatments during the monitoring period.

The project as-built condition closely mimics that proposed by the design. Differences are outlined below:

- The Stream and Wetland Mitigation Plan (Mitigation Plan) specified the planting of riparian live stakes during construction; however, due to the time of planting in May 2013 none were installed. During construction, it was determined that live stakes would be installed during the dormant season.

It is noted that as of March 27, 2014, approximately 300 live stakes were installed along the stream banks in the restored single thread channel of the UT1c area.

- Permanent fencing along Reach UT3 was originally proposed 50 feet from both of the streambanks outside of the conservation easement; however, the landowner decided to use the northern pasture for hay production only, so fencing was installed only on the southern side of the reach to exclude cattle.
- Sweetbay (*Magnolia virginiana*) was substituted for American Holly (*Ilex opaca*) in the understory plantings for the headwater riparian areas.
- Fifty percent of the proposed quantities of Water Oak (*Quercus nigra*) were substituted with Cherrybark Oak (*Quercus pagoda*) for the riparian wetland planting areas.

During Year 1 monitoring, the planted acreage performance categories were functioning at 100 percent with no bare areas or low stem density areas to report. The average density of total planted stems, based on data collected from the six monitoring plots during Year 1 monitoring, is 648 stems per acre. Therefore, the Year 1 data demonstrate that the Site is on track for meeting the minimum success interim criteria of 320 trees per acre by the end of Year 3.

Invasive species vegetation areas of concern were observed and documented accordingly. One area, totaling approximately 0.18 acre, or 0.9% of the total easement acreage for the Site, was found to contain the invasive species Chinese privet (*Ligustrum sinense*). However, this population of Chinese privet is currently located outside of the 50 foot stream buffer. To control this area of invasive species early, this area was treated in 2014 during the appropriate treatment window by use of the herbicide Glyphosate.

Year 1 groundwater monitoring demonstrated that only one of the ten groundwater monitoring wells located along UT1c exhibited water levels within 12 inches of the ground surface. Therefore, only one well met success criteria as stated in Site's mitigation plan. This gauge (MSAW8), demonstrated the longest consecutive hydroperiod of meeting criteria which was noted to be 14.1 percent of the growing season or 34.3 days.

Flow through UT1a and UT1b was recorded in late November 2013 and for the entire month of December 2013. Of the two flow gauges installed on the Site, both gauges recorded flow during this period. The gauges demonstrated similar patterns relative to rainfall events in the vicinity of the Site.

Year 1 monitoring survey data of eight (8) cross-sections indicates that the Site is geomorphically stable and performing at 100 percent for the all parameters evaluated. The data collected are within the lateral/vertical stability and in-stream structure performance categories.

The Site was found to have had at least two post-construction bankfull events based on crest gauge readings.

Summary information/data related to the Site and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report Appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report and in the Mitigation Plan available on the North Carolina Ecosystem Enhancement Program (NCEEP) website. All raw data supporting the tables and figures in the appendices is available from NCEEP upon request.

2.0 METHODOLOGY

The seven-year monitoring plan for the Site includes criteria to evaluate the success of the stream, wetland and vegetation components of the project. The methodology and report template used to evaluate these components adheres to the NCEEP monitoring guidance document dated November 7, 2011, which will

continue to serve as the template for subsequent monitoring years. The specific locations of monitoring features, such as vegetation plots, permanent cross-sections, reference photograph stations and crest gauges, are shown on the CCPV sheets found in Appendix B.

The majority of Year 1 monitoring data were collected in December 2013. All visual site assessment data contained in Appendix B were collected in November and December 2013 except for the vegetation plot data and corresponding plot photos, which were collected in October 2013 and May 2014.

2.1 Stream Assessment – Reach UT1a & UT1b

The UT1a and UT1b mitigation approach involved the restoration of historic flow patterns and flooding functions in a multi-thread headwater stream system. Monitoring efforts focus on visual observations to document stability and the use of water level monitoring gauges to document groundwater and flooding functions.

2.1.1 Hydrology

Two automated groundwater gauges (pressure transducers) are installed per transect, with a total of 4 well transects installed in the UT1a and UT1b area. The automated loggers are programmed to collect data at every 6 hours to record groundwater levels. Groundwater data collected during Year 1 monitoring are located in Appendix E.

Two flow gauges (pressure transducers) were installed to document the occurrence of extended periods of shallow surface ponding, indicative of flow. The gauges document flooding connectivity between the restored UT1a and UT1b reaches for at least 30 consecutive days under normal climatic conditions. Flow data collected during Year 1 monitoring are located in Appendix E.

2.1.2 Photographic Documentation

The headwater stream reaches were photographed longitudinally beginning at the downstream portion of the Site and moving towards the upstream end of the Site. Photographs were taken looking upstream at delineated locations throughout the restored stream valley. The photograph points were established close enough together to provide an overall view of the reach lengths and valley crenulations. The angle of the photo depends on what angle provides the best view and was noted and continued in future photos. Selected UT1a and UT1b site photographs are located in Appendix B.

2.2 Stream Assessment – Reach UT1c

The UT1c mitigation approach involved the restoration of historic flow patterns and flooding functions in a single-thread headwater stream system. Monitoring efforts focus on visual observations, the use of groundwater level monitoring gauges, a crest gauge to document bankfull flooding events and established stream cross-sections to monitor channel stability. Stream survey data were collected conventionally using a Nikon DM-522 total station unit and is georeferenced used NAD83-State Plane Feet-FIPS3200. This survey system collects point data with an accuracy of less than one tenth of a foot.

2.2.1 Morphologic Parameters and Channel Stability

Cross-sections were classified using the Rosgen Stream Classification System, and all monitored cross-sections fall within the quantitative parameters (i.e. BHR no more than 1.2 and ER no less than 2.2) defined for channels of the design stream type. Morphological survey data is presented in Appendix D.

A longitudinal profile was surveyed for the entire length of channel immediately after construction to document as-built baseline conditions for the first year of monitoring only. The survey was tied to a permanent benchmark and measurements included thalweg, water surface, bankfull, and top of low

bank. Each of these measurements was taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. Yearly longitudinal profiles will not be conducted during subsequent monitoring years unless channel instability has been documented or remedial actions/repairs are required by the USACE or NCEEP.

2.2.2 Hydrology

Ten automated groundwater-monitoring stations were installed in the UT1c wetland restoration area. Groundwater monitoring stations follow (USACE 1997). Groundwater data collected during Year 1 monitoring are located in Appendix E.

Total observed rainfall at the New River MCAS station for the period of January 2013 through December 2013 was 44.94 inches, as compared to the Onslow County WETS table of 55.96 inches annually. According to the New River MCAS gauge, total rainfall during the Year 1 monitoring period from January 2013 through December 2013 was 11.02 inches below the historic approximated average for Onslow County.

One crest gauge was installed on the floodplain at the bankfull elevation along the left top of bank on UT1c approximately at Station 45+50. The highest bankfull reading recorded in Year 1 was measured to be 0.19 feet and was estimated to have occurred on December 15, 2013. Crest gauge readings are presented in Appendix E.

2.2.3 Photographic Documentation

Reference photograph transects were taken at each permanent cross-section. The survey tape was centered in the photographs of the bank. The water line was located in the lower edge of the frame, and as much of the bank as possible is included in each photograph. Photographs were also taken of grade control structures along the restored stream, and limited to log weirs or log jams. Selected UT1c site photographs from Year 1 monitoring are shown in Appendix B.

2.2.4 Visual Stream Morphological Stability Assessment

The visual stream morphological stability assessment involves the qualitative evaluation of lateral and vertical channel stability, and the integrity and overall performance of in-stream structures throughout the Project reach as a whole. Habitat parameters, and pool depth maintenance, are also measured and scored. During Year 1 monitoring, the entire project reach was walked, noting geomorphic conditions of the stream bed profile (riffle/pool facets); both stream banks, and engineered in-stream structures. Photos were taken at every stream photograph reference station as discussed in the previous section, and in locations of potential SPAs which were documented in the field for subsequent mapping on the CCPV figures. A more detailed summary of the methodology and results for the visual stream stability assessment can be found in Appendix B which includes supporting data tables, and SPA photos if applicable.

2.3 Vegetation Assessment

In order to determine if the criteria are achieved, vegetation-monitoring quadrants were installed and are monitored across the restoration site in accordance with the CVS-NCEEP Protocol for Recording Vegetation, Version 4.1 (2007). The vegetation monitoring plots are a minimum of 2 percent of the planted portion of the site with six plots established randomly within the planted riparian buffer areas per Monitoring Levels 1 and 2. No monitoring quadrants were established within the undisturbed wooded areas of UT1a and UT1b. The sizes of individual quadrants are 100 square meters for woody tree species.

Additionally, the existing vegetation areas were visually monitored during the annual site visits to document any mortality, due to construction activities or changes to the water table, which could negatively impact

existing forest cover or favorable buffer vegetation. Following Year 1 monitoring, it is reported that no areas of concern regarding the existing vegetation was observed along UT1a and UT1b.

Year 1 vegetation assessment information is provided in Appendix B and C.

3.0 REFERENCES

Carolina Vegetation Survey (CVS) and NC Ecosystem Enhancement Program (NCEEP). 2007. CVS-NCEEP Data Entry Tool v. 2.2.7. University of North Carolina, Raleigh, NC.

Lee, M., Peet R., Roberts, S., Wentworth, T. 2007. CVS-NCEEP Protocol for Recording Vegetation, Version 4.1.

North Carolina Ecosystem Enhancement Program. 2011. Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation. November 7, 2011.

Rosgen, D. L. 1994. A Classification of Natural Rivers. Catena 22:169-199.

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, NCDENR. Raleigh, NC.

United States Army Corps of Engineers. 1997. Corps of Engineers Wetlands Research Program. Technical Note VN-rs-4.1. Environmental Laboratory. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

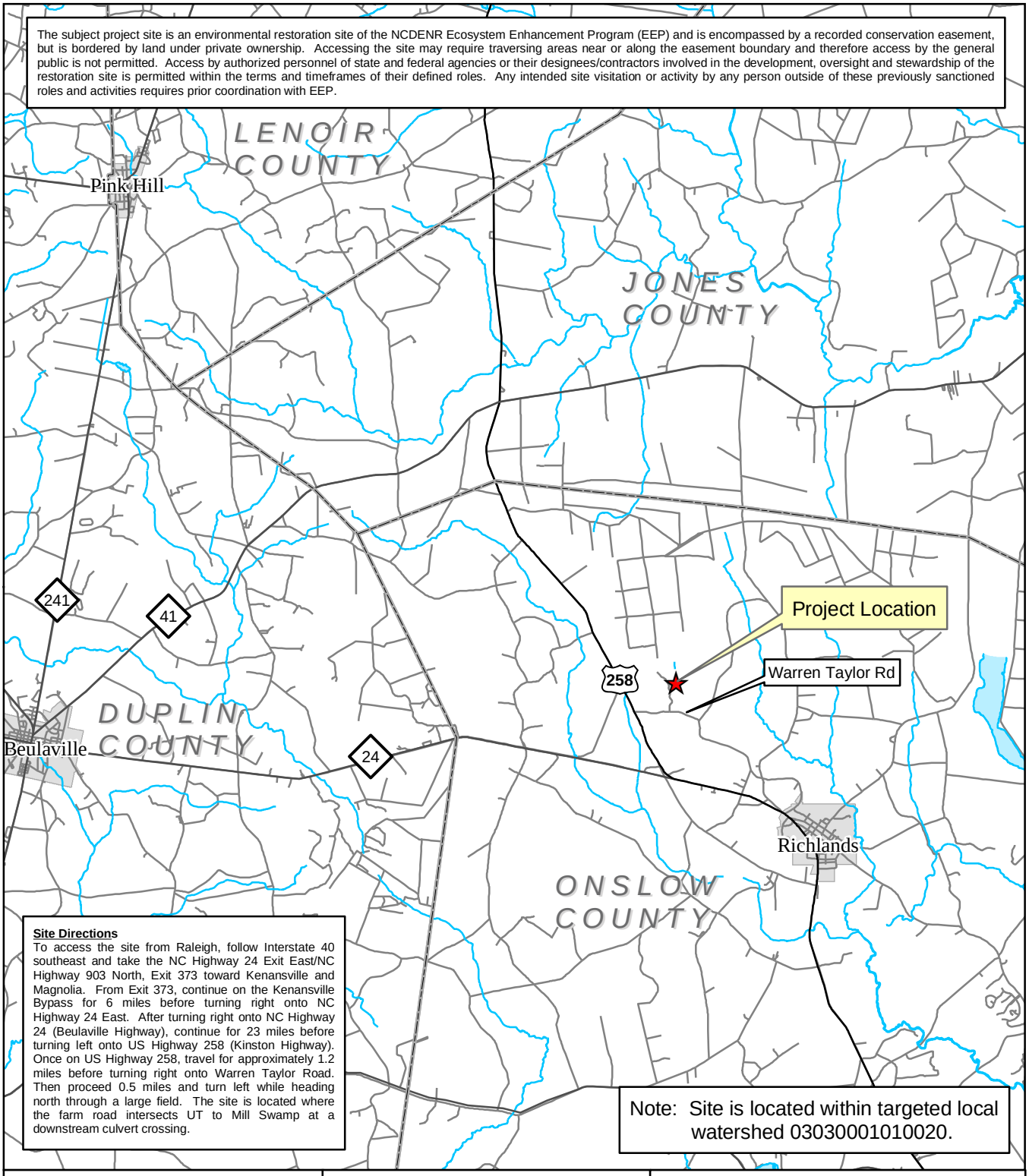
____. 2005. "Technical Standard for Water-Table Monitoring of Potential Wetland Sites," WRAP Technical Notes Collection (ERDC TN-WRAP-05-2), U.S. Army Engineer Research and Development Center. Vicksburg, MS.

____. 2003. Stream Mitigation Guidelines, April 2003, U.S. Army Corps of Engineers. Wilmington District.

Appendix A

Project Vicinity Map and Background Tables

The subject project site is an environmental restoration site of the NCDENR Ecosystem Enhancement Program (EEP) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with EEP.



Site Directions
To access the site from Raleigh, follow Interstate 40 southeast and take the NC Highway 24 Exit East/NC Highway 903 North, Exit 373 toward Kenansville and Magnolia. From Exit 373, continue on the Kenansville Bypass for 6 miles before turning right onto NC Highway 24 East. After turning right onto NC Highway 24 (Beulaville Highway), continue for 23 miles before turning left onto US Highway 258 (Kinston Highway). Once on US Highway 258, travel for approximately 1.2 miles before turning right onto Warren Taylor Road. Then proceed 0.5 miles and turn left while heading north through a large field. The site is located where the farm road intersects UT to Mill Swamp at a downstream culvert crossing.

Note: Site is located within targeted local watershed 03030001010020.

EEP Project # 95019

Onslow County

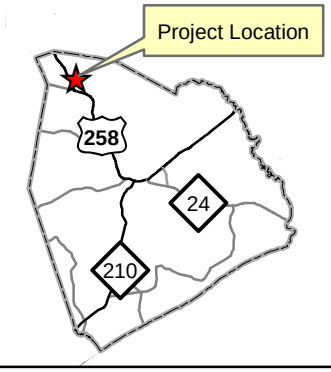


Figure 1
Project Vicinity Map
UT to Mill Swamp Site

Ecosystem Enhancement Program

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0 0.5 1 2 3 Miles

Table 1. Project Components and Mitigation Credits

UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Mitigation Credits

	Stream	Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorus Nutrient Offset
Type	R, E1	R	E					
Totals	4,006 SMU	4.0 WMU	0					

Project Components

Project Component or Reach ID	Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration/ Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio
Reach UT1a	10+00 – 16+00	600 LF	Enhancement Level I	400 SMU	600 LF	1.5:1
Reach UT1b	16+00 – 36+93	2,131 LF	Headwater Restoration	2,093 SMU	2,093 LF	1:1
Reach UT1c	37+24 – 52+37	1,350 LF	Single thread Restoration	1,513 SMU	1,513 LF	1:1
Reach UT3	10+00 – 23+69	1,060 LF	Cattle Exclusion	N/A	N/A	N/A
Wetland Area #1	See plan sheets	0.0 AC	Restoration	4.0 WMU	4.0 AC	1:1

Component Summation

Restoration Level	Stream (LF)	Riparian Wetland (AC)		Non-riparian Wetland (AC)	Buffer (SF)	Upland (AC)
		Riverine	Non-Riverine			
Restoration	3,606	4.0				
Enhancement I	600					
Enhancement II						
Creation						
Preservation						
High Quality Preservation						

BMP Elements

Element	Location	Purpose/Function	Notes

BMP Elements: BR= Bioretention Cell; SF= Sand Filter; SW= Stormwater Wetland; WDP= Wet Detention Pond; DDP= Dry Detention Pond; FS= Filter Strip; S= Grassed Swale; LS= Level Spreader; NI=Natural Infiltration Area

Table 2. Project Activity and Reporting History			
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Mitigation Plan Prepared	N/A	N/A	Aug-13
Mitigation Plan Amended	N/A	N/A	Sep-13
MItigation Plan Approved	N/A	N/A	Nov-13
Final Design – (at least 90% complete)	N/A	N/A	Mar-13
Construction Begins	N/A	N/A	Apr-13
Temporary S&E mix applied to entire project area	N/A	N/A	N/A
Permanent seed mix applied to entire project area	N/A	N/A	Jun-13
Planting of live stakes	Fall/Winter 2013	N/A	N/A
Planting of bare root trees	N/A	N/A	Jun-13
End of Construction	N/A	N/A	Jun-13
Survey of As-built conditions (Year 0 Monitoring-baseline)	N/A	Aug-13	Aug-13
Year 1 Monitoring	Dec-13	Dec-13	Jun-14
Year 2 Monitoring	Dec-13	N/A	N/A
Year 3 Monitoring	Dec-13	N/A	N/A
Year 4 Monitoring	Dec-13	N/A	N/A
Year 5 Monitoring	Dec-13	N/A	N/A
Year 6 Monitoring	Dec-13	N/A	N/A
Year 7 Monitoring	Dec-13	N/A	N/A

Table 3. Project Contacts Table **UT to Mill Swamp Restoration Project: EEP Project ID No. 95019**	
Designer	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 Contact: Kayne Van Stell, Tel. 919-481-5730
Construction Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Planting Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seeding Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seed Mix Sources Nursery Stock Suppliers	Green Resources, Tel. 336-855-6363 Mellow Marsh Farm, 919-742-1200 ArborGen, 843-528-3204 Superior Tree, 850-971-5159
Monitoring Performers	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 Contact:
Stream Monitoring Point of Contact	Dwayne Huneycutt, Tel. 919-481-5745
Vegetation Monitoring Point of Contact	Dwayne Huneycutt, Tel. 919-481-5745
Wetland Monitoring Point of Contact	Dwayne Huneycutt, Tel. 919-481-5745

Table 4. Project Attributes
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

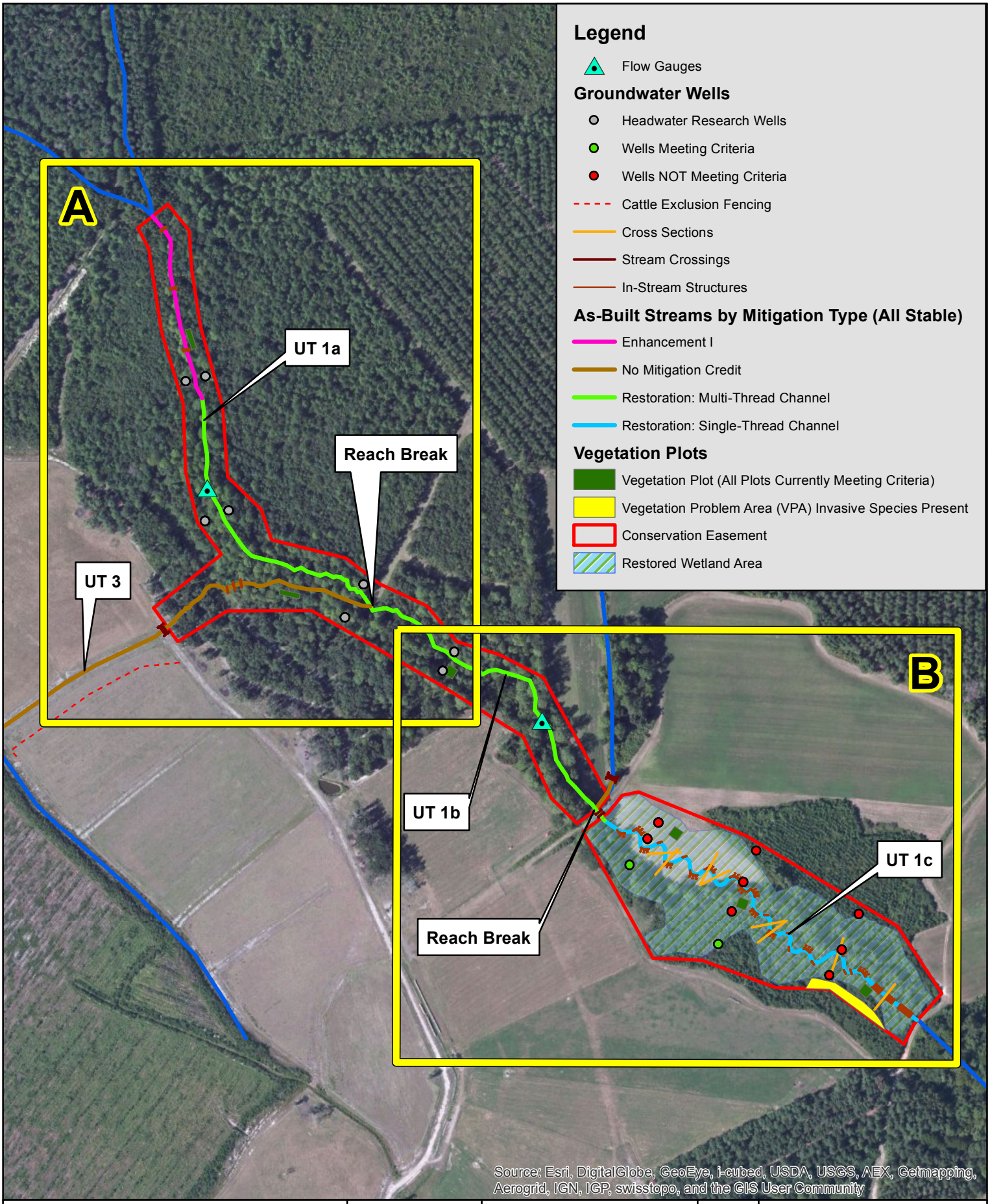
Project Information		
Project Name	UT to Mill Swamp Restoration Project	
County	Onslow	
Project Area (acres)	19.6	
Project Coordinates (latitude and longitude)	34.9377 N, -77.5897 W	
Watershed Summary Information		
Physiographic Province	Inner Coastal Plain	
River Basin	White Oak	
USGS Hydrologic Unit 8-digit and 14-digit	03030001 / 03030001010020	
DWQ Sub-basin	03-05-02	
Project Drainage Area (AC)	421 (d/s main stem UT1)	
Project Drainage Area Percentage of Impervious Area	<1%	
CGIA Land Use Classification	2.01.03.99, Other Hay, Rotation, or Pasture; 413	
NCEEP Land Use Classification for UT to Mill Swamp Watershed (White Oak River Basin Restoration Priorities, 2010)	Forest (52%) Agriculture (44%) Impervious Cover (0.6%)	
Stream Reach Summary Information		
Parameters	**Reach UT1**	**Reach UT3**
Length of Reach (LF)	4,091	1,060
Valley Classification (Rosgen)	X	X
Drainage Area (AC)	421	23
NCDWQ Stream Identification Score	40.5	21
NCDWQ Water Quality Classification	C; NSW	C; NSW
Morphological Description (Rosgen stream type)	G/F (Channelized Headwater System)	Intermittent Ditch (N/A)
Evolutionary Trend	Gc→F	Intermittent Ditch (N/A)
Underlying Mapped Soils	Mk, St, Ly, FoA	Mk, St
Drainage Class	Poorly drained, somewhat poorly drained	Poorly drained, somewhat poorly drained
Soil Hydric Status	Hydric	Hydric
Average Channel Slope (ft/ft)	0.0041	0.0058
FEMA Classification	N/A	N/A
Native Vegetation Community	Coastal Plain Small Stream Swamp	Coastal Plain Small Stream Swamp
Percent Composition of Exotic/Invasive Vegetation	~10%	<5%
Wetland Summary Information		
Parameters	**Wetland 1 (Non-Jurisdictional W1)**	
Size of Wetland (AC)	4.0	
Wetland Type	Riparian Riverine	
Mapped Soil Series	Mk (Muckalee), St (Stallings), Ly (Lynchburg)	
Drainage Class	Poorly drained, somewhat poorly drained	
Soil Hydric Status	Hydric	
Source of Hydrology	Groundwater	
Hydrologic Impairment	Partially (disconnected floodplain from ditches and channel incision)	
Native Vegetation Community	Coastal Plain Small Stream Swamp, Successional	
Percent Composition of Exotic/Invasive Vegetation	~5%	

Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes	See Mitigation Plan
Waters of the United States – Section 401	Yes	Yes	See Mitigation Plan
Endangered Species Act	No	N/A	See Mitigation Plan
Historic Preservation Act	No	N/A	See Mitigation Plan
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (C	No	N/A	See Mitigation Plan
FEMA Floodplain Compliance	No	N/A	See Mitigation Plan
Essential Fisheries Habitat	No	N/A	See Mitigation Plan

Source: White Oak River Basin Restoration Priorities, 2010 (http://www.nceep.net/services/restplans/FINAL%20RBRP%20White%20Oak%2020110523.pdf)

Appendix B

Visual Assessment Data



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Ecosystem Enhancement Program

0 250 500 Feet

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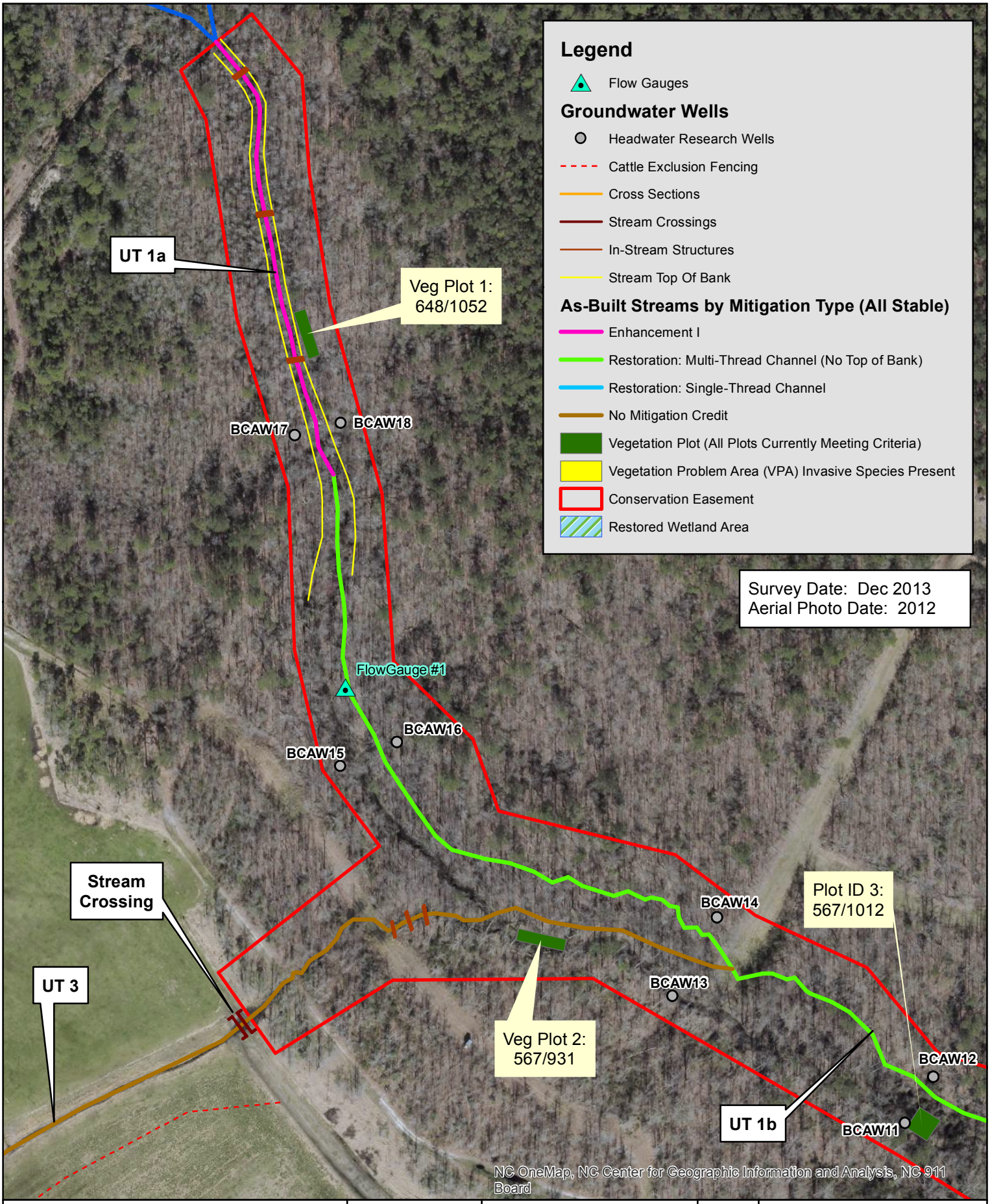
EEP Project # 95019

Current Condition Plan View - Figure Key
UT to Mill Swamp Site
Onslow County, NC



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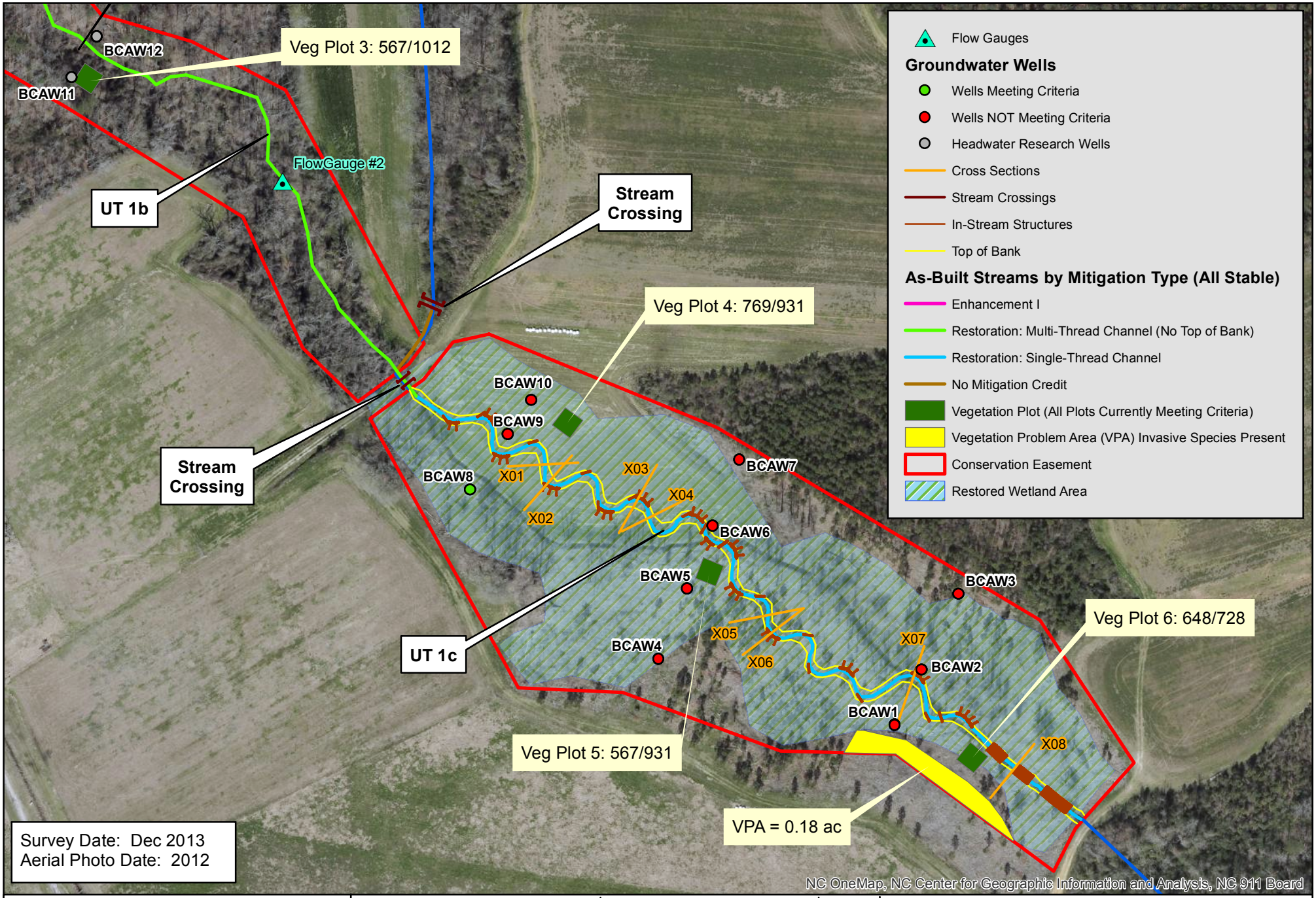
Ecosystem Enhancement Program

0 100 200 Feet

N

EEP Project # 95019

Current Condition Plan View Figure A
UT to Mill Swamp Site
Onslow County, NC



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Ecosystem Enhancement Program

0 100 200 Feet

N

EEP Project # 95019

Current Condition
Plan View Figure B
UT to Mill Swamp Site
Onslow County, NC

Table 5a. Visual Steam Morphology Stability Assessment

UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Reach ID: UT1c

Assessed Length (LF): 1,513

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0%	100%			
	2. Riffle Condition	1. Texture Substrate	3	3			100%			
	3. Meander Pool Condition	1. Depth	22	22			100%			
		2. Length	22	22			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	19	19			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	19	19			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
		Totals			0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	8	8			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	8	8			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	8	8			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth	8	8			100%			

Table 5b. Stream Problem Areas
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Feature Issue	Station Number	Suspected Cause	Photo Number
None Observed	N/A	N/A	N/A

Table 6a. Vegetation Conditions Assessment
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Reach ID: UT1c

Planted Acreage: 4.0

Vegetation Category	Defintions	Mapping Threshold (acres)	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover both woody and herbaceous material.	0.1	NA	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4 or 5 stem count criteria.	0.1	NA	0	0.00	0.0%
			Total	**0**	**0.00**	**0.0%**
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems or a size class that are obviously small given the monitoring year.	0.25	NA	0	0.00	0.0%
			Cumulative Total	**0**	**0.00**	**0.0%**

Easement Acreage:

Vegetation Category	Defintions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
5. Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale)	1000 ft²	NA	0	0.00	0.0%
6. Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale)	none	NA	0	0.00	0.0%

Table 6b. Vegetation Problem Areas
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Feature Issue	Station Number	Suspected Cause	Photo Number
Invasive/Exotic Populations	48+00 to 52+00	Ligustrum sinense	Vegetaton Photo Log

Photo Point 1 – Downstream at Culvert

Photo Point 2 – Log Jam

Photo Point 3 – Log Jam

Photo Point 4 – Log Jam

Photo Point 5 – Log Weir

Photo Point 6 – Log Weir

Photo Point 7 – Log Weir

Photo Point 8 – UT1b Downstream

Photo Point 9 – UT1b at Flow Gauge #2

Photo Point 10 – UT3 above confluence

Photo Point 11 – UT3 Log Weir

Photo Point 12 – UT3 Log Weir

Photo Point 13 – UT3 Log Weir

Photo Point 14 – UT1b view upstream

Photo Point 15 – UT1b view upstream

Photo Point 16 – Log Weir

Photo Point 17 – Log Weir

Photo Point 18 – Log Weir, UT1a tie-in

Crest gauge location

Crest gauge reading, 0.17 inches – October 16, 2013

Flow Gauge #1 – December 16, 2013

Flow Gauge #2 – December 16, 2013

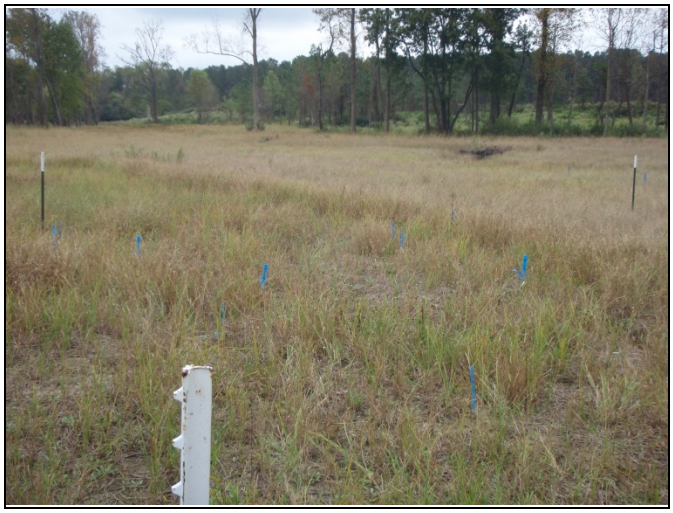
Flow in UT1a - December 16, 2013

Flow in UT1b - December 16, 2013

Vegetation Plot 1

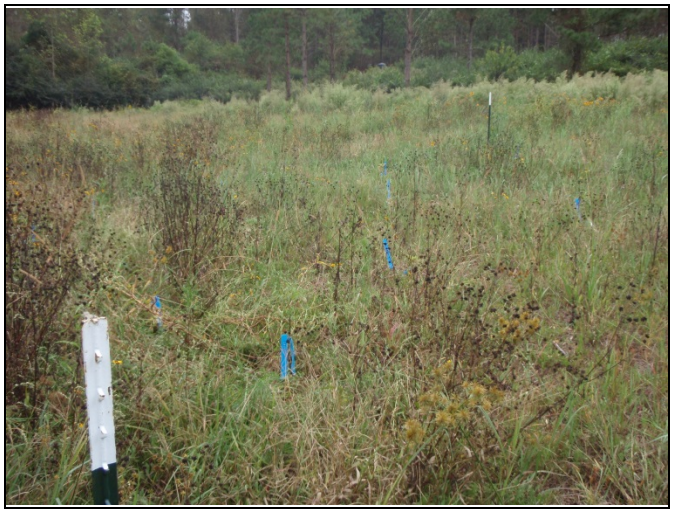
Vegetation Plot 2

Vegetation Plot 3

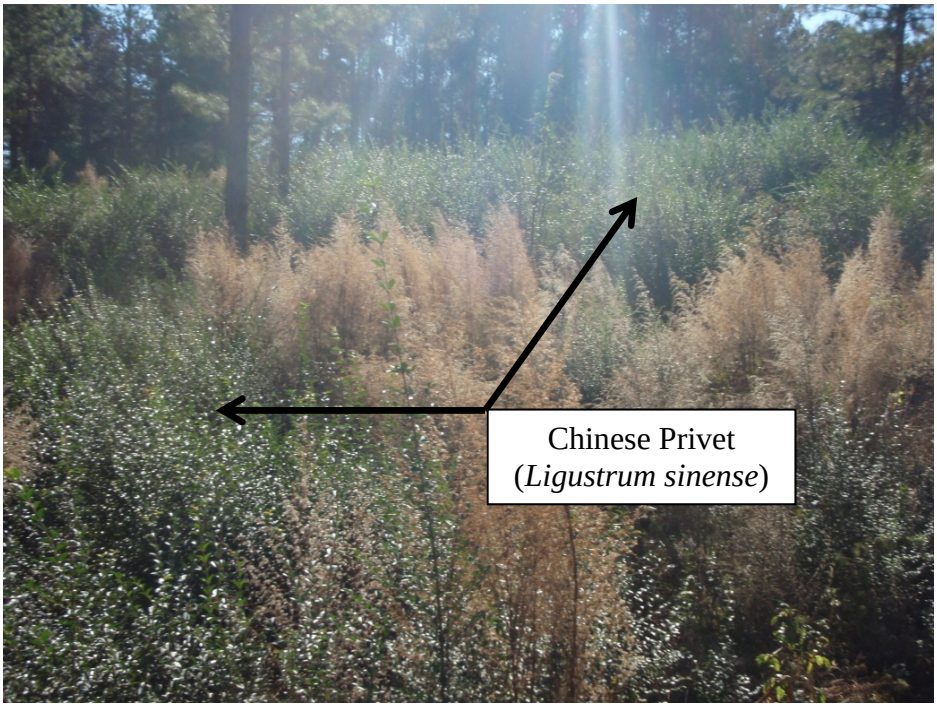


Vegetation Plot 4

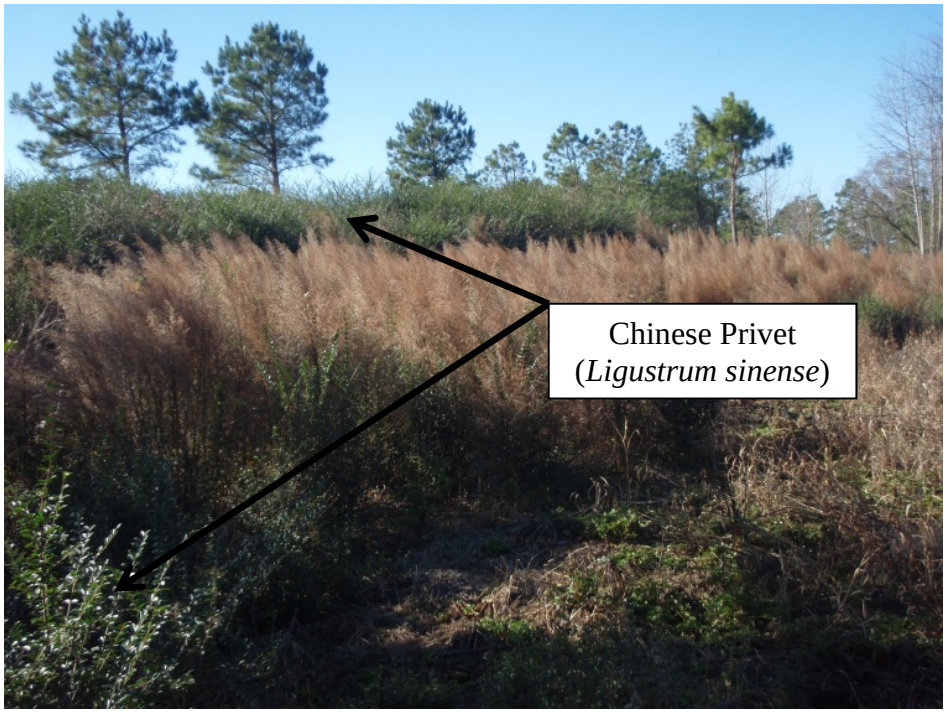
Vegetation Plot 5



Vegetation Plot 6



View of Chinese Privet Problem Area 1 - View is East



View of Chinese Privet Problem Area 1 - View is West

Appendix C

Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Plot ID	Vegetation Survival Threshold Met?	Total/Planted Stem Count*	Tract Mean
1	Y	648/1052	648
2	Y	567/931	
3	Y	567/1012	
4	Y	769/931	
5	Y	688/809	
6	Y	648/728	

Note: *Total/Planted Stem Count reflects the changes in stem density based on the density of stems at the time of the As-Built Survey (Planted) and the current total density of planted stems (Total)

Table 8. CVS Vegetation Plot Metadata
UT to Mill Swamp Restoration Project: Project ID No. 95019

Report Prepared By	Dwayne Huneycutt
Date Prepared	11/14/2013 12:47
database name	cvs-eep-entrytool-v2.3.1.mdb
database location	L:\Monitoring\Veg Plot Info\CVS Data Tool\Candiff
computer name	CARYLDHUNEYCUTT
file size	62787584
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.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	95019
project Name	UT to Mill Swamp
Description	
River Basin	White Oak
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	6

Table 9a. CVS Stem Count of Planted Stems by Plot and Species

UT to Mill Swamp Restoration Project: Project ID No. 95019

	Comment	Species	Species Type	CommonName	Total Planted Stems	No. of Plots	Average No. of Stems	Plot 95019-01-0001-year:1	Plot 95019-01-0002-year:1	Plot 95019-01-0003-year:1	Plot 95019-01-0004-year:1	Plot 95019-01-0005-year:1	Plot 95019-01-0006-year:1	
		Carpinus caroliniana	Shrub Tree	American hornbeam	5	3	1.67				3	1	1	
		Itea virginica	Shrub	Virginia sweetspire	2	2	1	1					1	
		Liriodendron tulipifera	Tree	tuliptree	7	2	3.5	4					3	
		Nyssa biflora	Tree	swamp tupelo	12	6	2	1	1	2	4	2	2	
		Persea palustris	Tree	swamp bay	6	3	2	2	2				2	
		Quercus lyrata	Tree	overcup oak	9	6	1.5	3	1	1	2	1	1	
		Quercus michauxii	Tree	swamp chestnut oak	21	5	4.2	3	3	9	1	5		
		Quercus nigra	Tree	water oak	6	4	1.5	1	3	1	1			
		Quercus pagoda	Tree	cherrybark oak	12	5	2.4	1	2		3	5	1	
		Quercus phellos	Tree	willow oak	10	4	2.5		1		4	3	2	
		Ulmus americana	Tree	American elm	4	2	2				1		3	
		Unknown	unknown		2	2	1		1	1				
TOT:	**0**	**12**	**12**	**11**	**96**	**12**		**16**	**14**	**14**	**19**	**17**	**16**	

Table 9b. Vegetation Stem Count Densities								
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019								
Tree Species	**Plots**						**Year 1 Totals**	**Yearly Average Stems/acre**
	1	**2**	**3**	**4**	**5**	**6**		
American hornbeam				3	1	1	5	
Virginia sweetspire	1					1	2	
Tuliptree	4					3	7	
Swamp tupelo	1	1	2	4	2	2	12	
swamp bay	2	2				2	6	
Overcup oak	3	1	1	2	1	1	9	
Swamp chestnut oak	3	3	9	1	5		21	
Water oak	1	3	1	1			6	
Cherrybark oak	1	2		3	5	1	12	
Willow oak		1		4	3	2	10	
American elm				1		3	4	
Unknown		1	1				2	
Number of stems/plot	16	14	14	19	17	16	96	
Stems/acre Year 1	648	567	567	769	688	648		648
Stems/acre Initial	1052	931	1012	931	809	728		911

Appendix D

Stream Survey Data

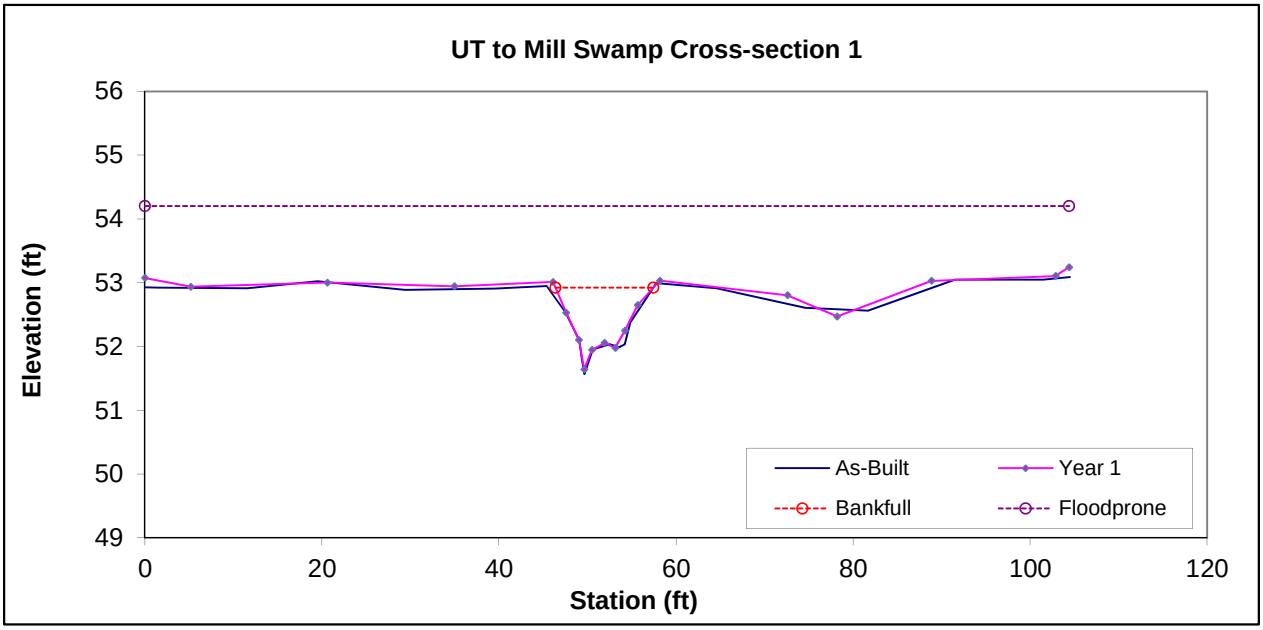
Permanent Cross-section 1

(Year 1 Data - Collected December 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Cc	6.9	11.06	0.63	1.28	17.66	1.1	9.4	52.92	53.01



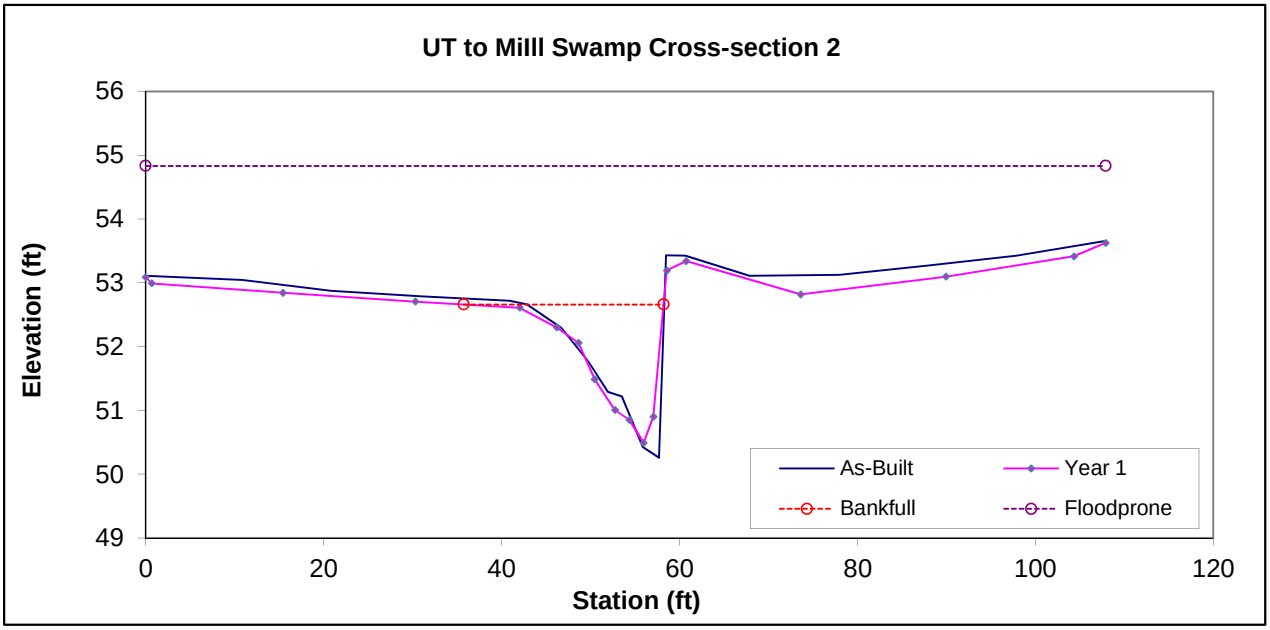
Permanent Cross-section 2

(Year 1 Data - Collected December 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		16.2	22.48	0.72	2.17	31.24	1	4.8	52.66	52.61



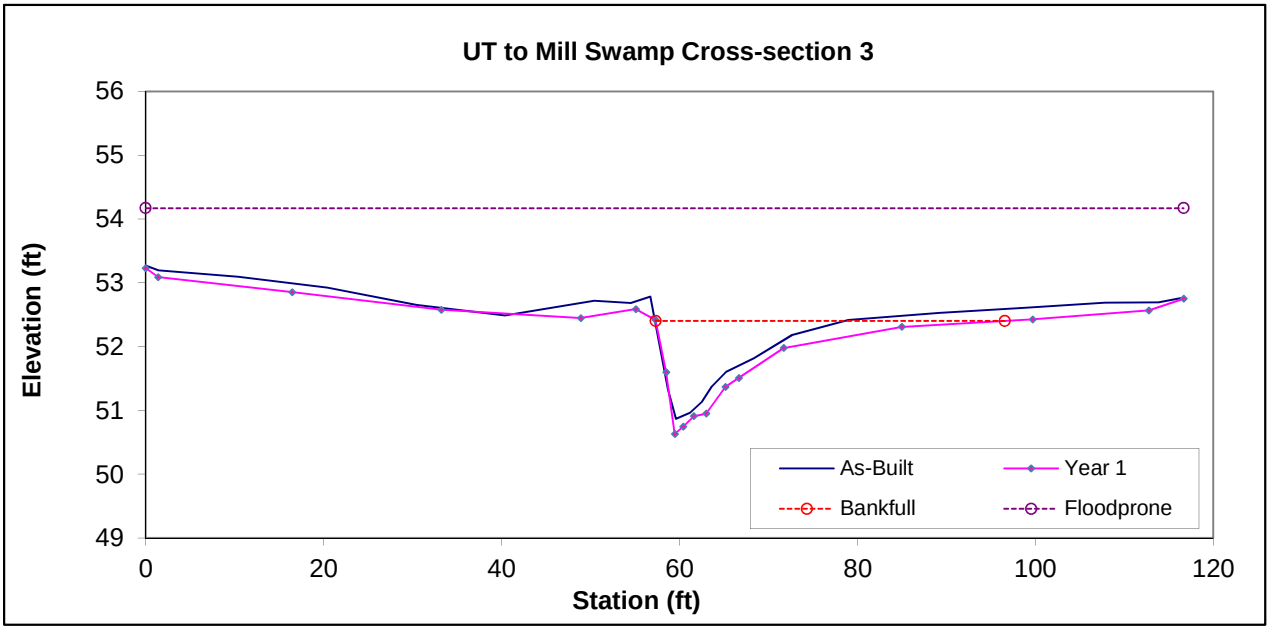
Permanent Cross-section 3

(Year 1 Data - Collected December 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		18.7	39.23	0.48	1.77	82.43	0.8	3	52.4	51.98



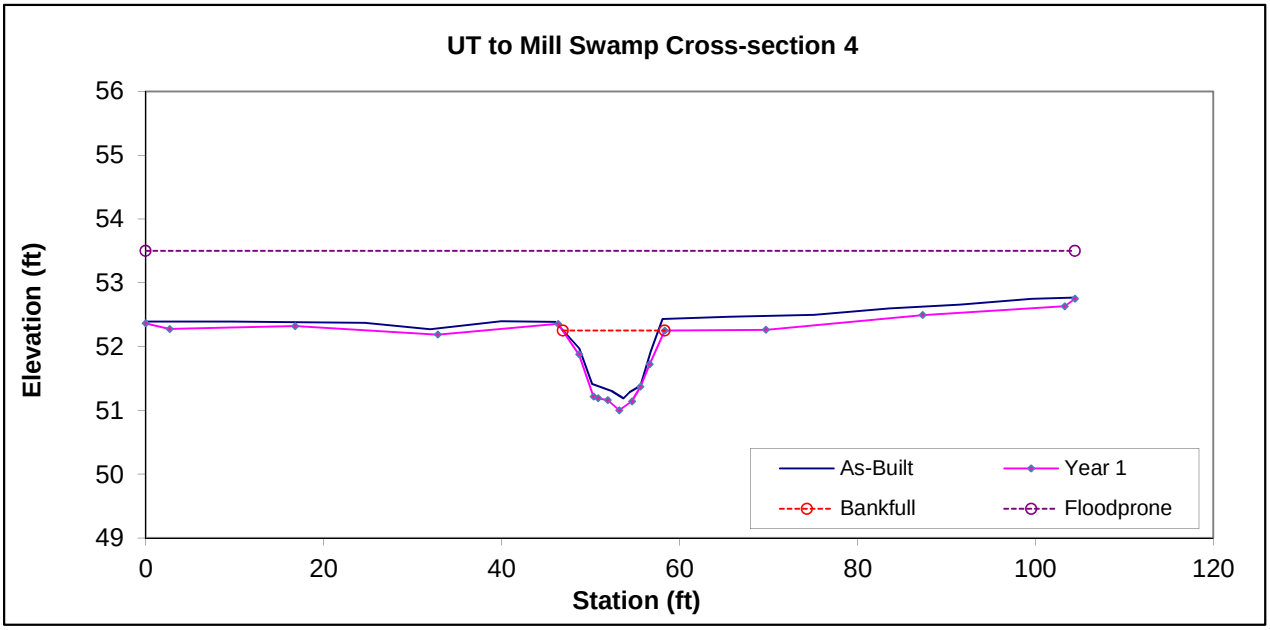
Permanent Cross-section 4

(Year 1 Data - Collected December 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Cc	8.5	11.45	0.74	1.25	15.43	1	9.1	52.25	52.25



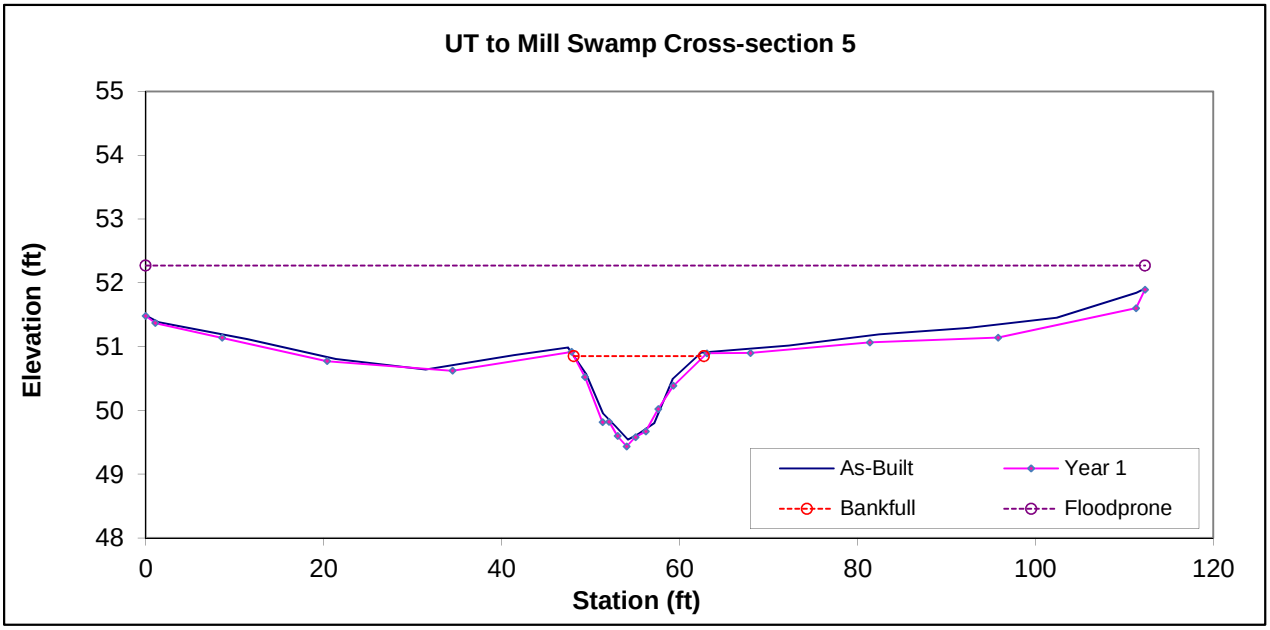
Permanent Cross-section 5

(Year 1 Data - Collected December 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Cc	10.8	14.63	0.74	1.42	19.78	1	7.7	50.85	50.89



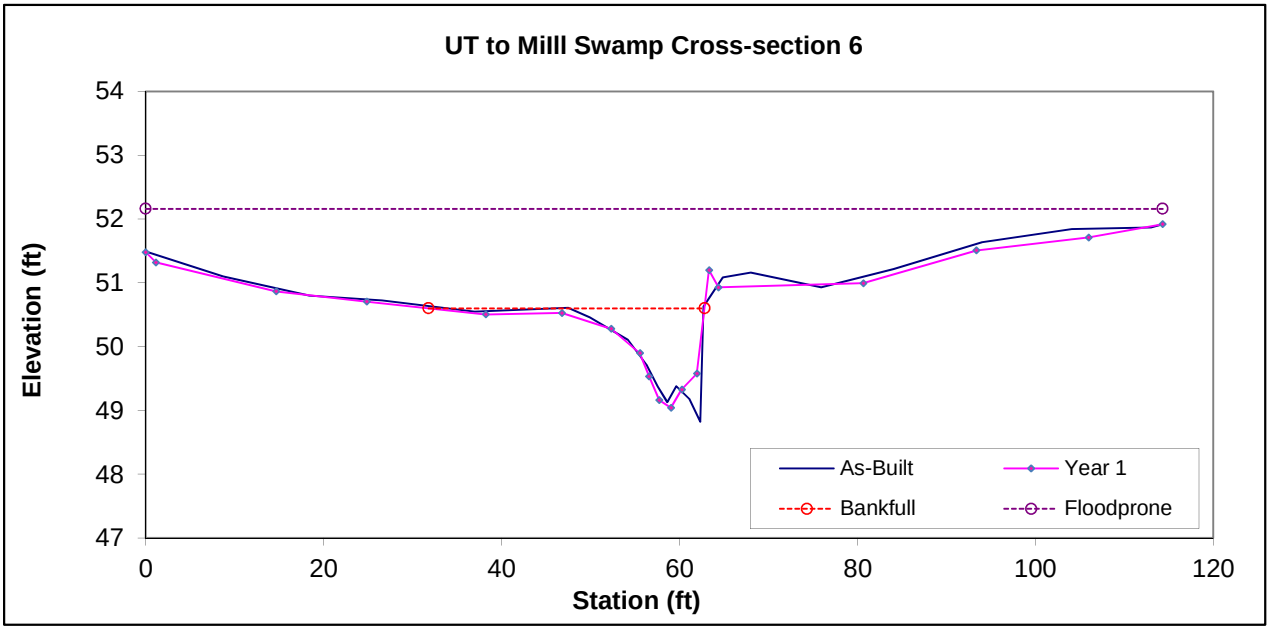
Permanent Cross-section 6

(Year 1 Data - Collected December 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		12.2	31.02	0.39	1.56	78.79	1	3.7	50.6	50.53



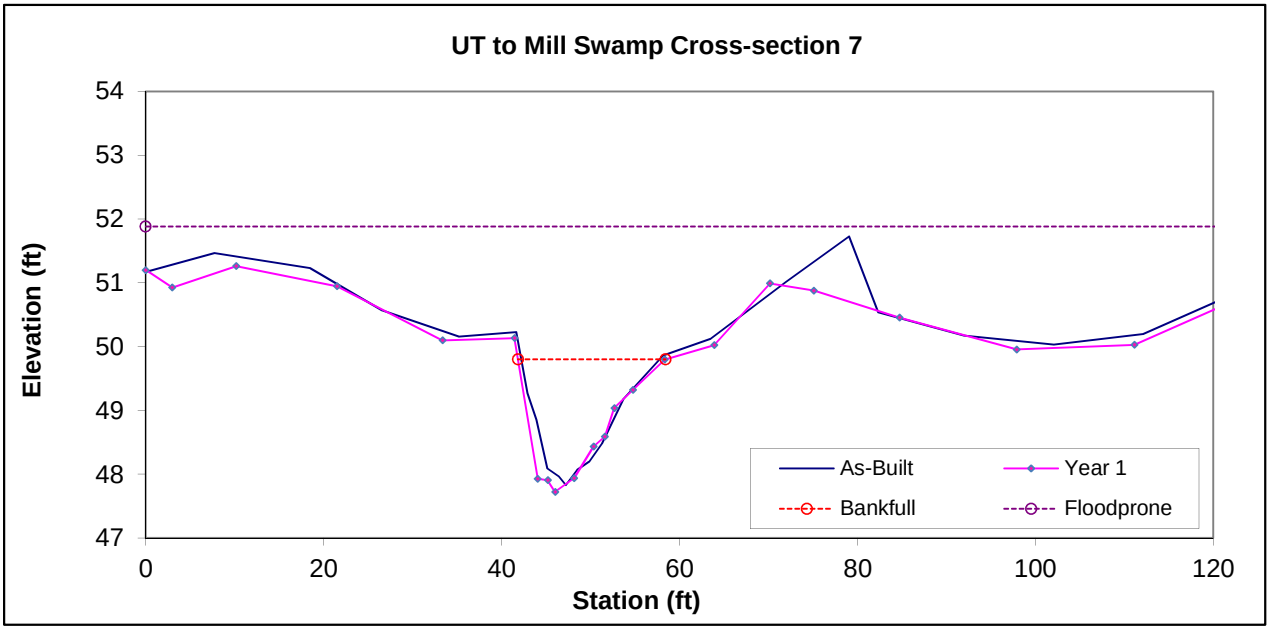
Permanent Cross-section 7

(Year 1 Data - Collected December 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		18.4	16.59	1.11	2.08	14.93	1	8	49.8	49.8



Permanent Cross-section 8

(Year 1 Data - Collected December 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	13.6	10.65	1.27	2.15	8.38	1	7.8	48.7	48.7

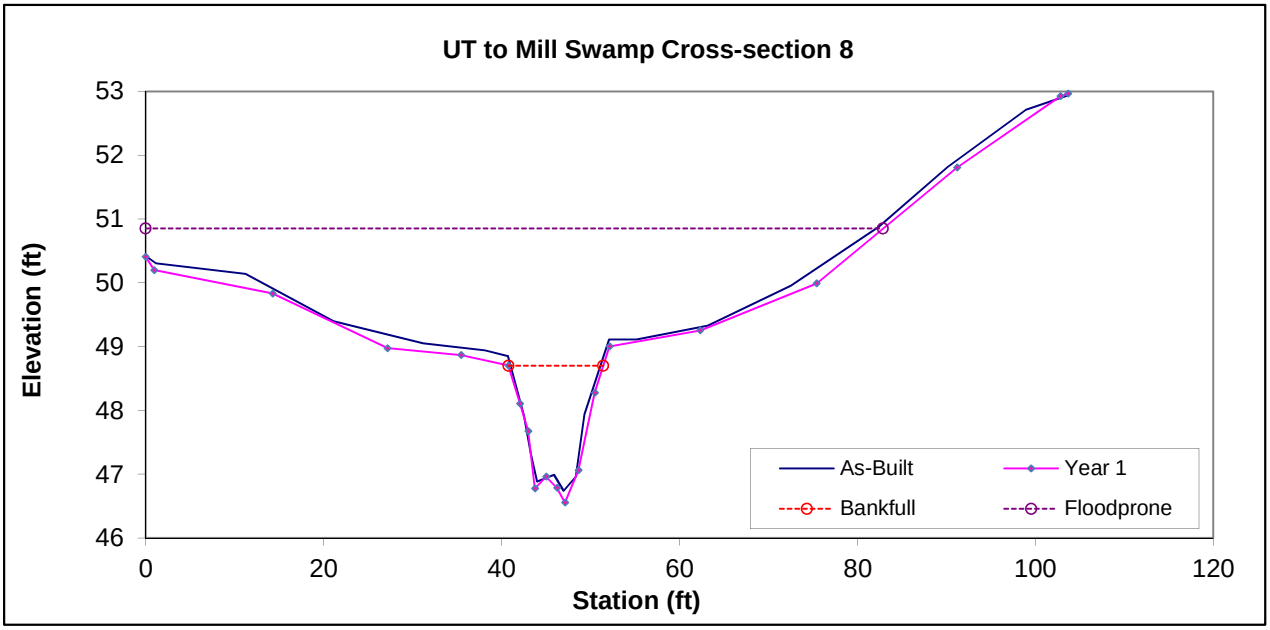


Table 10. Baseline Stream Summary

UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Reach UT1c (1,513 LF)

Parameter	USGS Gauge	Regional Curve Interval (Harman et al, 1999)*			Pre-Existing Condition[1]					
Dimension and Substrate - Riffle		LL	UL	Eq.	Min	Mean	Med	Max	SD	n
BF Width (ft)	-----	23.0	80.0	9.9	6.8	-----	-----	8.7	-----	2
Floodprone Width (ft)	-----	-----	-----	-----	8.2	-----	-----	11.8	-----	2
BF Mean Depth (ft)	-----	2.3	5.8	1.3	0.8	-----	-----	1.0	-----	2
BF Max Depth (ft)	-----	-----	-----	-----	1.1	-----	-----	1.4	-----	2
BF Cross-sectional Area (ft^2)	-----	80.0	300.0	16.2	5.6	-----	-----	8.6	-----	2
Width/Depth Ratio	-----	-----	-----	-----	8	-----	-----	9	-----	2
Entrenchment Ratio	-----	-----	-----	-----	1.2	-----	-----	1.4	-----	2
Bank Height Ratio	-----	-----	-----	-----	4.2	-----	-----	2.8	-----	2
d50 (mm)	-----	-----	-----	-----	-----	0.25	-----	-----	-----	1[2]
Pattern										
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rc:Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Profile										
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	1.1	-----	-----	1.16	-----	2
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters										
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----			0.10 / 0.15 / 0.25 / 1.2 / 2.7[2]			
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters										
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	0.66	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----		-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	Gc	-----	-----	-----	-----
BF Velocity (fps)	-----	-----	-----	-----	0.8	-----	-----	1.2	-----	2
BF Discharge (cfs)	-----	290.0	2000.0	66.0	-----	6.48	-----	-----	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	4091	-----	-----	-----	-----
Sinuosity	-----	-----	-----	-----	-----	1.13	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	0.0045	-----	-----	-----	2
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

[1] Existing conditions survey data is compiled for the entire UT1 Reach within the project limits.

[2] Bulk samples taken since pebble count procedure is not applicable for sand-bed streams.

[3] Values were chosen based on sand-bed reference reach data and past project evaluations.

[4] Composite reference reach information from Johannah Creek, Johnston County; Panther Branch, Brunswick County; Rocky Swamp, Halifax County; and Beaver Dam Branch, Jones County

Table 10. Baseline Stream Summary

UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Reach UT1c (1,513 LF)

	Reference Reach(es) Data											
	Beaverdam Branch						NC Coastal Plain Composite Data[4]					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Mean Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	24	-----	-----	-----	2	7.8	-----	-----	95.9	-----	-----
Width/Depth Ratio	11	-----	-----	17	-----	2	8	-----	-----	14	-----	-----
Entrenchment Ratio	10	-----	-----	11	-----	2	4	-----	-----	13	-----	-----
Bank Height Ratio	1.0	-----	-----	1.3	-----	2	1.0	-----	-----	1.3	-----	-----
d50 (mm)	-----	0.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rc:Bankfull width (ft/ft)	1.8	-----	-----	2.4	-----	-----	1.5	-----	-----	3.0	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	2.0	-----	-----	6.3	-----	-----
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
d16 / d35 / d50 / d84 / d95			0.3 / 0.4 / 0.5 / 0.9 / 1.2				-----	-----	-----	-----	-----	-----
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	3.0	-----	-----	1.0	-----	-----	19.5	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classificatior	-----	C5c	-----	-----	-----	-----	-----	E5/C5	-----	-----	-----	-----
BF Velocity (fps)	-----	1.5	-----	-----	-----	-----	1.0	-----	-----	1.4	-----	-----
BF Discharge (cfs)	-----	37	-----	-----	-----	-----	10	-----	-----	127	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel length (ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sinuosity	-----	1.66	-----	-----	-----	-----	1.22	-----	-----	1.77	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0004	-----	-----	-----	-----	0.0004	-----	-----	0.0022	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bankfull Floodplain Area (acres	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

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4 Composite reference reach information from Johannah Creek, Johnston County; Panther Branch, Brunswick County; Rocky Swamp, Halifax County; and Beaver Dam Branch, Jones County

Table 10. Baseline Stream Summary

UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Reach UT1c (1,513 LF)

	Design						As-built					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-----	10.3	-----	-----	-----	1	10.1	-----	-----	13.8	-----	4
Floodprone Width (ft)	-----	>100	-----	-----	-----	1	80.1	-----	-----	105.0	-----	4
BF Mean Depth (ft)	-----	0.7	-----	-----	-----	1	0.6	-----	-----	1.2	-----	4
BF Max Depth (ft)	-----	1.0	-----	-----	-----	1	1.1	-----	-----	2.0	-----	4
BF Cross-sectional Area (ft^2)	-----	7.6	-----	-----	-----	1	7.5	-----	-----	12.3	-----	4
Width/Depth Ratio	-----	14	-----	-----	-----	1	8.3	-----	-----	19.4	-----	4
Entrenchment Ratio	-----	>10	-----	-----	-----	1	7.9	-----	-----	9.4	-----	4
Bank Height Ratio	-----	1.0	-----	-----	-----	1	1.0	-----	-----	1.1	-----	4
d50 (mm)	-----	0.25	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	35	-----	-----	60	-----	-----[3]	38.0	79.0	-----	120.0	-----	-----
Radius of Curvature (ft)	20	-----	-----	30	-----	-----[3]	21.0	26.0	-----	31.0	-----	-----
Rc:Bankfull width (ft/ft)	2.0	-----	-----	3.0	-----	-----[3]	38.0	79.0	-----	120.0	-----	-----
Meander Wavelength (ft)	80	-----	-----	110	-----	-----[3]	72.0	104.0	-----	124.0	-----	-----
Meander Width Ratio	3.5	-----	-----	6.0	-----	-----[3]	3.5	6.0	-----	8.0	-----	-----
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	0.004	-----	-----	0.010	-----	-----	0.0046	0.0043	-----	0.0039	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----						-----
Pool Spacing (ft)	30	-----	-----	80	-----	-----	41	-----	72	57	-----	-----
Pool Max Depth (ft)	-----	1.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
Reach Shear Stress (competency) lb/ft^2	-----	0.149	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	4.181	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	0.66	-----	-----	-----	-----	-----	0.66	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	C5	-----	-----	-----	-----	-----	C5	-----	-----	-----	-----
BF Velocity (fps)	-----	1.76	-----	-----	-----	-----	-----	3.0	-----	-----	-----	-----
BF Discharge (cfs)	-----	12.9	-----	-----	-----	-----	-----	340.0	-----	-----	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	3523	-----	-----	-----	-----
Channel length (ft)[1]	-----	1453	-----	-----	-----	-----	-----	4238	-----	-----	-----	-----
Sinuosity	-----	1.24	-----	-----	-----	-----	-----	1.20	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0038	-----	-----	-----	-----	-----	0.0042	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0054	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

1 Existing conditions survey data is compiled for the entire UT1 Reach within the project limits.

2 Bulk samples taken since pebble count procedure is not applicable for sand-bed streams.

3 Values were chosen based on sand-bed reference reach data and past project evaluations.

4 Composite reference reach information from Johannah Creek, Johnston County; Panther Branch, Brunswick County; Rocky Swamp, Halifax County; and Beaver Dam Branch, Jones County

Table 11. Morphology and Hydraulic Monitoring Summary

UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

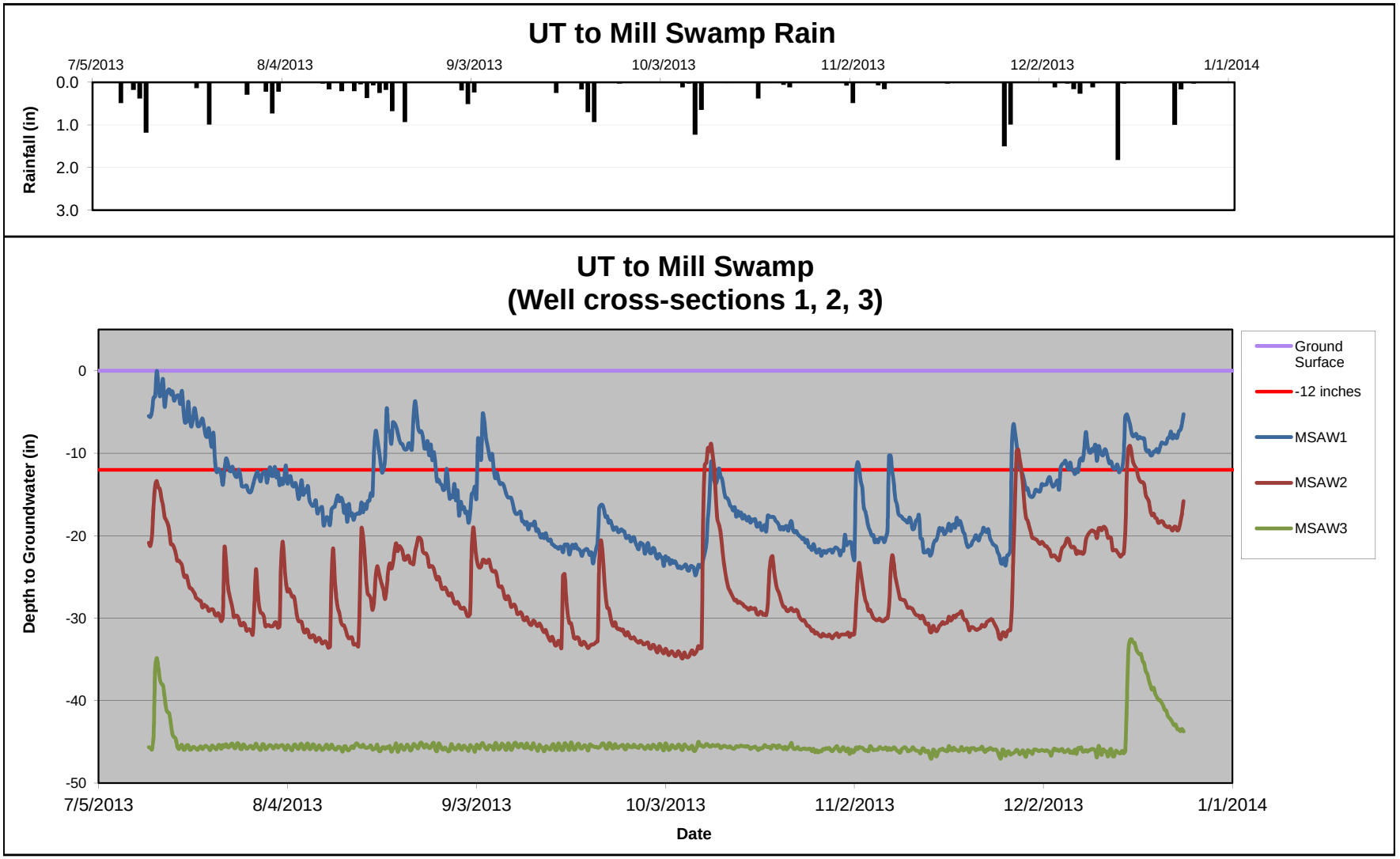
Reach UT1c (1,513 LF)

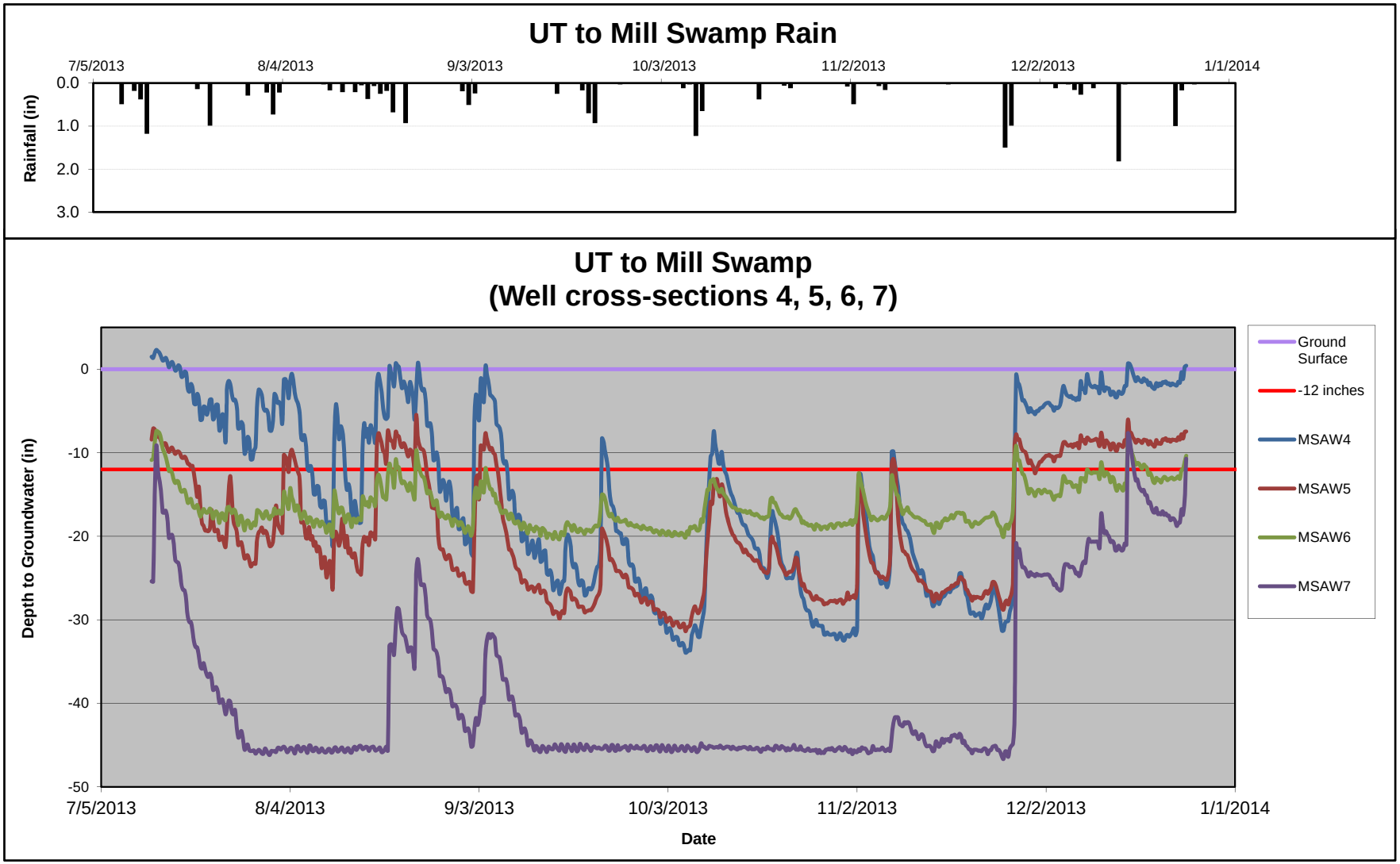
	Cross-section X-1 (Riffle)							Cross-section X-2 (Pool)							Cross-section X-3 (Pool)							Cross-section X-4 (Riffle)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	11.9	11.1						15.4	22.5						21.3	39.23						11.2	11.5					
BF Mean Depth (ft)	0.6	0.6						1.1	0.7						0.6	0.48						0.7	0.7					
Width/Depth Ratio	18.9	17.7						14.4	31.2						33.9	82.4						16.5	15.4					
BF Cross-sectional Area (ft²)	7.5	6.9						16.6	16.2						13.4	18.7						7.5	8.5					
BF Max Depth (ft)	1.4	1.3						2.4	2.2						1.5	1.8						1.1	1.3					
Width of Floodprone Area (ft)	104.5	104.4						107.9	107.9						117.0	116.7						104.5	104.5					
Entrenchment Ratio	8.8	9.4						7.0	4.8						5.5	3						9.4	9.1					
Bank Height Ratio	1.0	1.1						1.0	1.0						1.0	0.8						1.1	1.0					
Wetted Perimeter (ft)	13.2	12.3						17.6	23.9						22.5	40.2						12.5	12.9					
Hydraulic Radius (ft)	0.6	0.6						0.9	0.7						0.6	0.5						0.6	0.7					
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft²)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
d50 (mm)								-																				

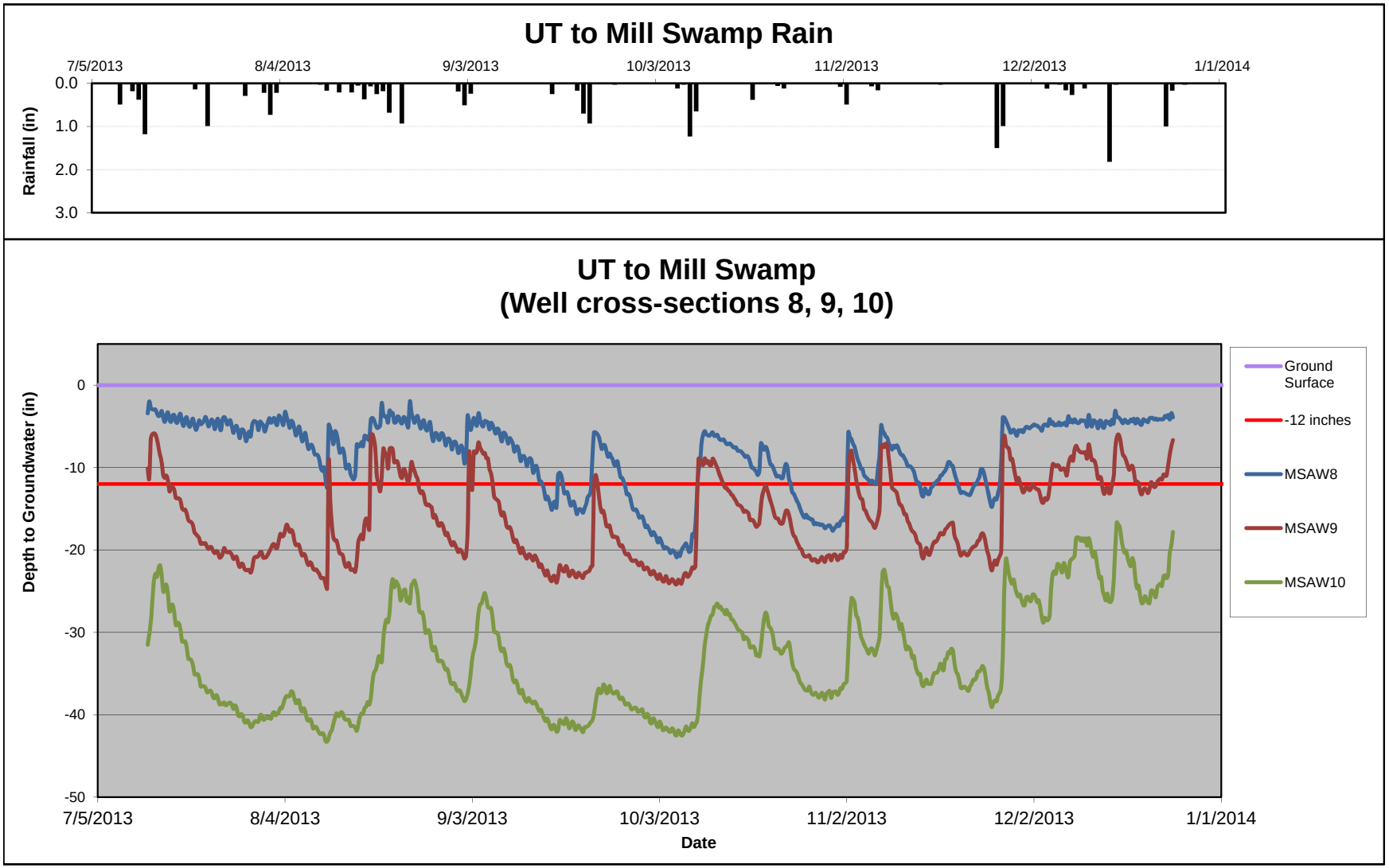
	Cross-section X-5 (Riffle)							Cross-section X-6 (Pool)							Cross-section 7 (Pool)							Cross-section X-8 (Riffle)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	13.8	14.6						15.1	31.0						15.5	16.6						10.1	10.7					
BF Mean Depth (ft)	0.7	0.7						0.8	0.4						1.1	1.1						1.2	1.3					
Width/Depth Ratio	19.4	19.8						20.1	78.8						14.5	14.9						8.3	8.4					
BF Cross-sectional Area (ft²)	9.9	10.8						11.3	12.2						16.7	18.4						12.3	13.6					
BF Max Depth (ft)	1.3	1.4						1.8	1.6						2.0	2.1						2.0	2.2					
Width of Floodprone Area (ft)	112.3	112.3						114.3	114.3						132.4	132.4						80.1	82.9					
Entrenchment Ratio	8.1	7.7						7.6	3.7						8.5	8.0						7.9	7.8					
Bank Height Ratio	1.0	1.0						1.0	1.0						1.0	1.0						1.1	1.0					
Wetted Perimeter (ft)	15.3	16.1						16.6	31.8						17.7	18.8						12.5	13.2					
Hydraulic Radius (ft)	0.6	0.7						0.7	0.4						0.9	1.0						1.0	1.0					
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft²)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
d50 (mm)								-							-							-						

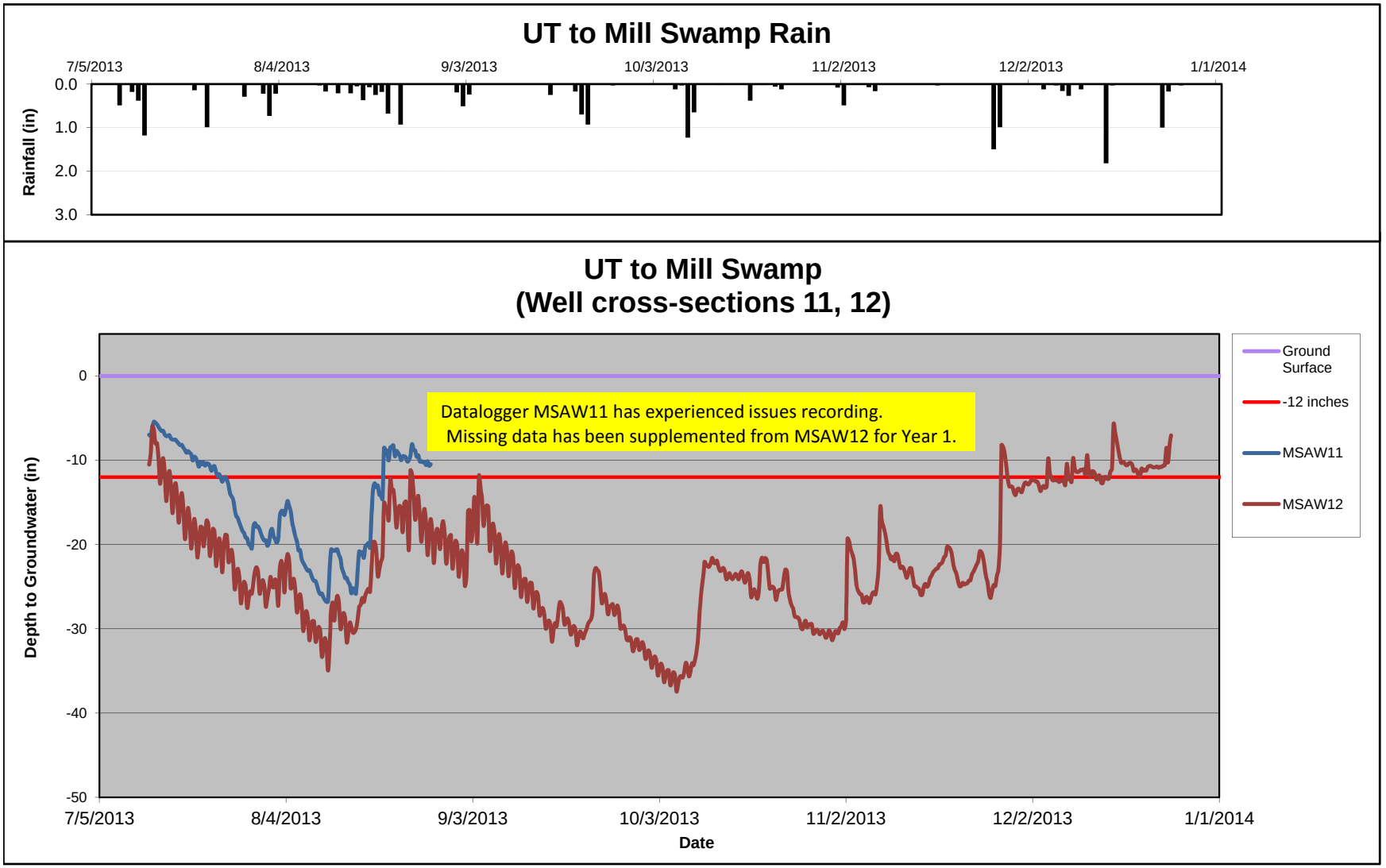
Appendix E

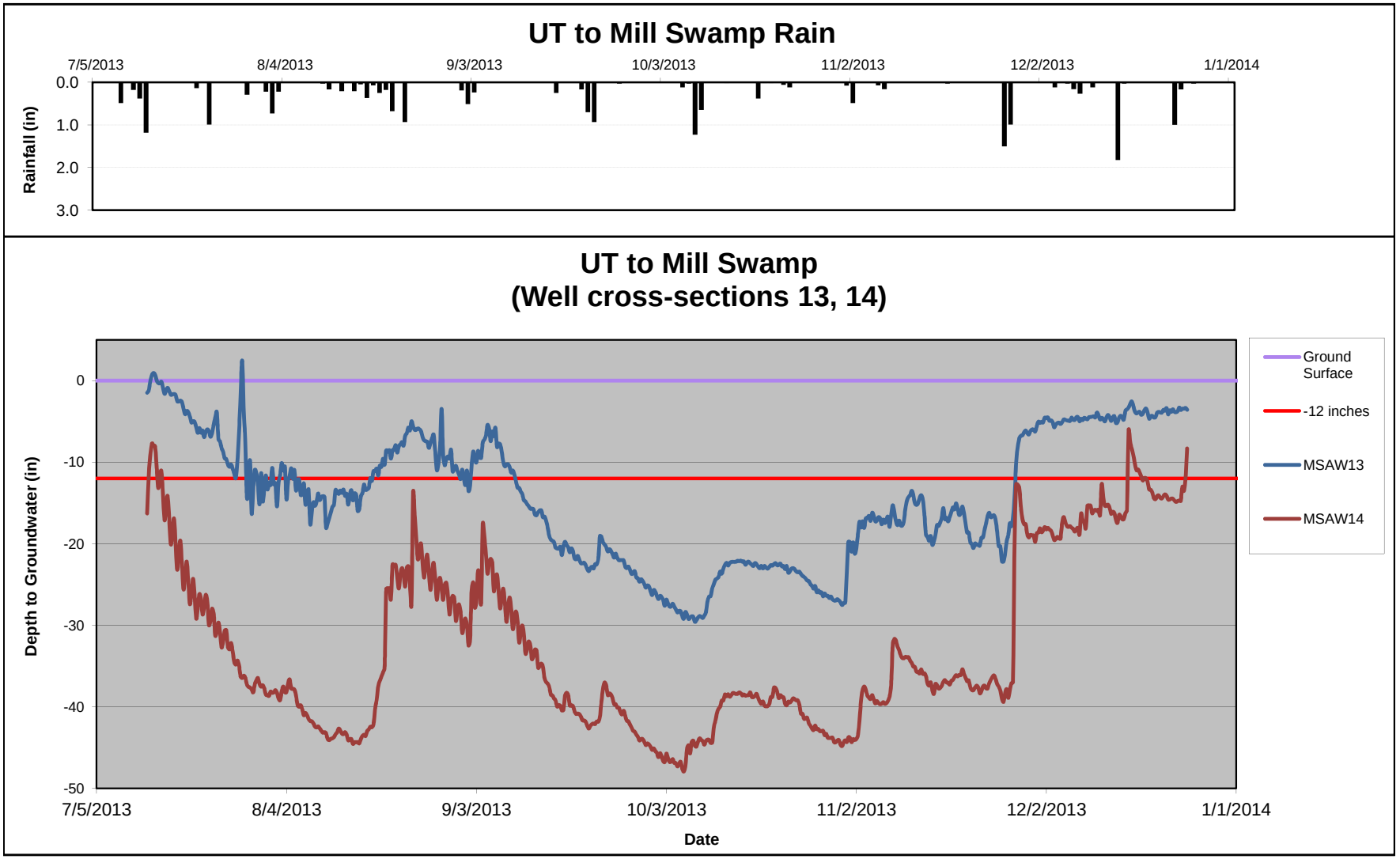
Hydrologic Data

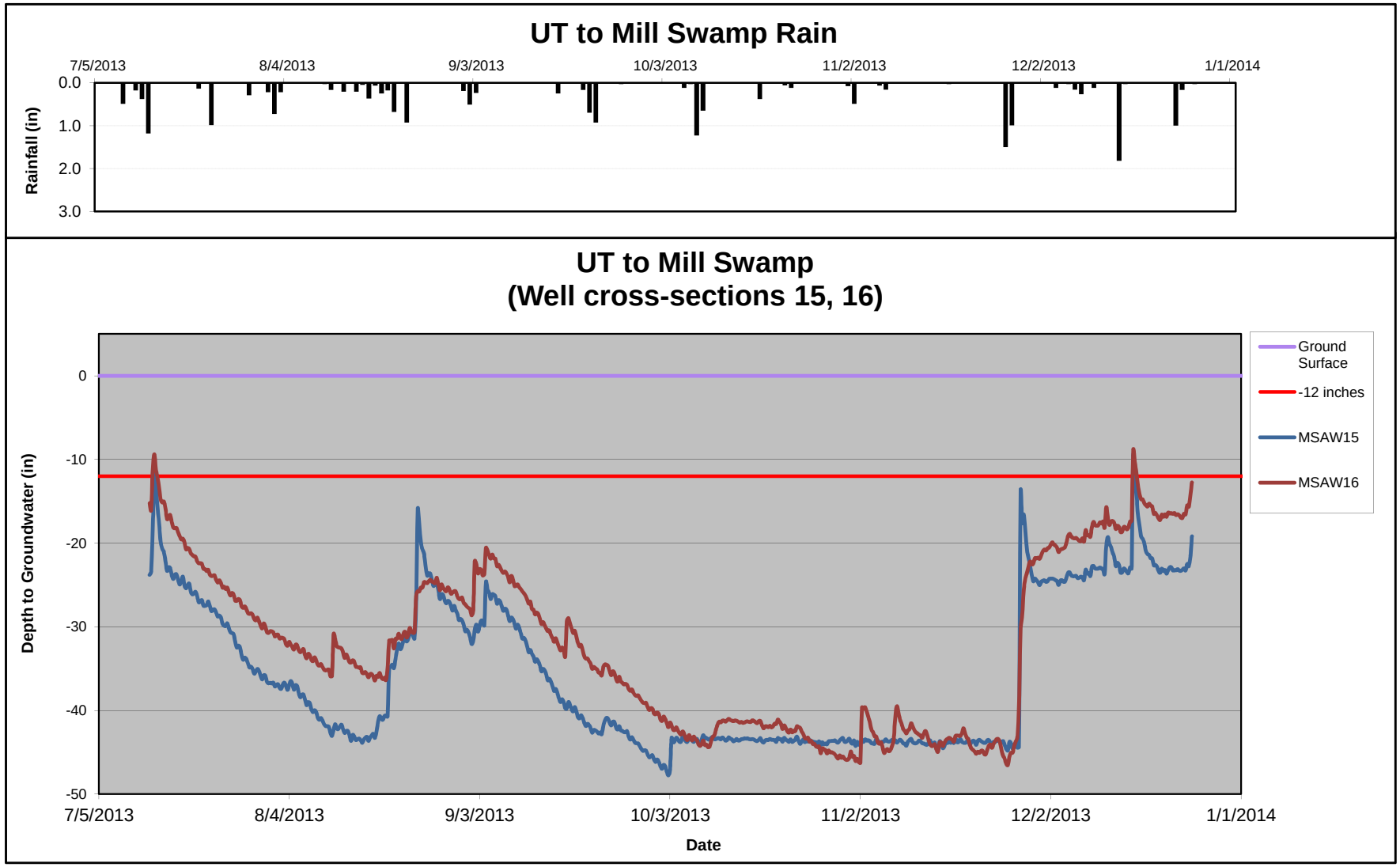

UT to Mill Swamp Rain
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
0.0
1.0
2.0
3.0
Rainfall (in)
UT to Mill Swamp
(Well cross-sections 1, 2, 3)
0
-10
-20
-30
-40
-50
Depth to Groundwater (in)
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
Date
Ground Surface
-12 inches
MSAW1
MSAW2
MSAW3

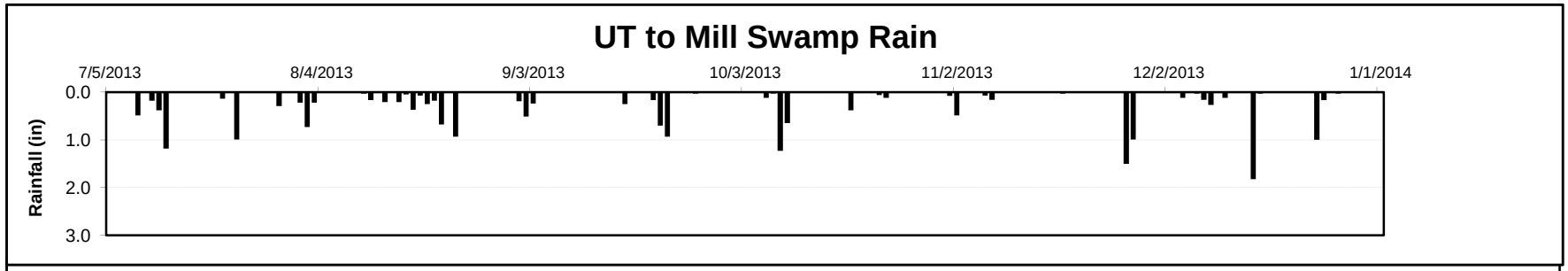

UT to Mill Swamp Rain
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
0.0
1.0
2.0
3.0
Rainfall (in)
UT to Mill Swamp
(Well cross-sections 4, 5, 6, 7)
Depth to Groundwater (in)
0
-10
-20
-30
-40
-50
Ground Surface
-12 inches
MSAW4
MSAW5
MSAW6
MSAW7
Date

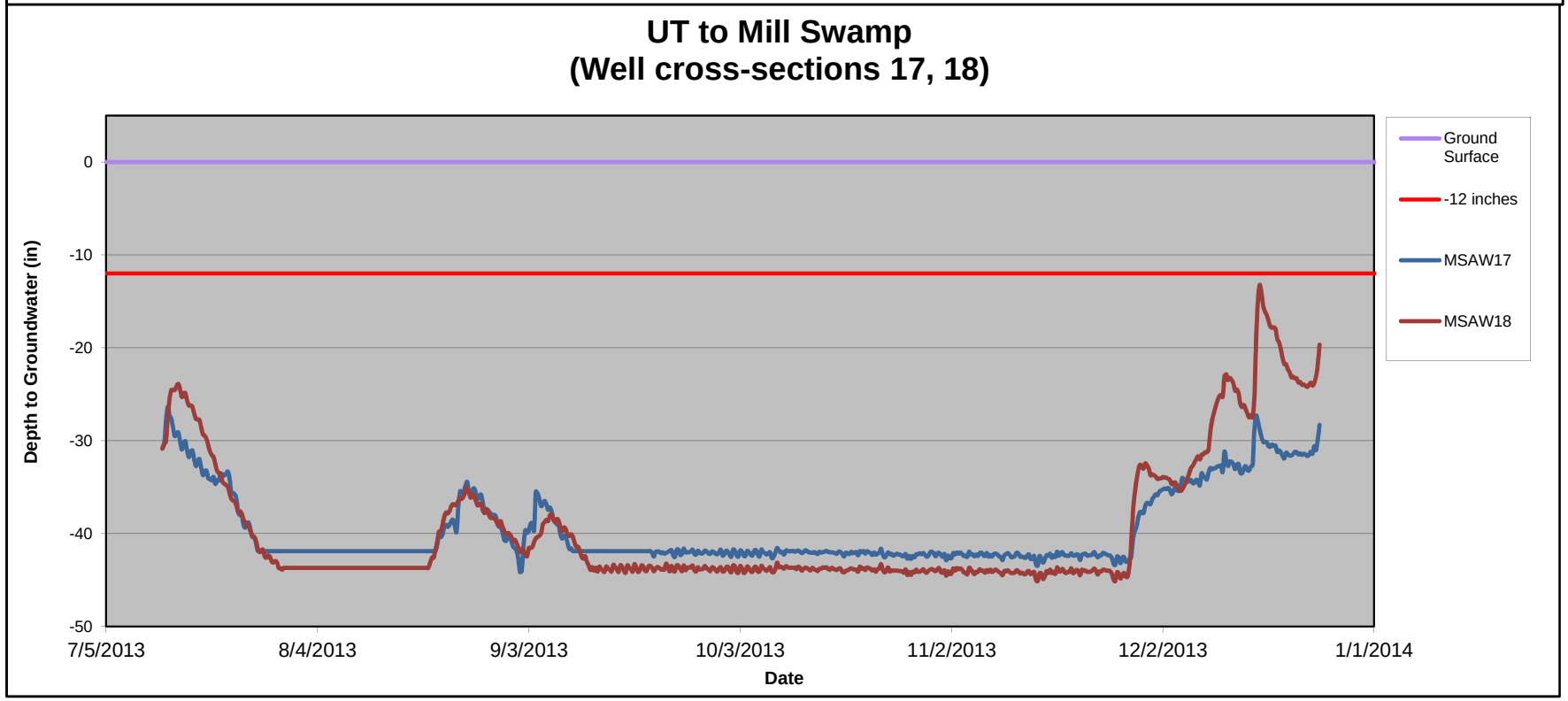

UT to Mill Swamp Rain
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
0.0
1.0
2.0
3.0
Rainfall (in)
UT to Mill Swamp
(Well cross-sections 8, 9, 10)
Depth to Groundwater (in)
0
-10
-20
-30
-40
-50
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
Date
Ground Surface
-12 inches
MSAW8
MSAW9
MSAW10

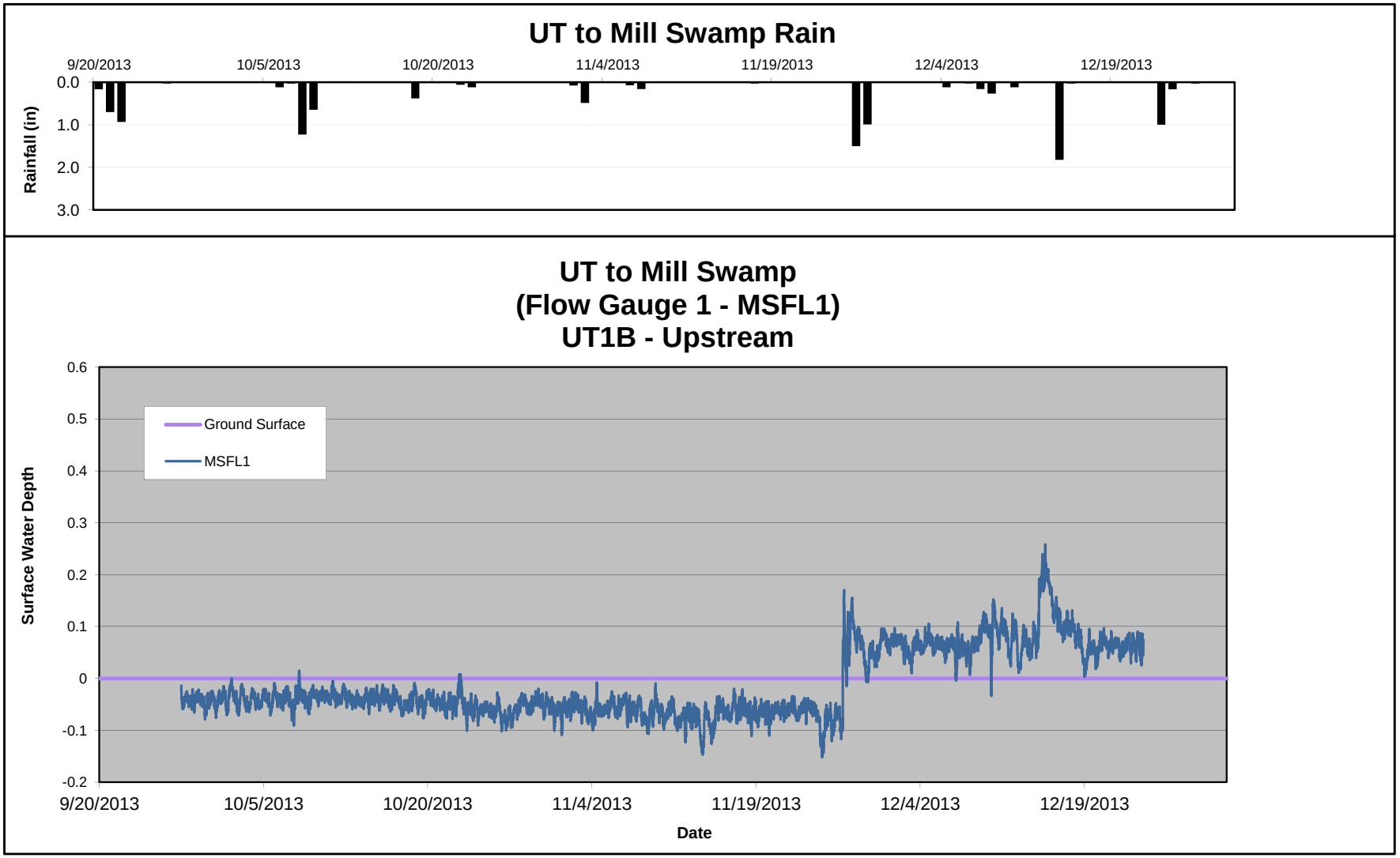

UT to Mill Swamp Rain
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
0.0
1.0
2.0
3.0
Rainfall (in)
UT to Mill Swamp
(Well cross-sections 11, 12)
Datalogger MSAW11 has experienced issues recording.
Missing data has been supplemented from MSAW12 for Year 1.
Ground Surface
-12 inches
MSAW11
MSAW12
0
-10
-20
-30
-40
-50
Depth to Groundwater (in)
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
Date


UT to Mill Swamp Rain
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
0.0
1.0
2.0
3.0
Rainfall (in)
UT to Mill Swamp
(Well cross-sections 13, 14)
0
-10
-20
-30
-40
-50
Depth to Groundwater (in)
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
Date
Ground Surface
-12 inches
MSAW13
MSAW14


UT to Mill Swamp Rain
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
0.0
1.0
2.0
3.0
Rainfall (in)
UT to Mill Swamp
(Well cross-sections 15, 16)
0
-10
-20
-30
-40
-50
Depth to Groundwater (in)
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
Date
Ground Surface
-12 inches
MSAW15
MSAW16


UT to Mill Swamp Rain
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
0.0
1.0
2.0
3.0
Rainfall (in)


UT to Mill Swamp
(Well cross-sections 17, 18)
0
-10
-20
-30
-40
-50
Depth to Groundwater (in)
7/5/2013
8/4/2013
9/3/2013
10/3/2013
11/2/2013
12/2/2013
1/1/2014
Date
Ground Surface
-12 inches
MSAW17
MSAW18


UT to Mill Swamp Rain
9/20/2013
10/5/2013
10/20/2013
11/4/2013
11/19/2013
12/4/2013
12/19/2013
0.0
1.0
2.0
3.0
Rainfall (in)
UT to Mill Swamp
(Flow Gauge 1 - MSFL1)
UT1B - Upstream
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
Ground Surface
MSFL1
Surface Water Depth
9/20/2013
10/5/2013
10/20/2013
11/4/2013
11/19/2013
12/4/2013
12/19/2013
Date

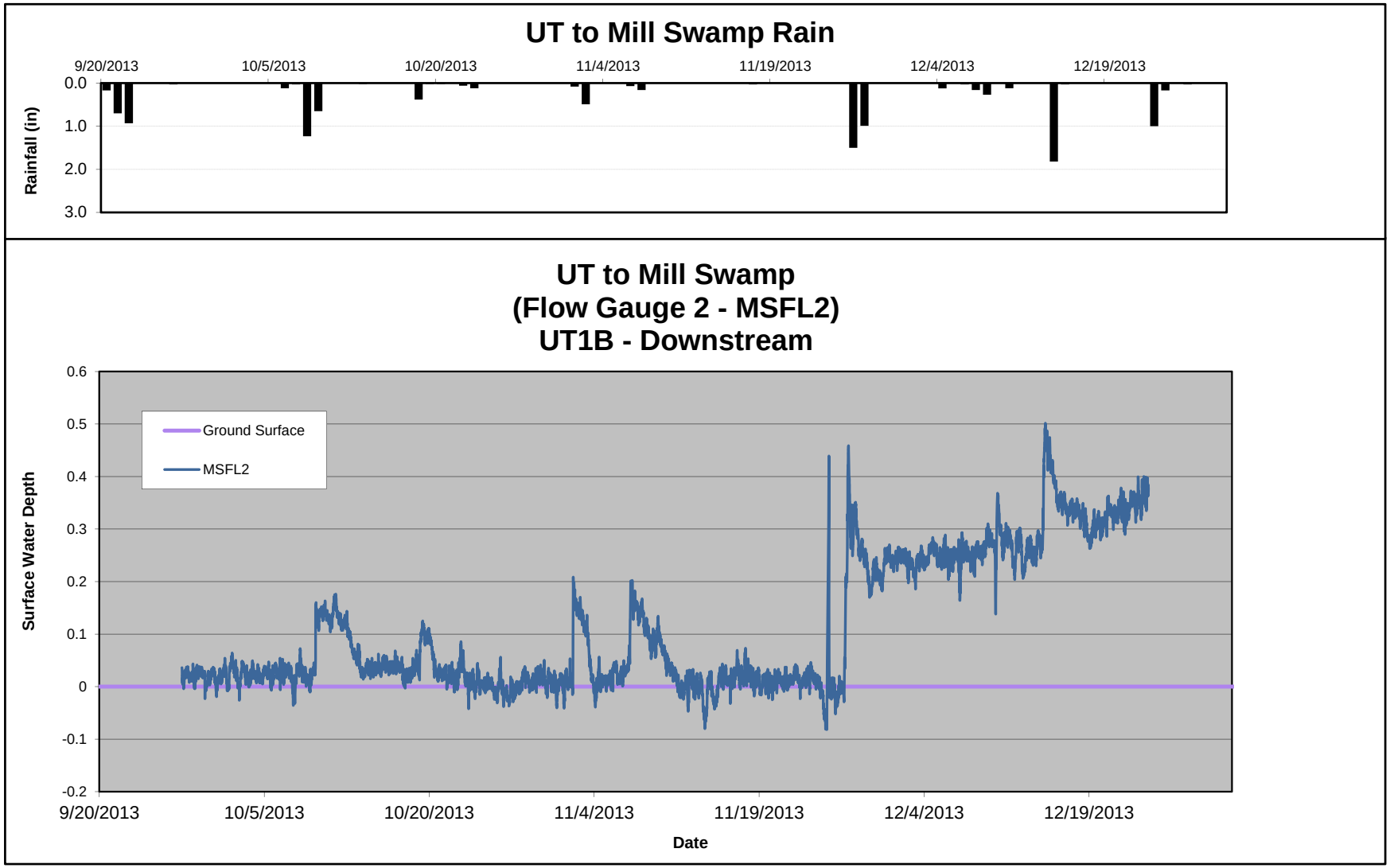

UT to Mill Swamp Rain
9/20/2013
10/5/2013
10/20/2013
11/4/2013
11/19/2013
12/4/2013
12/19/2013
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp
(Flow Gauge 2 - MSFL2)
UT1B - Downstream
Ground Surface
MSFL2
Surface Water Depth
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
9/20/2013
10/5/2013
10/20/2013
11/4/2013
11/19/2013
12/4/2013
12/19/2013
Date

Table 12. Wetland Restoration Area Well Success
UT to Mill Swamp Restoration Project: Project ID No. 95019

Well ID	*Percentage of Consecutive Days <12 inches from Ground Surface[1]	Most Consecutive Days Meeting Criteria[2]	Cumulative Days Meeting Criteria[3]	Number of Instances Water Exceeded 12 Inches Below Ground Surface[4]
Cross-sectional Well Arrays				
BCAW1	4.4	10.8	53.5	4.0
BCAW2	0.7	1.8	3.5	1.0
BCAW3	0.0	0.0	0.0	0.0
BCAW4	10.3	25.0	97.0	6.0
BCAW5	3.3	8.0	40.5	4.0
BCAW6	1.1	2.8	9.5	1.0
BCAW7	0.2	0.5	0.3	0.0
BCAW8	14.1	34.3	193.0	8.0
BCAW9	2.5	6.0	44.5	7.0
BCAW10	0.0	0.0	0.0	0.0
****Headwater Restoration Well Arrays**				
BCAW11	4.7	11.5	38.5	2.0
BCAW12	0.7	1.8	7.0	1.0
BCAW13	6.5	15.8	81.5	4.0
BCAW14	0.6	1.5	4.0	1.0
BCAW15	0.8	2.0	4.0	1.0
BCAW16	2.4	5.8	14.5	2.0
BCAW17	0.0	0.0	0.0	0.0
BCAW18	3.8	9.3	18.5	1.0

Notes:

[1]Indicates the percentage of most consecutive number of days within the monitored growing season with a water 12 inches or less from the soil surface,

[2]Indicates the most consecutive number of days within the monitored growing season with a water table 12 inches or less from the soil surface,

[3]Indicates the cumulative number of days within the monitored growing season with a water table 12 inches or less from the soil surface,

[4]Indicates the number of instances within the monitored growing season that the water table exceeded 12 inches or less from the soil surface,

Growing season for Onslow County is from March 18 to November 16 and is 243 days long

HIGHLIGHTED indicates wells that *did not* meet the success criteria for the most consecutive number of days within the monitored growing season with a water 12 inches or less from the soil surface.

*All In-Situ groundwater monitoring dataloggers were installed on 7/12/2013. The installation of the dataloggers was complete after the 2013 spring wet season when groundwater levels are normally closer to the ground surface. For monitoring 2013, the dataloggers mainly recorded the fall wet season groundwater levels, therefore likelyhood of well success decreased due to the shorter saturation period.

**Headwater Restoration groundwater monitoring dataloggers are for data collection only are not required to meet succes criteria.

Table 13. Verification of Bankfull Events			
UT to Mill Swamp Restoration Project: Project No. 95019			
Date of Data Collection	Estimated Occurrence of Bankfull Event	Method of Data Collection	M3 Crest (feet)
8/15/2013	Gauge Installed	NA	NA
10/16/2013	10/11/2013	Crest Gauge	0.17
12/24/2013	12/15/2013	Crest Gauge	0.19

Figure 6. Observed Rainfall versus Historic Average