ANNUAL MONITORING REPORT
YEAR 2 (2009) ANNUAL MONITORING

BROWN MARSH SWAMP STREAM AND WETLAND RESTORATION SITE

Robeson County, North Carolina
Hydrologic Unit 03040204037010 of the Lumber River Basin
Contract No. 16-D06038

Prepared for:

NCDENR-Ecosystem Enhancement Program
2728 Capital Boulevard, Suite 1H 103
Raleigh, North Carolina 27604

November 2009

Prepared by:

Ko & Associates, P.C.
Florence & Hutcheson, Inc.
5121 Kingdom Way, Suite 100
Raleigh, North Carolina 27607
919.851.6066
919.851.6846 (fax)

For:

Restoration Systems
1101 Haynes Street, Suite 211
Raleigh, North Carolina 27604

EXECUTIVE SUMMARY

The Brown Marsh Swamp Restoration Site (Site) is located one mile east of the North Carolina and South Carolina state line, and is approximately 15 miles southwest of the Town of Lumberton, in Robeson County. The Site is situated due east of the intersection of Cotton Valley Road and McCormick Road, approximately one mile south of Interstate 95. The Site is located within United States Geological Survey (USGS) Hydrologic Unit and Targeted Local Watershed 03040204037010 (North Carolina Division of Water Quality Subbasin 03-07-55) of the Lumber River Basin and will service the USGS 8-digit Cataloging Unit 03040204. The Site was identified to assist the North Carolina Ecosystem Enhancement Program in meeting its stream and wetland restoration goals.

Primary activities at the Site included 1) stream restoration, 2) wetland restoration, 3) soil scarification, and 4) plant community restoration. Project restoration efforts provided 5004 Stream Mitigation Units and 5.0 Nonriverine Wetland Mitigation Units.

Seventeen vegetation plots (10-10 meters by 10 meters and 7-20 meters by 5 meters in size) were established and permanently monumented. These plots were surveyed in August 2009 for the Year 2 (2009) monitoring season. Based on the number of stems counted, average densities were measured at 705 planted stems per acre surviving in Year 2 (2009). The dominant species identified at the Site were planted stems of silky dogwood (*Cornus amomum*), elm (*Ulmus* sp.), green ash (*Fraxinus pennsylvanica*), and swamp chestnut oak (*Quercus michauxii*), and natural recruits of red maple (*Acer rubrum*). No vegetation problem areas were noted during the Year 2 (2009) monitoring season.

Twenty cross-sections and longitudinal profiles within five 600-foot reaches were measured for the Year 2 (2009) monitoring season. As a whole, monitoring measurements indicate minimal changes in both the longitudinal profile and cross-sections as compared to as-built data. The channel geometry compares favorably with the emulated, stable E/C type stream reach as set forth in the detailed mitigation plan and as constructed. Current monitoring has demonstrated dimension, pattern, and profile were stable over the course of the monitoring period. No stream problem areas were noted during Year 2 (2009) monitoring.

Two onsite groundwater gauges and one reference groundwater gauge were maintained for the Year 2 (2009) monitoring season. All monitored gauges within restoration areas were inundated/saturated within 12 inches of the surface for greater than 12.5 percent of the growing season. No wetland problem areas were noted during Year 2 (2009) monitoring.

In summary, the Site achieved success criteria for vegetation, stream, and hydrology attributes in the Second Monitoring Year (2009).

Table of Contents

List of Figures

List of Tables

Appendices

1.0 PROJECT BACKGROUND

1.1 Location and Setting

The Site is located one mile east of the North Carolina and South Carolina state line, and approximately 3.2 miles southeast of the town of Rowland (Figure 1). The center of the Site has a latitude and longitude of 034º 29' 31.85" N and 079º 16' 26.87'' W. The Site is situated due east of the intersection of Cotton Valley Road (SR 2492) and McCormick Road (SR 2491), approximately one mile south of Interstate 95. The Site is located within United States Geological Survey (USGS) Hydrologic Unit and Targeted Local Watershed 03040204037010 (North Carolina Division of Water Quality [NCDWQ] Subbasin 03-07-55) of the Lumber River Basin and will service the USGS 8-digit Cataloging Unit 03040204 (USGS 1974, NCWRP 2003). The Site was identified to assist the North Carolina Ecosystem Enhancement Program (EEP) in meeting its stream and wetland restoration goals.

Directions to the Site from Raleigh, North Carolina, are as follows:

- Take Interstate 40 East for approximately 18 miles to Interstate Highway 95 (I-95) South
- Take I-95 South for approximately 80 miles to Exit 2, North Carolina Highway 130 (NC-130)
- Take a left/travel south on NC-130 for approximately 0.1 mile to Cotton Valley Road (SR 2492) and turn right
- Follow Cotton Valley Road for approximately 2 miles
- The project is south of Cotton Valley Road and east of McCormick Road (SR 2491)

1.2 Project Objectives

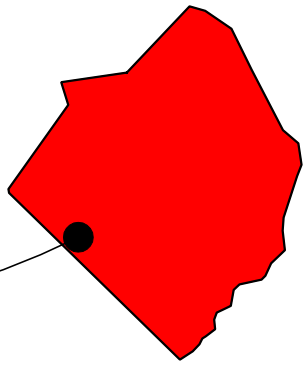
The primary components of the restoration project included 1) construction of a stable, riffle-pool stream channel; 2) enhancement of water quality functions within, upstream, and downstream of the Site; 3) creation of a natural vegetated buffer along restored stream channels; 4) restoration of jurisdictional nonriverine wetlands in the Site; 5) improvement of aquatic habitat and species diversity by enhancing stream bed variability; and 6) restoration of wildlife functions associated with a riparian corridor/stable stream.

1.3 Project Structure, Restoration Type, and Approach

A 20.25-acre conservation easement has been placed on the Site to incorporate all restoration activities. The Site contains 5.0 acres of hydric soils, two first-order unnamed tributaries (UTs) to Contrary Swamp (Northern UT and Southern UT), associated floodplain, and upland slopes. The purpose of this project was to restore stable pattern, dimension, and profile to the UTs; restore hydrology to drained nonriverine wetlands; and revegetate streams, floodplains, wetlands, and upland slopes within the Site. The contributing watershed is characterized primarily by agricultural row crop production and pine plantation/forest land. Preproject Site conditions consisted of agricultural row crop production. Land use modifications including the removal of riparian vegetation, straightening and dredging of stream channels, and ditching of floodplain wetlands resulted in degraded water quality and unstable channel characteristics (stream entrenchment, erosion, and bank collapse).

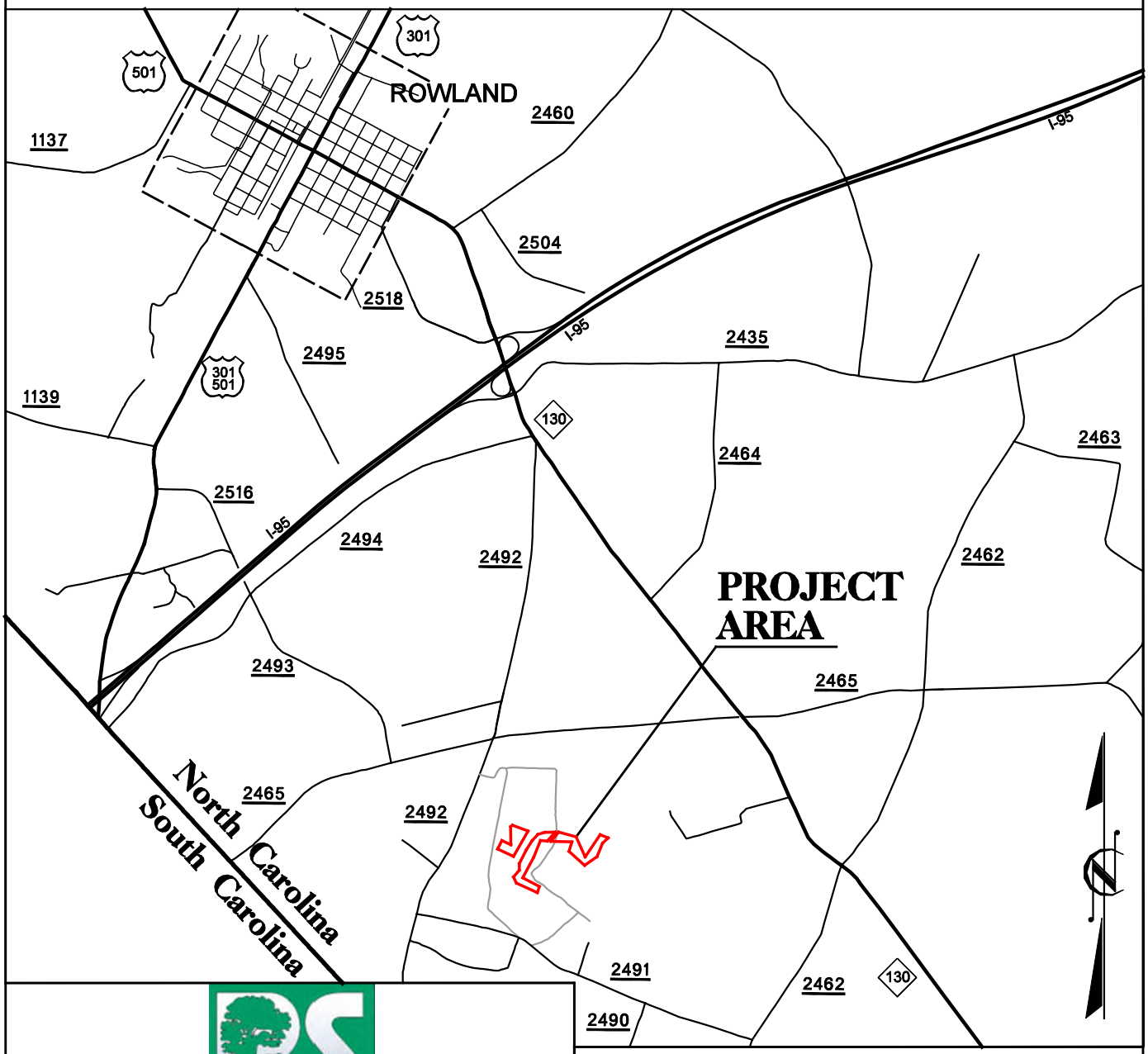
The primary goals of this stream and wetland restoration project focused on improving water quality, decreasing floodwater levels, and restoring aquatic and riparian habitat. These goals were accomplished by:

Robeson County
North Carolina



PROJECT AREA

0 2000 4000
FEET



RESTORATION SYSTEMS, LLC

KO & ASSOCIATES, P.C.
Consulting Engineers
5121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

Vicinity Map

Brown Marsh Swamp
Robeson County, North Carolina

Date: 11/07/08

Figure: 1

- Reducing nonpoint sources of pollution associated with agricultural land uses by providing a forested buffer adjacent to streams to treat surface runoff.
- Reestablishing stream stability and the capacity to transport watershed flows and sediment loads by restoring stable dimension, pattern, and profile.
- Promoting floodwater attenuation by;
    - excavating a floodplain at a new bankfull elevation;
    - restoring a secondary, entrenched tributary thereby reducing floodwater velocities within smaller catchment basins;
    - increasing storage capacity for floodwaters within the Site limits; and
    - revegetating floodplains to increase frictional resistance on floodwaters.
- Improving aquatic habitat by enhancing stream bed variability, restoring a riffle-pool complex, and by incorporating grade control/habitat structures.
- Providing wildlife habitat including a forested riparian corridor within an area highly dissected by agricultural land uses.

Primary activities at the Site included 1) stream restoration, 2) wetland restoration, 3) soil scarification, and 4) plant community restoration. Table 1 describes the Site restoration structures and objectives, which have provided 5004 Stream Mitigation Units (SMUs) and 5.0 Nonriverine Wetland Mitigation Units (WMUs).

- Restored 5004 linear feet of two unnamed tributaries to Contrary Swamp (Northern UT and Southern UT) by constructing moderately sinuous, E-type channels on new location.
- Restored 5.0 acres of nonriverine wetland within the interstream flat filling ditches, removing elevated spoil, thereby reestablishing historic water table elevations.
- Reforested approximately 20.05 acres of floodplain, stream bank, upland slopes, and nonriverine wetlands with native forest species.

Table 1. Site Restoration Structures and Objectives

Restoration Segment/ Reach ID	Station Range	Restoration Type/Approach*	Existing Linear Footage/ Acreage	Designed Linear Footage/Acreage	SMU/WMUs
Northern UT	10+00 – 54+65	Restoration/PII	2700	4,465	4465
Southern UT	10+00 – 15+39	Restoration/PII	442	539	539
Nonriverine Wetlands	--	Restoration	5.0	5.0	5.0
Mitigation Unit Summations					
Stream	**Nonriverine Wetland**				
5004 SMUs	5.0 WMUs				

*PII=Priority 2

1.4 Project History and Background

Completed project activities, reporting history, completion dates, project contacts, and background information are summarized in Tables 2-4.

Table 2. Project Activity and Reporting History

Activity or Report	Data Collection Completion	Actual Completion or Delivery
Restoration Plan	November 2006	December 2006
Final Design (~90%)	NA	July 2007
Construction Completion	NA	November 2007
Site Planting	NA	January 2008
Mitigation Plan/As-builts	February 2008	April 2008
Year 1 Monitoring (2008)	September 2008	November 2008
Year 2 Monitoring (2009)	September 2009	November 2009

Table 3. Project Contacts Table

Full Delivery Provider	Restoration Systems 1101 Haynes Street, Suite 211 Raleigh, North Carolina 27604 George Howard and John Preyer (919) 755-9490
Designer and Monitoring Performer	Ko & Associates, P.C. 1011 Schaub Drive, Suite 202 Raleigh, North Carolina 27606 Kevin Williams (919) 851-6066
Construction Contractor	Land Mechanics Designs, Inc. Lloyd Glover 126 Circle G Lane Willow Springs, North Carolina 27592 (919) 639-6132
Planting Contractor	Carolina Silvics 908 Indian Trail Road Edenton, North Carolina 27932 Dwight McKinney (252) 482-8491
Monitoring Performer	Axiom Environmental, Inc. 20 Enterprise Street, Suite 7 Raleigh, North Carolin 27607 Grant Lewis (919) 215-1693

Table 4. Project Background Table

Project County	Robeson County, North Carolina
Drainage Area	Northern UT - 1.13 square miles Southern UT - 0.18 square mile
Drainage impervious cover estimate (%)	< 1
Stream Order	Second
Physiographic Region	Coastal Plain
Ecoregion	Southeastern Plains, Atlantic Southern Loam Plains
Rosgen Classification of As-built	E-/C-type
Dominant Soil Types	Trebloc, Nahunta, Exum, Faceville
Reference Site ID	Mill Creek, UT to Wildcat Branch, UT to Hog Swamp
USGS HUC	03040204
NCDWQ Subbasin	03-07-55
NCDWQ Classification	C Sw (Stream Index # 14-35-2)
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	Not Applicable
% of project easement fenced	0%

1.5 Monitoring Plan View

Monitoring activities for the Site, including relevant structures and utilities, project features, specific project structures, and monitoring features are detailed in the monitoring plan view in Appendix D. Site features including vegetation, stream dimension (cross-sections), stream profile and pattern, wetland hydrology, and photographic documentation were monitored in Year 2 (2009).

2.0 PROJECT CONDITION AND MONITORING RESULTS

2.1 Vegetation Assessment

Following Site construction, seventeen plots (10-10 meters by 10 meters and 7-20 meters by 5 meters in size) were established and monumented with metal fence posts at all plot corners and PVC at each plot origin. Sampling was conducted as outlined in the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee et al. 2006) (http://cvs.bio.unc.edu/methods.htm); results are included in Appendix A. The taxonomic standard for vegetation used for this document was *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas* (Weakley 2007). The locations of vegetation monitoring plots were placed to accurately represent the entire Site and are depicted on the monitoring plan view in Appendix D.

2.1.1 Vegetation Success Criteria

Success criteria have been established to verify that the vegetation component supports community elements necessary for forest development. Success criteria are dependent upon the density and growth of characteristic forest species. Additional success criteria are dependent upon density and growth of "Character Tree Species." Character Tree Species include planted species, species identified through visual inventory of an approved reference (relatively undisturbed) forest community used to orient the Site design, and appropriate community descriptions from *Classification of the Natural Communities of North Carolina* (Schafale and Weakley 1990) including Coastal Plain Small Stream Swamp and

Nonriverine Wet Hardwood Forest. All canopy tree species planted and identified in the reference forest will be utilized to define "Character Tree Species" as termed in the success criteria. Table 5 below outlines planted and reference forest species.

Table 5. Planted and Reference Forest Ecosystem

Planted and Reference Forest Ecosystem Character Tree Species
Red maple (*Acer rubrum*)
Ironwood (*Carpinus caroliniana*)
Green ash (*Fraxinus pennsylvanica*)
American holly (*Ilex opaca*)
Sweetgum (*Liquidambar styraciflua*)
Tulip poplar (*Liriodendron tulipifera*)
Water tupelo (*Nyssa biflora*)
Laurel oak (*Quercus laurifolia*)
Swamp chestnut oak (*Quercus michauxii*)
Water oak (*Quercus nigra*)
American elm (*Ulmus americana*)

Success criteria dictate that an average density of 320 stems per acre of Character Tree Species must be surviving in the first three monitoring years. Subsequently, 290 Character Tree Species per acre must be surviving in year 4 and 260 Character Tree Species per acre in year 5.

2.1.2 Vegetative Problem Areas

During Year 1 (2008) monitoring, vegetation sampling across the Site was above the required average density with 476 stems per acre of Character Tree Species surviving; however, five of the seventeen plots had low densities (plots 12 and 14-17). To rectify this issue, 5 acres of within the wetland area of the Site was replanted at a density of approximately 680 stems per acre in early 2009. These areas should be watched over the monitoring period; the establishment of natural recruits is expected over the next few years as well. No other vegetation problem areas were noted during the Year 2 (2009) monitoring season.

2.2 Stream Assessment

Twenty permanent cross-sections within five 600-foot reaches were established after construction was completed. Measurements of each cross-section include points at all breaks in slope including top of bank, bankfull, and thalweg. Riffle cross-sections are classified using the Rosgen stream classification system. Longitudinal profile measurements of five 600-foot reaches include thalweg, water surface, and bankfull; with each measurement taken at the head of facets (i.e. riffle, run, pool, and glide) in addition to the maximum pool depth.

2.2.1 Stream Success Criteria

Success criteria for stream restoration will include 1) successful classification of the reach as a functioning stream system (Rosgen 1996) and 2) channel variables indicative of a stable stream system.

The channel configuration will be measured on an annual basis in order to track changes in channel geometry and profile. These data will be utilized to determine the success in restoring stream channel

stability. Specifically, the width-to-depth ratio should characterize an E-type or borderline E-/C-type channel, bank-height ratios indicative of a stable or moderately unstable channel, and minimal changes in cross-sectional area, channel width, and/or bank erosion along the monitoring reach. In addition, channel abandonment and/or shoot cutoffs must not occur and sinuosity values must remain relatively constant. The field indicator of bankfull will be described in each monitoring year and indicated on a representative channel cross-section figure. If the stream channel is down-cutting or the channel width is enlarging due to bank erosion, additional bank or slope stabilization methods will be employed.

Stream substrate is not expected to coarsen over time; therefore, pebble counts are not proposed as part of the stream success criteria.

Visual assessment of in-stream structures will be conducted to determine if failure has occurred. Failure of a structure may be indicated by collapse of the structure, undermining of the structure, abandonment of the channel around the structure, and/or stream flow beneath the structure.

2.2.2 Bankfull Events

Documented bankfull events are included in the table below. One bankfull event was documented during the Year 2 (2009) monitoring period for a total of three bankfull events.

Table 6. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
April 5, 2008	April 5, 2008	A total of 3.73 inches of rain fell on April 5, 2008 as recorded by a nearby rain station in Lumberton*	--
September 6, 2008	September 6, 2008	A total of 4.6 inches of rain fell on September 5-6, 2008 as recorded by a nearby rain station in Lumberton*	See below
April 2009	March 1, 2009	A total of 2.0 inches of rain fell on February 28-March 1, 2009 as recorded by a nearby rain station in Lumberton*. In addition wrack was documented within the floodplain during a Site visit.	--

*Weather Underground 2008/2009

2.2.3 Stream Problem Areas

No stream problem areas were documented within the Site during the Year 2 (2009) monitoring period.

2.2.4 Categorical Stream Feature Visual Stability Assessment

Each stream reach was visually inspected during the Year 2 (2009) monitoring period using eight feature categories and various metrics within each category. Assessment features included riffles, pools, thalweg, meanders, channel bed, structures, and root wads/boulders. Tables for semi-quantitative assessements of each reach are included in Appendix B (Tables B1-B5). The mean percentage of performance for features within each reach are summarized in the tables below.

Table 7A. Categorical Stream Feature Visual Stability Assessment

Brown Marsh (Reach 1)

Feature	Year 1 (2008)	Year 2 (2009)	Year 3 (2010)	Year 4 (2011)	Year 5 (2012)
A. Riffles	100%	100%			
B. Pools	100%	100%			
C. Thalweg	100%	100%			
D. Meanders	100%	100%			
E. Bed General	100%	100%			
F. Banks	100%	100%			
G. Vanes / J. Hooks, Etc.	NA	NA			
H. Wads and Boulders	NA	NA			

Table 7B. Categorical Stream Feature Visual Stability Assessment

Brown Marsh (Reach 2)

Feature	Year 1 (2008)	Year 2 (2009)	Year 3 (2010)	Year 4 (2011)	Year 5 (2012)
A. Riffles	100%	100%			
B. Pools	100%	100%			
C. Thalweg	100%	100%			
D. Meanders	100%	100%			
E. Bed General	100%	100%			
F. Banks	100%	100%			
G. Vanes / J. Hooks, Etc.	NA	NA			
H. Wads and Boulders	NA	NA			

Table 7C. Categorical Stream Feature Visual Stability Assessment

Brown Marsh (Reach 3)

Feature	Year 1 (2008)	Year 2 (2009)	Year 3 (2010)	Year 4 (2011)	Year 5 (2012)
A. Riffles	100%	100%			
B. Pools	100%	100%			
C. Thalweg	100%	100%			
D. Meanders	100%	100%			
E. Bed General	100%	100%			
F. Banks	100%	100%			
G. Vanes / J. Hooks, Etc.	NA	NA			
H. Wads and Boulders	100%	100%			

Table 7D. Categorical Stream Feature Visual Stability Assessment

Brown Marsh (Reach 4)

Feature	Year 1 (2008)	Year 2 (2009)	Year 3 (2010)	Year 4 (2011)	Year 5 (2012)
A. Riffles	100%	100%			
B. Pools	100%	100%			
C. Thalweg	100%	100%			
D. Meanders	100%	100%			
E. Bed General	100%	100%			
F. Banks	100%	100%			
G. Vanes / J. Hooks, Etc.	NA	NA			
H. Wads and Boulders	100%	100%			

Table 7E. Categorical Stream Feature Visual Stability Assessment

Brown Marsh (Reach 5)

Feature	Year 1 (2008)	Year 2 (2009)	Year 3 (2010)	Year 4 (2011)	Year 5 (2012)
A. Riffles	100%	100%			
B. Pools	100%	100%			
C. Thalweg	100%	100%			
D. Meanders	100%	100%			
E. Bed General	100%	100%			
F. Banks	100%	100%			
G. Vanes / J. Hooks, Etc.	NA	NA			
H. Wads and Boulders	100%	100%			

2.2.5 Quantitative Stream Measurements

During the Year 2 (2009) monitoring period 20 cross-sections and longitudinal profiles within five 600-foot reaches were measured. Permanent cross-sections and longitudinal profiles are included in Appendix B; each is graphically depicted for as-built through Year 2 (2009) for analysis. As a whole, monitoring measurements indicate minimal changes in both the longitudinal profile and cross-sections as compared to as-built data. The channel geometry compares favorably with the emulated, stable E/C type stream reach as set forth in the detailed mitigation plan and as constructed. Current monitoring has demonstrated dimension, pattern, and profile were stable over the course of the monitoring period. Tables for quantitative assessements are included below; these tables include data from previous years.

2.3 Wetland Assessment

Two groundwater monitoring gauges and one reference groundwater gauge were maintained and monitored throughout the Year 2 (2009) growing season. Graphs of groundwater hydrology and precipitation from a nearby rain station (Weather Underground 2009) are included in Appendix C.

2.3.1 Wetland Success Criteria

Target hydrological characteristics include saturation or inundation for at least 12.5 percent within Trebloc soils (nonriverine wetlands) of the growing season, during average climatic conditions. This value is based on DRAINMOD simulations for 62 years of rainfall data in an old field stage. These areas are expected to support hydrophytic vegetation. If wetland parameters are marginal a jurisdictional determination will be performed for vegetation and soils in these areas (Environmental Laboratory 1987).

2.3.2 Wetland Problem Areas

No wetland problem areas were identified within the Site during Year 2 (2009) monitoring.

2.3.3 Wetland Criteria Attainment

All monitored gauges within restoration areas were inundated/saturated within 12 inches of the surface for greater than 12.5 percent of the growing season (Table 10). Hydrographs containing groundwater and precipitation data for each gauge can be found in Appendix C. Data has been collected through September 16, 2009 and will continue to be collected for the remainder of the growing season (until November 14, 2009).

Table 8A. Baseline Morphology and Hydraulic Summary
Brown Marsh Swamp (Reach 1)

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Stream (Mill Cr)			Project Reference Stream (Wild Cat Br)			Design			As-built		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)	USGS gage data is unavailable for this project					5.6			11.3			8.2			7.5	6.2	6.3	6.3
Floodprone Width (ft)						7.3			300			130			15	25	39	32
BF Cross Sectional Area (ft2)						3			21			8.5			5.9	3.8	4.2	4
BF Mean Depth (ft)						0.9			1.9			1			0.8	0.6	0.7	0.6
BF Max Depth (ft)						1.2			2.6			1.6			1.6			1.1
Width/Depth Ratio						6			6			8			9.5	10	11	11
Entrenchment Ratio						1.3			26			16			2	4	6	5
Bank Height Ratio						===			===			===			1			1
Wetted Perimeter(ft)						===			===			===			===			===
Hydraulic radius (ft)						===			===			===			===			===
Pattern																		
Channel Beltwidth (ft)						100	15	27		14	19		15	45		16	36	27
Radius of Curvature (ft)						11.7	10	30		11	15		15	22.5				18
Meander Wavelength (ft)						800	38	73		23	29		22.5	75		61	89	74
Meander Width ratio						18	1.3	2.4		1.7	2.4		2	6		10	14	12
Profile																		
Riffle length (ft)						===			===			===			===	13	33	23
Riffle slope (ft/ft)						===			===			===			===	0.02%	2.36%	0.88%
Pool length (ft)						===			===			===			===	12	22	16
Pool spacing (ft)				4.7	54.1		11.4	61		14	17		18	46		26	55	40
Substrate																		
d50 (mm)						===			===			===			===			===
d84 (mm)						===			===			===			===			===
Additional Reach Parameters																		
Valley Length (ft)						===			===			===			===			===
Channel Length (ft)						===			===			===			===			599
Sinuosity						1			1.2			1.2			1.2			1.2
Water Surface Slope (ft/ft)						0.03%			0.03%			0.02%			0.03%			0.23%
BF slope (ft/ft)						===			===			===			===			===
Rosgen Classification						G5			E5			E5			E5			E5

Table 8B. Baseline Morphology and Hydraulic Summary
Brown Marsh Swamp (Reaches 2, 3, 4, and 5)

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Stream (Mill Cr)			Project Reference Stream (Wild Cat Br)			Design			As-built		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)	USGS gage data is unavailable for this project					10.7			11.3			8.2			11.5	10	15	12
Floodprone Width (ft)						21.7			300			130			35	35	50	39
BF Cross Sectional Area (ft2)						19.7			21			8.5			17.6	12	19	14
BF Mean Depth (ft)						1.9			1.9			1			1.5	1.2	1.3	1.2
BF Max Depth (ft)						2.9			2.6			1.6			1.5	2	2.3	2.2
Width/Depth Ratio						6			6			8			7.5	8.3	12.5	10.0
Entrenchment Ratio						2			26			16			3	2.9	4.2	3.3
Bank Height Ratio						===			===			===			1			1
Wetted Perimeter(ft)						===			===			===			===			===
Hydraulic radius (ft)						===			===			===			===			===
Pattern																		
Channel Beltwidth (ft)						600	15	27		14	19		23	69		23	87	62
Radius of Curvature (ft)				150	400		10	30		11	15		23	35				35
Meander Wavelength (ft)						1500	38	73		23	29		34	115		95	180	142
Meander Width ratio						56	1.3	2.4		1.7	2.4		2	6		7.9	15.0	11.8
Profile																		
Riffle length (ft)						===			===			===			===	45	75	59
Riffle slope (ft/ft)						===			===			===			===	0.03%	0.31%	0.21%
Pool length (ft)						===			===			===			===	19	37	28
Pool spacing (ft)				60	140		11.4	61		14	17		27	70		62	105	81
Substrate																		
d50 (mm)						===			===			===			===			===
d84 (mm)						===			===			===			===			===
Additional Reach Parameters																		
Valley Length (ft)						===			===			===			===			===
Channel Length (ft)						===			===			===			===			4465
Sinuosity						1			1.2			1.2			1.4			1.4
Water Surface Slope (ft/ft)						0.01%			0.03%			0.02%			0.01%			0.11%
BF slope (ft/ft)						===			===			===			===			===
Rosgen Classification						G5			E5			E5			E5			E5

Table 9A. Morphology and Hydraulic Monitoring Summary
Brown Marsh Swamp
Reach 1 (Sta. 10+10 to 15+67)

Parameter	Cross Section 17 Station 13+60 Riffle						Cross Section 18 Station 12+45 Pool						Cross Section 19 Station 10+72 Riffle						Cross Section 20 Station 10+52 Pool					
Dimension	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)	8.8	7.8					7.0	8.2					6.7	7.2					6.2	6.9				
Floodprone Width (ft) (approx)	35.0						35.0						35.0						35.0					
BF Cross Sectional Area (ft^2)	4.7	4.9					7.7	6.9					4.3	3.8					6.2	5.4				
BF Mean Depth (ft)	0.5	0.6					1.1	0.8					0.6	0.5					1.0	0.8				
BF Max Depth (ft)	1.3	1.3					2.1	1.6					1.1	1.0					1.9	1.5				
Width/Depth Ratio	16.2	12.6					NA	NA					10.4	13.6					NA	NA				
Entrenchment Ratio	3.4	4.5					NA	NA					4.5	4.9					NA	NA				
Bank Height Ratio	1.0	1.0					NA	NA					1.0	1.0					NA	NA				
Wetted Perimeter(ft)	9.3	8.3					8.3	8.9					7.1	7.6					7.4	7.6				
Hydraulic radius (ft)	0.5	0.6					0.9	0.8					0.6	0.5					0.8	0.7				
Substrate	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
d50 (mm)																								
d84 (mm)																								

Parameter	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)			MY+		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	16	36	27	16	36	27												
Radius of Curvature (ft)	0	0	18	0	0	18												
Meander Wavelength (ft)	61	74	89	61	74	89												
Meander Width ratio	1.7	2.1	2.5	1.7	2.1	2.5												
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)	7	36.7	19.7	5	35	20												
Riffle slope (ft/ft)	0.1%	2.4%	0.4%	NA*	NA*	NA*												
Pool length (ft)	3	17.3	4.1	7	27	20												
Pool spacing (ft)	26	55	40	26	55	40												

Additional Reach Parameters	MY-01 (2008)	MY-02 (2009)	MY-03 (2010)	MY-04 (2011)	MY-05 (2012)	MY+
Valley Length (ft)	499	493				
Channel Length (ft)	599	591				
Sinuosity	1.2	1.2				
Water Surface Slope (ft/ft)	0.18%	NA*				
BF slope (ft/ft)	– – –	– – –				
Rosgen Classification	C/E type	C/E type				
Number of Bankfull Events	1	1				

NA* No water in channel; therefore, slope calculations could not be evaluated.

Table 9B. Morphology and Hydraulic Monitoring Summary
Brown Marsh Swamp
Reach 2 (Sta. 46+10 to 52+78)

Parameter	Cross Section 13 Station 47+45 Pool						Cross Section 14 Station 47+48 Riffle						Cross Section 15 Station 50+75 Pool						Cross Section 16 Station 52+02 Riffle					
Dimension	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)	12.9	12.5					10.9	10.9					10.9	11.4					10.8	12.0				
Floodprone Width (ft) (approx)	45.0						45.0						45.0						45.0					
BF Cross Sectional Area (ft^2)	21.3	20.1					14.1	12.8					20.0	20.1					14.4	13.9				
BF Mean Depth (ft)	1.7	1.6					1.3	1.2					1.8	1.8					1.3	1.2				
BF Max Depth (ft)	3.1	3.0					2.1	2.3					3.3	3.4					2.3	2.4				
Width/Depth Ratio	NA	NA					8.4	9.2					NA	NA					8.1	10.4				
Entrenchment Ratio	NA	NA					4.1	4.1					NA	NA					4.2	3.8				
Bank Height Ratio	NA	NA					1.0	1.0					NA	NA					1.0	1.0				
Wetted Perimeter(ft)	14.8	14.1					12.0	11.9					13.1	13.4					12.0	13.2				
Hydraulic radius (ft)	1.4	1.4					1.2	1.1					1.5	1.5					1.2	1.1				
Substrate	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
d50 (mm)																								
d84 (mm)																								

Parameter	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)			MY+		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	23	87	62	23	87	62												
Radius of Curvature (ft)	0	0	35	0	0	35												
Meander Wavelength (ft)	95	180	142	95	180	142												
Meander Width ratio	2.1	4.0	3.2	2.1	4.0	3.2												
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)	53.6	85.8	68.3	26	68	57												
Riffle slope (ft/ft)	0.1%	0.3%	0.1%	NA*	NA*	NA*												
Pool length (ft)	2.6	5.4	3.4	13	51	21												
Pool spacing (ft)	62	105	81	62	105	81												

Additional Reach Parameters	MY-01 (2008)	MY-02 (2009)	MY-03 (2010)	MY-04 (2011)	MY-05 (2012)	MY+
Valley Length (ft)	478	429				
Channel Length (ft)	669	600				
Sinuosity	1.4	1.4				
Water Surface Slope (ft/ft)	0.10%	NA*				
BF slope (ft/ft)	– – –	– – –				
Rosgen Classification	E type	E type				
Number of Bankfull Events	1	1				

NA* No water in channel; therefore, slope calculations could not be evaluated.

Table 9C. Morphology and Hydraulic Monitoring Summary
Brown Marsh Swamp
Reach 3 (Sta. 37+30 to 43+69)

Parameter	Cross Section 9 Station 41+25 Riffle						Cross Section 10 Station 42+30 Pool						Cross Section 11 Station 43+75 Riffle						Cross Section 12 Station 45+05 Pool					
Dimension	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)	12.3	11.6					14.6	11.7					12.6	10.4					12.0	9.3				
Floodprone Width (ft) (approx)	45.0						45.0						45.0						45.0					
BF Cross Sectional Area (ft^2)	14.8	13.1					20.3	17.4					16.4	11.1					18.6	10.5				
BF Mean Depth (ft)	1.2	1.1					1.4	1.5					1.3	1.1					1.6	1.1				
BF Max Depth (ft)	2.3	2.1					3.6	2.8					2.5	2.1					2.9	2.1				
Width/Depth Ratio	10.2	10.2					NA	NA					9.7	9.8					NA	NA				
Entrenchment Ratio	3.7	3.9					NA	NA					3.6	4.3					NA	NA				
Bank Height Ratio	1.0	1.0					NA	NA					1.0	1.0					NA	NA				
Wetted Perimeter(ft)	13.2	12.4					16.6	13.1					13.7	11.2					13.6	10.3				
Hydraulic radius (ft)	1.1	1.1					1.2	1.3					1.2	1.0					1.4	1.0				
Substrate	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
d50 (mm)																								
d84 (mm)																								

Parameter	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)			MY+		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	23	87	62	23	87	62												
Radius of Curvature (ft)	0	0	35	0	0	35												
Meander Wavelength (ft)	95	180	142	95	180	142												
Meander Width ratio	2.1	4.0	3.2	2.1	4.0	3.2												
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)	55.3	98.7	70.8	6	62	38												
Riffle slope (ft/ft)	0.03%	0.08%	0.03%	NA*	NA*	NA*												
Pool length (ft)	0.7	4.6	3.4	19	47	39												
Pool spacing (ft)	62	105	81	62	105	81												

Additional Reach Parameters	MY-01 (2008)	MY-02 (2009)	MY-03 (2010)	MY-04 (2011)	MY-05 (2012)	MY+
Valley Length (ft)	456	429				
Channel Length (ft)	639	600				
Sinuosity	1.4	1.4				
Water Surface Slope (ft/ft)	0.14%	NA*				
BF slope (ft/ft)	– – –	– – –				
Rosgen Classification	E type	E type				
Number of Bankfull Events	1	1				

NA* No water in channel; therefore, slope calculations could not be evaluated.

Table 9D. Morphology and Hydraulic Monitoring Summary
Brown Marsh Swamp
Reach 4 (Sta. 20+16 to 26+22)

Parameter	Cross Section 5						Cross Section 6						Cross Section 7						Cross Section 8					
	Station 20+55 Pool						Station 21+80 Riffle						Station 22+95 Pool						Station 25+80 Riffle					
Dimension	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)	11.1	11.2					11.3	11.5					13.6	12.9					11.2	12.0				
Floodprone Width (ft) (approx)	45.0						45.0						45.0						45.0					
BF Cross Sectional Area (ft^2)	19.0	15.1					13.9	13.2					21.8	18.9					11.2	12.3				
BF Mean Depth (ft)	1.7	1.4					1.2	1.1					1.6	1.5					1.0	1.0				
BF Max Depth (ft)	3.2	2.6					2.4	2.3					3.2	2.7					2.2	2.2				
Width/Depth Ratio	NA	NA					9.1	10.1					NA	NA					11.3	11.7				
Entrenchment Ratio	NA	NA					4.0	3.9					NA	NA					4.0	3.8				
Bank Height Ratio	NA	NA					1.0	1.0					NA	NA					1.0	1.0				
Wetted Perimeter(ft)	13.0	12.6					12.4	12.5					15.5	14.2					12.3	12.9				
Hydraulic radius (ft)	1.5	1.2					1.1	1.1					1.4	1.3					0.9	1.0				
Substrate	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
d50 (mm)																								
d84 (mm)																								

Parameter	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)			MY+		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	23	87	62	23	87	62												
Radius of Curvature (ft)	0	0	35	0	0	35												
Meander Wavelength (ft)	95	180	142	95	180	142												
Meander Width ratio	2.1	4.0	3.2	2.1	4.0	3.2												
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)	54.7	130.6	73.5	11	59	30												
Riffle slope (ft/ft)	0.00%	0.27%	0.06%	NA*	NA*	NA*												
Pool length (ft)	2	16.7	3.7	14	63	33												
Pool spacing (ft)	62	105	81	62	105	81												

Additional Reach Parameters	MY-01 (2008)	MY-02 (2009)	MY-03 (2010)	MY-04 (2011)	MY-05 (2012)	MY+
Valley Length (ft)	433	429				
Channel Length (ft)	606	600				
Sinuosity	1.4	1.4				
Water Surface Slope (ft/ft)	0.05%	NA*				
BF slope (ft/ft)	– – –	– – –				
Rosgen Classification	E type	E type				
Number of Bankfull Events	1	1				

NA* No water in channel; therefore, slope calculations could not be evaluated.

Table 9E. Morphology and Hydraulic Monitoring Summary
Brown Marsh Swamp
Reach 5 (Sta. 14+25 to 20+27)

Parameter	Cross Section 1 Station 11+60 Riffle						Cross Section 2 Station 13+70 Pool						Cross Section 3 Station 14+90 Riffle						Cross Section 4 Station 17+40 Pool					
Dimension	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)	17.2	13.7					16.2	17.5					12.0	16.4					13.6	11.9				
Floodprone Width (ft) (approx)	45.0						45.0						45.0						45.0					
BF Cross Sectional Area (ft^2)	21.0	13.5					22.2	20.9					13.6	15.4					19.1	15.4				
BF Mean Depth (ft)	1.2	1.0					1.4	1.2					1.1	0.9					1.4	1.3				
BF Max Depth (ft)	2.4	2.0					2.8	2.5					2.2	2.2					3.0	2.5				
Width/Depth Ratio	14.2	13.9					NA	NA					10.6	17.6					NA	NA				
Entrenchment Ratio	2.6	3.3					NA	NA					3.7	2.7					NA	NA				
Bank Height Ratio	1.0	1.0					NA	NA					1.0	1.0					NA	NA				
Wetted Perimeter(ft)	18.1	14.3					17.4	18.4					12.9	17.1					15.1	13.0				
Hydraulic radius (ft)	1.2	0.9					1.3	1.1					1.1	0.9					1.3	1.2				
Substrate	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
d50 (mm)																								
d84 (mm)																								

Parameter	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)			MY+		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	23	87	62	23	87	62												
Radius of Curvature (ft)	0	0	35	0	0	35												
Meander Wavelength (ft)	95	180	142	95	180	142												
Meander Width ratio	2.1	4.0	3.2	2.1	4.0	3.2												
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)	47	81.5	70.5	29	63	41												
Riffle slope (ft/ft)	0.06%	0.09%	0.07%	NA*	NA*	NA*												
Pool length (ft)	1.4	15.8	4.5	22	61	52												
Pool spacing (ft)	62	105	81	62	105	81												

Additional Reach Parameters	MY-01 (2008)	MY-02 (2009)	MY-03 (2010)	MY-04 (2011)	MY-05 (2012)	MY+
Valley Length (ft)	429	435				
Channel Length (ft)	601	609				
Sinuosity	1.4	1.4				
Water Surface Slope (ft/ft)	0.07%	NA*				
BF slope (ft/ft)	– – –	– – –				
Rosgen Classification	C/E type	C/E type				
Number of Bankfull Events	1	1				

Table 10. Wetland Criteria Attainment for Year 2 (2009)

Gauge ID	Hydrology Threshold Met?	Hydrophytic Vegetation Criteria Met?	Site Mean	Vegetation Plot ID	Vegetation Survival Threshold Met?	Site Mean
1	Yes	Yes	100 %	1	Yes	100 %
2	Yes	Yes		2	Yes	
				3	Yes	
				4	Yes	
				5	Yes	
				6	Yes	
				7	Yes	
				8	Yes	
				9	Yes	
				10	Yes	
				11	Yes	
				12	Yes	
				13	Yes	
				14	Yes	
				15	Yes	
				16	Yes	
				17	Yes	

3.0 CONCLUSIONS

The Site achieved the defined (or targeted) success criteria, with saturation (free water) within one foot of the soil surface for a minimum of 12.5 percent (30 consecutive days) of the growing season, for all Site groundwater gauges in the Second Monitoring Year (Year 2009). A summary of groundwater gauge data is included in Table 11. Vegetation plots across the Site were above the required 320 stems per acre with an average of 705 planted tree stems per acre in the Second Monitoring Year (Year 2009) (Table 12). In addition, each individual plot was above success criteria with planted stems alone with the exception of plot 12; however, when including appropriate natural recruits/Character Tree Species such as *Nyssa aquatica* and *Quercus nigra* this plot was well-above required densities with 445 stems per acre.

Table 11. Summary of Groundwater Gauge Results

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)				
	Year 1 (2008)	Year 2 (2009)*	Year 3 (2010)	Year 4 (2011)	Year 5 (2012)
1	Yes/68 days (28 percent)	Yes/53 days (21.5 percent)			
2	Yes/35 days (23 percent)	Yes/55 days (22.4 percent)			
Ref 1	Yes/34 days (14 percent)	Yes/42 days (17.1 percent)			

*Data was collected through September 16, 2009; data will continue to be collected for the remainder of the Year 2 (2009) growing season (through November 14, 2009).

Table 12. Summary of Planted Vegetation Plot Results

Plot	Planted Stems/Acre Counting Towards Success Criteria				
	Year 1 (2008)	Year 2 (2009)	Year 3 (2010)	Year 4 (2011)	Year 5 (2012)
1	526	809			
2	486	567			
3	445	526			
4	243	850			
5	971	1214			
6	445	607			
7	405	850			
8	809	1214			
9	931	1052			
10	1093	1012			
11	405	486			
12	40	162			
13	567	607			
14	162	647			
15	40	526			
16	202	445			
17	81	647			
Average of All Plots (1-17)	**476**	**705**			

4.0 REFERENCES

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. United States Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Lee, Michael T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0. (online). Available: http://cvs.bio.unc.edu/methods.htm

North Carolina Wetlands Restoration Program (NCWRP). 2003. Lumber River Basin Watershed Restoration Plan (online). Available: http://www.nceep.net/services/restplans/Lumber_2003.pdf [November 21, 2006]. North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina.

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, North Ccarolina Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

United States Geological Survey (USGS). 1974. Hydrologic Unit Map - 1974. State of North Carolina.

Weakley, Alan S. 2007. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas (online). Available: http://www.herbarium.unc.edu/WeakleysFlora.pdf [February 1, 2008]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.

Weather Underground. 2008. Station in Lumberton, North Carolina. (online). Available: http://www.wunderground.com/cgibin/findweather/hdfForecast?query=lumberton%2C+nc&searchType=WEATHER [September 22, 2008]. Weather Underground.

Weather Underground. 2009. Station in Lumberton, North Carolina. (online). Available: http://www.wunderground.com/cgi-bin/findweather/getForecast?query=lumberton,%20nc&wuSelect=WEATHER [October 29, 2009]. Weather Underground.

APPENDIX A

VEGETATION DATA

1. Vegetation Survey Data Tables
2. Vegetation Monitoring Plot Photos

Report Prepared By	Corri Faquin
Date Prepared	8/26/2009 17:25

database name	RestorationSystems-2009-A-v2.2.7.mdb
database location	C:\Axiom\Business\CVS database
computer name	CORRILAPTOP
file size	51564544

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.
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	BrownMarsh
project Name	Brown Marsh Restoration Site
Description	Stream and Wetland Restoration Site in Robeson County
Sampled Plots	17

Living planted stems, excluding live stakes, per acre: Negative (red) numbers indicate the project failed to reach requirements in a particular year.

Project Code	Project Name	River Basin	Year 2
BrownMarsh	Brown Marsh Restoration Site	Lumber	704.63

Total stems, including planted stems of all kinds (including live stakes) and natural/volunteer stems:

Project Code	Project Name	River Basin	Year 2
BrownMarsh	Brown Marsh Restoration Site	Lumber	1266.428012

Plot Info

plot	Planted Living Stems	Planted Living Stems EXCLUDING Live Stakes	Dead/Missing Stems	Natural (Volunteer) Stems	Total Living Stems	Total Living Stems EXCLUDING Live Stakes	Planted Living Stems per ACRE	Planted Living Stems EXCLUDING Live Stakes PER ACRE	Natural (Volunteer) Stems PER ACRE	Total Living Stems PER ACRE	Total Living Stems EXCLUDING Live Stakes PER ACRE	# species
1	20	20	0	1	21	21	809	809	40	850	850	4
2	14	14	0	0	14	14	567	567	0	567	567	1
3	13	13	0	0	13	13	526	526	0	526	526	1
4	21	17	0	3	24	20	850	688	121	971	809	4
5	30	30	0	6	36	36	1214	1214	243	1457	1457	5
6	15	13	0	0	15	13	607	526	0	607	526	4
7	21	21	0	0	21	21	850	850	0	850	850	6
8	30	30	1	1	31	31	1214	1214	40	1255	1255	9
9	26	26	2	8	34	34	1052	1052	324	1376	1376	4
10	25	25	2	0	25	25	1012	1012	0	1012	1012	2
11	12	12	0	3	15	15	486	486	121	607	607	3
12	4	4	0	8	12	12	162	162	324	486	486	1
13	15	15	2	177	192	192	607	607	7163	7770	7770	2
14	16	16	0	1	17	17	647	647	40	688	688	3
15	13	13	0	0	13	13	526	526	0	526	526	3
16	11	11	2	22	33	33	445	445	890	1335	1335	4
17	16	16	0	0	16	16	647	647	0	647	647	5

Vigor

vigor	Count	Percent
0	1	0.3
1	2	0.6
2	38	12.2
3	109	35
4	153	49.2
Missing	8	2.6

Vigor by Species

Species	CommonName	4	3	2	1	0	Missing	Unknown
Cephalanthus occidentalis	common buttonbush	2						
Cornus amomum	silky dogwood	35	36	18		1	3	
Fraxinus pennsylvanica	green ash	39	4	1				
Nyssa aquatica	water tupelo	1	8	1				
Quercus falcata	southern red oak		1					
Quercus laurifolia	laurel oak	1					1	
Quercus lyrata	overcup oak	4	16	1				
Quercus michauxii	swamp chestnut oak	14	9	5			1	
Quercus nigra	water oak	3	1					
Quercus pagoda	cherrybark oak	15	6	2			2	
Quercus phellos	willow oak		1					
Salix nigra	black willow	3						
Sambucus canadensis	Common Elderberry		1					
Fraxinus	ash	2						
Cephalanthus	buttonbush		1					
Ulmus	elm	34	24	9	2		1	
Ulmus americana	American elm		1	1				
17	**17**	**153**	**109**	**38**	**2**	**1**	**8**	

Damage

Damage	Count	Percent Of Stems
(no damage)	261	83.9
Site Too Dry	28	9
Unknown	11	3.5
Insects	7	2.3
Vine Strangulation	2	0.6
Human Trampled	2	0.6

Damage by Species

Species	CommonName	Count of Damage Categories	(no damage)	Human Trampled	Insects	Site Too Dry	Unknown	Vine Strangulation
Cephalanthus	buttonbush	0	1					
Cephalanthus occidentalis	common buttonbush	0	2					
Cornus amomum	silky dogwood	16	77	1		12	3	
Fraxinus	ash	0	2					
Fraxinus pennsylvanica	green ash	2	42				1	1
Nyssa aquatica	water tupelo	1	9				1	
Quercus falcata	southern red oak	0	1					
Quercus laurifolia	laurel oak	0	2					
Quercus lyrata	overcup oak	2	19		1		1	
Quercus michauxii	swamp chestnut oak	8	21		2	5	1	
Quercus nigra	water oak	0	4					
Quercus pagoda	cherrybark oak	3	22			1	1	1
Quercus phellos	willow oak	0	1					
Salix nigra	black willow	0	3					
Sambucus canadensis	Common Elderberry	0	1					
Ulmus	elm	17	53	1	4	10	2	
Ulmus americana	American elm	1	1				1	
17	**17**	**50**	**261**	**2**	**7**	**28**	**11**	**2**

Damage by Plot

plot	Count of Damage Categories	(no damage)	Human Trampled	Insects	Site Too Dry	Unknown	Vine Strangulation
1	1	19		1			
2	3	11			3		
3	2	11	1			1	
4	1	20				1	
5	2	28				2	
6	1	14			1		
7	2	19		2			
8	3	28		3			
9	7	21	1		5	1	
10	19	8			19		
11	1	11				1	
12	0	4					
13	0	17					
14	3	13		1			2
15	0	13					
16	3	10				3	
17	2	14				2	
17	**50**	**261**	**2**	**7**	**28**	**11**	**2**

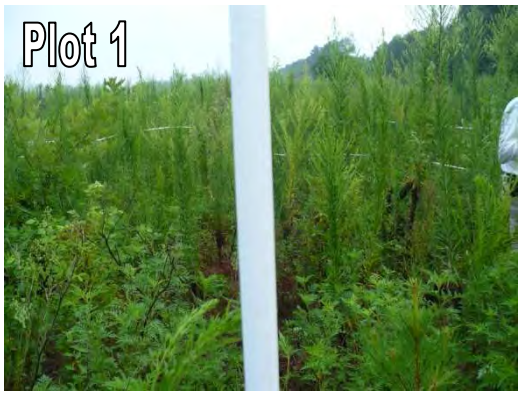
Planted Stems by Plot and Species

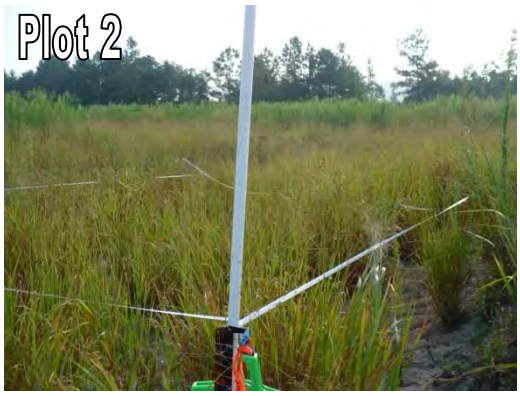
Species	CommonName	Total Planted Stems	# plots	avg# stems	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cephalanthus	buttonbush	1	1	1				1													
Cephalanthus occidentalis	common buttonbush	2	2	1						1					1						
Cornus amomum	silky dogwood	89	10	8.9		14	13	11		9	1	4		15	9		12				1
Fraxinus	ash	2	1	2					2												
Fraxinus pennsylvanica	green ash	44	5	8.8	14													13	5	1	11
Nyssa aquatica	water tupelo	10	4	2.5					3		1								3	3	
Quercus falcata	southern red oak	1	1	1								1									
Quercus laurifolia	laurel oak	1	1	1								1									
Quercus lyrata	overcup oak	21	6	3.5							7	1						2	5	5	1
Quercus michauxii	swamp chestnut oak	28	7	4	1				2	1	9	2	11		2						
Quercus nigra	water oak	4	3	1.33							1	2	1								
Quercus pagoda	cherrybark oak	23	9	2.56	1			7	2	4			1			4		1		2	1
Quercus phellos	willow oak	1	1	1								1									
Salix nigra	black willow	3	1	3													3				
Sambucus canadensis	Common Elderberry	1	1	1								1									
Ulmus	elm	69	7	9.86	4			2	21		2	17	13	10							
Ulmus americana	American elm	2	1	2																	2
17	**17**	**302**	**17**		**20**	**14**	**13**	**21**	**30**	**15**	**21**	**30**	**26**	**25**	**12**	**4**	**15**	**16**	**13**	**11**	**16**

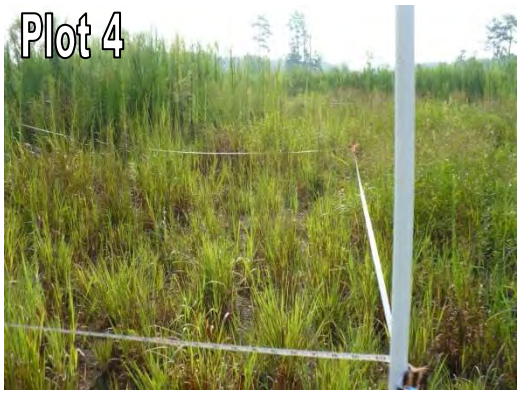
Planted and Natural Recruit Stems by Plot and Species

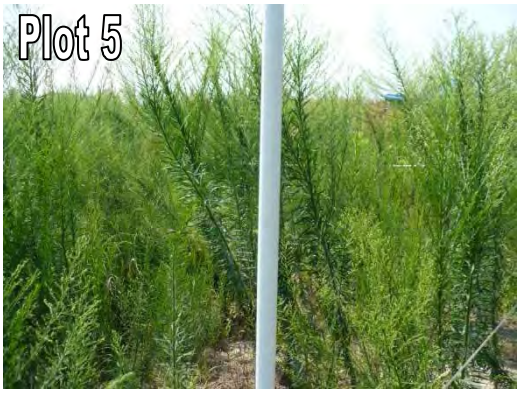
Species	CommonName	Total Stems	# plots	avg# stems	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Acer rubrum	red maple	165	4	41.25					1							2	161	1			
Baccharis halimifolia	eastern baccharis	13	5	2.6				2	5				4			1	1				
Cephalanthus	buttonbush	1	1	1				1													
Cephalanthus occidentalis	common buttonbush	3	3	1						1					1		1				
Cornus amomum	silky dogwood	91	10	9.1		14	13	11		9	1	4		16	10		12				1
Diospyros virginiana	common persimmon	23	2	11.5													1			22	
Fraxinus	ash	2	1	2					2												
Fraxinus pennsylvanica	green ash	44	5	8.8	14													13	5	1	11
Liquidambar styraciflua	sweetgum	14	4	3.5									2		1	4	7				
Nyssa aquatica	water tupelo	10	4	2.5					3		1								3	3	
Pinus taeda	loblolly pine	7	4	1.75	1			1					2				3				
Quercus falcata	southern red oak	1	1	1								1									
Quercus laurifolia	laurel oak	1	1	1								1									
Quercus lyrata	overcup oak	21	6	3.5							7	1						2	5	5	1
Quercus michauxii	swamp chestnut oak	28	7	4	1				2	1	9	2	11		2						
Quercus nigra	water oak	5	4	1.25							1	2	1			1					
Quercus pagoda	cherrybark oak	23	9	2.56	1			7	2	4			1			4		1		2	1
Quercus phellos	willow oak	1	1	1								1									
Salix nigra	black willow	6	2	3											1		5				
Sambucus canadensis	Common Elderberry	3	2	1.5								2					1				
Ulmus	elm	69	7	9.86	4			2	21		2	17	13	10							
Ulmus americana	American elm	2	1	2																	2
22	**22**	**533**	**22**		**21**	**14**	**13**	**24**	**36**	**15**	**21**	**31**	**34**	**26**	**15**	**12**	**192**	**17**	**13**	**33**	**16**

Brown Marsh Swamp Restoration Site
Year 2 (2009) Annual Monitoring
Vegetation Plot Photos
Taken August 2009



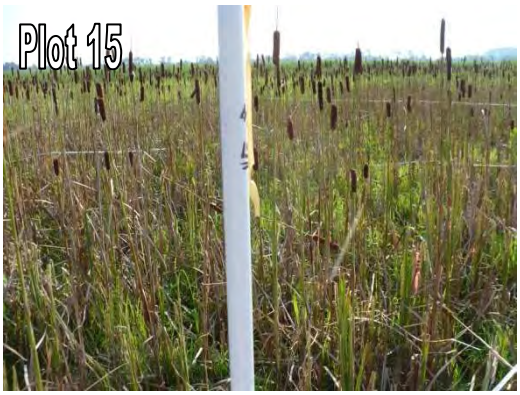


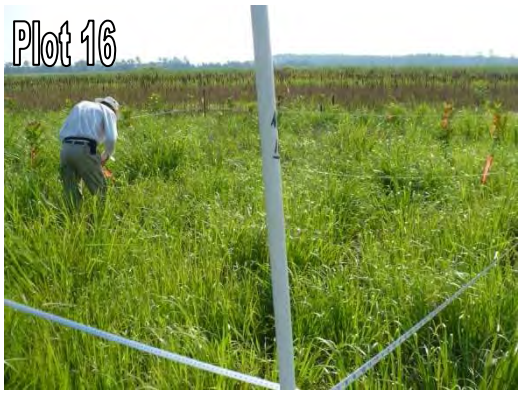




Brown Marsh Swamp Restoration Site
Year 2 (2009) Annual Monitoring
Vegetation Plot Photos
Taken August 2009
(continued)

Brown Marsh Swamp Restoration Site
Year 2 (2009) Annual Monitoring
Vegetation Plot Photos
Taken August 2009
(continued)





APPENDIX B

GEOMORPHOLOGIC DATA

1. Tables B1-B5. Qualitative Visual Stability Assessment
2. Cross-section Plots and Tables
3. Longitudinal Profile Plots

Table B1. Visual Morphological Stability Assessment
Brown Marsh Reach 1 (557 linear feet)

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	12	12	NA	100%	
	2. Armor stable (e.g. no displacement)?	12	12	NA	100%	
	3. Facet grade appears stable?	12	12	NA	100%	
	4. Minimal evidence of embedding / fining?	12	12	NA	100%	
A. Riffles	5. Length appropriate?	12	12	NA	100%	100%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	12	12	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	12	12	NA	100%	
B. Pools	3. Length appropriate?	12	12	NA	100%	100%
	1. Upstream of meander bend (run/inflection) centering?	12	12	NA	100%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	12	12	NA	100%	100%
	1. Outer bend in state of limited/controlled erosion?	12	12	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation?	NA	NA	0	100%	
	3. Apparent Rc within spec?	12	12	NA	100%	
D. Meanders	4. Sufficient floodplain access and relief?	12	12	NA	100%	100%
	1. General channel bed aggradation areas (bar formation)	NA	NA	0	100%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0	100%	100%
F. Bank	1. Actively eroding, wasting, or slumping bank	NA	NA	0	100%	100%
	1. Free of back or arm scour?	NA	NA	NA	NA	
	2. Height appropriate?	NA	NA	NA	NA	
	3. Angle and geometry appear appropriate?	NA	NA	NA	NA	
G. Vanes	4. Free of piping or other structural failures?	NA	NA	NA	NA	NA
	1. Free of scour?	NA	NA	NA	NA	
H. Wads / Boulders	2. Footing stable?	NA	NA	NA	NA	NA

Table B2. Visual Morphological Stability Assessment
Brown Marsh Reach 2 (668 linear feet)

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	10	10	NA	100%	
	2. Armor stable (e.g. no displacement)?	10	10	NA	100%	
	3. Facet grade appears stable?	10	10	NA	100%	
	4. Minimal evidence of embedding / fining?	10	10	NA	100%	
A. Riffles	5. Length appropriate?	10	10	NA	100%	100%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	10	10	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	10	10	NA	100%	
B. Pools	3. Length appropriate?	10	10	NA	100%	100%
	1. Upstream of meander bend (run/inflection) centering?	10	10	NA	100%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	10	10	NA	100%	100%
	1. Outer bend in state of limited/controlled erosion?	10	10	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation?	NA	NA	0	100%	
	3. Apparent Rc within spec?	10	10	NA	100%	
D. Meanders	4. Sufficient floodplain access and relief?	10	10	NA	100%	100%
	1. General channel bed aggradation areas (bar formation)	NA	NA	0	100%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0	100%	100%
F. Bank	1. Actively eroding, wasting, or slumping bank	NA	NA	0	100%	100%
	1. Free of back or arm scour?	NA	NA	NA	NA	
	2. Height appropriate?	NA	NA	NA	NA	
	3. Angle and geometry appear appropriate?	NA	NA	NA	NA	
G. Vanes	4. Free of piping or other structural failures?	NA	NA	NA	NA	NA
	1. Free of scour?	NA	NA	NA	NA	
H. Wads / Boulders	2. Footing stable?	NA	NA	NA	NA	NA

Table B3. Visual Morphological Stability Assessment
Brown Marsh Reach 3 (639 linear feet)

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	8	8	NA	100%	
	2. Armor stable (e.g. no displacement)?	8	8	NA	100%	
	3. Facet grade appears stable?	8	8	NA	100%	
	4. Minimal evidence of embedding / fining?	8	8	NA	100%	
A. Riffles	5. Length appropriate?	8	8	NA	100%	100%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	8	8	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	8	8	NA	100%	
B. Pools	3. Length appropriate?	8	8	NA	100%	100%
	1. Upstream of meander bend (run/inflection) centering?	8	8	NA	100%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	8	8	NA	100%	100%
	1. Outer bend in state of limited/controlled erosion?	8	8	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation?	NA	NA	0	100%	
	3. Apparent Rc within spec?	8	8	NA	100%	
D. Meanders	4. Sufficient floodplain access and relief?	8	8	NA	100%	100%
	1. General channel bed aggradation areas (bar formation)	NA	NA	0	100%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0	100%	100%
F. Bank	1. Actively eroding, wasting, or slumping bank	NA	NA	0	100%	100%
	1. Free of back or arm scour?	NA	NA	NA	NA	
	2. Height appropriate?	NA	NA	NA	NA	
	3. Angle and geometry appear appropriate?	NA	NA	NA	NA	
G. Vanes	4. Free of piping or other structural failures?	NA	NA	NA	NA	NA
	1. Free of scour?	2	2	NA	100%	
H. Wads / Boulders	2. Footing stable?	2	2	NA	100%	100%

Table B4. Visual Morphological Stability Assessment
Brown Marsh Reach 4 (606 linear feet)

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	7	7	NA	100%	
	2. Armor stable (e.g. no displacement)?	7	7	NA	100%	
	3. Facet grade appears stable?	7	7	NA	100%	
	4. Minimal evidence of embedding / fining?	7	7	NA	100%	
A. Riffles	5. Length appropriate?	7	7	NA	100%	100%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	7	7	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	7	7	NA	100%	
B. Pools	3. Length appropriate?	7	7	NA	100%	100%
	1. Upstream of meander bend (run/inflection) centering?	7	7	NA	100%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	7	7	NA	100%	100%
	1. Outer bend in state of limited/controlled erosion?	7	7	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation?	NA	NA	0	100%	
	3. Apparent Rc within spec?	7	7	NA	100%	
D. Meanders	4. Sufficient floodplain access and relief?	7	7	NA	100%	100%
	1. General channel bed aggradation areas (bar formation)	NA	NA	0	100%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0	100%	100%
F. Bank	1. Actively eroding, wasting, or slumping bank	NA	NA	0	100%	100%
	1. Free of back or arm scour?	NA	NA	NA	NA	
	2. Height appropriate?	NA	NA	NA	NA	
	3. Angle and geometry appear appropriate?	NA	NA	NA	NA	
G. Vanes	4. Free of piping or other structural failures?	NA	NA	NA	NA	NA
	1. Free of scour?	1	1	NA	100%	
H. Wads / Boulders	2. Footing stable?	1	1	NA	100%	100%

Table B5. Visual Morphological Stability Assessment
Brown Marsh Reach 5 (602 linear feet)

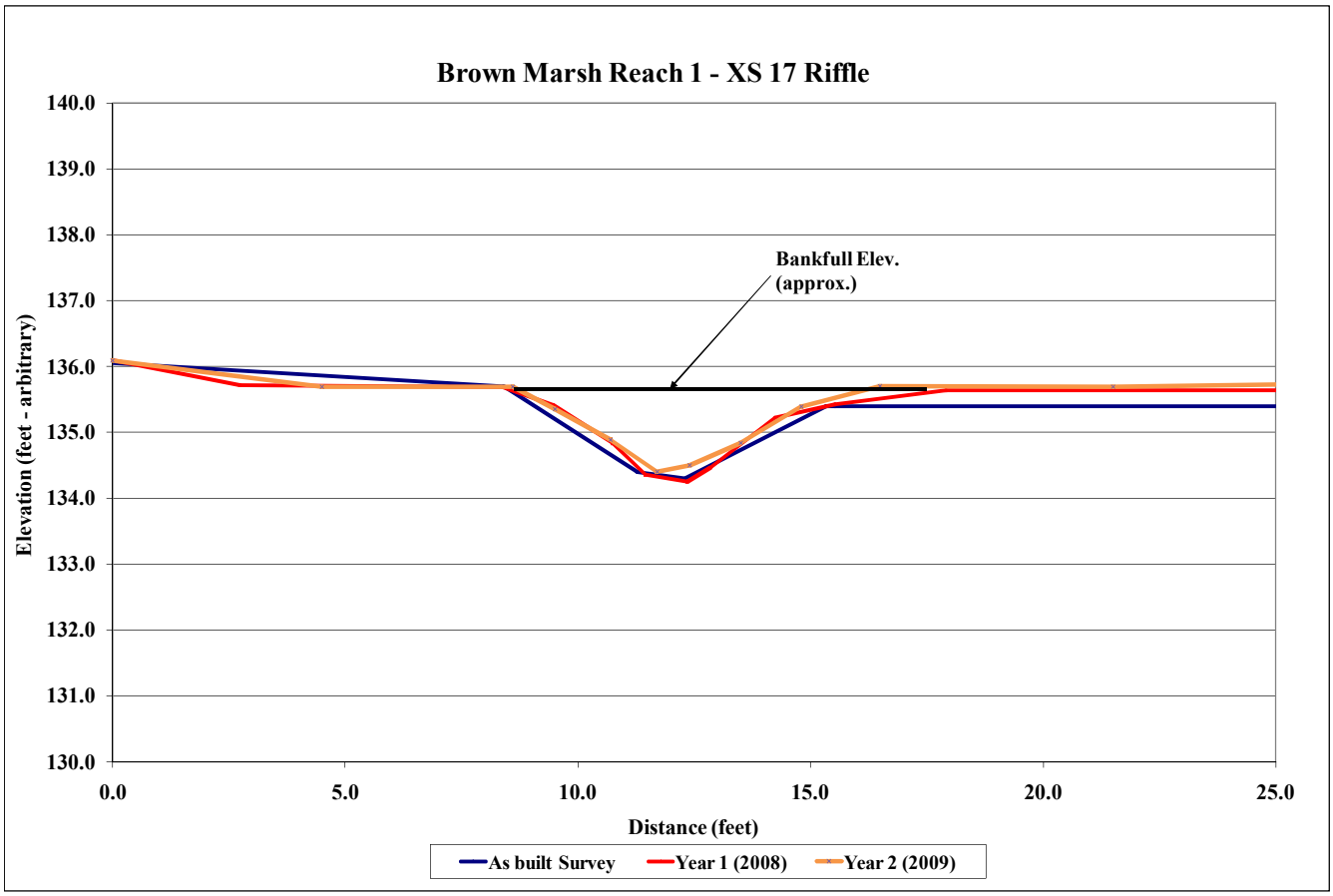
Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	12	12	NA	100%	
	2. Armor stable (e.g. no displacement)?	12	12	NA	100%	
	3. Facet grade appears stable?	12	12	NA	100%	
	4. Minimal evidence of embedding / fining?	12	12	NA	100%	
A. Riffles	5. Length appropriate?	12	12	NA	100%	100%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	12	12	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	12	12	NA	100%	
B. Pools	3. Length appropriate?	12	12	NA	100%	100%
	1. Upstream of meander bend (run/inflection) centering?	12	12	NA	100%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	12	12	NA	100%	100%
	1. Outer bend in state of limited/controlled erosion?	12	12	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation?	NA	NA	0	100%	
	3. Apparent Rc within spec?	12	12	NA	100%	
D. Meanders	4. Sufficient floodplain access and relief?	12	12	NA	100%	100%
	1. General channel bed aggradation areas (bar formation)	NA	NA	0	100%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0	100%	100%
F. Bank	1. Actively eroding, wasting, or slumping bank	NA	NA	0	100%	100%
	1. Free of back or arm scour?	NA	NA	NA	NA	
	2. Height appropriate?	NA	NA	NA	NA	
	3. Angle and geometry appear appropriate?	NA	NA	NA	NA	
G. Vanes	4. Free of piping or other structural failures?	NA	NA	NA	NA	NA
	1. Free of scour?	1	1	NA	100%	
H. Wads / Boulders	2. Footing stable?	1	1	NA	100%	100%

Project Name	Brown Marsh
Cross Section	Reach 1 - XS 17
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-6.9	138.2	26.1	135.6	26.5	135.7		
-1.2	136.1	17.9	135.6	21.5	135.7		
8.4	135.7	15.5	135.4	16.5	135.7		
11.3	134.4	14.2	135.2	14.8	135.4		
12.3	134.3	12.9	134.5	13.5	134.8		
15.3	135.4	12.4	134.3	12.4	134.5		
15.5	135.4	11.4	134.4	11.7	134.4		
31.9	135.4	10.7	134.8	10.7	134.9		
40.5	137.2	9.5	135.4	9.5	135.4		
		8.4	135.7	8.6	135.7		
		2.7	135.7	4.5	135.7		
		0.0	136.1	0.0	136.1		

Photo of Cross-Section R1-17 - Looking Downstream @ STA 13+60

	2008	2009	2010	2011	2012
Area	4.7	4.9			
Width	8.8	7.8			
Mean Depth	0.5	0.6			
Max Depth	1.3	1.3			
W/D	16.2	12.6			

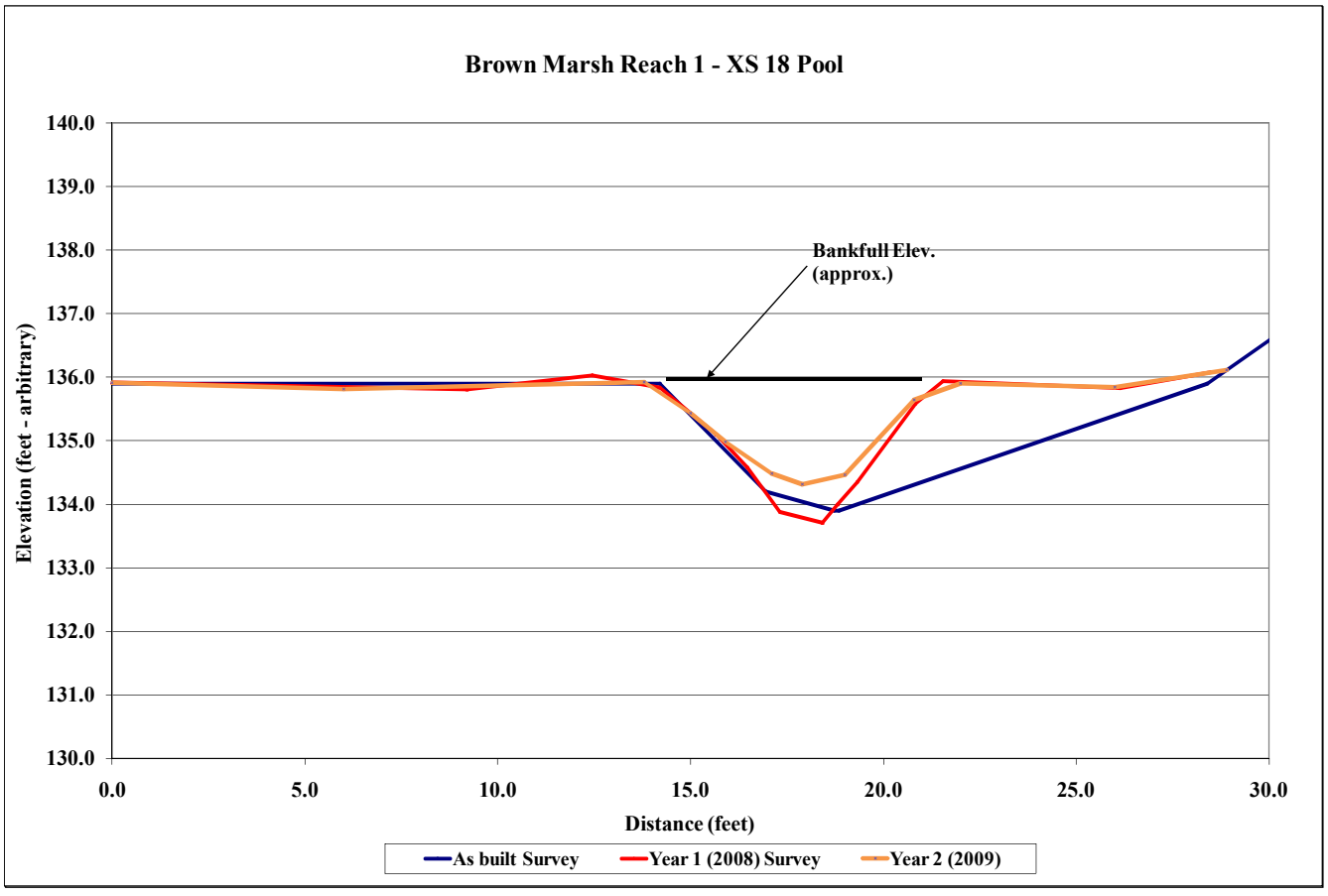


Project Name	Brown Marsh
Cross Section	Reach 1 - XS 18
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-6.7	135.9	0.0	135.9	0.0	135.9		
14.2	135.9	9.2	135.8	6.0	135.8		
17.0	134.2	12.4	136.0	13.8	135.9		
18.7	133.9	14.2	135.8	15.0	135.4		
18.8	133.9	15.7	135.1	15.9	135.0		
28.4	135.9	16.5	134.6	17.1	134.5		
34.3	138.4	17.3	133.9	17.9	134.3		
		18.4	133.7	19.0	134.5		
		18.8	134.0	20.8	135.6		
		19.3	134.4	22.0	135.9		
		20.8	135.6	26.0	135.8		
		21.6	135.9	28.9	136.1		
		26.1	135.8				
		28.5	136.1				

Photo of Cross-Section R1-18 - Looking Downstream @ STA 12+45

	2008	2009	2010	2011	2012
Area	7.7	6.9			
Width	7.0	8.2			
Mean Depth	1.1	0.8			
Max Depth	2.1	1.6			
W/D	NA	NA			

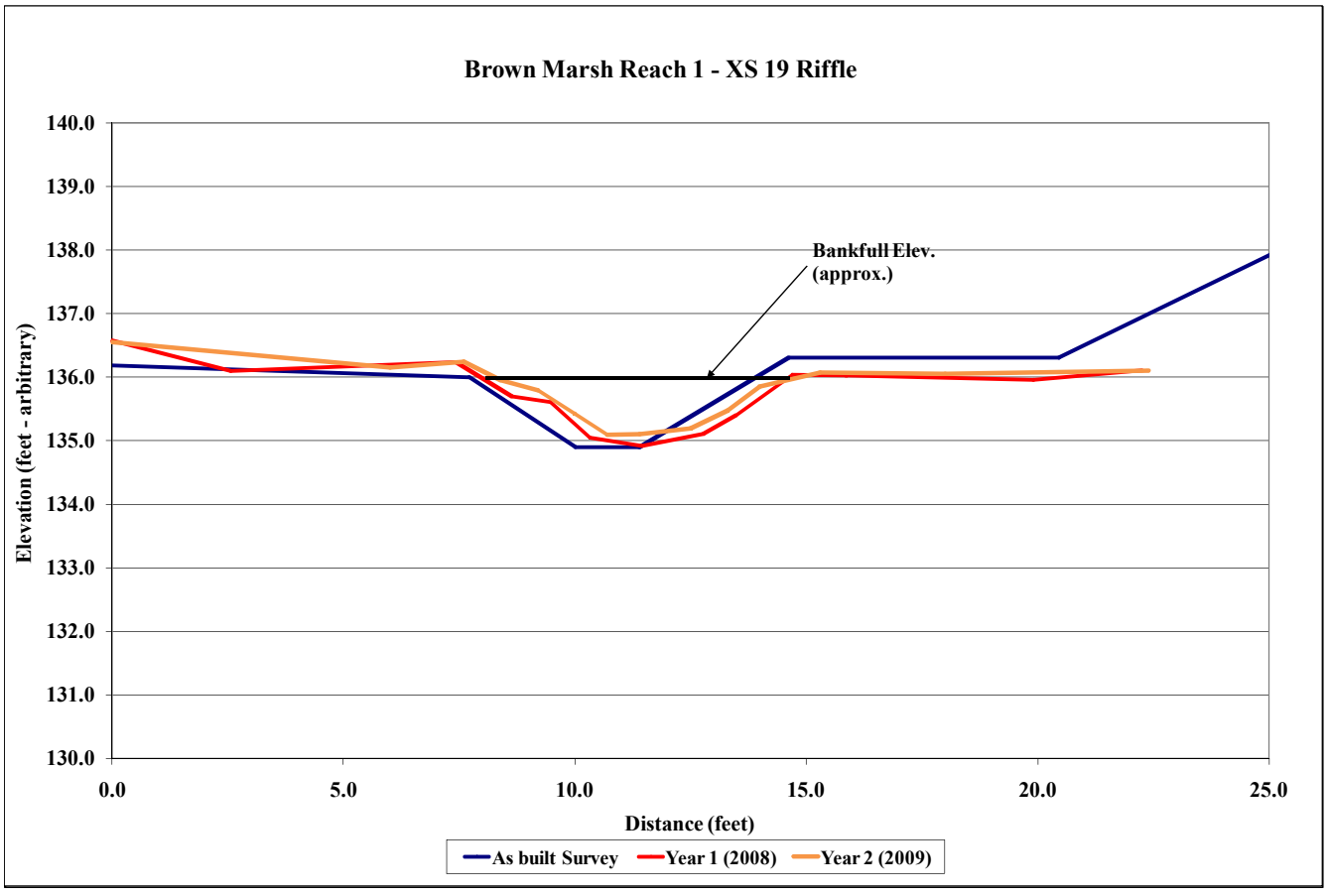


Project Name	Brown Marsh
Cross Section	Reach 1 - XS 19
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-4.6	137.9	0.0	136.6	0.0	136.6		
-0.5	136.2	2.6	136.1	6.0	136.2		
7.7	136.0	7.4	136.2	7.6	136.2		
10.0	134.9	8.6	135.7	8.4	136.0		
11.4	134.9	9.5	135.6	9.2	135.8		
14.6	136.3	10.3	135.0	10.0	135.4		
20.5	136.3	11.4	134.9	10.7	135.1		
29.8	139.6	12.8	135.1	11.4	135.1		
		13.5	135.4	12.5	135.2		
		14.7	136.0	13.3	135.5		
		15.9	136.0	14.0	135.9		
		19.9	136.0	15.3	136.1		
		22.3	136.1	18.0	136.1		
				22.4	136.1		

Photo of Cross-Section R1-19 - Looking Downstream @ STA 10+72

	2008	2009	2010	2011	2012
Area	4.3	3.8			
Width	6.7	7.2			
Mean Depth	0.6	0.5			
Max Depth	1.1	1.0			
W/D	10.4	13.6			

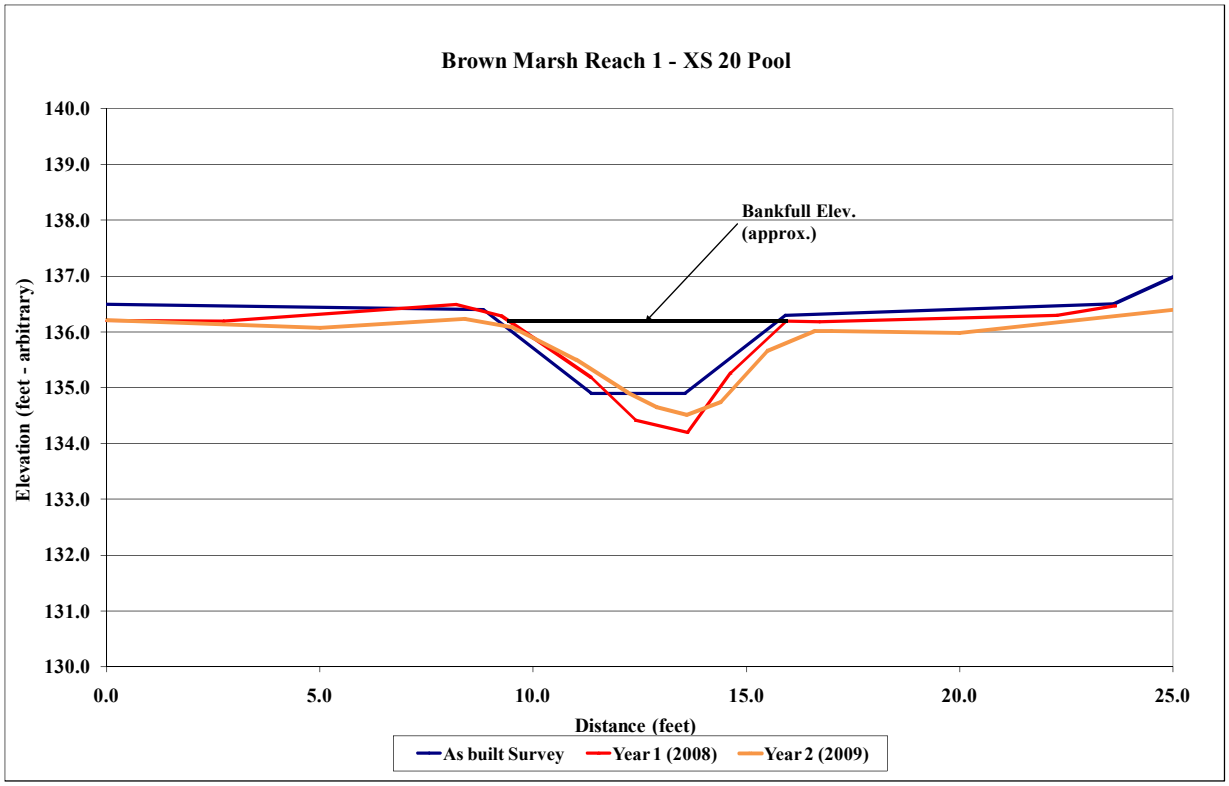


Project Name	Brown Marsh
Cross Section	Reach 1 - XS 20
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-8.5	139.2	0.0	136.2	0.0	136.2		
-0.7	136.5	2.7	136.2	5.0	136.1		
8.8	136.4	8.2	136.5	8.4	136.2		
11.4	134.9	9.3	136.3	9.5	136.1		
13.6	134.9	10.0	135.9	11.0	135.5		
15.9	136.3	11.4	135.2	12.2	134.9		
23.6	136.5	12.4	134.4	12.9	134.7		
28.5	138.2	13.6	134.2	13.6	134.5		
		14.6	135.3	14.4	134.7		
		15.9	136.2	15.5	135.7		
		16.7	136.2	16.6	136.0		
		22.3	136.3	17.0	136.0		
		23.7	136.5	20.0	136.0		
				25.4	136.4		

Photo of Cross-Section R1-20 - Looking Downstream @ STA 10+52

	2008	2009	2010	2011	2012
Area	6.2	5.4			
Width	6.2	6.9			
Mean Depth	1.0	0.8			
Max Depth	1.9	1.5			
W/D	NA	NA			

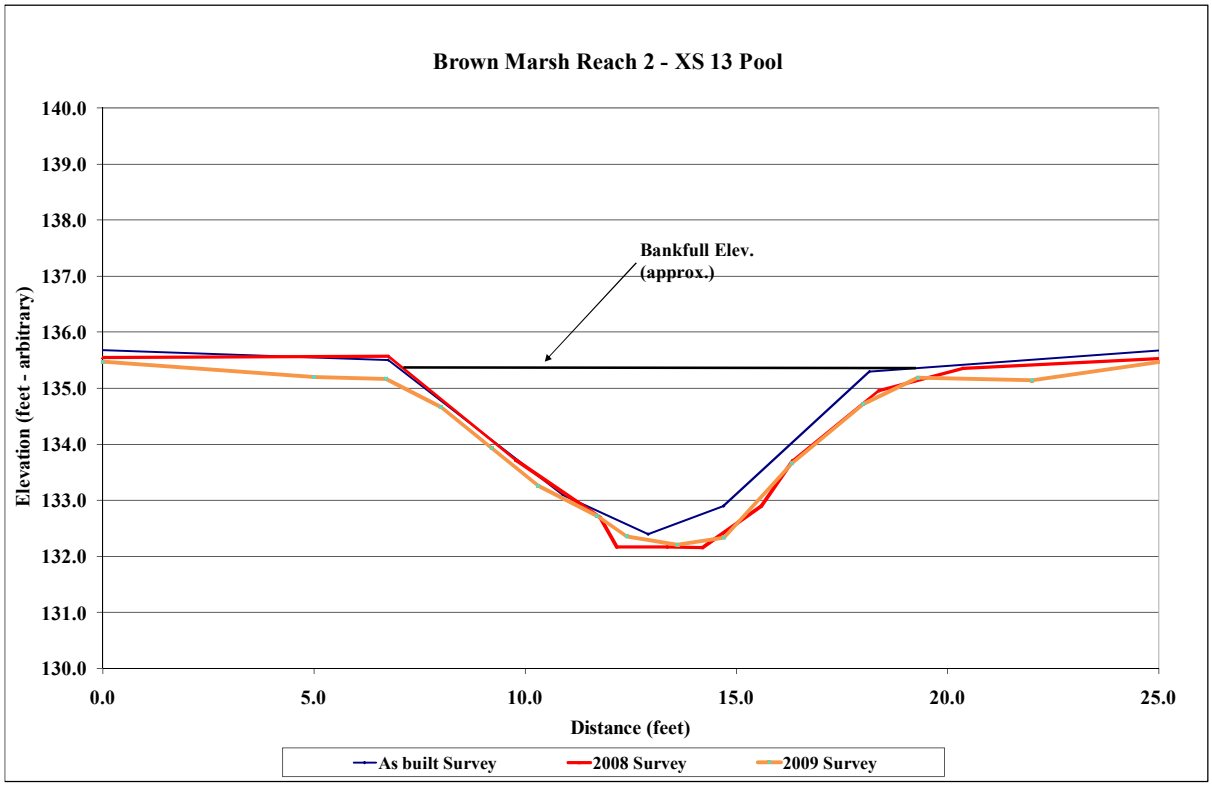


Project Name	Brown Marsh
Cross Section	Reach 2 - XS 13
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-10.5	138.7	0.0	135.6	0.0	135.5		
-0.7	135.7	6.7	135.6	5.0	135.2		
6.7	135.5	9.8	133.7	6.7	135.2		
10.9	133.1	11.8	132.7	8.0	134.7		
12.9	132.4	12.2	132.2	9.2	133.9		
14.7	132.9	13.4	132.2	10.3	133.3		
18.1	135.3	14.2	132.2	11.7	132.7		
25.4	135.7	15.6	132.9	12.4	132.4		
33.2	138.5	16.3	133.7	13.6	132.2		
		18.4	135.0	14.7	132.3		
		20.4	135.4	16.3	133.7		
		26.1	135.6	18.0	134.7		
				19.3	135.2		
				22.0	135.1		
				26.0	135.6		

Photo of Cross-Section R2-13 - Looking Downstream @ STA 47+45

	2008	2009	2010	2011	2012
Area	21.3	20.1			
Width	12.9	12.5			
Mean Depth	1.7	1.6			
Max Depth	3.1	3.0			
W/D	NA	NA			

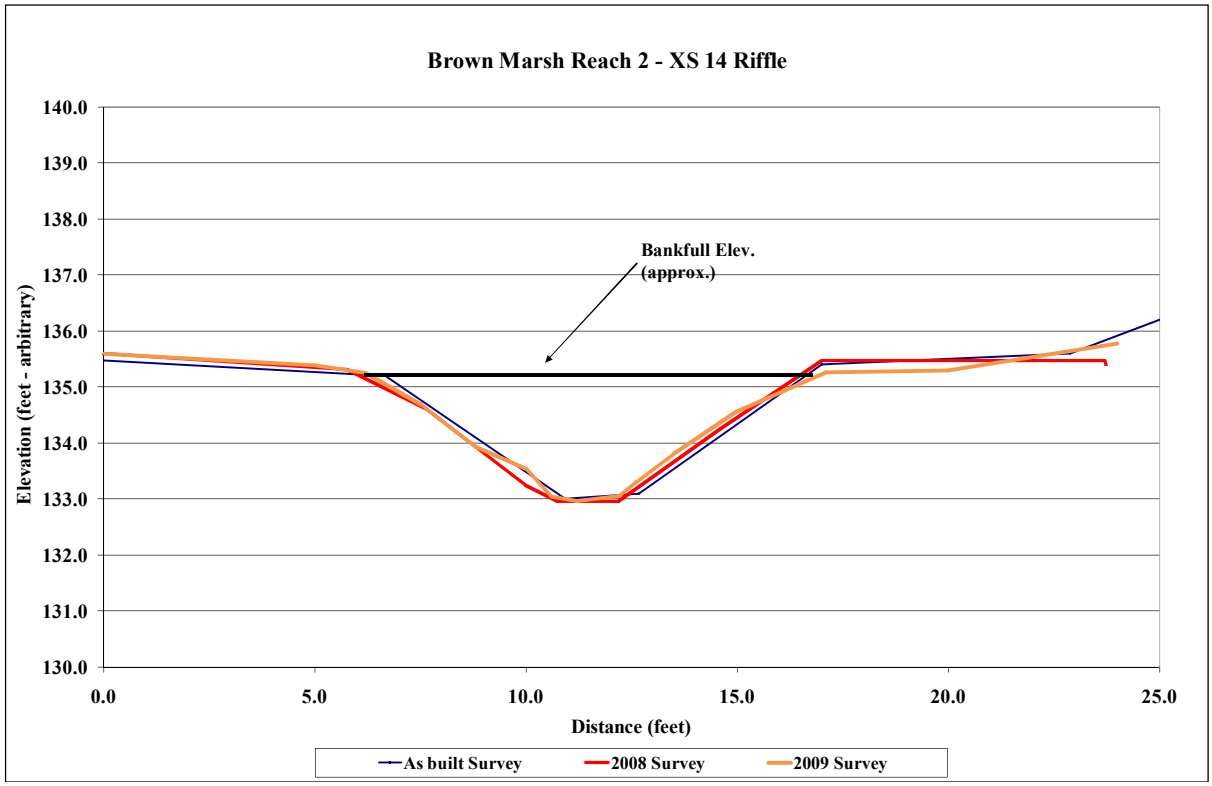


Project Name	Brown Marsh
Cross Section	Reach 2 - XS 14
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-9.2	138.5	0.0	135.6	0.0	135.6		
-0.8	135.5	5.7	135.3	5.0	135.4		
6.7	135.2	7.6	134.6	6.2	135.3		
10.9	133.0	10.0	133.2	7.5	134.7		
12.7	133.1	10.7	133.0	8.8	133.9		
17.0	135.4	12.2	133.0	10.0	133.5		
22.9	135.6	14.6	134.3	10.6	133.0		
34.8	139.0	17.0	135.5	11.2	133.0		
		23.7	135.5	12.2	133.1		
		23.7	135.4	12.6	133.3		
				13.5	133.8		
				15.0	134.6		
				17.1	135.3		
				20.0	135.3		
				24.0	135.8		

Photo of Cross-Section R2-14 - Looking Downstream @ STA 47+48

	2008	2009	2010	2011	2012
Area	14.1	12.8			
Width	10.9	10.9			
Mean Depth	1.3	1.2			
Max Depth	2.1	2.3			
W/D	8.4	9.2			

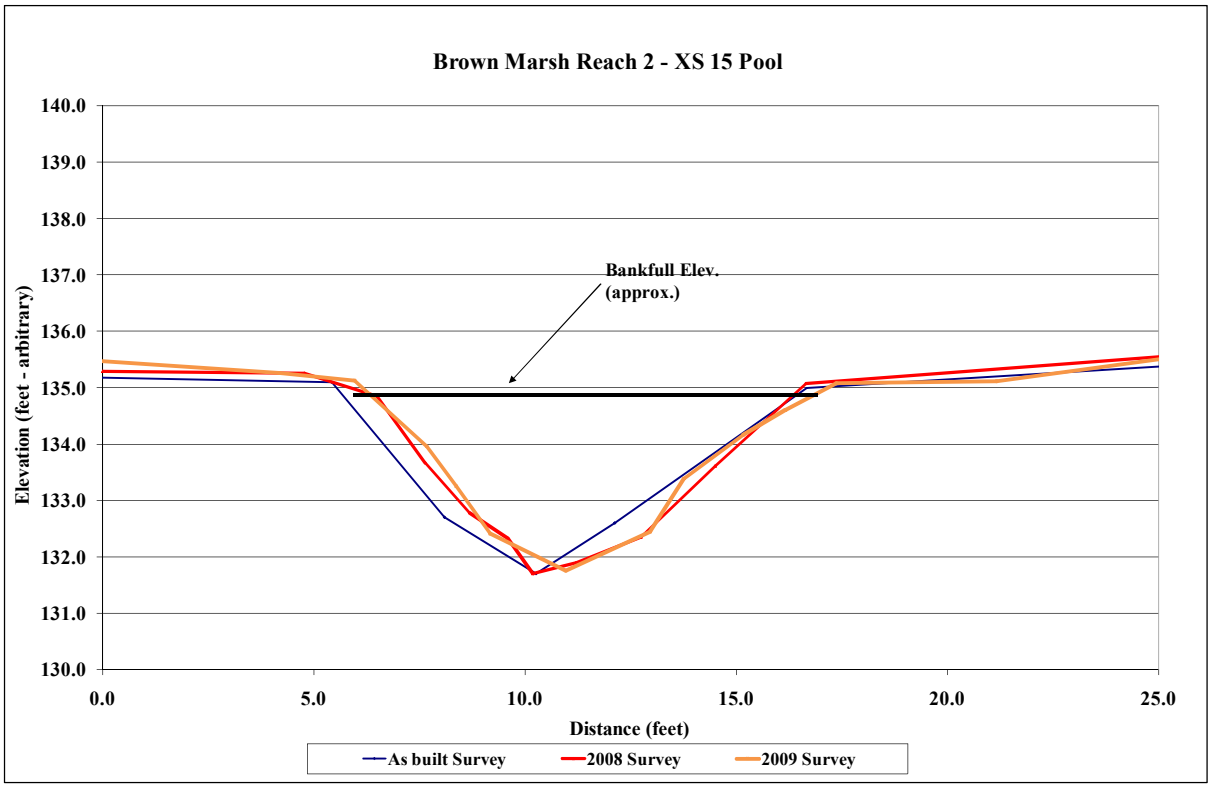


Project Name	Brown Marsh
Cross Section	Reach 2 - XS 15
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-13.6	139.2	0.0	135.3	-0.8	135.5		
-1.4	135.2	4.8	135.3	4.2	135.3		
5.4	135.1	6.5	134.9	6.0	135.1		
8.1	132.7	7.6	133.7	7.7	134.0		
10.3	131.7	8.7	132.8	8.4	133.3		
12.1	132.6	9.6	132.3	9.2	132.4		
16.7	135.0	10.2	131.7	11.0	131.8		
25.4	135.4	11.2	131.9	13.0	132.5		
33.7	138.8	12.8	132.3	13.8	133.4		
		14.5	133.6	15.2	134.2		
		16.7	135.1	16.2	134.6		
		25.9	135.6	17.4	135.1		
				21.2	135.1		
				25.9	135.6		

Photo of Cross-Section R2-15 - Looking Downstream @ STA 50+75

	2008	2009	2010	2011	2012
Area	20.0	20.1			
Width	10.9	11.4			
Mean Depth	1.8	1.8			
Max Depth	3.3	3.4			
W/D	NA	NA			

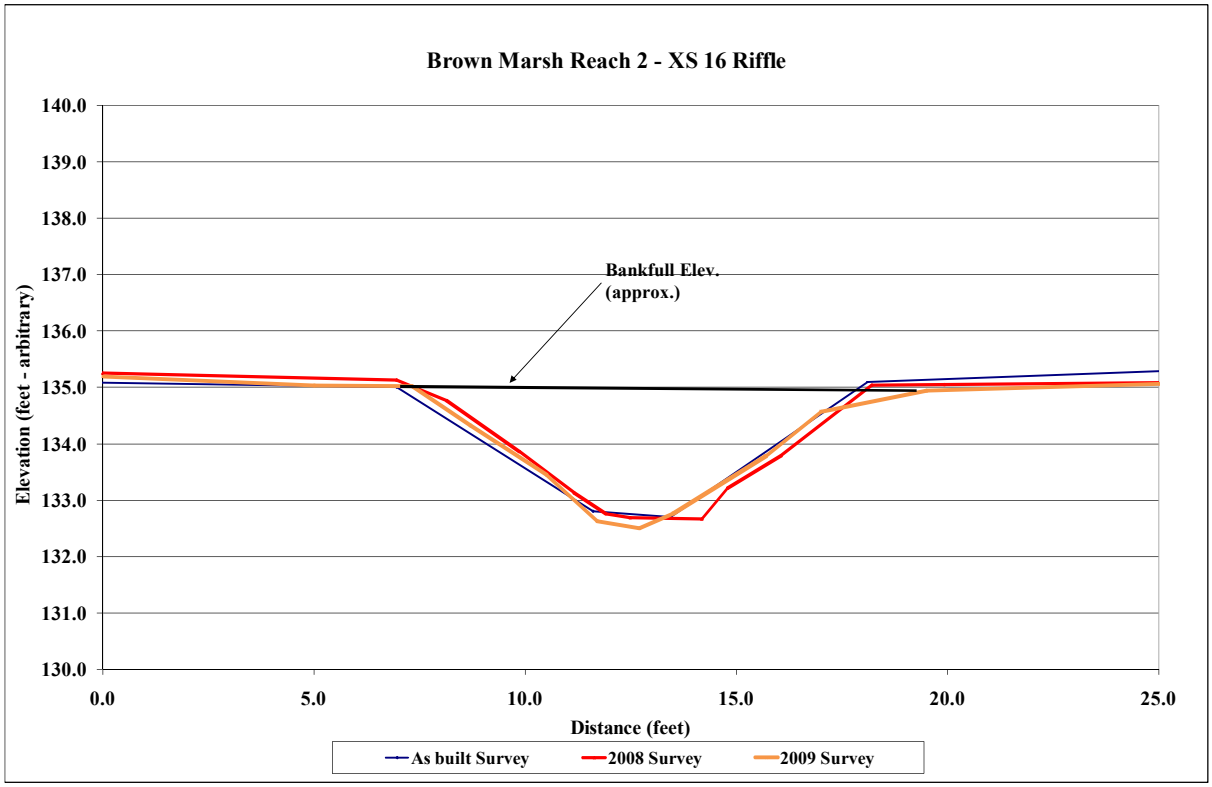


Project Name	Brown Marsh
Cross Section	Reach 2 - XS 16
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-12.3	138.4	0.0	135.3	0.0	135.2		
-1.1	135.1	6.9	135.1	5.0	135.0		
7.0	135.0	8.1	134.8	7.3	135.0		
11.6	132.8	9.9	133.9	8.7	134.3		
13.4	132.7	11.1	133.1	10.5	133.5		
18.1	135.1	11.9	132.8	11.7	132.6		
25.4	135.3	12.5	132.7	12.7	132.5		
34.6	139.0	14.2	132.7	13.5	132.8		
		14.8	133.2	15.7	133.8		
		16.1	133.8	17.0	134.6		
		18.2	135.0	19.5	134.9		
		19.9	135.1	26.3	135.1		
		26.8	135.1				

Photo of Cross-Section R2-16 - Looking Downstream @ STA 52+02

	2008	2009	2010	2011	2012
Area	14.4	13.9			
Width	10.8	12.0			
Mean Depth	1.3	1.2			
Max Depth	2.3	2.4			
W/D	8.1	10.4			

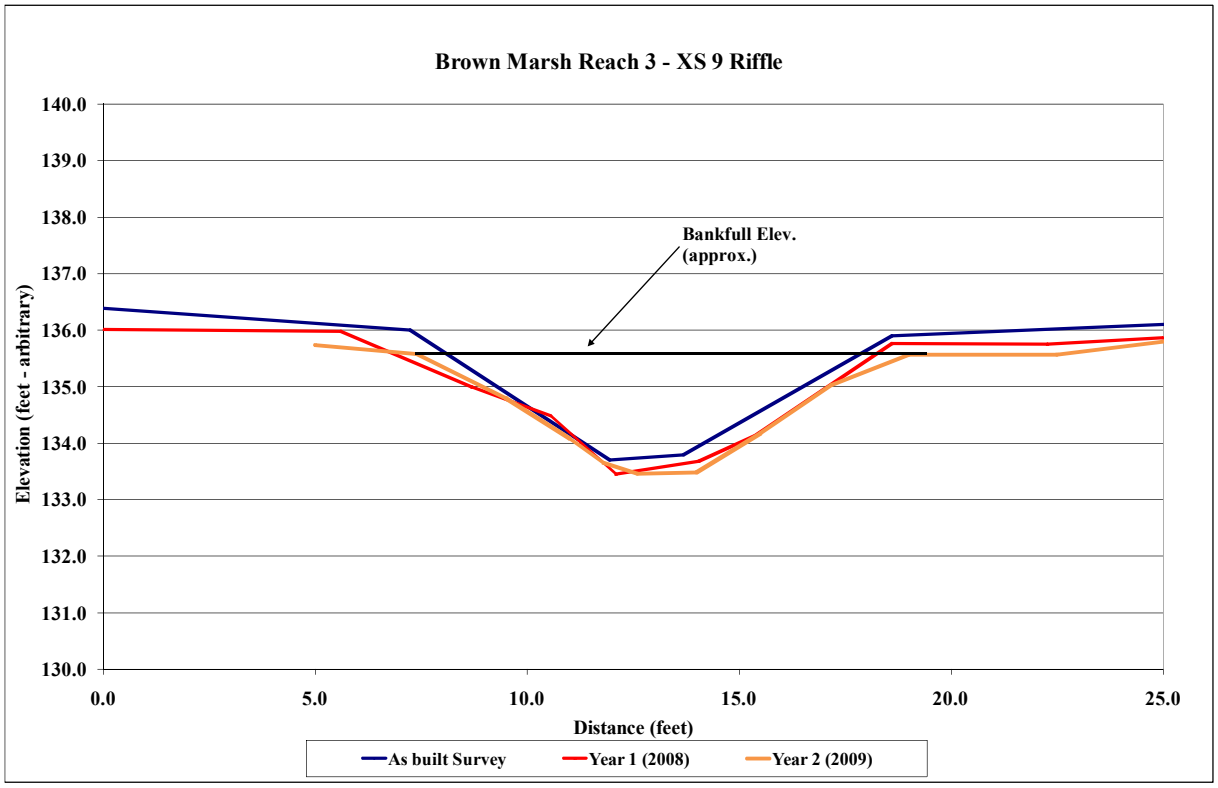


Project Name	Brown Marsh
Cross Section	Reach 3 - XS 9
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-9.1	139.3	0.0	136.0	5.0	135.7		
-0.2	136.4	5.6	136.0	7.4	135.6		
7.2	136.0	8.7	135.0	9.5	134.8		
11.9	133.7	10.6	134.5	11.0	134.1		
13.7	133.8	12.1	133.5	11.8	133.7		
18.6	135.9	14.0	133.7	12.6	133.5		
25.1	136.1	15.4	134.1	14.0	133.5		
36.5	139.7	18.6	135.8	15.5	134.2		
		22.3	135.8	17.2	135.0		
		25.0	135.9	19.0	135.6		
				22.5	135.6		
				25.7	135.9		

Photo of Cross-Section R3-9 - Looking Downstream @ STA 41+25

	2008	2009	2010	2011	2012
Area	14.8	13.1			
Width	12.3	11.6			
Mean Depth	1.2	1.1			
Max Depth	2.3	2.1			
W/D	10.2	10.2			

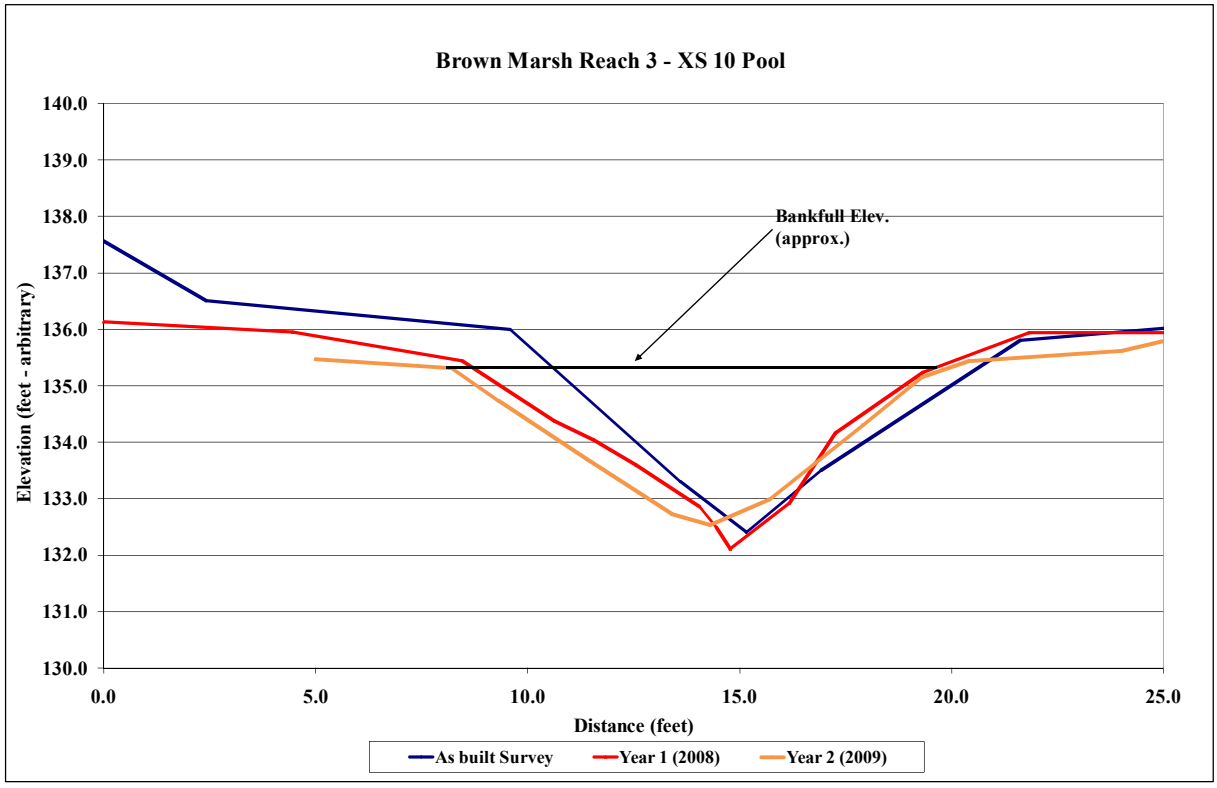


Project Name	Brown Marsh
Cross Section	Reach 3 - XS 10
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-4.0	139.3	0.0	136.1	5.0	135.5		
2.4	136.5	4.5	135.9	8.2	135.3		
9.6	136.0	8.5	135.4	9.3	134.7		
13.6	133.3	10.6	134.4	11.4	133.7		
15.2	132.4	11.6	134.0	13.4	132.7		
16.9	133.5	12.6	133.6	14.3	132.5		
21.6	135.8	14.0	132.9	15.7	133.0		
29.5	136.3	14.4	132.5	17.9	134.3		
37.7	139.0	14.8	132.1	19.3	135.2		
		16.2	132.9	20.4	135.4		
		17.3	134.2	24.0	135.6		
		19.3	135.2	26.9	136.1		
		21.8	135.9				
		25.1	135.9				
		26.7	136.4				

Photo of Cross-Section R3-10 - Looking Downstream @ STA 42+30

	2008	2009	2010	2011	2012
Area	20.3	17.4			
Width	14.6	11.7			
Mean Depth	1.4	1.5			
Max Depth	3.6	2.8			
W/D	NA	NA			

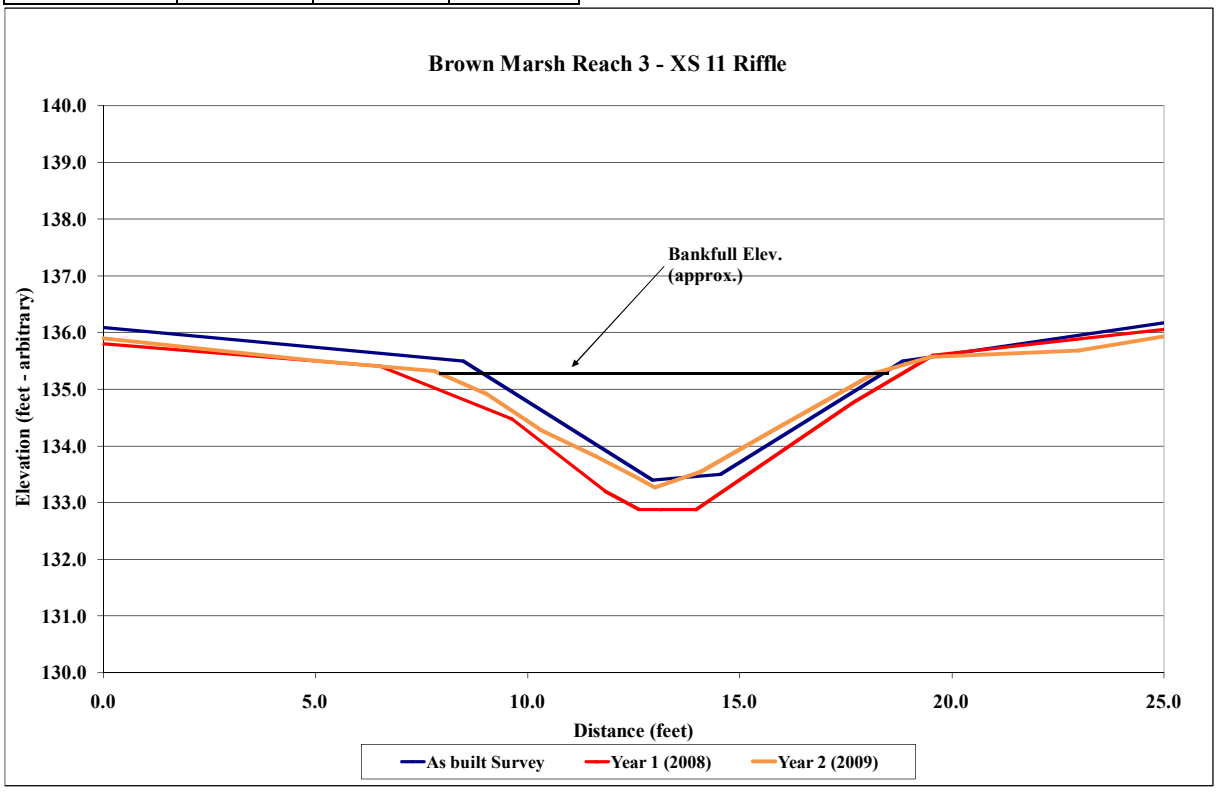


Project Name	Brown Marsh
Cross Section	Reach 3 - XS 11
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-8.7	139.0	0.0	135.8	0.0	135.9		
-0.3	136.1	6.5	135.4	5.0	135.5		
8.5	135.5	9.6	134.5	7.8	135.3		
13.0	133.4	11.8	133.2	9.0	134.9		
14.5	133.5	12.6	132.9	10.3	134.3		
18.9	135.5	13.1	132.9	11.6	133.8		
27.1	136.4	14.0	132.9	12.5	133.5		
33.7	138.8	17.7	134.8	13.0	133.3		
		19.5	135.6	14.1	133.6		
		27.1	136.2	15.9	134.3		
				17.0	134.8		
				18.2	135.3		
				19.5	135.6		
				23.0	135.7		
				27.0	136.2		

Photo of Cross-Section R3-11 - Looking Downstream @ STA 43+75

	2008	2009	2010	2011	2012
Area	16.4	11.1			
Width	12.6	10.4			
Mean Depth	1.3	1.1			
Max Depth	2.5	2.1			
W/D	9.7	9.8			

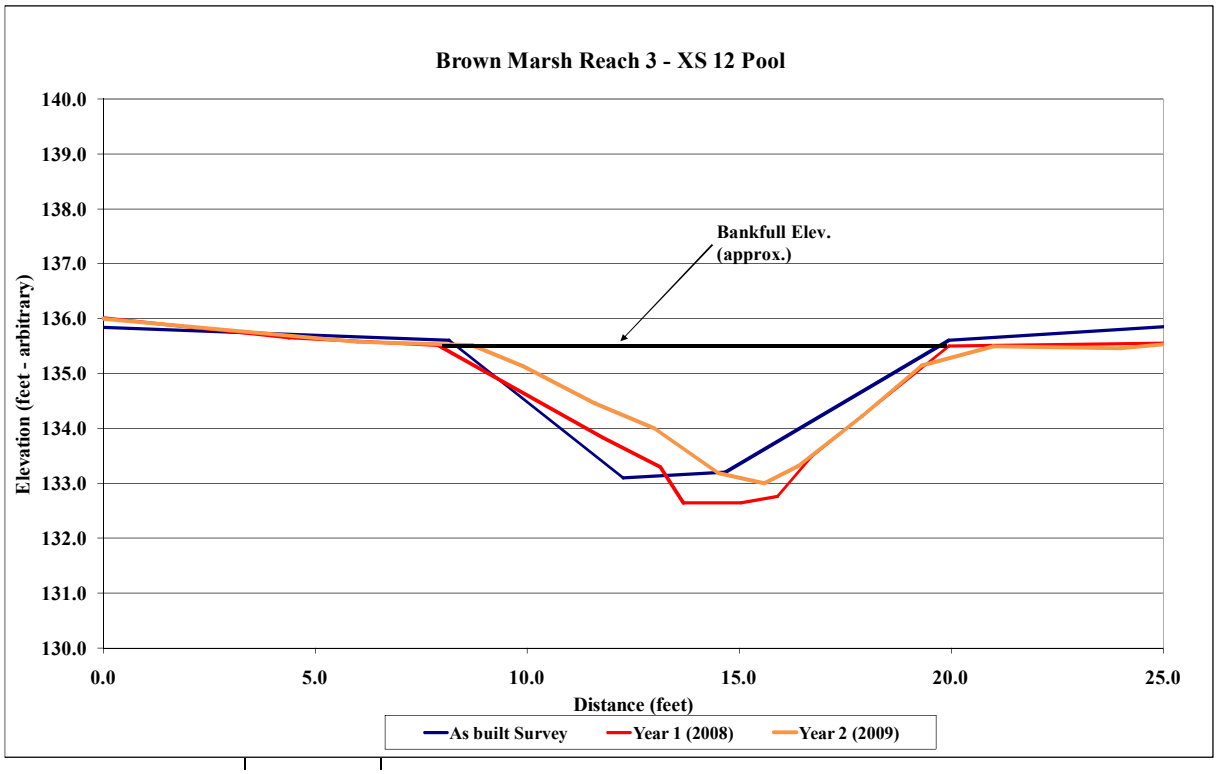


Project Name	Brown Marsh
Cross Section	Reach 3 - XS 12
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-8.8	138.1	0.0	136.0	0.0	136.0		
-8.7	138.1	4.4	135.7	6.0	135.6		
-2.0	135.9	7.9	135.5	8.7	135.5		
8.2	135.6	11.8	133.8	9.9	135.1		
12.3	133.1	13.1	133.3	11.6	134.5		
14.7	133.2	13.7	132.6	13.0	134.0		
19.9	135.6	15.0	132.6	14.5	133.2		
28.1	136.0	15.9	132.8	15.6	133.0		
35.5	138.6	16.7	133.5	16.4	133.3		
		19.9	135.5	17.9	134.2		
		25.6	135.6	19.3	135.2		
		30.0	135.7	21.0	135.5		
				24.0	135.5		
				30.4	135.9		

Photo of Cross-Section R3-12 - Looking Downstream @ STA 45+05

	2008	2009	2010	2011	2012
Area	18.6	10.5			
Width	12.0	9.3			
Mean Depth	1.6	1.1			
Max Depth	2.9	2.1			
W/D	NA	NA			

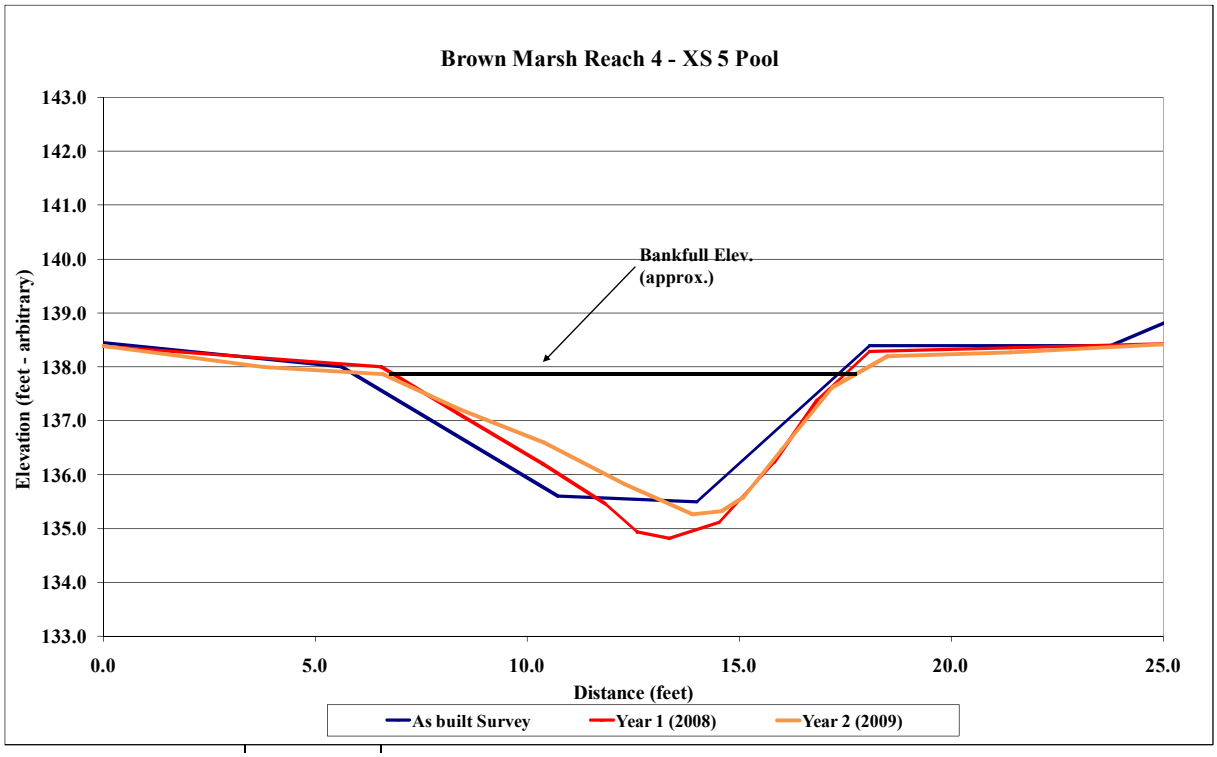


Project Name	Brown Marsh
Cross Section	Reach 4 - XS 5
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-7.5	140.4	0.0	138.4	25.4	138.4		
-0.6	138.5	6.6	138.0	21.4	138.3		
5.6	138.0	8.4	137.1	18.5	138.2		
10.7	135.6	10.4	136.2	17.2	137.6		
14.0	135.5	11.8	135.5	16.0	136.5		
18.1	138.4	12.6	134.9	15.1	135.6		
23.8	138.4	13.4	134.8	14.6	135.3		
31.3	140.9	14.5	135.1	13.9	135.3		
		15.8	136.2	12.3	135.8		
		16.8	137.4	10.4	136.6		
		18.1	138.3	8.4	137.2		
		25.0	138.4	6.6	137.9		
				3.8	138.0		
				0.0	138.4		

Photo of Cross-Section R4-X5 - Looking Downstream @ STA 20+55

	2008	2009	2010	2011	2012
Area	19.0	15.1			
Width	11.1	11.2			
Mean Depth	1.7	1.4			
Max Depth	3.2	2.6			
W/D	NA	NA			

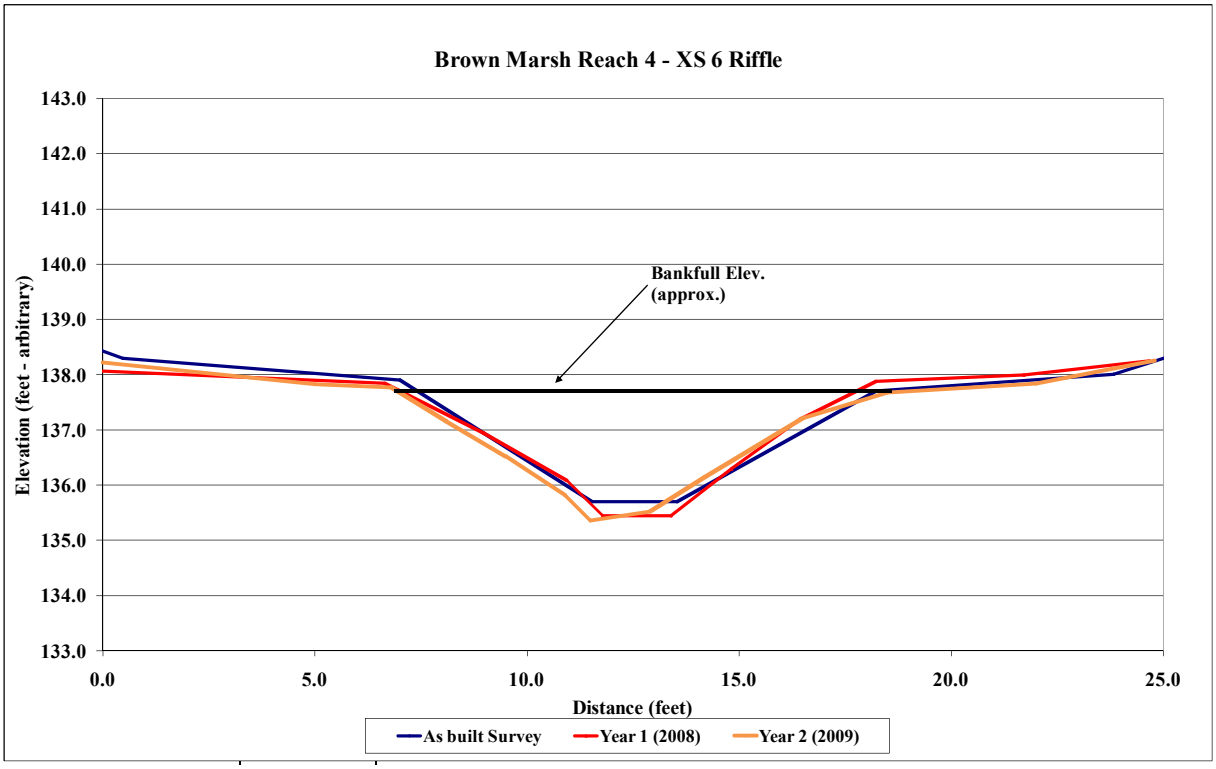


Project Name	Brown Marsh
Cross Section	Reach 4 - XS 6
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-8.5	140.8	0.0	138.1	0.0	138.2		
0.5	138.3	6.6	137.8	5.0	137.8		
7.0	137.9	9.0	136.9	6.8	137.8		
11.5	135.7	10.9	136.1	8.1	137.2		
13.5	135.7	11.8	135.4	9.5	136.5		
18.2	137.7	13.4	135.4	10.9	135.8		
23.8	138.0	14.8	136.3	11.5	135.4		
33.9	140.5	16.5	137.2	12.9	135.5		
		18.2	137.9	14.2	136.2		
		21.7	138.0	16.5	137.2		
		24.7	138.2	18.5	137.7		
				22.0	137.8		
				24.8	138.3		

Photo of Cross-Section R4-6 - Looking Downstream @ STA 21+80

	2008	2009	2010	2011	2012
Area	13.9	13.2			
Width	11.3	11.5			
Mean Depth	1.2	1.1			
Max Depth	2.4	2.3			
W/D	9.1	10.1			

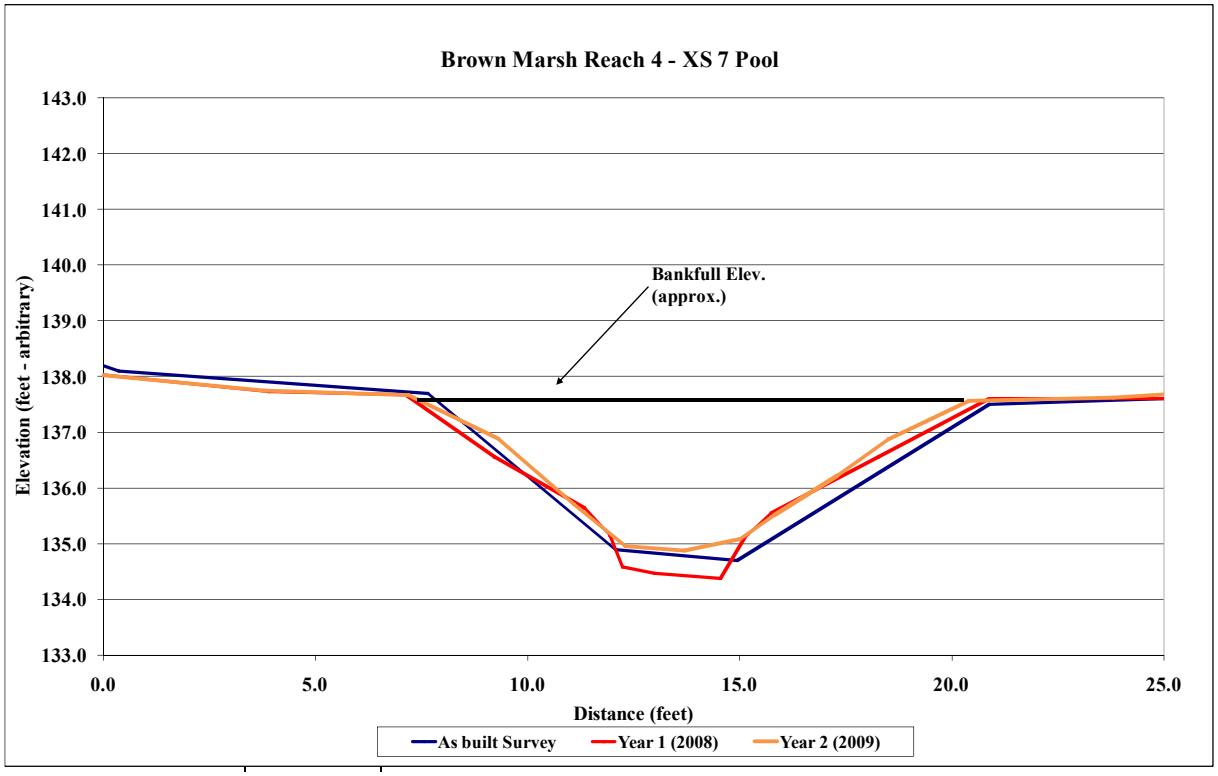


Project Name	Brown Marsh
Cross Section	Reach 4 - XS 7
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-9.5	140.7	0.0	138.0	28.8	137.9		
0.4	138.1	3.9	137.7	23.8	137.6		
7.7	137.7	7.1	137.7	20.4	137.6		
12.1	134.9	9.2	136.6	18.5	136.9		
14.9	134.7	11.4	135.6	17.3	136.2		
20.9	137.5	11.9	135.2	15.8	135.5		
28.7	137.7	12.2	134.6	15.0	135.1		
38.8	140.4	13.0	134.5	13.7	134.9		
		14.5	134.4	12.3	135.0		
		15.1	135.1	11.1	135.7		
		15.7	135.6	9.3	136.9		
		18.3	136.6	7.2	137.7		
		20.9	137.6	3.8	137.8		
		28.2	137.6	0.0	138.0		

Photo of Cross-Section R4-7 - Looking Downstream @ STA 22+95

	2008	2009	2010	2011	2012
Area	21.8	18.9			
Width	13.6	12.9			
Mean Depth	1.6	1.5			
Max Depth	3.2	2.7			
W/D	NA	NA			

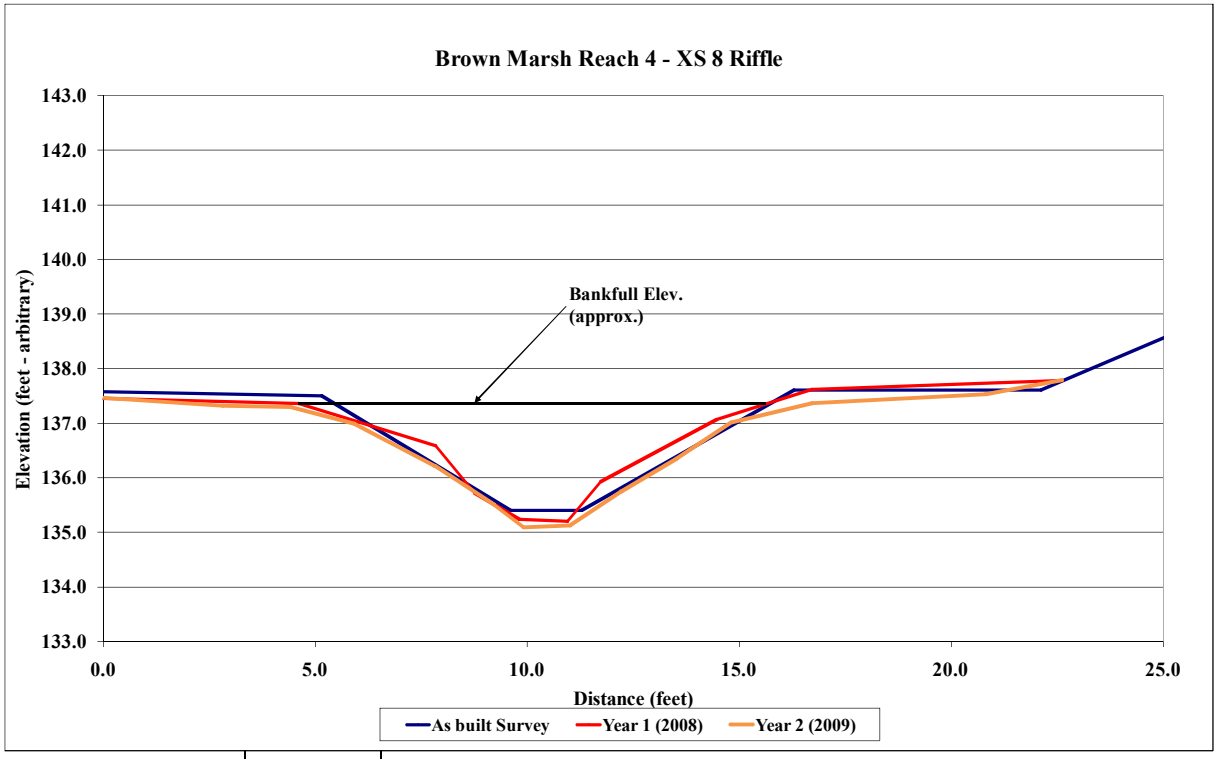


Project Name	Brown Marsh
Cross Section	Reach 4 - XS 8
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-11.0	140.3	0.0	137.4	-2.2	137.6		
-2.1	137.6	4.6	137.4	2.8	137.3		
5.2	137.5	7.8	136.6	4.4	137.3		
9.6	135.4	8.8	135.7	5.9	137.0		
11.3	135.4	9.8	135.2	7.8	136.2		
16.3	137.6	10.9	135.2	9.2	135.5		
22.1	137.6	11.7	135.9	9.9	135.1		
30.9	140.5	14.5	137.1	11.0	135.1		
		16.7	137.6	12.2	135.8		
		22.6	137.8	13.5	136.4		
				14.8	137.0		
				16.7	137.4		
				20.8	137.5		
				22.6	137.8		

Photo of Cross-Section R4-8 - Looking Downstream @ STA 25+80

	2008	2009	2010	2011	2012
Area	11.2	12.3			
Width	11.2	12.0			
Mean Depth	1.0	1.0			
Max Depth	2.2	2.2			
W/D	11.3	11.7			

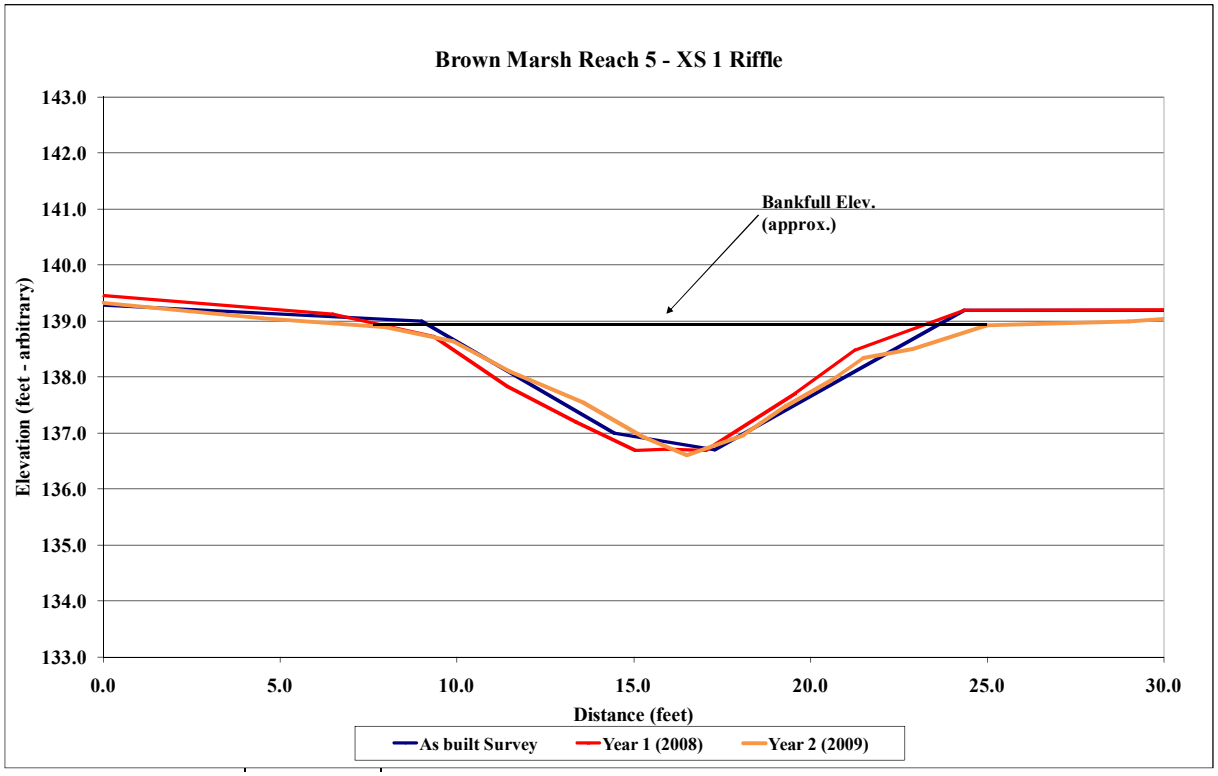


Project Name	Brown Marsh
Cross Section	Reach 5 - XS 1
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-7.7	141.1	0.0	139.5	0.0	139.3		
-0.4	139.3	6.5	139.1	4.5	139.1		
9.0	139.0	9.3	138.7	8.0	138.9		
14.5	137.0	11.4	137.8	9.9	138.6		
17.3	136.7	13.4	137.2	11.5	138.1		
24.3	139.2	15.0	136.7	13.6	137.5		
31.8	139.2	16.0	136.7	15.3	136.9		
38.9	141.7	17.0	136.7	16.5	136.6		
		19.6	137.7	18.1	137.0		
		21.3	138.5	19.3	137.5		
		24.3	139.2	20.6	137.9		
		32.0	139.2	21.5	138.3		
				22.9	138.5		
				25.0	138.9		
				29.0	139.0		
				32.5	139.2		

Photo of Cross-Section R5-1 - Looking Downstream @ STA 11+60

	2008	2009	2010	2011	2012
Area	21.0	13.5			
Width	17.2	13.7			
Mean Depth	1.2	1.0			
Max Depth	2.4	2.0			
W/D	14.2	13.9			

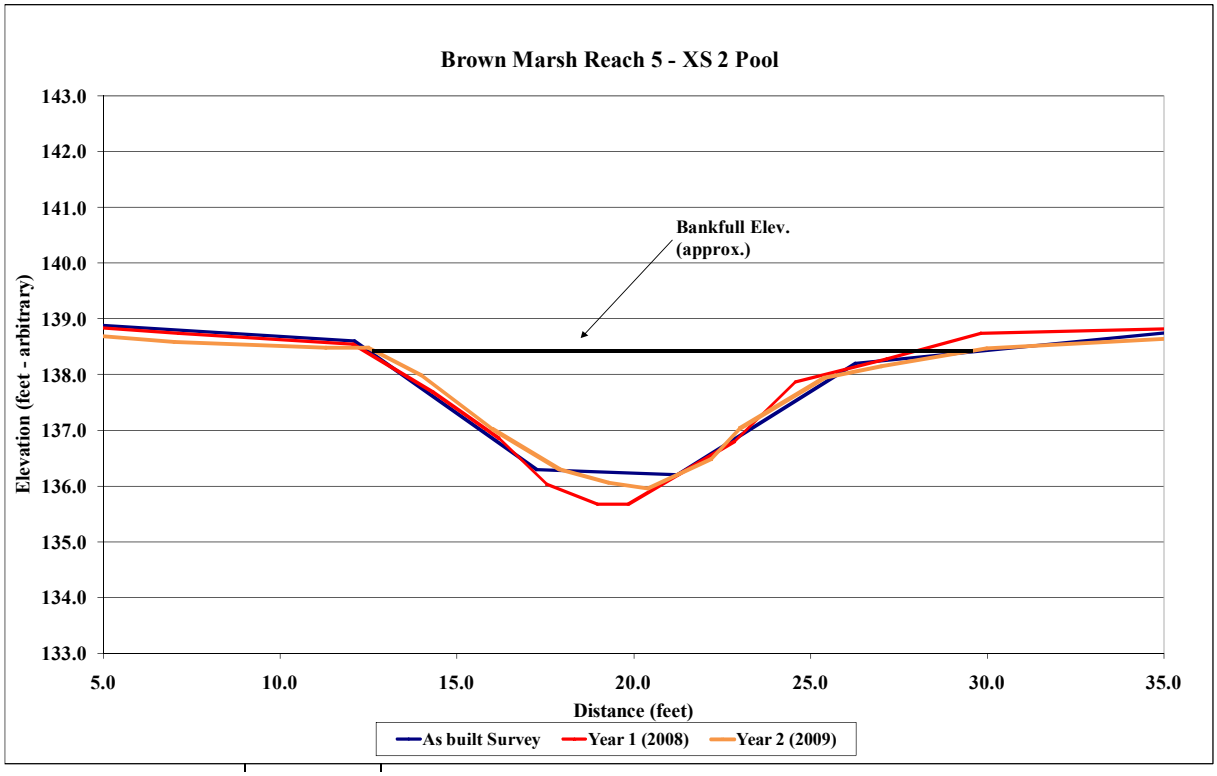


Project Name	Brown Marsh
Cross Section	Reach 5 - XS 2
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-5.8	140.8	0.0	139.1	0.0	138.9		
-0.5	139.1	7.1	138.7	7.0	138.6		
12.1	138.6	12.1	138.5	11.3	138.5		
17.3	136.3	14.3	137.7	12.5	138.5		
21.2	136.2	16.2	136.9	14.0	138.0		
26.3	138.2	17.6	136.0	16.0	137.0		
37.5	138.9	19.0	135.7	17.9	136.3		
44.8	140.7	19.9	135.7	19.3	136.1		
		22.9	136.8	20.4	136.0		
		24.6	137.9	22.2	136.5		
		27.2	138.3	23.0	137.0		
		29.8	138.7	25.4	137.9		
		37.3	138.9	27.0	138.2		
				30.0	138.5		
				38.1	138.8		

Photo of Cross-Section R5-2 - Looking Downstream @ STA 13+70

	2008	2009	2010	2011	2012
Area	22.2	20.9			
Width	16.2	17.5			
Mean Depth	1.4	1.2			
Max Depth	2.8	2.5			
W/D	NA	NA			

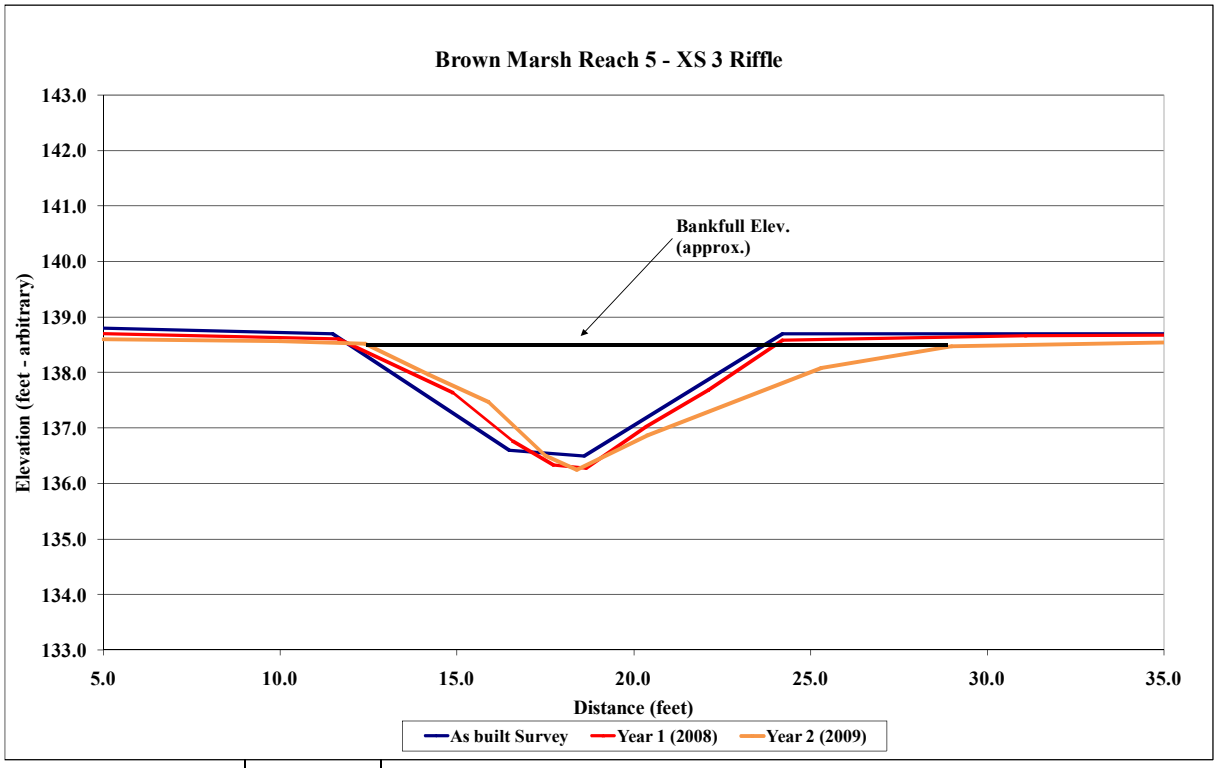


Project Name	Brown Marsh
Cross Section	Reach 5 - XS 3
Feature	Riffle
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-7.3	140.8	0.0	139.0	0.0	139.0		
-1.0	138.9	3.6	138.7	5.0	138.6		
11.5	138.7	11.6	138.6	10.0	138.6		
16.5	136.6	14.9	137.6	12.4	138.5		
18.6	136.5	16.6	136.8	14.2	138.0		
24.2	138.7	17.7	136.3	15.9	137.5		
35.8	138.7	18.6	136.3	17.5	136.5		
42.9	140.8	20.4	137.0	18.4	136.3		
		22.1	137.7	20.4	136.9		
		24.2	138.6	25.3	138.1		
		31.1	138.7	29.0	138.5		
		35.5	138.7	36.1	138.6		

Photo of Cross-Section R5-3 - Looking Downstream @ STA 14+90

	2008	2009	2010	2011	2012
Area	13.6	15.4			
Width	12.0	16.4			
Mean Depth	1.1	0.9			
Max Depth	2.2	2.2			
W/D	10.6	17.6			

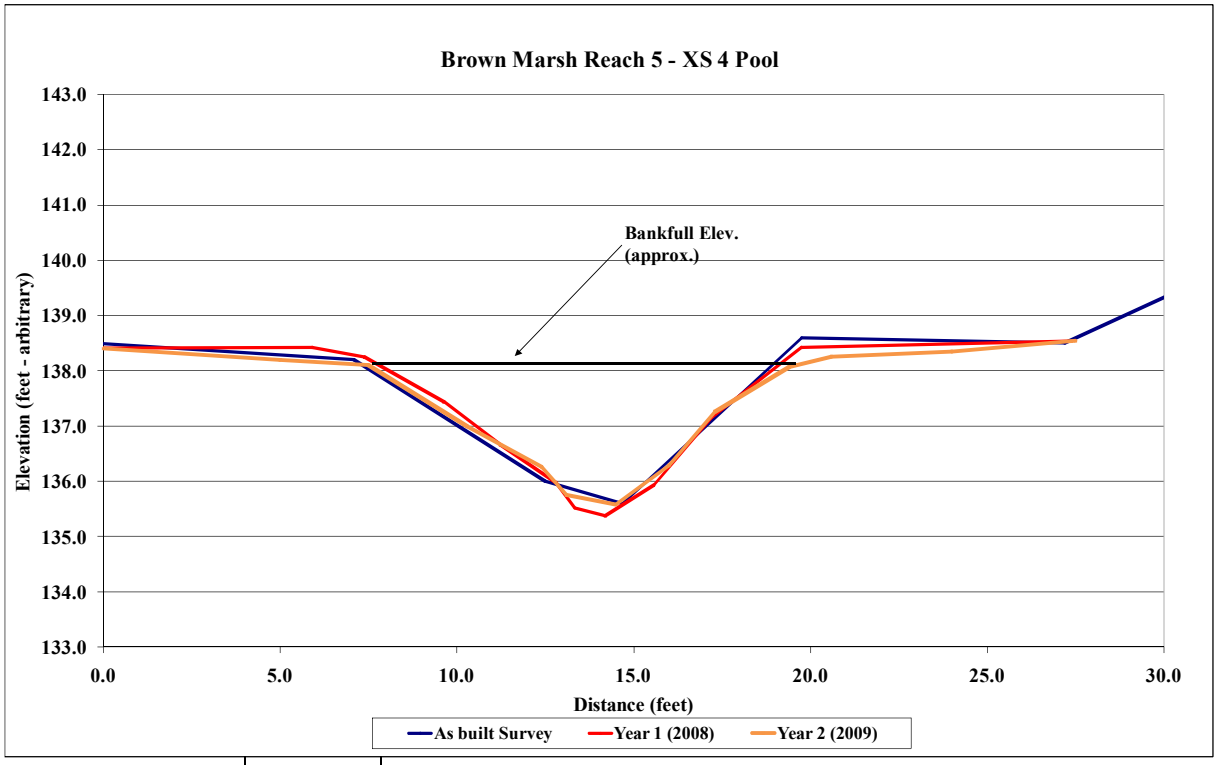


Project Name	Brown Marsh
Cross Section	Reach 5 - XS 4
Feature	Pool
Date	10/1/09
Crew	Smith, Lamb

2008 As-built Survey		2008 YR 1 Survey		2009 YR 2 Survey		2010 YR 3 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-7.4	140.2	0.0	138.4	0.0	138.4		
-0.3	138.5	5.9	138.4	5.0	138.2		
7.1	138.2	7.4	138.3	7.5	138.1		
12.5	136.0	9.6	137.4	10.3	137.0		
14.7	135.6	11.2	136.7	12.4	136.3		
19.8	138.6	12.8	136.0	13.1	135.8		
27.2	138.5	13.3	135.5	14.5	135.6		
33.7	140.4	14.2	135.4	16.0	136.3		
		15.6	135.9	17.3	137.3		
		17.2	137.2	19.4	138.1		
		19.8	138.4	20.6	138.3		
		27.4	138.5	24.0	138.4		
				27.5	138.5		

Photo of Cross-Section R5-4 - Looking Downstream @ STA 17+40

	2008	2009	2010	2011	2012
Area	19.1	15.4			
Width	13.6	11.9			
Mean Depth	1.4	1.3			
Max Depth	3.0	2.5			
W/D	NA	NA			

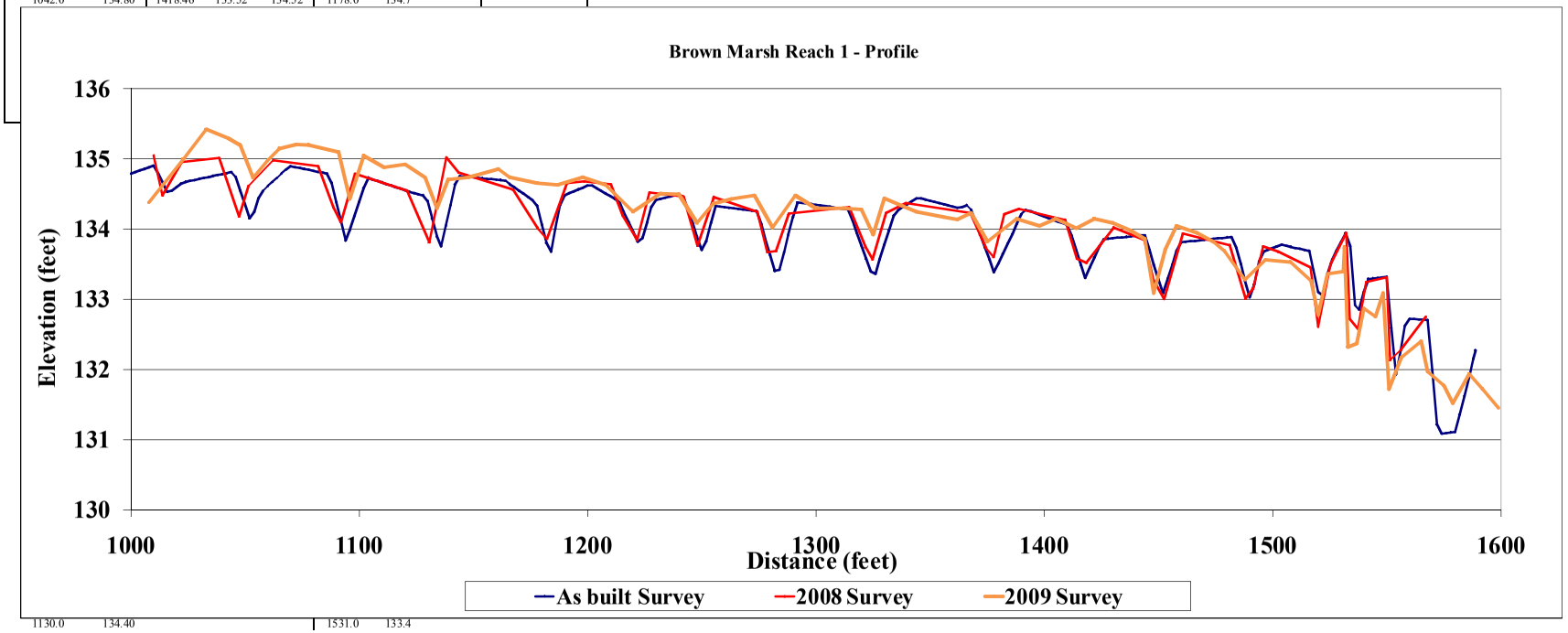


Project Name	Brown Marsh
Cross Section	Reach 1
Feature	Profile
Date	10/1/09
Crew	Lamb, Smith

2008 As-built Survey		2008 YR 1 Survey			2009 YR 2 Survey			2010 YR 3 Survey	
			Bed	H2O		Bed	H2O		
Station	**Elevation**	**Station**	**Elevation**	**Elevation**	**Station**	**Elevation**	**Elevation**	**Station**	**Elevation**
1000.0	134.79	1567.25	132.75	132.90	1008.0	134.4			
1002.0	134.81	1556.23	132.27	132.82	1023.0	135.0			
1004.0	134.84	1551.45	132.14	132.94	1033.0	135.4			
1006.0	134.86	1549.89	133.31	133.35	1043.0	135.3			
1008.0	134.88	1541.01	133.25	133.40	1048.0	135.2			
1010.0	134.90	1537.42	132.58	133.38	1053.5	134.7			
1012.0	134.79	1533.68	132.72	133.42	1060.0	135.0			
1014.0	134.66	1532.29	133.95	133.94	1065.0	135.2			
1016.0	134.53	1525.26	133.50	134.02	1072.5	135.2			
1018.0	134.55	1520.08	132.61	133.98	1078.0	135.2			
1020.0	134.60	1516.65	133.46	134.02	1091.0	135.1			
1022.0	134.65	1502.43	133.68	134.09	1096.0	134.4			
1024.0	134.67	1495.74	133.75	134.10	1102.0	135.1			
1026.0	134.69	1491.44	133.16	134.11	1111.0	134.9			
1028.0	134.70	1488.05	133.01	134.07	1120.0	134.9			
1030.0	134.72	1481.29	133.78	133.96	1129.0	134.7			
1032.0	134.73	1460.66	133.94	134.46	1134.0	134.3			
1034.0	134.74	1452.49	133.01	134.46	1139.0	134.7			
1036.0	134.76	1447.98	133.27	134.46	1148.0	134.7			
1038.0	134.77	1443.91	133.85	134.47	1161.0	134.9			
1040.0	134.78	1430.44	134.02	134.50	1166.0	134.7			
1042.0	134.80	1418.46	133.52	134.52	1178.0	134.7			
1130.0	134.40				1531.0	133.4			

	2008	2009	2010	2011	2012
Ave Slope	0.0018	NA*			
Riffle Length	19.7	20.0			
Riffle Slope	0.0039	NA*			
Pool Length	4.1	20.0			
Pool Slope	0.0000	NA*			

* No water in channel.



Project Name	Brown Marsh
Cross Section	Reach 2
Feature	Profile
Date	10/1/09
Crew	Lamb, Smith

2008 As-built Survey		2008 YR 1 Survey			2009 YR 2 Survey			2010 YR 3 Survey	
Station	Elevation	Station	Bed Elevation	H2O Elevation	Station	Bed Elevation	H2O Elevation	Station	Elevation
4602.0	133.17	5278.2	131.40	132.84	4628.5	132.5			
4604.0	133.18	5276.4	131.63	132.92	4637.5	133.0			
4606.0	133.19	5273.3	132.29	132.94	4645.5	133.0			
4608.0	133.00	5259.4	132.47	132.88	4659.5	133.0			
4610.0	132.74	5249.1	132.43	132.84	4670.5	133.0			
4614.0	132.21	5230.4	132.26	132.90	4685.5	132.9			
4616.0	131.94	5202.9	132.34	133.04	4695.5	132.9			
4618.0	131.89	5187.5	132.38	133.02	4701.5	132.3			
4620.0	132.13	5181.2	131.92	133.05	4708.5	132.6			
4624.0	132.61	5175.9	131.67	133.03	4713.5	132.9			
4626.0	132.85	5172.1	132.27	133.07	4728.5	132.9			
4628.0	132.96	5158.8	132.44	133.10	4739.5	132.9			
4630.0	132.95	5144.0	132.67	133.13	4750.5	132.9			
4634.0	132.94	5102.1	132.54	133.18	4757.5	132.9			
4636.0	132.94	5091.2	132.25	133.13	4764.5	132.3			
4638.0	132.93	5088.8	131.75	133.16	4770.5	132.8			
4736.0	132.97				5217.50	132.39			

	2008	2009	2010	2011	2012
Ave Slope	0.0010	NA*			
Riffle Length	68.3	57.0			
Riffle Slope	0.0012	NA*			
Pool Length	3.7	21.0			
Pool Slope	0.0000	NA*			

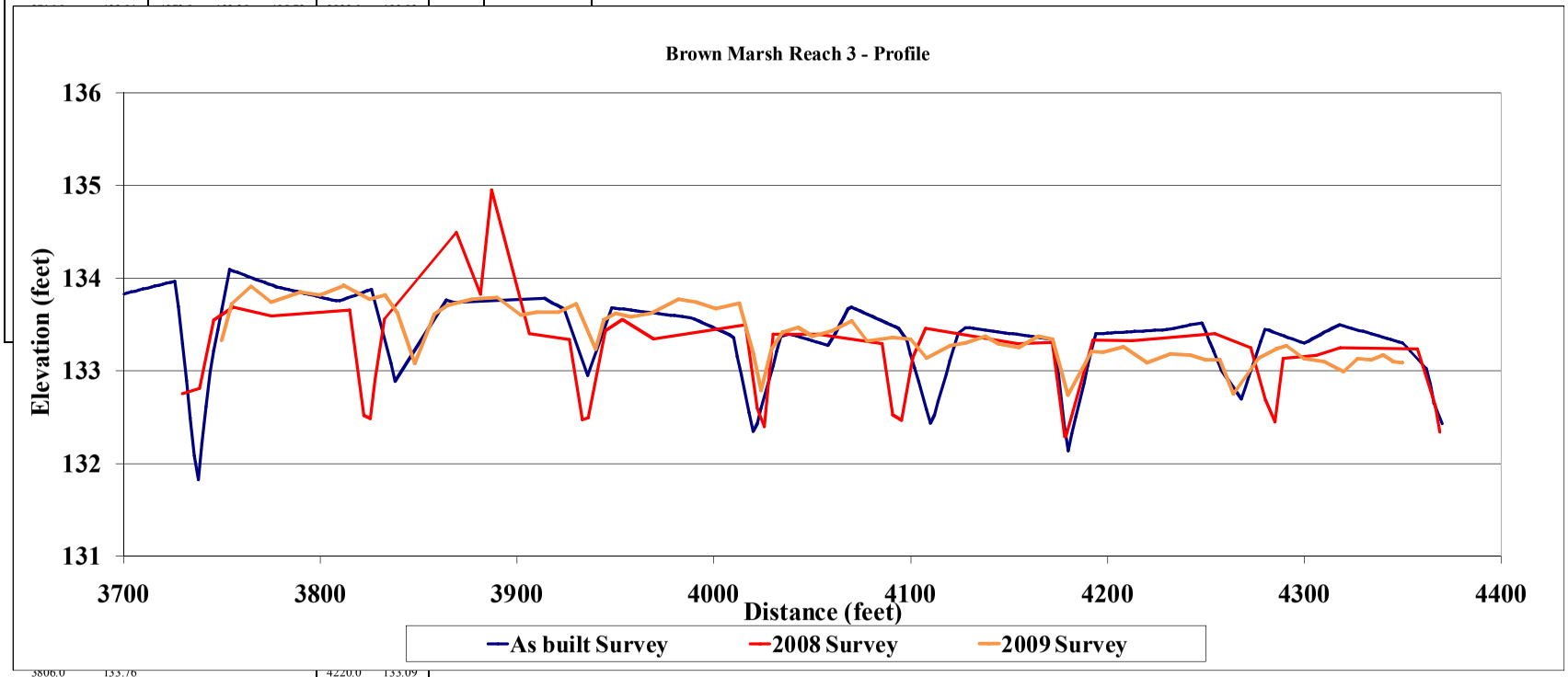
* No water in channel.

Project Name	Brown Marsh
Cross Section	Reach 3
Feature	Profile
Date	10/1/09
Crew	Lamb, Smith

2008 As-built Survey		2008 YR 1 Survey			2009 YR 2 Survey			2010 YR 3 Survey	
Station	Elevation	Station	Bed Elevation	H2O Elevation	Station	Bed Elevation	H2O Elevation	Station	Elevation
3700.0	133.83	4368.8	132.34		3750.0	133.33			
3702.0	133.84	4366.6	132.63		3755.0	133.72			
3704.0	133.85	4357.6	133.24	135.64	3765.0	133.91			
3706.0	133.86	4318.4	133.25		3775.0	133.74			
3708.0	133.87	4306.1	133.17		3790.0	133.85			
3710.0	133.88	4289.4	133.14	135.66	3800.0	133.82			
3712.0	133.89	4285.0	132.45	135.71	3812.0	133.92			
3714.0	133.90	4280.3	132.69	135.73	3825.0	133.77			
3806.0	133.76				4220.0	133.09			
3808.0	133.75				4232.0	133.18			

	2008	2009	2010	2011	2012
Ave Slope	0.0014	NA*			
Riffle Length	70.8	37.5			
Riffle Slope	0.0003	NA*			
Pool Length	3.4	39.0			
Pool Slope	0.0038	NA*			

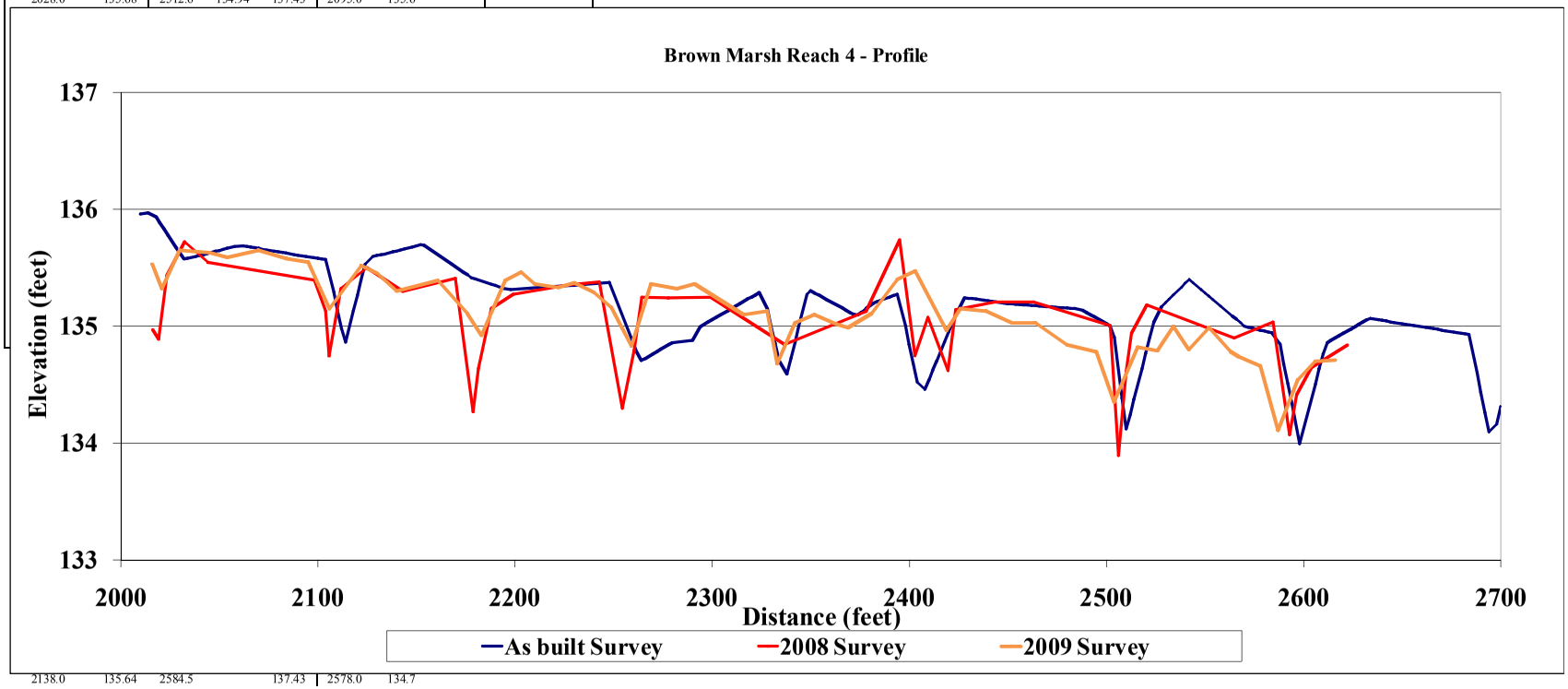
* No water in channel.



Project Name	Brown Marsh
Cross Section	Reach 4
Feature	Profile
Date	10/1/09
Crew	Lamb, Smith

2008 As-built Survey		2008 YR 1 Survey			2009 YR 2 Survey			2010 YR 3 Survey	
Station	Elevation	Station	Bed Elevation	H2O Elevation	Station	Bed Elevation	H2O Elevation	Station	Elevation
2010.0	135.96	2622.3	134.84		2016.0	135.5			
2012.0	135.96	2603.8	134.65		2021.0	135.3			
2014.0	135.97	2596.5	134.42		2030.0	135.7			
2018.0	135.93	2592.9	134.07		2045.0	135.6			
2020.0	135.88	2584.5	135.04	137.43	2054.0	135.6			
2022.0	135.83	2564.7	134.90		2070.0	135.7			
2024.0	135.78	2520.6	135.18		2084.0	135.6			
2028.0	135.68	2512.6	134.94	137.43	2095.0	135.6			
2138.0	135.64	2584.5		137.43	2578.0	134.7			

	2008	2009	2010	2011	2012
Ave Slope	0.0005	NA*			
Riffle Length	73.5	30.0			
Riffle Slope	0.0006	NA*			
Pool Length	3.7	33.0			
Pool Slope	0.0064	NA*			

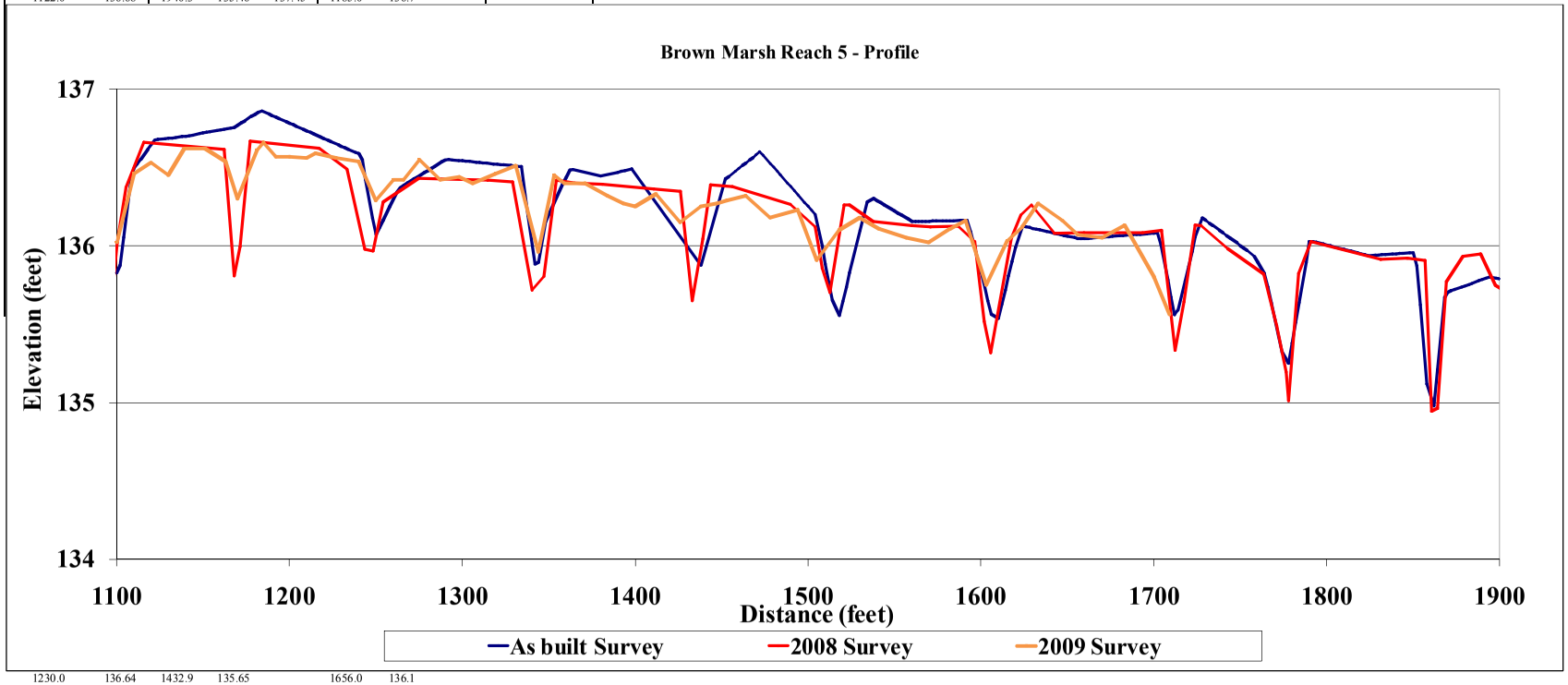


Project Name	Brown Marsh
Cross Section	Reach 5
Feature	Profile
Date	10/1/09
Crew	Lamb, Smith

2008 As-built Survey		2008 YR 1 Survey			2009 YR 2 Survey			2010 YR 3 Survey	
Station	Elevation	Station	Bed Elevation	H2O Elevation	Station	Bed Elevation	H2O Elevation	Station	Elevation
1100.0	135.83	2027.0	134.65		1100.0	136.0			
1102.0	135.88	2024.7	135.05		1110.0	136.5			
1104.0	136.06	2020.5	135.76	137.47	1120.0	136.5			
1108.0	136.41	2005.3	135.80		1130.0	136.5			
1110.0	136.49	1993.6	135.80		1139.0	136.6			
1112.0	136.52	1955.3	135.62		1151.0	136.6			
1114.0	136.55	1950.0	135.28	137.51	1163.0	136.5			
1118.0	136.61	1947.5	135.12	137.51	1170.0	136.3			
1120.0	136.65	1943.5	134.74	137.52	1181.0	136.6			
1122.0	136.68	1940.3	135.46	137.45	1185.0	136.7			
1230.0	136.64	1432.9	135.65		1656.0	136.1			

	2008	2009	2010	2011	2012
Ave Slope	0.0007	NA*			
Riffle Length	70.5	41.0			
Riffle Slope	0.0007	NA*			
Pool Length	4.5	52.0			
Pool Slope	0.0000	NA*			

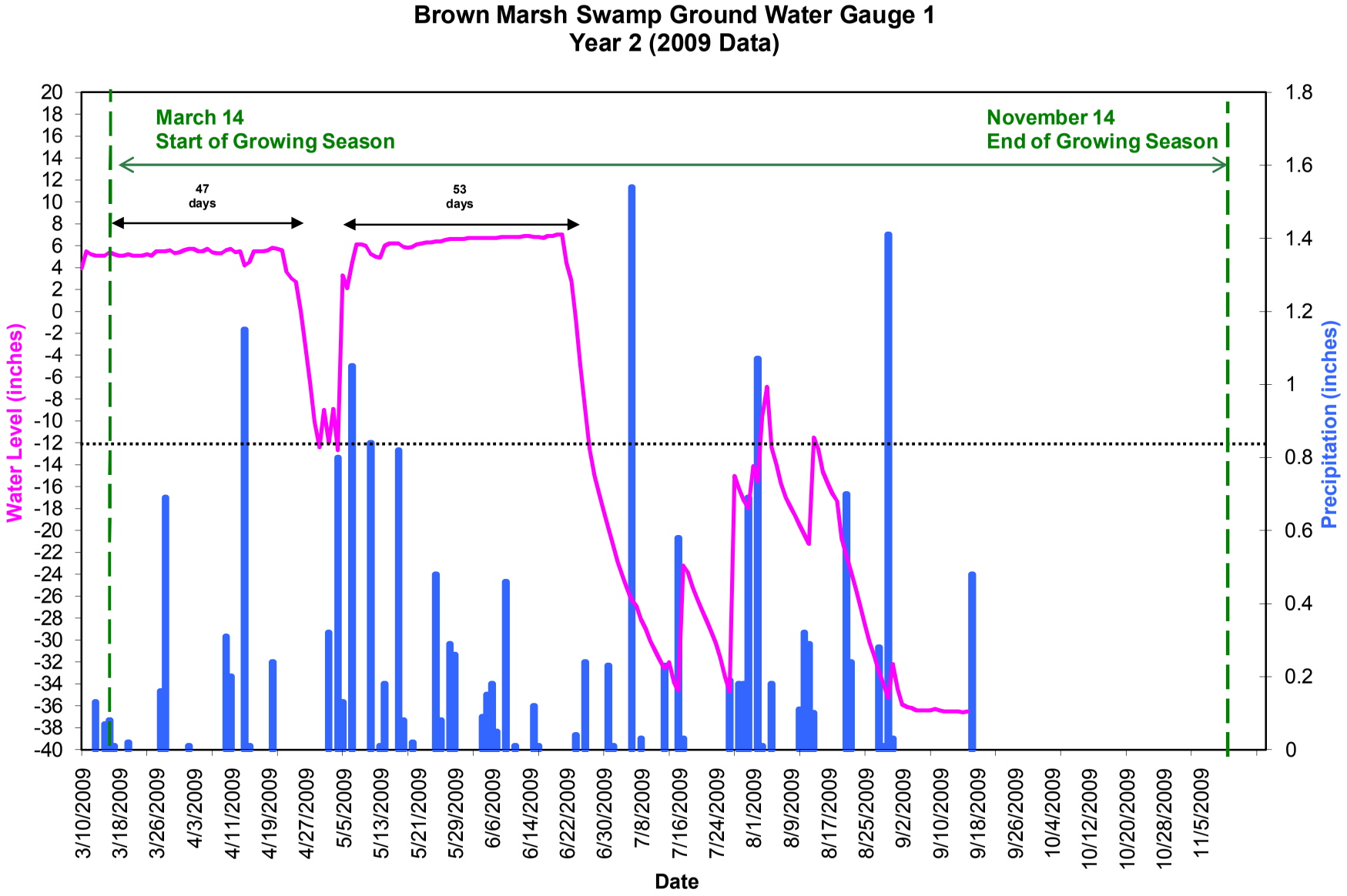
* No water in channel.

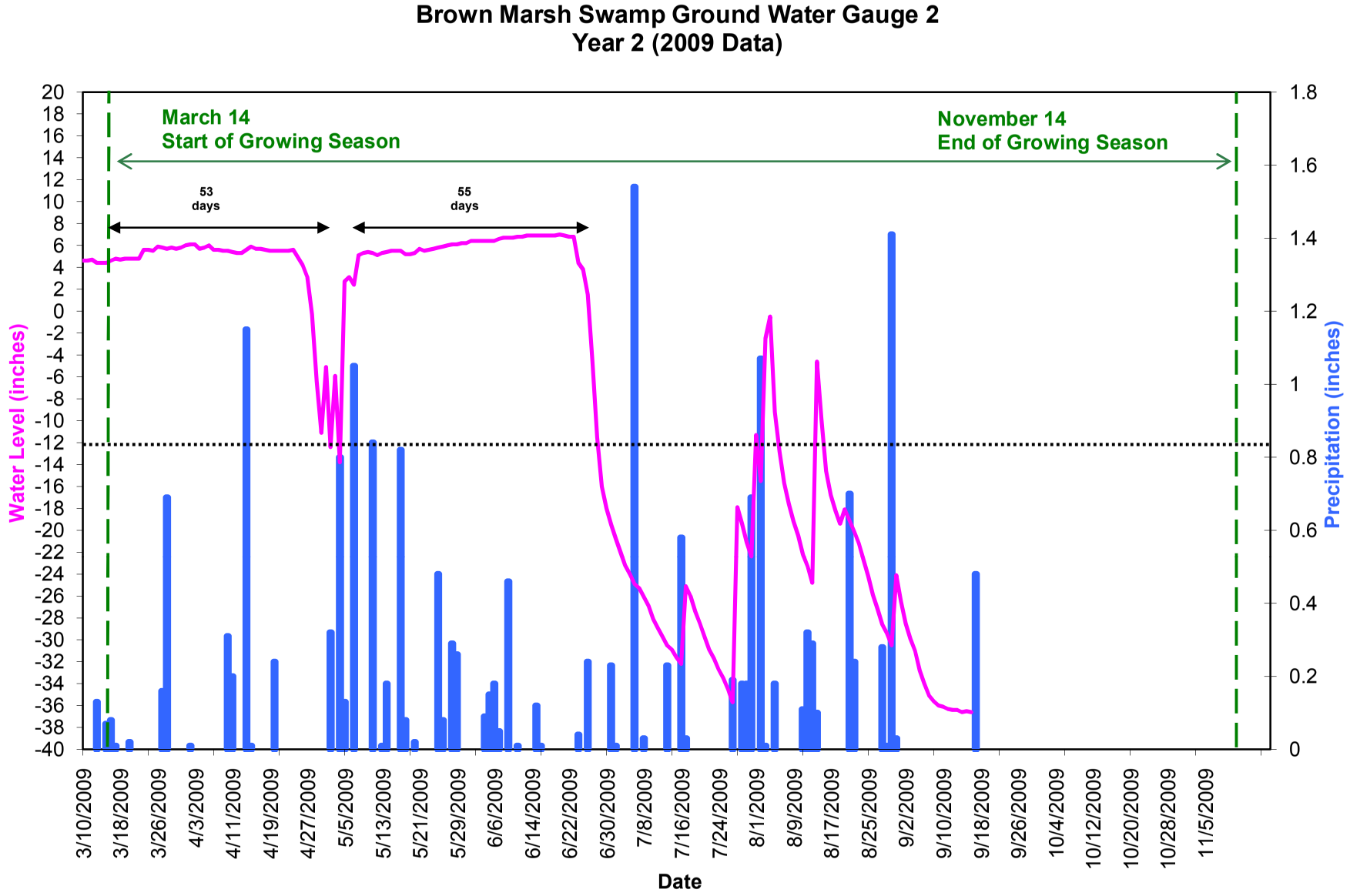


APPENDIX C

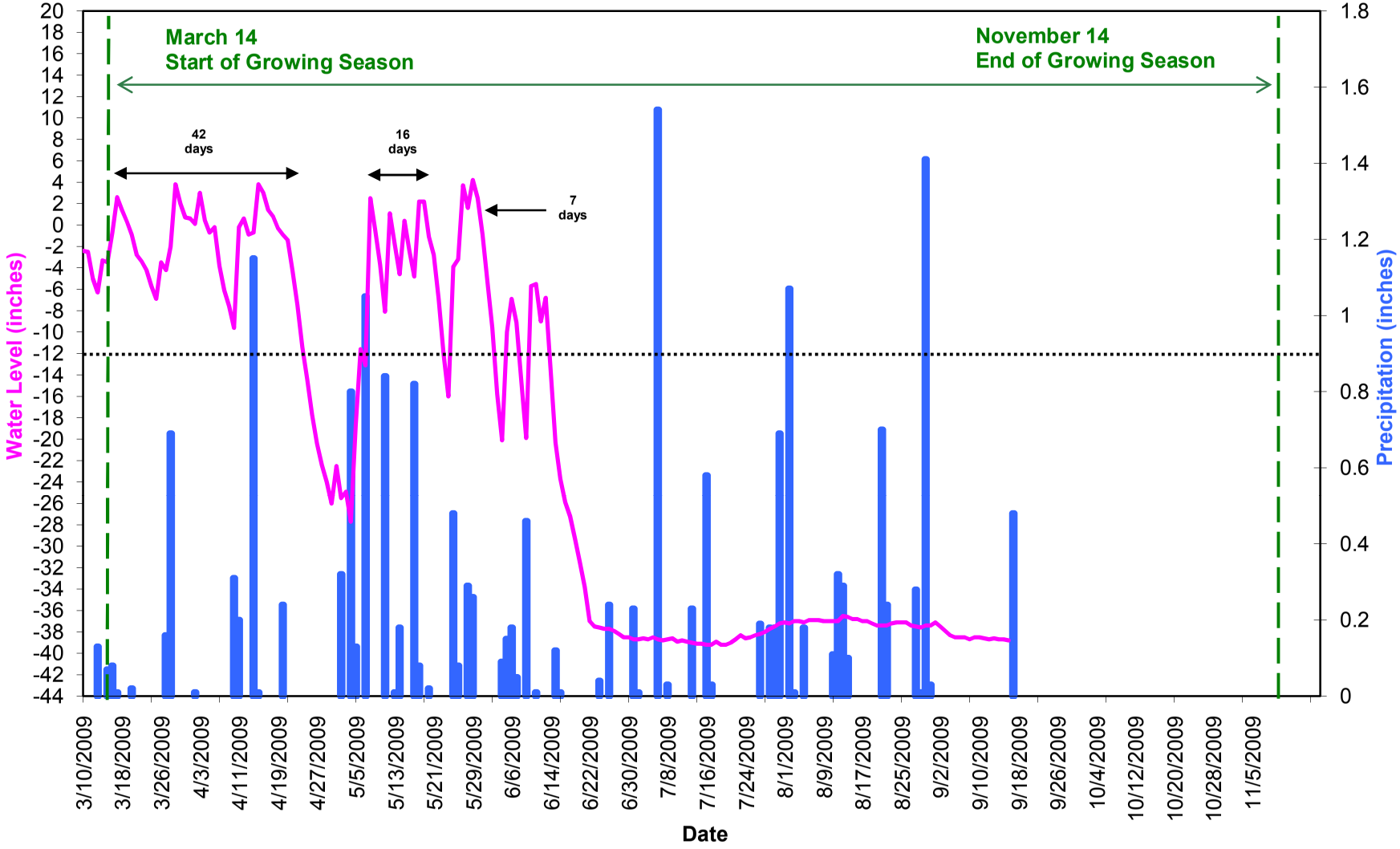
HYDROLOGY DATA

2009 Groundwater Gauge Graphs


Brown Marsh Swamp Ground Water Gauge 1
Year 2 (2009 Data)
March 14
Start of Growing Season
November 14
End of Growing Season
47
days
53
days
Water Level (inches)
Precipitation (inches)
Date
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
3/10/2009
3/18/2009
3/26/2009
4/3/2009
4/11/2009
4/19/2009
4/27/2009
5/5/2009
5/13/2009
5/21/2009
5/29/2009
6/6/2009
6/14/2009
6/22/2009
6/30/2009
7/8/2009
7/16/2009
7/24/2009
8/1/2009
8/9/2009
8/17/2009
8/25/2009
9/2/2009
9/10/2009
9/18/2009
9/26/2009
10/4/2009
10/12/2009
10/20/2009
10/28/2009
11/5/2009


Brown Marsh Swamp Ground Water Gauge 2
Year 2 (2009 Data)
March 14
Start of Growing Season
November 14
End of Growing Season
53
days
55
days
Water Level (inches)
Precipitation (inches)
Date
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
3/10/2009
3/18/2009
3/26/2009
4/3/2009
4/11/2009
4/19/2009
4/27/2009
5/5/2009
5/13/2009
5/21/2009
5/29/2009
6/6/2009
6/14/2009
6/22/2009
6/30/2009
7/8/2009
7/16/2009
7/24/2009
8/1/2009
8/9/2009
8/17/2009
8/25/2009
9/2/2009
9/10/2009
9/18/2009
9/26/2009
10/4/2009
10/12/2009
10/20/2009
10/28/2009
11/5/2009

Brown Marsh Swamp Ground Water Reference Gauge
Year 2 (2009 Data)



APPENDIX D

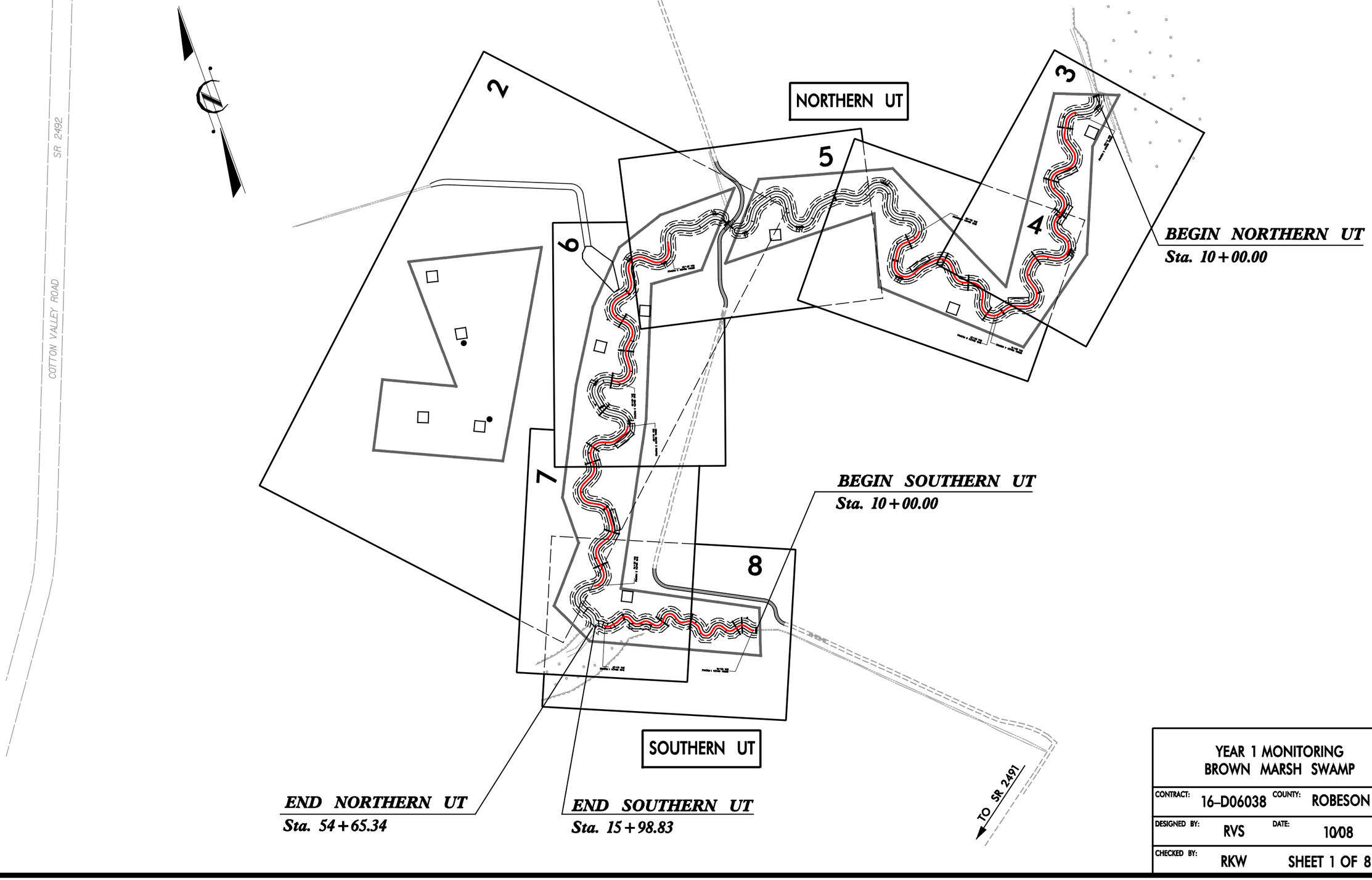
MONITORING PLAN VIEWS

8/17/99

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

NOT TO SCALE

OVERVIEW MAP



YEAR 1 MONITORING
BROWN MARSH SWAMP

CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	10/08
CHECKED BY:	RKW		SHEET 1 OF 8

11/5/2008
S:\Monitoring\Year 1 2008\BMS_monitoring_psh_1.dgn

YEAR 1 MONITORING

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

50 0 100
SCALE

EXISTING SOIL ROAD

CULVERT CROSSING

Sta.34+00

Sta.35+00

Sta.36+00

Sta.37+00

Sta.38+00

Sta.39+00

Sta.40+00

Sta.41+00

Sta.42+00

Sta.43+00

Sta.44+00

Sta.45+00

Sta.46+00

Sta.47+00

Sta.48+00

Sta.49+00

Sta.50+00

Sta.52+00

Sta.53+00

BEGIN REACH 3 PROFILE
STA 37+30

END REACH 3 PROFILE
STA 43+69

BEGIN REACH 2 PROFILE
STA 46+09

CROSS-SECTION 9

CROSS-SECTION 10

CROSS-SECTION 11

CROSS-SECTION 12

CROSS-SECTION 13

CROSS-SECTION 14

CROSS-SECTION 15

CROSS-SECTION 16

VEG PLOT 8

VEG PLOT 9

VEG PLOT 10

VEG PLOT 11

NORTHERN UT

STORMWATER WETLAND

AGRICULTURAL DITCH

GROUNDWATER GAUGE 2

VEG PLOT 16

NONRIVERINE WETLAND RESTORATION

GROUNDWATER GAUGE 1

VEG PLOT 15

VEG PLOT 17

VEG PLOT 14

LEGEND

- FLOW DIRECTION
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- MONITORING PROFILE

YEAR 1 MONITORING BROWN MARSH SWAMP			
CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	10/08
CHECKED BY:	RKW	SHEET 2 OF 8	

11/5/2008
R:\Monitoring\Year 1 2008\BMS_monitoring_psh_2.dgn

8/17/99

YEAR 1 MONITORING

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

CLEARCUT

BEGIN NORTHERN UT
Sta. 10+00.00

BEGIN REACH 5 PROFILE
STA 11+00

CROSS SECTION 3

CROSS SECTION 4

DRAIN TILE

MATCHLINE- STATION 19+00
SEE SHEET NO. 4

VEG PLOT 1

VEG PLOT 2

VEG PLOT 3

NORTHERN UT

AGRICULTURAL FIELDS

Sta.10+00
Sta.11+00
Sta.12+00
Sta.13+00
Sta.14+00
Sta.15+00
Sta.16+00
Sta.17+00
Sta.18+00

CROSS SECTION 1

CROSS SECTION 2

E

LEGEND

- FLOW DIRECTION
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION
- MONITORING PROFILE

YEAR 1 MONITORING
BROWN MARSH SWAMP

CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	10/08
CHECKED BY:	RKW		SHEET 3 OF 8

11/5/2008
H:\Monitoring\Year 1 2008\BMS_monitoring_psh_3.dgn

YEAR 1 MONITORING

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

BEGIN REACH 4 PROFILE
STA 20+16

END REACH 5 PROFILE
STA 20+27

AGRICUTURAL FIELDS

Sta.20+00

Sta.21+00

VEG PLOT 5

NORTHERN UT

Sta.24+00

Sta.25+00

-MATCHLINE- STATION 19+00
SEE SHEET NO. 3

VEG PLOT 4

VEG PLOT 6

CROSS SECTION 5

CROSS SECTION 8

Sta.29+00

CROSS SECTION 6

Sta.22+00

Sta.23+00

Sta.26+00

CROSS SECTION 7

-MATCHLINE- STATION 29+50
SEE SHEET NO. 5

END REACH 4 PROFILE
STA 26+22

Sta.27+00

AGRICUTURAL FIELDS

Sta.28+00

LEGEND

- FLOW DIRECTION
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION
- MONITORING PROFILE

YEAR 1 MONITORING BROWN MARSH SWAMP			
CONTRACT: 16-D06038	COUNTY: ROBESON		
DESIGNED BY: RVS	DATE: 10/08		
CHECKED BY: RKW	SHEET 4 OF 8		

11/5/2008
R:\Monitoring\Year 1 2008\BMS_monitoring_psh_4.dgn

8/17/99

YEAR 1 MONITORING

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

LEGEND

- FLOW DIRECTION
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION
- MONITORING PROFILE

AGRICULTURAL FIELDS

NORTHERN UT

VEG PLOT 7

Sta. 30+00
Sta. 31+00
Sta. 32+00
Sta. 33+00
Sta. 34+00
Sta. 35+00
Sta. 36+00
Sta. 37+00
Sta. 38+00

-MATCHLINE- STATION 29+50
SEE SHEET NO. 4

BEGIN REACH 3 PROFILE
STA 37+30

-MATCHLINE- STATION 38+50
SEE SHEET NO. 6

CULVERT CROSSING

AGRICULTURAL FIELDS

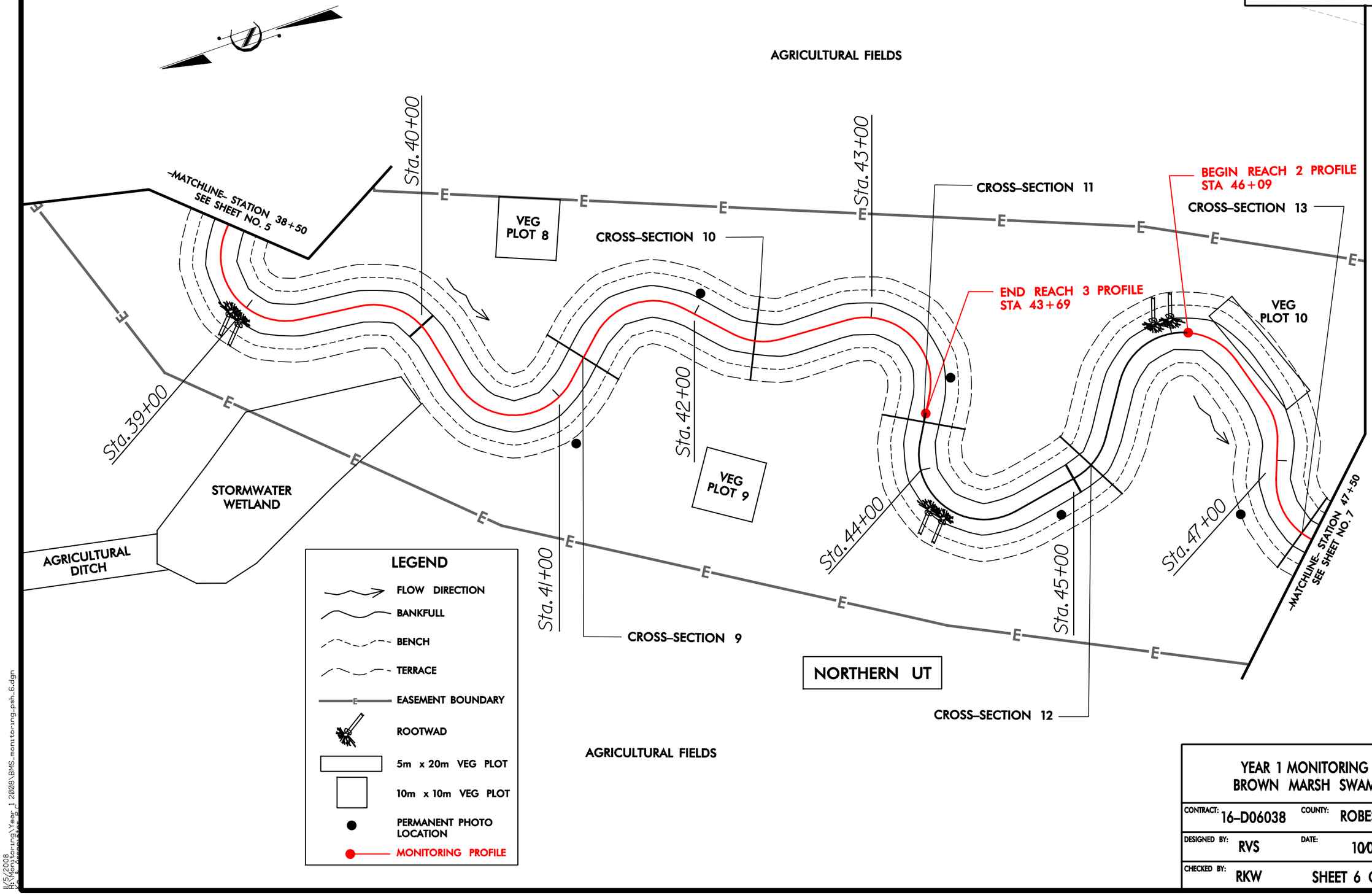
YEAR 1 MONITORING BROWN MARSH SWAMP			
CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	10/08
CHECKED BY:	RKW		SHEET 5 OF 8

11/5/2008
S:\Monitoring\Year 1 2008\BMS_monitoring_psh_5.dgn

YEAR 1 MONITORING

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE



LEGEND

- FLOW DIRECTION
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION
- MONITORING PROFILE

YEAR 1 MONITORING BROWN MARSH SWAMP			
CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	10/08
CHECKED BY:	RKW	SHEET 6 OF 8	

11/5/2008
H:\Monitoring\Year 1 2008\BMS_monitoring_psh_6.dgn

8/17/99

YEAR 1 MONITORING

LEGEND

- FLOW DIRECTION
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- LOG SILL
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION
- MONITORING PROFILE

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

EXISTING SOIL ROAD

AGRICULTURAL FIELDS

END REACH 2 PROFILE
STA 52+78

FOR SOUTHERN UT
SEE SHEET NO. 8 OF 8

NORTHERN UT

VEG PLOT 11

CROSS-SECTION 16

Sta. 48+00

Sta. 49+00

Sta. 50+00

Sta. 51+00

Sta. 52+00

Sta. 53+00

Sta. 54+00

Sta. 16+00

MATCHLINE- STATION 47+50
SEE SHEET NO. 6

CROSS-SECTION 14

CROSS-SECTION 15

WOODS

END NORTHERN UT
Sta. 54+65.34

AGRICULTURAL FIELDS

YEAR 1 MONITORING BROWN MARSH SWAMP	
CONTRACT: 16-D06038	COUNTY: ROBESON
DESIGNED BY: RVS	DATE: 10/08
CHECKED BY: RKW	SHEET 7 OF 8

11/5/2008
R:\Monitoring\Year 1 2008\BMS_monitoring_psh_7.dgn

8/17/99

YEAR 1 MONITORING

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

BEGIN SOUTHERN UT
Sta. 10+00.00

END SOUTHERN UT
Sta. 15+98.83

AGRICULTURAL FIELDS

BEGIN REACH 1 PROFILE
STA 10+10

END REACH 1 PROFILE
STA 15+67

WOODS

CROSS-SECTION 19

CROSS-SECTION 17

Sta.10+00

Sta.12+00

Sta.16+00

Sta.15+00

SOUTHERN UT

VEG
PLOT 13

CROSS-SECTION 20

CROSS-SECTION 18

Sta.11+00

Sta.13+00

Sta.14+00

VEG
PLOT 12

FOR NORTHERN UT
SEE SHEET NO. 7 OF 8

AGRICULTURAL FIELDS

LEGEND

- FLOW DIRECTION
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- LOG SILL
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION
- MONITORING PROFILE

YEAR 1 MONITORING
BROWN MARSH SWAMP

CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	10/08
CHECKED BY:	RKW		SHEET 8 OF 8

11/5/2008
H:\Monitoring\Year 1 2008\BMS_monitoring_psh_8.dgn