BAILEY FORK WETLAND AND STREAM RESTORATION PROJECT

ANNUAL MONITORING REPORT FOR 2006 (YEAR 1)

Project Number D04006-3

Submitted to: NCDENR - Ecosystem Enhancement Program
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TABLE OF CONTENTS

FIGURES

LIST OF TABLES

LIST OF FIGURES

1.0 SUMMARY

This Annual Report details the monitoring activities during the 2006 growing season (Monitoring Year 1) on the Bailey Fork Wetland and Stream Restoration Site ("site"). Construction of the site, including planting of trees, was completed in April 2006. In order to document project success, 21 vegetation monitoring plots, 13 permanent cross-sections, longitudinal profiles surveys, and 8 hydrologic monitoring gauges (4 automated and 4 manual) were installed and assessed across the restoration site. The 2006 data represents results from the first year of vegetation and hydrologic monitoring for both wetlands and streams.

The design for the Bailey Fork Site involved the restoration of "Piedmont/ Low Mountain alluvial forest" and associated riverine wetlands described by Schafale and Weakley (1990). Prior to restoration, wetland, stream, and buffer functions on the site were impaired as a result of agricultural conversion. Streams flowing through the site were channelized many years ago to reduce flooding and provide drainage for adjacent farm fields. After construction, it was determined that 12.1 acres of riverine wetlands and 6,097 linear feet (LF) of stream were restored, and 5.3 acres of riverine wetlands and 9,765 LF of stream were enhanced.

Weather station data from the Morganton Weather Station (Morganton, NC UCAN: 14224, COOP: 315838) were used in conjunction with a manual rain gauge located on the site to document precipitation amounts. The manual gauge is used to validate observations made at the automated station. For the 2006 growing season, total rainfall during the monitoring period was on track with the normal average (approximately 0.82 inches less from October 2005 through October 2006). Much of the rain that fell during the 2006 growing season fell during the months of June, August, and September when evapotranspiration losses were highest.

A total of 21 monitoring plots 100 square meters (m^2) (10m x 10m) in size were used to predict survivability of the woody vegetation planted on site. The vegetation monitoring indicated an average survivability of 624 stems per acre, which puts the site on trajectory for meeting the initial vegetation survival criteria of 320 stems per acre surviving after the third growing season.

Dimension, pattern, profile and in-stream structures remained stable during the first growing season. Two bankfull events were observed and documented during the months of August and October. No repairs have been necessary during the first growing season and no areas of concern have been noted.

In 2006, all eight hydrology monitoring gauges have met the seven percent hydrologic success criteria based on field observations. Based on these results, it was concluded that the site is performing as designed during the 2006 monitoring year.

2.0 PROJECT BACKGROUND

The Bailey Fork restoration site is located in Burke County, North Carolina (Figure 1). The project is within cataloging unit 03050101. The site has recently been used for pasture and hay production. In the past, the site was used for row crop agriculture and pasture. Ditches were installed to increase arable land and improve drainage when the land was under agricultural production. The streams on the project site were channelized and riparian vegetation was cleared in most locations. Wetland and stream functions on the site had been severely impacted as a result of these land use changes.

The project involved the restoration of 12.1 acres of riverine wetlands, enhancement of 5.3 acres of riverine wetlands, restoration of 6,097 LF of stream, and enhancement of 9,765 LF of stream. Figures 2(a), 2(b), 2(c), and 2(d) summarize the restoration and enhancement zones on the project site. A total of 61 acres of stream, wetland, and riparian buffer are protected through a permanent conservation easement.

2.1 Project Location

The Bailey Fork restoration site is located approximately two miles southwest of the town of Morganton, along Hopewell Road. The site is divided into two parts by Hopewell Road and I-40. The monitoring entrance for the northern half of the site is located at a farm gate on the north side of Hopewell Road immediately east of Bailey Fork. The monitoring entrance for the southern half is located at the end of an access road along I-40 that connects to Hopewell Road immediately west of the I-40 overpass.

2.2 Mitigation Goals and Objectives

The specific goals for the Bailey Fork Restoration Site were as follows:

- Restore 6,097 LF of stream channel
- Enhance 9,765 LF of stream channel
- Restore 12.1 acres of riparian wetlands
- Enhance of 5.3 acres of existing wetlands
- Exclude cattle from stream, wetland and riparian buffer areas
- Develop an ecosystem-based restoration design
- Improve habitat functions
- Realize water quality benefits

2.3 Project Description and Restoration Approach

For analysis and design purposes, the on-site streams were divided into four reaches. The reaches were numbered sequentially, moving from south to north, with unnamed tributaries carrying a "UT" designation. UT1 is a second order stream that begins offsite, flows into the project area from the southwest, and ends at its confluence with Bailey Fork. UT2 is a first order stream that begins offsite, flows into the project area from the west, and ends at its confluence with UT1. UT3 is a second order stream that begins offsite, flows into the project area from the south, and ends at its confluence with the main stem of Bailey Fork. Bailey Fork flows into the project area from the south and ends at the confluence with Silver Creek. The drainage area of the three tributaries ranges from 0.25 square miles (mi^2) to 0.92 mi^2, while the drainage area at the downstream end of Bailey Fork is 8.3 mi^2. All four reaches were classified as incised and

straightened E5 channels prior to restoration activities. Design information is presented in Table 1.

Wetland functions on the site had been severely impaired by agricultural conversion. Streams flowing through the site were channelized many years ago to reduce flooding and provide drainage for adjacent farm fields. As a result, nearly all wetland functions were destroyed within the project area.

The design for the restored stream involved the construction of a new, meandering channel across the agricultural fields. Reaches UT1, UT2, and UT3 reaches were restored to Rosgen "C5" channels with design dimensions based on nearby reference reaches. The enhancement areas along Bailey Fork and UT3 were accomplished through the use of stabilizing in-stream structures in highly eroded areas and additional buffer planting. Wetland restoration of the prior-converted farm fields on the site involved grading areas of the farm fields and raising the local water table to restore a natural flooding regime. The streams through the site were restored to a stable dimension, pattern, and profile, such that riparian wetland functions were restored to the adjacent hydric soil areas. Drainage ditches within the restoration areas were filled to decrease surface and subsurface drainage and raise the local water table. Total stream length across the Bailey Fork Restoration Project was increased from approximately 14,076 LF to 15,862 LF.

The designs allow stream flows larger than bankfull flows to spread onto the floodplain, dissipating flow energies and reducing stress on stream banks. In-stream structures were used to control streambed grade, reduce stream bank stress, and promote bedform sequences and habitat diversity. The in-stream structures consisted of root wads, log vanes, log weirs, and rock vanes, which promote a diversity of habitat features in the restored channel. Where grade control was a consideration, constructed riffles or rock cross vanes were installed to provide long-term stability. Stream banks were stabilized using a combination of erosion control matting, bare-root planting, and transplants. Transplants provide living root mass to increase stream bank stability and create holding areas for fish and aquatic biota. Native vegetation was planted across the site, and the entire restoration site is protected through a permanent conservation easement.

Table 1. Design Approach for Bailey Fork Restoration Site

Bailey Fork Restoration Site: EEP Contract No. D04006-3			
Project Segment or Reach ID	**Mitigation Type ***	**Approach****	**Linear Footage or Acreage**
Reach UT1	R	P1	1,948 ft
Reach UT2	R	P1	923 ft
Reach UT3	R	P1	3,226 ft
Reach UT3	EII	SS	135 ft
Reach Bailey Fork	EII	SS	9,630 ft
Riverine Wetland	R	-	12.1 ac
Riverine Wetland	E	-	5.3 ac

* R = Restoration
EI = Enhancement I
EII = Enhancement II

** P1 = Priority I
P2 = Priority II
SS = Stabilization

2.4 Project History and Background

The chronology of the Bailey Fork Creek Mitigation Project is presented in Table 2. The contact information for all designers, contractors, and relevant suppliers is presented in Table 3. Relevant project background information is presented in Table 4.

Table 2. Project Activity and Reporting History

Bailey Fork Wetland and Stream Restoration Project: EEP Contract No. D04006-3			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan Prepared	N/A	N/A	Apr-05
Restoration Plan Amended	N/A	N/A	Apr-05
Restoration Plan Approved	N/A	N/A	Apr-06
Final Design – (at least 90% complete)	N/A	N/A	N/A
Construction Begins	Jun-05	N/A	Apr-06
Temporary S&E mix applied to entire project area	Mar-06	N/A	Apr-06
Permanent seed mix applied to entire project area	Mar-06	N/A	Apr-06
Planting of live stakes	Mar-06	N/A	Apr-06
Planting of bare root trees	Mar-06	N/A	Apr-06
End of Construction	Mar-06	N/A	Apr-06
Survey of As-built conditions (Year 0 Monitoring-baseline)	Mar-06	Apr-06	Apr-06
Year 1 Monitoring	Dec-06	Nov-06	Dec-06
Year 2 Monitoring	Dec-07	TBD	TBD
Year 3 Monitoring	Dec-08	TBD	TBD
Year 4 Monitoring	Dec-09	TBD	TBD
Year 5 Monitoring	Dec-10	TBD	TBD

Table 3. Project Contact Table

Bailey Fork Restoration Site: EEP Contract No. D04006-3	
Full Service Delivery Contractor	
EBX Neuse-I, LLC	909 Capability Drive, Suite 3100 Raleigh, NC 27606 Contact: Norton Webster, Tel. 919-829-9909
Designer	
Buck Engineering *A Unit of Michael Baker Corporation*	8000 Regency Parkway, Suite 200 Cary, NC 27518 Contact: Eng. Kevin Tweedy, Tel. 919-463-5488
Construction Contractor	
Riverworks	8000 Regency Parkway, Suite 200 Cary, NC 27518 Contact: Will Pedersen, Tel. 919-459-9001
Planting Contractor	
Riverworks	8000 Regency Parkway, Suite 200 Cary, NC 27518 Contact: Will Pedersen, Tel. 919-459-9001
Seeding Contractor	
Riverworks	8000 Regency Parkway, Suite 200 Cary, NC 27518 Contact: Will Pedersen, Tel. 919-459-9001
Seed Mix Sources	Mellow Marsh Farm, 919-742-1200
Nursery Stock Suppliers	International Paper, 1-888-888-7159
Monitoring Performers	
Buck Engineering *A Unit of Michael Baker Corporation*	8000 Regency Parkway, Suite 200 Cary, NC 27518
Stream Monitoring Point of Contact:	Eng. Kevin Tweedy, Tel. 919-463-5488
Wetland Monitoring Point of Contact:	Eng. Kevin Tweedy, Tel. 919-463-5488
Wetland and Natural Resource Consultants, Inc.	11 South College Ave., Suite 206 Newton, NC 28658
Vegetation Monitoring Point of Contact:	Chris Huysman, Tel. 828-465-3035

Table 4. Project Background Table

Bailey Fork Restoration Site: EEP Contract No. D04006-3	
Project County:	Burke County, NC
Drainage Area:	
Reach: Bailey Fork	8.3 mi^2
Reach: UT1	0.81mi^2
Reach: UT2	0.24mi^2
Reach: UT3	0.92 mi^2
Estimated Drainage Percent Impervious Cover:	
Reach: Bailey Fork	> 5%
Reach: UT1	> 5%
Reach: UT2	> 5%
Reach: UT3	> 5%
Stream Order:	
Bailey Fork	2
UT1	1
UT2	1
UT3	1
Physiographic Region	Piedmont
Ecoregion	Northern Inner Piedmont
Rosgen Classification of As-Built	C5
Cowardin Classification	Riverine, Upper Perennial, Unconsolidated Bottom
Dominant Soil Types	Refer to Section 3.1 for Soil Descriptions
Bailey Fork	AaA, CvA
UT1	FaC2, HaA, UnB
UT2	FaC2, HaA, UnB
UT3	FaC2, HaA, UnB
Reference site ID	(Remnant channel - Bailey Fork)
USGS HUC for Project and Reference sites	3050101040020
NCDWQ Sub-basin for Project and Reference	03-08-31
NCDWQ classification for Project and Reference	WS-IV
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor?	N/A
% of project easement fenced	100%

2.5 Project Plan

Plans depicting the as-built conditions of the major project elements, location of permanent monitoring cross-sections, locations of hydrologic monitoring stations, and locations of permanent vegetation monitoring plots are presented in Figure 2(a), 2(b), 2(c) and 2(d) of this report.

3.0 VEGETATION MONITORING

3.1 Soil Data

The soil data for the project site are presented in Table 5.

Table 5. Project Soil Types and Descriptions

Bailey Fork Restoration Site: EEP Contract No. D04006-3		
Soil Name	**Location**	**Description**
Arkaqua**	Main Channel and Floodplain	Arkaqua series consists of somewhat poorly drained soils that formed in loamy alluvium along nearly level floodplains and creeks. Runoff is slow, and permeability is moderate. Soil texture within the profile ranges from loam to clay loam to sandy loam to sandy clay loam.
Colvard CvA	Main Channel and Floodplain	Colvard series consists of very deep, well drained soils that formed in loamy alluvium on floodplains. These soils are occasionally flooded, well drained, and have slow surface runoff and moderately rapid permeability. The surface layer and subsurface layers are loamy sands in texture.
Fairview FaC2	Floodplain	Fairview soil type occurs on nearly level floodplains along creeks and rivers in pastureland. It has a very deep soil profile and moderate permeability. The surface layer and subsurface layers are clay loams in texture, with an increase in clay content starting at about 1 foot below the surface.
Hatboro* HaA	Floodplain	Hatboro series consists of a very deep soil profile that is poorly drained with moderate permeability. The series primarily consists of silt loams with underlying layers of sandy clay loam. These soils are generally found on floodplains in pastures and woodlands.
Unison UnB	Floodplain	Unison soil type occurs on mountain foot slopes or stream terraces. It generally has a very deep soil profile, is well drained, and is moderately permeable. Uses include cultivated crops, pasture, orchards, and mixed hardwood forests.
Notes: Source: From Burke County Soil Survey, USDA-NRCS, http://efotg.nrcs.usda.gov * Hydric "A" soil type ** Hydric "B" soil type		

3.2 Vegetation Problem Areas

There are a few weedy species occurring on the site, though none seem to be impeding the growth of woody or herbaceous hydrophytic vegetation. The weedy species are mostly annuals and seem to pose little threat to survivability on site. Commonly seen weedy vegetation includes various pasture grasses and ragweed (*Ambrosia artemisiifolia*).

For the 21 monitoring plots, survivability ranged from 400 stems per acre to 760 stems per acre with an overall average of 624 stems per acre. Based on these data, the site is on track to meet the initial vegetation survival criteria of 320 stems per acre surviving after the third growing season.

3.3 Description of Vegetation Monitoring

As a final stage of construction, the stream margins and riparian area of the Bailey Fork stream restoration site were planted with bare root trees, live stakes, and a seed mixture of permanent ground cover herbaceous vegetation. The woody vegetation was planted randomly six to eight feet apart from the top of the stream banks to the outer edge of the project's revegetation limits. The tree species planted at the site are shown in Table 6. The seed mix of herbaceous species applied to the project's riparian area included Soft rush (*Juncus effusus*), Bentgrass (*Agrostis alba),* Virginia wild rye (*Elymus virginicus),* Switch grass (*Panicum virgatum),* Gamagrass, (*Tripsicum dactyloides),* Smartweed (*Polygonum pennsylvanicum),* Little bluestem (*Schizachyrium scoparium),* Devil's beggartick (*Bidens frondosa),* Lanceleaf tickseed (*Coreopsis lanceolata),* Deertounge (*Panicum clandestinum),* Big bluestem (*Andropogon gerardii),* and Indian grass (*Sorghastrum nutans).*

This seed mixture was broadcast on the site at a rate of 15 pounds per acre. All planting was completed in April 2006.

Table 6. Tree Species Planted in the Bailey Fork Restoration Area

Bailey Fork Restoration Site: EEP Contract No. D04006-3			
ID	**Scientific Name**	**Common Name**	**FAC Status**
1	*Betula nigra*	River Birch	FACW
2	*Fraxinus pennsylvanica*	Green Ash	FACW
3	*Platanus occidentalis*	Sycamore	FACW-
4	*Quercus phellos*	Willow oak	FACW-
5	*Quercus rubra*	Red oak	FACU
6	*Quercus michauxii*	Swamp chestnut oak	FACW-
7	*Liriodendron tulipifera*	Tulip poplar	FACW
8	*Celtis laevigata*	Sugarberry	FACW
9	*Diospyros virginiana*	Persimmon	FAC
10	*Nyssa sylvatica*	Blackgum	FAC

At the time of planting, vegetation plots labeled 1 through 21 were delineated onsite to monitor survival of the planted woody vegetation. Each vegetation plot is 0.025 acre in size, or 10 meters x 10 meters. All of the planted stems inside the plot were flagged to distinguish them from any colonizing individuals and to facilitate locating them in the future.

3.4 Vegetation Success Criteria

To define vegetation success criteria objectively, specific goals for woody vegetation density have been defined. Data from vegetation monitoring plots should display a surviving tree density of at least 320 trees per acre at the end of the third year of monitoring, and a surviving tree density of at least 260, five-year-old trees per acre at the end of the five-year monitoring period. Although the select native canopy species planted throughout the site are the target

woody vegetation cover, up to 20 percent of the site's established woody vegetation at the end of the monitoring period may be comprised of invading species.

3.5 Results of Vegetative Monitoring

Table 7 presents stem counts of surviving individuals found at each of the monitoring stations at the end of Year 1 of the post-construction monitoring period. Trees within each monitoring plot are flagged regularly to prevent planted trees from losing their identifying marks due to flag degradation. It is important for trees within the monitoring plots to remain marked to ensure accurate annual stem counts and calculations of tree survivability. Volunteer individuals found within the plots are also flagged during this process. Flags are used to tag trees because they do not interfere with the growth of the tree.

3.6 Vegetation Observations

After construction of the mitigation site, a permanent ground cover seed mixture of Virginia wild rye (*Elymus virginicus*), switch grass (*Panicum virgatum*) was broadcast on the site at a rate of 15 pounds per acre.

These species are present on the site. Hydrophytic herbaceous vegetation, including Soft rush (*Juncus effusus*), spike-rush (*Eleocharis obtusa*), Boxseed (*Ludwigia* sp.), and sedge (*Carex* sp.), are observed across the site, particularly in areas of periodic inundation. The presence of these herbaceous wetland plants helps to confirm the presence of wetland hydrology on the site.

There are quite a few weedy species occurring on the site, though none seem to be impeding the growth of woody or herbaceous hydrophytic vegetation. The weedy species are mostly annuals and seem to pose very little threat to survivability on site. Commonly seen weedy vegetation includes various pasture grasses and ragweed (*Ambrosia artemisiifolia*). Any threatening weedy vegetation found in the future will be documented and discussed in future reports.

3.7 Vegetation Photos

Photos of the project showing the onsite vegetation are included in Appendix A of this report.

Table 7. Year 1 (2006) Stem Counts for Each Species Arranged by Plot.

Table 7. Year 1 Stem Counts for Each Species Arranged by Plot **Bailey Fork Restoration Site: EEP Contract No. D04006-3**																						Initial Totals	Year 1 Totals	% Survival
	Plots																							
Tree Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
Betula nigra	0	0	0	0	0	0	0	0	0	0	0	3	5	2	8	4	5	14	3	6	0	44	50	N/A
Fraxinus pennsylvanica	0	0	2	2	0	0	0	0	0	0	0	4	11	6	0	8	4	0	5	6	8	48	56	N/A
Platanus occidentalis	0	0	1	9	10	5	8	0	0	9	0	0	1	0	4	0	0	5	2	4	1	54	59	N/A
Quercus phellos	0	0	4	0	0	3	0	4	0	0	3	0	0	0	0	0	0	0	0	0	0	10	14	N/A
Quercus rubra	1	4	3	0	4	1	2	0	0	0	4	0	0	0	0	0	0	0	0	0	1	1	20	N/A
Quercus michauxii	0	0	1	0	0	0	5	2	0	0	0	2	0	0	0	0	0	0	1	0	0	9	11	N/A
Liriodendron tulipiferra	1	5	0	2	0	0	0	1	3	6	8	9	0	0	0	0	0	0	0	0	0	38	35	N/A
Celtis laevigata	4	5	0	0	0	0	0	0	3	0	0	0	0	8	3	5	3	0	2	0	5	49	38	N/A
Diospyros virginiana	0	0	2	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	N/A
Nyssa sylvatica	6	4	5	0	4	6	0	9	4	0	0	0	0	0	0	0	0	0	0	0	0	26	38	N/A
Quercus spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	N/A
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	0	N/A
Stems/plot	12	18	18	17	18	15	16	16	10	15	15	18	17	16	15	17	12	19	13	16	15	362	328	90.6
Stems/acre	480	720	720	680	720	600	640	640	400	600	600	720	680	640	600	680	480	760	520	640	600		624 (average of all plots)	

4.0 STREAM MONITORING

4.1 Description of Stream Monitoring

To document the stated success criteria, the following monitoring program was instituted following construction completion on the Bailey Fork Restoration Site:

Bankfull Events: Three crest gauges were installed on the site to document bankfull events. The gauges are checked each month to record the highest out-of-bank flow event that occurred since the last inspection. Crest gauge 1 is located on UT1 near station 25+00 (Figure 2(c)) . Crest gauge 2 is located on UT2 near station 17+00 (Figure 2(c)). Crest gauge 3 is located on UT3 near station 31+00 (Figure 2(d)).

Cross-Sections: Two permanent cross-sections were installed per 1,000 LF of stream restoration work, with one of the locations being a riffle cross-section and one location being a pool cross-section. A total of 13 permanent cross-sections were established across the site. Each cross-section was marked on both banks with permanent pins to establish the exact transect used. Permanent cross-section pins were surveyed and located relative to a common benchmark to facilitate easy comparison of year-to-year data. The annual cross-section surveys include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg. Riffle cross-sections are classified using the Rosgen stream classification system. Permanent cross-sections for 2006 (Year 1) were surveyed in October 2006.

Longitudinal Profiles: A complete longitudinal profile was surveyed following construction completion to record as-built conditions. The profile was conducted for the entire length of the restored channels (UT1, UT2, and UT3). Measurements included thalweg, water surface, bankfull, and top of low bank. Each measurement was taken at the head of the feature (e.g., riffle, pool, glide). In addition, maximum pool depths were recorded. All surveys were tied to a single, permanent benchmark.

Photo Reference Stations: Photographs are used to visually document restoration success. A total of 52 reference stations were established to document conditions at the constructed grade control structures across the site, and additional photo stations were established at each of the 13 permanent cross-sections and hydrologic monitoring stations. The GPS coordinates of each photo station were noted as additional references to ensure the same photo location is used throughout the monitoring period. Reference photos are taken at least once per year.

Each stream bank is photographed at each permanent cross-section photo station. For each stream bank photo, the photo view line follows a survey tape placed across the channel, perpendicular to flow (representing the cross-section line). The photograph is framed so that the survey tape is centered in the photo (appears as a vertical line at the center of the photograph), keeping the channel water surface line horizontal and near the lower edge of the frame. A photo log of the Bailey Fork Creek site is included in Appendix A of this report.

4.2 Stream Restoration Success Criteria

The approved Mitigation Plan requires the following criteria be met to achieve stream restoration success:

- *Bankfull Events*: Two bankfull flow events must be documented within the five-year monitoring period. The two bankfull events must occur in separate years.

- *Cross-Sections:* There should be little change in as-built cross-sections. If changes to channel cross-sections take place, they should be minor changes representing a move to increasing stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen stream classification method and all monitored cross-sections should fall within the quantitative parameters defined for "C" type channels.
- *Longitudinal Profiles:* The longitudinal profiles should show that the bedform features are remaining stable (not aggrading or degrading). The pools should remain deep with flat water surface slopes and the riffles should remain steeper and shallower than the pools. Bedforms observed should be consistent with those observed in "C" type channels.
- *Photo Reference Stations*: Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and effectiveness of erosion control measures. Photos should indicate the absence of developing bars within the channel, no excessive bank erosion or increase in channel depth over time, and maturation of riparian vegetation.

4.3 Bankfull Discharge Monitoring Results

The onsite crest gauge documented the occurrence of at least two bankfull flow events during the first year (2006) of the post-construction monitoring period, as shown in Table 8. Inspection of conditions during a site visit revealed visual evidence of out-of-bank flow, confirming the crest gauge reading. The largest onsite stream flow documented by the crest gauge during Year 1 of monitoring was approximately 3.6 feet (43.2 inches) above the bankfull stage and was the result of overbank flooding of both Bailey Fork and Silver Creek.

Table 8. Verification of Bankfull Events

Bailey Fork Restoration Site : EEP Contract No. D04006-3			
Date of Data Collection	Date of Ocurrence of Bankfull Event	Method of Data Collection	Photo # or Measurement
8/18/2006	Unknown	Crest Gage 1 UT1	0.14
8/18/2006	Unknown	Crest Gage 2 UT2	0.14
8/18/2006	Unknown	Crest Gage 3 UT3	1.68 ft.
10/11/2006	Unknown	Debris Line	Photo # 53
10/11/2006	Unknown	Debris Line	Photo # 54
11/29/2006	Unknown	Crest Gage 3 UT3	0.23
11/29/2006	Unknown	Crest Gage 1 UT1	0.22
11/29/2006	Unknown	Crest Gage 2 UT2	0.4

4.4 Stream Monitoring Data and Photos

A photo log of the project showing each of the 52 photo point locations is included in Appendix A of this report. Data and photos from each permanent cross-section are included in Appendix B of this report.

4.5 Stream Stability Assessment

Table 9 presents a summary of the results obtained from the visual inspection of in-stream structures performed during Year 1 of post-construction monitoring. The percentages noted are a general overall field evaluation of the how the features were performing at the time of the photo point survey.

Table 9. Categorical Stream Feature Visual Stability Assessment

Bailey Fork Creek Mitigation Site: EEP Contract No. D04006-3						
	Performance Percentage					
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
Riffles	100%	100%				
Pools	100%	100%				
Thalweg	100%	100%				
Meanders	100%	100%				
Bed General	100%	100%				
Vanes / J Hooks etc.	100%	100%				
Wads and Boulders	100%	100%				

4.6 Stream Stability Baseline

The quantitative pre-construction, reference reach, and design data used to determine mitigation approach and prepare the construction plans for the project are summarized in Table 10. The as-built baseline data that determines stream stability during the project's post construction monitoring period are also summarized in Appendix C.

4.7 Cross-section Monitoring Results

Year 1 cross-section monitoring data for stream stability were collected during October 2006 and compared to baseline stream geometry data collected in April 2006 (as-built conditions).

The 13 permanent cross-sections along the restored channels (7 located across riffles and 6 located across pools) were re-surveyed to document stream dimension at the end of monitoring Year 1. Data from each of these cross-sections are summarized in Appendix D. The cross-sections show that there has been very little adjustment to stream dimension since construction.

Cross-sections 2, 5, 8, and 12 are located across pools found at the apex of a meander bend. Survey data from all these sections indicate the development of point bar features on the inside bank of the meander bend. Flow through a meander bend possesses higher conveyance velocity along its boundary with the outer bank of the bend, and lower flow velocity along its boundary with the bend's inner bank. As flow velocity reduces, its sediment transport capacity also reduces, causing flow to drop some of its transported sediment as it slows down. Point bar formation along the inside of a meander bend indicates flow velocity vectors occurring as designed, and is therefore expected. All monitored cross-sections fell within the quantitative parameters defined for "C" type channels.

In-stream structures installed within the restored stream included constructed riffles, rock cross vanes, a rock step-pool, log vanes, log weirs, and root wads. A constructed riffle and a rock step-pool installed on the lower end of UT1, and a constructed riffle installed at the lower end of UT3 step down the elevation of the restored stream bed to match the existing channel invert at the confluences of the restored channels and Bailey Fork. Visual observations of these structures throughout the Year 1 growing season have indicated that all structures are functioning as designed and holding their elevation grade. Log vanes placed in meander pool areas have provided scour to keep pools deep and provide cover for fish. Log weirs placed in riffle areas have maintained riffle elevations and provided a downstream scour hole which provides habitat. Root wads placed on the outside of meander bends have provided bank stability and in-stream cover for fish and other aquatic organisms.

Photographs of the channel were taken throughout the monitoring season to document the evolution of the restored stream geometry (see Appendix A). Herbaceous vegetation is dense along the edges of the restored stream, making it difficult in some areas to photograph the stream channel.

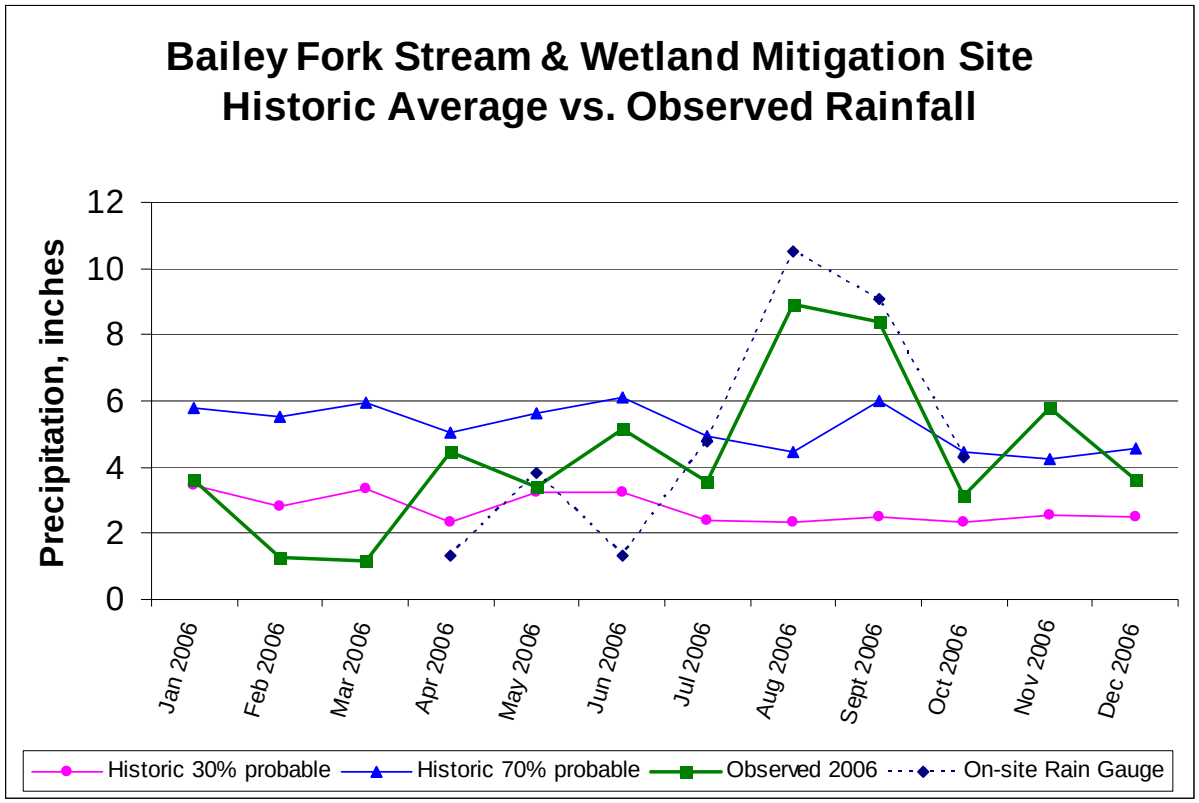
5.0 HYDROLOGY

Weather station data from the Morganton Weather Station (Morganton, NC UCAN: 14224, COOP: 315838) were used in conjunction with a manual rain gauge located on the site to document precipitation amounts. The manual gauge is used to validate observations made at the automated station. For the 2006 growing season, total rainfall during the monitoring period was on track with the normal average (approximately 0.82 inches less from October 2005 through October 2006). Much of the rain that fell during the 2006 growing season fell during the months of June, August, and September when evapotranspiration losses were highest (Table 10 and Figure 3).

Table 10. Comparison of Historic Rainfall to Observed Rainfall

Comparison of Historic Average Rainfall to Observed Rainfall (Inches)				
Month	**Average**	**30%**	**70%**	**Observed 2006 Precipitation**
January	4.43	3.45	5.79	**3.61**
February	4.14	2.83	5.53	**1.25**
March	4.85	3.36	5.94	**1.16**
April	3.79	2.36	5.06	**4.46**
May	4.49	3.22	5.62	**3.41**
June	4.74	3.25	6.12	**5.14**
July	3.91	2.38	4.95	**3.58**
August	3.74	2.36	4.45	**8.92**
September	4.18	2.48	5.98	**8.39**
October	3.84	2.03	4.76	**3.12**
November	3.79	2.55	4.27	**5.79**
December	3.72	2.48	4.59	**3.63**
Total:	49.62		Total:	**52.46**

Figure 3. Historic Average vs. Observed Rainfall



The restoration plan for the Bailey Fork Site specifies that eight monitoring wells (four automated and four manual) would be established across the restored site. A total of eight wells (four automated and four manual) were installed during early-March 2006 to document water table hydrology in all required monitoring locations. All wells are located in the restored wetland areas adjacent to UT3, and the locations of monitoring wells are shown on the as-built plan sheets. Hydrologic monitoring results are shown in Table 11. A photo log of the wetland well monitoring stations is included in Appendix A of this report.

Table 11. Hydrologic Monitoring Results for 2006 (Year 1)

Bailey Fork Restoration Site: EEP Contract No. D04006-3			
Monitoring Station	Most Consecutive Days Meeting Criteria[1]	Cumulative Days Meeting Criteria[2]	Number of Instances Meeting Criteria[3]
AW1	37 (18%)	52 (25%)	7
AW2	41 (20%)	65 (31%)	5
AW3	53 (26%)	94 (45%)	2
AW4	31 (15%)	98 (47%)	7
MW1[4]	41 (20%)	65 (31%)	5
MW2[4]	41 (20%)	65 (31%)	5
MW3[5]	53 (26%)	94 (45%)	2
MW4[6]	31 (15%)	98 (47%)	7

[1] Indicates the most consecutive number of days within the monitored growing season with a water table less than 12 inches form the soil surface.

[2] Indicates the cumulative number of days within the monitored growing season with a water table less than 12 inches from the soil surface.

[3] Indicates the number of instances within the monitored growing season when the water table rose to less than 12 inches from the soil surface.

[4] Groundwater gauge MW1 and MW2 are manual gauges. Hydrologic parameters are estimated based on data from gauge AW2.

[5] Groundwater gauge MW3 is a manual gauge. Hydrologic parameters are estimated based on data from gauge AW3.

[6] Groundwater gauge MW4 is a manual gauge. Hydrologic parameters are estimated based on data from gauge AW4.

6.0 OVERALL CONCLUSIONS AND RECOMMENDATIONS

Vegetation Monitoring. There are a few weedy species occurring on the site, though none seem to be impeding the growth of woody or herbaceous hydrophytic vegetation. The weedy species are mostly annuals and seem to pose little threat to survivability on site.

For the 21 monitoring plots, survivability ranged from 400 stems per acre to 760 stems per acre with an overall average of 624 stems per acre. Based on these data, the site is on track to meet the initial vegetation survival criteria of 320 stems per acre surviving after the third growing season.

Stream Monitoring. The total length of stream channel restored on the site was 6,097 feet. This entire length was inspected during Year 1 of the monitoring period (2006) to assess stream performance. Based on the data collected, all riffles, pools, and other constructed features along the restored channel are stable and functioning as designed. The lack of problem areas along the length of the restored channel after the occurrence of at least one river flow larger than bankfull discharge further supports functionality of the design. It is expected that stability and in-stream habitat of the system will improve in the coming years as permanent vegetation becomes more established.

Hydrologic Monitoring. First year hydrologic monitoring has shown that the required wetland hydrology criteria of a hydroperiod of 7 percent of the growing season has been achieved throughout the site. All eight hydrology monitoring gauges recorded consecutive hydroperiods for at least 15 percent of the growing season.

7.0 WILDLIFE OBSERVATIONS

Observations of deer and raccoon tracks are common on the Bailey Fork Site. During certain times of the year, frogs, turtles, fish, and also wild turkeys, have been periodically observed.

8.0 REFERENCES

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. NCDEHNR. Raleigh, NC.

USDA, NC Agricultural Experiment Station, *Soil Survey of Burke County, North Carolina*, 2006.

FIGURES

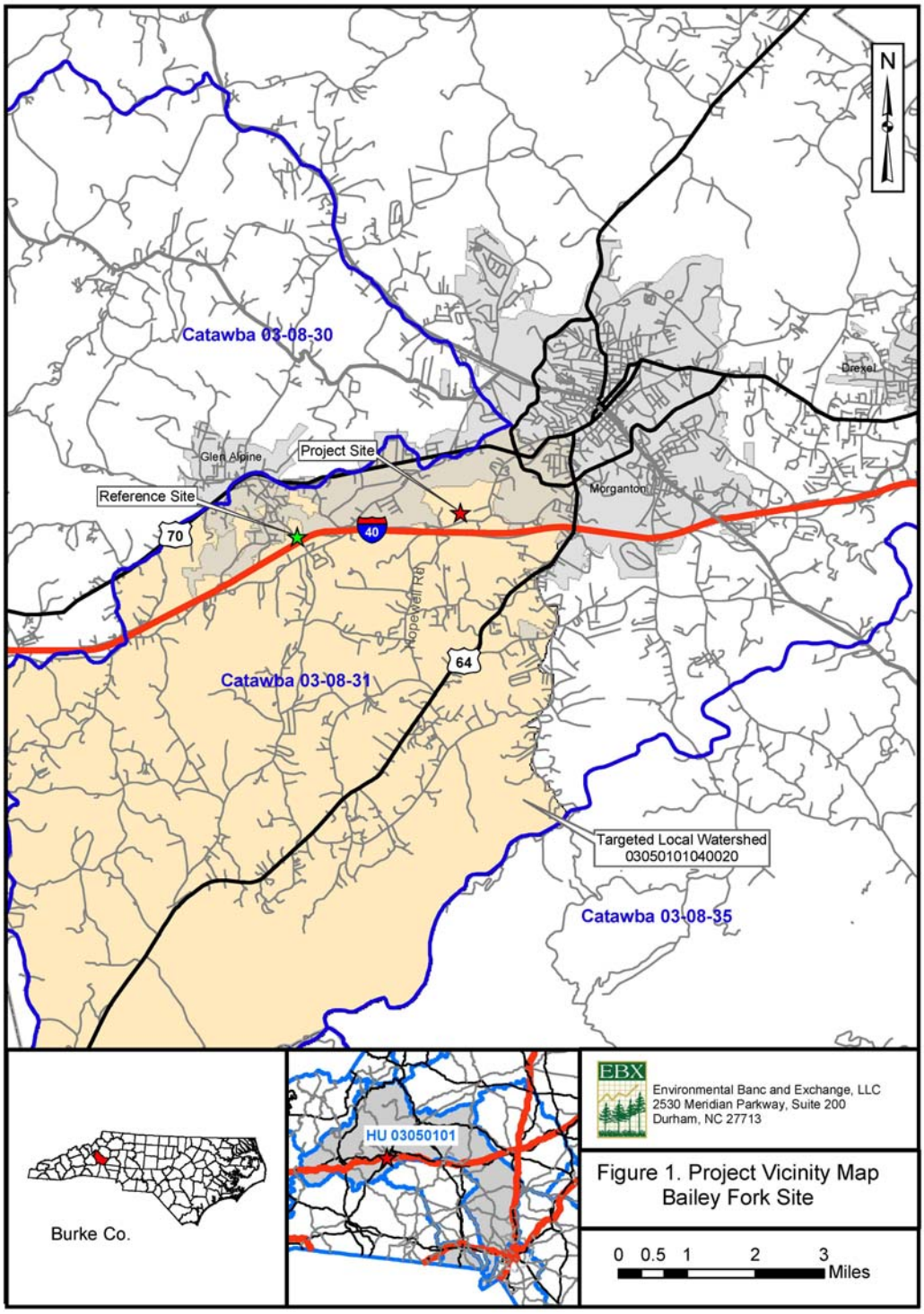


Figure 1. Location of Bailey Fork Creek Stream Mitigation Site.

2/26/03

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0221R	13

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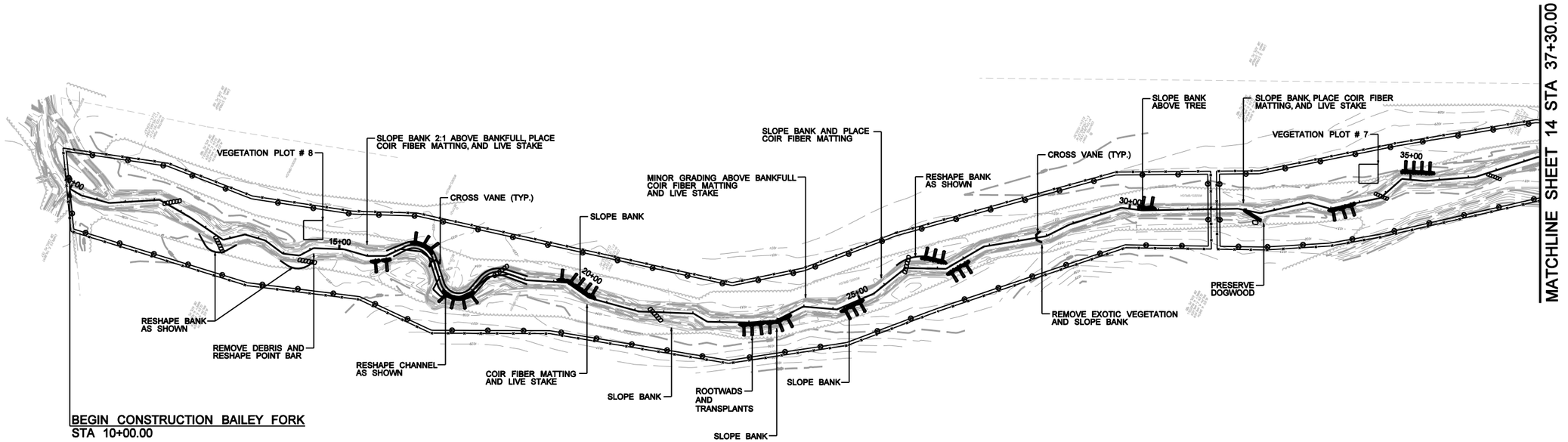

Figure 2 (a)

PLAN VIEW

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SCALE (FT)

12/14/2006
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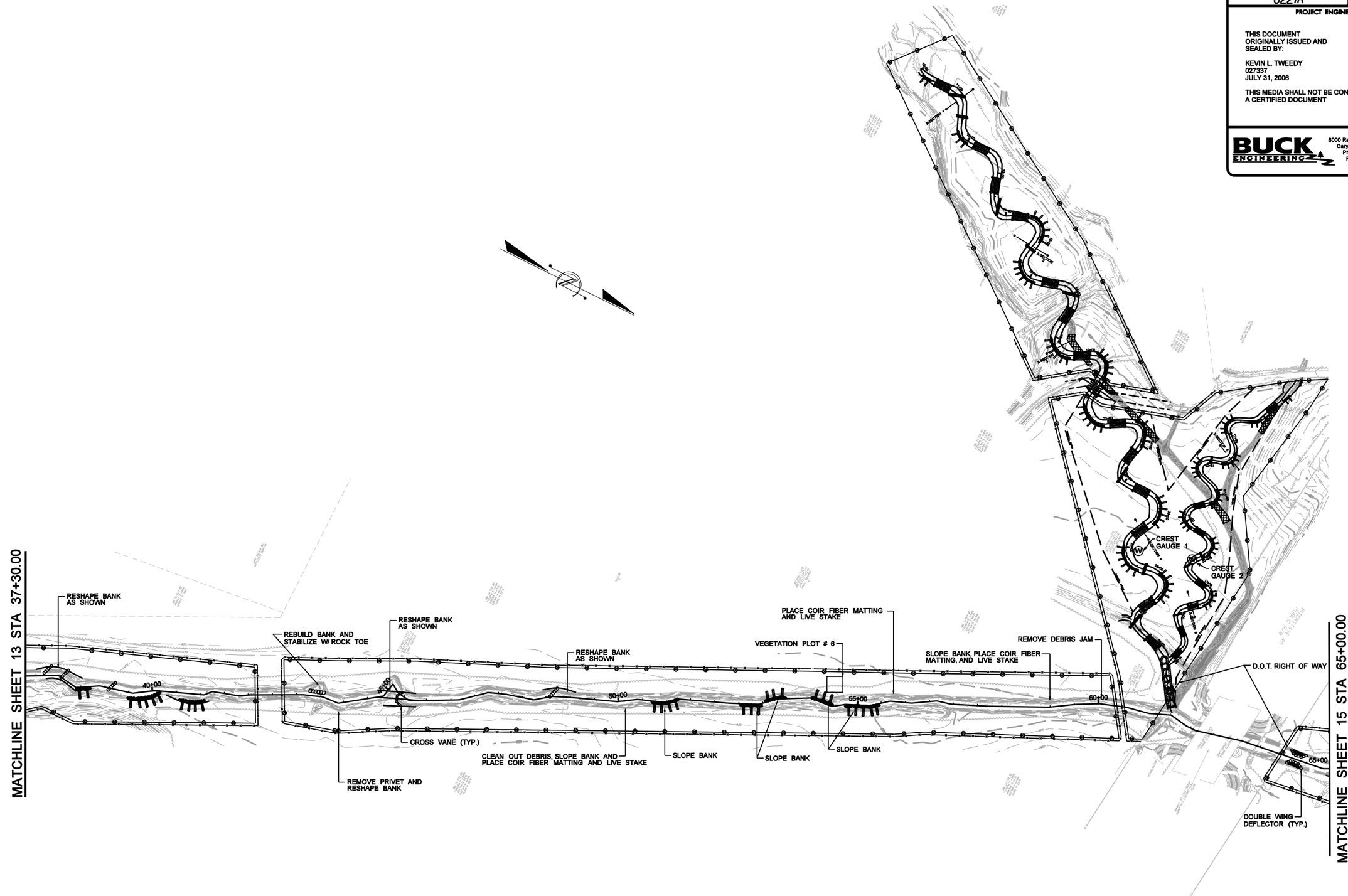

Figure 2 (b)

12/4/2006
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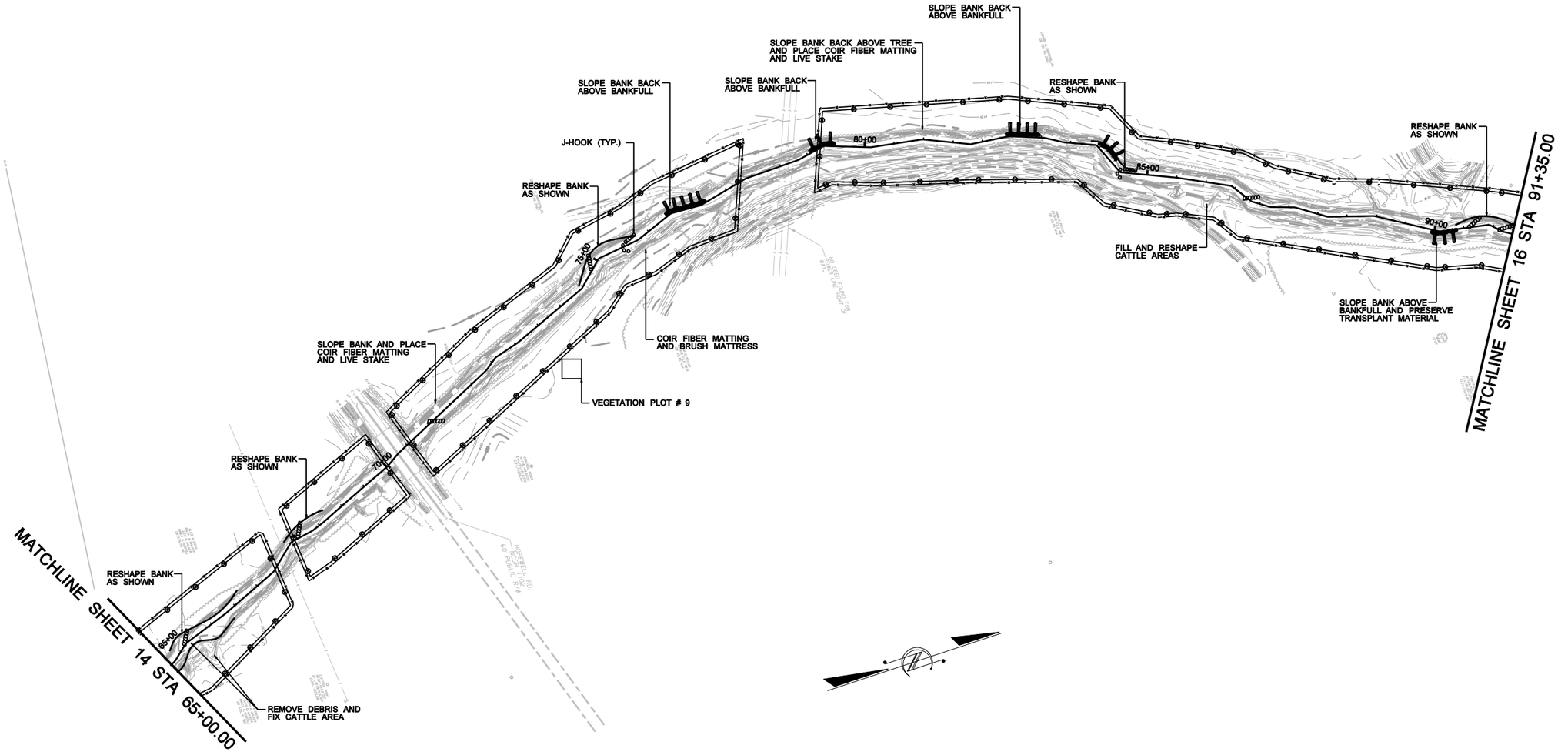

Figure 2 (c)

PLAN VIEW

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SCALE (FT)

2/26/03

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MATCHLINE SHEET 15 STA 91+35.00

END CONSTRUCTION BAILEY FORK
STA 104+72.48

GATE

VEGETATION PLOT # 10

GATE

SLOPE BANK, PLACE COIR FIBER MATTING, LIVE STAKE, AND TRANSPLANTS

SLOPE BANK, PLACE COIR FIBER MATTING, AND LIVE STAKE

SLOPE BANK, PLACE COIR FIBER MATTING, AND LIVE STAKE

SLOPE BANK ABOVE BANKFULL AND PLACE COIR FIBER MATTING AND LIVE STAKE

VEGETATION PLOT # 11

1 FOOT HIGH BERM

AUTOMATIC WELL 4

MANUAL WELL 4

GATE

AUTOMATIC WELL 3

MANUAL WELL 3

CREST GAUGE 3

AUTOMATIC WELL 2

MANUAL WELL 2

MANUAL WELL 1

AUTOMATIC WELL 1

FILL EXISTING CHANNEL

EXISTING WETLAND

PLAN VIEW

100 50 0 100 200
SCALE (FT)

Figure 2 (d)

12/4/2006
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APPENDIX A

PROJECT PHOTO LOG

VEGETATION PHOTOS

Photo 1 - Bailey Fork Vegetation Plot 1

Photo 2 - Bailey Fork Vegetation Plot 2

Photo 3 - Bailey Fork Vegetation Plot 3

Photo 4 - Bailey Fork Vegetation Plot 4

Photo 5 - Bailey Fork Vegetation Plot 5

Photo 6 - Bailey Fork Vegetation Plot 6

Photo 7 - Bailey Fork Vegetation Plot 7

Photo 8 - Bailey Fork Vegetation Plot 8

Photo 9 - Bailey Fork Vegetation Plot 9

Photo 10 - Bailey Fork Vegetation Plot 10

Photo 11 - Bailey Fork Vegetation Plot 11

Photo 12 - Bailey Fork Vegetation Plot 12

Photo 13 - Bailey Fork Vegetation Plot 13

Photo 14 - Bailey Fork Vegetation Plot 14

Photo 15 - Bailey Fork Vegetation Plot 15

Photo 16 - Bailey Fork Vegetation Plot 16

Photo 17 - Bailey Fork Plot Vegetation 17

Photo 18 - Bailey Fork Vegetation Plot 18

Photo 19 - Bailey Fork Vegetation Plot 19

Photo 20 - Bailey Fork Vegetation Plot 20

Photo 21 - Bailey Fork Vegetation Plot 21

STREAM PHOTOS AND WETLAND PHOTOS

Photo 1 - Constructed Riffle 1 – UT3

Photo 2 - Constructed Riffle 2 – UT3

Photo 3 - Constructed Riffle 3 – UT3

Photo 4 - Constructed Riffle 4 – UT3

Photo 5 - Constructed Riffle 5 – UT3

Photo 6 - Constructed Riffle 6 – UT3

Photo 7 - Constructed Riffle 7 – UT3

Photo 8 - Constructed Riffle 8 – UT3

Photo 9 - Constructed Riffle 9 – UT3

Photo 10 - Constructed Riffle 10 – UT3

Photo 11 - Constructed Riffle 11 – UT3

Photo 12 - Constructed Riffle 12 – UT3

Photo 13 - Constructed Riffle 13 – UT3

Photo 14 - Constructed Riffle 14 – UT2

Photo 15 - Constructed Riffle 15 – UT2

Photo 16 - Constructed Riffle 16 – UT2

Photo 17 - Constructed Riffle 17 – UT2

Photo 18 - Constructed Riffle 18 – UT2

Photo 19 - Constructed Riffle 19 – UT2

Photo 20 - Constructed Riffle 20 – UT2

Photo 21 - Constructed Riffle 21 – UT2

Photo 22 - Constructed Riffle 22 – UT1

Photo 23 - Constructed Riffle 23 – UT1

Photo 24 - Constructed Riffle 24 – UT1

Photo 25 - Constructed Riffle 25 – UT1

Photo 26 - Constructed Riffle 26 – UT1

Photo 27 - Constructed Riffle 27 – UT1

Photo 28 - Constructed Riffle 28 – UT1

Photo 29 - Constructed Riffle 29 – UT1

Photo 30 - Constructed Riffle 30 – UT1

Photo 31 - Constructed Riffle 31 – UT1

Photo 32 - Constructed Riffle 32 – UT1

Photo 33 - Cross Vane 1 – Bailey Fork

Photo 34 - Cross Vane 2 – Bailey Fork

Photo 35 - Log Weir 1 – UT3

Photo 36 - Log Weir 2 – UT3

Photo 37 - Log Weir 3 – UT3

Photo 38 - Log Weir 4 – UT3

Photo 39 - Log Weir 5 – UT3

Photo 40 - Log Weir 6 – UT3

Photo 41 - Log Weir 7 – UT3

Photo 42 - Log Weir 8 – UT3

Photo 43 - Log Weir 9 – UT3

Photo 44 - Log Weir 10 – UT3

Photo 45 - Log Weir 11 – UT3

Photo 46 - Log Weir 12 – UT3

Photo 47 - Log Weir 13 – UT3

Photo 48 - Log Weir 14 – UT2

Photo 49 - Log Weir 15 – UT2

Photo 50 - Log Weir 16 – UT1

Photo 51 - Log Weir 17 – UT1

Photo 52 - Step Pool – UT1

Photo 53 – Bankfull Evidence Near CR8

Photo 54 – Bankfull Evidence Near LW12

Photo 55 - Auto Well 1 - East

Photo 56 - Auto Well 1 - North

Photo 57 - Auto Well 1 – South

Photo 58 - Auto Well 1 - West

Photo 59 - Auto Well 2 - East

Photo 60 - Auto Well 2 - North

Photo 61 - Auto Well 2 - South

Photo 62 - Auto Well 2 - West

Photo 63 - Auto Well 3 - East

Photo 64 - Auto Well 3 - North

Photo 65 - Auto Well 3 - South

Photo 66 - Auto Well 3 - West

Photo 67 - Auto Well 4 - East

Photo 68 - Auto Well 4 - North

Photo 69 - Auto Well 4 - South

Photo 70 - Auto Well 4 - West

Photo 71 - Manual Well 1 - East

Photo 72 - Manual Well 1 - North

Photo 73 - Manual Well 1 - South

Photo 74 - Manual Well 1 - West

Photo 75 - Manual Well 2 - East

Photo 76 - Manual Well 2 - North

Photo 77 - Manual Well 2 - South

Photo 78 - Manual Well 2 - West

Photo 79 - Manual Well 3 - East

Photo 80 - Manual Well 3 - North

Photo 81 - Manual Well 3 - South

Photo 82 - Manual Well 3 - West

Photo 83 - Manual Well 4 - East

Photo 84 - Manual Well 4 - North

Photo 85 - Manual Well 4 – South

Photo 86 - Manual Well 4 - West

Photo 87 – Bar Deposition near Beginning of UT3

APPENDIX B

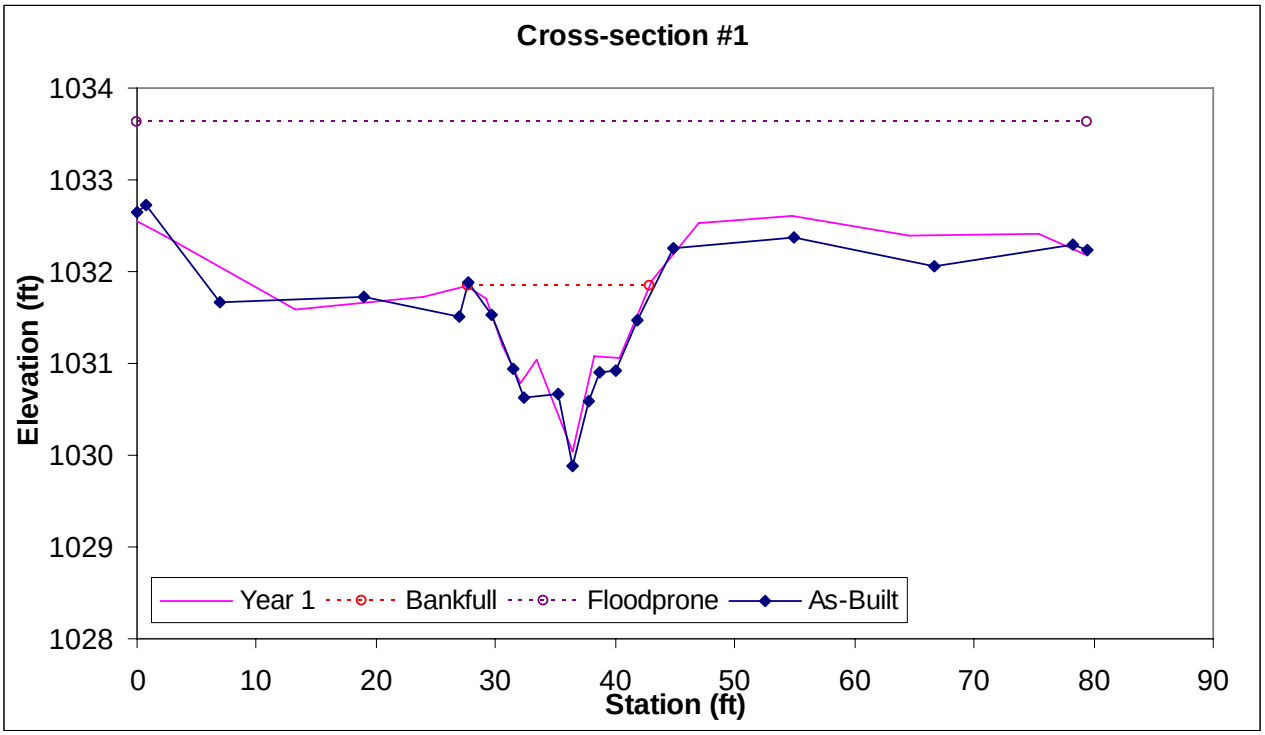
STREAM MONITORING DATA

Permanent Cross-section #1
Bailey Fork Site - Unnamed Tributary 1
(Year 1 Data - collected Oct. 2006)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	12	15.25	0.79	1.79	1.79	19.3	5.2	1031.84	1031.85

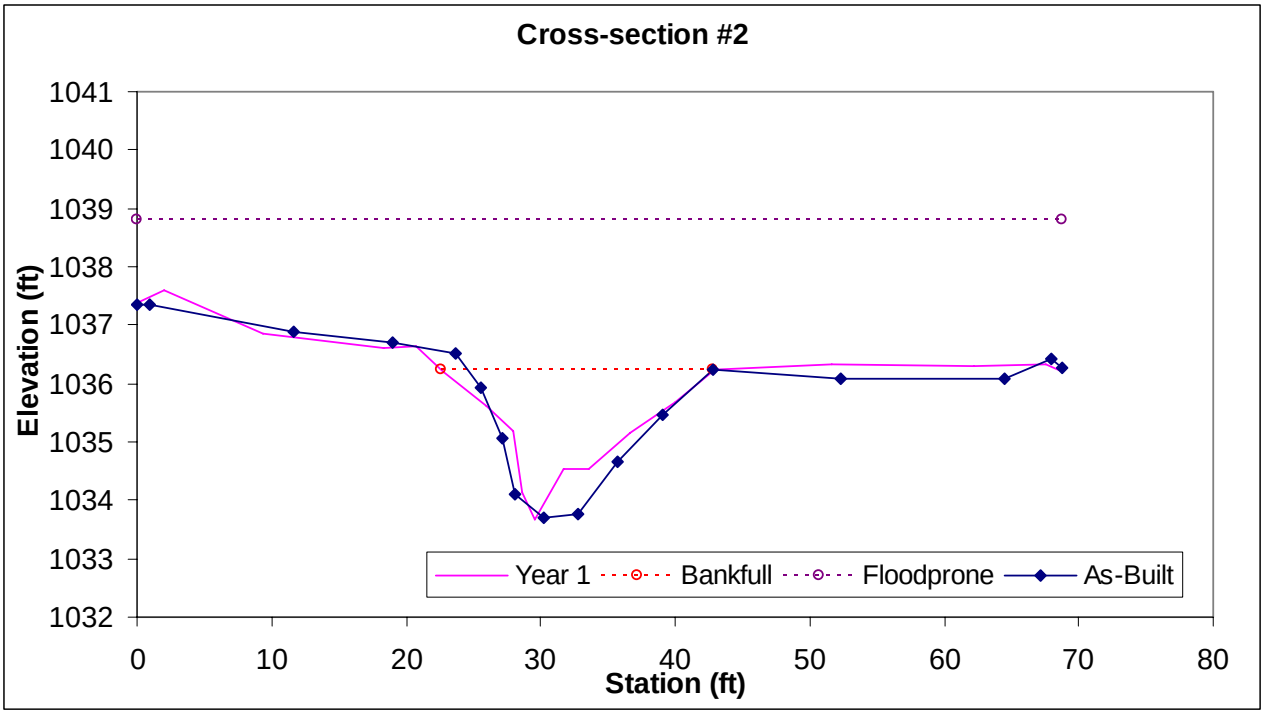


Permanent Cross-section #2
Bailey Fork Site - Unnamed Tributary 1
(Year 1 Data - collected Oct. 2006)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		21.3	20.19	1.06	2.56	19.1	1	3.4	1036.23	1036.2

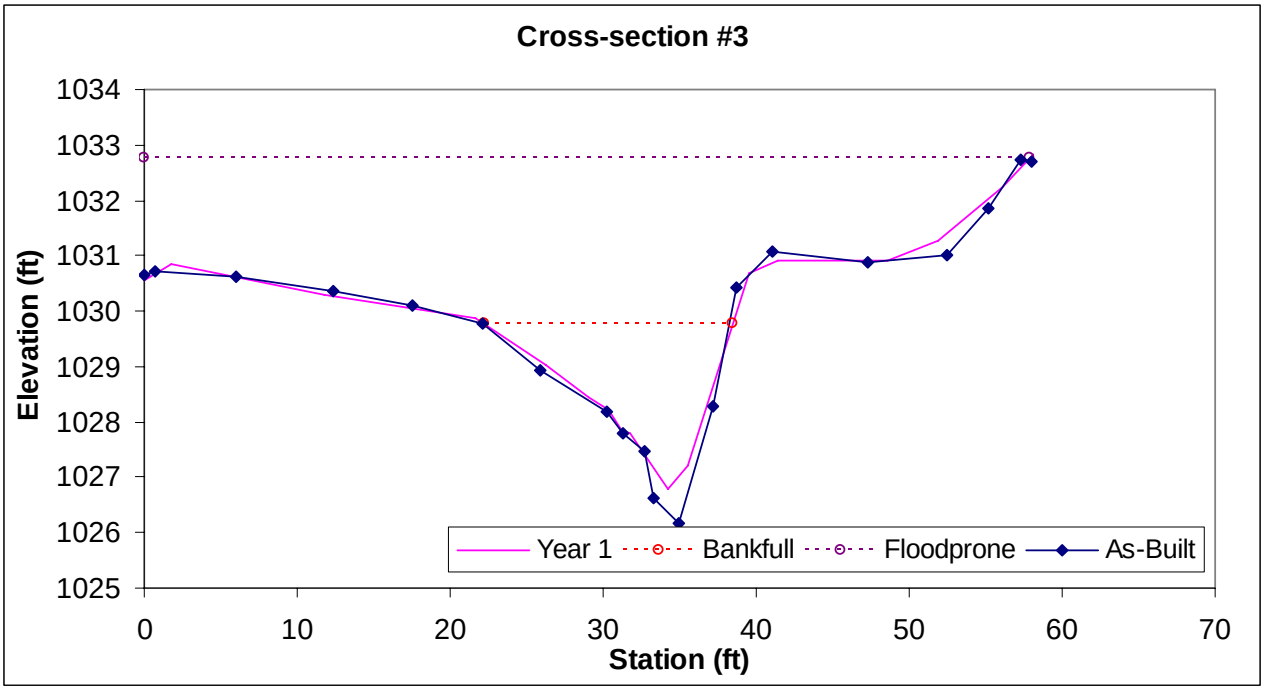


Permanent Cross-section #3
Bailey Fork Site - Unnamed Tributary 1
(Year 1 Data - collected Oct. 2006)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		22.4	16.29	1.37	2.99	11.87	1	3.6	1029.78	1029.89

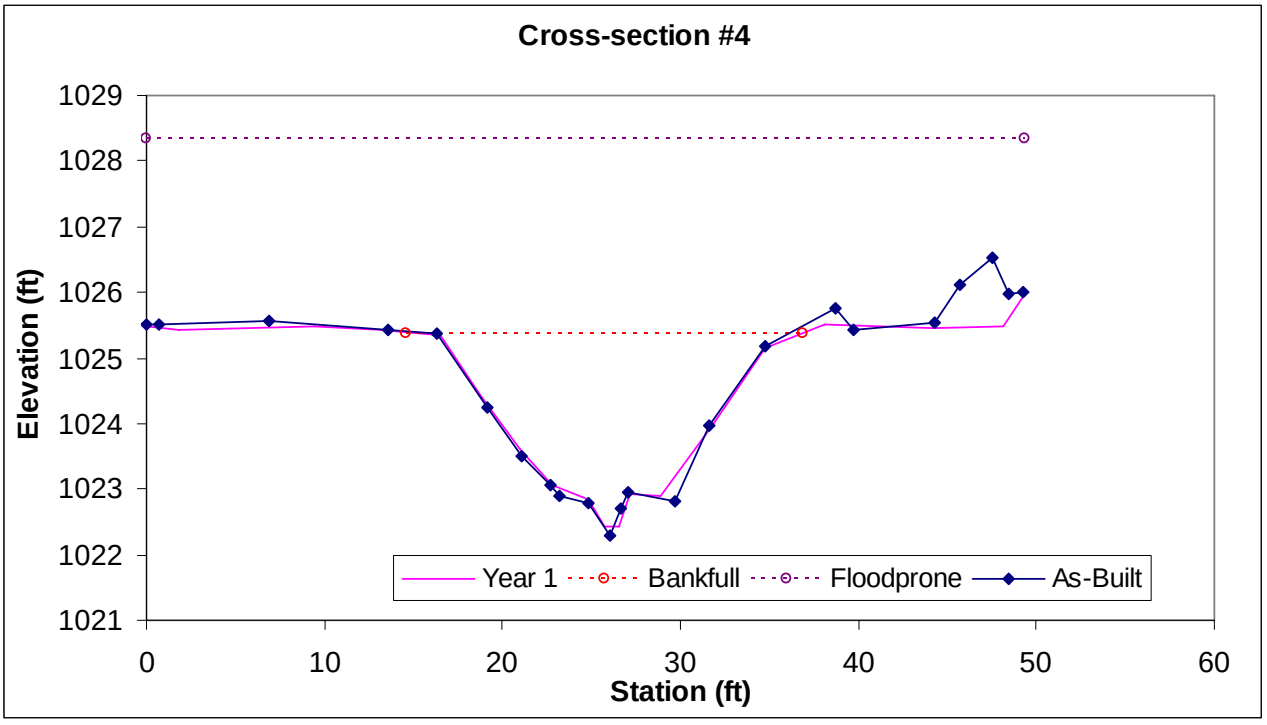


Permanent Cross-section #4
Bailey Fork Site - Unnamed Tributary 1
(Year 1 Data - collected Oct. 2006)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	32	22.25	1.44	2.96	15.48	1	2.2	1025.38	1025.33

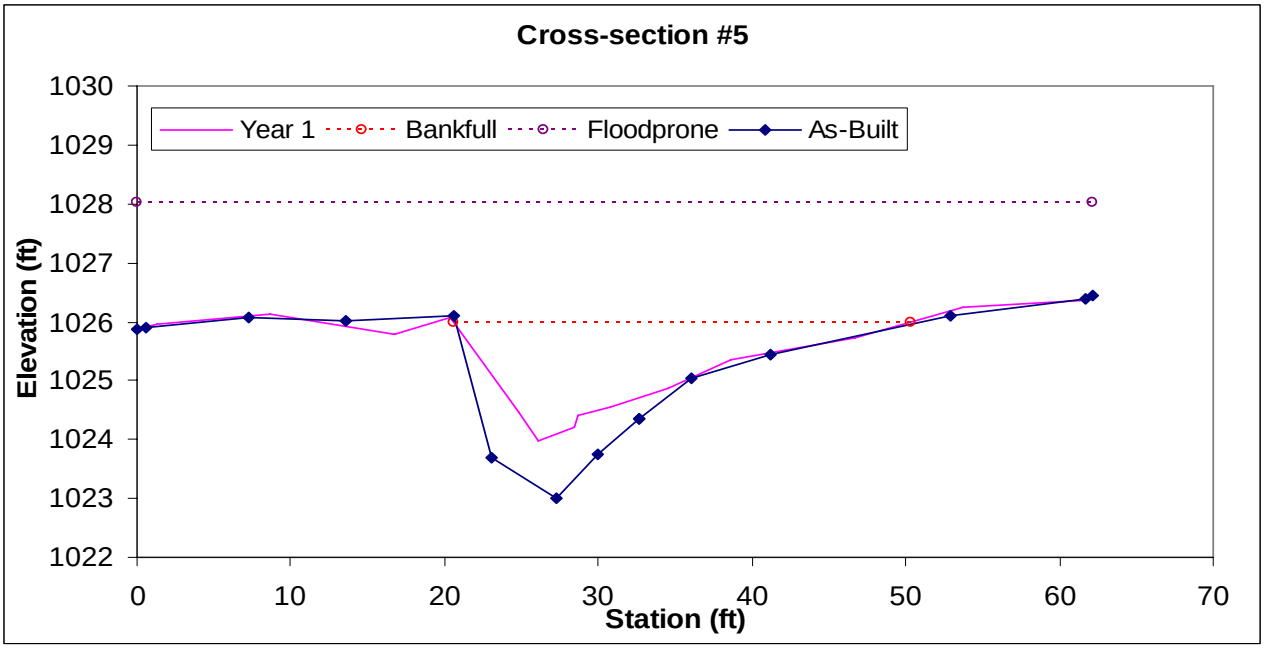


Permanent Cross-section #5
Bailey Fork Site – Unnamed Tributary 2
(Year 1 Data - collected Oct. 2006)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		26.2	29.75	0.88	2.01	33.81	1	2.1	1026	1026.08

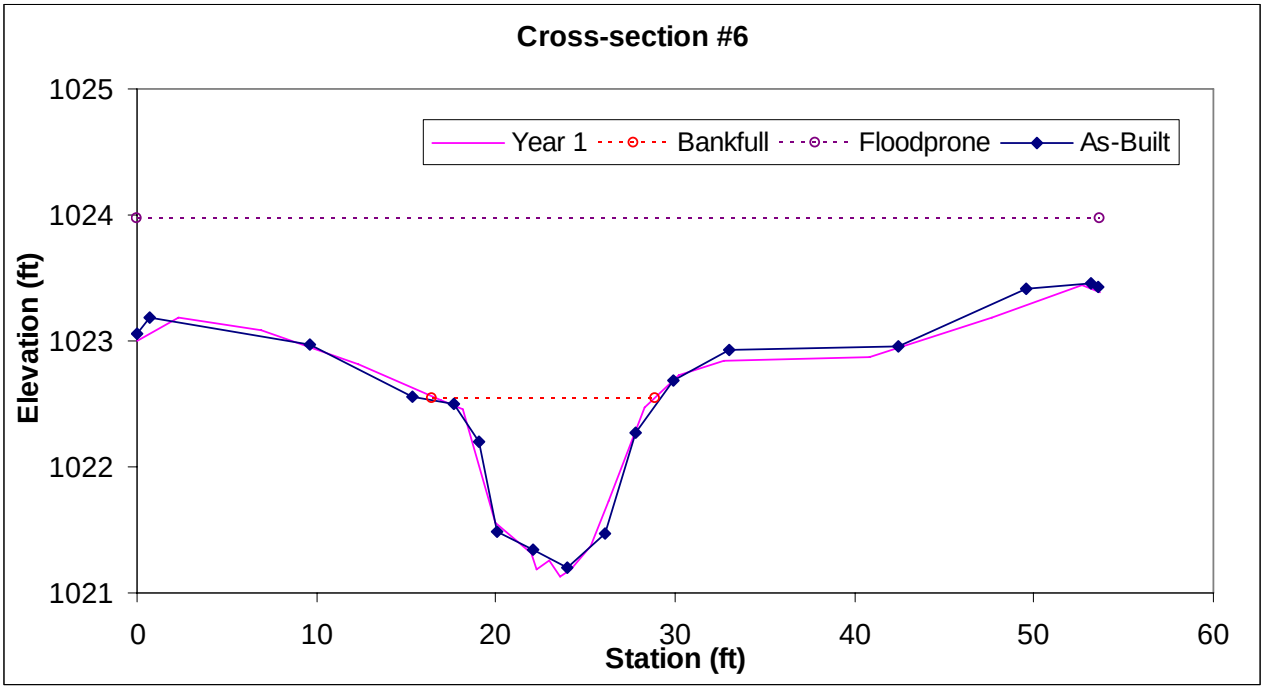


Permanent Cross-section #6
Bailey Fork Site – Unnamed Tributary 2
(Year 1 Data - collected Oct. 2006)

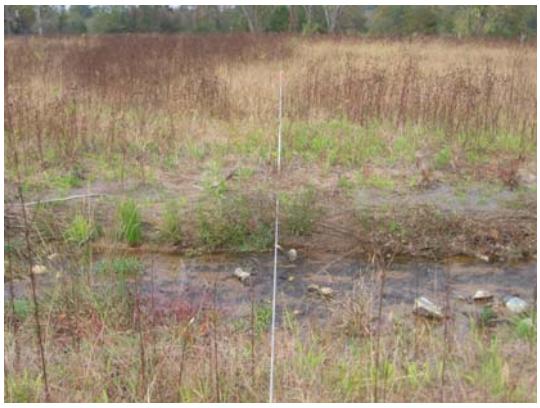
Looking at the Left Bank

Looking at the Right Bank

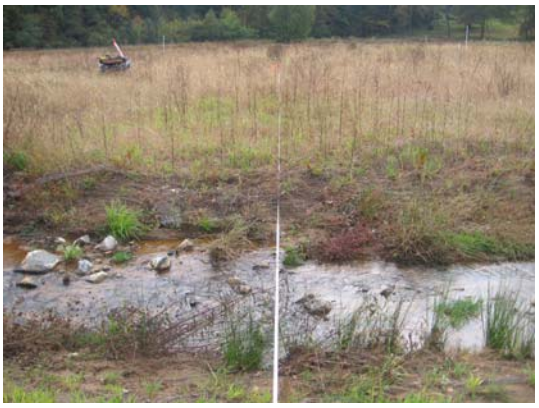
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	9.6	12.41	0.78	1.42	15.98	1	4.3	1022.55	1022.52



Permanent Cross-section #7
Bailey Fork Site - Unnamed Tributary 3
(Year 1 Data - collected Oct. 2006)

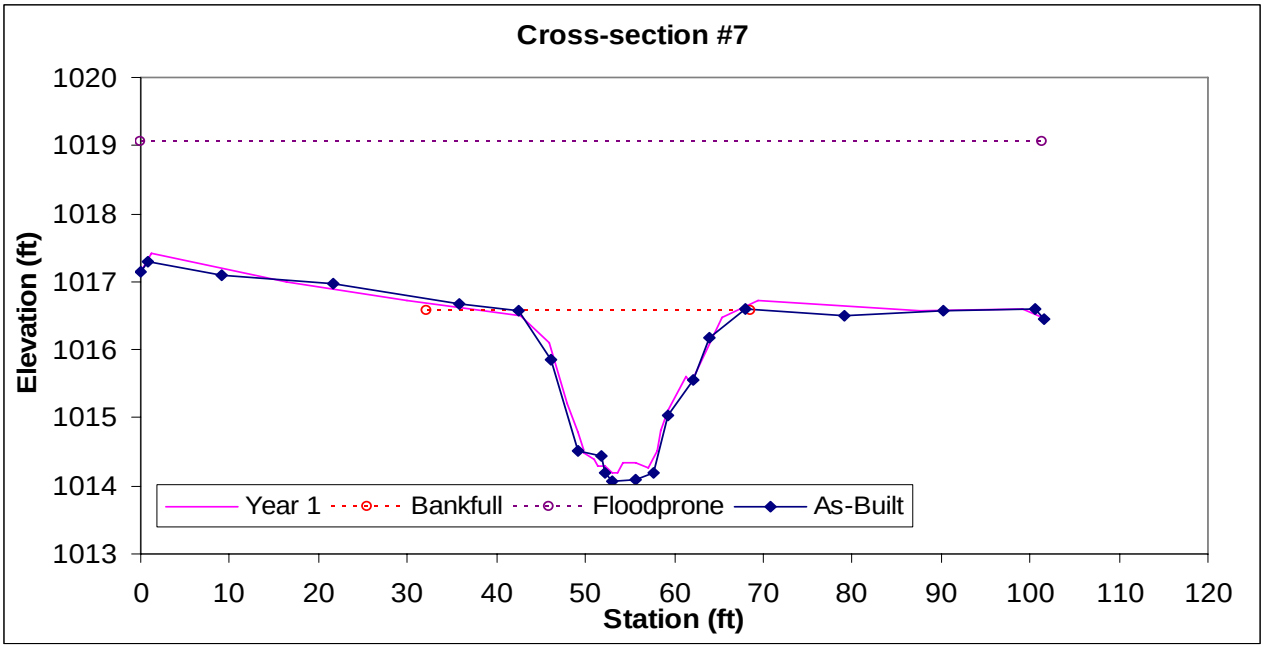


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	29.40	22.4	1.31	2.29	37.72	1.1	>4.5	1016.38	1016.61

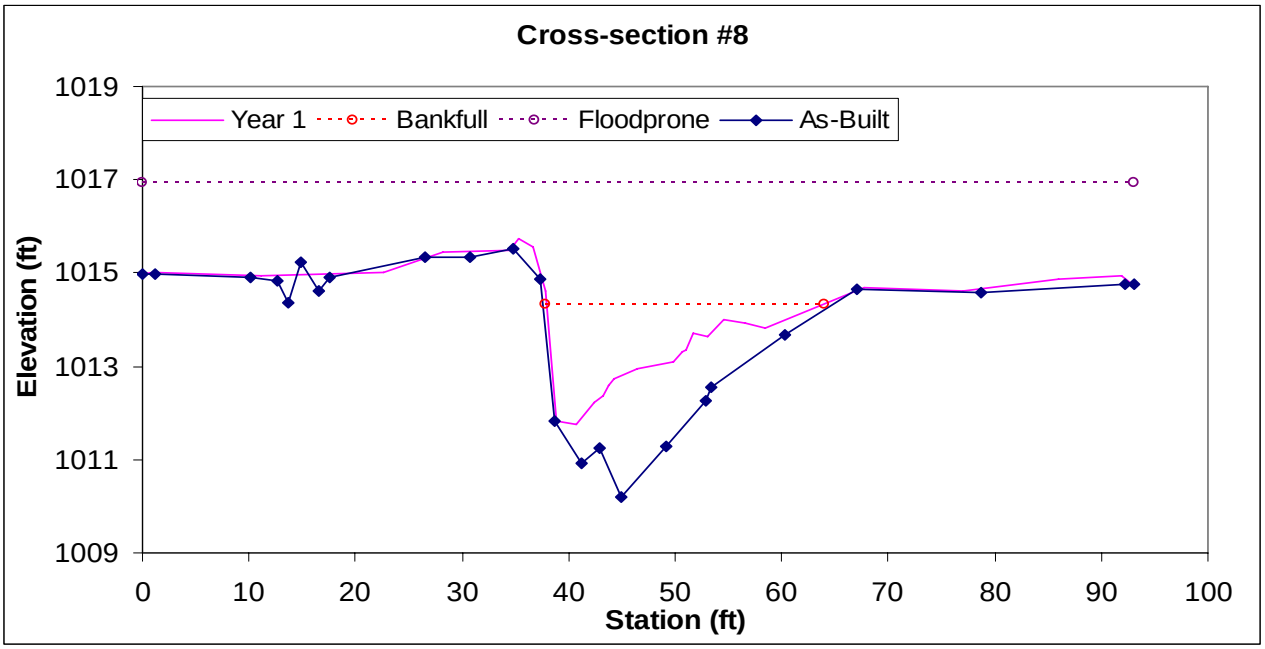


Permanent Cross-section #8
Bailey Fork Site - Unnamed Tributary 3
(Year 1 Data - collected Oct. 2006)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		27.7	26.14	1.06	2.58	24.65	1.1	3.6	1014.34	1014.68

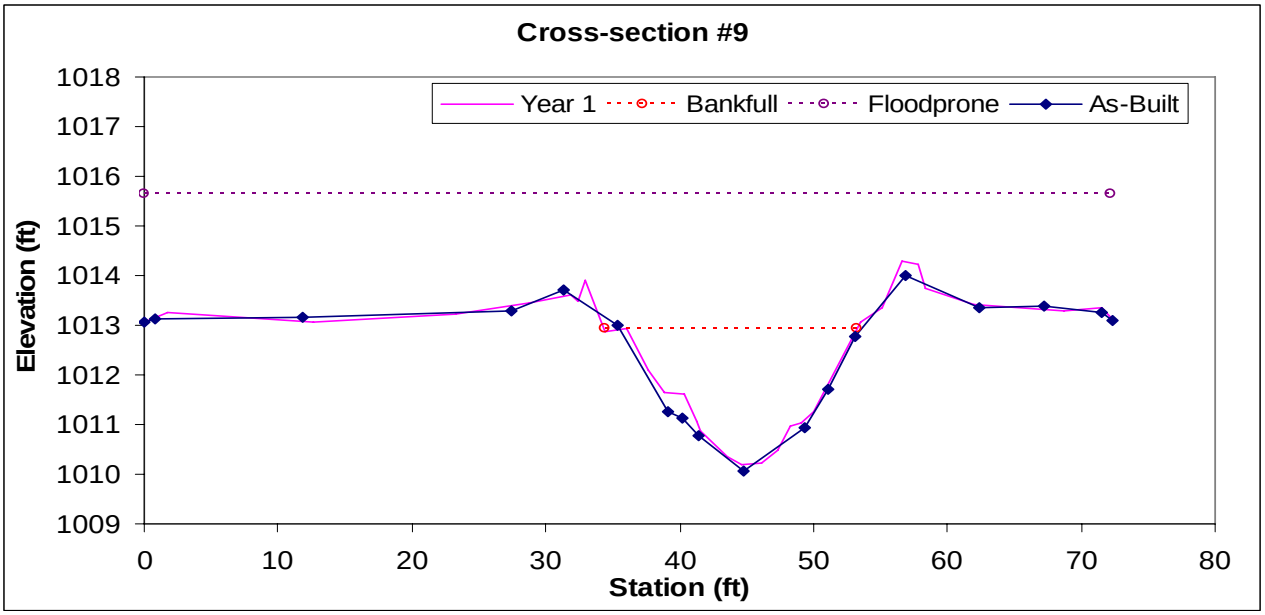


Permanent Cross-section #9
Bailey Fork Site - Unnamed Tributary 3
(Year 1 Data - collected Oct. 2006)

Looking at the Left Bank

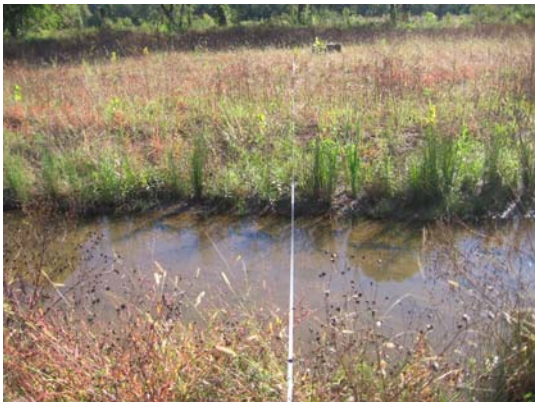
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	28.43	18.81	1.51	2.74	12.4	1.4	3.2	1012.92	1013.91



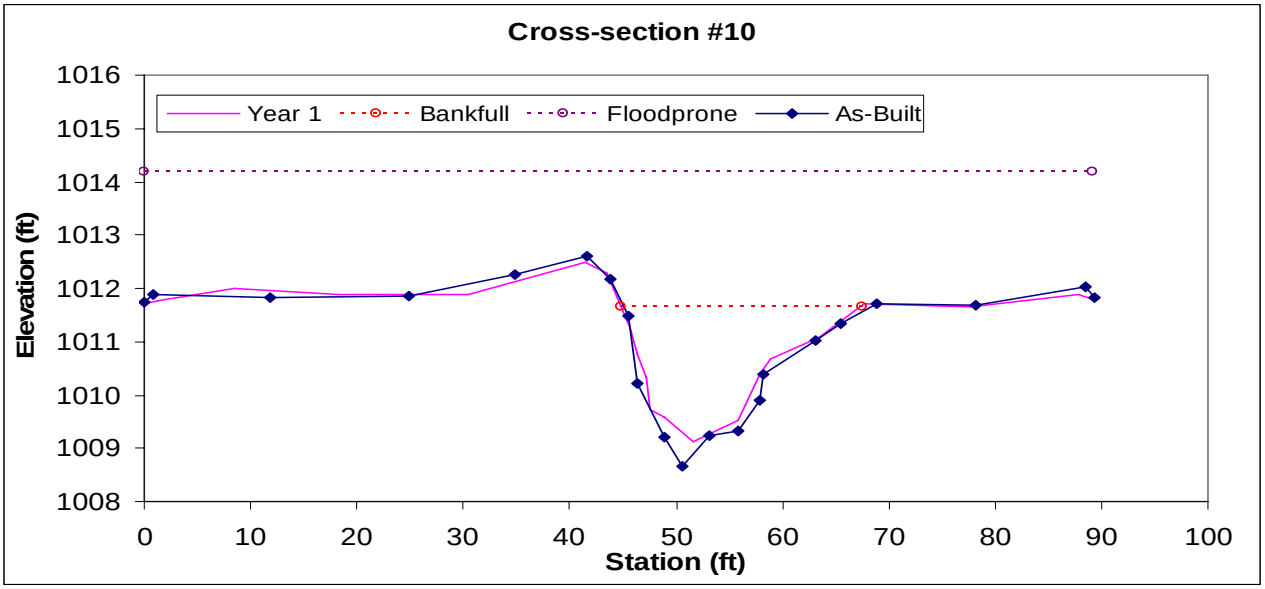
Permanent Cross-section #10
Bailey Fork Site - Unnamed Tributary 3
(Year 1 Data - collected Oct. 2006)

Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		30	22.62	1.32	2.54	17.08	1	3.9	1011.65	1011.7

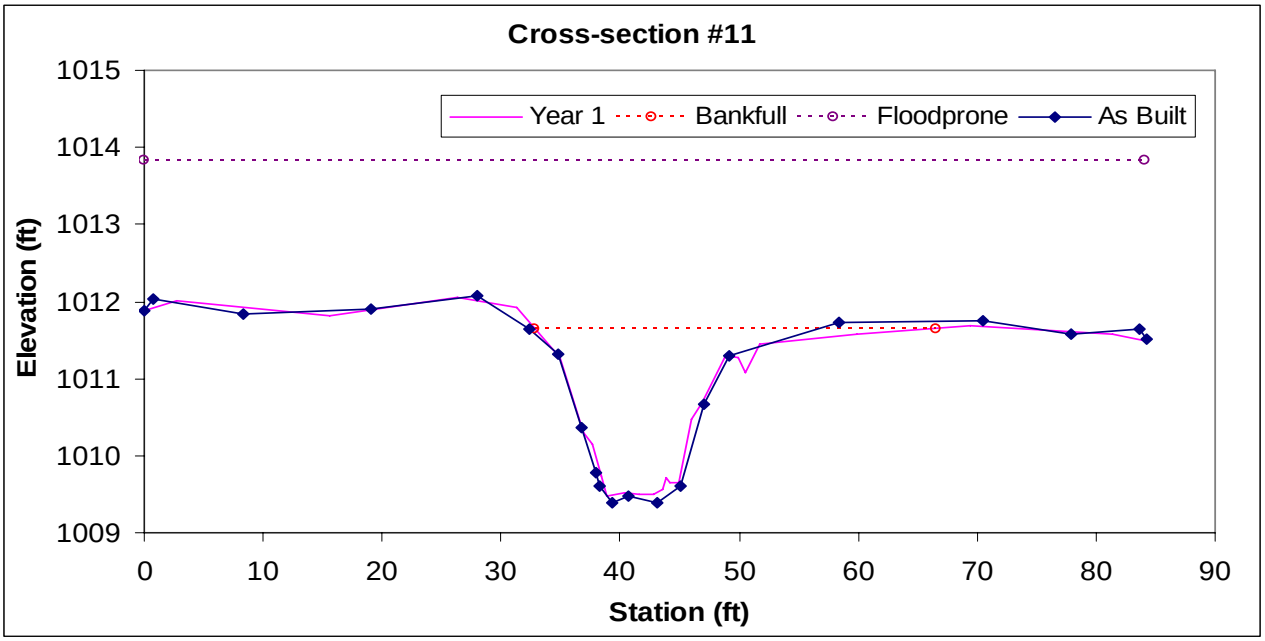


Permanent Cross-section #11
Bailey Fork Site - Unnamed Tributary 3
(Year 1 Data - collected Oct. 2006)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	24.6	33.77	0.73	2.17	46.36	1	2.5	1011.65	1011.68

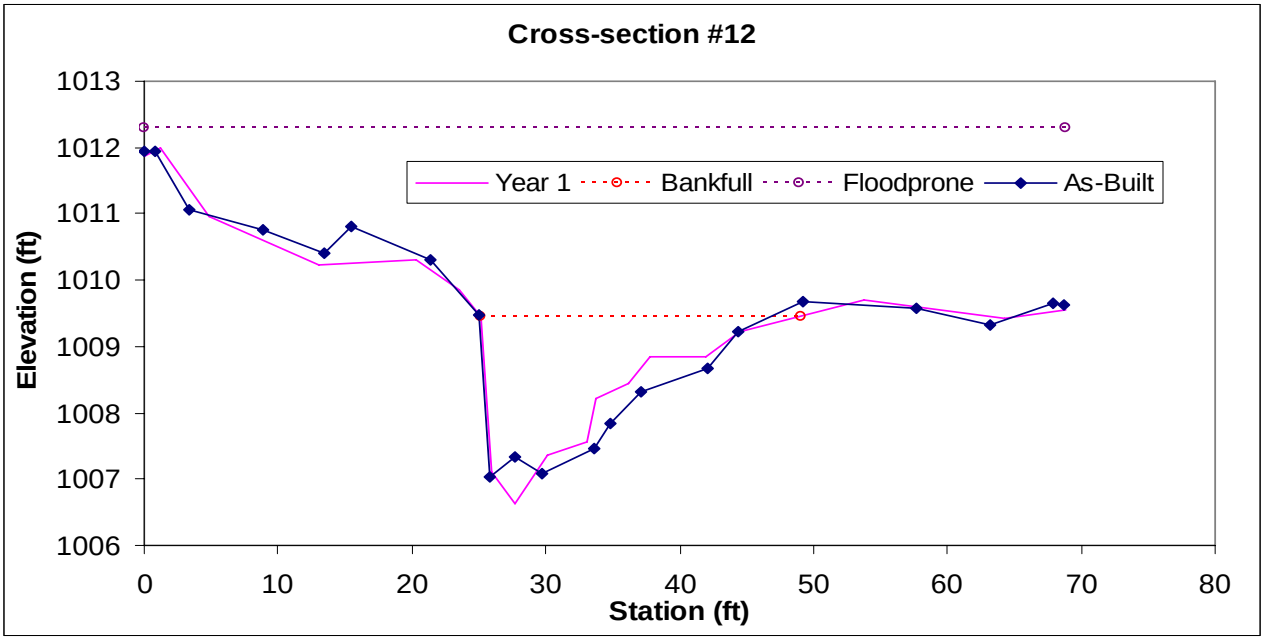


Permanent Cross-section #12
Bailey Fork Site - Unnamed Tributary 3
(Year 1 Data - collected Oct. 2006)

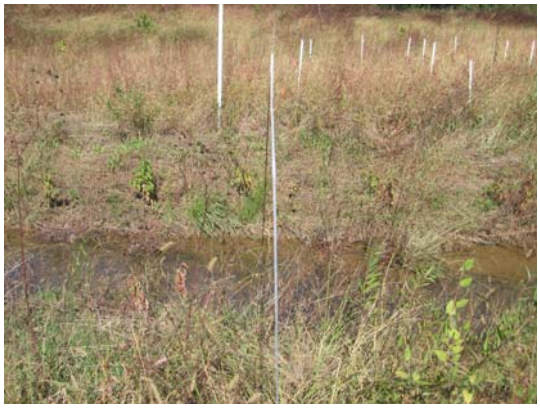
Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		26.6	23.85	1.12	2.83	21.36	1.1	2.9	1009.46	1009.71



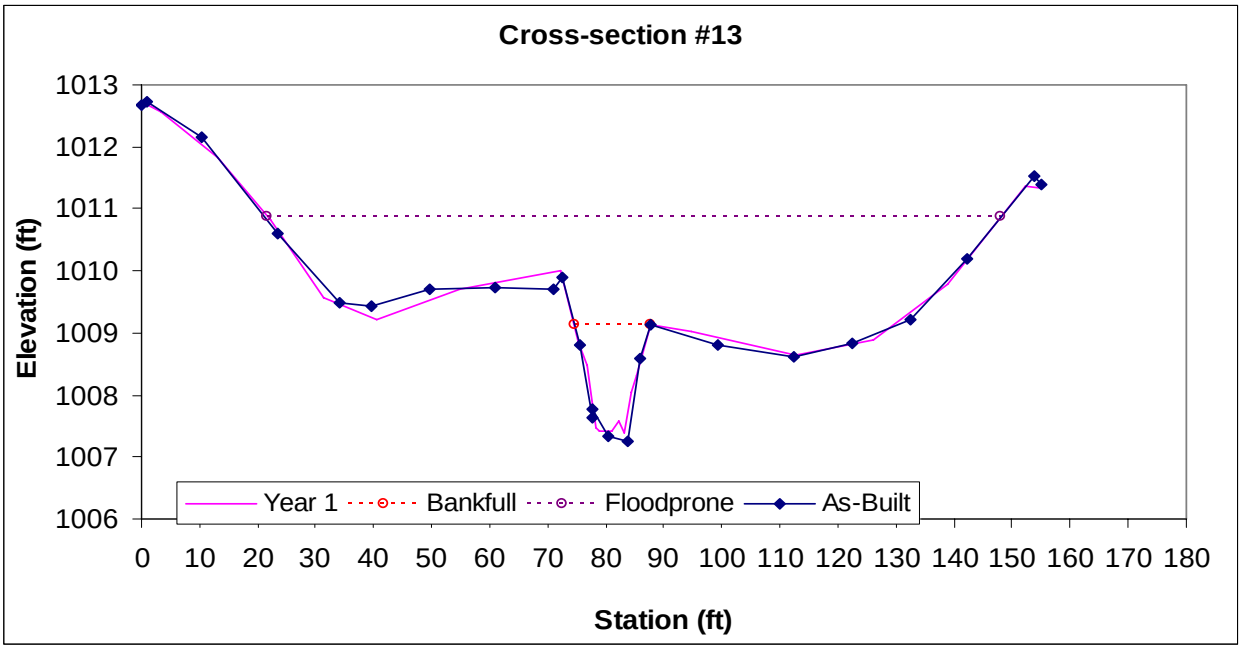
Permanent Cross-section #13
Bailey Fork Site - Unnamed Tributary 3
(Year 1 Data - collected Oct. 2006)

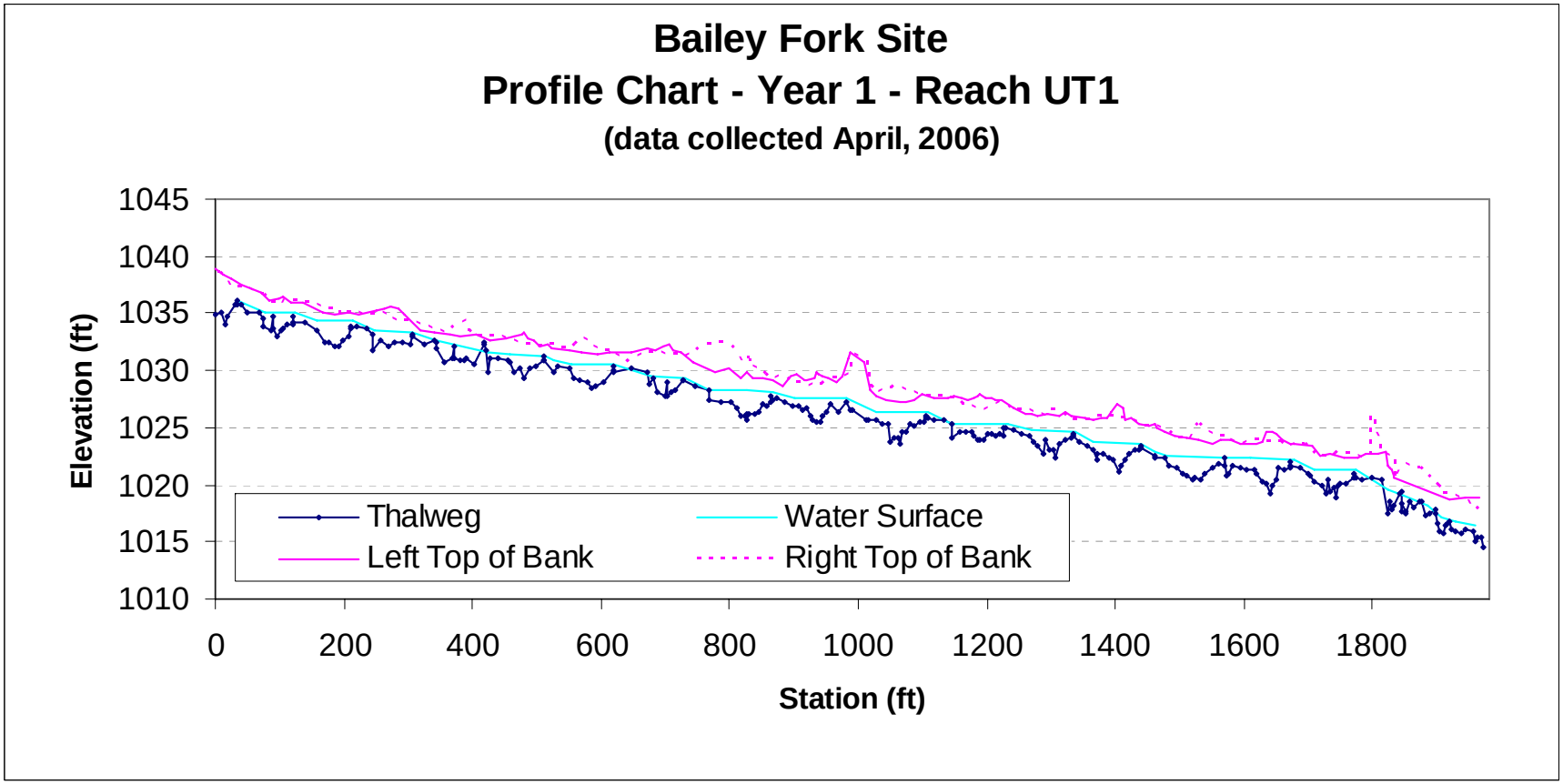


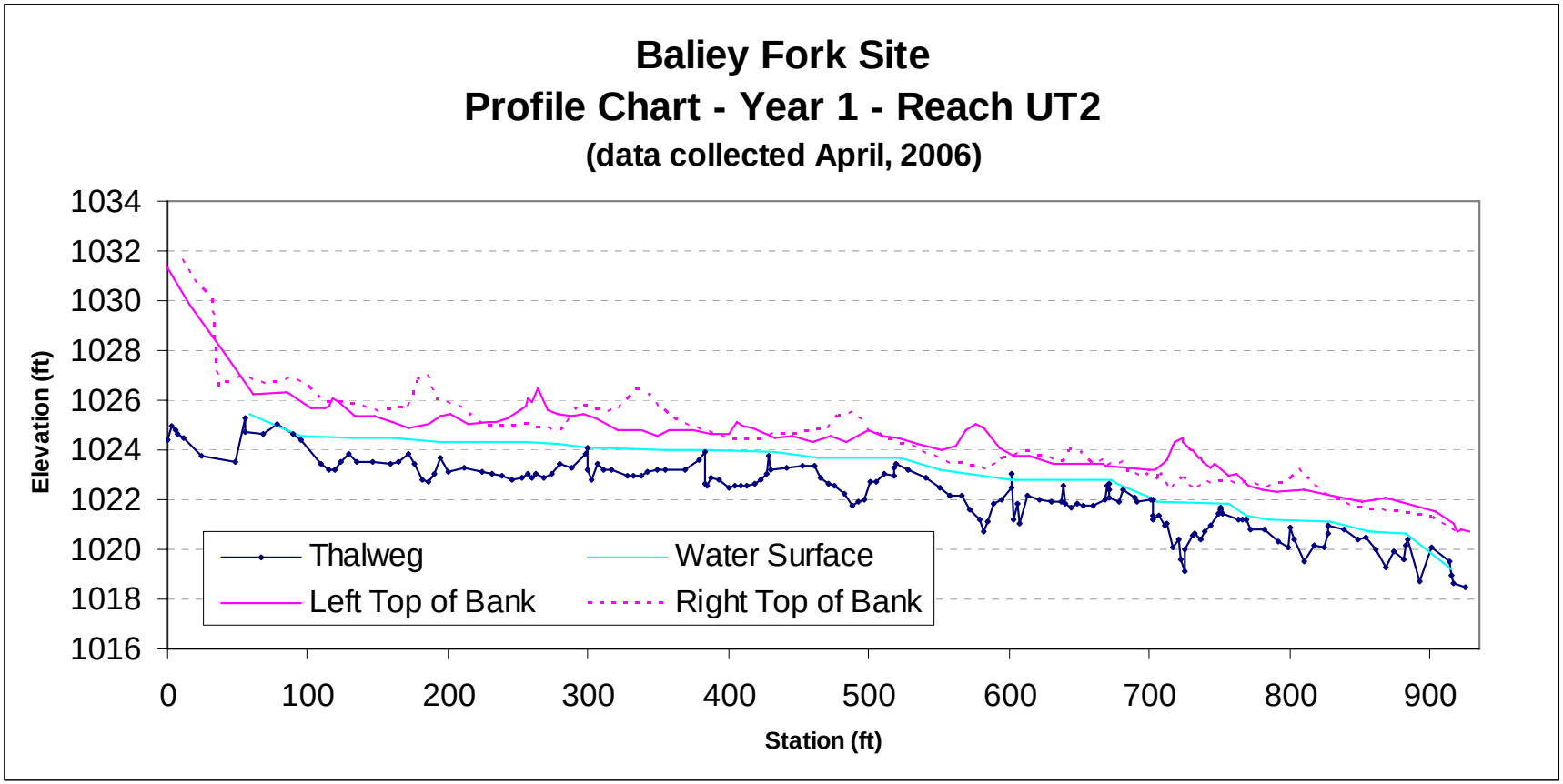
Looking at the Left Bank

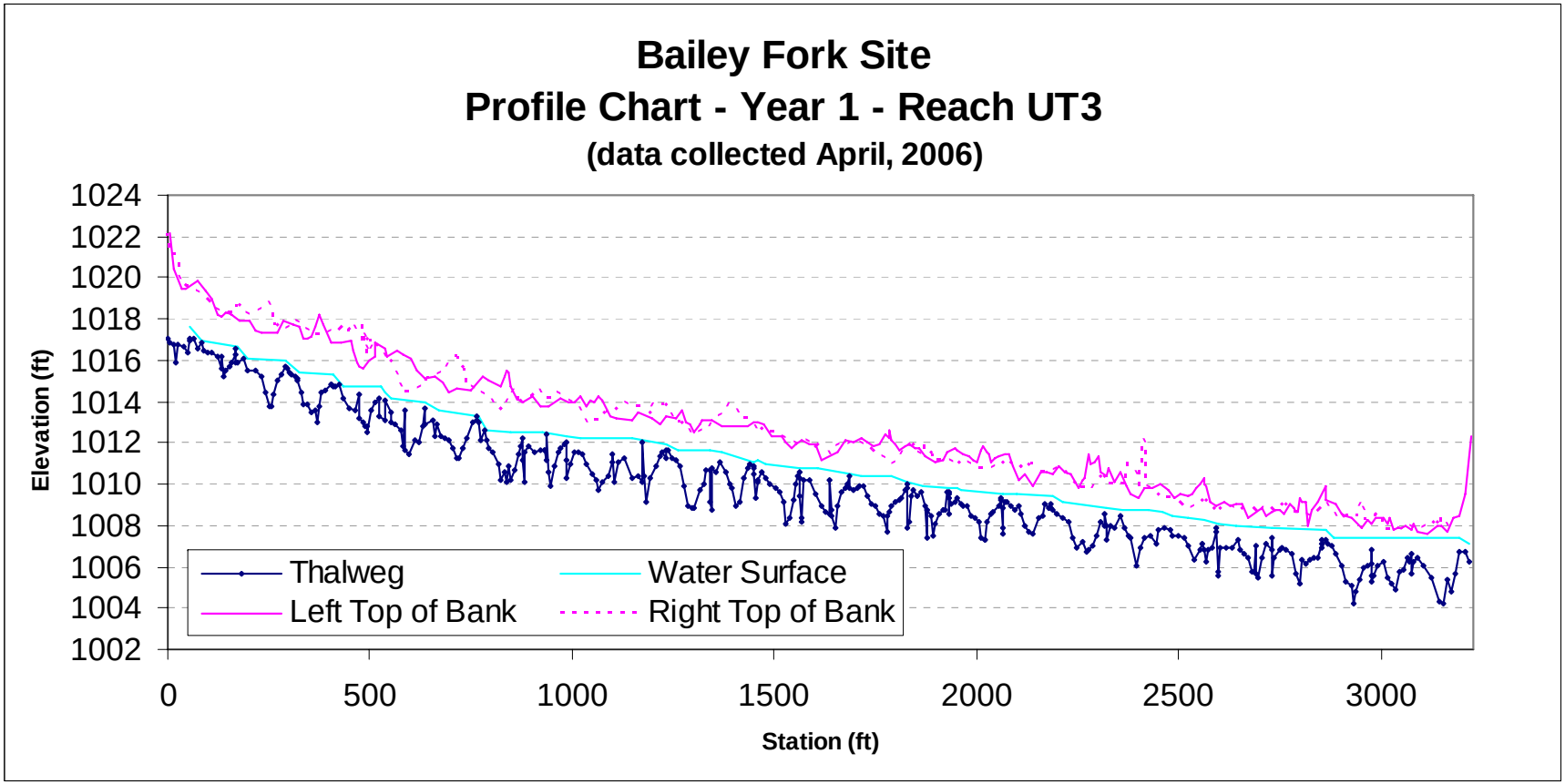
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	14.3	13.09	1.09	1.74	12	1	9.7	1009.14	1009.14




Bailey Fork Site
Profile Chart - Year 1 - Reach UT1
(data collected April, 2006)
Elevation (ft)
1045
1040
1035
1030
1025
1020
1015
1010
0
200
400
600
800
1000
1200
1400
1600
1800
Station (ft)
Thalweg
Water Surface
Left Top of Bank
Right Top of Bank


Baliey Fork Site
Profile Chart - Year 1 - Reach UT2
(data collected April, 2006)
Elevation (ft)
1034
1032
1030
1028
1026
1024
1022
1020
1018
1016
0
100
200
300
400
500
600
700
800
900
Station (ft)
Thalweg
Water Surface
Left Top of Bank
Right Top of Bank


Bailey Fork Site
Profile Chart - Year 1 - Reach UT3
(data collected April, 2006)
Elevation (ft)
1024
1022
1020
1018
1016
1014
1012
1010
1008
1006
1004
1002
0
500
1000
1500
2000
2500
3000
Station (ft)
Thalweg
Water Surface
Left Top of Bank
Right Top of Bank

APPENDIX C

BASELINE STREAM SUMMARY FOR RESTORATION REACHES

Baseline Stream Summary for Restoration Reaches

Bailey Fork Creek Mitigation Site: EEP Contract No. D04006-3																	
Reach UT1																	
Parameter	**USGS Gauge**		**Regional Curve Interval**			**Pre-Existing Condition**			**Reference Reach(es) Data**			**Design**			**As-Built**		
Dimension - Riffle	Jacob	Norwood	LL	UL	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Med	Max	Min	Mean	Max
Bankfull Width (ft)	61.3	32	6.7	25	10.9	9.2	10.0	10.9	-----	-----	-----	-----	14.9	-----	15.7	17.7	19.8
Floodprone Width (ft)	96.3	-----	-----	-----	-----	12.9	35.9	58.9	-----	-----	-----	130.0	185.0	240.0	80.0	105.4	130.7
Bankfull Mean Depth (ft)	4.7	3.1	0.9	2.4	1.4	1.2	1.6	2.0	-----	-----	-----	-----	1.2	-----	0.9	1.3	1.7
Bankfull Max Depth (ft)	5.8	-----	-----	-----	-----	2.0	2.4	2.9	-----	-----	-----	-----	1.8	-----	2.0	2.5	3.1
Bankfull Cross-sectional Area (ft2)	290	99	9	37	18.6	10.9	16.3	21.6	-----	-----	-----	-----	18.5	-----	14.0	23.3	32.7
Width/Depth Ratio	13	10.3	-----	-----	-----	5.5	6.6	7.8	5.1	7.1	9.1	-----	12.0	-----	17.0	17.4	17.7
Entrenchment Ratio	1.6	-----	-----	-----	-----	1.4	3.4	5.4	-----	23.5	-----	8.7	12.4	16.1	5.1	5.9	6.6
Bank Height Ratio	1.3	-----	-----	-----	-----	1.0	1.5	2.0	-----	1.2	-----	-----	1.0	-----	1.0	1.1	1.3
Bankfull Velocity (fps)	3.9	2.6	-----	-----	-----	-----	4.8	-----	-----	5.8	-----	-----	3.9	-----	-----	3.9	-----
Pattern																	
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	52	85.5	119	51	67	84
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	30	37.5	45	28	32	37
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	104	134	164	130	150	162
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	2.42	5.46	8.5	3.5	5.75	8	2.9	3.8	4.7
Profile																	
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	18	45	59	10	45	60
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.016	0.0235	0.031	0.016	0.0235	0.031
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	19	50.8	69.7	19	40	63
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	52	67	82	65	75	80
Substrate and Transport Parameters																	
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	-----	0.25 / 0.46 / 0.86 / 9.05 / 14.98			-----	-----	-----		N/A			Not Collected	
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	0.98	-----	-----	-----	-----	-----	0.66	-----	-----	0.64	-----
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	93.5	-----	-----	-----	-----	-----	43.7	-----	-----	39.6	-----
Additional Reach Parameters																	
Channel length (ft)	850	-----	-----	-----	-----	-----	1,638	-----	-----	-----	-----	-----	1,920	-----	-----	1,948	-----
Drainage Area (SM)	25.7	7.2	-----	-----	-----	-----	0.8	-----	0.39	0.945	1.5	-----	0.8	-----	-----	0.8	-----
Rosgen Classification	C4	E	-----	-----	-----	-----	E5/G5	-----	E5	-----	E4/5	-----	C5	-----	-----	C5	-----
Bankfull Discharge (cfs)	1140	254	18	220	76.47	-----	72	-----	-----	119	-----	-----	72	-----	-----	72	-----
Sinuosity	1.06	-----	-----	-----	-----	-----	1.1	-----	1.24	1.52	1.8	-----	1.3	-----	-----	1.4	-----
BF slope (ft/ft)	0.0025	0.0008	-----	-----	-----	-----	0.013	-----	-----	-----	-----	-----	0.010	-----	-----	0.010	-----

Reach UT2																	
Parameter	**USGS Gauge**		**Regional Curve Interval**			**Pre-Existing Condition**			**Reference Reach(es) Data**			**Design**			**As-built**		
Dimension - Riffle	Jacob	Norwood	LL	UL	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	61.3	32.0	4.0	17.0	6.4	-----	5.1	-----	-----	-----	-----	-----	9.9	-----	-----	13.8	-----
Floodprone Width (ft)	96.3	-----	-----	-----	-----	-----	10.0	-----	-----	-----	-----	60.0	140.0	220.0	-----	53.6	-----
Bankfull Mean Depth (ft)	4.7	3.1	0.5	1.7	1.0	-----	1.6	-----	-----	-----	-----	-----	0.8	-----	-----	0.7	-----
Bankfull Max Depth (ft)	5.8	-----	-----	-----	-----	-----	1.9	-----	-----	-----	-----	-----	1.2	-----	-----	1.4	-----
Bankfull Cross-sectional Area (ft2)	290.0	99.0	3.8	17.0	8.2	-----	8.0	-----	-----	-----	-----	-----	8.2	-----	-----	9.7	-----
Width/Depth Ratio	13.0	10.3	-----	-----	-----	-----	3.3	-----	5.1	7.1	9.1	-----	12.0	-----	-----	19.7	-----
Entrenchment Ratio	1.6	-----	-----	-----	-----	-----	2.0	-----	-----	23.5	-----	6.1	14.2	22.2	-----	3.9	-----
Bank Height Ratio	1.3	-----	-----	-----	-----	-----	2.5	-----	-----	1.2	-----	-----	1.0	-----	-----	1.0	-----
Bankfull Velocity (fps)	3.9	2.6	-----	-----	-----	-----	2.2	-----	-----	5.8	-----	-----	2.2	-----	-----	1.9	-----
Pattern																	
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	35	57	79	54	64	72
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	20	25	30	19	21	24
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	69	89	109	83	99	111
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	2.42	5.46	8.5	3.5	5.75	8	3.9	4.6	5.2
Profile																	
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	22	27	36	22	27	32
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.003	0.013	0.022	0.003	0.013	0.022
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	21	44	58	21	47	64
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	35	45	55	41.6	49.285	55.73
Substrate and Transport Parameters																	
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	-----	0.23 / 0.39 / 0.61 / 2.67 / 5.90			-----	-----	-----		N/A			Not Collected	
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	0.32	-----	-----	-----	-----	-----	0.25	-----	-----	0.21	-----
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	19.3	-----	-----	-----	-----	-----	9.6	-----	-----	6.6	-----
Additional Reach Parameters																	
Channel length (ft)	850	-----	-----	-----	-----	-----	270	-----	-----	-----	-----	-----	870	-----	-----	923	-----
Drainage Area (SM)	25.7	7.2	-----	-----	-----	-----	0.24	-----	0.39	0.945	1.5	-----	0.24	-----	-----	0.24	-----
Rosgen Classification	C4	E	-----	-----	-----	-----	E5	-----	E5		E4/5	-----	C5	-----	-----	C5	-----
Bankfull Discharge (cfs)	1140	254	10	100	32	-----	18	-----		119		-----	18	-----	-----	18	-----
Sinuosity	1.06	-----	-----	-----	-----	-----	1.0	-----	1.2	1.5	1.8	-----	1.4	-----	-----	1.4	-----
BF slope (ft/ft)	0.0025	0.0008	-----	-----	-----	-----	0.005	-----	-----	-----	-----	-----	0.006	-----	-----	0.005	-----

Reach UT3																	
Parameter	**USGS Gauge**		**Regional Curve Interval**			**Pre-Existing Condition**			**Reference Reach(es) Data**			**Design**			**As-built**		
Dimension - Riffle	Jacob	Norwood	LL	UL	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Med	Max	Min	Mean	Max
Bankfull Width (ft)	61.3	32.0	6.8	26.0	11.5	9.2	10.0	10.8	-----	-----	-----	-----	16.7	-----	13.3	24.4	26.8
Floodprone Width (ft)	96.3	-----	-----	-----	-----	40.0	60.0	80.0	-----	-----	-----	80.0	280.0	480.0	72.3	96.9	129.7
Bankfull Mean Depth (ft)	4.7	3.1	0.9	2.5	1.5	1.9	2.1	2.2	-----	-----	-----	-----	1.2	-----	1.0	1.2	1.4
Bankfull Max Depth (ft)	5.8	-----	-----	-----	-----	2.9	3.0	3.1	-----	-----	-----	-----	1.7	-----	1.9	2.2	2.5
Bankfull Cross-sectional Area (ft2)	290.0	99.0	10.0	40.0	20.3	19.8	20.3	20.7	-----	-----	-----	-----	20.0	-----	15.9	24.5	34.1
Width/Depth Ratio	13.0	10.3	-----	-----	-----	4.3	5.0	5.6	5.1	7.1	9.1	-----	14.0	-----	11.1	17.2	26.6
Entrenchment Ratio	1.6	-----	-----	-----	-----	3.4	5.1	6.8	-----	23.5	-----	4.8	16.8	28.7	3.2	6.5	9.8
Bank Height Ratio	1.3	-----	-----	-----	-----	1.3	1.6	1.9	-----	1.2	-----	-----	1.0	-----	-----	1.0	-----
Bankfull Velocity (fps)	3.9	2.6	-----	-----	-----	2.7	2.7	2.6	-----	5.8	-----	-----	2.7	-----	3.4	2.2	1.6
Pattern																	
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	59	96.5	134	85	91	120
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	33	41.5	50	27	37	43
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	117	150.5	184	172	179	200
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	2.42	5.46	8.5	3.5	5.75	8	3.5	3.7	4.9
Profile																	
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	26	75	91	26	50	63
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.004	-----	-----	0.004	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	26	49	69	26	75	98
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	59	75.5	92	86	90	100
Substrate and Transport Parameters																	
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	-----	0.24 / 0.34 / 0.44 / 1.38 / 3.40			-----	-----	-----		N/A			Not Collected	
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	0.4	-----	-----	-----	-----	-----	0.3	-----	-----	0.3	-----
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	25.0	-----	-----	-----	-----	-----	14.7	-----	-----	9.5	-----
Additional Reach Parameters																	
Channel length (ft)	850	-----	-----	-----	-----	-----	2,513	-----	-----	-----	-----	-----	3,227	-----	-----	3,226	-----
Drainage Area (SM)	25.7	7.2	-----	-----	-----	-----	0.92	-----	0.39	0.945	1.5	-----	0.92	-----	-----	0.92	-----
Rosgen Classification	C4	E	-----	-----	-----	-----	E5	-----	E5	-----	E4/5	-----	C5	-----	-----	C5	-----
Bankfull Discharge (cfs)	1140	254	29	250	83.83	-----	54	-----	-----	119	-----	-----	54	-----	-----	54	-----
Sinuosity	1.06	-----	-----	-----	-----	-----	1.1	-----	1.24	1.52	1.8	-----	1.4	-----	-----	1.4	-----
BF slope (ft/ft)	0.0025	0.0008	-----	-----	-----	-----	0.002	-----	-----	-----	-----	-----	0.004	-----	-----	0.004	-----

APPENDIX D

MORPHOLOGY AND HYDRAULIC MONITORING SUMMARY - YEAR 1 MONITORING

Morphology and Hydraulic Monitoring Summary - Year 1 Monitoring

Bailey Fork Restoration Site: EEP Contract No. D04006-3

Reach: UT1

I. Cross-Section Parameters	Cross-section 1 Riffle					Cross-section 2 Pool					Cross-section 3 Pool					Cross-section 4 Riffle				
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
Dimension																				
BF Width (ft)	15.25					20.19					16.29					22.25				
Floodprone Width (ft)	3.58					5.12					5.98					5.92				
BF Cross-sectional Area (ft2)	12.0					21.3					22.4					32				
BF Mean Depth (ft)	.79					1.06					1.37					1.44				
BF Max Depth (ft)	1.79					2.56					2.99					2.96				
Width/Depth Ratio	19.32					19.1					11.87					15.48				
Entrenchment Ratio	5.2					3.4					3.6					2.2				
Wetted Perimeter (ft)	-					-					-					-				
Hydraulic Radius (ft)	-					-					-					-				
Substrate																				
d50 (mm)																				
d84 (mm)																				

II. Reachwide Parameters	MY-1 (2006)			MY-2 (2007)			MY-3 (2008)			MY-4 (2009)			MY-5 (2010)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)			-												
Radius of Curvature (ft)			-												
Meander Wavelength (ft)			-												
Meander Width Ratio			-												
Profile															
Riffle Length (ft)			-												
Riffle Slope (ft/ft)			-												
Pool Length (ft)			-												
Pool Spacing (ft)			-												
Additional Reach Parameters															
Valley Length (ft)			-												
Channel Length (ft)			1,948												
Sinuosity			1.4												
Water Surface Slope (ft/ft)			-												
BF Slope (ft/ft)			0.0142												
Rosgen Classification			C5												

Reach: UT2															
I. Cross-Section Parameters	Cross-section 5 Pool					Cross-section 6 Riffle									
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5					
Dimension															
BF Width (ft)	29.75					12.41									
Floodprone Width (ft)	4.02					2.84									
BF Cross-sectional Area (ft2)	26.2					9.6									
BF Mean Depth (ft)	0.88					0.78									
BF Max Depth (ft)	2.01					1.42									
Width/Depth Ratio	33.81					15.98									
Entrenchment Ratio	2.1					4.3									
Wetted Perimeter (ft)	-					-									
Hydraulic Radius (ft)	-					-									
Substrate															
d50 (mm)															
d84 (mm)															

II. Reachwide Parameters	MY-1 (2006)			MY-2 (2007)			MY-3 (2008)			MY-4 (2009)			MY-5 (2010)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)			-												
Radius of Curvature (ft)			-												
Meander Wavelength (ft)			-												
Meander Width Ratio			-												
Profile															
Riffle length (ft)			-												
Riffle Slope (ft/ft)			-												
Pool Length (ft)			-												
Pool Spacing (ft)			-												
Additional Reach Parameters															
Valley Length (ft)			-												
Channel Length (ft)			923												
Sinuosity			1.4												
Water Surface Slope (ft/ft)			-												
BF Slope (ft/ft)			0.005												
Rosgen Classification			C5												

Reach: UT3				
I. Cross-Section Parameters	Cross-section 7	Cross-section 8	Cross-section 9	Cross-section 10

	Riffle					Pool					Riffle					Pool				
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
Dimension																				
BF Width (ft)	22.4					26.14					18.81					22.62				
Floodprone Width (ft)	4.58					5.16					3.02					5.08				
BF Cross-sectional Area (ft2)	29.40					27.7					28.43					30				
BF Mean Depth (ft)	1.31					1.06					1.51					1.32				
BF Max Depth (ft)	2.29					2.58					2.74					2.54				
Width/Depth Ratio	17.1					24.65					12.4					17.08				
Entrenchment Ratio	>4.5					3.6					>3.8					3.9				
Wetted Perimeter (ft)	-					-					-					-				
Hydraulic Radius (ft)	-					-					-					-				
Substrate																				
d50 (mm)																				
d84 (mm)																				

II. Reachwide Parameters	MY-1 (2006)			MY-2 (2007)			MY-3 (2008)			MY-4 (2009)			MY-5 (2010)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)			-												
Radius of Curvature (ft)			-												
Meander Wavelength (ft)			-												
Meander Width Ratio			-												
Profile															
Riffle length (ft)			-												
Riffle Slope (ft/ft)			-												
Pool Length (ft)			-												
Pool Spacing (ft)			-												
Additional Reach Parameters															
Valley Length (ft)			-												
Channel Length (ft)			3226												
Sinuosity			1.4												
Water Surface Slope (ft/ft)			-												
BF Slope (ft/ft)			0.0049												
Rosgen Classification			C5												

Reach: UT3 Continued

I. Cross-Section Parameters	Cross-section 11 Riffle					Cross-section 12 Pool					Cross-section 13 Riffle					
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	

Dimension														
BF Width (ft)	33.77			23.85			13.09							
Floodprone Width (ft)	4.34			5.66			3.48							
BF Cross-sectional Area (ft2)	24.6			26.6			14.3							
BF Mean Depth (ft)	0.73			1.12			1.09							
BD Max Depth (ft)	2.17			2.83			1.74							
Width/Depth Ratio	46.36			21.36			12							
Entrenchment Ratio	2.5			2.9			9.7							
Wetted Perimeter (ft)	-			-			-							
Hydraulic Radius (ft)	-			-			-							
Substrate														
d50 (mm)														
d84 (mm)														

II. Reachwide Parameters	MY-1 (2006)			MY-2 (2007)			MY-3 (2008)			MY-4 (2009)			MY-5 (2010)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)			-												
Radius of Curvature (ft)			-												
Meander Wavelength (ft)			-												
Meander Width Ratio			-												
Profile															
Riffle Length (ft)			-												
Riffle Slope (ft/ft)			-												
Pool Length (ft)			-												
Pool Spacing (ft)			-												
Additional Reach Parameters															
Valley Length (ft)			-												
Channel Length (ft)			3226												
Sinuosity			1.4												
Water Surface Slope (ft/ft)			-												
BF Slope (ft/ft)			0.0049												
Rosgen Classification			C5												