MITIGATION PLAN

BOBS CREEK STREAM AND WETLAND RESTORATION SITE

McDowell County, North Carolina
Contract No. 080730801

Prepared for:

NCDENR-Ecosystem Enhancement Program
2728 Capital Boulevard, Suite 1H 103
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EXECUTIVE SUMMARY

The Bobs Creek Stream and Wetland Restoration Site (Site) is located approximately five (5) miles southeast of the town of Marion (the center of the Site has a latitude and longitude of 35.6567°N, 81.9355°W). The Site is situated due southwest of the intersection of Marlowe Road and Fat Wall Road in McDowell County, North Carolina and is located within the United States Geological Survey (USGS) Hydrologic Unit and Targeted Local Watershed 03050101040010 (North Carolina Division of Water Quality Subbasin 03-08-30) of the Catawba River Basin and will service USGS 8-digit Cataloging Unit 03050101. The Site was identified to assist the North Carolina Ecosystem Enhancement Program (EEP) in meeting its stream and wetland restoration goals.

This document details planned stream and wetland restoration activities at the Site. 31.8-acre conservation easement will be placed on the Site to incorporate all mitigation activities. The Site contains Bobs Creek, eight unnamed tributaries (UTs) to Bobs Creek, associated floodplains, two wetlands and upland slopes.

The contributing watersheds are characterized primarily by forest land (approximately 87 percent of the total area) with pasture at the lower elevations (approximately 10 percent of the total area) and low-density residential development scattered along the outer fringes of the pasture/agricultural land. Impervious surfaces appear to account for approximately one percent of the watershed land surface. The removal of riparian vegetation, manipulation of stream channels, and hoof shear from livestock on stream banks and floodplain soils are responsible for degraded water quality and unstable channel characteristics (stream entrenchment, erosion, and bank collapse) within restoration reaches.

The primary goals of the project focus on improving water quality by reducing nutrient loading from the on-site buffalo and horse operation, reducing excess sedimentation input from site channel banks and hill slopes, increasing the attenuation of floodwater flows, and restoring and enhancing aquatic and riparian habitat. These goals will be accomplished through the following objectives:

- Reduce point (i.e. buffalo directly accessing the channel) and non-point source (i.e. stormwater runoff through pastures) pollution associated with an on-site buffalo and horse operation by exclusionary fencing from the stream and riparian buffer, and by providing a vegetative buffer on stream banks and adjacent floodplains to treat nutrient enriched surface runoff from adjacent pastureland.
- Stabilize degraded portions of on-site streams, to reduce sediment inputs. Stabilization methods will include:

1. Restoring a stable dimension, pattern, and profile to selected sections of channels to ensure the channel will transport and attenuate watershed flows and sediment loads without aggrading or degrading.
2. Stabilize selected channel banks by excavating bankfull benches, placing stream structures to reduce shearing forces on outside meander bends, and planting native vegetative species to provide soil stability.
3. Stabilize selected channel banks by matting and planting native vegetative species to establish root masses along channel and valley side slopes.

- Improve aquatic habitat by enhancing stream bed variability, providing shading/cover areas within the stream channel, and introducing woody debris in the form of rootwads, log vanes, and log sills.
- Diversify aquatic habitat by creating floodplain oxbows that will be breeding grounds for amphibians and also store overbank flows from adjacent stream channels.
- Enhancing fish passage within Bobs Creek and UT 8 Bobs Creek. This is accomplished by removing livestock fencing that has become clogged with debris on Bobs Creek, and restoring UT 8 Bobs Creek and replacing an existing perched culvert to allow fish passage upstream.
- Enhancing riparian wildlife habitat by fencing livestock out of existing and restored riparian buffers as well as installing alternative watering devices that will ensure livestock have sufficient watering areas. This is detailed further in the Farm Management Plans completed for the site by EEP.
- Enhance wildlife habitat by vegetating existing denuded riparian buffers with native trees, shrubs, herbs and grasses. Forest vegetation species were selected by studying a Reference Forest Ecosystem located on-site and reviewing Montane Alluvial Forest species listed in *Classification of the Natural Communities of North Carolina: Third Approximation* (Schafale and Weakley 1990).
- Create wildlife corridors through agricultural lands which have significantly dissected the landscape. The corridors will provide connectivity to a diversity of habitats including mature forest, early successional forest, stream-side forest, riparian wetlands, and uplands.

Project restoration efforts will result in the following:

- Restore 912 linear feet of Site streams.
- Enhancement I of 236 linear feet of Site streams
- Enhancement II of 420 linear feet of Site streams.
- Preservation of 6,775 linear feet of Site streams.
- Preservation of 0.35 acres of riparian wetlands.
- Plant 1.90 acres of floodplain, stream bank, upland slope buffers.

The Muddy Creek Restoration Partnership (Partnership) was formed in 1998 to address impacts to the Muddy Creek Watershed. The Partnership completed the Muddy Creek Watershed

Restoration Initiative Feasibility Report and Restoration Plan (Watershed Plan) for the Muddy Creek Watershed in December of 2003 (MCRP 2003). Since 2004 the North Carolina Ecosystem Enhancement Program (EEP) has informally participated in the Partnership by implementing priority projects named by the partnership and adopted the 2003 report as part of its Local Watershed Plan (LWP). The EEP's Upper Catawba River Basin Restoration Priorities (2009) identifies North Muddy Creek as a Targeted Local Watershed (TLW). The Walton Crawley and Neighbors Branch Stream and Wetland Restoration Site is located within the North Muddy Creek Watershed. In 2008 the EEP contracted with a consulting firm to conduct outreach programs with landowners and identify additional project sites in the Muddy Creek Watershed.

The primary goals identified by the Partnership's Watershed Plan include 1.) Restore the Watershed to its Full Intended Use, 2.) Restore Riparian Buffers, 3.) Enhance Open Space Preservation, 4.)Improve Water Quality, 5.) Restore Physical Habitat, and 6.) Establish a Trout Fishery.

The Watershed Plan listed the following components of watershed restoration to be expected:

- Natural Channel Design Stream Restoration
- Riparian Reforestation
- Livestock Exclusion
- Riparian Forest Preservation

These four components are included within the Bobs Creek Stream and Wetland Restoration Site's Restoration Plan. This project will help restore the watershed to its full intended use by restoring a stream, floodplain and riparian wetland ecosystem through stream and wetland restoration, enhancement and preservation. The project will restore riparian buffers through revegetation of buffer zones with native riparian and wetland species along all Site streams. The project enhances open space preservation by placing Site streams, wetlands, and their buffer into a permanent conservation easement. The overall Site helps improve water quality by reducing sedimentation in on-Site streams and planting a vegetated riparian buffer that filters nutrients from adjacent pasturelands. Additionally, exclusionary fencing and alternate watering devices will remove livestock from accessing on-site channels and their riparian buffers. The project will restore and enhance physical habitat for both aquatic and terrestrial species by planting native vegetation along stream banks and riparian buffers, creating wildlife corridors through a currently dissected landscape, and restoring bedform variability to Site stream. The stabilization of streams and buffers in the project area will enhance water quality in downstream receiving waters which should help in the re-establishment of the watershed's ability to host trout and enhance their ability to propagate.

This document represents a detailed restoration plan summarizing activities proposed for the Site. The plan includes 1) descriptions of existing conditions; 2) reference stream, wetland, and

forest studies; 3) restoration plans; and 4) monitoring and success criteria. Upon approval of this plan by the EEP, engineering construction plans will be prepared and activities implemented as outlined. Proposed restoration activities may be modified during the design stage to address constraints such as sediment-erosion control measures, drainage needs (floodway constraints), or other design considerations.

This document is consistent with the requirements of the federal rule for compensatory mitigation project sites as described in the Federal RegisterTitle 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.8 paragraphs (c)(2) through (c)(14). Specifically the document addresses the following requirements of the federal rule:

- (2) *Objectives.* A description of the resource type(s) and amount(s) that will beprovided, the method of compensation (i.e., restoration, establishment, enhancement, and/or preservation), and the manner in which the resource functions of the compensatory mitigation project will address the needs of the watershed, ecoregion, physiographic province, or other geographic area of interest.
- (3) *Site selection.* A description of the factors considered during the site selection process. This should include consideration of watershed needs, onsite alternatives where applicable, and the practicability of accomplishing ecologically self-sustaining aquatic resource restoration, establishment, enhancement, and/or preservation at the compensatory mitigation project site. (See § 332.3(d).)
- (4) *Site protection instrument.* A description of the legal arrangements and instrument, including site ownership, that will be used to ensure the long-term protection of the compensatory mitigation project site (see § 332.7(a)).
- (5) *Baseline information.* A description of the ecological characteristics of the proposed compensatory mitigation project site and, in the case of an application for a DA permit, the impact site. This may include descriptions of historic and existing plant communities, historic and existing hydrology, soil conditions, a map showing the locations of the impact and mitigation site(s) or the geographic coordinates for those site(s), and other site characteristics appropriate to the type of resource proposed as compensation. The baseline information should also include a delineation of waters of the United States on the proposed compensatory mitigation project site. A prospective permittee planning to secure credits from an approved mitigation bank or in-lieu fee program only needs to provide baseline information about the impact site, not the mitigation bank or in-lieu fee project site.
- (6) *Determination of credits.* A description of the number of credits to be provided, including a brief explanation of the rationale for this determination. (See § 332.3(f).)
- (7) *Mitigation work plan.* Detailed written specifications and work descriptions for the compensatory mitigation project, including, but not limited to, the geographic boundaries of the project; construction methods, timing, and sequence; source(s) of water, including connections to existing waters and uplands; methods for establishing the desired plant community; plans to control invasive plant species; the proposed grading plan, including

elevations and slopes of the substrate; soil management; and erosion control measures. For stream compensatory mitigation projects, the mitigation work plan may also include other relevant information, such as plan form geometry, channel form (e.g. typical channel cross-sections), watershed size, design discharge, and riparian area plantings.

- (8) *Maintenance plan.* A description and schedule of maintenance requirements to ensure the continued viability of the resource once initial construction is completed.
- (9) *Performance standards.* Ecologically-based standards that will be used to determine whether the compensatory mitigation project is achieving its objectives. (See § 332.5.)
- (10) *Monitoring requirements.* A description of parameters to be monitored in order to determine if the compensatory mitigation project is on track to meet performance standards and if adaptive management is needed. A schedule for monitoring and reporting on monitoring results to the district engineer must be included. (See § 332.6.)
- (11) *Long-term management plan.* A description of how the compensatory mitigation project will be managed after performance standards have been achieved to ensure the long-term sustainability of the resource, including long-term financing mechanisms and the party responsible for long-term management. (See § 332.7(d).)
- (12) *Adaptive management plan.* A management strategy to address unforeseen changes in site conditions or other components of the compensatory mitigation project, including the party or parties responsible for implementing adaptive management measures. The adaptive management plan will guide decisions for revising compensatory mitigation plans and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect compensatory mitigation success. (See § 332.7(c).)
- (13) *Financial assurances.* A description of financial assurances that will be provided and how they are sufficient to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with its performance standards (see § 332.3(n)).“

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1.0 PROJECT SITE IDENTIFICATION AND LOCATION

The Site is located approximately five (5) miles southeast of the town of Marion (Figure 1). The center of the Site has a latitude and longitude of 35.6267°N, 81.9355°W. The Site is situated southwest of the intersection of Marlowe Road and Fat Wall Road.

This document details planned stream and wetland restoration activities at the Site. A **31.83**-acre conservation easement will be placed on the Site to incorporate all restoration activities.

1.1 Directions to Project Site

Directions to the Site:

- From Interstate 40 take exit 86 onto NC 226 towards Marion/Shelby
- Take NC 226 South for approximately 2.2 miles
- Turn right/west onto Marlowe Road for approximately 0.7 mile
- Turn left/south on Fat Wall Road
- The Site is approximately 0.1 mile ahead on the right
- Patton Site Latitude and Longitude (35.6267°N, 81.9355°W)

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designation

The Site is located in McDowell County, North Carolina within United States Geological Survey (USGS) Hydrologic Unit (HU) and Targeted Local Watershed 03050101040010 (North Carolina Division of Water Quality [NCDWQ] Subbasin 03-08-30) of the Catawba River Basin and will service USGS 8-digit Cataloging Unit (CU) 03050101 (USGS 1974, NCEEP 2009).

1.3 Project Components, Restoration Type, and Approach

Proposed Site mitigation activities include the construction of stable stream channels resulting in 912 linear feet of stream restoration, stabilizing degraded stream banks using stream structures, bank grading, and vegetation plantings resulting in 236 linear feet of stream enhancement (Level I), matting, planting, and fencing out livestock to stabilize degraded portions of stream bank resulting in 420 linear feet of stream enhancement (Level II), and preserving 6,775 linear feet of currently stable streams. Additionally, proposed site plans include preserving 0.35 acres of riparian wetlands through a permanent conservation easement.

Table 1. Project Components

Restoration Segment/ Reach ID	Existing LF/AC	Restoration Level	Approach	Designed LF/AC	Station Range	Buffer Acres	Comment
Bobs Creek	3315	R	PI	318	40+04 – 43+21	11.93	Channel moved away from terrace and around existing mature vegetation.
		EI		161	36+74 – 37+21 37+89 – 38+67 39+14 – 39+50		Bankfull bench excavation, channel structures, and vegetative plantings on degraded banks.
		EII		215	37+21 – 37+89 38+67 – 39+14 39+50 – 40+04		Exclusionary fencing and permanent conservation easement.
		P		2674	10+00 – 36+74		--
UT 1 Bobs Creek	1061			1061	10+00 – 20+60	3.04	--
UT 2 Bobs Creek	591			591	10+00 – 15+90	4.43	--
UT 3 Bobs Creek	530			530	10+00 – 15+30	3.48	--
UT 4 Bobs Creek	726			726	10+00 – 16+50 10+00 – 10+30	2.71	--
UT 5 Bobs Creek	224			224	10+00 – 12+23	1.17	--
UT 6 Bobs Creek	369	EII		52	10+17 – 10+37 10+73 – 10+78 12+50 – 12+76	0.61	Vegetative plantings on degraded meanders and matting.--
		P		286	10+00 – 10+17 10+37 – 10+73 10+78 – 12+50 12+76 – 13+37		--

Table 1. Project Components (Continued)

UT 7 Bobs Creek	682	EI		25	15+23 – 15+48	1.03	Bankfull bench excavation, channel structures, and vegetative plantings on degraded banks.
		P		613	10+00 – 15+23 15+47 – 16+36		--
UT 8 Bobs Creek	985	R	PI	504	11+58 – 13+35 15+22 – 16+95 17+85 – 19+39	2.68	Channel moved away from valley side slope, and around mature vegetation in Upstream Reach. New channel location in new valley in Downstream Reach.
		R	PII	90	16+95 – 17+85-		Channel moved approximately 100 feet to the west of existing location to historic valley.
		EI		50	10+93 – 11+25 14+45 – 14+65		Bankfull bench excavation, channel structures, and vegetative plantings on degraded banks.
		EII		200	11+25 – 11+58 13+35 – 14+45 14+65 – 15+22		Vegetative plantings on degraded meanders and matting.
		P		94	10+00 – 10+93		--
Wetlands	0.35	P		0.35		0.75	--

Table 1. Project Components (continued)

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)	Buffer
Restoration	912		1.9
Enhancement 1	236		
Enhancement II	420		
Preservation	6,775	0.35	29.93
Totals	8,343	0.35	31.83

1.4 Project History

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 Complete	Completion or Delivery
Restoration Plan	April 2009	May 28, 2009
Final Design – Construction Plans		November 26, 2009
Construction		December 22, 2010
Temporary S&E Mix Applied to Entire Project Area		
Permanent Seed Mix Applied to Entire Project Area		
Containerized and B&B plantings for Entire Project Area		
Mitigation Plan/As-built (Year 0 Monitoring-Baseline)		January 19, 2011
Year 1 Monitoring		January 19, 2012
Year 2 Monitoring		January 19, 2013
Structural maintenance (bench expansion, vane, etc.)		
Year 3 Monitoring		January 19, 2014
Supplemental planting of containerized material		
Year 4 Monitoring		January 19, 2015

Table 3. Project Contacts Table

Designer Primary project design POC	Ko & Associates, P.C. A Florence & Hutcheson, Inc. Company 5121 Kingdom Way, Suite 100 Raleigh, North Carolina 27607 Kevin Williams (919) 851-6066
Construction Contractor Construction Contractor POC	Company Information/Address POC name and phone
Planting Contractor Planting Contractor POC	Company Information/Address POC name and phone
Seeding Contractor Seeding Contractor POC	Company Information/Address POC name and phone
Seed Mix Sources	Company and contact phone
Nursery Stock Suppliers	Company and contact phone
Monitoring Performers	Firm Information/address
Stream Monitoring POC	POC name and phone
Vegetation Monitoring POC	POC name and phone
Wetland Monitoring POC	POC name and phone

Table 4. Project Attributes Table

Project County	McDowell County, North Carolina
Physiographic Region	Blue Ridge
Ecoregion	Eastern Blue Ridge Foothills
Project River Basin	Catawba
USGS HUC for Project (14 digit)	03050101040010
NCDWQ Sub-basin for Project	03-08-30
Within extent of EEP Watershed Plan?	Yes – Upper Catawba River Basin Restoration Priorities 2009
WRC Class (Warm, Cool, Cold)	Warm
% of project easement fenced or demarcated	25
Beaver activity observed during design phase?	No

Table 4. Project Attributes Table (continued)

Restoration Component Attributes						
	Bobs Creek	UTs to Bobs Creek				
		UT 1	UT 2/UT 3	UT 5/UT 4	UT 6/UT 7	UT 8
Drainage Area	930 acres	1 acre	20/120 acres	40/20 acres	440/45 acres	60 acres
Stream Order (USGS	Third	Not Shown	Not Shown/First	Not Shown	Third/First	First
Restored Length (feet)	371	--	--	--	--/--	646
Perennial (P) or Intermittent (I)	P	I	P	P	P	P
Watershed Type	Rural	Rural	Rural	Rural	Rural	Rural
Watershed impervious	< 1 %	< 1 %	< 1 %	< 1 %	< 1 %	< 1 %
NCDWQ AU/Index	11-32-1-3	11-32-1-3	11-32-1-3	11-32-1-3	11-32-1-3	11-32-1-3
NCDWQ Classification	C	C	C	C	C	C
303d listed?	No	No	No	No	No	No
Upstream of a 303d listed	No	No	No	No	No	No
Reasons for 303d listed segment	NA	NA	NA	NA	NA	NA
Total acreage of easement	31.83 ac					
Total vegetated acreage	29.93 ac					
Total planted restoration acreage	1.90 ac					
Rosgen Classification of preexisting	B4-C4-F4	B4	B4/B4	E4-C4/A4-B4	B4/C4-E4	B4-C4-G4
Rosgen Classification of As-built	C4	B4	B4/B4	E4-C4/A4-B4	B4/C4-E4	E/C4
Valley type	VIII	II	II/II	II/II	II/II and VIII	II
Valley slope	0.0173	0.191	0.258/0.286	0.086/0.255	0.039/0.047	0.0342
Cowardin classification	R3UB1/2	R4SB3/4	R3UB1/2	R3UB1/2	R3UB1/2	R3UB1/2
Trout waters designation	No	No	No	No	No	No
Species of concern, endangered etc.	No	No	No	No	No	No
Dominant Soil Series	Tate/Chestnut-Ashe complex	Tate	Tate/Evard-Cowee complex	Hayesville-Evard complex/Tate	Iotla	Iotla/ Hayesville

2.0 WATERSHED CHARACTERIZATION

2.1 Drainage Area

Drainage areas for site streams are listed in Table 4 (Project Attributes Table) and Figure 2. Onsite elevations are moderately steep with a high of 1560 feet on slopes in the upper extents of the Site and a low of 1220 feet National Geodetic Vertical Datum (NGVD) (Marion East and Glenwood, North Carolina USGS 7.5-minute topographic quadrangles).

2.2 Surface Water Classification/Water Quality

Bobs Creek and its tributaries have been assigned Stream Index Number 11-32-1-3. All Site stream have been assigned a Best Usage Classification of C, and have not been rated for their intended uses (NCDWQ 2009, NCDWQ 2004). Class C waters are suitable for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner.

Site streams are not included in the NCDWQ final 2006 Section 303(d) lists of impaired streams in the state (NCDWQ 2007).

2.3 Physiography, Geology, and Soils

The Site is located within both the Blue Ridge and Piedmont physiographic provinces of North Carolina in the Eastern Blue Ridge Foothills ecoregion and the Northern Inner Piedmont ecoregion. The Eastern Blue Ridge Foothills ecoregion is characterized by low mountains, rolling foothills, and gently rounded to steep slopes with moderate gradient streams with bedrock, boulder, cobble, and gravel substrate (Griffith 2002). The Northern Inner Piedmont ecoregion is characterized by high elevations, rugged topography, and mountain outliers with higher gradient streams with mountain-type macroinvertebrate species (Griffith 2002).

The Site is located within the Hayesville-Evard map unit, which consists of strongly sloping to steep, well-drained soils that have a predominantly clayey or loamy subsoil formed in material weathered from gneiss and schist (USDA 1995). Soils mapped within the Site according to the *Soil Survey of McDowell County, North Carolina* are depicted in Figure 3 and described in the table below (USDA 1995). Although all Site soils listed in the county soil survey are nonhydric, two wetlands/pockets occur within the Site floodplains. These areas are most likely characterized by soils of the Wehadkee series (*Fluvaquentic Endoaquepts*). The Wehadkee series consists of very deep, poorly drained and very poorly drained soils that formed in loamy sediments on floodplains along streams with slopes ranging from 0-2 percent (USDA 2007).

Table 5. USDA Mapping Units within the Site

Soil Series	Hydric Status	Family	Description
Chestnut-Ashe complex	Nonhydric	*Typic Dystrochrepts*	This series consists of moderately deep, well-drained, moderately steep Chestnut soils and moderately deep, somewhat excessively drained, moderately steep Ashe soils on ridgetops in the mountains. Slopes range from 10-25 percent.
Dillard loam	Nonhydric	*Aquic Hapludults*	This series consists of very deep, moderately well-drained, nearly level, gently sloping, rarely flooded soils on low stream terraces along many of the larger streams. Slopes range from 1-4 percent.
Evard-Cowee complex	Nonhydric	*Typic Hapludults*	This series consists of very deep, well-drained, steep Evard soils and moderately deep, well-drained, steep Cowee soils on mountain side slopes. Slopes range from 25-60 percent.
Hayesville clay loam	Nonhydric	*Typic Kanhapludults*	This series consists of very deep, well-drained soils that formed in material weathered from gneiss and schist on rolling to hilly uplands of foothills and low mountains. Slopes range from 6-25 percent.
Hayesville-Evard complex	Nonhydric	*Typic Kanhapludults/Typic Hapludults*	This series consists of very deep, well-drained, moderately steep Hayesville and Evard soils in intermountain areas on sideslopes of foothills. Slopes range from 15-25 percent.
Iotla sandy loam	Nonhydric	*Aquic Udifluvents*	This series consists of very deep, somewhat poorly drained, occasionally flooded soils that formed in recent stream sediments on floodplains. Slopes range from 0-2 percent.
Tate loam	Nonhydric	*Typic Hapludults*	This series consists of very deep, well-drained soils on mountain foot slopes, benches, and colluvial fans. Slopes range from 6-15 percent.

2.4 Historical Land Use and Development Trends

The Site watersheds are characterized primarily by forest land (approximately 87 percent of the total area) with pasture at the lower elevations (approximately 10 percent of the total area) and low-density residential development scattered along the fringe of the watershed. Impervious surfaces appear to account for approximately one percent of the watershed land surface. Historical and current logging practices within the Muddy Creek watershed contribute significantly to overland flows. Timbering and clear cutting have resulted in numerous small, non-navigable streams with less than 25 feet of riparian forest buffer throughout the Muddy Creek watershed, contributing to further sediment loading of streams. It is anticipated that land uses will remain constant for the foreseeable future because there are currently no pressures from surrounding cities for development.

Table 6. Land Use of Watershed

Land Use	Acres	Percentage
Forest land	940	87
Pasture/Agricultural land	110	10
Residential Development	30	3
Total	**1080**	**100**

The 14-digit HU which encompasses the Site is a 59-square mile watershed characterized by 66 percent forest, 21 percent agricultural land cover, and 2.1 percent impervious cover concentrated primarily along its northwestern divide within the town of Marion (NCEEP 2009).

2.5 Watershed Planning

The Muddy Creek Restoration Partnership (Partnership) was formed in 1998 to address impacts to the Muddy Creek Watershed. The Partnership completed the Muddy Creek Watershed Restoration Initiative Feasibility Report and Restoration Plan (Watershed Plan) for the Muddy Creek Watershed in December of 2003. Since 2004 the North Carolina Ecosystem Enhancement Program (EEP) has informally participated in the Partnership by implementing priority projects named by the partnership and adopted the 2003 report as part of its Local Watershed Plan (LWP). The EEP's Upper Catawba River Basin Restoration Priorities (2009) identifies North Muddy Creek as a Targeted Local Watershed (TLW). The Bobs Creek Stream and Wetland Restoration Site is located within the North Muddy Creek Watershed. In 2008 the EEP contracted with a consulting firm to conduct outreach programs with landowners and identify additional project sites in the Muddy Creek Watershed.

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These four components are included within the Bobs Creek Stream and Wetland Restoration Site's Restoration Plan. This project will help restore the watershed to its full intended use by restoring a stream, floodplain and riparian wetland ecosystem through stream and wetland restoration, enhancement and preservation. The project will restore riparian buffers through revegetation of buffer zones with native riparian and wetland species along all Site streams. The project enhances open space preservation by placing Site streams, wetlands, and their buffer into a permanent conservation easement. The overall Site helps improve water quality by reducing sedimentation in on-Site streams and planting a vegetated riparian buffer that filters nutrients from adjacent pasturelands. Additionally, exclusionary fencing and alternate watering devices will remove livestock from accessing on-site channels and their riparian buffers. The project will restore and enhance physical habitat for both aquatic and terrestrial species by planting native vegetation along stream banks and riparian buffers, creating wildlife corridors through a currently dissected landscape, and restoring bedform variability to Site stream. The stabilization of streams and buffers in the project area will enhance water quality in downstream receiving

waters which should help in the re-establishment of the watershed's ability to host trout and enhance their ability to propagate.

2.6 Protected Species

Species with a Federal classification of Endangered or Threatened are protected under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). The term "Endangered species" is defined as "any species which is in danger of extinction throughout all or a significant portion of its range," and the term "Threatened species" is defined as "any species which is likely to become an Endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. 1532).

Based on the most recently updated county-by-county database of federally listed species in North Carolina as posted by the USFWS at http://nc-es.fws.gov/es/countyfr.html, five federally protected species are listed for McDowell County. The following table lists the federally protected species and indicates if potential habitat exists within the Site for each.

North Carolina Natural Heritage Program (NCNHP) records were reviewed on March 16, 2009 and no known documents of federally listed species occur in or within one mile of the Site.

Table 7. Federally Protected Species for McDowell County

Common Name	Scientific Name	Status*	Habitat Present Within Site	Biological Conclusion
Vertebrates				
Bald eagle	*Haliaeetus leucocephalus*	BGPA**	No	No Effect
Bog turtle	*Clemmys muhlenbergii*	T (S/A)	No	Not Applicable
Carolina northern flying squirrel	*Glaucomys sabrinus coloratus*	Endangered	No	No Effect
Vascular Plants				
Mountain golden heather	*Hudsonia montana*	Threatened	No	No Effect
Small whorled pogonia	*Isotria medeoloides*	Threatened	Yes	No Effect

*Endangered = a taxon "in danger of extinction throughout all or a significant portion of its range"; Threatened = a taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range"; Threatened (due to Similarity of Appearance) = a species that is threatened due to similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation.
**BPGA (Bald and Golden Eagle Protection Act) = After delisting, the Bald and Golden Eagle Protection Act (Eagle Act) (16 U.S.C. 668-668d) has become the primary law protecting bald eagles.

***Haliaeetus leucocephalus* (bald eagle) Threatened**

Adult bald eagles are identified by their large white head, short white tail, and dark-brown to chocolate- brown body plumage. Immature eagles lack the white head plumage and have brown to black body plumage. In flight bald eagles can be identified by their flat wing soar. Adults average about three feet from head to tail, weigh approximately 10-12 pounds, and have a wingspan that can reach up to seven feet. Fish are the major food source for bald eagles

although bald eagles also consume a variety of birds, mammals, and turtles when fish are not readily available.

Eagle nests are generally found in close proximity to water (within 0.5 mile) where the eagle has a clear flight path to the water. They generally nest in the largest living tree with an open view of the surrounding land. Human disturbance may cause an eagle to abandon otherwise suitable habitat.

Biological Conclusion: **NO EFFECT**

Potential habitat for the bald eagle does not occur within or adjacent to the Site. The nearest open water which may serve as habitat for the bald eagle is 4.5 miles to the north in Lake James. The Site may serve as a fly over corridor for the bald eagle; however, the proposed project will have no effect on the bald eagle. No known occurrences are documented by the NCNHP within or near the Site.

***Glaucomys sabrinus coloratus* (Carolina northern flying squirrel) Endangered**

The Carolina northern flying squirrel is an isolated, endangered subspecies of the more wide-ranging northern flying squirrel (*Glaucomys sabrinus fuscus*). Flying squirrels are nocturnal and have a loose, fully furred fold of skin on each side of the body between the wrists and the ankles that enable the squirrels to glide through the air. Carolina flying squirrel can be distinguished from the similar southern flying squirrel (*G. volans*) by larger size (ranging from 10.2- 12 inches total length) and by having gray rather than white bases of the ventral hairs.

The Carolina flying squirrel typically occurs in spruce-fir forests and mature hardwood forest adjacent to spruce-fir forests at elevations above 4000 feet. Endemic to the Appalachians of western North Carolina and eastern Tennessee, this subspecies is known from the Great Smoky Mountains, Roan Mountain, and Mount Mitchell.

BIOLOGICAL CONCLUSION: **NO EFFECT**

This project is not expected to affect the Carolina northern flying squirrel because typical habitat is not present within the Site. The highest elevations within the Site boundaries are 2000 feet in elevation. No known occurrences are documented by the NCNHP within or near the Site.

***Hudsonia montana* (mountain golden heather) Threatened**

Mountain golden heather is a low spreading, freely branched shrub to about 16 inches tall. The leaves are mostly evergreen, crowded, and needle-shaped, to about 0.3 inches long. Flowers are small, solitary, pale yellow, 5-petaled, and have numerous stamens. Sepals are 0.2- 0.3 inch in length and petals may be slightly longer to twice as long as the sepals. Flowers are produced at the end of the branches from May through July, with fruiting occurring from July through September. Mountain golden heather can be distinguished from similar species by sepal length and shape, and leaf size.

A North Carolina endemic, mountain golden heather has only been found in a few counties on high peaks and ridges where it inhabits quartzitic ledges and cliffs in heath bald clearings. Mountain golden heather typically is found in depressions or rock cracks where a shallow, acidic, sandy or stony soil is present and the plant receives full sun.

BIOLOGICAL CONCLUSION: **NO EFFECT**

This project is not expected to affect mountain golden heather because typical habitat is not present within the Site. No sink quartzitic ledges, cliffs, or suitable heath balds were noted within the project area. No known occurrences are documented by the NCNHP within or near the Site.

***Isotria medeoloides* (small-whorled pogonia) Threatened**

Small-whorled pogonia is a terrestrial orchid growing to about 10 inches high. Five or six drooping, pale dusty green, widely rounded leaves with pointed tips are arranged in a whorl at the apex of the greenish or purplish, hollow stem. Typically a single, yellowish green, nearly stalkless flower is produced just above the leaves; a second flower rarely may be present. Flowers consist of three petals, which may reach lengths of 0.7 inch, surrounded by 3 narrow sepals up to 1 inch in length. Flower production, which occurs from May to July, is followed by the formation of an erect ellipsoidal capsule 0.7 to 1.2 inches in length. This species may remain dormant for periods up to 10 years between blooming periods.

The small-whorled pogonia is widespread, occurring from southern Maine to northern Georgia, but is very local in distribution. In North Carolina, this species is found in scattered locations in the Mountains, Piedmont, and Sandhills. Small-whorled pogonia is found in open, dry deciduous or mixed pine-deciduous forest, or along stream banks. Examples of areas providing suitable conditions (open canopy and shrub layer with a sparse herb layer) where small-whorled pogonia has been found include old fields, pastures, windthrow areas, cutover forests, old orchards, and semi-permanent canopy breaks along roads, streams, lakes, and cliffs. In the Mountains and Piedmont of North Carolina, this species is usually found in association with white pine (*Pinus strobus*).

BIOLOGICAL CONCLUSION: **NO EFFECT**

Habitat for small-whorled pogonia is present within the Site in the form of dry deciduous or mixed pine-deciduous forest, or along stream banks. Plant-by-plant surveys for this species were conducted within all areas of suitable habitat of the Site on May 20-21, 2009, which is within the optimal survey window. Surveys resulted in the findings of no small-whorled pogonia plants within the Site. In addition, no known occurrences are documented by the NCNHP within or near the Site.

Designated Critical Habitat

No designated critical habitat is documented to occur within McDowell County.

2.7 Cultural Resources

Pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for compliance with Section 106 (36 CFR Part 800) comments were received concerning the Site from the North Carolina State Historic Preservation Office (NCSHPO). No documented archaeological sites or structures of historical or architectural importance occur within the Site. See the approved Categorical Exclusion document for more information concerning cultural resources.

2.8 Potential Constraints

The presence of conditions or characteristics that have the potential to hinder restoration activities within the Site was evaluated. The evaluation focused primarily on the presence of hazardous materials, utilities and restrictive easements, rare/threatened/endangered species or critical habitats, and the potential for hydrologic trespass. Existing information regarding constraints was acquired and reviewed. In addition, any Site conditions that have the potential to restrict the restoration design and implementation were documented during the field investigation. No constraints, including beaver, bedrock or an overabundance of invasive/nuisance species, that may present fatal flaws for site mitigation were identified. Invasisve/nuisance species included Chinese privet and multi-flora rose, however their abundance within the Site is not substantial. The following are primarily design constraints that have been identified.:

- Bobs Creek:
  - Existing mature trees within forested areas. Existing trees larger than 10 inches in diameter were located and taken into account during the design process.
- UT 6 Bobs Creek:
  - Existing mature trees are situated adjacent to the channel throughout the reach. Placement of channel structures or grading activities on the banks is hindered by the amount of vegetation that is currently exhibited.
  - Very deep side slopes along the channel hinder the ability of heavy equipment to access the channel.
- UT 8 Bobs Creek:
  - Existing mature trees are situated adjacent to the channel throughout the reach. Placement of channel structures or grading activities on the banks is hindered by the amount of vegetation that is currently exhibited.
  - Very deep side slopes along the channel hinder the ability of heavy equipment to access the channel.

2.8.1 Property Ownership and Boundary

The property is held by Mr. Paul Patton (NC Parcel ID 129-76-1057). A perpetual conservation easement and recordable map of the easement boundary will be signed by the owners and recorded in McDowell County prior to construction activities.

2.8.2 Project Access

The Patton property is situated immediately west of Fat Wall Road. Two access points will be required for restorative actions on-site. The first access point will be located approximately 50 feet south of UT 8 Bobs Creek along an existing soil/gravel road. Access will be directly from Fat Wall Road. This access point will serve all actions along UT 8 Bobs Creek.

The second access point is located approximately 250 feet south of the first access point along another soil/gravel road. Access will be directly from Fat Wall Road. This access point runs adjacent to a fenced pasture towards UT 6 Bobs Creek and Bobs Creek. This access road will serve all actions along Bobs Creek and UT 1, 2, 3, 4, 5, 6, and 7 Bobs Creek.

2.8.3 Utilities

No utilities are located within or directly adjacent to the project area.

2.8.4 FEMA/Hydrologic Trespass

The HEC-RAS analysis indicates that the restoration design will result in a no-rise in the 100-year floodplain water surface elevations outside of the project area. The results of this analysis affirm that hydrologic trespass to adjacent properties will not occur. A more detailed discussion and HEC-RAS analysis can be found in section 7.4 and Appendix 6.

2.9 Point Source & Non-point Source Discharges

Point source discharges are in the form of livestock. Streams on-site are utilized by livestock as watering sources. Fecal contamination from the livestock can be considered a direct point source discharge. Non-point source discharges include overland flow from adjacent pastures. These pastures contain sizeable amounts of livestock which contributes to an abundance of fecal matter that washes into adjacent stream channels.

3.0 PROJECT SITE STREAMS (EXISTING CONDITIONS)

The Site contains nine (9) jurisdictional stream channels that were studied for potential mitigation opportunities. The location of these channels and their reaches are depicted on Sheets 1 and 1a. The nine jurisdictional streams include Bobs Creek and UTs 1 through 8 Bobs Creek. UTs 1 through 5 are relatively stable channels and were only considered for preservation opportunities. The remaining jurisdictional channels were studied for their restoration and enhancement opportunities and are detailed below. Existing conditions cross sections and profiles can be found in Appendix 10.

3.1 Existing Conditions Survey

A Rosgen Level II stream survey was conducted along Bobs Creek, UT 6 Bobs Creek, and two reaches along UT 8 Bobs Creek. The approximate locations of the surveys are shown on Sheets 1 and 1a. The surveys included conducting a longitudinal profile for between 20 and 30 bankfull widths, cross-sectional surveys, measurement of plan form variables, determination of sediment size distributions, photographic logs, vegetation surveys, and general visual assessments of existing channel and watershed conditions.

3.2 Channel Classification

It should be noted that only those channels that are proposed to be restored or enhanced were surveyed for channel classification purposes. A Rosgen Level II survey was not performed on the stable channels that are proposed for preservation. Existing conditions cross-sections and profiles can be found in Appendix 10. Stream reach locations are depicted on Sheet 2.

Bobs Creek

Bobs Creek is divided into three separate reaches (Upstream, Middle, and Downstream) for site description purposes. Two of the reaches (Middle and Downstream Reaches) were surveyed to determine channel classification and overall channel stability because it was evident that these reaches were experiencing degradation. The Upstream Reach is a stable channel for its entirety on the Site. The Upstream Reach was surveyed in the lower portions of the Reach (immediately upstream of the Middle Reach) as a reference stream (C type stream) for site restoration planning. A description of this data can be found in Section 4.0. However, the majority of the Upper Reach's length is upstream of the reference section and is primarily a stable B type channel (not surveyed).

Middle and Downstream Reaches

The Middle Reach has numerous areas of apparent degradation; however there are also sections where the banks and invert appear stable. The Downstream Reach however exhibits degradation throughout virtually the entire reach.

Evidence that Bobs Creek is in a state of flux is the fact that of the three riffle cross-sections completed on Bobs Creek the channel displayed three different stream types (B4, C4, and F4). B

and C type streams are both stable stream types and commonly found in similar physical settings as Bobs Creek. However, the B type section displayed an unusually high width to depth ratio (18.7) and somewhat low entrenchment ratio (1.72). The section of the B type channel also displayed a bank height ratio of 1.76 which typically indicates bankfull flows are entrenched inside of a larger channel and do not readily reach their floodplain. The section of C type channel appears to have a stable left bank and invert, however its right bank for its entirety is abutting a steep slope (terrace of adjacent hill slope). Materials in the terrace are dominated by silt and loam. Existing mature trees and their root systems appear to be the only form of bank stabilization on the right bank. The F type channel section displays a high width to depth ratio (22.3) and a very low entrenchment ratio (1.17), both typical indicators of a degrading F type stream. The 4 descriptor indicates that the channel substrate is dominated by gravel.

UT 6 Bobs Creek

The majority of UT 6 Bobs creek is somewhat stable with some areas of bank degradation at meanders along hill slopes. Survey data revealed that the channel displays characteristics of B and E type channels, however for overall classification purposes it will be classified as a B4 type channel. The channel displays a low width to depth ratio for B type streams (8.5) but an entrenchment ratio (1.66) that is typical of B type streams. The channel could be classified as an E4 type channel (due to the low width ratio) through some straight sections where the entrenchment ratio is higher, but for overall classification purposes the channel is a B type stream. The low entrenchment ratios are a product of valley confinement rather than incision. Additionally, the pool-to-pool spacing is relatively low which is common to B type channels. The 4 descriptor indicates that the channel substrate is dominated by gravel.

UT 8 Bobs Creek

Upstream Reach

The Upstream Reach displays two typical channel types (B4 and C4). B4 type sections of the channel display a typical width to depth ratio of 7.6 and entrenchment ratio of 2.07. These B type sections could be classified as an E type channel due to the low width to depth ratio, however due to valley confinement they appear to perform more typical of a B type channel. Other sections of the channel can be classified as a C type stream. The C type sections display a typical width to depth ratio of 13.6 and typical entrenchment ratio of 2.57. The C type sections are commonly found in areas where the valley temporarily widens allowing for higher entrenchment ratios. There are stretches through the Upstream Reach where the channel is very stable and shows no signs of degradation. However, channel degradation is prevalent in the form of undercut banks and mass wasting of valley side slopes in those areas where the valley side slope and channel top of bank approach each other. The 4 descriptor indicates that the channel substrate is dominated by gravel.

Downstream Reach

The majority of the Downstream Reach can be classified as a G4 type channel. The entire reach appears to be incising through the alluvial valley which has resulted in a channel that typically

displays a very low width to depth ratio of 5.3 and low entrenchment ratio of 1.58. The very low width to depth ratio and low entrenchment ratio are both typical of gully (G type) channels. The low entrenchment ratio is derived from the channel incising through the landscape and due to valley confinement. The 4 descriptor indicates that the channel substrate is dominated by gravel.

3.3 Valley Classification

Bobs Creek (in restored and enhanced areas on-site) is situated in a somewhat broad valley that can be classified as a Valley Type VIII. UT 6 Bobs Creek and UT 8 Bobs Creek are situated in somewhat confined and steep valleys that can be classified as a Valley Type II.

3.4 Discharge

Determined bankfull discharges for the channels that are proposed for restoration are as follows:

- Bobs Creek: 110 cfs
- UT 8 Bobs Creek: 15 cfs

3.5 Channel Morphology

Morphological characteristics of the Site streams were collected during a Rosgen Level II survey. The Morphological Characteristics Tables below include a summary of existing dimension, profile, and pattern data for the Site streams and references.

Table 8. Morphological Characteristics of Bobs Creek and Reference

Morphological Characteristics of Bobs Creek and Reference															
Restoration Plan:	Bobs Creek Stream and Wetland Restoration Site														
Reach:	Bobs Creek														
County:	McDowell County, NC														
Design by:	RVS														
Checked by:	RKW														
ITEM	Existing Conditions				Existing Conditions				Existing Conditions				Reference Reach		Proposed Conditions	
LOCATION	Bobs Creek				Bobs Creek				Bobs Creek				Bobs Creek		Bobs Creek	
STREAM TYPE	B4				C4				F4				C4		C4	
DRAINAGE AREA, Ac - Sq Mi	932 Ac -	1.46 Sq Mi			932 Ac -	1.46 Sq Mi			932 Ac -	1.46 Sq Mi			429 Ac -	0.67 Sq Mi	934 Ac -	1.46 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	20.2	ft			14.5	ft			25.5	ft			12.7	ft	17.5	ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	1.08	ft			1.20	ft			1.14	ft			0.90	ft	1.25	ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	18.7				12.1				22.3				14.1		14.0	
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	21.81	ft^2			17.40	ft^2			29.02	ft^2			11.4	ft^2	22.3	ft^2
BANKFULL MEAN VELOCITY, fps	5.04	fps			6.32	fps			3.79	fps			6.2	fps	4.5	fps
BANKFULL DISCHARGE, cfs	110.0	cfs			110.0	cfs			110.0	cfs			70.0	cfs	110.0	cfs
BANKFULL MAX DEPTH (d_{max}), ft	1.42	ft			2.04	ft			1.42	ft			1.21	ft	1.68	ft
BANK HEIGHT RATIO	1.76				1.23				1.23				1.00		1.00	
TYPICAL BANK HEIGHT ABOVE BANKFULL	2.50	ft			2.50	ft			2.50	ft			1.21	ft	1.68	ft
WIDTH Flood-Prone Area (W_{fpa}), ft	34.8	ft			45.2	ft			29.8	ft			150.0	ft	100.00	ft
ENTRENCHMENT RATIO (ER)	1.72				3.12				1.17				11.8		5.7	
MEANDER LENGTH (Lm), ft	100 -	145 ft			100 -	145 ft			100 -	145 ft			95.0 -	98.0 ft	87.5 -	175.0 ft
RATIO OF Lm TO W_{bkf}	4.9 -	7.2			6.9 -	10.0			3.9 -	5.7			7.5 -	7.7	5.0 -	10.0
RADIUS OF CURVATURE, ft	7 -	30 ft			7 -	30 ft			7 -	30 ft			14.5 -	20.0 ft	40.3 -	70.0 ft
RATIO OF Rc TO W_{bkf}	0.3 -	1.5			0.5 -	2.1			0.3 -	1.2			1.1 -	1.6	2.3 -	4.0
BELT WIDTH, ft	36.00 -	55.00 ft			36.00 -	55.00 ft			36.00 -	55.00 ft			30.5 -	32.0 ft	43.8 -	105.0 ft
MEANDER WIDTH RATIO	1.78 -	2.72 ft			2.49 -	3.80 ft			1.41 -	2.16 ft			2.4 -	2.5	2.5 -	6.0
SINUOSITY (K)	1.17				1.17				1.17				1.22		1.13	
*VALLEY SLOPE, ft/ft	0.0173	ft/ft			0.0173	ft/ft			0.0173	ft/ft			0.0250	ft/ft	0.0173	ft/ft
**AVERAGE SLOPE (S), ft/ft	0.0149	ft/ft			0.0149	ft/ft			0.0149	ft/ft			0.0205	ft/ft	0.0070	ft/ft
RIFFLE SLOPE, ft/ft	0.0239	ft/ft			0.0239	ft/ft			0.0239	ft/ft			0.0344	ft/ft	0.0105	ft/ft
RATIO OF RIFFLE SLOPE TO AVERAGE SLOPE	1.6				1.6				1.6				1.7		1.5	
POOL SLOPE, ft/ft	0.0249	ft/ft			0.0249	ft/ft			0.0249	ft/ft			0.0015	ft/ft	0.0000	ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE	1.7				1.7				1.7				0.1		0.0	
MAX POOL DEPTH, ft	3.34	ft			3.34	ft			3.34	ft			2.16	ft	3.29	ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	3.1				2.8				2.9				2.4		2.6	
POOL WIDTH, ft	13.1	ft			13.1	ft			13.1	ft			8.37	ft	17.50	ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH	0.6				0.9				0.5				0.66		1.00	
POOL TO POOL SPACING, ft	43.81 -	171.55 ft			43.81 -	171.55 ft			43.81 -	171.55 ft			38.8 -	64.7 ft	53.7 -	89.4 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	2.17 -	8.48			3.03 -	11.85			1.72 -	6.74			3.1 -	5.1	3.1 -	5.1

* Valley Slope, and Sinuosity were taken from topographical data obtained on the entire site for existing conditions (i.e. data was not taken along reach lengths).

** Average Slope was taken along a reach length for existing conditions.

Table 9. Morphological Characteristics of UT 6 Bobs Creek and Reference

Morphological Characteristics of UT 6 Bobs Creek		
Restoration Plan:	Bobs Creek Stream and Wetland Restoration Site	
Reach:	UT 6 Bobs Creek	
County:	McDowell County, NC	
Design by:	RVS	
Checked by:	RKW	
ITEM	Existing Conditions	
LOCATION	UT 6 Bobs Creek	
STREAM TYPE	B4	
DRAINAGE AREA, Ac - Sq Mi	41 Ac -	0.06 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	4.4	ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	0.52	ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	8.5	
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	2.31	ft^2
BANKFULL MEAN VELOCITY, fps	4.33	fps
BANKFULL DISCHARGE, cfs	10.0	cfs
BANKFULL MAX DEPTH (d_{max}), ft	0.64	ft
BANK HEIGHT RATIO	2.14	
TYPICAL BANK HEIGHT ABOVE BANKFULL	1.37	ft
WIDTH Flood-Prone Area (W_{fpa}), ft	7.3	ft
ENTRENCHMENT RATIO (ER)	1.66	
MEANDER LENGTH (Lm), ft	36 -	85 ft
RATIO OF Lm TO W_{bkf}	8.1 -	19.2
RADIUS OF CURVATURE, ft	2 -	5 ft
RATIO OF Rc TO W_{bkf}	0.5 -	1.1
BELT WIDTH, ft	25.00 -	37.00 ft
MEANDER WIDTH RATIO	5.66 -	8.37 ft
SINUOSITY (K)	1.31	
*VALLEY SLOPE, ft/ft	0.0390	ft/ft
**AVERAGE SLOPE (S), ft/ft	0.0280	ft/ft
RIFFLE SLOPE, ft/ft	0.0540	ft/ft
RATIO OF RIFFLE SLOPE TO AVERAGE SLOPE	1.9	
POOL SLOPE, ft/ft	0.0058	ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE	0.2	
MAX POOL DEPTH, ft	1.20	ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	2.3	
POOL WIDTH, ft	5.4	ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH	1.2	
POOL TO POOL SPACING, ft	3.9 -	38.3 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	0.9 -	8.7

* Valley Slope, and Sinuosity were taken from topographical data obtained on the entire site for existing conditions (i.e. data was not taken along reach lengths).

** Average Slope was taken along a reach length for existing conditions.

Table 10. Morphological Characteristics of UT 8 Bobs Creek and Reference

Morphological Characteristics of UT 8 Bobs Creek and Reference																		
Restoration Plan:	Bobs Creek Stream and Wetland Restoration Site																	
Reach:	UT 8 Bobs Creek - Upstream and Downstrem Reaches																	
County:	McDowell County, NC																	
Design by:	RVS																	
Checked by:	RKW																	
ITEM	Existing Conditions				Existing Conditions				Existing Conditions				Reference Reach				Proposed Conditions				Proposed Conditions			
LOCATION	UT 8 Bobs Creek - Upstream Reach				UT 8 Bobs Creek - Upstream Reach				UT 8 Bobs Creek - Downstream Reach				UT 5 Bobs Creek				UT 8 Bobs Creek - Upstream Reach				UT 8 Bobs Creek - Downstream Reach			
STREAM TYPE	B4				C4				G4				E/C4				E/C4				E/C4			
DRAINAGE AREA, Ac - Sq Mi	68 Ac -	0.11 Sq Mi			68 Ac -	0.11 Sq Mi			72 Ac -	0.11 Sq Mi			24 Ac -	0.04 Sq Mi			68 Ac -	0.11 Sq Mi			72 Ac -	0.11 Sq Mi		
BANKFULL WIDTH (W_{bkf}), ft	5.3	ft			7.8	ft			5.0	ft			5.6	ft			8.0	ft			8.0	ft		
BANKFULL MEAN DEPTH (d_{bkf}), ft	0.70	ft			0.57	ft			0.94	ft			0.53	ft			0.76	ft			0.76	ft		
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	7.6				13.6				5.3				10.5				10.5				10.5			
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	3.72	ft^2			4.44	ft^2			4.66	ft^2			3.0	ft^2			5.9	ft^2			5.9	ft^2		
BANKFULL MEAN VELOCITY, fps	4.03	fps			3.38	fps			3.22	fps			4.5	fps			2.3	fps			2.3	fps		
BANKFULL DISCHARGE, cfs	15.0	cfs			15.0	cfs			15.0	cfs			13.4	cfs			15.0	cfs			15.0	cfs		
BANKFULL MAX DEPTH (d_{max}), ft	0.89	ft			0.94	ft			1.19	ft			0.65	ft			0.99	ft			0.99	ft		
BANK HEIGHT RATIO	1.12				1.06				7.30				1.00				1.00				1.00			
TYPICAL BANK HEIGHT ABOVE BANKFULL	1.00	ft			1.00	ft			6.50	ft			0.65	ft			0.99	ft			0.99	ft		
WIDTH Flood-Prone Area (W_{fpa}), ft	11.0	ft			20.0	ft			7.8	ft			13.0	ft			20.0	ft			25.0	ft		
ENTRENCHMENT RATIO (ER)	2.07				2.57				1.58				2.3				2.5				3.1			
MEANDER LENGTH (Lm), ft	32 -	63 ft			32 -	63 ft			35 -	65 ft			31.0 -	38.0 ft			40.0 -	80.0 ft			40.0 -	80.0 ft		
RATIO OF Lm TO W_{bkf}	6.0 -	11.8			4.1 -	8.1			7.0 -	13.1			5.6 -	6.8			5.0 -	10.0			5.0 -	10.0		
RADIUS OF CURVATURE, ft	5 -	12 ft			5 -	12 ft			4 -	10 ft			10.0 -	13.0 ft			16.0 -	32.0 ft			16.0 -	32.0 ft		
RATIO OF Rc TO W_{bkf}	0.9 -	2.3			0.6 -	1.5			0.8 -	2.0			1.8 -	2.3			2.0 -	4.0			2.0 -	4.0		
BELT WIDTH, ft	23.00 -	28.00 ft			23.00 -	28.00 ft			25.00 -	33.00 ft			17.0 -	25.0 ft			24.0 -	48.0 ft			24.0 -	48.0 ft		
MEANDER WIDTH RATIO	4.32 -	5.26 ft			2.96 -	3.60 ft			5.03 -	6.64 ft			3.1 -	4.5			3.0 -	6.0			3.0 -	6.0		
SINUOSITY (K)	1.18				1.18				1.11				1.28				1.11				1.17			
*VALLEY SLOPE, ft/ft	0.0342	ft/ft			0.0342	ft/ft			0.0188	ft/ft			0.0538	ft/ft			0.0342	ft/ft			0.0188	ft/ft		
**AVERAGE SLOPE (S), ft/ft	0.0148	ft/ft			0.0148	ft/ft			0.0172	ft/ft			0.0273	ft/ft			0.0040	ft/ft			0.0040	ft/ft		
RIFFLE SLOPE, ft/ft	0.0348	ft/ft			0.0348	ft/ft			0.0449	ft/ft			0.0480	ft/ft			0.0060	ft/ft			0.0060	ft/ft		
RATIO OF RIFFLE SLOPE TO AVERAGE SLOPE	2.3				2.3				2.6				1.8				1.5				1.5			
POOL SLOPE, ft/ft	0.0013	ft/ft			0.0013	ft/ft			0.0245	ft/ft			0.0017	ft/ft			0.0000	ft/ft			0.0000	ft/ft		
RATIO OF POOL SLOPE TO AVERAGE SLOPE	0.1				0.1				1.4				0.1				0.0				0.0			
MAX POOL DEPTH, ft	1.53	ft			1.53	ft			2.64	ft			0.93	ft			1.90	ft			1.90	ft		
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	2.2				2.7				2.8				1.8				2.5				2.5			
POOL WIDTH, ft	3.9	ft			3.9	ft			9.1	ft			5.45	ft			8.80	ft			8.80	ft		
RATIO OF POOL WIDTH TO BANKFULL WIDTH	0.7				0.5				1.8				0.98				1.10				1.10			
POOL TO POOL SPACING, ft	15.34 -	45.22 ft			15.34 -	45.22 ft			14.07 -	33.92 ft			6.1 -	25.9 ft			8.0 -	37.1 ft			8.0 -	37.1 ft		
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	2.88 -	8.50			1.97 -	5.81			2.83 -	6.82			1.1 -	4.6			1.0 -	4.6			1.0 -	4.6		

* Valley Slope, and Sinuosity were taken from topographical data obtained on the entire site for existing conditions (i.e. data was not taken along reach lengths).

** Average Slope was taken along a reach length for existing conditions.

3.6 Channel Evolution

A discussion of the channel evolution/successional stages will center on only those channels/reaches that are to be restored/enhanced. It is assumed that preserved channels/reaches are currently in a stable state and are not expected to progress through successional trends in the near future. Stream reach locations are depicted on Sheet 2.

Bobs Creek

The proposed restored reaches of Bobs Creek to be restored and enhanced are currently classified as degraded B, C and F type channels. It is believed that Bobs Creek's successional trend will progress in the following manner (following Rosgen's Stream Type Succession Scenarios):

B Type Sections

It is anticipated that the B type sections (Enhancement I and II areas) will continue to evolve as evidenced by degraded/vertical channel banks and a high bank height ratio. The most likely trend could be that the B type channel sections will continue to expand the overbank (above bankfull) areas through bank degradation until it reaches a point of equilibrium where vegetation will establish along the channel bank and above bankfull. The endpoint could continue to be a B type channel, except with a larger overbank/floodplain (higher entrenchment ratio), however much of the existing channel banks and vegetation will be lost during the expansion.

C Type Sections

The C type sections are located primarily in the Downstream Reach of Bobs Creek (Restoration areas) where the channel is experiencing down valley meander migration. If existing vegetation along the banks is lost due to channel expansion the following successional scenario can be reasonably expected:

C→G→F→C

It is anticipated that the channel will avulse in numerous areas creating higher slopes which will create G type channels. The channel will expand laterally until it can create a new meander pattern, and then will stabilize back to a C type channel.

F Type Sections

F type sections appear to in areas where buffalo may have historically congregated, and where fencing across the channel has blocked the transport of some sediments during high flows causing the channel to widen. The following successional scenario can be reasonably expected in the F type channel sections:

F→C

It is anticipated that the channel will eventually narrow because the F type section begin to fill in with sediment on high flows. The narrowing of the channel will occur to a point at which the

stream can convey its discharge and sediment supply without aggrading, which may be in the form of a C type channel.

UT 6 Bobs Creek

As a whole, UT 6 Bobs Creek is somewhat stable with minor areas of bank degradation (in Enhancement II areas) on outside meander bends and scattered nick points. It is anticipated that the channel will continue to expand its overbank at degraded outside meander bends to allow for a larger floodplain, however, it is also anticipated that the channel will maintain its current channel classification.

UT 8 Bobs Creek

Upstream Reach

Many sections of the Upstream Reach are currently stable with B and C type channels. Degraded sections primarily occur at the toe of slope of the valley (at Restoration and Enhancement I and II areas) where the channel appears to be expanding its overbank areas. It is anticipated that the channel would continue to expand its overbank areas to allow for a larger floodplain, however, it is anticipated that the channel will maintain it current channel classification as a whole.

Downstream Reach

The Downstream Reach is currently an incised G type channel. It is believed that the Downstream Reach's succesional trend will progress in one of the following manners (following Rosgen's Stream Type Succession Scenarios):

C→G→F→C

Or

C→G→B

If the Downstream Reach were to remain in its current degraded condition, it is believed that the channel would continue to incise to a point at which the bankfull channel would follow one of the following two successional scenarios:

1. Widen to allow for a larger belt width to create meanders and increase length, ultimately forming a stable C type channel at a lower elevation.
2. Incise and slightly widen its overbank area while creating a pool to pool spacing that would sufficiently dissipate energy throughout the bed form rather than plan form.

3.7 Channel Stability Assessment

Each channel/swale within the Site boundary was evaluated to determine its perenniality and state of stability. DWQ Stream Identification Forms and United States Army Corps of Engineer Stream Quality Assessment Worksheets were completed for each channel within the Site boundaries and can be found in Appendix 3. Additionally, a channel stability assessment was completed for each channel and reach within the channel. Part of the stability assessment

included completing a Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) analysis (Appendix 8) on any section of channel that appeared to be eroding or have a high potential for erosion. This assessment was completed to estimate sediment loss through the Site and validate proposed mitigation practices. The assessment details are listed below.

Bobs Creek

Upstream Reach

The Upstream Reach is a stable stream that flows through a somewhat steep valley. The channel is surrounded by dense, mature vegetation on the stream banks and adjacent valley side slopes. Existing vegetation provides dense shading over the channel and contributes valuable woody debris such as leaves and sticks. It appears that the channel has had little to no impacts from humans or livestock over the last 30 to 50 years (estimated from tree age). BEHI and NBS values were not determined through the Upstream Reach because it is a stable reach that appears to lose low amounts of sediment on an annual basis.

Middle Reach

The Middle Reach displays sections of channel that are very stable with mature vegetation along the bank and floodplain and also sections of channel that exhibit mass wasting in channel banks, undermining of mature trees on the channel banks, and areas of little to no vegetation along the channel banks. Dilapidated fencing is not sufficient to exclude buffalo from accessing the channel.

Stable areas along the Middle Reach display mature vegetation and well formed root masses along the channel banks. The vegetation is shading the channel, which helps regulate water temperatures and contributes biomass such as leaves, sticks, and nuts. The roots through the channel banks help to provide soil stabilization and also armor the banks from erosive forces during high flows.

The valley of the Middle Reach is broad enough at the historic floodplain elevation to provide flood relief during very high flow events, however a terrace rises quickly on both the left and right side of the valley. Much of the channel through this reach is located along the left side of the valley along the terrace side slope. Eroded areas along the channel occur primarily along a stretch where there is no mature vegetation along the high terrace (approximately four (4) feet higher than the right bank and historic floodplain) of the left bank. This portion of the reach is primarily classified as a B type channel due to channel incision in the landscape (channel does not readily access the floodplain during high flows). The lack of vegetation along the left bank, and the inability of the channel to access its historic floodplain which is off of the right bank has enabled shearing forces during high flows to under cut and erode the bank, which loads the channel with fine sediments.

An erosion rate study was performed using BEHI and NBS. The BEHI and NBS values were used to model and predict the amount of sediment loss through the Middle Reach (Appendix 8).

The study revealed that a wide range of BEHI and NBS levels exist. BEHI ranges from Moderate to High and NBS ranges from Moderate to Extreme. The model predicts that a total 0.03 tons/yr/ft of sediment are lost off of the studied banks leading to a total predicted loss of approximately 4.5 tons of sediment lost per year.

Lower Reach

The Lower Reach is primarily a degraded C type channel that has historically had buffalo accessing the channel as a watering and shading source. The valley of the Lower Reach is broad enough at the historic floodplain elevation to provide flood relief during very high flow events, however a terrace rises quickly on both the left and right side of the valley. For much of this reach, the channel has migrated towards the right side of the valley against the terrace side slope, which is approximately three (3) feet higher than the historic floodplain. Trees lining the right bank are being undercut and provide the only protection from the channel migrating further into the terrace. There are mature trees scattered through the historic floodplain off of the left bank, however outside meander bends on the left bank do not have vegetation that will stabilize soils and protect the bank during high flows. The lack of vegetation in these areas is allowing the channel to migrate down valley which is causing massive failures in the channel side slopes. A tortuous meander bend near the downstream end of the reach is currently held in place by a large tree that is being undermined. It is apparent that if the tree were to fall that the meander would avulse, cutting off this portion of the channel and increasing the slope.

Much of the channel degradation can be attributed to direct and indirect impacts of the buffalo. It appears that buffalo have recently accessed much of the Lower Reach as evidenced by a sparse understory, lack of vegetation along the channel banks, and hoof shear along portions of the channel banks. Additionally, fencing across the channel has created a blockage that traps large sediment which has caused channel aggradation and channel widening.

The channel substrate is dominated by gravel thorough the Lower Reach, however it is evident that fine sediment is being washed in from on-site degradation of channel banks. It is apparent that the driving forces for channel degradation are a loss of vegetation along degraded banks and impacts from buffalo accessing the channel as a watering and cooling source.

An erosion rate study revealed that a wide range of BEHI and NBS levels exist. BEHI ranges from Moderate to Extreme and NBS ranges from Moderate to Extreme. The model predicts that a total 0.17 tons/yr/ft of sediment are lost off of the studied banks leading to a total predicted loss of approximately 44.1 tons of sediment lost per year.

UT 1 – UT 5 Bobs Creek

UT 1 through UT 5 Bobs Creek are stable streams that flow through steep to somewhat steep valleys on-site. The channels are surrounded by dense, mature vegetation on the stream banks and adjacent valley side slopes. Existing vegetation provides dense shading over the channel and contributes valuable woody debris such as leaves and sticks. It appears that the majority of the

channels have had little to no impacts from humans or livestock over the last 30 to 50 years (estimated from tree age) with the exception of small areas of clear cuts that have now grown back to early successional forests. BEHI and NBS values were not determined because the channels are stable and appear to lose low amounts of sediment on an annual basis.

UT 6 Bobs Creek

UT 6 Bobs Creek appears to be an intermittent stream that periodically receives large stormwater events while conveying minimal base flow. The valley is steep and very confining which does not allow for much if any floodplain through the majority of the reach. The channel banks and valley side slopes adjacent to channel banks are populated with dense, mature vegetation that provides shade and biomass input to the channel. The mature vegetation also provides soils stability and bank protection through the large majority of the reach. Much of the reach is stable due to the vegetation, however there are small sections, mainly in outside meander bends that display active erosion along the channel and valley side slopes. It appears that these eroding sections of the channel have little vegetation and root masses that would stabilize soils and channel side slopes.

There are some nick points through the reach that are being held primarily by tree roots across the channel. These areas show minor scour of the channel invert downstream of the nick point, but mass failure of the invert and channel banks are not prevelant.

An erosion rate study on the eroded banks revealed that a range of BEHI and NBS levels exist. BEHI ranges from High to Very High and NBS ranges from Moderate to Very High. The model predicts that a total of 0.05 tons/yr/ft of sediment are lost off of the studied banks leading to a total predicted loss of approximately three tons of sediment per year.

UT 7 Bobs Creek

UT 7 is a perennial stream that can be considered a stable channel for the large majority of its length through the Site. The channel displays stable side slopes and a consistent pool to pool spacing with a mature riparian buffer throughout most of the Site. A few meander bends exhibit signs of undercutting, however existing vegetation is maintaining the side slopes as a whole. One meander bend exhibits excessive undercutting and is in danger of mass failure if some stabilization measures are not taken. It appears that the failure is due to the lack of thick roots in the channel side slope and the small radius through the bend.

An erosion rate study on the eroded bank revealed that the BEHI is Very High and NBS is Very High. The model predicts that a total of 0.15 tons/yr/ft of sediment are lost off of the studied bank leading to a total predicted loss of approximately four tons of sediment per year.

UT 8 Bobs Creek

Upstream Reach

The Upstream Reach appears to be a perennial stream that flows through a valley that is very confined in some sections and wider in other sections, allowing for some floodplain. Typically, the channel is a B type stream where the valley confines the stream and a C type stream where there is more room for floodplain development. There are long sections of the Upstream Reach that are very stable and show little to no degradation. These sections of the Upstream Reach are dominated by mature vegetation along the channel and valley side slopes. The vegetation provides soil and side slope stabilization while providing essential shading and biomass to the channel.

Although there are stable sections of the Upstream Reach, there are also many sections that display channel degradation. These degraded sections are primarily found where the channel has migrated to the valley side slope, in meander bends abutting the valley side slope, and in a series of tortuous meanders. The majority of erosion in the Upstream Reach is in the form of valley side slopes eroding during high flow events. The valley side slopes are eroding because the channel has migrated to the valley toe of slope, which does not allow for much if any floodplain on the valley toe of slope side of the channel. This scenario creates high stress on the valley and channel side slopes, leading to advanced rates of erosion. Similarly, there are numerous meander bends that abut the valley side slope without any floodplain on the outside of the meander bend, which also leads to advanced rates of erosion. Another primary source of channel degradation is found in a series of tortuous meanders. These meanders exhibit signs of side slope erosion, mass wasting, and undermining of mature vegetation along the channel banks. It appears that vegetation along the channel banks is failing and the potential for an avulsion is high. If the channel avulses through the existing meander, the channel slope will increase substantially through this section and the potential for further degradation of the invert and side slopes exists.

The channel substrate is dominated by gravel. However, the channel substrate exhibits more fine materials as it approaches the Downstream Reach, which seems to indicate that fine sediments from onsite degradation may be accumulating through the Reach.

An erosion rate study on the eroded banks revealed that a range of BEHI and NBS levels exist. BEHI ranges from Low to Very High and NBS ranges from Moderate to Extreme. The model predicts that a total of 0.14 tons/yr/ft of sediment are lost off of the studied banks leading to a total predicted loss of approximately 37.8 tons of sediment per year.

Downstream Reach

As a whole the Downstream Reach is a degraded gully (G type channel). Historically, before human disturbance, it appears that he channel may have been located approximately 100 feet to the west of its current location. It may have been relocated to its current location (at the toe of slope of a hill) to allow for more pasture/agricultural land. The historic valley of the Downstream Reach appears to be the floodplain of Bobs Creek, which is a broad gently sloping

landscape. It appears that the bankfull channel should be at a much higher elevation than it actually is. However, the channel has incised numerous feet through the landscape and has essentially created a valley within the incised channel. Numerous trees have lined the existing valley and channel banks through the reach. Although there are numerous trees through the Downstream Reach, there are still massive amounts of erosion from channel side slopes, channel invert, and valley side slopes. The channel appears to be expanding its belt width through the valley to allow for a more meandering system. This is causing large amounts of erosion along the valley side slopes during storm events.

The channel displays gravel in the substrate, however there is a noticeable degree of siltation through the Downstream Reach. Silt/sand accumulations it the channel are signs that degradation of channel and valley side slopes are filling pools and riffles and degrading aquatic habitat.

An erosion rate study on the eroded banks revealed that a range of BEHI and NBS levels exist. BEHI ranges from Moderate to Very High and NBS ranges from Low to Extreme. The model predicts that a total 0.11 tons/yr/ft of sediment are lost off of the studied banks leading to a total predicted loss of approximately 54 tons of sediment lost per year

3.8 Bankfull Verification

Bankfull indicators were identified along all studied reaches during field inspections. Table 11 shows estimated discharge rates and cross-sectional areas for only restored streams. Existing conditions surveys were conducted which included surveying representative riffle cross-sections, representative hydraulic (bankfull) slope, and determining an existing Manning's n coefficient for the surveyed reaches. The surveyed data and calculated Manning's n coefficient were correlated with identified bankfull indicators to estimate bankfull cross-sectional area and velocity, and consequently bankfull discharge. The estimated bankfull cross-sectional area and discharge were compared with a calculated bankfull cross-sectional area and discharge using both the *Bankfull Hydraulic Geometry Relationships for North Carolina Streams* (Harman, W. H. et al., 1999) (Piedmont Regional Curve) and *Bankfull Regional Curves for North Carolina Mountain Streams* (Harman, W. H. et al.) (Mountain Regional Curve).

Table 11. Site Stream Discharges and Areas

	Discharge BKF (cfs)			Area BKF (sq ft)		
	Piedmont Regional Curve	Mountains Regional Curve	Site Conditions	Piedmont Regional Curve	Mountains Regional Curve	Site Conditions
Bobs Creek	116.7	133.9	110	27.7	27.9	17.4
UT 8 Bobs Creek Upstream	17.8	18.4	15	4.7	4.7	4.4
UT 8 Bobs Creek Downstream	18.5	19.2	15	4.9	4.9	4.7

Data collected for Bobs Creek, and UT 8 Bobs Creek corresponded closely with the Piedmont Regional Curve giving a high level of confidence in data collected from site surveys.

3.9 Vegetation

Distribution and composition of plant communities reflect landscape-level variations in topography, soils, hydrology, and past or present land use practices. The Site is composed of pasture, scrub/shrub, and mature forest.

Pastureland is currently dominated by fescue (*Festuca* sp.) planted for grazing, in addition to opportunistic herbaceous species, and maintains little vegetative diversity. Forested areas adjacent to stream channels include forest ranging from disturbed areas to more diverse mature forest areas at the upper reaches. Species within forested areas include sourwood *(Oxydendrum arboreum*), red maple (*Acer rubrum*), oaks *(Quercus* spp.), ironwood (*Carpinus caroliniana*), tag alder (*Alnus serrulata*), sycamore (*Platanus occidentalis*), eastern red cedar (*Juniperus virginiana*), American holly (*Ilex opaca*), white pine (*Pinus strobus*), doghobble (*Leucothoe fontanesiana*), mountain laurel (*Kalmia latifolia*), American beech (*Fagus grandifolia*), tulip poplar (*Liriodendron tulipifera*), dogwood *(Cornus florida*), greenbrier (*Smilax* sp.), running cedar (*Licopodium digitatum*), muscadine (*Vitis rotundifolia*), azalea (*Rhododendron* sp.), and black cherry (*Prunus serotina*).

Invasive species identified within the project boundaries include Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa palustris*).

4.0 REFERENCE STREAMS

Two reference streams were used to assist in establishing project design parameters. Their descriptions are as follows.

4.1 Bobs Creek

A stable reach of Bobs Creek was surveyed on the Patton Property as a reference channel to be used for the design of Bobs Creek. The stable section of Bobs Creek is located immediately upstream of Bobs Creek's Middle Reach (upstream of the convergence with UT 7 Bobs Creek). The reference section of Bobs Creek has the same Valley Type (Valley Type VIII in the Rosgen Classification system) as the restored section of Bobs Creek.

4.1.1 Watershed Characterization

Bobs Creek's watershed is dominated by mature forest on hill slopes. The watershed is predominantly wooded with scattered areas of recently harvested timber and haul roads.

4.1.2 Channel Classification

Bobs Creek is classified as a C4 type channel.

4.1.3 Discharge

The bankfull discharge for Bobs Creek within the reference reach survey section was determined to be 70 cfs.

4.1.4 Channel Morphology

A Rosgen Level II stream assessment was completed for Bobs Creek. Surveys included profile and cross-sectional analysis, plan form analysis, bed material evaluation, and buffer assessment. A summary of morphological characteristics can be found in Morphological Characteristics Tables (Tables 8 through 10). These tables include a summary of dimension, profile, and pattern data to assist with the establishment of design parameters.

4.1.5 Channel Stability Assessment

The major components for stability assessment include determining if the channel is conveying its discharge and sediment load without aggrading or degrading. Evidence that a channel does not fit these criteria includes: bank degradation, channel incision, channel widening, channel aggradation, sediment loading within and/or outside of the channel banks, channel armoring, and sparse vegetation on the channel's banks.

A visual assessment accompanied by a morphological assessment using data collected during a Rosgen Level II survey was used to determine channel stability. These data can be found in the Morphological Characteristics Tables, Appendix 4 (Reference Site Photographs), and Appendix 5 (Reference Site NCDWQ Stream Classification Forms).

Bobs Creek was determined to be a stable C4 type channel that is transporting its flow and sediment supply while maintaining its dimension, pattern, and profile. Thick stands of vegetation were lining the channel banks and adjacent floodplain throughout the reach with the exception of a short ford crossing through a riffle area. The channel exhibits a continuous, stable plan form with frequent riffle-pool complexes that do not appear to be degrading or aggrading with fine sediments.

4.1.6 Bankfull Verification

Bankfull indicators were identified along Bobs Creek during field inspections. Existing condition surveys were conducted which included surveying representative riffle cross-sections, representative hydraulic (bankfull) slope, and determining an existing Manning's n coefficient for the surveyed reaches. The surveyed data and calculated Manning's n coefficient were correlated with identified bankfull indicators to estimate bankfull cross-sectional area and velocity, and consequently bankfull discharge. The estimated bankfull cross-sectional area and discharge were compared with a calculated bankfull cross-sectional area and discharge using both the *Bankfull Hydraulic Geometry Relationships for North Carolina Streams* (Harman, W. H. et al., 1999) (Piedmont Regional Curve) and *Bankfull Regional Curves for North Carolina Mountain Streams* (Harman, W. H. et al.) (Mountain Regional Curve). Data obtained from on-site falls within a level of confidence of the data obtained from the Piedmont regional curve.

4.1.7 Vegetation Community Types

Species adjacent to Bobs Creek and its floodplain include sourwood, red maple, sycamore, eastern red cedar, American holly, white pine, doghobble, American beech, tulip poplar, greenbrier, and black cherry.

4.2 UT 5 Bobs Creek

A stable reach of UT 5 Bobs Creek was surveyed on the Patton Property as a reference channel to be used for the design of UT 8 Bobs Creek. The reference section of UT 5 Bobs Creek has the same Valley Type (Valley Type II in the Rosgen Classification system) as the restored sections of UT 8 Bobs Creek.

4.2.1 Watershed Characterization

UT 5 Bobs Creek's watershed exhibits little to no recent human disturbance. The watershed drains off of a steep hill side and appears to be completely forested by mature trees (approximately 50 years old).

4.2.2 Channel Classification

UT 5 Bobs Creek is classified as an E/C4 type channel. The E/C descriptor is designated because the channel displays a width to depth ratio of 10.5 which would indicate that the channel could be classified as either an E or C type channel. The channel displays characteristics of both channel types such as small point bar development on some small meanders (indicative of C type channels) however some pools/meanders did not have noticeable point bar development.

It should be noted that the channel displays some attributes of a B type channel. Typically B type channels have low pool-to-pool spacing to dissipate energy through the bed form. This is common of channels found in steep valleys or channels in confined valleys where a meander pattern is not prevalent. The UT 5 Bobs Creek displays a pool to pool spacing to width ratio of 1.1 to 4.6, which is fairly low and common in B type channels found in physical settings similar to the UT 5 Bobs Creek area.

4.2.3 Discharge

The bankfull discharge for UT 5 Bobs Creek within the reference reach survey section was determined to be 13.4 cfs.

4.2.4 Channel Morphology

A Rosgen Level II stream assessment was completed for UT 5 Bobs Creek. Surveys included profile and cross-sectional analysis, plan form analysis, bed material evaluation, and buffer assessment. A summary of morphological characteristics can be found in Morphological Characteristics Tables (Tables 8 through 11). These tables include a summary of dimension, profile, and pattern data to assist with the establishment of design parameters.

4.2.5 Channel Stability Assessment

The major components for stability assessment include determining if the channel is conveying its discharge and sediment load without aggrading or degrading. Evidence that a channel does not fit these criteria includes: bank degradation, channel incision, channel widening, channel aggradation, sediment loading within and/or outside of the channel banks, channel armoring, and sparse vegetation on the channel's banks.

A visual assessment accompanied by a morphological assessment using data collected during a Rosgen Level II survey was used to determine channel stability. These data can be found in the Morphological Characteristics Tables, Appendix 4 (Reference Site Photographs), and Appendix 5 (Reference Site NCDWQ Stream Classification Forms).

UT 5 Bobs Creek was determined to be a stable E/C4 type channel that is transporting its flow and sediment supply while maintaining its dimension, pattern, and profile. Thick stands of vegetation were lining the channel banks and adjacent floodplain throughout the reach. The channel exhibits a continuous, stable plan form with frequent riffle-pool complexes that do not appear to be degrading or aggrading with fine sediments.

4.2.6 Bankfull Verification

Bankfull indicators were identified along UT 5 Bobs Creek during field inspections. Existing conditions surveys were conducted which included surveying representative riffle cross-sections, representative hydraulic (bankfull) slope, and determining an existing Manning's n coefficient for the surveyed reaches. The surveyed data and calculated Manning's n coefficient were

correlated with identified bankfull indicators to estimate bankfull cross-sectional area and velocity, and consequently bankfull discharge. The estimated bankfull cross-sectional area and discharge were compared with a calculated bankfull cross-sectional area and discharge using both the *Bankfull Hydraulic Geometry Relationships for North Carolina Streams* (Harman, W. H. et al., 1999) (Piedmont Regional Curve) and *Bankfull Regional Curves for North Carolina Mountain Streams* (Harman, W. H. et al.) (Mountain Regional Curve). Data obtained from on-site falls within a level of confidence of the data obtained from the Piedmont regional curve.

4.2.7 Vegetation Community Types

Species adjacent to UT 5 Bobs Creek and its floodplain include sourwood, red maple, sycamore, eastern red cedar, American holly, white pine, doghobble, mountain laurel, American beech, tulip poplar, azalea and black cherry.

5.0 Site Wetlands

5.1 Existing Jurisdictional Wetlands

Jurisdictional wetlands/hydric soils within the Site were delineated in the field following guidelines set forth in the *Corps of Engineers Wetlands Delineation Manual* and located using GPS technology with reported submeter accuracy during January 2009 (Environmental Laboratory 1987). Study area wetlands are considered palustrine systems, as defined by Cowardin et al. (1979). Wetlands are depicted on Sheets 1 and 1A.

Wetlands are defined by the presence of three criteria: hydrophytic vegetation, hydric soils, and evidence of wetland hydrology during the growing season (Environmental Laboratory 1987). Open water systems and wetlands receive similar treatment and consideration with respect to Section 404 review. Two wetland systems characterized by the North Carolina Wetland Assessment Method (NCWAM) as Bottomland Hardwood Forest wetlands are present within the Site (NCWFAT 2008); characteristics for each are given in the following table below. Routine Wetland Determination and Jurisdictional Determination data forms are included in Appendix 2.

Table 12. Wetland Characteristics

Wetland	Type	NC WAM Classification	Cowardin Classification*	Acreage
A	Floodplain Depression	Bottomland Hardwood Forest	PFO1B	0.02
B	Floodplain Depression	Bottomland Hardwood Forest	PFO1B	0.33
			TOTAL	**0.35**

*P = Palustrine, FO = Forested (1 = Broad-leaved deciduous), B = Saturated

5.2 Hydrological Characterization

Riparian wetlands within the Site receive hydrological inputs from periodic overbank flooding of Site tributaries, groundwater migration into the wetlands, upland/stormwater runoff, and, to a lesser extent, direct precipitation.

5.3 Soil Characterization

Onsite verification and ground-truthing of county soil survey map units were conducted in March 2009 by Grant Lewis, a licensed soil scientist, to refine soil map units and to locate hydric soil inclusions. Delineations of hydric soil limits (wetlands) within the Site can be found in Sheets 1 and 1A.. Hydric soil/jurisdictional wetland delineations are subject to United States Army Corps of Engineers (USACE) review and are expected to be confirmed in the field in the summer of 2009.

5.3.1 Taxonomic Classification

Detailed soil mapping indicates that hydric soils most likely of the Wehadkee series encompass approximately 0.35 acres within the Site. Soils of the Wehadkee series are characterized by

grayish-brown to dark gray with mottles consisting of fine sandy loam textured surface soils underlain by loam, sandy loam, or sandy clay loam textured soils.

5.3.2 Profile Description

A typical soil profile for Wehadkee soils within the Site proposed for riparian wetland preservationt is as follows.

- 0-8 inches 10 YR 5/2 sandy loam
- 8-17 inches 10 YR 4/1 loam
- 17-40 inches 10 YR 6/1 sandy clay loam

5.4 Plant Community Characterization

Existing vegetation within the Site is discussed in Section 3.9 (Vegetation). Vegetation within Site wetlands is identical to vegetation found adjacent to Site streams.

6.0 Reference Forest Ecosystem

A Reference Forest Ecosystem (RFE) is a forested area on which to model restoration efforts at the Site in relation to soils and vegetation. RFEs should be ecologically stable climax communities and should be a representative model of the Site forested ecosystem as it likely existed prior to human disturbances. Data describing plant community composition and structure should be collected at the RFEs and subsequently applied as reference data in an attempt to emulate a natural climax community. The RFE for this project is located throughout preservation areas within the Site. The RFE supports plant community and landform characteristics that restoration efforts will attempt to emulate. Tree and shrub species identified within the reference forest, outlined in Table 13, will be used in addition to other relevant species in appropriate Schafale and Weakley (1990) community descriptions.

Table 13. Reference Forest Ecosystem

Montane Alluvial Forest	
Canopy Species	**Understory Species**
red maple (*Acer rubrum*)	tag alder (*Alnus serrulata*)
American beech (*Fagus grandifolia*)	dogwood (*Cornus florida*)
tulip poplar (*Liriodendron tulipifera*)	ironwood (*Carpinus caroliniana*)
sourwood (*Oxydendron arboreum*)	American holly (*Ilex opaca*)
white pine (*Pinus strobus*)	eastern red cedar (*Juniperus virginiana*)
sycamore (*Platanus occidentalis*)	mountain laurel (*Kalmia latifolia*)
black cherry (*Prunus serotina*)	dog hobble (*Leucothoe fontanesiana*)
blackjack oak (*Quercus marilandica*)	rhododendron (*Rhododendron* sp.)
red oak (*Quercus* sp.)	wild azalea (*Rhododendron periclymenoides*)
black locust (*Robinia pseudoacacia*)	
hemlock (*Tsuga* sp.)	

7.0 PROJECT SITE RESTORATION PLAN

7.1 Stream Design

Sheets 3 through 3E and Sheet 4 depict the proposed mitigation actions. Stream reach locations are depicted on Sheet 2.

Bobs Creek

Upstream Reach

The Upstream Reach is currently a stable stream that will be preserved in perpetuity. A conservation easement will be placed along and adjacent to the channel to ensure long term protection of the channel and its adjacent riparian buffer.

Middle Reach

The proposed mitigation actions on the Middle Reach include excavating a bankfull bench along degraded and entrenched side slopes, placement of channel structures, matting channel banks, planting native vegetation, and exclusionary fencing. These actions warrant Enhancement I and Enhancement II mitigation for this reach.

Enhancement I areas will consist of the following actions. A bankfull bench will be graded along degraded portions of the channel where the bankfull elevation is below existing ground. One reason that degradation in these sections has occurred is because bankfull and higher flows are not accessing a floodplain. Excavating a floodplain bench will allow for energy dissipation of high flows on the floodplain and a large reduction in sediment loss from previously unstable banks. Stream structures will be placed in the channel in currently degraded areas to help turn high flows away from the banks (newly excavated side slopes). These structures will protect the side slopes and allow soil stabilization from vegetative plantings while creating a deep pool in the center of the structure. Pool formation from the structures will provide cover and spawning habitat for fish and other benthics in the channel. Native vegetation will be planted along the channel banks and in the riparian buffer (assuming the buffer is not currently vegetated with mature trees). Vegetation will provide essential root mass on the channel side slopes for stabilization and will also eventually provide channel shading and a source of biomass input into the channel. Planting vegetation in sections of the buffer that do not currently exhibit woody species will enhance terrestrial habitat by providing foraging areas and expanding habitat cover corridors. Fencing around the easement area will exclude buffalo from utilizing the Middle Reach as a watering and cooling source.

Enhancement I areas will consist of the following actions. Native vegetation will be planted along the channel banks and in the riparian buffer (assuming the buffer is not currently vegetated with mature trees). Fencing around the easement area will exclude buffalo from utilizing the Middle Reach as a watering and cooling source.

Downstream Reach
The proposed mitigation actions on the Downstream Reach include restoring a more natural pattern, profile and dimension that will transport its sediment and watershed flows without aggrading or degrading. Additionally, a native vegetative buffer will be planted adjacent to the channel, which will stabilize side slopes and barren soil as well as filter nutrients from adjacent active pasture land. A fence will be placed along the proposed easement to exclude buffalo from accessing the channel as a water source and cooling location.

After reviewing current site conditions it was determined that establishing a new channel at the low point of the valley away from the high terrace would be the most beneficial mitigation action for the Downstream Reach. The current channel abuts the terrace side slope with only mature trees holding soil intact. Excavating a bankfull bench along the existing pattern and rehabilitating the existing radii was considered an option through the Downstream Reach. However, if a bankfull bench and new radii were to be excavated, virtually every mature tree along the right bank would be removed. These trees were considered to be valuable assets of the Downstream Reach and need to be preserved if at all possible. The most viable option (the proposed option) is to move the channel to the low point of the valley (primarily towards the existing left portion of the valley) away from the terrace on the right hand side of the valley. The mature trees along the existing right bank will be kept in tact along with almost all of the trees within the low point of the valley. Restoring a new dimension, pattern, and profile will allow for a properly sized channel to be excavated ensuring stability immediately following restorative actions. The channel will be primarily a Priority I restoration where the bankfull elevation will be at or near existing ground, which will allow flood flows to access the floodplain. Utilizing the existing mature trees in the floodplain and along the terrace/existing channel side slope will provide immediate root stabilization to the restored channel and also provide much coveted shading and biomass to the channel.

Native riparian vegetation will be planted along the channel side slopes and buffer areas. Planting vegetation in sections of the buffer that do not currently exhibit woody species will enhance terrestrial habitat by providing foraging areas and expanding habitat cover corridors. Fencing around the easement area will exclude buffalo from utilizing the Lower Reach as a watering and cooling source.

UT 1 – UT 5 Bobs Creek
UT 1 through UT 5 Bobs Creek are all currently stable streams that will be preserved in perpetuity. A conservation easement will be placed along and adjacent to the channels to ensure long term protection of the channels and their adjacent riparian buffers.

UT 6 Bobs Creek
The majority of UT 6 Bobs Creek is a fairly stable channel with a mature forested buffer on the channel banks and riparian buffer. The stable sections of UT 6 Bobs Creek will be preserved in perpetuity through a perpetual conservation easement.

Three small sections of UT 6 Bobs Creek will be enhanced (Enhancement II) by matting and planting degraded channel banks. The degraded sections of channel banks are primarily on the outside of meander bends where the channel banks abut valley side slopes. Options that were considered for UT 6 Bobs Creek were to excavate bankfull benches at degraded banks and placement of channel structures to turn flows through the meander bends while protecting the banks. After reviewing site conditions it was determined that moving heavy equipment into UT 6 Bobs Creek for any excavation work, including structure placement would be detrimental to the existing forest buffer, would require massive amounts of cut into the adjacent hill slopes in order to create a bankfull bench and stable side slope, and in general the work would be difficult in nature due to the steepness and depth of the valley through which UT 6 Bobs Creek flows.

The proposed action is to use manual labor to shape existing side slopes and place matting on the slopes to deter erosion. Native vegetation will be planted along the degraded side slopes to promote root mass to stabilize soils and in turn the side slope.

UT 7 Bobs Creek

The majority of UT 7 Bobs Creek is a stable channel with a mature forested buffer on the channel banks and riparian buffer. The stable sections of UT 7 Bobs Creek will be preserved in perpetuity through a perpetual conservation easement. One small section of UT 7 Bobs Creek will be enhanced (Enhancement I) at a degraded meander bend. The proposed action is to place a structure at the meander bend to turn water away from the bank, mat the bank, and plant native vegetation on the side slopes to promote root mass growth for soil stabilization.

UT 8 Bobs Creek

Upstream Reach

The proposed mitigation actions on the Upstream Reach include Enhancement I level mitigation (excavating a bankfull bench along degraded and entrenched side slopes, placement of channel structures, matting channel banks, planting native vegetation) along select sections of channel and Restoration level mitigation (constructing a more natural pattern, profile and dimension that will transport its sediment and watershed flows without aggrading or degrading) through other, more extended sections of degraded channel.

Enhancement I level mitigation will occur on select short lengths of degraded channel. This will occur in two sections of channel primarily through meander bends. The proposed action through these sections is to grade a bankfull bench on outside meander bends to allow for energy dissipation of flood flows onto the floodplain. Stream structures will be placed in the channel to protect the excavated banks by turning water towards the inside bend and create a scour pool in the downstream direction. Matting and native plants will be placed on the excavated side slopes and bankfull bench to promote root stabilization.

Restoration level mitigation will occur on two extended sections of degraded channel through the Upstream Reach. In both reaches the primary reason for proposing restoration was to move the

existing channel away (towards the center of valley, also the left bank of the channel) from the valley side slope to allow for overbank floodplain relief, which is in contrast to the existing conditions that exhibit no floodplain relief on the right bank side of the channel. Restoring a new dimension, pattern, and profile will allow for a properly sized channel to be excavated ensuring stability immediately following restorative actions. The channel will be primarily a Priority I restoration where the bankfull elevation will be at or near existing ground, which will allow flood flows to access the floodplain and not be forced on the side slope of the valley. Existing mature vegetation will largely be kept intact with only one tree over 10 inches in diameter expected to be lost during construction. Maintaining the exiting mature vegetation in the valley is a critical component of the design. Utilizing exiting trees will help provide immediate stabilization from roots and also maintain a shaded stream corridor.

Restoration level mitigation is also proposed for the section of channel that currently displays a series of degrading tortuous meanders. The proposed channel alignment maintains the general meander path of the channel, however radii, meander lengths, and belt widths that are more consistent with a stable channel will be constructed to ensure channel stability. This section also moves the channel meanders off of the valley side slope which will allow the channel to access the floodplain on both the left and right banks rather directing flows that are above bankfull into the valley side slope.

Native riparian vegetation will be planted along the channel side slopes and buffer areas. Planting vegetation in sections of the buffer that do not currently exhibit woody species will enhance terrestrial habitat by providing foraging areas and expanding habitat cover corridors.

Downstream Reach

The proposed mitigation action for the Downstream Reach is to restore a more natural pattern, profile and dimension that will transport its sediment and watershed flows without aggrading or degrading completely offline of the existing channel and existing valley.

The existing gullied channel and its corresponding valley are incised in the landscape and have been relocated from the channels historic valley. It is not believed that the current location of the channel is its natural or historic location in the landscape, and therefore will not be utilized for the channels restoration. The proposed action will relocate the restored channel approximately 100 feet west of its current location to what is believed to be the historic valley of the channel. Restoring a new dimension, pattern, and profile will allow for a properly sized channel to be excavated ensuring stability immediately following restorative actions. The channel will be restored as both a Priority I and Priority II restoration. Priority II restorations require a bankfull bench to be excavated at the bankfull elevation. A Priority I restoration has the bankfull elevation at or near existing ground, which will allow flood flows to access the floodplain. Priority II restoration sections will occur at the beginning of the reach and will be maintained until the bankfull elevation “rises” to the point at which it is at existing ground. Priority I

restoration sections will be maintained for almost 200 feet until the channel begins to step down to match the invert elevation of Bobs Creek.

The new location of the restored channel will flow through existing pasture land that exhibits no mature vegetation. Native riparian vegetation will be planted along the channel side slopes and buffer areas. Vegetative plantings will enhance terrestrial habitat by providing foraging areas and expanding habitat cover corridors.

7.2 Restoration Site Goals and Objectives

The Muddy Creek Restoration Partnership (Partnership) was formed in 1998 to address impacts to the Muddy Creek Watershed. The Partnership completed the Muddy Creek Watershed Restoration Initiative Feasibility Report and Restoration Plan (Watershed Plan) for the Muddy Creek Watershed in December of 2003. Since 2004 the North Carolina Ecosystem Enhancement Program (EEP) has informally participated in the Partnership by implementing priority projects named by the partnership and adopted the 2003 report as part of its Local Watershed Plan (LWP). The EEP's Upper Catawba River Basin Restoration Priorities (2009) identifies North Muddy Creek as a Targeted Local Watershed (TLW). The Bobs Creek Stream and Wetland Restoration Site is located within the North Muddy Creek Watershed. In 2008 the EEP contracted with a consulting firm to conduct outreach programs with landowners and identify additional project sites in the Muddy Creek Watershed.

The Site was identified as part of that effort. The primary goals of the project focus on improving water quality by reducing nutrient loading from the on-site buffalo and horse operation, reducing excess sedimentation input from site channel banks and hill slopes, increasing the attenuation of floodwater flows, and restoring and enhancing aquatic and riparian habitat. These goals will be accomplished through the following objectives:

- Reduce point (i.e. cattle directly accessing the channel) and non-point source (i.e. stormwater runoff through pastures) pollution associated with an on-site buffalo and horse operation by exclusionary fencing from the stream and riparian buffer, and by providing a vegetative buffer on stream banks and adjacent floodplains to treat nutrient enriched surface runoff from adjacent pastureland.
- Stabilize degraded portions of on-site streams, to reduce sediment inputs. Stabilization methods will include:
    1. Restoring a stable dimension, pattern, and profile to selected sections of channels to ensure the channel will transport and attenuate watershed flows and sediment loads without aggrading or degrading.
    2. Stabilize selected channel banks by excavating bankfull benches, placing stream structures to reduce shearing forces on outside meander bends, and planting native vegetative species to provide soil stability.
    3. Stabilize selected channel banks by matting and planting native vegetative species to establish root masses along channel and valley side slopes.

- Improve aquatic habitat by enhancing stream bed variability, providing shading/cover areas within the stream channel, and introducing woody debris in the form of rootwads, log vanes, and log sills.
- Diversify aquatic habitat by creating floodplain oxbows that will be breeding grounds for amphibians and also store overbank flows from adjacent stream channels.
- Enhancing fish passage within Bobs Creek and UT 8 Bobs Creek. This is accomplished by removing livestock fencing that has become clogged with debris on Bobs Creek, and restoring UT 8 Bobs Creek and replacing an existing perched culvert to allow fish passage upstream.
- Enhancing riparian wildlife habitat by fencing livestock out of existing and restored riparian buffers as well as installing alternative watering devices that will ensure livestock have sufficient watering areas. This is detailed further in the Farm Management Plans completed for the site by EEP.
- Enhance wildlife habitat by vegetating existing denuded riparian buffers with native trees, shrubs, herbs and grasses. Forest vegetation species were selected by studying a Reference Forest Ecosystem located on-site and reviewing Montane Alluvial Forest species listed in *Classification of the Natural Communities of North Carolina: Third Approximation* (Schafale and Weakley 1990).
- Create wildlife corridors through agricultural lands which have significantly dissected the landscape. The corridors will provide connectivity to a diversity of habitats including mature forest, early successional forest, stream-side forest, riparian wetlands, and uplands.

7.2.1 Designed Channel Classification

All streams were designed using Natural Channel Design principals. The Morphological Characteristics Tables detail channel classification and variables used to classify the design channels.

Bobs Creek

Bobs Creek is designed as a C4 type stream channel with a moderately high width-to-depth ratio (14). This channel type is consistent with the reference stream's (Bobs Creek) channel type. Additionally, the restored section of Bobs Creek and the reference section of Bobs Creek are both flowing through a Valley Type VIII. C type channels are typically found in a Valley Type VIII. The 4 designation denotes that sediment in the channel will be dominated by gravel.

UT 8 Bobs Creek

UT 8 Bobs Creek is designed as an E/C 4 type channel with a moderate width-to-depth ratio of 10.5. This channel type is consistent with the reference stream's (UT 5 Bobs Creek) channel type. Additionally, both UT 2 Walton Crawley Branch and UT 5 Bobs Creek are flowing through a Valley Type II. C type channels with relatively low entrenchment ratios and low pool to pool spacing can be found within a Valley Type II.

7.2.2 Target Wetland Communities/Buffer Communities

Onsite buffer areas targeted for restoration and enhancement have endured significant disturbance from land use activities such as land clearing, livestock grazing, and other anthropogenic maintenance. These areas will be revegetated with native forest species typical of buffer communities in the region. Emphasis will focus on developing a diverse plant assemblage. There are two target buffer communities (Montane Alluvial Forest and Streamside Assemblage). These communities are consistent with reference communities that were found within the site boundaries.

7.3 Sediment Transport Analysis

One of the primary goals of this Project is to construct a stable channel that will transport its sediment and flow such that, over time, the stream system neither aggrades nor degrades. This stability is achieved when the sediment input to the design reach equals the sediment output. The following are discussions of the sediment transport analysis conducted on Bobs Creek and UT 8 Bobs Creek.

Bobs Creek and UT 8 Bobs Creek

It is common practice in gravel bed streams to study the competency of the stream's ability to entrain the largest sized particle during bankfull flows for stability analysis. The primary factor studied is shear stress of the bankfull channel. The bankfull mean depth and slope are the two primary variables used to determine if the channel has the competency to entrain its largest particle size under bankfull flows. Entrainment calculations for both existing and proposed conditions on Bobs Creek and UT 8 Bobs Creek are included as Appendix 9.

In summary, Bobs Creek existing conditions exhibits an excess amount of shear stress (1.00 lb/ft^2) during bankfull flows as evidenced by an average slope that is too steep (1.49 percent) and mean depth that is shallow (1.08 ft). The proposed design substantially lowers the shear stress to 0.54 lb/ft^2, by lowering the bankfull slope to 0.70 percent, and lowering the mean depth to 1.25 ft. The proposed shear stress will entrain a particle size between 41 and 96 mm as predicted by the Shields Diagram and Revised Shields Diagram by Rosgen, respectively. The site's largest particle size is 82 mm, which would indicate that the proposed channel dimensions and slope are adequate to transport sediment input through the reach.

UT 8 Bobs Creek's existing conditions exhibits an excess amount of shear stress (0.56 lb/ft^2) during bankfull flows as evidenced by an average slope that is too steep (1.48 percent) and mean depth that is shallow (0.70 ft). The proposed design lowers the shear stress to 0.18 lb/ft^2 by lowering the bankfull slope to 0.40 percent, and lowering the mean depth to 0.76 ft. The proposed shear stress will entrain a particle size between 13 and 42 mm as predicted by the Shields Diagram and Revised Shields Diagram by Rosgen, respectively. The site's largest particle size is 30 mm which would indicate that the proposed channel dimensions and slope are adequate to transport sediment input through the reach.

7.3.1 Methodology

See section 7.3 Sediment Transport Analysis for a discussion of methodologies.

7.3.2 Calculations and Discussion

See section 7.3 Sediment Transport Analysis for a summary of calculations and a discussion of results. See Appendix 9 for sediment transport calculations.

7.4 HEC-RAS Analysis

Given that the project involves modifications to a stream channel, it is important to analyze the effect of these changes on flood elevations. Floodwater elevations were analyzed using HEC Hydrologic Engineering Center's River Analysis System (HEC-RAS Version 3.1.3). HEC-RAS is a software package designed to perform one-dimensional, steady flow, analysis of water surface profiles for a network of natural and constructed channels.

HEC-RAS uses two equations, energy and/or momentum, depending upon the water surface profile. The model is based on the energy equation. The energy losses are evaluated by friction (Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is used in situations where the water surface profile rapidly varies, such as hydraulic jumps and stream junctions.

Backwater analysis was performed for the existing and proposed conditions for both bankfull and 100-year discharges. In addition to steady flow data, geometric data is also required to run HEC-RAS. Geometric data consists of establishing the connectivity of the river system, which includes cross-section data, reach lengths, energy loss coefficients (friction losses, contraction, and expansion losses), and stream junction information.

7.4.1 Bankfull Discharge Analysis

Bankfull indicators were identified along all restored reaches during field inspections. Existing conditions surveys were conducted which included surveying representative riffle cross-sections, representative hydraulic (bankfull) slope, and determining an existing Manning's n coefficient for the surveyed reaches. The surveyed data and calculated Manning's n were correlated with identified bankfull indicators to estimate bankfull cross-sectional area and velocity, and consequently bankfull discharge. The estimated on-site bankfull cross-sectional area and discharge were compared with a calculated bankfull cross-sectional area and discharge using the Piedmont Regional Curve and Mountain Regional Curve. Data obtained from on-site falls within a level of confidence of the data obtained from the Piedmont regional curve.

HEC-RAS (HEC-RAS Version 3.1.3, see Section 7.4) was used to evaluate how the discharge of each restored channel flows within the proposed channel geometry. This evaluation verifies that the proposed plan, dimension, and profile would adequately convey the discharge at the bankfull stage; the point where water begins to overflow onto the floodplain.

7.4.2 No-Rise

A HEC-RAS analysis has been prepared and completed on existing and proposed conditions of the project channel(s). The resulting data output has been analyzed to determine if the design channel is adequately conveying its bankfull discharge, and to determine if a rise, fall, or no-rise in water surface elevations during the 100-year flood event has occurred.

The analysis indicates that the proposed channel geometry will not increase the 100-year flood elevations upstream of the project area. Results are located within the HEC-RAS Summary Table in Appendix 6.

7.4.3 Hydrologic Trespass

Hydrologic trespass includes any issue which may affect hydrology outside of the property boundaries on which the Site is located. These issues were reviewed for this project. All on-site modifications should not affect offsite hydrology.

7.5 Stormwater Best Management Practices

No stormwater best management practices are proposed for this Site.

7.6 Soil Restoration

An effort will be made to reuse excavated topsoil in areas disturbed during construction activities. Replacing topsoil will allow for a better medium for planted trees and grass/herbaceous seeds to thrive. In areas where topsoil is not feasible to be reused soil amendments will be utilized to add much need nutrients for plant and grass growth.

7.6.1 Topsoil Stockpiling

Soil grading will occur during stream restoration activities. Topsoils may be stockpiled during construction activities and will be respread on the soil surface once critical subgrade has been established. The replaced topsoil will provide nutrients, serve as a viable growing medium for community restoration, and aid in the survival of planted species.

7.6.2 Floodplain Soil Scarification

Microtopography and differential drainage rates within localized floodplain areas represent important components of floodplain functions. Reference forests in the region exhibit complex surface microtopography. Efforts to advance the development of characteristic surface microtopography will be implemented; in areas where soil surfaces have been compacted, ripping or scarification will be performed. After construction, the soil surface is expected to exhibit complex microtopography ranging up to one foot in vertical asymmetry. Subsequently, plant community restoration will be initiated.

7.7 Natural Plant Community Restoration

Restoration of floodplain forest and stream-side habitat allows for development and expansion of characteristic species across the landscape. Ecotonal changes between community types contribute to diversity and provide secondary benefits, such as enhanced feeding and nesting opportunities for mammals, birds, amphibians, and other wildlife.

Reference Forest Ecosystem (RFE) data, on-site observations, and community descriptions from *Classification of the Natural Communities of North Carolina* (Schafale and Weakley 1990) were used to develop the primary plant community associations that will be promoted during community restoration activities.

Stream-side trees and shrubs include species with high value for sediment stabilization, rapid growth rate, and the ability to withstand hydraulic forces associated with bankfull flow and overbank flood events. Stream-side trees and shrubs will be planted within 15 feet of the channel throughout the meander belt-width. Shrub elements will be planted along the reconstructed stream banks, concentrated along outer bends. Montane Alluvial Forest is targeted for the remainder of the Site (Sheet 5). The following planting plan is the blueprint for community restoration.

7.7.1 Planting Plan

The purpose of a planting plan is to reestablish vegetative community patterns across the landscape. The plan consists of 1) acquisition of available plant species, 2) implementation of proposed Site preparation, and 3) planting of selected species. Species selected for planting will be dependent upon availability of local seedling sources. Advance notification to nurseries (one year) will facilitate availability of various noncommercial elements.

Bare-root seedlings of tree species will be planted within specified map areas at a density of approximately 680 stems per acre on 8-foot centers. Shrub species in the stream-side assemblage will be planted at a density of 2720 stems per acre on 4-foot centers. Table 14 depicts the total number of stems and species distribution within each vegetation association. Planting will be performed between December 1 and March 15 to allow plants to stabilize during the dormant period and set root during the spring season.

Table 14. Planting Plan

Montane Alluvial Forest										**Acres**	**1.81**
Species	**Common Name**	**Max Space (Ft)**	**Unit Type***	**Size****	**Stratum**	**Indiv. Space (Ft)**	**% of Total**	**# of Stems**	**lbs per Acre**	**Total lbs**	
Betula nigra	River birch	8	R	2 -3'	Canopy	8	15	185			
Carpinus caroliniana	Ironwood	8	R	2 -3'	Subcanopy	8	15	185			
Cornus amomum	Silky dogwood	8	R	2 -3'	Shrub	8	5	62			
Fagus grandifolia	American beech	8	R	2 -3'	Canopy	8	15	185			
Kalmia latifolia	Mountain laurel	8	R	2 -3'	Shrub	8	5	62			
Leucothoe fontanesiana	Doghobble	8	R	2 -3'	Shrub	8	10	123			
Platanus occidentalis	Sycamore	8	R	2 -3'	Canopy	8	20	246			
Rhodedendron maximum	Great laurel	8	R	2 -3'	Shrub	8	15	185			
Panicum virgatum	Switchgrass		S		Herb		15		30	8	
Sorghastum nutans	Indiangrass		S		Herb		20		30	10	
Andropogon gerardii	Big bluestem		S		Herb		15		30	8	
Andropogon virginicius	Broomsedge bluestem		S		Herb		15		30	8	
Tripsicum dactyloides	Gamagrass		S		Herb		15		30	8	
Tridens flavus	Purpletop		S		Herb		20		30	10	
						Subtotal		**1233**		**54**	

Table 14. Planting Plan (Continued)

Streamside Assemblage										**Acres**	**0.29**
Species	**Common Name**	**Max Space (Ft)**	**Unit Type***	**Size****	**Stratum**	**Indiv. Space (Ft)**	**% of Total**	**# of Stems**	**lbs per Acre**	**Total lbs**	
Cornus amomum	Silky dogwood	4	R	2'	Subcanopy	4	25	196			
Leucothoe fontanesiana	Doghobble	4	R	2'	Shrub	4	25	196			
Alnus Serrulata	Tag alder	4	L	2'	Subcanopy	4	25	196			
Salix nigra	Black willo	4	R	2'	Subcanopy	4	25	196			
Carex vulpinoidea	Fox sedge		S		Herb		20		30	6	
Andropogon gerardii	Big bluestem		S		Herb		20		30	6	
Elymus virgatum	Virginia wildrye		S		Herb		15		30	5	
Panicum virgatum	Switchgrass		S		Herb		15		30	5	
Juncus effusus	Soft rush		S		Herb		10		30	3	
Dichanthelium clandestinum	Deetrongue		S		Herb		20		30	6	
						Subtotal		**444**		**31**	
						Total					**2.10**

* Unit Type choices inlcude: Transplant (T), Lives stake (L), Ball and Burlap (B), Pot (P), Tubling (T), Bare Root (R), Mechanically Planted (M), and Seed (S)

** Size units may vary, but must be stated.

7.8.2 Nuisance Species Management

Beavers, nonnative floral species, and other potential nuisance species will be monitored over the course of the 5-year monitoring period. Appropriate actions will be taken to ameliorate any negative impacts regarding vegetation development and/or water management on an as-needed basis. Existing nuisance species that may be required to be managed include Chinese privet and multiflora rose.

7.9 Farm Management Plan and Watering Devices

EEP has completed a farm management plan that will assist the land owner in managing his property in a more environmentally sensitive manner. Included in the farm management plan is exclusionary fencing to remove and keep livestock from accessing on-site stream channels and wetlands. Additionally, alternative watering devices are to be installed within the pastures to ensure livestock are able to access water without entering on-site streams.

8.0 PERFORMANCE CRITERIA

Monitoring of restoration efforts will be performed until success criteria are fulfilled. Monitoring is proposed for the stream channel, wetland hydrology, and vegetation. In general, the restoration success criteria, and required remediation actions, are based on the *Stream Mitigation Guidelines* (USACE et al. 2003).

8.1 Streams

The restored stream reaches are proposed to be monitored for geometric activity. Annual fall monitoring will include development of channel cross-sections on riffles and pools and a water surface profile of the channel. The data will be presented in graphic and tabular format. Data to be presented will include 1) cross-sectional area, 2) bankfull width, 3) average depth, 4) maximum depth, 5) width-to-depth ratio, 6) meander wavelength, 7) belt-width, 8) water surface slope, and 9) sinuosity. The stream will subsequently be classified according to stream geometry and substrate (Rosgen 1996). Significant changes in channel morphology will be tracked and reported by comparing data in each successive monitoring year. A photographic record that will include preconstruction and postconstruction pictures has been initiated with current Site photographs (Appendix 1).

8.1.1 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.

For Restoration or Enhancement I components, 3,000 linear feet or less, the entire length of channel will be surveyed on an annual basis in order to track changes in channel geometry, profile, or substrate. For segments in excess of 3,000 linear feet, 30 percent of the length or 3,000 linear feet (whichever is greater) shall be surveyed to track changes The following table will be used to determine the amount of cross-sections to be surveyed per reach:

Segment/Reach			Segment/Reach		
Footage	# Riffle	# Pool	Footage	# Riffle	# Pool
500 or Less	Visual	Visual	4001 – 4500	5	3
501 – 1000	3	1	4501 – 5000	5	4
1001 – 1500	3	2	5001 – 5500	6	4
1501 – 2000	3	2	5501 – 6000	7	4
2001 – 2500	3	2	6001 – 6500	8	4
2501 – 3000	4	2	6501 – 7000	9	5
3001 – 3500	4	2	7001 – 10,000	10	5
3501 – 4000	4	3	10,000 or >	14	6

These data will be utilized to determine the success in restoring stream channel stability. Specifically, the width-to-depth ratio and bank-height ratios should be indicative of a stable or moderately unstable channel with 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. 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.

8.1.2 Stream Dimension

General maintenance of a stable cross-section and hydrologic access to the floodplain features over the course of the monitoring period will generally represent success in dimensional stability. Some changes in dimension (such as lowering of bankfull width) should be expected. Key parameters such as cross-sectional area and the channel's width to depth ratio should demonstrate modes overall change. Riffle sections should generally maintain a Bank Height ration approaching 1.0, with some variation in this ration naturally occurring. Pool sections naturally adjust based on recent flows and time between flows, therefore more leeway on pool section geometry is expected.

8.1.3 Stream Pattern and Profile

The profile should not demonstrate significant trends towards degradation or aggradation over a significant portion of a reach. Additionally, bed form variables should remain noticeably intact and consistent with original design parameters that were based off of reference conditions.

Pattern features should show little adjustment over the standard 5 year monitoring period and will be monitored to ensure adjustment is minor prior to close out.

8.1.4 Substrate

Substrate measurements should indicate the progression towards or the maintenance of the known distributions from the design phase.

8.1.5 Sediment Transport

There should be an absence of any significant trend in the aggradational or depositional potential of the channel.

8.1.6 Hydraulics

A minimum of two bankfull events must be documented within the standard 5 year monitoring period. The two bankfull events shall occur within separate years.

8.1.7 Stream Contingency

In the event that stream success criteria are not fulfilled, a mechanism for contingency will be implemented. Stream contingency may include, but may not be limited to 1) structure repair

and/or installation; 2) repair of dimension, pattern, and/or profile variables; and 3) bank stabilization. The method of contingency is expected to be dependent upon stream variables that are not in compliance with success criteria. Primary concerns, which may jeopardize stream success include 1) structure failure, 2) headcut migration through the Site, and/or 3) bank erosion.

Structure Failure

In the event that structures are compromised the affected structure will be repaired, maintained, or replaced. Once the structure is repaired or replaced, it must function to stabilize adjacent stream banks and/or maintain grade control within the channel. Structures which remain intact, but exhibit flow around, beneath, or through the header/footer will be repaired by excavating a trench on the upstream side of the structure and reinstalling filter fabric in front of the pilings. Structures which have been compromised, resulting in shifting or collapse of header/footer, will be removed and replaced with a structure suitable for Site flows.

Headcut Migration Through the Site

In the event that a headcut occurs within the Site (identified visually or through measurements [i.e. bank-height ratios exceeding 1.4]), provisions for impeding headcut migration and repairing damage caused by the headcut will be implemented. Headcut migration may be impeded through the installation of in-stream grade control structures (boulder sill, rip-rap sill, rock cross vane, and/or log cross-vane weir) and/or restoring stream geometry variables until channel stability is achieved. Channel repairs to stream geometry may include channel backfill with coarse material and stabilizing the material with erosion control matting, vegetative transplants, and/or willow stakes.

Bank Erosion

In the event that severe bank erosion occurs within the Site, resulting in elevated width-to-depth ratios, contingency measures to reduce bank erosion and width-to-depth ratio will be implemented. Bank erosion contingency measures may include the installation of log-vane weirs and/or other bank stabilization measures. If the resultant bank erosion induces shoot cutoffs or channel abandonment, a channel may be excavated which will reduce shear stress to stable values.

8.2 Wetlands

Wetland mitigation areas within the Site boundaries consist of existing wetlands that currently satisfy the three parameter approach for identifying wetlands. These wetlands are proposed for preservation. No modifications or enhancement of these wetlands are proposed, therefore monitoring is not recommended.

8.3 Vegetation

Restoration monitoring procedures for vegetation will monitor plant survival and species diversity. After planting has been completed in winter or early spring, an initial evaluation will

be performed to verify planting methods and to determine initial species composition and density. Supplemental planting and additional modifications will be implemented, if necessary. A photographic record of plant growth should be included in each annual monitoring report.

During the first year, vegetation will receive a cursory, visual evaluation on a periodic basis to ascertain the degree of overtopping of planted elements by nuisance species. Subsequently, quantitative sampling of vegetation will be performed as outlined in the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee et al. 2006) in September of the first monitoring year and annually between June 1 and September 30 for the remainder of the monitoring period until vegetation success criteria are achieved.

During quantitative vegetation sampling in early fall of the first year, sample plots (10 meters by 10 meters) will be randomly placed within the restored buffer on-site; however, best professional judgment may be necessary to establish vegetative monitoring plots upon completion of construction activities. The amount of vegetation plots to be determined will be calculated using the CVS protocol based on the final acreage of vegetation plantings. In each sample plot, vegetation parameters to be monitored include species composition and species density.

8.3.1 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. An average density of 320 stems per acre of planted stems must be surviving in the first three monitoring years. Subsequently, 290 planted stems per acre must be surviving in year 4 and 260 planted stems per acre in year 5.

8.3.2 Vegetation Contingency

If vegetation success criteria are not achieved based on average density calculations from combined plots over the entire restoration area, supplemental planting may be performed with tree species approved by regulatory agencies. Supplemental planting will be performed as needed until achievement of vegetation success criteria.

8.4 Scheduling and Reporting

The first year monitoring report will be submitted at the end of December after Site implementation. Monitoring will continue for five years or until agreed upon success criteria are achieved, with a report submitted by the end of December for each monitoring year.

9.0 REFERENCES

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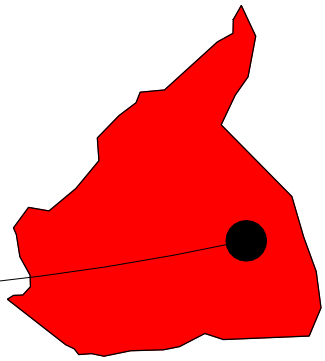
McDowell County
North Carolina



PROJECT AREA

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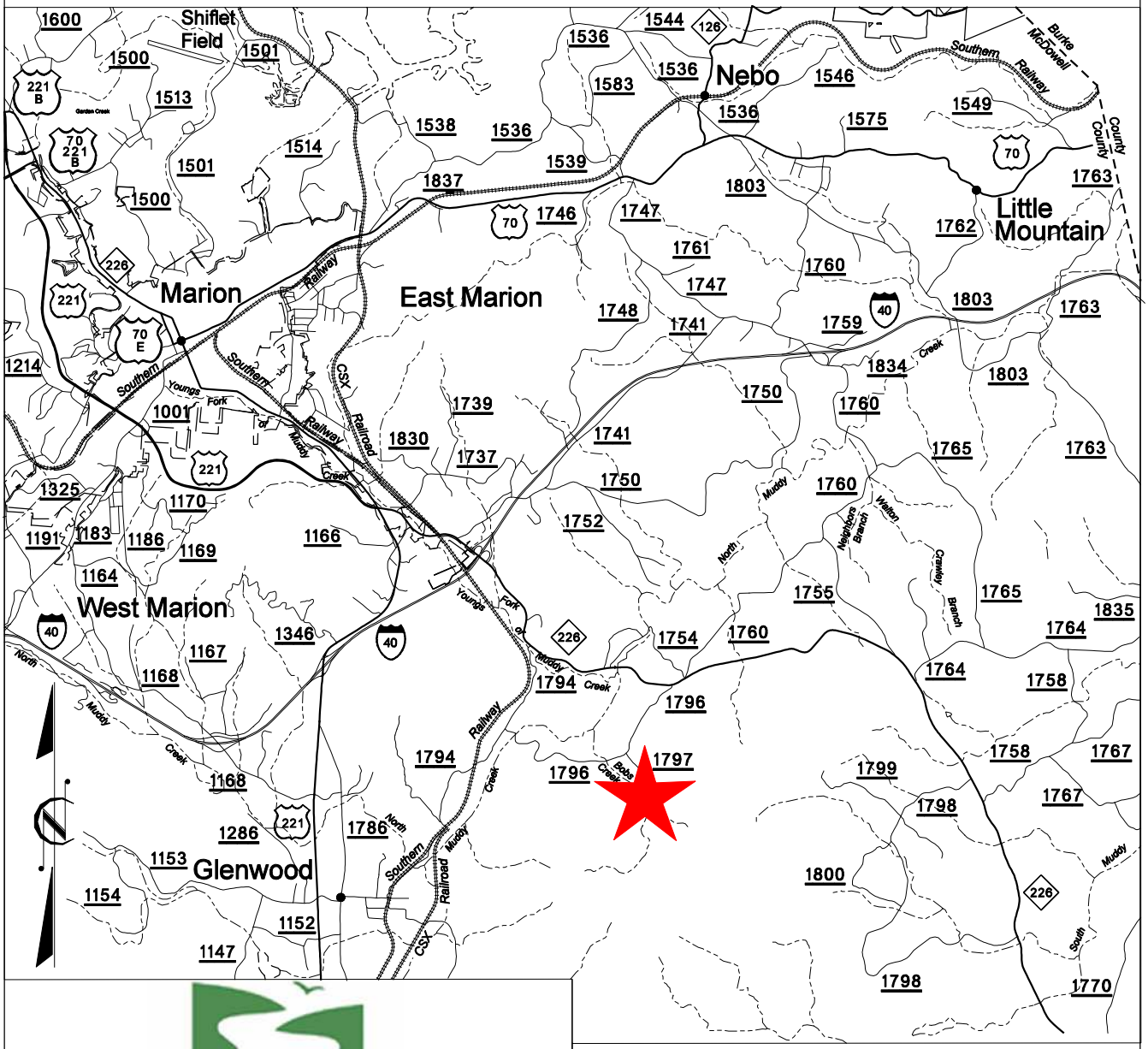

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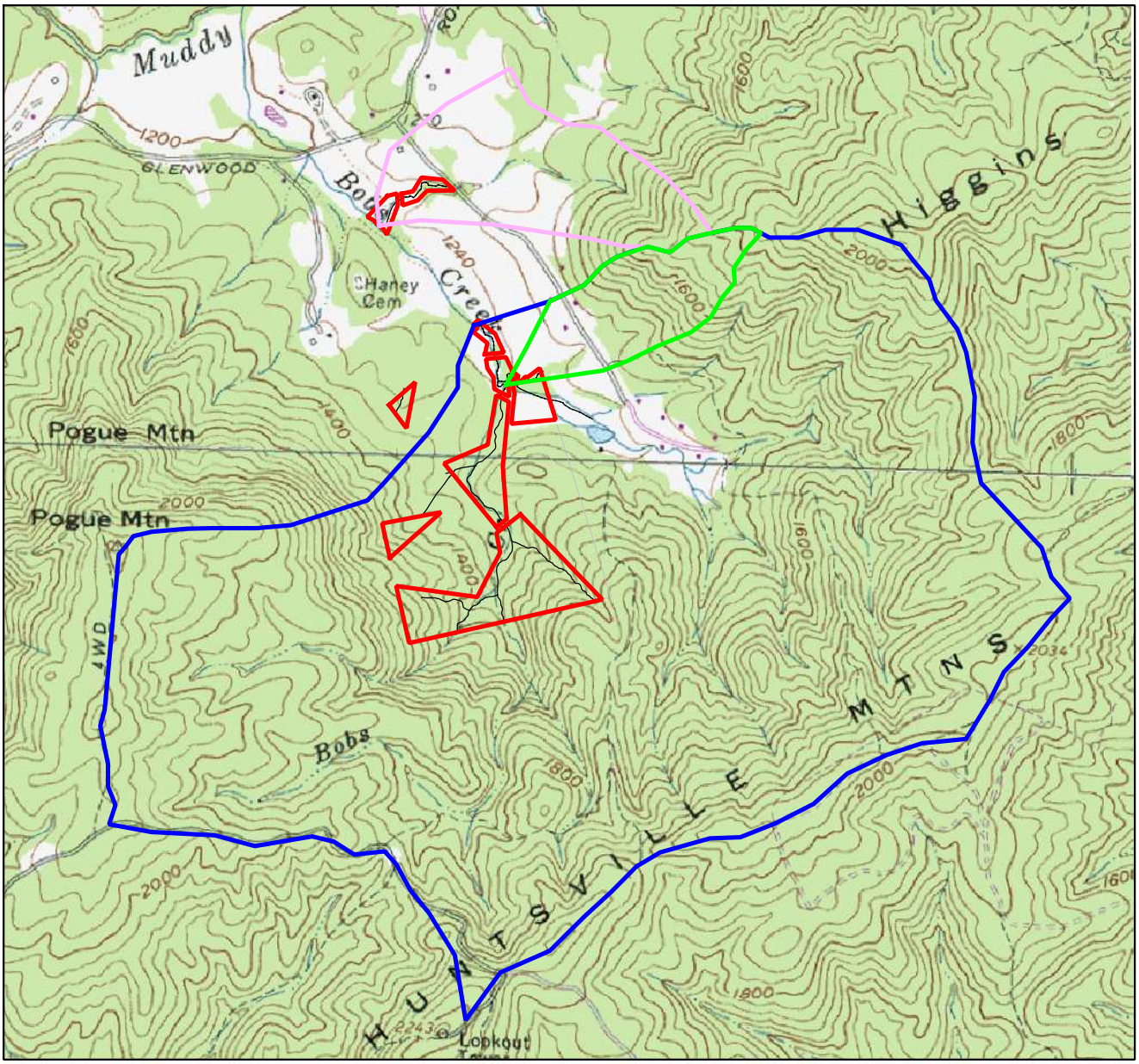
Vicinity Map

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

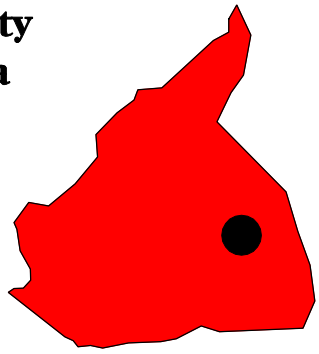
Date: 12/21/09	Figure: 1



LEGEND

- Bobs Creek Watershed (1.50 Sq. Miles)
- UT–6 Bobs Creek Watershed (0.06 Sq. Miles)
- UT–8 Bobs Creek Watershed (0.11 Sq. Miles)
- Proposed Easement

McDowell County North Carolina



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FEET

Watershed Map

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

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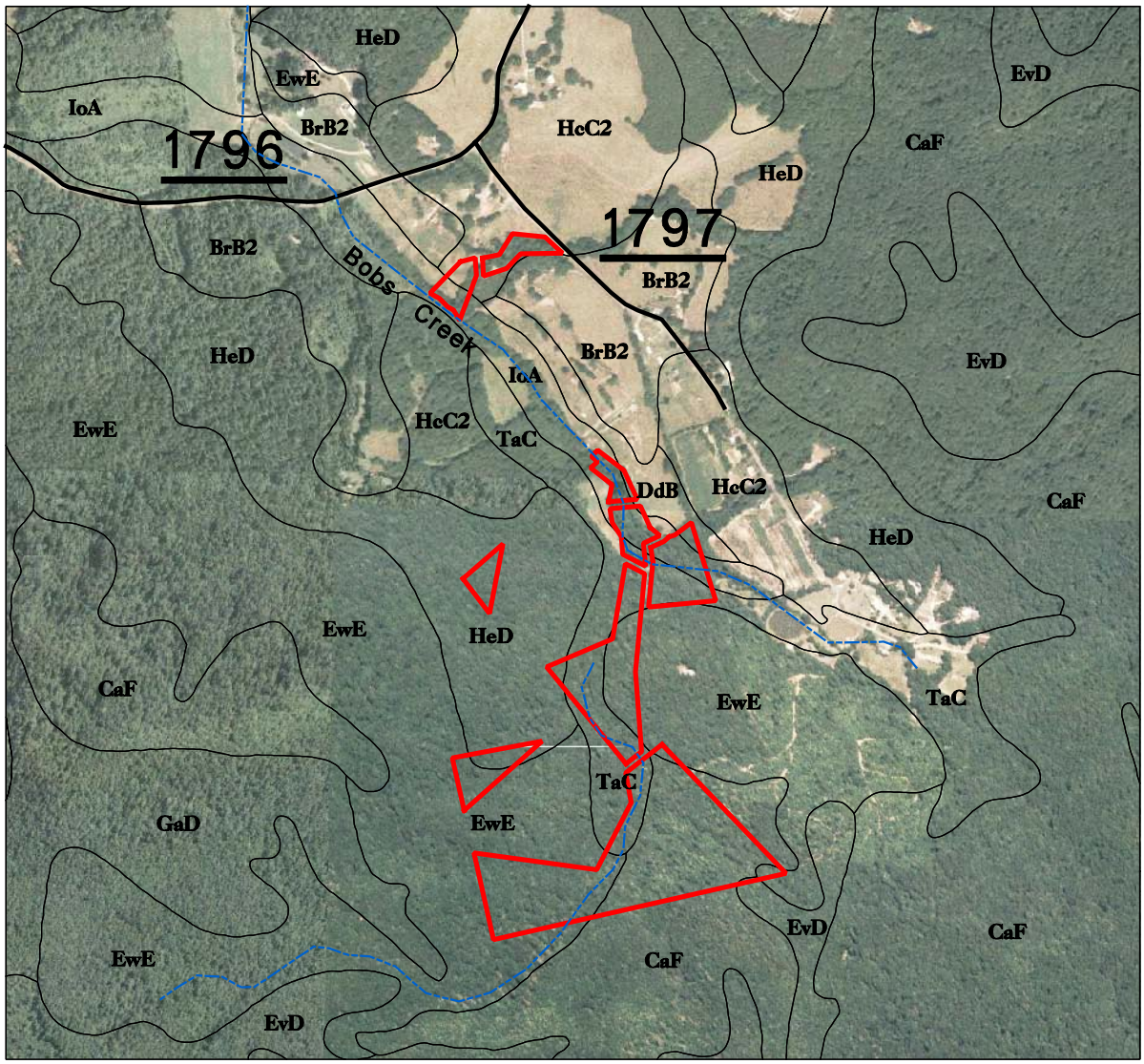
Date: 12/21/09

Figure: 2



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LEGEND

Symbol	Name	Symbol	Name
CaF -	Chestnut - Ashe	HeD -	Hayesville-Evard
DdB -	Dillard Loam	IoA -	Iotla
EwE -	Evard - Cowee	TaC -	Tate Loam
EvD -	Evard Loam	-	Proposed Easement
HcC2 -	Hayesville Clay Loam		

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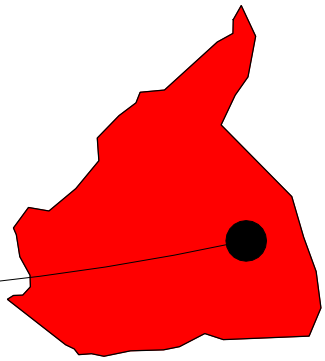
Soil Survey Map

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09

Figure: 3

McDowell County
North Carolina



PROJECT AREA

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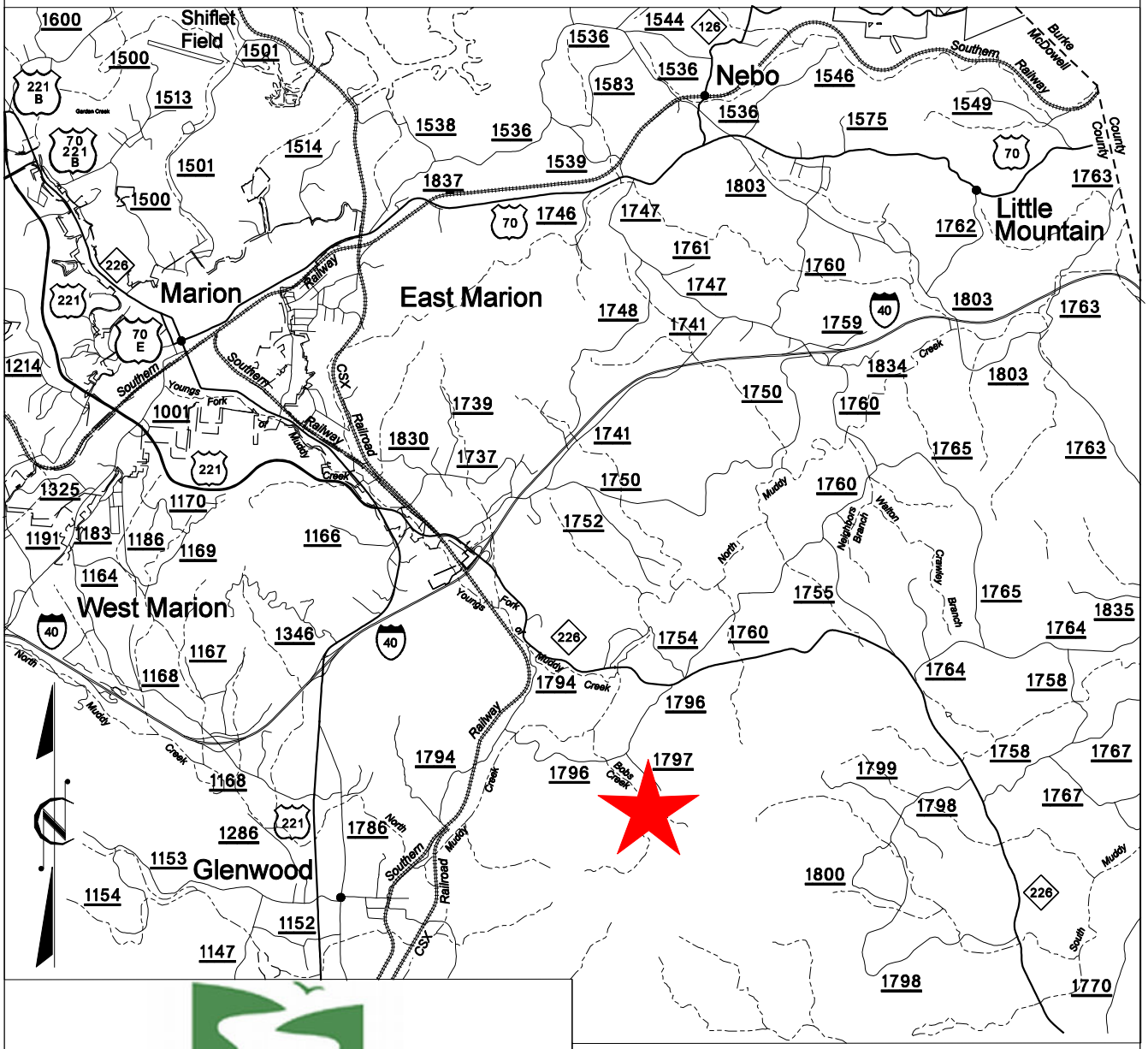

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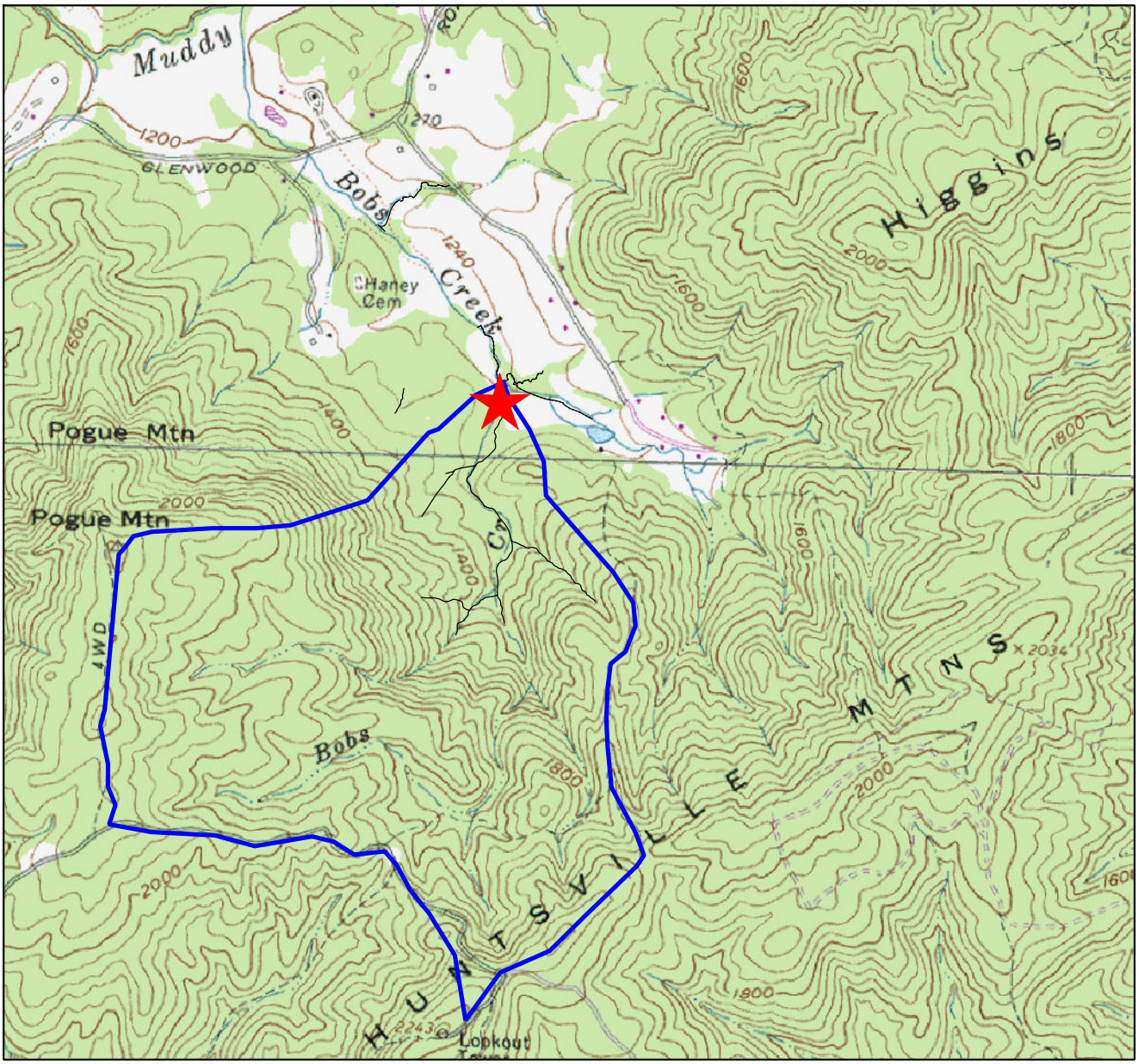
Bobs Creek Reference Site Vicinity Map

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 06/05/09

Figure: 4

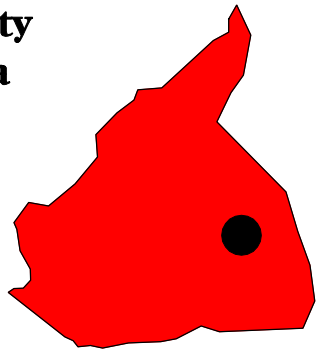


LEGEND

Bobs Creek Watershed (0.67 Sq. Miles)

Reference Site Survey

McDowell County
North Carolina



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Bobs Creek Reference Site Watershed Map

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

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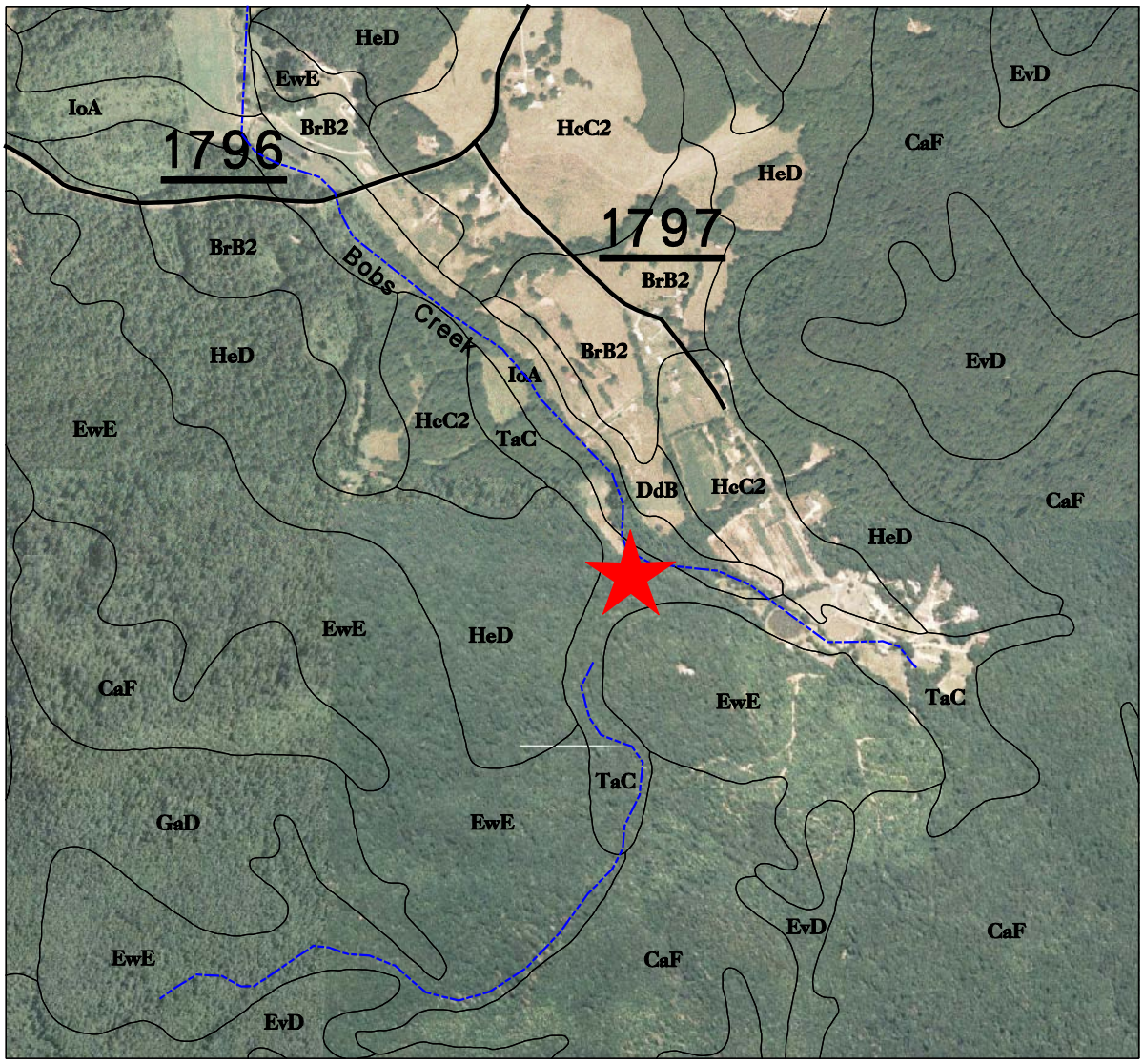
Figure: 5



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FEET

LEGEND

Symbol	Name
IoA -	Iotla
TaC -	Tate Loam
-	Reference Site Survey

Bobs Creek Reference Site Soil Survey Map

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

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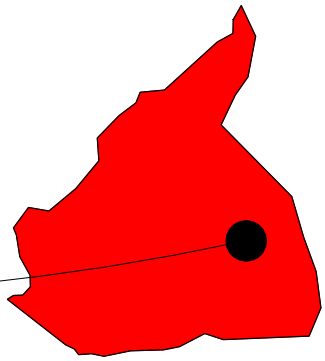
Date: 06/05/09

Figure: 6

McDowell County
North Carolina



PROJECT AREA

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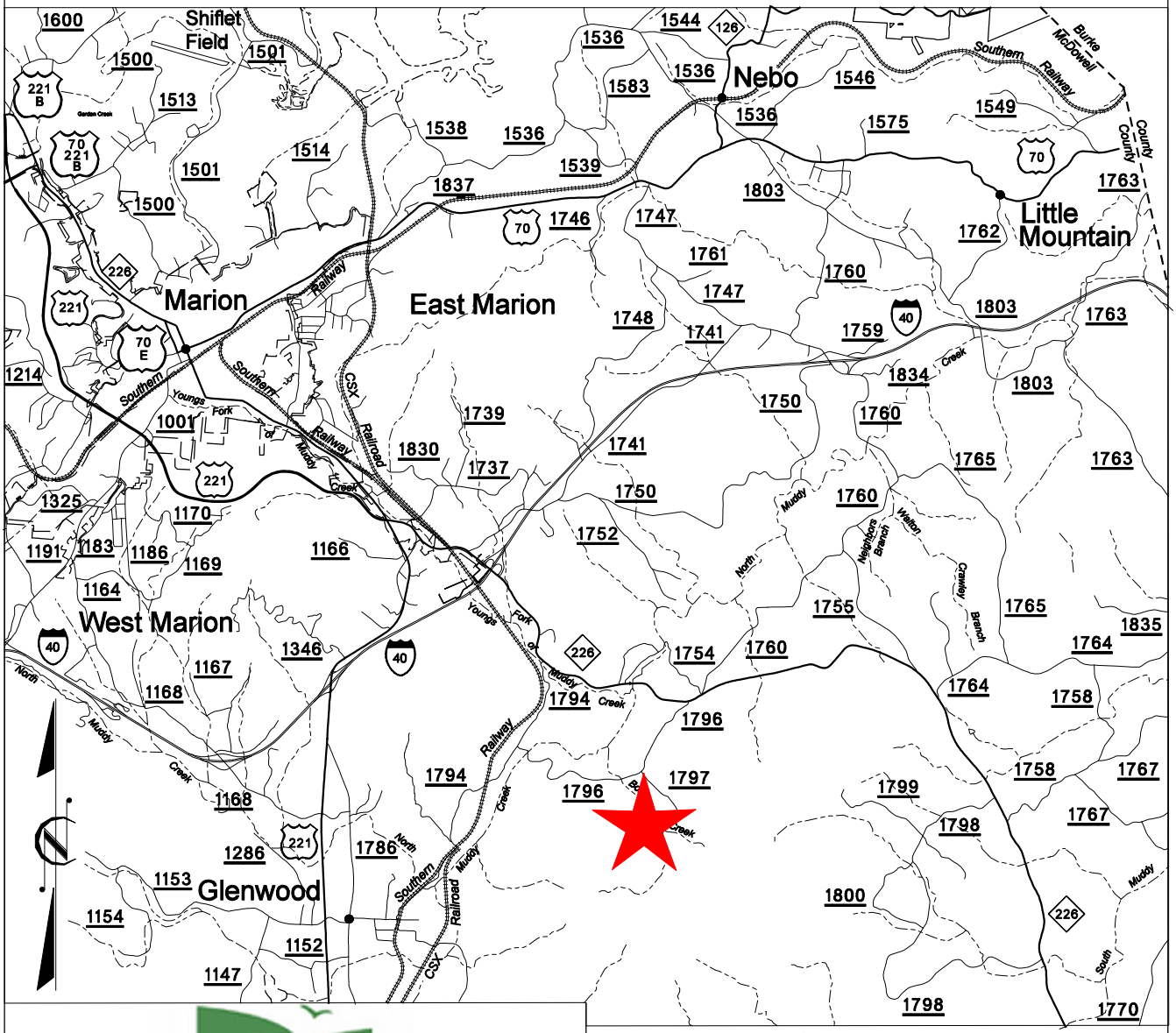

UT 5 Bobs Creek Reference Site Vicinity Map

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McDowell County, North Carolina

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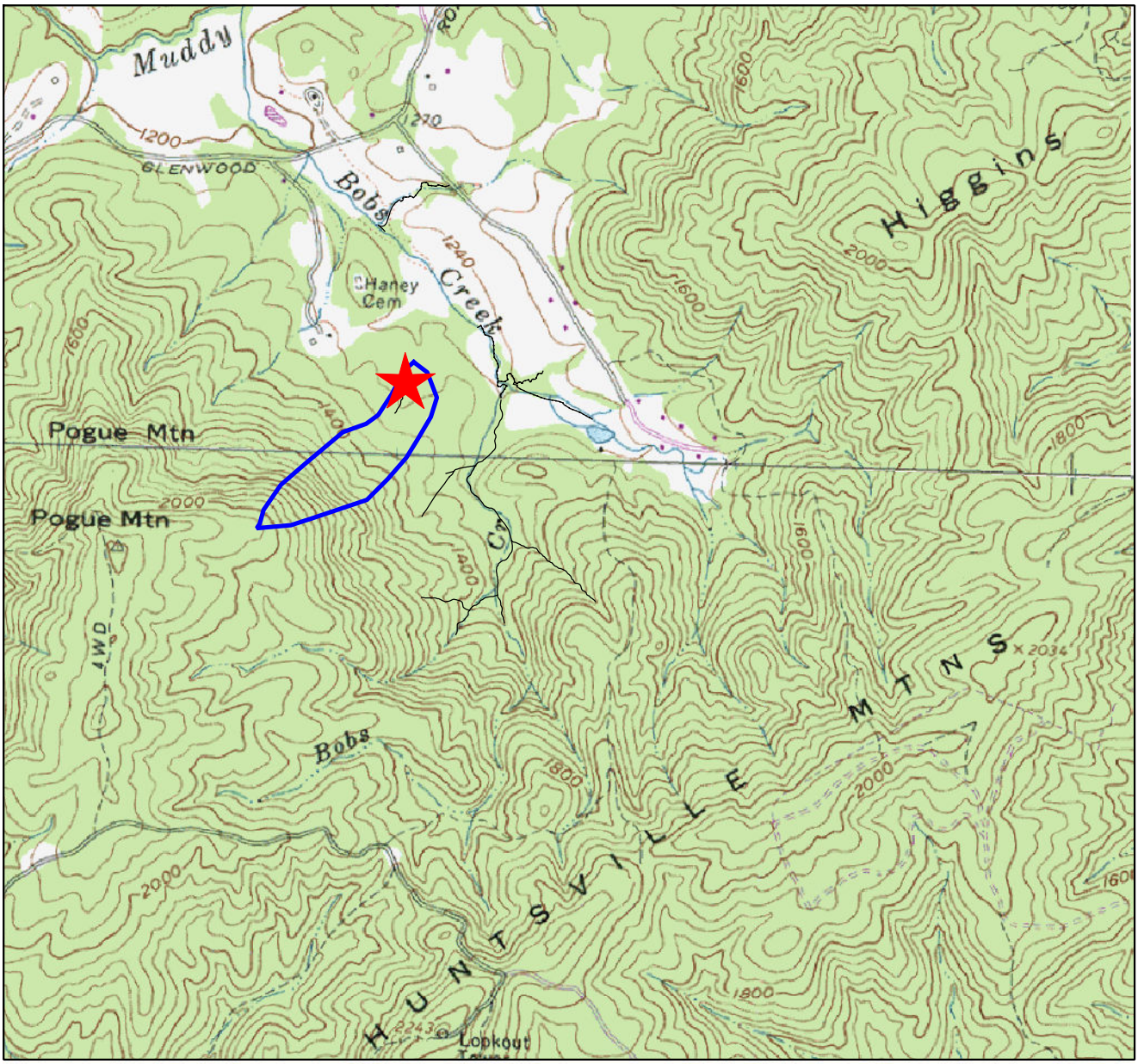
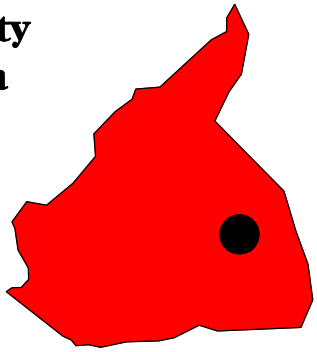
Figure: 7



McDowell County
North Carolina



LEGEND

UT–5 Bobs Creek Watershed (0.045 Sq. Miles)
Reference Site Survey

0 1000 2000
FEET

UT 5 Bobs Creek Reference Site Watershed Map

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Stream & Wetland Restoration Plan
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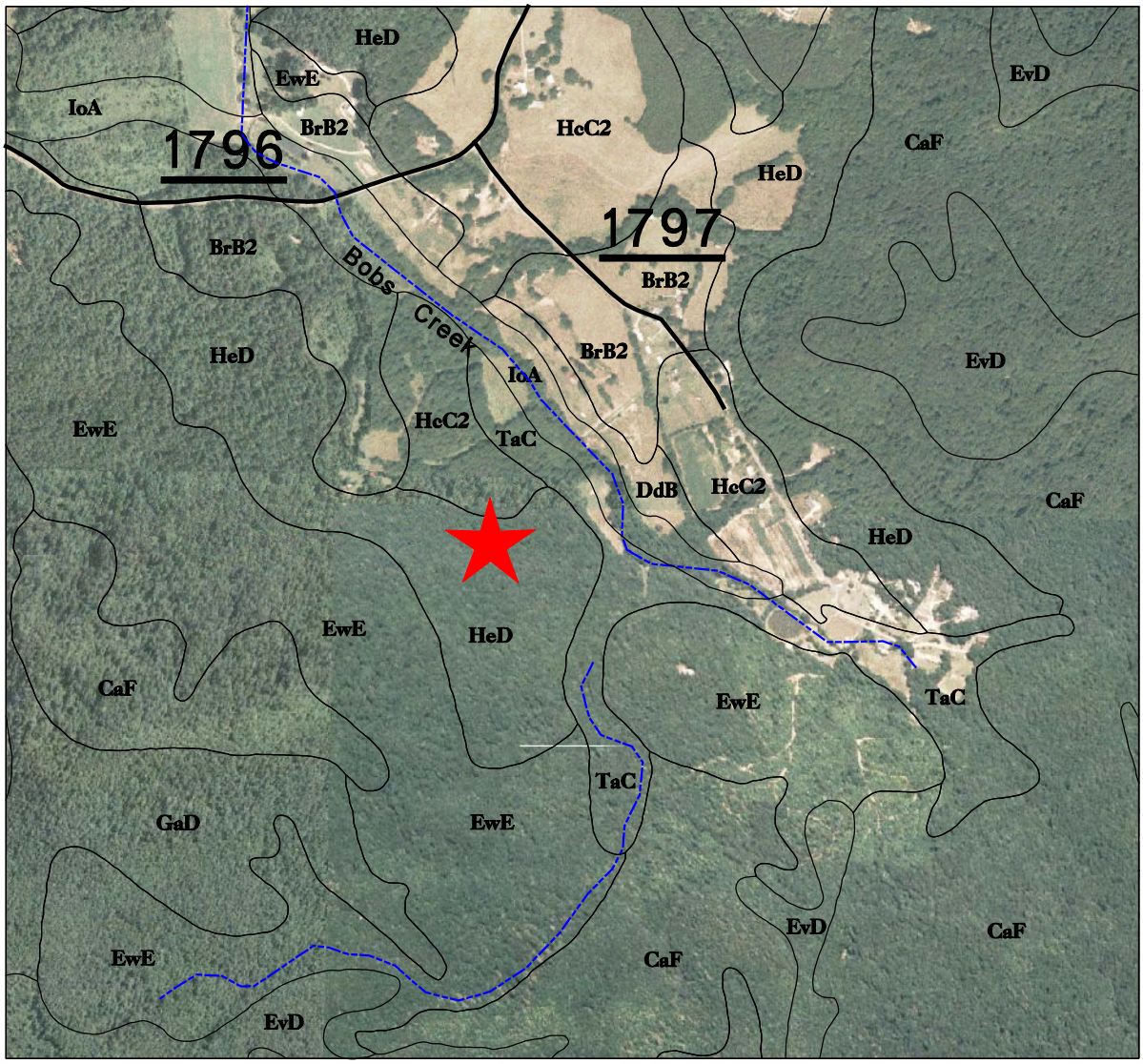
Figure: 8



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FEET

LEGEND

Symbol	Name
HeD	Hayesville - Evard
★	Reference Site Survey

UT 5 Bobs Creek Reference Site Soil Survey Map

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Stream & Wetland Restoration Plan
McDowell County, North Carolina

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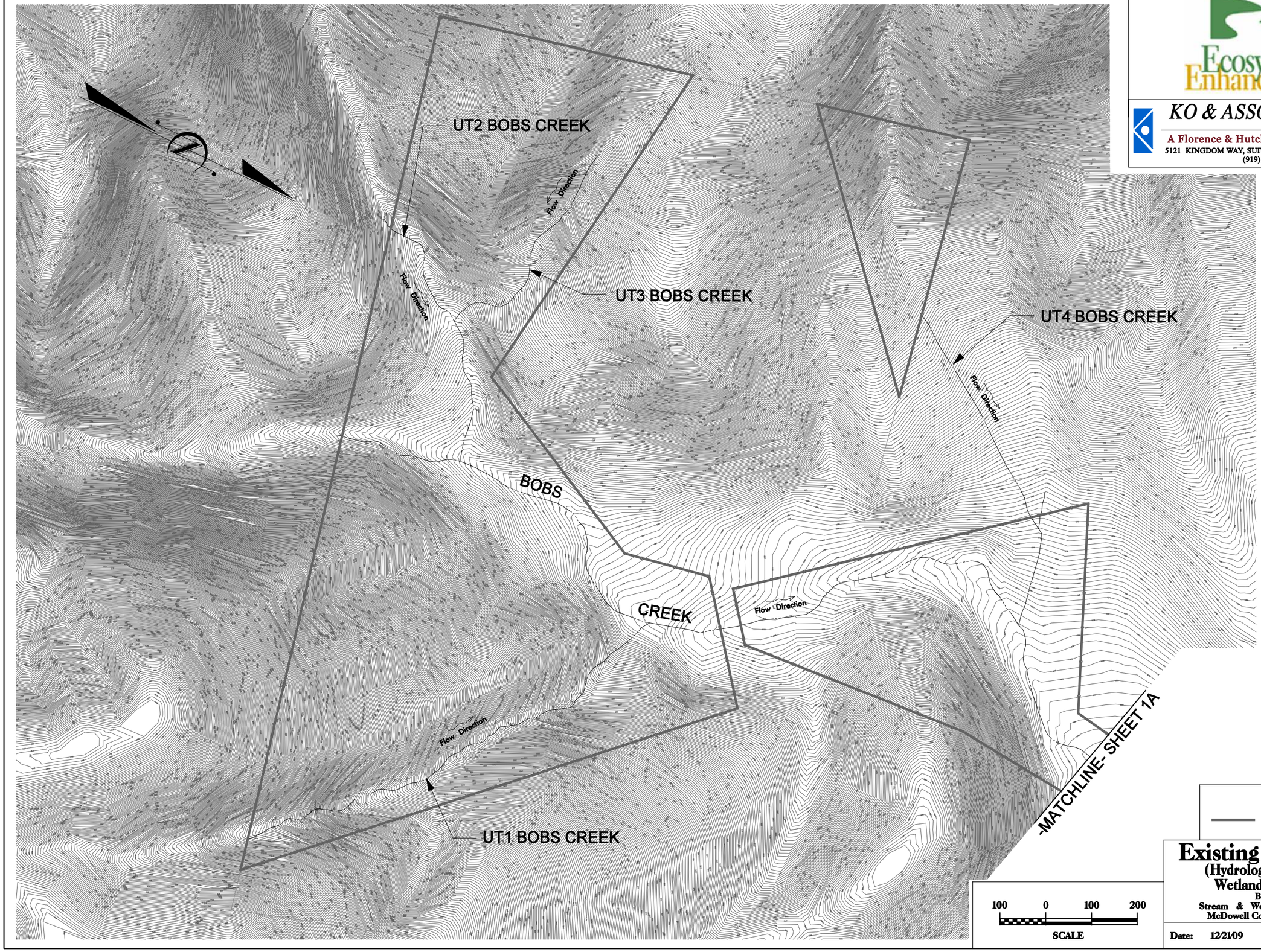
Figure: 9



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LEGEND

Proposed Easement

Existing Conditions
(Hydrological Features & Wetland Delineation)

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

100 0 100 200
SCALE

Date: 12/21/09

Sheet 1

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UT5 BOBS CREEK

-MATCHLINE- SHEET 1

BOBS CREEK

A

Flow Direction

B

SOIL ROAD

UT7 BOBS CREEK

UT6 BOBS CREEK

SOIL ROAD

UT8 BOBS CREEK

SR 1797

LEGEND

- Proposed Easement
- Existing Conditions Survey
- Reference Survey
- Existing Wetlands
- Tree

100 0 100 200

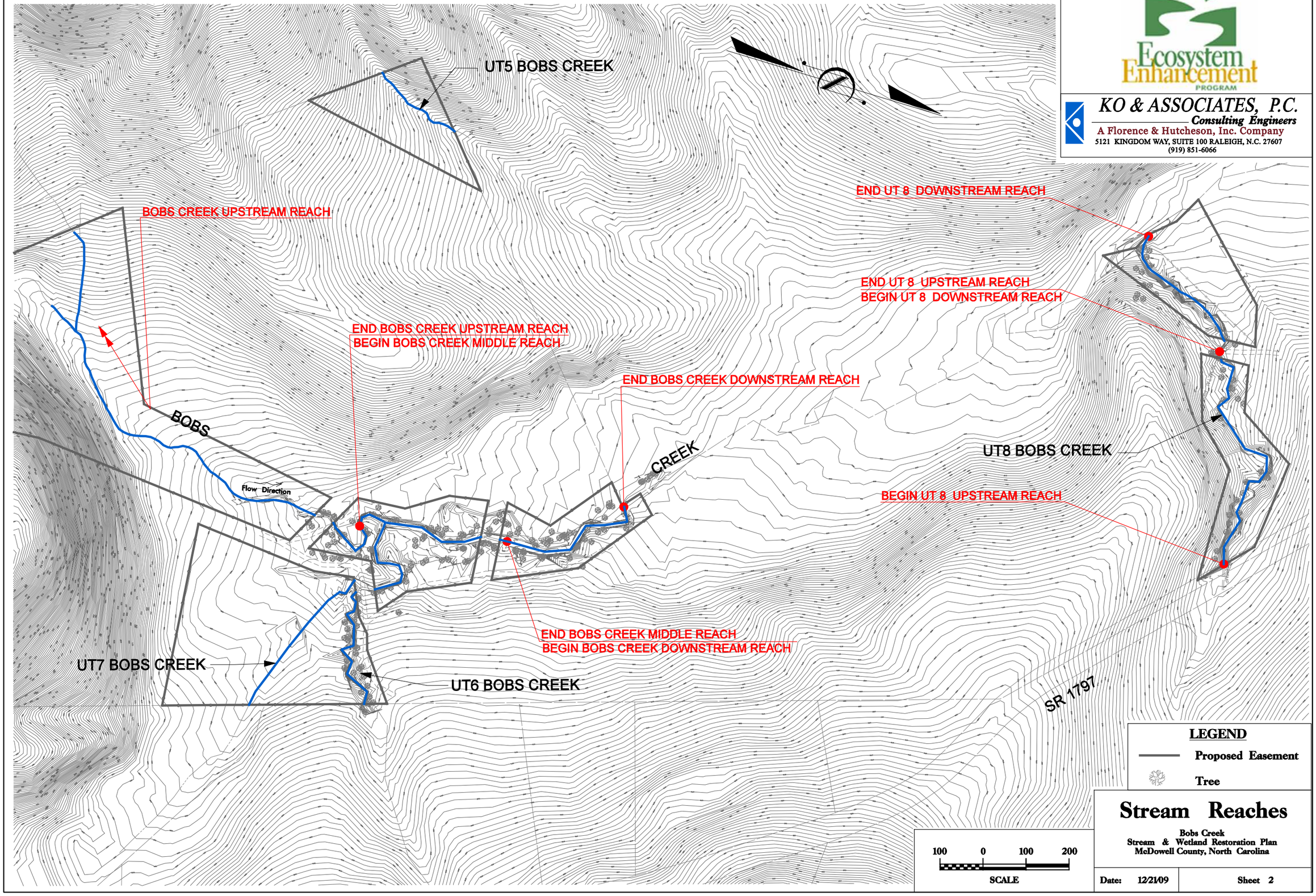
SCALE

Existing Conditions
(Hydrological Features & Wetland Delineation)

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09

Sheet 1A



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Stream Reaches

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09

Sheet 2

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-MATCHLINE- SHEET 3

UT1 BOBS CREEK

UT 1 BOBS CREEK
BEGIN STA. 10+00.00

UT 1 BOBS CREEK
END STA. 13+31.29

BOBS CREEK
END STA. 20+27.67

BOBS CREEK
BEGIN STA. 20+27.67

UT 1 BOBS CREEK
END STA. 20+60.49

Flow Direction

Flow Direction

CREEK

-MATCHLINE- SHEET 3B

LEGEND

- Proposed Easement
- Preservation

50 0 50 100

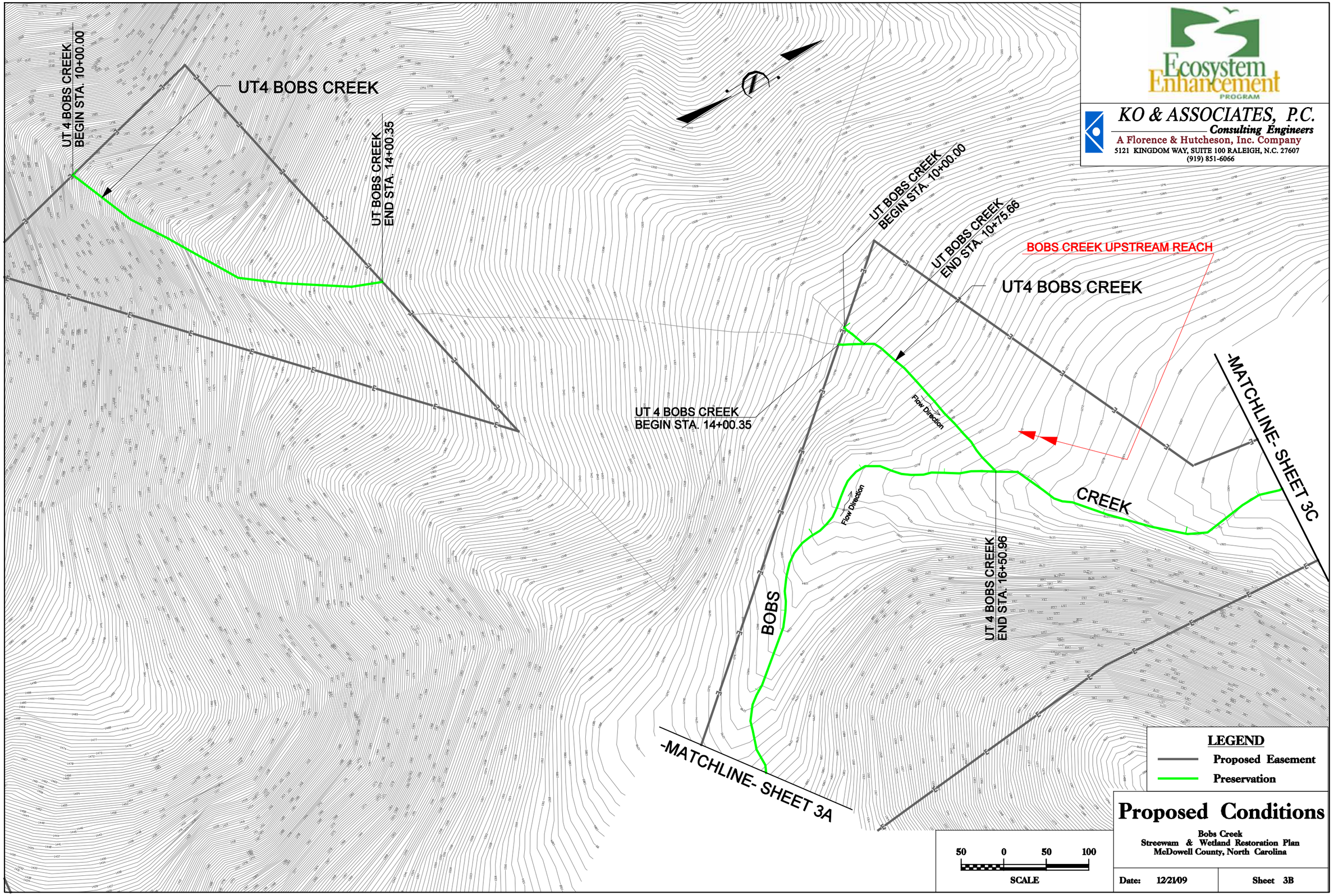
SCALE

Proposed Conditions

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09

Sheet 3A



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LEGEND

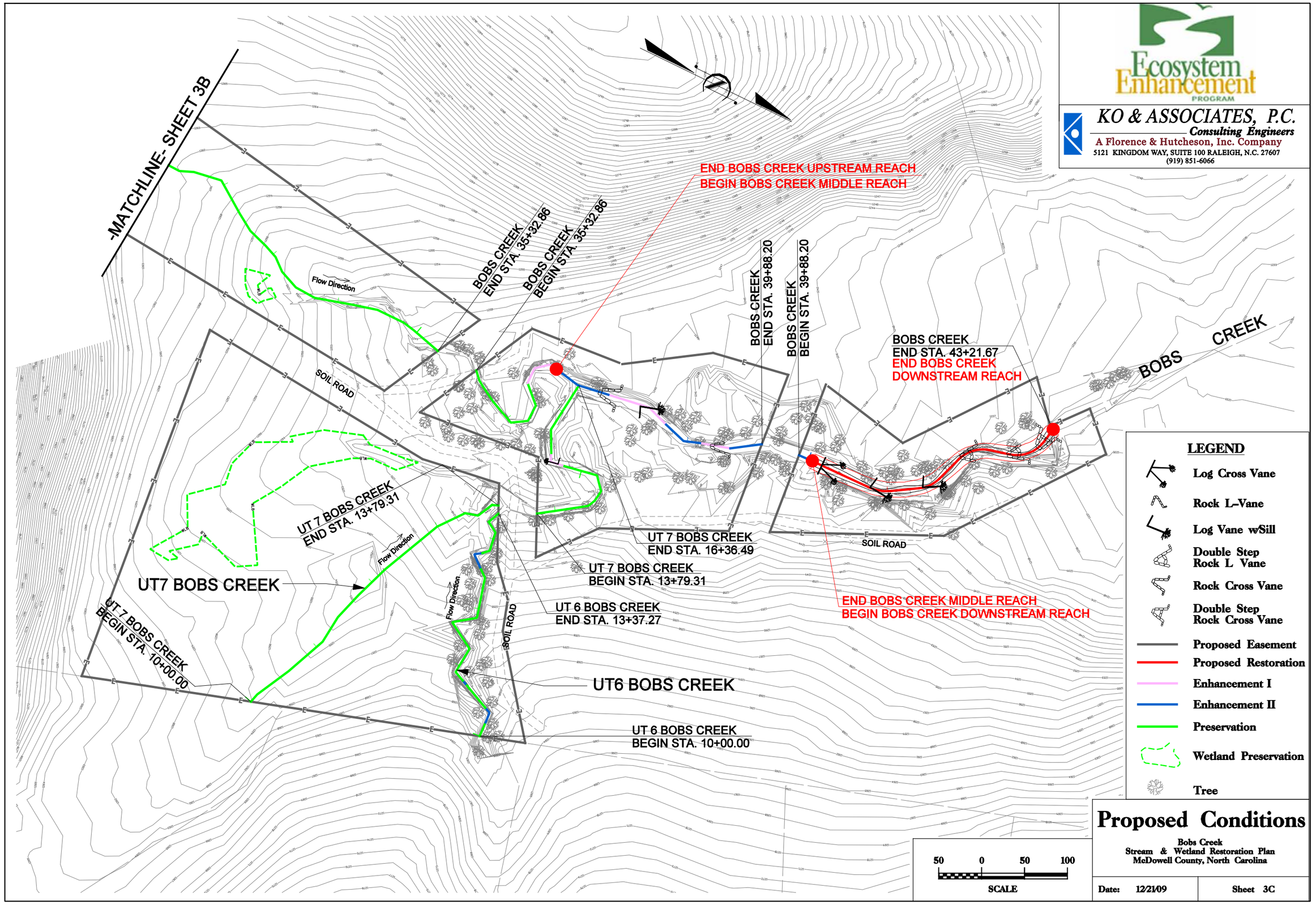
- Proposed Easement
- Preservation

50 0 50 100
SCALE

Proposed Conditions

Bobs Creek
Streewam & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09 | Sheet 3B



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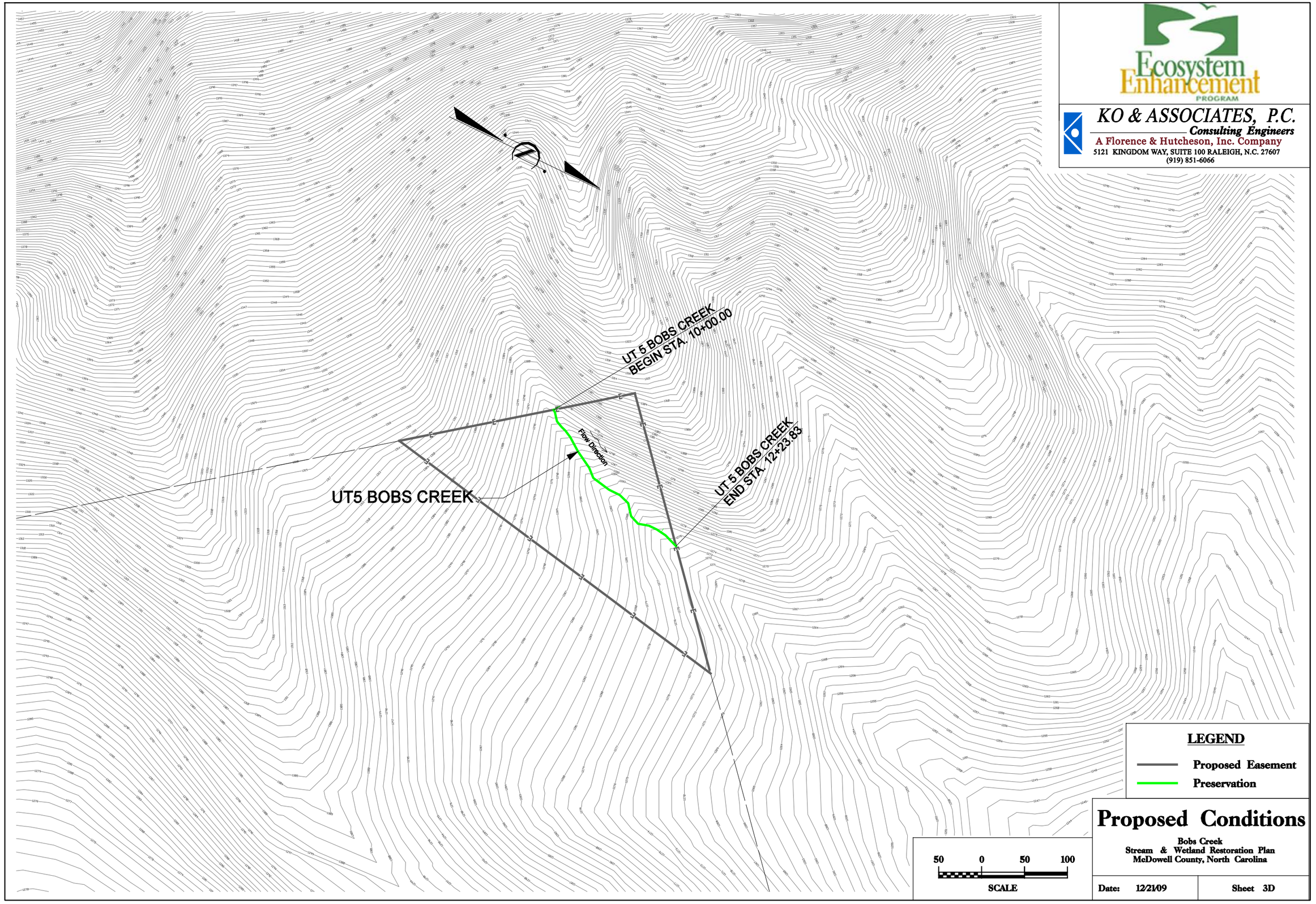
Proposed Conditions

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09

Sheet 3C



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Proposed Conditions

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09

Sheet 3D

Ecosystem Enhancement PROGRAM

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END UT 8 UPSTREAM REACH
BEGIN UT 8 DOWNSTREAM REACH

UT 8 BOBS CREEK
BEGIN STA. 10+00.00
BEGIN UT 8 UPSTREAM REACH

UT8 BOBS CREEK

UT 8 BOBS CREEK
END STA. 15+91.05

UT 8 BOBS CREEK
BEGIN STA. 15+91.05

SOIL ROAD

END UT 8 DOWNSTREAM REACH

UT 8 BOBS CREEK
END STA. 19+39.15

Flow Direction

Flow Direction

SR 1797

BOBS

CREEK

N

LEGEND

- Double Step Rock L–Vane
- Log Step Structure
- Rock L–Vane
- Double Step Log Vane
- Log Vane w/Sill
- Log Sill
- A–Vane
- Rock Cross Vane
- Rootwad
- Proposed Easement
- Proposed Restoration
- Enhancement I
- Enhancement II
- Preservation
- Tree

50 0 50 100
SCALE

Proposed Conditions

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09

Sheet 3E

5/28/99

LONGITUDINAL PROFILE

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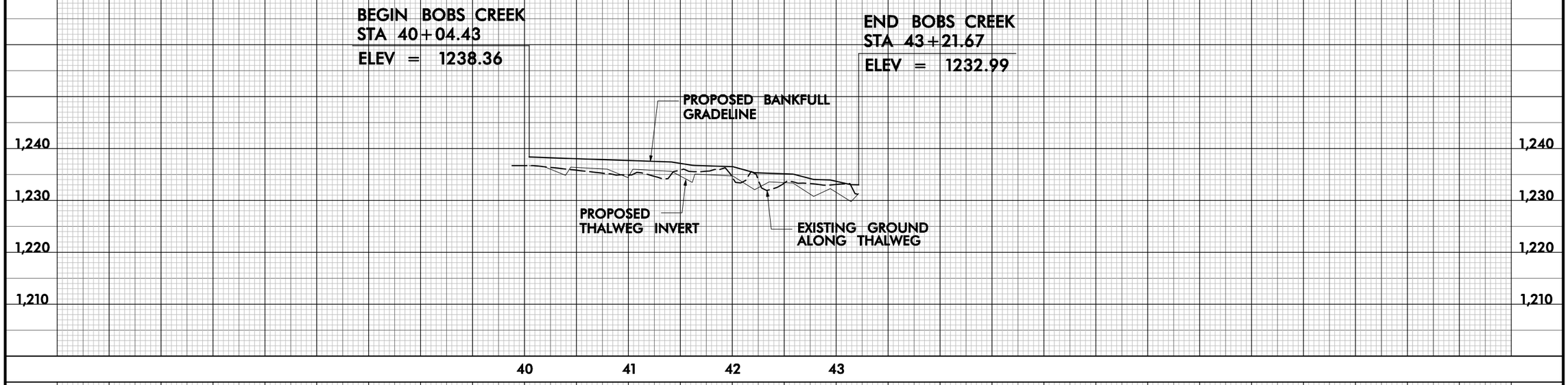
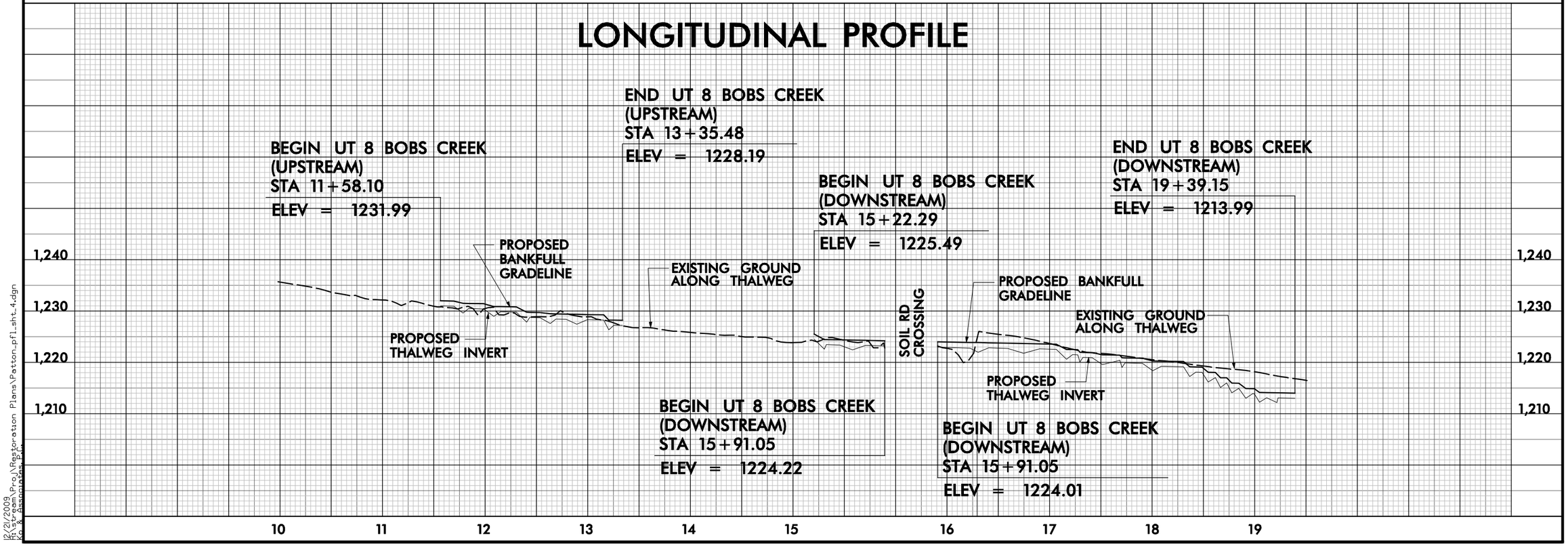
PROJECT REFERENCE NO.	SHEET NO.
NEIGHBOR BOB	4
PROJECT ENGINEER	



LONGITUDINAL PROFILE



12/21/2009
F:\stream\Proj\Restoration Plans\Patton_pfl_sht_4.dgn
Ko & Associates, P.C.

Ecosystem Enhancement PROGRAM

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

UT5 BOBS CREEK

BOBS CREEK

Flow Direction

UT8 BOBS CREEK

SOIL ROAD

UT7 BOBS CREEK

UT6 BOBS CREEK

SR 1797

LEGEND

- Proposed Easement
- Streamside Assemblage
- Montane Alluvial Forest
- Tree

100 0 100 200

SCALE

Planting Plan

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09

Sheet 5

APPENDIX 1
PROJECT SITE
PHOTOGRAPHS

Bobs Creek

Tortuous meander degrading terrace

Degraded meander and fine sediments in channel

Degrading left bank along terrace side slope

Undercut trees stabilizing bank at terrace

Aggradation and channel widening at fence blockage

Bank degradation due to buffalo access

UT 6 Bobs Creek

Undercutting of bank in meander

Degraded bank in meander

Vertical bank in meander

Stable section of channel in steep valley

UT 8 Bobs Creek

Degrading valley side slope along top of channel bank

Debris in channel with degrading banks

Undercutting of vegetation and side slope degradation

Vertical bank in meander

Tortuous meander degrading valley side slope

Incised channel with degrading banks

UT 1 through 5 and 7 Bobs Creek

UT 1 to Bobs Creek

UT 2 to Bobs Creek

UT 3 Bobs Creek

UT 4 Bobs Creek

UT 5 Bobs Creek

UT 7 Bobs Creek

APPENDIX 2
PROJECT SITE
USACE ROUTINE WETLAND DETERMINATION DATA FORMS

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

Project / Site: Neighbor Bob - Patton Site
Applicant / Owner: NCEEP
Investigator: Axiom - Lewis

Date: 3/4/09
County: McDowell
State: NC

Do normal circumstances exist on the site? Yes ✓ No ___
Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓
Is the area a potential problem area? Yes ___ No ✓
(explain on reverse if needed)

Community ID: hrlwd
Transect ID: CoK16
Plot ID: upland

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. Liriodendron tulipifera	canopy	FAC
2. Pinus taeda	canopy	FAC
3. Pinus echinata	canopy	
4. Carpinus caroliniana	Sapling	FAC
5. Acer rubrum	canopy	FAC
6. Ilex opaca	Sapling	FAC-
7. Lonicera japonica	herb	FAC-
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 57%

Remarks:

HYDROLOGY

___ Recorded Data (Describe In Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

___ No Recorded Data Available

Field Observations:

Depth of Surface Water: _____(in.)

Depth to Free Water in Pit: _____(in.)

Depth to Saturated Soil: _____(in.)

Wetland Hydrology Indicators

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12"
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators:
- ___ Oxidized Roots Channels in Upper 12"
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

No wetland hydrology indicators.

SOILS

GK16 upland

Map Unit Name
(Series and Phase): Tate loam Drainage Class: well drained

Taxonomy (Subgroup): Typic Hapludults Confirm Mapped Type? Yes ___ No ✓

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-12+		10 YR 4/4	—	—	fine sandy loam

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
___ Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed On Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:
No hydric soil indicators.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ✓ No ___
Wetland Hydrology Present? Yes ___ No ✓
Hydric Soils Present? Yes ___ No ✓

Is the Sampling Point Within a Wetland? Yes ___ No ✓

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Determination Manual)

Project / Site: Neighbor Bob - Patton Site
Applicant / Owner: NCEEP
Investigator: Axiom - Lewis

Date: 3/4/09
County: McDowell
State: NC

Do normal circumstances exist on the site? Yes ✓ No ___
Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓
Is the area a potential problem area? Yes ___ No ✓
(explain on reverse if needed)

Community ID: hydrid.
Transect ID: GK14
Plot ID: wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. Acer rubrum	canopy	FAC
2. Vaccinium sp.	shrub	FAC to OBL
3. Woodwardia areolata	herb	OBL
4. Alnus serrulata	subcanopy	FACW+
5. Carex sp.	herb	FAC to OBL
6. Juncus sp.	herb	FAC to OBL
7. Osmunda cinnamomea	herb	FACW+
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 100 %

Remarks:

HYDROLOGY

___ Recorded Data (Describe In Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

___ No Recorded Data Available

Field Observations:

Depth of Surface Water: — (in.)

Depth to Free Water in Pit: — (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators

Primary Indicators:
- ___ Inundated
- X Saturated in Upper 12"
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators:
- X Oxidized Roots Channels in Upper 12"
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

GKIE wetland.

Map Unit Name
(Series and Phase): Wehadkee fine sandy loam Drainage Class: poorly to very poorly drained

Taxonomy (Subgroup): Fluvaquentic Endoaquepts Confirm Mapped Type? Yes ___ No ✓

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10YR 3/2	—	—	loam
4-12+		10YR 3/2	—	—	sandy clay loam
			w/ oxidized	rhizospheres 2%	

Hydric Soil Indicators:

___ Histosol
___ Histic Epipedon
✓ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
___ Gleyed or Low-Chroma Colors
___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed On Local Hydric Soils List
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ✓ No ___
Wetland Hydrology Present? Yes ✓ No ___
Hydric Soils Present? Yes ✓ No ___

Is the Sampling Point Within a Wetland? Yes ✓ No ___

Remarks:

APPENDIX 3
PROJECT SITE
NCDWQ STREAM CLASSIFICATION FORMS/
USACE STREAM QUALITY ASSESSMENT WORKSHEETS

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/2/2009	**Project**: Neighbor Bob	**Latitude:** 35.6206228N
Evaluator: Ryan Smith	**Site:** Bobs Creek	**Longitude:** 81.9350204W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 46.5	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 27)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 11)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 8.5)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/2/2009	**Project**: Neighbor Bob	**Latitude:** 35.6212442N
Evaluator: Ryan Smith	**Site:** Bobs Creek UT 1	**Longitude:** 81.9320329W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 24	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 15)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 4)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 5)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/2/2009	**Project:** Neighbor Bob	**Latitude:** 35.6202776N
Evaluator: Ryan Smith	**Site:** Bobs Creek UT 2	**Longitude:** 81.9365773W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 39	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 21)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 10)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 8)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/2/2009	**Project**: Neighbor Bob	**Latitude:** 35.6212786N
Evaluator: Ryan Smith	**Site:** Bobs Creek UT 3	**Longitude:** 81.9377976W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 24	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 13.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 5)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 5.5)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/2/2009	**Project**: Neighbor Bob	**Latitude:** 35.6233497N
Evaluator: Ryan Smith	**Site:** Bobs Creek UT 4	**Longitude:** 81.9378398W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 27	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 15)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6.5)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 5.5)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/2/2009	**Project:** Neighbor Bob	**Latitude:** 35.6258350N
Evaluator: Ryan Smith	**Site:** Bobs Creek UT 5	**Longitude:** 81.9387237W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 34	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 18)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 8)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/2/2009	**Project:** Neighbor Bob	**Latitude:** 35.6273194N
Evaluator: Ryan Smith	**Site:** Bobs Creek UT 6	**Longitude:** 81.9339687W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 27	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 16.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6.5)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 4)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/2/2009	**Project:** Neighbor Bob	**Latitude:** 35.6266636N
Evaluator: Ryan Smith	**Site:** Bobs Creek UT 7	**Longitude:** 81.9334637W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 41.5	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 24.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 8.5)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/2/2009	**Project:** Neighbor Bob	**Latitude:** 35.6321174N
Evaluator: Ryan Smith	**Site:** Bobs Creek UT 8	**Longitude:** 81.9369988W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 33.5	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 17.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 7.5)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Ko/Florence & Hutcheson

2. Evaluator's name: Ryan Smith

3. Date of evaluation: 4/2/2009

4. Time of evaluation: 11:00am

5. Name of stream: Bobs Creek

6. River basin: Catawba

7. Approximate drainage area: 204 AC

8. Stream order: I

9. Length of reach evaluated: 400 FT

10. County: McDowell

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):_____

Latitude (ex. 34.872312): 35.6206228N Longitude (ex. –77.556611): 81.9350204W

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):_____

SW of intersection of Marlowe Rd and Fat Wall Rd on Patton property, approx. 1 mi. S of 226.

14. Proposed channel work (if any):_____

15. Recent weather conditions: Light rain

16. Site conditions at time of visit: Light rain

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? YES NO

20. Does channel appear on USDA Soil Survey? YES NO

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial ___% Agricultural 100 % Forested ___% Cleared / Logged ___% Other (_____)

22. Bankfull width: 13FT

23. Bank height (from bed to top of bank): 1.5FT

24. Channel slope down center of stream: ___Flat (0 to 2%) ___Gentle (2 to 4%) X Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ____Straight X Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 83 **Comments:**_____

Evaluator's Signature_____ **Date**_____

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	5
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	4
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	5
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	4
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	2
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	4
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	5
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	5
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	5
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	5
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	6
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	6
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	5
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	4
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	4
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	3
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	3
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	5
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						83

* These characteristics are not assessed in coastal streams.

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Ko/Florence & Hutcheson

2. Evaluator's name: Ryan Smith

3. Date of evaluation: 4/2/2009

4. Time of evaluation: 11:00am

5. Name of stream: Bobs Creek UT 1

6. River basin: Catawba

7. Approximate drainage area: 16.5 AC

8. Stream order: I

9. Length of reach evaluated: 1035 FT

10. County: McDowell

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):_____

Latitude (ex. 34.872312): 35.6212442N Longitude (ex. –77.556611): 81.920329W

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):_____

SW of intersection of Marlowe Rd and Fat Wall Rd on Patton property, approx. 1 mi. S of 226.

14. Proposed channel work (if any):_____

15. Recent weather conditions: Light rain

16. Site conditions at time of visit: Light rain

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? YES NO

20. Does channel appear on USDA Soil Survey? YES NO

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial ___% Agricultural 100 % Forested ___% Cleared / Logged ___% Other (_____)

22. Bankfull width: 4.0FT

23. Bank height (from bed to top of bank): 0.5FT

24. Channel slope down center of stream: ___Flat (0 to 2%) ___Gentle (2 to 4%) X Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ____Straight X Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 60 **Comments:**_____

Evaluator's Signature_____ **Date**_____

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	2
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	5
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	2
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	4
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	4
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	5
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	5
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	4
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	2
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	3
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	4
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	2
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	3
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	4
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						60

* These characteristics are not assessed in coastal streams.

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Ko/Florence & Hutcheson

2. Evaluator's name: Ryan Smith

3. Date of evaluation: 4/2/2009

4. Time of evaluation: 11:00am

5. Name of stream: Bobs Creek UT 2

6. River basin: Catawba

7. Approximate drainage area: 96 AC

8. Stream order: I

9. Length of reach evaluated: 248 FT

10. County: McDowell

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):_____

Latitude (ex. 34.872312): 35.6202776N Longitude (ex. –77.556611): 81.9365773W

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):

SW of intersection of Marlowe Rd and Fat Wall Rd on Patton property, approx. 1 mi. S of 226.

14. Proposed channel work (if any):_____

15. Recent weather conditions: Light rain

16. Site conditions at time of visit: Light rain

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? YES NO **20.** Does channel appear on USDA Soil Survey? YES NO

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial ___% Agricultural 100 % Forested ___% Cleared / Logged ___% Other (_____)

22. Bankfull width: 9FT **23**. Bank height (from bed to top of bank): 1FT

24. Channel slope down center of stream: ___Flat (0 to 2%) ___Gentle (2 to 4%) X Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ____Straight X Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 85 **Comments:**_____

Evaluator's Signature_____ **Date**_____

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	5
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	4
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	5
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	4
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	1
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	4
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	5
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	4
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	5
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	5
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	5
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	6
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	6
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	4
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	3
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	4
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						85

* These characteristics are not assessed in coastal streams.

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Ko/Florence & Hutcheson

2. Evaluator's name: Ryan Smith

3. Date of evaluation: 4/2/2009

4. Time of evaluation: 11:00am

5. Name of stream: Bobs Creek UT 3

6. River basin: Catawba

7. Approximate drainage area: 36 AC

8. Stream order: I

9. Length of reach evaluated: 157 FT

10. County: McDowell

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):_____

Latitude (ex. 34.872312): 35.6212786N Longitude (ex. –77.556611): 81.9377976W

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):

SW of intersection of Marlowe Rd and Fat Wall Rd on Patton property, approx. 1 mi. S of 226.

14. Proposed channel work (if any):_____

15. Recent weather conditions: Light rain

16. Site conditions at time of visit: Light rain

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? YES NO

20. Does channel appear on USDA Soil Survey? YES NO

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial ___% Agricultural 100 % Forested ___% Cleared / Logged ___% Other (_____)

22. Bankfull width: 4FT

23. Bank height (from bed to top of bank): 0.5FT

24. Channel slope down center of stream: ___Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) X Steep (>10%)

25. Channel sinuosity: ____Straight X Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 65 **Comments:**_____

Evaluator's Signature_____ **Date**_____

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	3
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	4
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	5
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	0
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	0
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	3
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	3
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	4
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	4
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	5
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	5
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	4
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	3
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						65

* These characteristics are not assessed in coastal streams.

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Ko/Florence & Hutcheson

2. Evaluator's name: Ryan Smith

3. Date of evaluation: 4/2/2009

4. Time of evaluation: 11:00am

5. Name of stream: Bobs Creek UT 4

6. River basin: Catawba

7. Approximate drainage area: 24 AC

8. Stream order: I

9. Length of reach evaluated: 364 FT

10. County: McDowell

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):_____

Latitude (ex. 34.872312): 35.6233497N Longitude (ex. –77.556611): 81.9378398W

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):_____

SW of intersection of Marlowe Rd and Fat Wall Rd on Patton property, approx. 1 mi. S of 226.

14. Proposed channel work (if any):_____

15. Recent weather conditions: Light rain

16. Site conditions at time of visit: Light rain

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? YES NO **20.** Does channel appear on USDA Soil Survey? YES NO

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial ___% Agricultural 100 % Forested ___% Cleared / Logged ___% Other (_____)

22. Bankfull width: 3FT **23**. Bank height (from bed to top of bank): 0.5FT

24. Channel slope down center of stream: ___Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) X Steep (>10%)

25. Channel sinuosity: ____Straight X Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 69 **Comments:**_____

Evaluator's Signature_____ **Date**_____

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	4
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	5
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	2
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	4
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	2
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	4
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	5
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	4
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	5
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	4
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	4
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	5
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	3
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	3
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	4
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						69

* These characteristics are not assessed in coastal streams.

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Ko/Florence & Hutcheson

2. Evaluator's name: Ryan Smith

3. Date of evaluation: 4/2/2009

4. Time of evaluation: 11:00am

5. Name of stream: Bobs Creek UT 5

6. River basin: Catawba

7. Approximate drainage area: 31 AC

8. Stream order: I

9. Length of reach evaluated: 211 FT

10. County: McDowell

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):_____

Latitude (ex. 34.872312): 35.6258350N Longitude (ex. –77.556611): 81.9387237W

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):_____

SW of intersection of Marlowe Rd and Fat Wall Rd on Patton property, approx. 1 mi. S of 226.

14. Proposed channel work (if any):_____

15. Recent weather conditions: Light rain

16. Site conditions at time of visit: Light rain

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? YES NO

20. Does channel appear on USDA Soil Survey? YES NO

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial ___% Agricultural 100 % Forested ___% Cleared / Logged ___% Other (_____)

22. Bankfull width: 3FT

23. Bank height (from bed to top of bank): 0.5FT

24. Channel slope down center of stream: ___Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) X Steep (>10%)

25. Channel sinuosity: ____Straight X Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 79 **Comments:**_____

Evaluator's Signature_____ **Date**_____

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	4
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	5
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	5
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	4
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	4
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	4
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	5
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	4
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	5
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	6
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	5
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	5
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	4
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	3
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	4
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						79

* These characteristics are not assessed in coastal streams.

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Ko/Florence & Hutcheson

2. Evaluator's name: Ryan Smith

3. Date of evaluation: 4/2/2009

4. Time of evaluation: 11:00am

5. Name of stream: Bobs Creek UT 6

6. River basin: Catawba

7. Approximate drainage area: 30 AC

8. Stream order: I

9. Length of reach evaluated: 316 FT

10. County: McDowell

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):_____

Latitude (ex. 34.872312): 35.6273194N Longitude (ex. –77.556611): 81.9339687W

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):

SW of intersection of Marlowe Rd and Fat Wall Rd on Patton property, approx. 1 mi. S of 226.

14. Proposed channel work (if any):_____

15. Recent weather conditions: Light rain

16. Site conditions at time of visit: Light rain

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? YES NO

20. Does channel appear on USDA Soil Survey? YES NO

21. Estimated watershed land use: 10 % Residential ___% Commercial ___% Industrial 40 % Agricultural 20 % Forested 30 % Cleared / Logged ___% Other (_____)

22. Bankfull width: 5FT

23. Bank height (from bed to top of bank): 0.5FT

24. Channel slope down center of stream: X Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ____Straight X Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 52 **Comments:**_____

Evaluator's Signature_____ **Date**_____

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	3
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	4
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	2
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	2
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	2
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	4
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	4
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	3
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	4
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	4
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	3
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	1
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	2
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						52

* These characteristics are not assessed in coastal streams.

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Ko/Florence & Hutcheson

2. Evaluator's name: Ryan Smith

3. Date of evaluation: 4/2/2009

4. Time of evaluation: 11:00am

5. Name of stream: Bobs Creek UT 7

6. River basin: Catawba

7. Approximate drainage area: 33 AC

8. Stream order: I

9. Length of reach evaluated: 404 FT

10. County: McDowell

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):_____

Latitude (ex. 34.872312): 35.6266636N Longitude (ex. –77.556611): 81.9334637W

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):_____

SW of intersection of Marlowe Rd and Fat Wall Rd on Patton property, approx. 1 mi. S of 226.

14. Proposed channel work (if any):_____

15. Recent weather conditions: Light rain

16. Site conditions at time of visit: Light rain

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? YES NO

20. Does channel appear on USDA Soil Survey? YES NO

21. Estimated watershed land use: 10 % Residential ___% Commercial ___% Industrial 40 % Agricultural 20 % Forested 30 % Cleared / Logged ___% Other (_____)

22. Bankfull width: 10FT

23. Bank height (from bed to top of bank): 1FT

24. Channel slope down center of stream: ___Flat (0 to 2%) X Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ____Straight ___Occasional bends X Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 80 **Comments:**_____

Evaluator's Signature_____ **Date**_____

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	5
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	4
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	5
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	4
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	2
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	1
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	3
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	5
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	4
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	5
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	3
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	6
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	5
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	4
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	1
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	3
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	3
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						80

* These characteristics are not assessed in coastal streams.

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Ko/Florence & Hutcheson

2. Evaluator's name: Ryan Smith

3. Date of evaluation: 4/2/2009

4. Time of evaluation: 11:00am

5. Name of stream: Bobs Creek UT 8

6. River basin: Catawba

7. Approximate drainage area: 76 AC

8. Stream order: I

9. Length of reach evaluated: 962 FT

10. County: McDowell

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):_____

Latitude (ex. 34.872312): 35.6321174N Longitude (ex. –77.556611): 81.9369988W

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other_____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):

SW of intersection of Marlowe Rd and Fat Wall Rd on Patton property, approx. 1 mi. S of 226.

14. Proposed channel work (if any):_____

15. Recent weather conditions: Light rain

16. Site conditions at time of visit: Light rain

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? YES NO

20. Does channel appear on USDA Soil Survey? YES NO

21. Estimated watershed land use: 10 % Residential ___% Commercial ___% Industrial 40 % Agricultural 20 % Forested 30 % Cleared / Logged ___% Other (_____)

22. Bankfull width: 5FT

23. Bank height (from bed to top of bank): 0.75FT

24. Channel slope down center of stream: X Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ____Straight X Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 63 **Comments:**_____

Evaluator's Signature_____ **Date**_____

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	4
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	2
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	3
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	1
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	3
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	4
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	4
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	4
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	5
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	3
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	3
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	3
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						63

* These characteristics are not assessed in coastal streams.

APPENDIX 4
REFERENCE SITE
PHOTOGRAPHS

Bobs Creek

Beginning of Bobs Creek profile

Bobs Creek meander bend

Bobs Creek middle of profile

Bobs Creek riffle upstream of crossing

Bobs Creek upstream of crossing

Bobs Creek downstream of crossing

UT 5 Bobs Creek

Beginning of UT 5 Bobs Creek profile

UT 5 Bobs Creek riffle at beginning of profile

UT 5 Bobs Creek middle of profile

UT 5 Bobs Creek downstream

UT 5 Bobs Creek downstream meander bend

UT 5 Bobs Creek end of profile

APPENDIX 5
REFERENCE SITE
NCDWQ STREAM CLASSIFICATION FORMS

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/22/2009	**Project:** Neighbor Bob	**Latitude:** 35.626642 N
Evaluator: RVS	**Site:** Bobs Creek Reference	**Longitude:** 81.935186 W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 44.5	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 23)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 10.5)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 11)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 4/22/2009	**Project:** Neighbor Bob	**Latitude:** 35.626608 N
Evaluator: RVS	**Site:** UT 5 Bobs	**Longitude:** 81.938428
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 27	**County:** McDowell	**Other** *e.g. Quad Name*: Marion East

A. Geomorphology (Subtotal = 16)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9 [a] Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 5.5)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 5.5)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	1	1.5
29 [b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

APPENDIX 6
HEC-RAS ANALYSIS

BOBS CREEK
HEC-RAS ANALYSIS

River Station	Storm Event	Discharge (cfs)	Existing WSEL (ft)	Proposed WSEL (ft)	Backwater (ft)
Upstream End of Project					
4184.74	BKF	110	1243.34	1243.34	0.00
4184.74	100 YR	942	1246.57	1246.57	0.00
4107.58	BKF	110	1241.7	1241.7	0.00
4107.58	100 YR	942	1244.5	1244.5	0.00
4021.04	BKF	110	1240.7	1240.7	0.00
4021.04	100 YR	942	1243.95	1243.95	0.00
3952.88	BKF	110	1239.31	1239.28	-0.03
3952.88	100 YR	942	1243.01	1243.05	0.04
3898.89	BKF	110	1239.02	1238.96	-0.06
3898.89	100 YR	942	1241.79	1241.69	-0.10
Begin Restoration					
3828.1	BKF	110	1238.1	1238.56	0.46
3828.1	100 YR	942	1240.94	1241.75	0.81
3814.1	BKF	110		1238.49	
3814.1	100 YR	942		1241.26	
3793.1	BKF	110		1238.59	
3793.1	100 YR	942		1241.4	
3788.1	BKF	110	1237.03	1238.39	1.36
3788.1	100 YR	942	1240.43	1240.85	0.42
3746.1	BKF	110		1237.99	
3746.1	100 YR	942		1240.38	
3741.54	BKF	110	1236.1	1238.15	2.05
3741.54	100 YR	942	1239.68	1240.52	0.84
3728.28	BKF	110		1237.87	
3728.28	100 YR	942		1240.21	
3691.1	BKF	110		1237.16	
3691.1	100 YR	942		1240.19	
3682.16	BKF	110	1235.38	1237.26	1.88
3682.16	100 YR	942	1239.44	1240.32	0.88
3668.45	BKF	110		1237	
3668.45	100 YR	942		1240.33	
3632.1	BKF	110		1236.29	
3632.1	100 YR	942		1239.21	

BOBS CREEK
HEC-RAS ANALYSIS

River Station	Storm Event	Discharge (cfs)	Existing WSEL (ft)	Proposed WSEL (ft)	Backwater (ft)
3611.1	BKF	110	1234.42	1235.72	1.30
3611.1	100 YR	942	1238.19	1239.05	0.86
3593.66	BKF	110		1235.49	
3593.66	100 YR	942		1238.33	
3560.1	BKF	110		1234.83	
3560.1	100 YR	942		1237.96	
3539.1	BKF	110	1233.5	1234.3	0.80
3539.1	100 YR	942	1236.34	1237.33	0.99
3521.11	BKF	110		1234.05	
3521.11	100 YR	942		1236.99	
End Restoration					
3493.84	BKF	110	1233.36	1233.45	0.09
3493.84	100 YR	942	1236.04	1236.41	0.37
3473.1	BKF	110		1233.58	
3473.1	100 YR	942		1236.53	
3468.1	BKF	110		1233.04	
3468.1	100 YR	942		1235.92	
3457.53	BKF	110	1232.79	1232.78	-0.01
3457.53	100 YR	942	1235.81	1235.64	-0.17
3412.97	BKF	110	1232.3	1232.3	0.00
3412.97	100 YR	942	1235.16	1235.16	0.00
3342.25	BKF	110	1231.55	1231.55	0.00
3342.25	100 YR	942	1234.68	1234.68	0.00
3280.92	BKF	110	1230.88	1230.88	0.00
3280.92	100 YR	942	1233.76	1233.76	0.00
3230.22	BKF	110	1230.34	1230.34	0.00
3230.22	100 YR	942	1233.12	1233.12	0.00
3166.35	BKF	110	1229.66	1229.66	0.00
3166.35	100 YR	942	1232.23	1232.23	0.00
3113.04	BKF	110	1229.09	1229.09	0.00
3113.04	100 YR	942	1231.71	1231.71	0.00
3062.67	BKF	110	1228.55	1228.55	0.00
3062.67	100 YR	942	1231.21	1231.21	0.00

BOBS CREEK
HEC-RAS ANALYSIS

River Station	Storm Event	Discharge (cfs)	Existing WSEL (ft)	Proposed WSEL (ft)	Backwater (ft)
3011.65	BKF	110	1228.01	1228.01	0.00
3011.65	100 YR	942	1230.65	1230.65	0.00
2950.01	BKF	110	1227.35	1227.35	0.00
2950.01	100 YR	942	1229.94	1229.94	0.00
2892.28	BKF	110	1226.73	1226.73	0.00
2892.28	100 YR	942	1229.44	1229.44	0.00
2827.86	BKF	110	1226.04	1226.04	0.00
2827.86	100 YR	942	1228.75	1228.75	0.00
2765.49	BKF	110	1225.37	1225.37	0.00
2765.49	100 YR	942	1227.8	1227.8	0.00
2707.57	BKF	110	1224.76	1224.76	0.00
2707.57	100 YR	942	1227.39	1227.39	0.00
2654.58	BKF	110	1224.18	1224.18	0.00
2654.58	100 YR	942	1227.06	1227.06	0.00
2603.69	BKF	110	1223.64	1223.64	0.00
2603.69	100 YR	942	1226.42	1226.42	0.00
2548.51	BKF	110	1223.05	1223.05	0.00
2548.51	100 YR	942	1225.98	1225.98	0.00
2498.64	BKF	110	1222.51	1222.51	0.00
2498.64	100 YR	942	1225.2	1225.2	0.00
2427.15	BKF	110	1221.75	1221.75	0.00
2427.15	100 YR	942	1224.15	1224.15	0.00
2375.66	BKF	110	1221.2	1221.2	0.00
2375.66	100 YR	942	1223.96	1223.96	0.00
2310.85	BKF	110	1220.51	1220.51	0.00
2310.85	100 YR	942	1223.75	1223.75	0.00
2237.35	BKF	110	1219.72	1219.72	0.00
2237.35	100 YR	942	1222.76	1222.76	0.00
2155.27	BKF	110	1218.84	1218.84	0.00
2155.27	100 YR	942	1221.56	1221.56	0.00
2090.69	BKF	110	1218.16	1218.16	0.00
2090.69	100 YR	942	1220.86	1220.86	0.00

BOBS CREEK
HEC-RAS ANALYSIS

River Station	Storm Event	Discharge (cfs)	Existing WSEL (ft)	Proposed WSEL (ft)	Backwater (ft)
2022.82	BKF	110	1217.42	1217.42	0.00
2022.82	100 YR	942	1220.15	1220.15	0.00
1945.17	BKF	110	1216.59	1216.59	0.00
1945.17	100 YR	942	1219.19	1219.19	0.00
Convergence with UT 8 Bobs Creek					
1874.16	BKF	110	1215.83	1215.83	0.00
1874.16	100 YR	942	1218.32	1218.32	0.00
1764.48	BKF	110	1214.66	1214.66	0.00
1764.48	100 YR	942	1217.17	1217.17	0.00
1702.14	BKF	110	1214	1214	0.00
1702.14	100 YR	942	1216.62	1216.62	0.00
1621.98	BKF	110	1213.13	1213.13	0.00
1621.98	100 YR	942	1215.8	1215.8	0.00
1550.28	BKF	110	1212.37	1212.37	0.00
1550.28	100 YR	942	1214.79	1214.79	0.00
1492.56	BKF	110	1211.74	1211.74	0.00
1492.56	100 YR	942	1214.36	1214.36	0.00
1412.44	BKF	110	1210.89	1210.89	0.00
1412.44	100 YR	942	1213.81	1213.81	0.00
1331.66	BKF	110	1210.03	1210.03	0.00
1331.66	100 YR	942	1212.89	1212.89	0.00
1250.26	BKF	110	1209.15	1209.15	0.00
1250.26	100 YR	942	1211.99	1211.99	0.00
1170.29	BKF	110	1208.3	1208.3	0.00
1170.29	100 YR	942	1210.9	1210.9	0.00
1106.65	BKF	110	1207.62	1207.62	0.00
1106.65	100 YR	942	1210.78	1210.78	0.00
1051.26	BKF	110	1207.03	1207.03	0.00
1051.26	100 YR	942	1210.59	1210.59	0.00
1003.1	BKF	110	1206.49	1206.49	0.00
1003.1	100 YR	942	1209.48	1209.48	0.00
End Analysis at State Road					

UT 8 BOBS CREEK
HEC-RAS ANALYSIS

River Station	Storm Event	Discharge (cfs)	Existing WSEL (ft)	Proposed WSEL (ft)	Backwater (ft)
Upstream End of Project					
2055.56	BKF	15	1238.77	1238.77	0.00
2055.56	100 YR	188	1245.5	1245.51	0.01
2054		Culvert			
1990.56	BKF	15	1236.37	1236.69	0.32
1990.56	100 YR	188	1239.09	1239.4	0.31
				0	
1907.34	BKF	15	1233.35	1233.31	-0.04
1907.34	100 YR	188	1236.2	1236.2	0.00
1832.74	BKF	15	1231.53	1231.9	0.37
1832.74	100 YR	188	1234.04	1233.71	-0.33
1819.74	BKF	15		1231.57	
1819.74	100 YR	188		1233.52	
1810.74	BKF	15		1231.54	
1810.74	100 YR	188		1233.76	
1805.23	BKF	15		1231.46	
1805.23	100 YR	188		1233.57	
1790.74	BKF	15	1230.34	1231.12	0.78
1790.74	100 YR	188	1233.2	1233.08	-0.12
1780.74	BKF	15		1230.93	
1780.74	100 YR	188		1233.04	
1774.03	BKF	15		1230.84	
1774.03	100 YR	188		1232.44	
1758.74	BKF	15		1230.49	
1758.74	100 YR	188		1232.33	
1748.74	BKF	15		1229.73	
1748.74	100 YR	188		1232.12	
1745.74	BKF	15		1229.65	
1745.74	100 YR	188		1231.81	
1735.74	BKF	15		1229.36	
1735.74	100 YR	188		1231.47	
1725.74	BKF	15	1229.34	1229.47	0.13
1725.74	100 YR	188	1230.97	1231.67	0.70

UT 8 BOBS CREEK
HEC-RAS ANALYSIS

River Station	Storm Event	Discharge (cfs)	Existing WSEL (ft)	Proposed WSEL (ft)	Backwater (ft)
1720.14	BKF	15		1229.38	
1720.14	100 YR	188		1231.3	
1710.29	BKF	15		1229.27	
1710.29	100 YR	188		1231.52	
1699.86	BKF	15		1229.31	
1699.86	100 YR	188		1231.51	
1689.42	BKF	15		1229.13	
1689.42	100 YR	188		1230.92	
1673.74	BKF	15		1228.73	
1673.74	100 YR	188		1230.67	
1668.74	BKF	15		1228.1	
1668.74	100 YR	188		1230.49	
1663.74	BKF	15	1228.19	1227.93	-0.26
1663.74	100 YR	188	1229.83	1229.82	-0.01
1600.72	BKF	15	1226.82	1226.95	0.13
1600.72	100 YR	188	1228.92	1229.16	0.24
1521.14	BKF	15	1225.5	1226.09	0.59
1521.14	100 YR	188	1227.84	1227.85	0.01
1468.55	BKF	15	1224.94	1225.21	0.27
1468.55	100 YR	188	1227.15	1227.16	0.01
1458.55	BKF	15		1224.54	
1458.55	100 YR	188		1227.17	
1456.55	BKF	15		1224.46	
1456.55	100 YR	188		1227.07	
1443.7	BKF	15	1224.42	1224.38	-0.04
1443.7	100 YR	188	1227.29	1227.05	-0.24
1431.09	BKF	15		1224.4	
1431.09	100 YR	188		1227.09	
1418.48	BKF	15		1224.3	
1418.48	100 YR	188		1226.99	
1397.55	BKF	15		1224.17	
1397.55	100 YR	188		1226.88	

UT 8 BOBS CREEK
HEC-RAS ANALYSIS

River Station	Storm Event	Discharge (cfs)	Existing WSEL (ft)	Proposed WSEL (ft)	Backwater (ft)
1387.55	BKF	15		1224.2	
1387.55	100 YR	188		1226.89	
1379.48	BKF	15	1223.57	1224.1	0.53
1379.48	100 YR	188	1226.89	1226.77	-0.12
1378		Culvert			
1363	BKF	15	1221.95	1224.11	2.16
1363	100 YR	188	1224.72	1226.45	1.73
1316.55	BKF	15		1223.89	
1316.55	100 YR	188		1226.4	
1308.68	BKF	15	1220.3	1223.91	3.61
1308.68	100 YR	188	1223.23	1226.46	3.23
1298.46	BKF	15		1223.81	
1298.46	100 YR	188		1225.99	
1279.83	BKF	15		1223.69	
1279.83	100 YR	188		1224.95	
1264.35	BKF	15		1223.71	
1264.35	100 YR	188		1225.34	
1248.88	BKF	15	1219.1	1223.6	4.50
1248.88	100 YR	188	1222.89	1225.11	2.22
1232.55	BKF	15		1223.24	
1232.55	100 YR	188		1224.69	
1222.55	BKF	15		1222.46	
1222.55	100 YR	188		1223.8	
1216.71	BKF	15		1222.19	
1216.71	100 YR	188		1223.45	
1211.55	BKF	15		1221.81	
1211.55	100 YR	188		1223.28	
1209.55	BKF	15		1221.92	
1209.55	100 YR	188		1223.13	
1206.55	BKF	15		1221.82	
1206.55	100 YR	188		1222.98	

UT 8 BOBS CREEK
HEC-RAS ANALYSIS

River Station	Storm Event	Discharge (cfs)	Existing WSEL (ft)	Proposed WSEL (ft)	Backwater (ft)
1197.55	BKF	15	1218.69	1221.54	2.85
1197.55	100 YR	188	1222.97	1222.75	-0.22
1187.55	BKF	15		1221.41	
1187.55	100 YR	188		1222.47	
1170.56	BKF	15		1221.11	
1170.56	100 YR	188		1222.45	
1168.55	BKF	15	1218.07	1220.92	2.85
1168.55	100 YR	188	1221.59	1222.01	0.42
1165.55	BKF	15		1220.86	
1165.55	100 YR	188		1222.01	
1148.55	BKF	15		1220.51	
1148.55	100 YR	188		1221.51	
1138.55	BKF	15		1220.35	
1138.55	100 YR	188		1221.08	
1130.21	BKF	15	1217.2	1220.26	3.06
1130.21	100 YR	188	1219.9	1221.03	1.13
1108.55	BKF	15	1216.68	1219.86	3.18
1108.55	100 YR	188	1219.95	1220.48	0.53
1102.55	BKF	15		1219.12	
1102.55	100 YR	188		1220.2	
1096.55	BKF	15		1218.98	
1096.55	100 YR	188		1220.24	
1090.55	BKF	15		1218.75	
1090.55	100 YR	188		1220.25	
1084.55	BKF	15		1217.82	
1084.55	100 YR	188		1218.92	
1077.55	BKF	15		1217.54	
1077.55	100 YR	188		1219.24	
1072.55	BKF	15	1216.37	1216.94	0.57
1072.55	100 YR	188	1220.07	1218.74	-1.33
1066.55	BKF	15		1216.66	
1066.55	100 YR	188		1218.7	

UT 8 BOBS CREEK
HEC-RAS ANALYSIS

River Station	Storm Event	Discharge (cfs)	Existing WSEL (ft)	Proposed WSEL (ft)	Backwater (ft)
1061.55	BKF	15		1215.86	
1061.55	100 YR	188		1217.83	
1054.76	BKF	15		1215.59	
1054.76	100 YR	188		1217.44	
1047.96	BKF	15		1214.82	
1047.96	100 YR	188		1217	
1041.17	BKF	15	1215.99	1214.54	-1.45
1041.17	100 YR	188	1218.82	1216.43	-2.39
1039.55	BKF	15		1214.43	
1039.55	100 YR	188		1216.34	
1034.55	BKF	15		1214.14	
1034.55	100 YR	188		1216.3	
1027.55	BKF	15		1214.04	
1027.55	100 YR	188		1216.05	
1017.55	BKF	15		1214.04	
1017.55	100 YR	188		1216.05	
1016.55	BKF	15	1215.57	1213.9	-1.67
1016.55	100 YR	188	1218.75	1215.62	-3.13
End Analysis at Convergence with Bobs Creek					

APPENDIX 7
EEP FLOODPLAIN REQUIREMENTS CHECKLIST

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. Edward Curtis), NC Floodplain Mapping Unit (attn. John Gerber) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Neighbor Bob Stream Restoration
Name if stream or feature:	Bobs Creek, Neighbor Branch, Walton Crawley Branch, and UTs to the three (3) streams listed.
County:	McDowell
Name of river basin:	Catawba
Is project urban or rural?	Rural and agriculture in nature.
Name of Jurisdictional municipality/county:	McDowell County
DFIRM panel number for entire site:	3710162800J and 3710172000J
Consultant name:	Ko & Associates, P.C.
Phone number:	(919) 851-6066
Address:	5121 Kingdom Way, Suite 100 Raleigh, North Carolina 27607

Design Information

The project site is located on two different properties, Paul Patton and Johnny Newton southeast of Marion. The Patton property is located at the southwest corner of the intersection of Marlowe Road and Fat Wall Road (Latitude 35.6336 & Longitude 81.9390). The Newton property is located southeast of the intersection of Harmony Grove Road and Gaddy Raod (Latitude 35.6641 & Longitude 81.8984) in McDowell County.

The primary goals of the project are to restore, enhance and preserve stream channels as outlined below:

PATTON PROPERTY	Restoration	Enhancement	Preservation
Bobs Creek	371	329	2,661
UT 1 to Bobs Creek			1,003
UT 2 to Bobs Creek			615
UT 3 to Bobs Creek			530
UT 4 to Bobs Creek			259
UT 5 to Bobs Creek			264
UT 6 to Bobs Creek		45	336
UT 7 to Bobs Creek		25	629
UT 8 to Bobs Creek	646	245	97
NEWTON PROPERTY			
Walton Crawley	1,287	264	1,050
UT 1 to Walton Crawley		304	495
UT 2 to Walton Crawley	429	159	
Neighbors Branch	548	815	
UT 1 to Neighbors Branch		208	
UT 2 to Neighbors Branch			
TOTALS	**3,281**	**2,395**	**9,682**

The existing stream footage is approximately 15,284 linear feet. The estimated restored stream length will be approximately 3,281 linear feet.

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

☑ Yes ☐ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☑ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation: AE & X

Check if applies:

- [x] AE Zone
  - [ ] Floodway
  - [ ] Non-Encroachment
  - [x] None
- [ ] A Zone
  - [ ] Local Setbacks Required
  - [ ] No Local Setbacks Required

If local setbacks are required, list how many feet:

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

- [ ] Yes
- [x] No

Land Acquisition (Check)

- [ ] State owned (fee simple)
- [x] Conservation easment (Design Bid Build)
- [ ] Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

- [x] Yes
- [ ] No

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: Edward Curtis, (919) 715-8000 x369)

Name of Local Floodplain Administrator: Jerry Silvers
Phone Number: 828-652-7121

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

- ☐ No Action
- ☐ No Rise
- ☐ Letter of Map Revision
- ☐ Conditional Letter of Map Revision (CLOMR)
- ☑ Other Requirements

List other requirements:

Discussions with the McDowell County Flood Plain Administrator, Jerry Silvers (828-652-7121) on September 23rd, 2008 revealed that as long as there is no change in base flood elevations along Bobs Creek (Zone AE), then it appears that no submittal to his office is required. All other streams are located within Zone X and no submittal to his office is required..

Comments:

Name: R. Kevin Williams, PE, PLS_____ Signature: _____

Title: Project Engineer/Manager_____ Date: _____

APPENDIX 8
BEHI AND NBS ASSESSMENT

LEGEND

NBS	BEHI
Extreme	High
Moderate	High
Very High	Moderate
Extreme	Moderate
High	Very High
Very High	High
High	High
Low	Moderate
Moderate	Very High
Extreme	Very High
Low	Very High
Low	High
Moderate	Moderate
Extreme	Extreme
High	Moderate
Very High	Low
Moderate	Extreme
Very High	Very High
Moderate	Low
High	Extreme

Ecosystem Enhancement PROGRAM

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

BOBS CREEK

Flow Direction

UT7 BOBS CREEK

UT6 BOBS CREEK

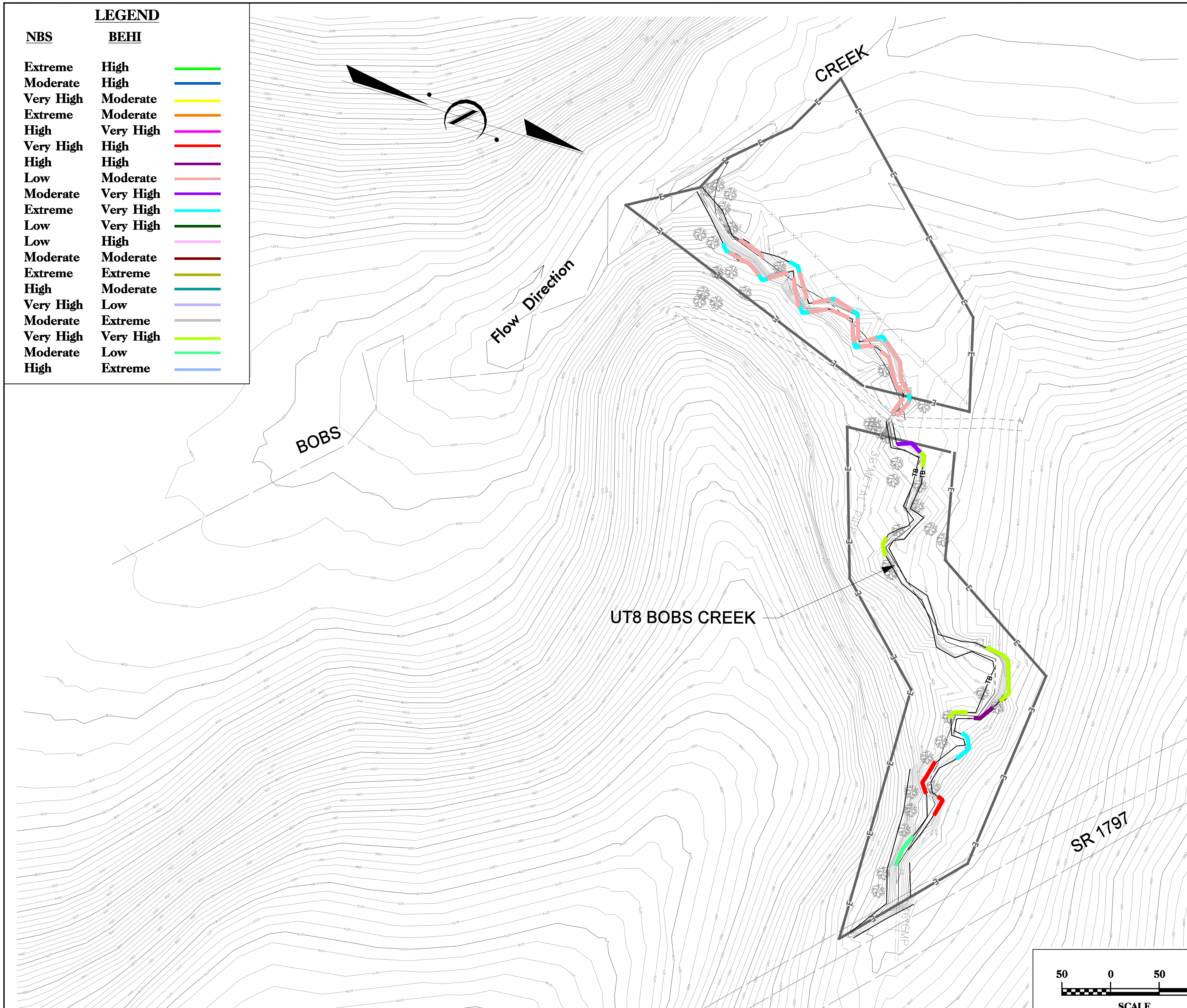
50 0 50 100

SCALE

BEHI and NBS

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09



LEGEND

NBS	BEHI
Extreme	High
Moderate	High
Very High	Moderate
Extreme	Moderate
High	Very High
Very High	High
High	High
Low	Moderate
Moderate	Very High
Extreme	Very High
Low	Very High
Low	High
Moderate	Moderate
Extreme	Extreme
High	Moderate
Very High	Low
Moderate	Extreme
Very High	Very High
Moderate	Low
High	Extreme

Ecosystem Enhancement PROGRAM

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

50 0 50 100
SCALE

BEHI and NBS

Bobs Creek
Stream & Wetland Restoration Plan
McDowell County, North Carolina

Date: 12/21/09

Bobs Creek: Sediment Loss Along Banks							
Stream:		Bobs	Total Bank Length:	414'	Stream Type:	B5,C5, F5	
Observers:		RVS/NGL	Date:	4/22/2009	Graph Used:	North Carolina	

	NBS	BEHI	Erosion Rate (ft/yr)	Length of Bank (ft)	Bank Height (ft)	Erosion Sub-total (ft^3/yr)	Tons/yr/ft
1	EXTREME	MODERATE	0.51	27.4	2.5	35	0.06
2	VERY HIGH	MODERATE	0.19	5.5	2.5	3	0.02
4	MODERATE	HIGH	0.16	79.0	2.5	32	0.02
5	EXTREME	HIGH	0.27	37.3	2.5	25	0.03
6	MODERATE	MODERATE	0.042	50.7	2.5	5	0.01
7	MODERATE	HIGH	0.16	20.9	2.5	8	0.02
8	MODERATE	MODERATE	0.042	19.4	2.5	2	0.01
9	HIGH	EXTREME	3.5	72.8	2.5	637	0.42
10	EXTREME	VERY HIGH	1.3	38.5	2.5	125	0.16
12	HIGH	VERY HIGH	0.89	62.3	2.5	139	0.11

I. Sum erosion sub-totals for each BEHI/NBS combination	**Total Erosion (ft3/yr)**	1011
II. Divide total erosion (ft^3) by 27 ft^3/yd^3	**Total Erosion (yd3/yr)**	37
III. Multiply total erosion (yd^3) by 1.3 (conversion of yd^3 to tons for average material type)	**Total Erosion (tons/yr)**	49
IV. Divide tons/yr by total length of bank	**Tons/yr/ft**	0.12

UT 6 Bobs Creek: Sediment Loss Along Banks							
Stream:		UT 6 Bobs	Total Bank Length:	70'	Stream Type:	B4	
Observers:		RVS/NGL	Date:	4/22/2009	Graph Used:	North Carolina	
	NBS	**BEHI**	**Erosion Rate (ft/yr)**	**Length of Bank (ft)**	**Bank Height (ft)**	**Erosion Sub-total (ft^3/yr)**	**Tons/yr/ft**
1	MODERATE	HIGH	0.16	13.6	1.37	3	0.01
2	VERY HIGH	HIGH	0.19	4.1	1.37	1	0.01
3	HIGH	VERY HIGH	0.89	28.7	1.37	35	0.06
4	VERY HIGH	VERY HIGH	1.02	23.8	1.37	33	0.07
I. Sum erosion sub-totals for each BEHI/NBS combination					**Total Erosion (ft3/yr)**	72	
II. Divide total erosion (ft^3) by 27 ft^3/yd^3					**Total Erosion (yd3/yr)**	3	
III. Multiply total erosion (yd^3) by 1.3 (conversion of yd^3 to tons for average material type)					**Total Erosion (tons/yr)**	3	
IV. Divide tons/yr by total length of bank					**Tons/yr/ft**	0.05	

UT 7 Bobs Creek: Sediment Loss Along Banks							
Stream:	UT 7 Bobs	Total Bank Length:	24'	Stream Type:	C4		
Observers:	RVS/NGL	Date:	4/22/2009	Graph Used:	North Carolina		

	NBS	BEHI	Erosion Rate (ft/yr)	Length of Bank (ft)	Bank Height (ft)	Erosion Sub-total (ft^3/yr)	Tons/yr/ft
1	MODERATE	HIGH	1.02	24	3	73	0.15
I. Sum erosion sub-totals for each BEHI/NBS combination					**Total Erosion (ft3/yr)**	73	
II. Divide total erosion (ft^3) by 27 ft^3/yd^3					**Total Erosion (yd3/yr)**	3	
III. Multiply total erosion (yd^3) by 1.3 (conversion of yd^3 to tons for average material type)					**Total Erosion (tons/yr)**	4	
IV. Divide tons/yr by total length of bank					**Tons/yr/ft**	0.15	

UT 8 Bobs Creek: Sediment Loss Along Banks							
Stream:		UT 8 Bobs	Total Bank Length:	12'	Stream Type:	B4, C4, G4	
Observers:		RVS/NGL	Date:	4/22/2009	Graph Used:	North Carolina	
	NBS	**BEHI**	**Erosion Rate (ft/yr)**	**Length of Bank (ft)**	**Bank Height (ft)**	**Erosion Sub-total (ft^3/yr)**	**Tons/yr/ft**
1	MODERATE	LOW	0.011	31.5	1	0	0.00
2	VERY HIGH	HIGH	0.19	20.2	3	12	0.03
3	VERY HIGH	HIGH	0.19	33.4	1	6	0.01
4	EXTREME	VERY HIGH	1.3	31.7	3	124	0.19
5	VERY HIGH	VERY HIGH	1.02	17.6	1	18	0.05
6	HIGH	HIGH	0.21	19.7	4	17	0.04
7	VERY HIGH	VERY HIGH	1.02	68.3	8	557	0.39
8	VERY HIGH	VERY HIGH	1.02	16.4	1	17	0.05
9	VERY HIGH	VERY HIGH	1.02	16.9	1	17	0.05
10	MODERATE	VERY HIGH	0.75	24.1	1	18	0.04
11	LOW	MODERATE	0.017	15.5	6.5	2	0.01
12	LOW	MODERATE	0.017	16.2	6.5	2	0.01
13	EXTREME	VERY HIGH	1.3	8.9	6.5	75	0.41
14	LOW	MODERATE	0.017	57.0	6.5	6	0.01
15	LOW	MODERATE	0.017	45.8	6.5	5	0.01
16	EXTREME	VERY HIGH	1.3	16.6	6.5	140	0.41
17	LOW	MODERATE	0.017	8.9	6.5	1	0.01
18	LOW	MODERATE	0.017	10.2	6.5	1	0.01
19	EXTREME	VERY HIGH	1.3	15.1	6.5	128	0.41
20	LOW	MODERATE	0.017	17.9	6.5	2	0.01
21	LOW	MODERATE	0.017	16.3	6.5	2	0.01
22	EXTREME	VERY HIGH	1.3	15.8	6.5	134	0.41
23	LOW	MODERATE	0.017	16.7	6.5	2	0.01
24	LOW	MODERATE	0.017	16.5	6.5	2	0.01
25	EXTREME	VERY HIGH	1.3	8.7	6.5	74	0.41
26	LOW	MODERATE	0.017	15.0	6.5	2	0.01
27	LOW	MODERATE	0.017	15.6	6.5	2	0.01
28	EXTREME	VERY HIGH	1.3	17.8	6.5	150	0.41
29	LOW	MODERATE	0.017	23.7	6.5	3	0.01
30	LOW	MODERATE	0.017	27.6	6.5	3	0.01
31	EXTREME	VERY HIGH	1.3	16.7	6.5	141	0.41
32	LOW	MODERATE	0.017	17.5	6.5	2	0.01
33	EXTREME	VERY HIGH	1.3	16.4	6.5	139	0.41
34	LOW	MODERATE	0.017	24.1	6.5	3	0.01
35	LOW	MODERATE	0.017	35.0	6.5	4	0.01
36	EXTREME	VERY HIGH	1.3	11.9	6.5	101	0.41
I. Sum erosion sub-totals for each BEHI/NBS combination					**Total Erosion (ft3/yr)**	1908	
II. Divide total erosion (ft^3) by 27 ft^3/yd^3					**Total Erosion (yd3/yr)**	71	
III. Multiply total erosion (yd^3) by 1.3 (conversion of yd^3 to tons for average material type)					**Total Erosion (tons/yr)**	92	
IV. Divide tons/yr by total length of bank					**Tons/yr/ft**	0.12	

APPENDIX 9
ENTRAINMENT AND SEDIMENT TRANSPORT CALCULATIONS

EXISTING ENTRAINMENT CALCULATION FORM

Stream:	Bobs Creek	Reach:	Bobs Creek
Team:	RVS, CLS, NL	Date:	2/9/2009

Information Input Area

39.4	D_{50}	Riffle bed material D50 (mm)			
37.0	$\hat{D}_{50}$	Bar sample D50 (mm)			
82.00	D_i	Largest particle from bar sample (mm)	0.27	(feet)	304.8 mm/foot
0.0149	S_e	Existing bankfull water surface slope (ft/ft)			
1.08	d_e	Existing bankfull mean depth (ft)			
1.08	R	Hydraulic Radius of Riffle Cross Section (ft)			
1.65	γ_s	Submerged specific weight of sediment			

Calculation of Critical Dimensionless Shear Stress

1.06	$D_{50}/\hat{D}_{50}$	If value is between 3-7 **Equation 1** will be used: $\tau^*_{ci} = 0.0834(D_{50}/\hat{D}_{50})^{-0.872}$		
2.08	D_i/D_{50}	If value is between 1.3-3.0 **Equation 2** will be used: $\tau^*_{ci} = 0.0384(D_i/D_{50})^{-0.887}$		
0.0200	τ^*_{ci}	Critical Dimensionless Shear Stress	**Equation used:**	**2**

Calculation of Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample

0.60	d_r	Required bankfull mean depth (ft/ft) $d_r = \frac{\tau^*_{ci}\gamma_s D_i}{S_e}$	
1.08	d_e	Existing bankfull mean depth (ft)	
1.81	d_e/d_r	**Existing Stream Condition:**	**Degrading**

Calculation of BKF Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample

0.0082	S_r	Required bankfull water surface slope (ft) $S_r = \overline{\tau^*_{ci}\gamma_s D_i}\ d_e$	
0.0149	S_e	Existing bankfull water surface slope (ft)	
1.81	S_e/S_r	**Existing Stream Condition:**	**Degrading**

Sediment Transport Validation

1.00	Bankfull Shear Stress	$\tau_c = \gamma RS$ (lb/ft2) γ = Specific Weight of water = 62.4 lbs/ft^3
78 - 152 mm	Moveable particle size (mm) at bankfull shear stress (based off trend line not confidence interval) (Using Sields Diagram and Revised Shields Diagram by Rosgen, 2002)	
0.43 - 1.05 lbs/sq ft	Predicted shear stress required to initiate movement of Di (mm) (based off trend line not confidence interval) (see Revised Shields Diagram, Rosgen, 2002)	

PROPOSED CONDITIONS ENTRAINMENT CALCULATION FORM

Stream:	Bobs Creek	Reach:	Bobs Creek
Designer:	RVS	Date:	4/29/2009

Information Input Area

39.4	D_{50}	Riffle bed material D50 (mm)			
37.0	$D^{\wedge}_{50}$	Bar sample D50 (mm)			
82.0	D_i	Largest particle from bar sample (mm)	0.27	(feet)	304.8 mm/foot
0.007	S_e	Proposed bankfull water surface slope (ft/ft)			
1.3	d_e	Proposed bankfull mean depth (ft)			
1.2	R	Proposed Hydraulic Radius of Riffle Cross Section (ft)			
1.65	γ_s	Submerged specific weight of sediment			

Calculation of Critical Dimensionless Shear Stress

1.06	$D_{50}/D^{\wedge}_{50}$	If value is between 3-7 **Equation 1** will be used: $\tau^*_{ci} = 0.0834(D_{50}/D^{\wedge}_{50})^{-0.872}$		
2.08	D_i/D_{50}	If value is between 1.3-3.0 **Equation 2** will be used: $\tau^*_{ci} = 0.0384(D_i/D_{50})^{-0.887}$		
0.0200	τ^*_{ci}	Critical Dimensionless Shear Stress	**Equation used:**	**2**

Calculation of Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample

1.27	d_r	Required bankfull mean depth (ft/ft)	$d_r = \frac{\tau^*_{ci}\gamma_s D_i}{S_e}$
1.25	d_e	Proposed bankfull mean depth (ft)	
0.98	d_e/d_r	**Design Stream Condition:**	**Stable**

Calculation of BKF Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample

0.0071	S_r	Required bankfull water surface slope (ft)	$S_r = \frac{\tau^*_{ci}\gamma_s D_i}{d_e}$
0.0070	S_e	Existing bankfull water surface slope (ft)	
0.98	S_e/S_r	**Design Stream Condition:**	**Stable**

Sediment Transport Validation

0.536	Bankfull Shear Stress	$\tau_c = \gamma RS$ (lb/ft2) γ = Specific Weight of water = 62.4 lbs/ft^3
41 - 96 mm	Moveable particle size (mm) at bankfull shear stress (based off trend line not confidence interval) (Using Sields Diagram and Revised Shields Diagram by Rosgen, 2002)	
0.43 - 1.05 lbs/sq ft	Predicted shear stress required to initiate movement of Di (mm) (based off trend line not confidence interval) (see Revised Shields Diagram, Rosgen, 2002)	

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EXISTING ENTRAINMENT CALCULATION FORM

Stream:	UT 8 Bobs Creek	Reach:	UT 8 Bobs Creek
Team:	RVS, CLS, NL	Date:	2/9/2009

Information Input Area

13.0	D_{50}	Riffle bed material D50 (mm)			
5.5	$\hat{D}_{50}$	Bar sample D50 (mm)			
30.00	D_i	Largest particle from bar sample (mm)	0.10	(feet)	304.8 mm/foot
0.0148	S_e	Existing bankfull water surface slope (ft/ft)			
0.70	d_e	Existing bankfull mean depth (ft)			
0.61	R	Hydraulic Radius of Riffle Cross Section (ft)			
1.65	γ_s	Submerged specific weight of sediment			

Calculation of Critical Dimensionless Shear Stress

2.36	$D_{50}/\hat{D}_{50}$	If value is between 3-7 **Equation 1** will be used: $\tau^*_{ci} = 0.0834(D_{50}/\hat{D}_{50})^{-0.872}$		
2.31	D_i/D_{50}	If value is between 1.3-3.0 **Equation 2** will be used: $\tau^*_{ci} = 0.0384(D_i/D_{50})^{-0.887}$		
0.0183	τ^*_{ci}	Critical Dimensionless Shear Stress	**Equation used:**	**2**

Calculation of Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample

0.20	d_r	Required bankfull mean depth (ft/ft)	$d_r = \frac{\tau^*_{ci}\gamma_s D_i}{S_e}$
0.70	d_e	Existing bankfull mean depth (ft)	
3.49	d_e/d_r	**Existing Stream Condition:**	**Degrading**

Calculation of BKF Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample

0.0042	S_r	Required bankfull water surface slope (ft)	$S_r = \overline{\tau^*_{ci}\gamma_s D_i}\ d_e$
0.0148	S_e	Existing bankfull water surface slope (ft)	
3.49	S_e/S_r	**Existing Stream Condition:**	**Degrading**

Sediment Transport Validation

0.56	Bankfull Shear Stress	$\tau_c = \gamma RS$ (lb/ft2) γ = Specific Weight of water = 62.4 lbs/ft^3
43 - 100 mm	Moveable particle size (mm) at bankfull shear stress (based off trend line not confidence interval) (Using Sields Diagram and Revised Shields Diagram by Rosgen, 2002)	
0.11 - 0.40 lbs/sq ft	Predicted shear stress required to initiate movement of Di (mm) (based off trend line not confidence interval) (see Revised Shields Diagram, Rosgen, 2002)	

PROPOSED CONDITIONS ENTRAINMENT CALCULATION FORM

Stream:	UT 8 Bobs Creek	Reach:	UT 8 Bobs Creek
Designer:	RVS	Date:	4/28/2009

Information Input Area

13.00	D_{50}	Riffle bed material D50 (mm)			
5.50	$D^{\wedge}_{50}$	Bar sample D50 (mm)			
30.00	D_i	Largest particle from bar sample (mm)	0.10	(feet)	304.8 mm/foot
0.0040	S_e	Proposed bankfull water surface slope (ft/ft)			
0.76	d_e	Proposed bankfull mean depth (ft)			
0.70	R	Proposed Hydraulic Radius of Riffle Cross Section (ft)			
1.65	γ_s	Submerged specific weight of sediment			

Calculation of Critical Dimensionless Shear Stress

2.36	$D_{50}/D^{\wedge}_{50}$	If value is between 3-7 **Equation 1** will be used: $\tau^*_{ci} = 0.0834(D_{50}/D^{\wedge}_{50})^{-0.872}$		
2.31	D_i/D_{50}	If value is between 1.3-3.0 **Equation 2** will be used: $\tau^*_{ci} = 0.0384(D_i/D_{50})^{-0.887}$		
0.0183	τ^*_{ci}	Critical Dimensionless Shear Stress	**Equation used:**	**2**

Calculation of Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample

0.74	d_r	Required bankfull mean depth (ft/ft)	$d_r = \frac{\tau^*_{ci}\gamma_s D_i}{S_e}$
0.76	d_e	Proposed bankfull mean depth (ft)	
1.03	d_e/d_r	**Design Stream Condition:**	**Stable**

Calculation of BKF Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample

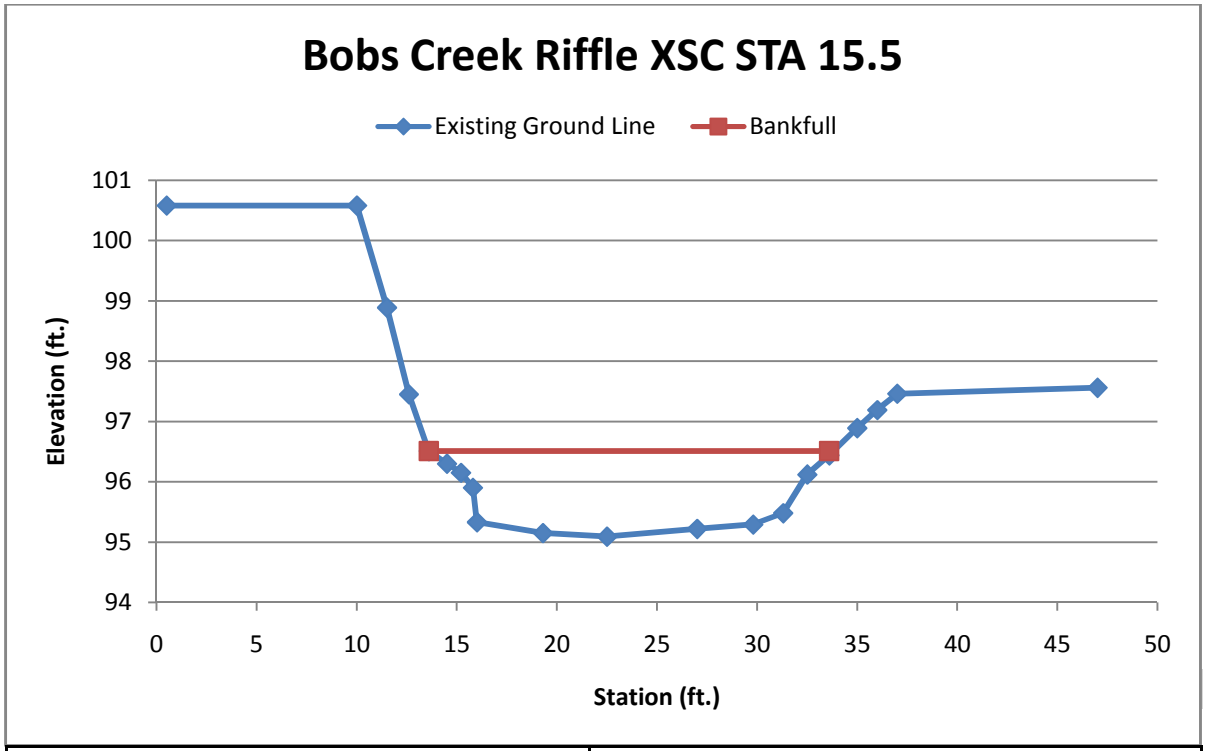
0.0039	S_r	Required bankfull water surface slope (ft)	$S_r = \frac{\tau^*_{ci}\gamma_s D_i}{d_e}$
0.0040	S_e	Existing bankfull water surface slope (ft)	
1.03	S_e/S_r	**Design Stream Condition:**	**Stable**

Sediment Transport Validation

0.175	Bankfull Shear Stress	$\tau_c = \gamma RS$ (lb/ft2) γ = Specific Weight of water = 62.4 lbs/ft^3
13 - 42 mm	Moveable particle size (mm) at bankfull shear stress (based off trend line not confidence interval) (Using Sields Diagram and Revised Shields Diagram by Rosgen, 2002)	
0.11 - 0.40 lbs/sq ft	Predicted shear stress required to initiate movement of Di (mm) (based off trend line not confidence interval) (see Revised Shields Diagram, Rosgen, 2002)	

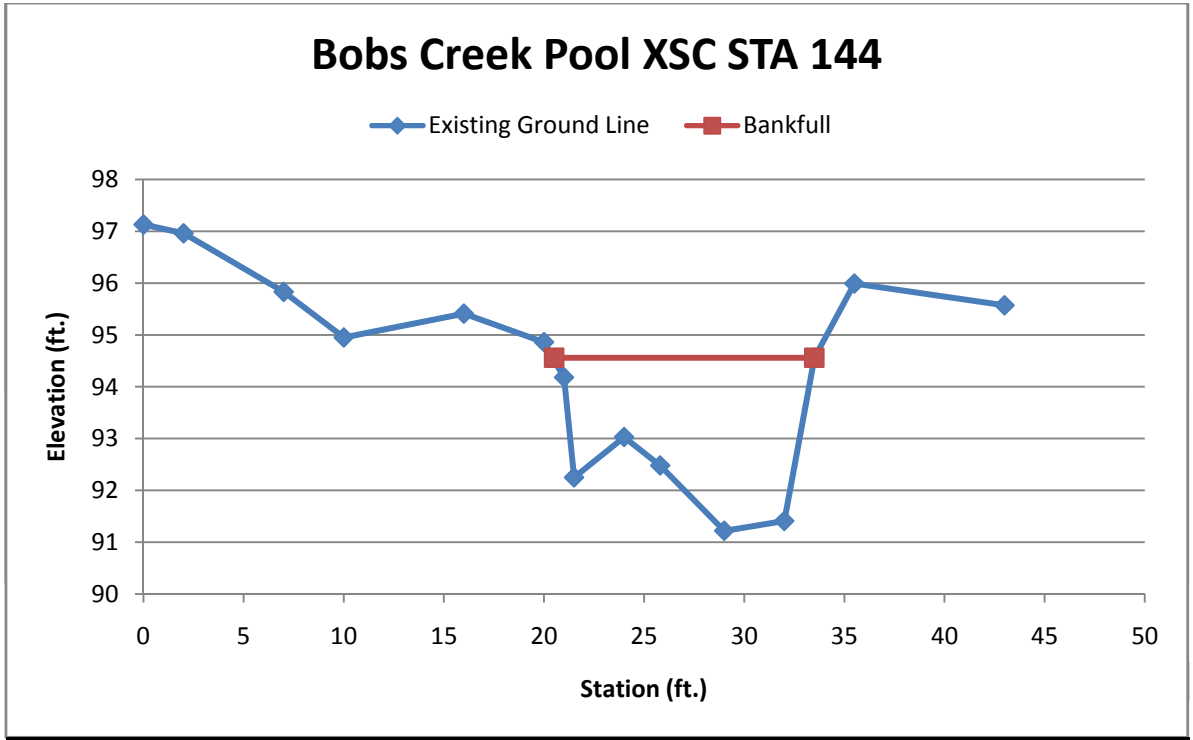
APPENDIX 10
EXISTING CONDITIONS CROSS SECTIONS AND PROFILES

Bobs Creek Riffle XSC STA 15.5		
Station (ft.)	*Elevation (ft.)*	*Feature*
0.5	100.58	
10	100.58	
11.5	98.89	
12.6	97.45	
13.6	96.51	BKF
14.5	96.30	
15.2	96.15	
15.8	95.90	
16	95.33	
19.3	95.15	
22.5	95.09	
27	95.22	
29.8	95.29	
31.3	95.48	
32.5	96.12	
33.6	96.44	
35	96.89	
36	97.19	
37	97.46	
47	97.56	



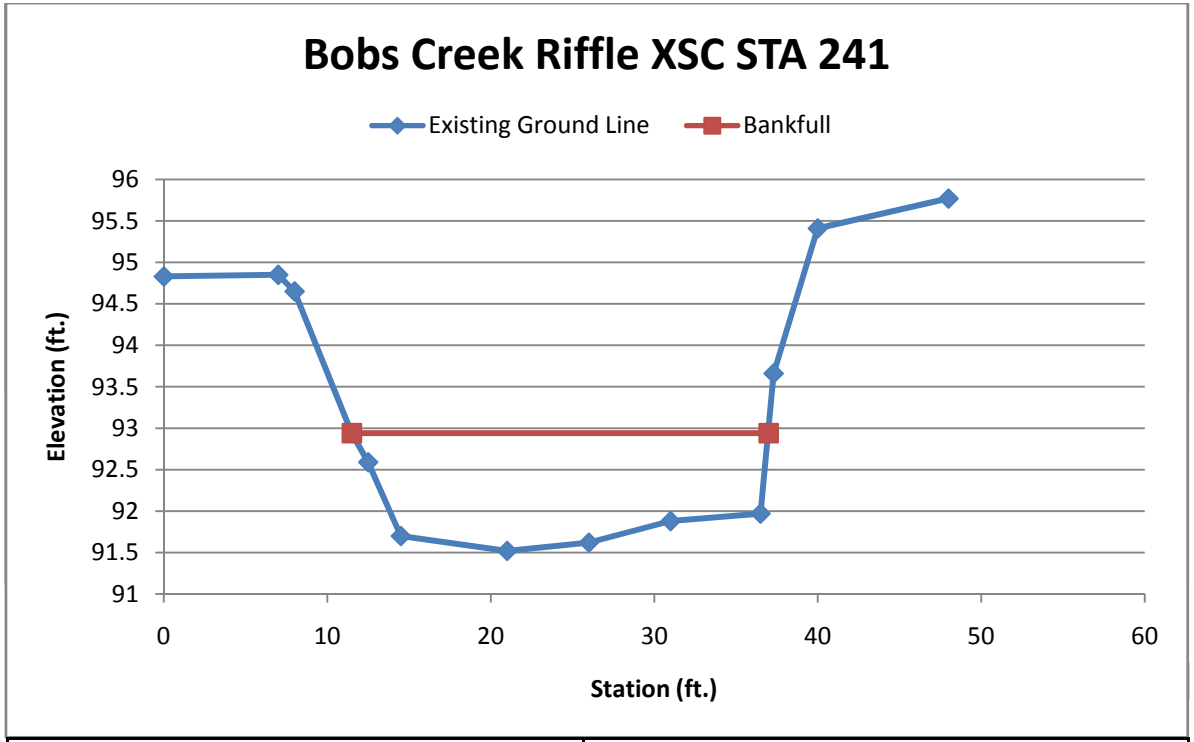
Bankfull Width (ft.):	20.22	*Mean Depth (ft.):*	1.08
Bankfull Area (ft.²)	21.81	*Max Depth (ft.):*	1.42
Entrenchment Ratio (ft.):	1.72	*Width/Depth Ratio (ft.):*	18.72

Bobs Creek Pool XSC STA 144		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	97.13	
2	96.96	
7	95.83	
10	94.95	
16	95.41	
20	94.86	
21	94.18	
21.5	92.25	
24	93.03	
25.8	92.48	
29	91.22	
32	91.41	
33.5	94.56	BKF
35.5	95.99	
43	95.57	



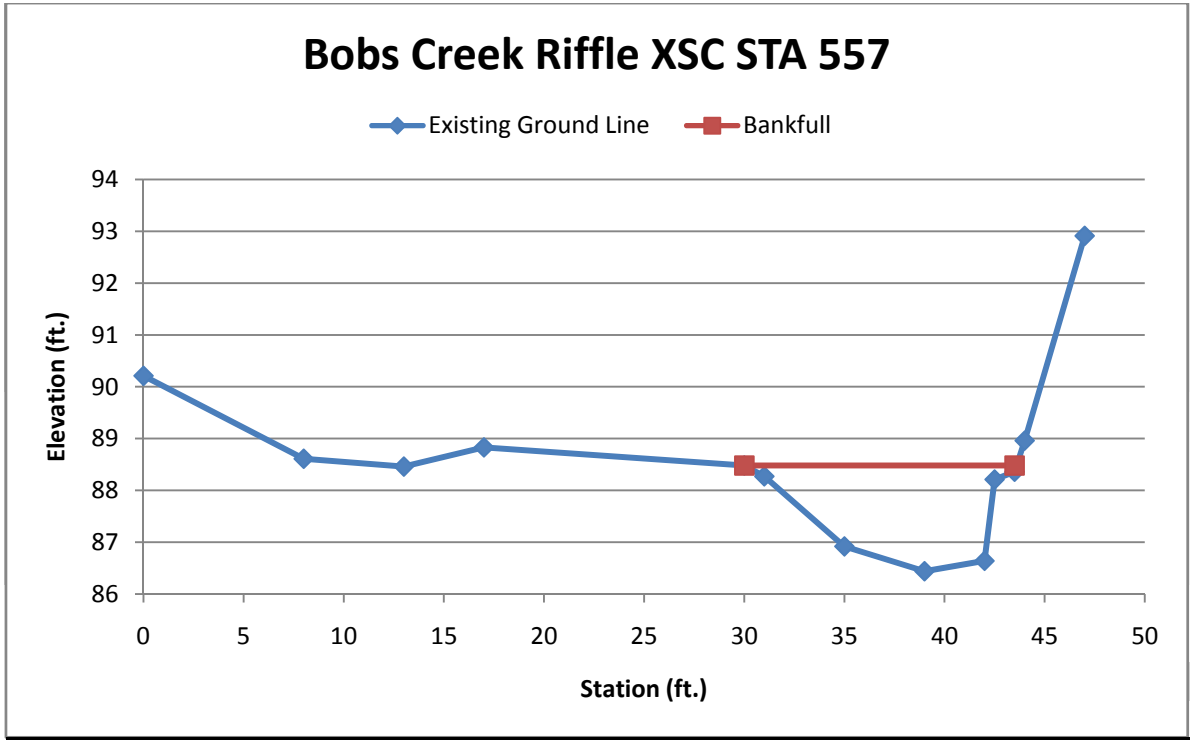
Bankfull Width (ft.):	13.06	*Mean Depth (ft.):*	2.27
Bankfull Area (ft. ²)	29.6	*Max Depth (ft.):*	3.34
Entrenchment Ratio (ft.):	3.29	*Width/Depth Ratio (ft.):*	5.75

Bobs Creek Riffle XSC STA 241		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	94.83	
7	94.85	
8	94.65	
11.5	92.94	BKF
12.5	92.59	
14.5	91.70	
21	91.52	
26	91.62	
31	91.88	
36.5	91.97	
37.3	93.66	
40	95.41	
48	95.77	



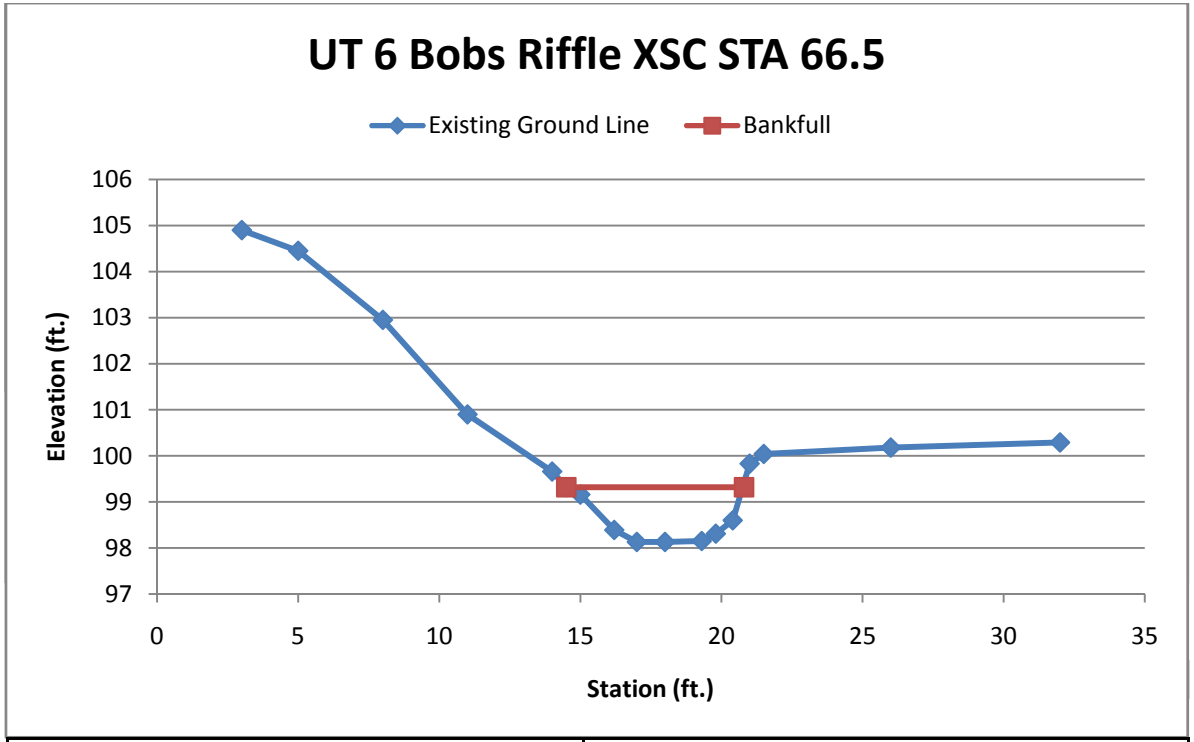
Bankfull Width (ft.):	25.46	*Mean Depth (ft.):*	1.14
Bankfull Area (ft. ²)	29.02	*Max Depth (ft.):*	1.42
Entrenchment Ratio (ft.):	1.17	*Width/Depth Ratio (ft.):*	22.33

Bobs Creek Riffle XSC STA 557		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	90.21	
8	88.61	
13	88.46	
17	88.83	
30	88.48	BKF
31	88.27	
35	86.92	
39	86.44	
42	86.64	
42.5	88.21	
43.5	88.36	
44	88.96	
47	92.91	



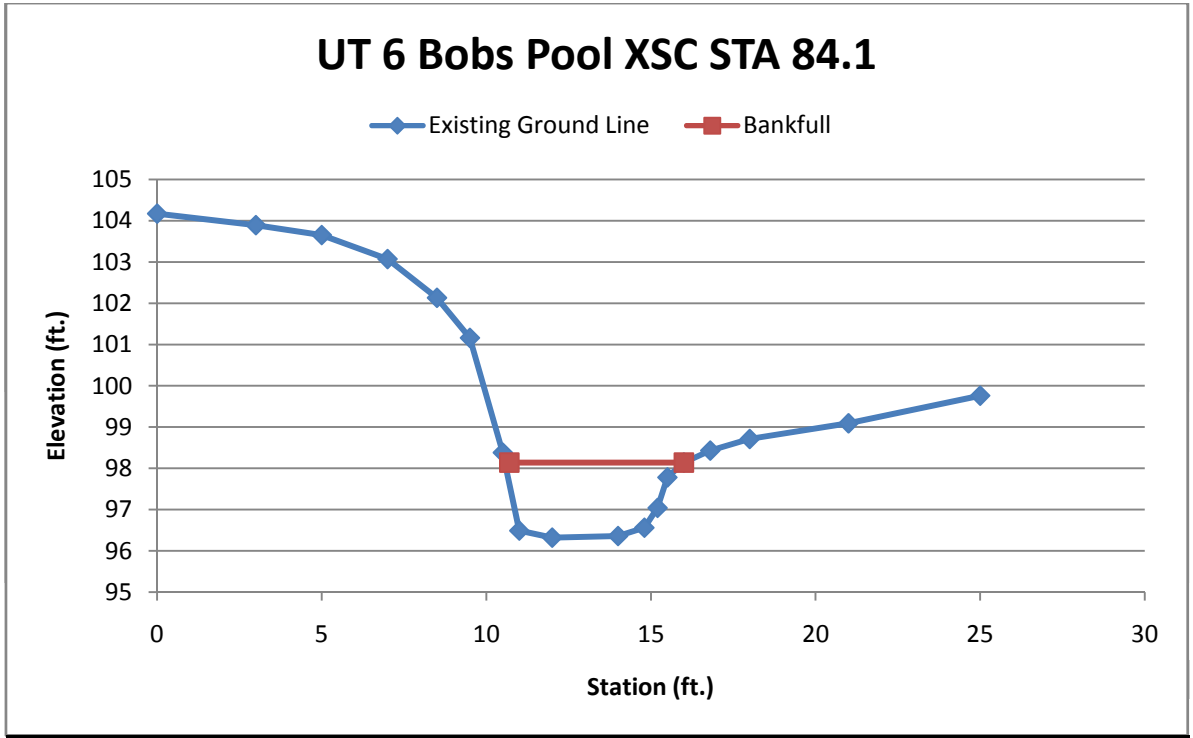
Bankfull Width (ft.):	14.48	*Mean Depth (ft.):*	1.2
Bankfull Area (ft. ²)	17.4	*Max Depth (ft.):*	2.04
Entrenchment Ratio (ft.):	3.12	*Width/Depth Ratio (ft.):*	12.07

UT 6 Bobs Riffle XSC STA 66.5		
Station (ft.)	*Elevation (ft.)*	*Feature*
3	104.9	
5	104.45	
8	102.95	
11	100.9	
14	99.66	
14.5	99.32	BKF
15	99.16	
16.2	98.39	
17	98.13	
18	98.13	
19.3	98.15	
19.8	98.31	
20.4	98.60	
21	99.83	
21.5	100.04	
26	100.18	
32	100.29	



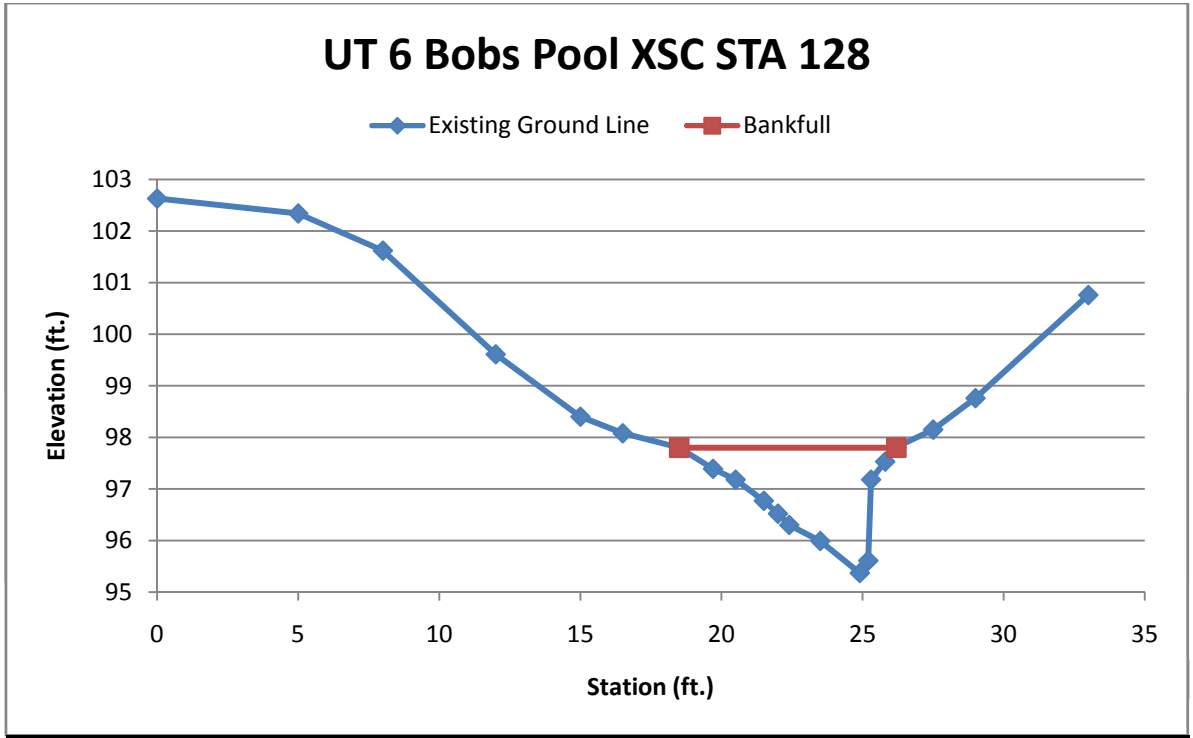
Bankfull Width (ft.):	6.25	*Mean Depth (ft.):*	0.87
Bankfull Area (ft. ²)	5.46	*Max Depth (ft.):*	1.19
Entrenchment Ratio (ft.):	3.21	*Width/Depth Ratio (ft.):*	7.18

UT 6 Bobs Pool XSC STA 84.1		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	104.17	
3	103.89	
5	103.65	
7	103.07	
8.5	102.13	
9.5	101.16	
10.5	98.38	
11	96.49	
12	96.32	
14	96.36	
14.8	96.56	
15.2	97.04	
15.5	97.78	
16	98.14	BKF
16.8	98.43	
18	98.71	
21	99.09	
25	99.76	



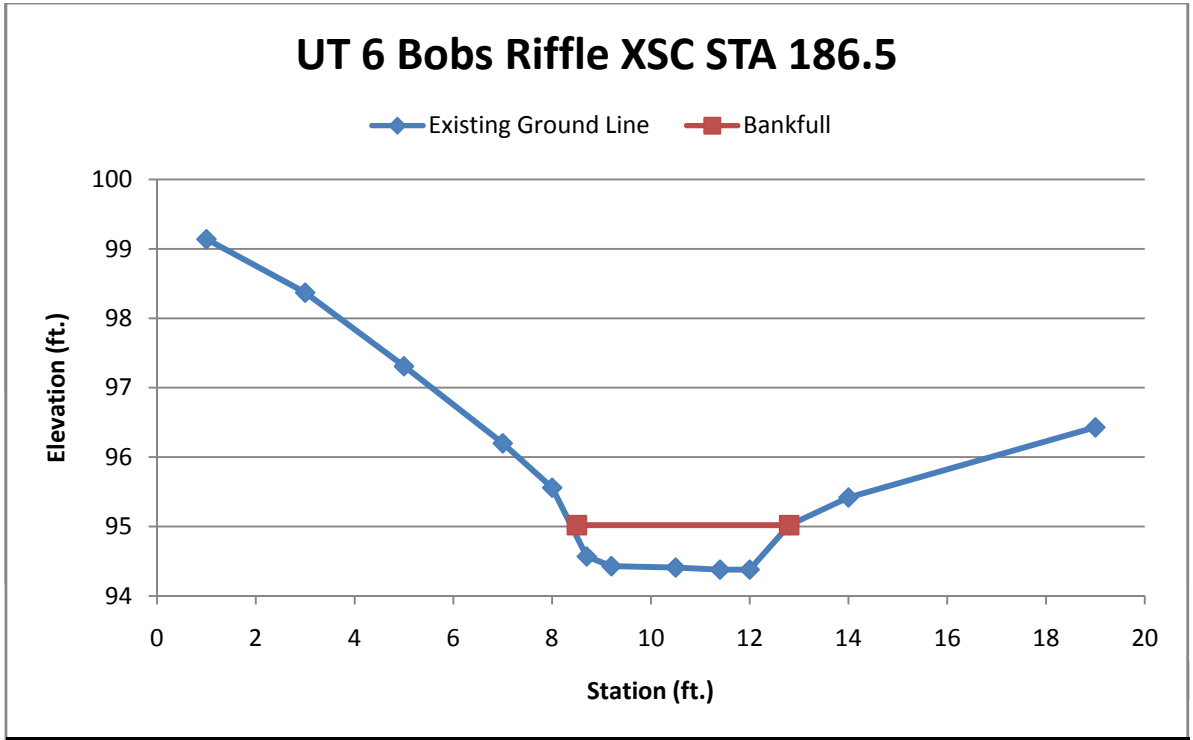
Bankfull Width (ft.):	5.44	*Mean Depth (ft.):*	1.45
Bankfull Area (ft. ²)	7.88	*Max Depth (ft.):*	1.82
Entrenchment Ratio (ft.):	2.77	*Width/Depth Ratio (ft.):*	3.75

UT 6 Bobs Pool XSC STA 128		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	102.63	
5	102.34	
8	101.62	
12	99.61	
15	98.40	
16.5	98.08	
18.5	97.80	BKF
19.7	97.39	
20.5	97.18	
21.5	96.77	
22	96.52	
22.4	96.30	
23.5	95.99	
24.9	95.37	
25.2	95.61	
25.3	97.18	
25.8	97.53	
26.2	97.81	
27.5	98.15	
29	98.76	
33	100.76	



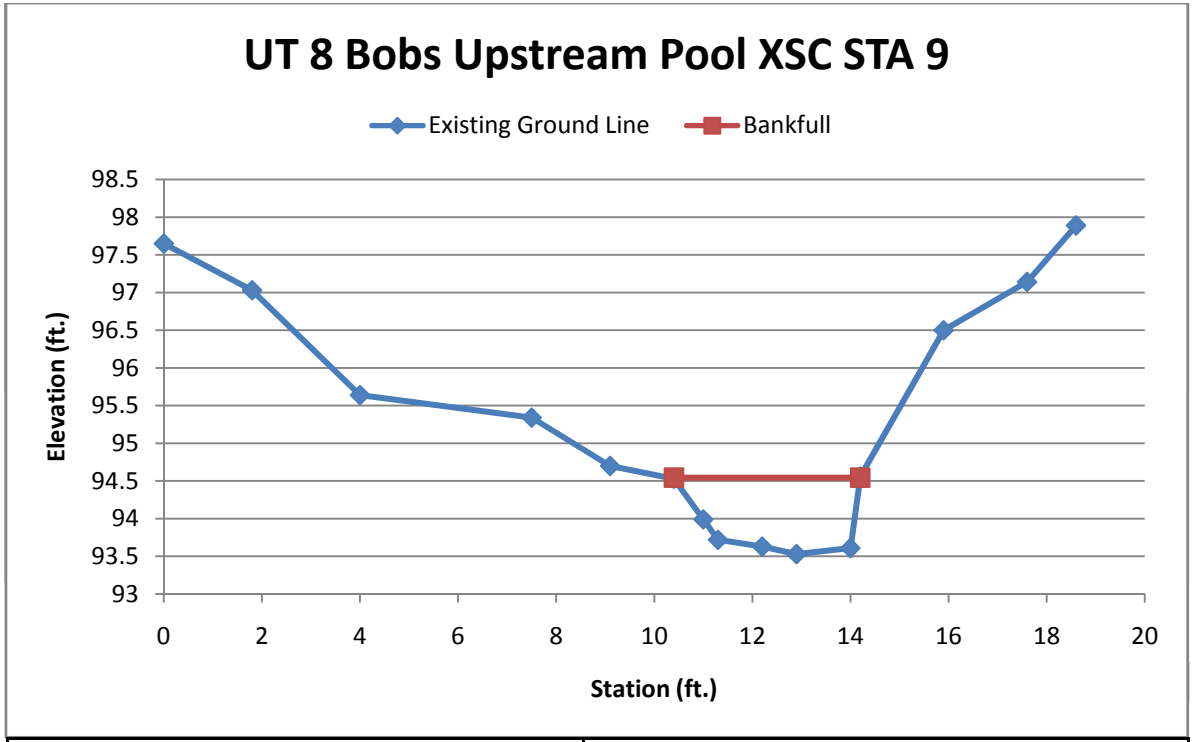
Bankfull Width (ft.):	7.56	*Mean Depth (ft.):*	1.1
Bankfull Area (ft. ²)	8.28	*Max Depth (ft.):*	2.4
Entrenchment Ratio (ft.):	2.77	*Width/Depth Ratio (ft.):*	6.87

UT 6 Bobs Riffle XSC STA 186.5		
Station (ft.)	*Elevation (ft.)*	*Feature*
1	99.14	
3	98.37	
5	97.31	
7	96.20	
8	95.56	
8.7	94.57	
9.2	94.43	
10.5	94.41	
11.4	94.38	
12	94.38	
12.8	95.02	BKF
14	95.42	
19	96.43	



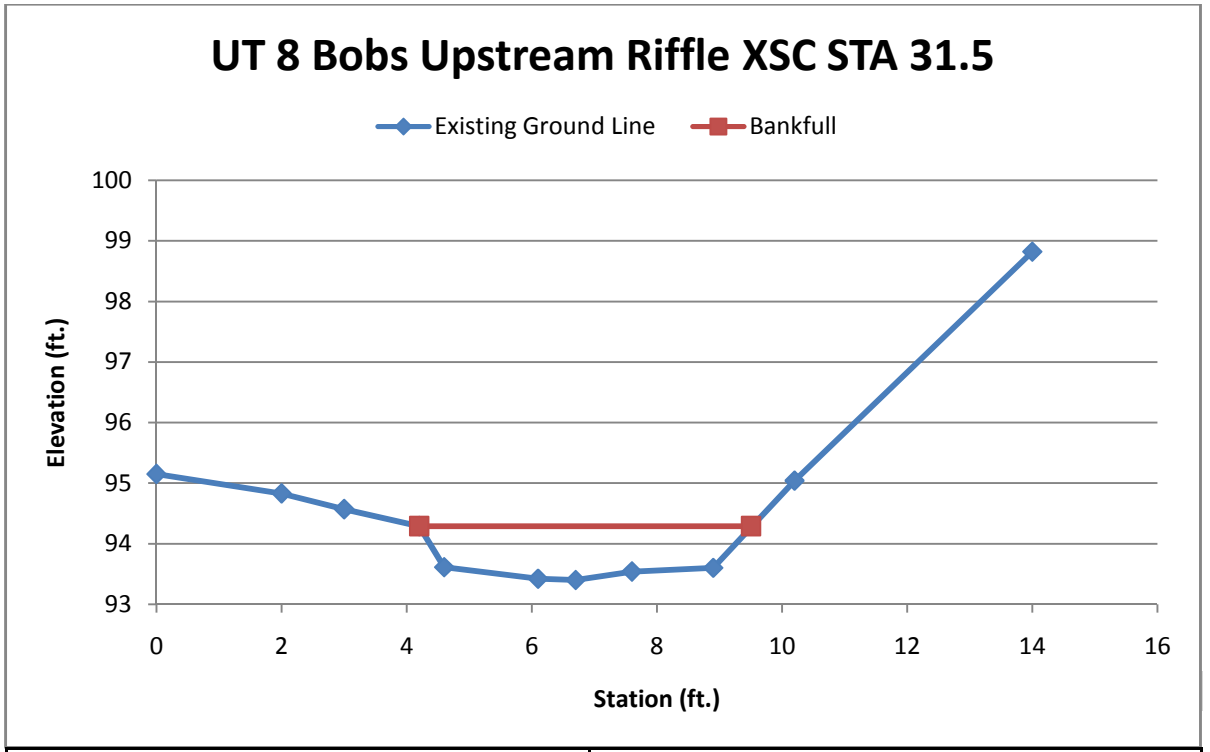
Bankfull Width (ft.):	4.42	*Mean Depth (ft.):*	0.52
Bankfull Area (ft. ²)	2.31	*Max Depth (ft.):*	0.64
Entrenchment Ratio (ft.):	1.66	*Width/Depth Ratio (ft.):*	8.5

UT 8 Bobs Upstream Pool XSC STA 9		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	97.65	
1.8	97.03	
4	95.64	
7.5	95.34	
9.1	94.70	
10.4	94.53	BKF
11	93.99	
11.3	93.72	
12.2	93.63	
12.9	93.53	
14	93.61	
14.2	94.56	BKF
15.9	96.50	
17.6	97.14	
18.6	97.89	



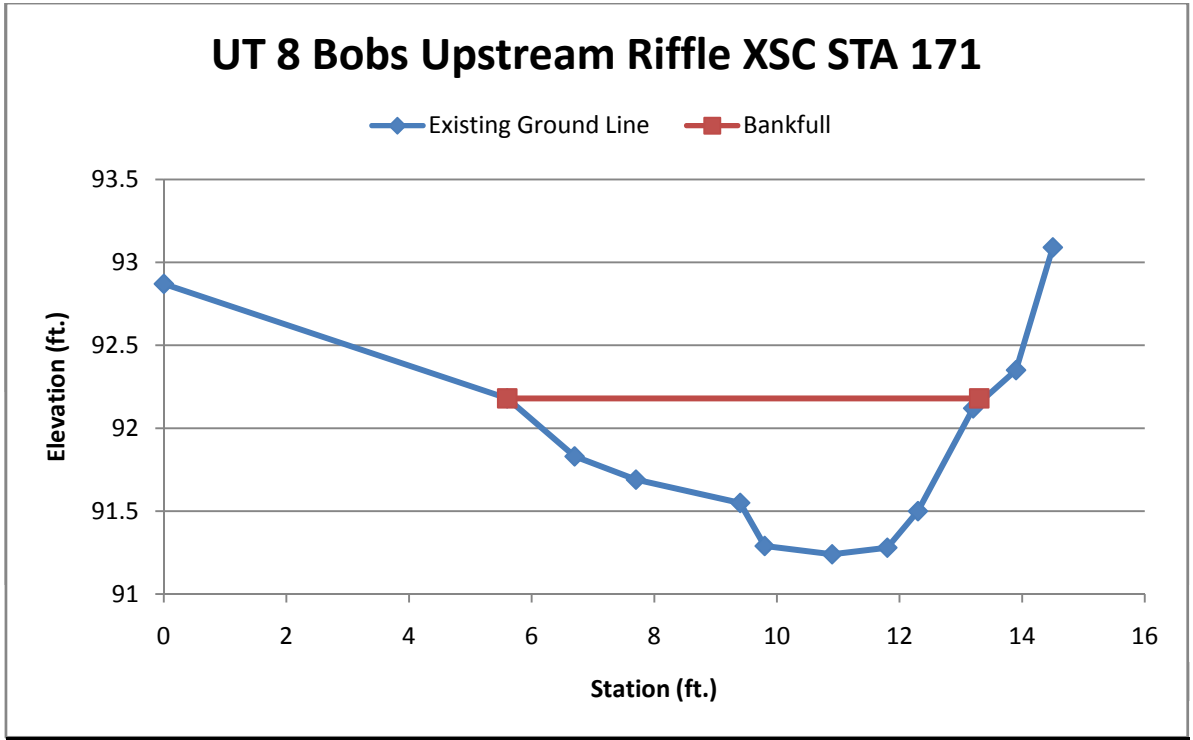
Bankfull Width (ft.):	3.87	*Mean Depth (ft.):*	0.77
Bankfull Area (ft. ²)	2.98	*Max Depth (ft.):*	1.01
Entrenchment Ratio (ft.):	2.59	*Width/Depth Ratio (ft.):*	5.03

UT 8 Bobs Upstream Riffle XSC STA 31.5		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	95.15	
2	94.83	
3	94.57	
4.2	94.29	BKF
4.6	93.61	
6.1	93.42	
6.7	93.40	
7.6	93.54	
8.9	93.60	
10.2	95.04	
14	98.82	



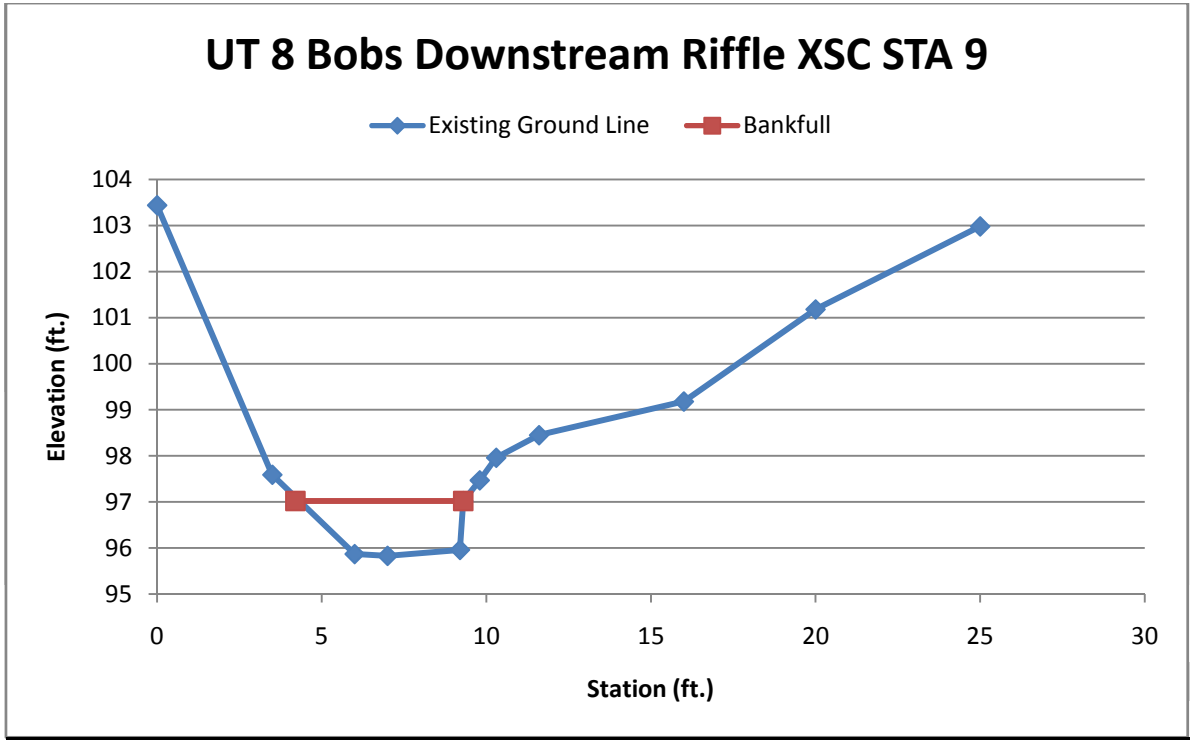
Bankfull Width (ft.):	5.32	*Mean Depth (ft.):*	0.7
Bankfull Area (ft.²)	3.72	*Max Depth (ft.):*	0.89
Entrenchment Ratio (ft.):	2.07	*Width/Depth Ratio (ft.):*	7.6

UT 8 Bobs Upstream Riffle XSC STA 171		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	92.87	
5.6	92.18	BKF
6.7	91.83	
7.7	91.69	
9.4	91.55	
9.8	91.29	
10.9	91.24	
11.8	91.28	
12.3	91.50	
13.2	92.12	
13.9	92.35	
14.5	93.09	



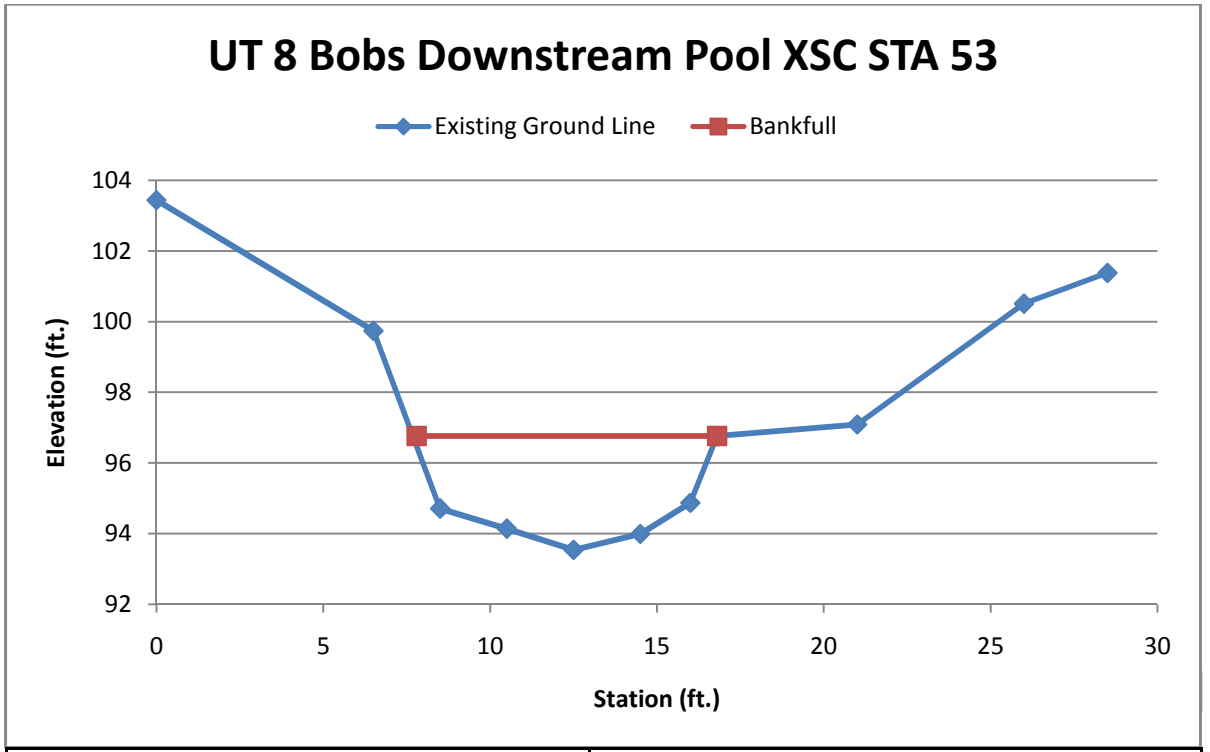
Bankfull Width (ft.):	7.78	*Mean Depth (ft.):*	0.57
Bankfull Area (ft. ²)	4.44	*Max Depth (ft.):*	0.94
Entrenchment Ratio (ft.):	2.57	*Width/Depth Ratio (ft.):*	13.65

UT 8 Bobs Downstream Riffle XSC STA 9		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	103.44	
3.5	97.59	
6	95.87	
7	95.83	
9.2	95.96	
9.3	97.02	BKF
9.8	97.47	
10.3	97.96	
11.6	98.45	
16	99.18	
20	101.18	
25	102.98	

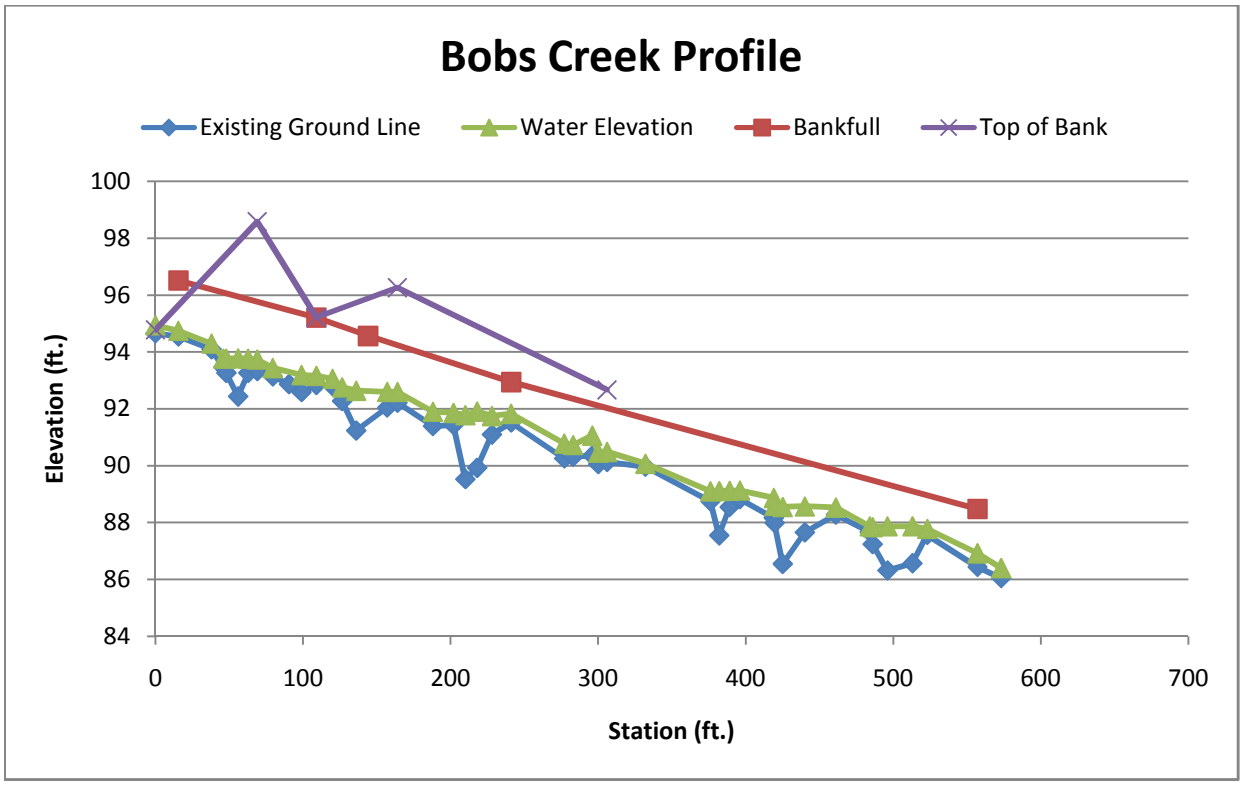


Bankfull Width (ft.):	4.97	*Mean Depth (ft.):*	0.94
Bankfull Area (ft. ²)	4.66	*Max Depth (ft.):*	1.19
Entrenchment Ratio (ft.):	1.58	*Width/Depth Ratio (ft.):*	5.29

UT 8 Bobs Downstream Pool XSC STA 53		
Station (ft.)	*Elevation (ft.)*	*Feature*
0	103.44	
6.5	99.74	
8.5	94.71	
10.5	94.14	
12.5	93.54	
14.5	93.99	
16	94.87	
16.8	96.76	BKF
21	97.09	
26	100.51	
28.5	101.38	

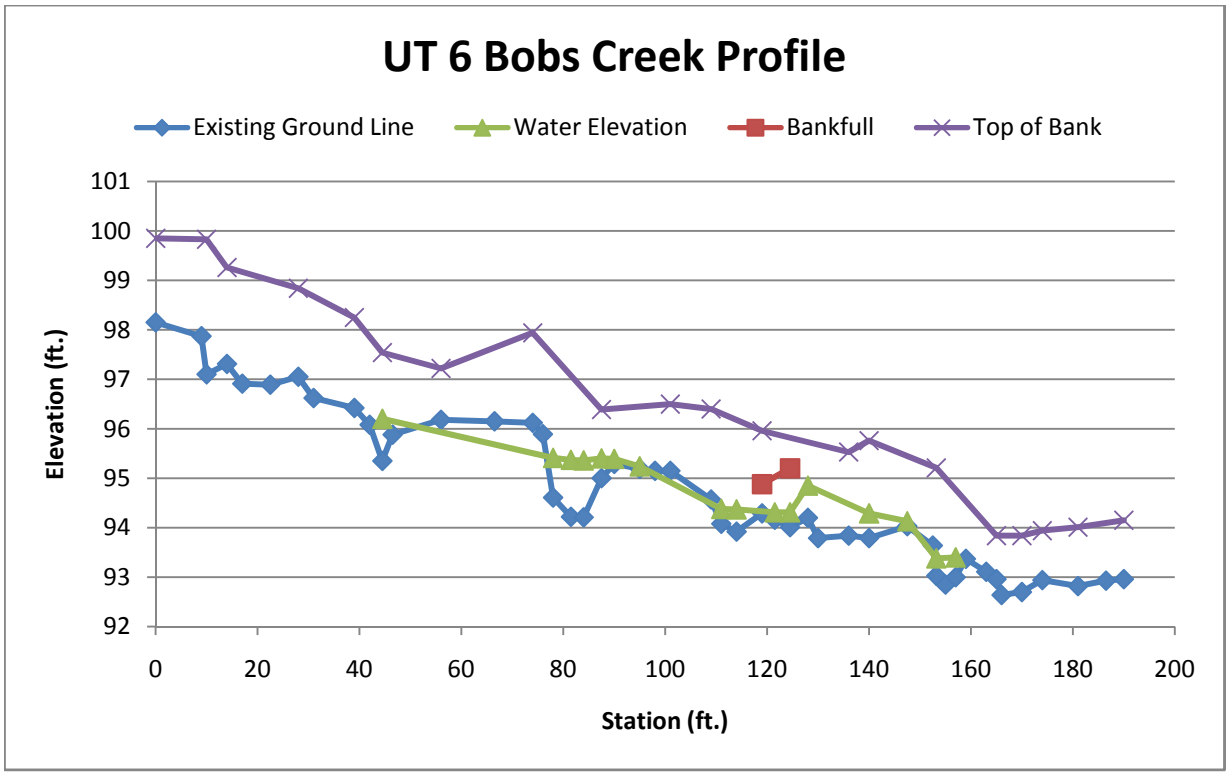


Bankfull Width (ft.):	9.12	*Mean Depth (ft.):*	2.37
Bankfull Area (ft.²)	21.59	*Max Depth (ft.):*	3.22
Entrenchment Ratio (ft.):	2.1	*Width/Depth Ratio (ft.):*	3.85



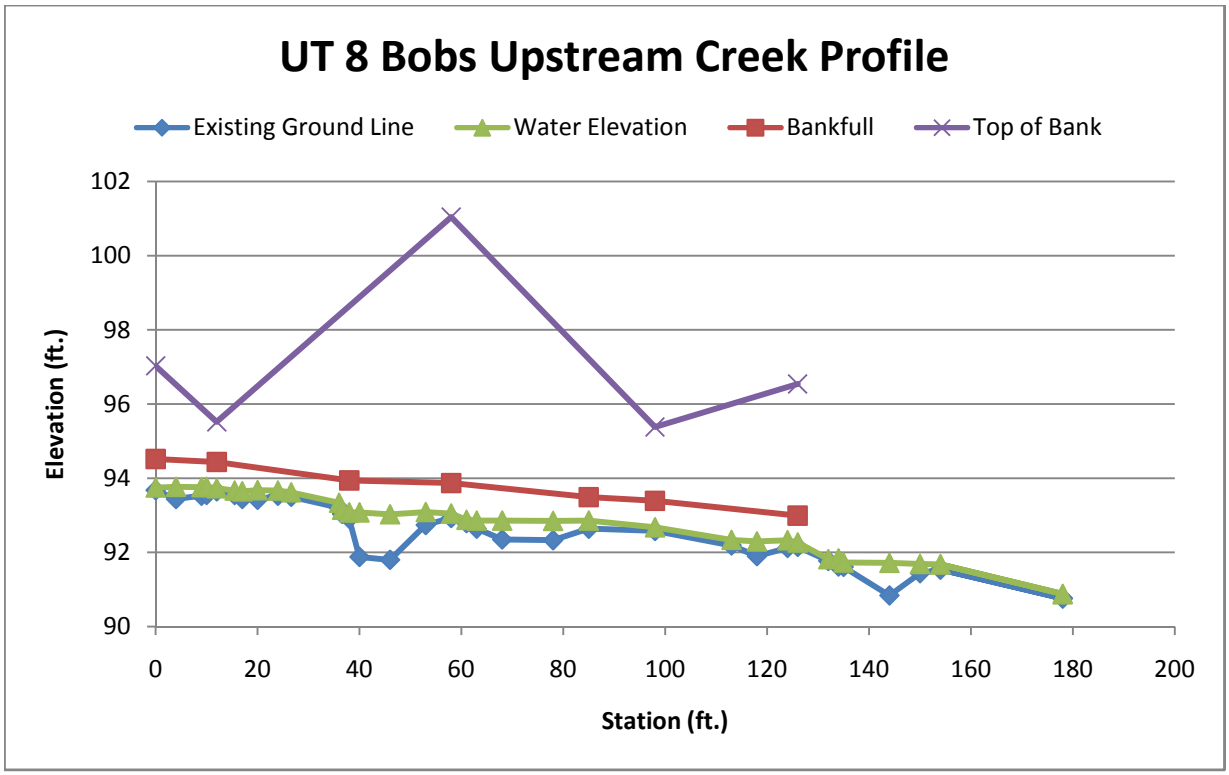
Bobs Creek Profile				
Station (ft.)	*Channel Elev. (ft.)*	*Water Elev. (ft.)*	*Bankfull Elev. (ft.)*	*Top of Bank Elev. (ft.)*
0	94.66	94.94		94.78
15.5	94.55	94.75	96.51	
38	94.1	94.3		
46	93.47	93.77		
48	93.27	93.77		
56	92.44	93.78		
62.8	93.27	93.77		
69	93.34	93.74		98.58
79.5	93.14	93.44		
90.5	92.87			
99	92.59	93.19		
109	92.84	93.16	95.21	95.21
120	92.81	93.06		
126.5	92.28	92.76		
136	91.24	92.64		
144			94.56	
157	92.05	92.6		
164	92.22	92.6		96.26
188	91.4	91.9		
202	91.43	91.86		
210	89.53	91.78		
218	89.93	91.91		
228	91.1	91.75		

241	91.52	91.83	92.94	
277	90.26	90.78		
283	90.32	90.73		
296	90.36	91.06		
300	90.06	90.46		
306	90.14	90.49		92.67
332	89.97	90.07		
376	88.75	89.1		
382	87.55	89.11		
389	88.55	89.12		
396	88.83	89.13		
419	88.17	88.87		
419.5	87.99	88.59		
425	86.55	88.55		
440	87.66	88.57		
461	88.28	88.53		
484	87.67	87.87		
486	87.24	87.84		
496	86.32	87.87		
513	86.57	87.87		
523	87.57	87.78		
557	86.44	86.92	88.48	
573	86.05	86.4		



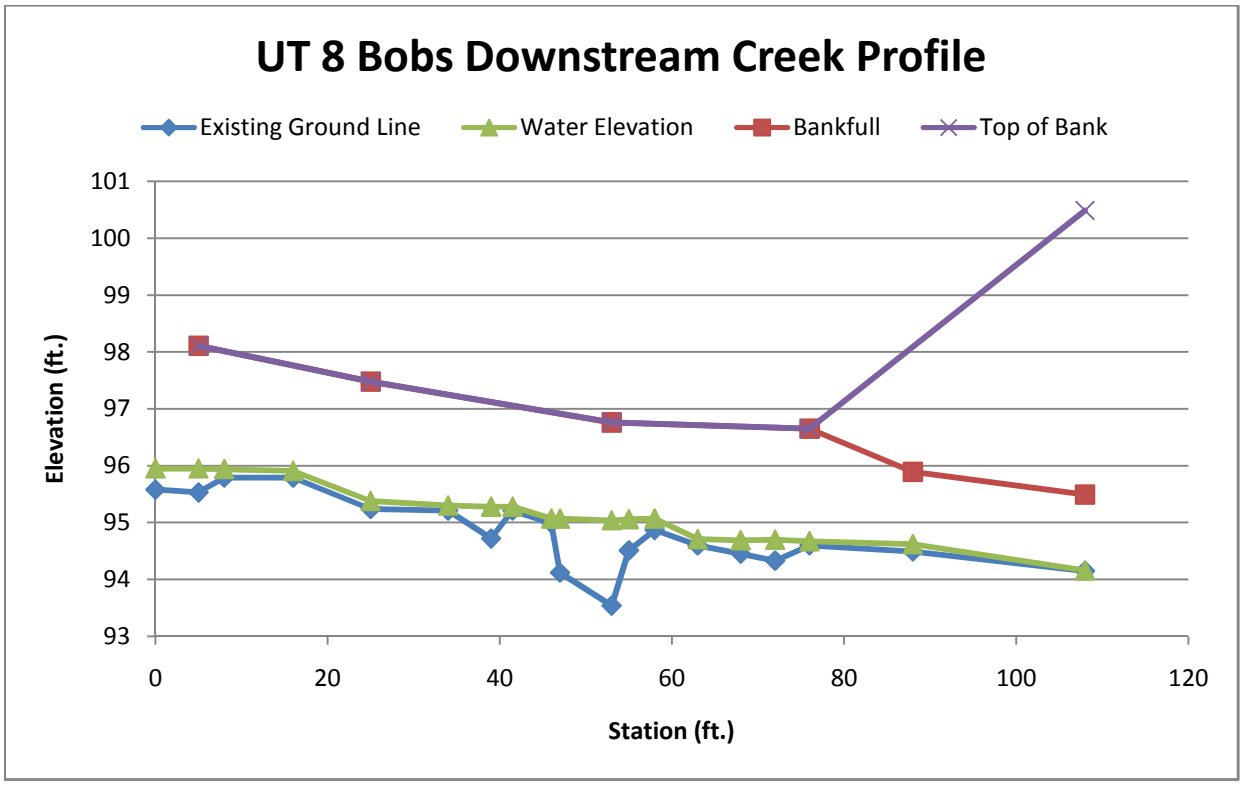
UT 6 Bobs Creek Profile				
Station (ft.)	*Channel Elev. (ft.)*	*Water Elev. (ft.)*	*Bankfull Elev. (ft.)*	*Top of Bank Elev. (ft.)*
0	98.15			99.85
9	97.87			
10	97.1			99.83
14	97.31			99.26
17	96.91			
22.5	96.89			
28	97.05			98.84
31	96.62			
39	96.42			98.25
42	96.08			
44.5	95.35	96.2		97.54
46.5	95.88			
56	96.18			97.22
66.5	96.15			
74	96.12			97.94
76	95.89			
78	94.61	95.41		
81.5	94.22	95.37		
84	94.21	95.36		
87.5	95	95.4		96.39
90	95.29	95.39		
95	95.19	95.24		
98	95.15			
101	95.15			96.5

109	94.57			96.4
111	94.08	94.38		
114	93.92	94.37		
119	94.29		94.88	95.96
121.5	94.16	94.31		
124.5	94.01	94.31	95.2	
128	94.2	94.85		
130	93.79			
136	93.84			95.53
140	93.79	94.29		95.76
147.5	94.03	94.13		
152.5	93.64			
153.2	93.03	93.38		95.21
155	92.85			
157	93	93.4		
159	93.37			
163	93.11			
165	92.96			93.84
166	92.64			
170	92.7			93.84
174	92.94			93.94
181	92.82			94.01
186.5	92.93			
190	92.96			94.15



UT 8 Bobs Upstream Creek Profile				
Station (ft.)	*Channel Elev. (ft.)*	*Water Elev. (ft.)*	*Bankfull Elev. (ft.)*	*Top of Bank Elev. (ft.)*
0	93.68	93.75	94.52	97.03
4	93.44	93.77		
9	93.53	93.76		
10	93.55	93.77		
12	93.65	93.73	94.44	95.52
15.5	93.55	93.67		
17	93.44	93.65		
20	93.42	93.68		
24	93.53	93.67		
26.6	93.5	93.62		
36	93.2	93.34		
36.6	93.04	93.15		
38	92.91	93.08	93.94	
40	91.88	93.08		
46	91.8	93.03		
53	92.74	93.09		
58	92.93	93.05	93.87	101.04
61	92.79	92.88		
63	92.64	92.86		
68	92.35	92.86		
78	92.33	92.85		
85	92.64	92.86	93.49	
98	92.58	92.68	93.39	95.38
113	92.19	92.34		

118	91.9	92.3		
124	92.12	92.33		
126	92.15	92.27	92.99	96.54
132	91.77	91.82		
134	91.62	91.84		
135	91.61	91.73		
144	90.84	91.72		
150	91.44	91.69		
154	91.54	91.68		
178	90.76	90.88		
154	91.54	91.68		
178	90.76	90.88		



UT 8 Bobs Downstream Creek Profile				
Station (ft.)	*Channel Elev. (ft.)*	*Water Elev. (ft.)*	*Bankfull Elev. (ft.)*	*Top of Bank Elev. (ft.)*
0	95.58	95.95		
5	95.53	95.95	98.11	98.11
8	95.79	95.94		
16	95.79	95.91		
25	95.24	95.38	97.48	97.48
34	95.21	95.30		
39	94.72	95.28		
41.5	95.21	95.28		
46	94.99	95.07		
47	94.12	95.07		
53	93.54	95.04	96.76	96.76
55	94.51	95.06		
58	94.87	95.07		
63	94.6	94.71		
68	94.45	94.69		
72	94.33	94.7		
76	94.6	94.67	96.65	96.65
88	94.49	94.62	95.89	
108	94.15	94.16	95.49	100.49