

**FINAL**  
**YEAR 3 (2018) ANNUAL**  
**MONITORING REPORT**

**BOBS CREEK**  
**STREAM MITIGATION SITE**

NCDMS Project No. 92879  
Contract No. D09023S  
USACE Action ID No. SAW-2009-917 & NCDWR Project No. 10-0122  
SCO No. 08-07308-01  
McDowell County, North Carolina

Data Collection: May-November 2018  
Submission: November 2018



**PREPARED FOR:**

**N.C. DEPARTMENT OF ENVIRONMENTAL QUALITY**  
**DIVISION OF MITIGATION SERVICES**  
**1601 MAIL SERVICE CENTER**  
**RALEIGH, NORTH CAROLINA 27699-1601**

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**BOBS CREEK**  
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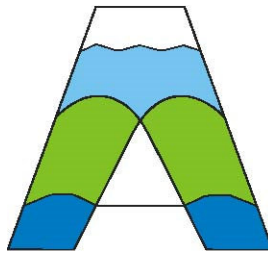
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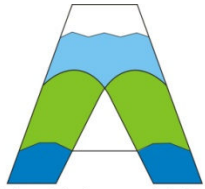
Data Collection: May-November 2018  
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**PREPARED BY:**

**AXIOM ENVIRONMENTAL, INC.**  
**218 SNOW AVENUE**  
**RALEIGH, NORTH CAROLINA 27603**





Axiom Environmental, Inc.

## ***Axiom Environmental, Inc.***

*218 Snow Avenue, Raleigh, NC 27603 919-215-1693*

November 30, 2018

Mr. Matthew Reid  
North Carolina Department of Environmental Quality  
Division of Mitigation Services  
5 Ravenscroft Drive, #102  
Asheville, North Carolina 28801

RE: Bobs Creek Monitoring (DMS Project # 92879, Contract # D09023S)  
Final Year 3 (2018) Annual Monitoring Report

**12-004.21**

Dear Matthew:

Axiom Environmental, Inc. (AXE) is pleased to provide you with three hard copies and one cd of electronic files for the Final Bobs Creek Year 3 (2018) Annual Monitoring Report. We received your comments via email on November 30, 2018 and have addressed them as follows.

- Streams page 4: Please add the following language or something similar: DMS has developed a remedial action plan and has a contract in place to repair the left arm of the rock cross-vane and the outer bend on Bobs Creek. This repair will be completed in winter 2019.  
*This verbiage was added to the stream areas of concern discussion.*
- Table 2: Under Year 3 Monitoring, please add two lines of additional data with dates. One for vegetation monitoring and one for geomorphology monitoring. The Table 2 used in the Final MY2 report was modified to present these dates. Please use that table in the MY3 report and for all future monitoring report submissions.  
*Table 2 was revised to include completion dates for vegetation and stream monitoring for years 2 and 3. Axiom will use this format for all future report submissions.*
- As Axiom had done in the past, please include a response to the comment letter and how/where the comments were addressed. Please insert this letter directly behind the cover page and before the table of contents in the final deliverables. The IRT has requested that we include this letter with the final deliverables. The response letter will need to be included with all future monitoring deliverables.  
*This response letter has been included directly behind the cover page in the final PDF deliverable. A word version of this letter was also included in the digital submittal.*

Please let us know if you have any questions or comments regarding any component of this submittal. Thank you for the opportunity to continue to assist the Division of Mitigation Services with this important project.

Sincerely,  
AXIOM ENVIRONMENTAL, INC.

Kenan R. Jernigan  
Project Scientist

Attachments: 3 hard copies Year 3 (2018) Bobs Creek Annual Monitoring Report  
1 CD containing digital support files

## TABLE OF CONTENTS

1.0	PROJECT SUMMARY .....	1
2.0	METHODS .....	4
3.0	REFERENCES .....	6

## APPENDICES

### APPENDIX A. SITE LOCATION MAP AND BACKGROUND TABLES

- Figure 1. Site Location
- Table 1. Project Components and Mitigation Units
- Table 2. Project Activity and Reporting History
- Table 3. Project Contacts Table
- Table 4. Project Attributes Table

### APPENDIX B. VISUAL ASSESSMENT DATA

- Figures 2, 2A-2B. Current Conditions Plan View
- Figures 3, 3A-3B. Project Assets
- Tables 5A-5B. Visual Stream Morphology Stability Assessment
- Table 6. Vegetation Condition Assessment
- Stream Fixed Station Photo Points
- Vegetation Plot Photographs

### APPENDIX C. VEGETATION DATA

- Table 7. Vegetation Plot Success Summary
- Table 8. CVS Vegetation Plot Metadata
- Table 9. Total Planted Stems by Plot and Species

### APPENDIX D. STREAM MEASUREMENT AND GEOMORPHOLOGY DATA

- Cross-section Plots
- Longitudinal Profile Plots
- Substrate Plots
- Tables 10A-10B. Baseline Morphology and Hydraulic Summary
- Tables 11A-11B. Morphology and Hydraulic Monitoring Summary

### APPENDIX E. HYDROLOGY DATA

- Table 12. Verification of Bankfull Events



## 1.0 PROJECT SUMMARY

The North Carolina Division of Mitigation Services (NCDMS) has established the Bobs Creek Stream Mitigation Site (Site). The primary goals of the project focused 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 were 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 installing exclusionary fencing along 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 the following.
  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 provide breeding grounds for amphibians and also store overbank flows from adjacent stream channels.
- Enhance fish passage within Bobs Creek and UT 8 Bobs Creek 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.
- Enhance 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 NCDMS.
- 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.

**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.

Collected 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 instream 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.

**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. Riffle cross-sections should generally maintain a bank-height ratio approaching 1.0, with some variation in this ratio naturally occurring. Pool cross-sections naturally adjust based on recent flows and time between flows, therefore more leeway on pool cross-section geometry is expected.

**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.

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

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

**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.

**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.

The Bobs Site is located approximately five miles southeast of the town of Marion (Figure 1, Appendix B). 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 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. Prior to Site construction, riparian vegetation had been removed, stream channels were manipulated, and hoof shear from livestock on stream banks and floodplain soils was responsible for degraded water quality and unstable channel characteristics (stream entrenchment, erosion, and bank collapse) within Site streams.

Project mitigation efforts resulted in the following.

- Restore 929 linear feet of stream
- Enhance (Level I) 238 linear feet of stream
- Enhance (Level II) 402 linear feet of stream
- Preserve 6794 linear feet of stream
- Preserve 0.35 acres of riparian wetland

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 NCDMS 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 NCDMS's *Upper Catawba River Basin Restoration Priorities* (2009) identifies North Muddy Creek as a Targeted Local Watershed (TLW). The Site is located within the North Muddy Creek Watershed. In 2008 NCDMS 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 the following.

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
6. Establish a Trout Fishery

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

1. Natural Channel Design Stream Restoration
2. Riparian Reforestation
3. Livestock Exclusion
4. Riparian Forest Preservation

These four components were included within the *Bobs Creek Site's Mitigation Plan* (NCEEP 2009). The project restored 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 restored riparian buffers through revegetation of buffer zones with native riparian and wetland species along all Site streams. The project enhanced open space preservation by placing Site streams, wetlands, and their buffers into a permanent conservation easement. The overall Site helps improve water quality by reducing sedimentation in on-Site streams and planted a vegetated riparian buffer that filters nutrients from adjacent pasturelands. Additionally, exclusionary fencing and alternate watering devices removed livestock from accessing on-site channels and riparian buffers. The project restored and enhanced physical habitat for both aquatic and terrestrial species by planting native vegetation along stream banks and riparian buffers, creating wildlife corridors through a dissected landscape, and restoring bedform variability to Site streams. The stabilization of streams and buffers in the project area enhanced 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.

Site design was completed in April 2014. Site construction was completed in December 2015 and Site planting was completed in December 2015. Completed project activities, reporting history, completion dates, project contacts, and project attributes are summarized in Tables 1-4 (Appendix A).

## **2.0 METHODS**

Monitoring of restoration efforts will be performed for five years or until success criteria are fulfilled. Monitoring is proposed for the stream channel and vegetation. In general, the restoration success criteria, and required remediation actions, are based on the *Stream Mitigation Guidelines* (USACE et al. 2003). Monitoring features are described below and are depicted on Figures 2A-B (Appendix B).

### **Streams**

The restored stream reaches are proposed to be monitored for geometric activity as follows.

- 850 linear feet of stream profile
- 4 riffle cross-sections
- 1 pool cross-section

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. Pebble counts will be completed at the 4 riffle cross-sections to be used for substrate analysis (Appendix D). Annual photographs will include 27 fixed station photographs (Appendix B). In addition, the Site contains two stream crest gauges to assist with documentation of bankfull events. Three bankfull events were documented during monitoring year 3 (2018) making a total of at least five documented bankfull events in three separate monitoring years (Table 12, Appendix E).

Early in Year 1 (2016), several structures were damaged and surrounding streambanks were eroded by significant storm events that occurred shortly after Site construction. Warranty repair work was completed in October 2016 to address these issues. The repaired structures and banks appeared stable during Year 3 (2018). Two stream areas of concern were observed. A log drop structure on the downstream reach of UT-8 to Bobs Creek appears to be piping (Area of Concern #1) and is no longer holding grade. This doesn't appear to be a direct threat to stream stability, but it is not functioning as designed. Additionally, approximately 60 feet of an outer bend on the downstream reach of Bobs Creek has become heavily eroded (Area of Concern #2). Several boulders from a rock cross-vane structure have become dislodged and fallen into the stream. NCDMS has developed a remedial action plan and has a contract in place to repair the left arm of the rock cross-vane and the outer bend on Bobs Creek. This repair will be completed in winter 2019. These areas of concern are depicted on Figures 2A-B (Appendix B). Currently, stream measurements are meeting success criteria.

### **Vegetation**

Restoration monitoring procedures for vegetation will monitor plant survival and species diversity. The Site planting area consists of 1.8 acres. After planting was completed, three vegetation plots were installed and monitored at the Site; results can be found in Appendix C. Annual measurements of vegetation will consist of 3 CVS vegetation plots.

A photographic record of plant growth should be included in each annual monitoring report; baseline photographs are included in Appendix B. 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 4.2* (Lee et al. 2008) 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.

Year 3 stem count measurements indicate planted stem densities are well above the required 320 stems per acre. The planted stem density across the Site is 404 planted stems per acre (Table 9, Appendix C). In addition, all three individual CVS plots met success criteria based on planted stems alone (Table 7, Appendix C). Therefore, the Site is currently meeting vegetation success criteria.

Several dense populations of Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa multiflora*) were observed along the upstream portion of UT-8 (Figure 2A, Appendix B). Additional areas of privet and multiflora rose were observed scattered throughout Site restoration reaches in quantities below mapping threshold. NCDMS plans to treat invasive species during year 4 (2019), and Axiom will monitor these areas to determine the success of the treatments.

### 3.0 REFERENCES

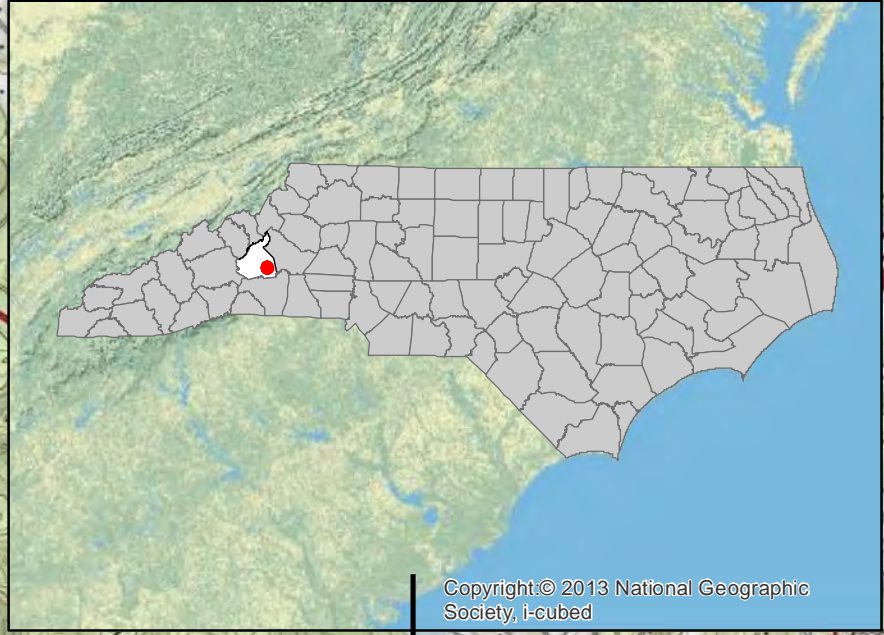
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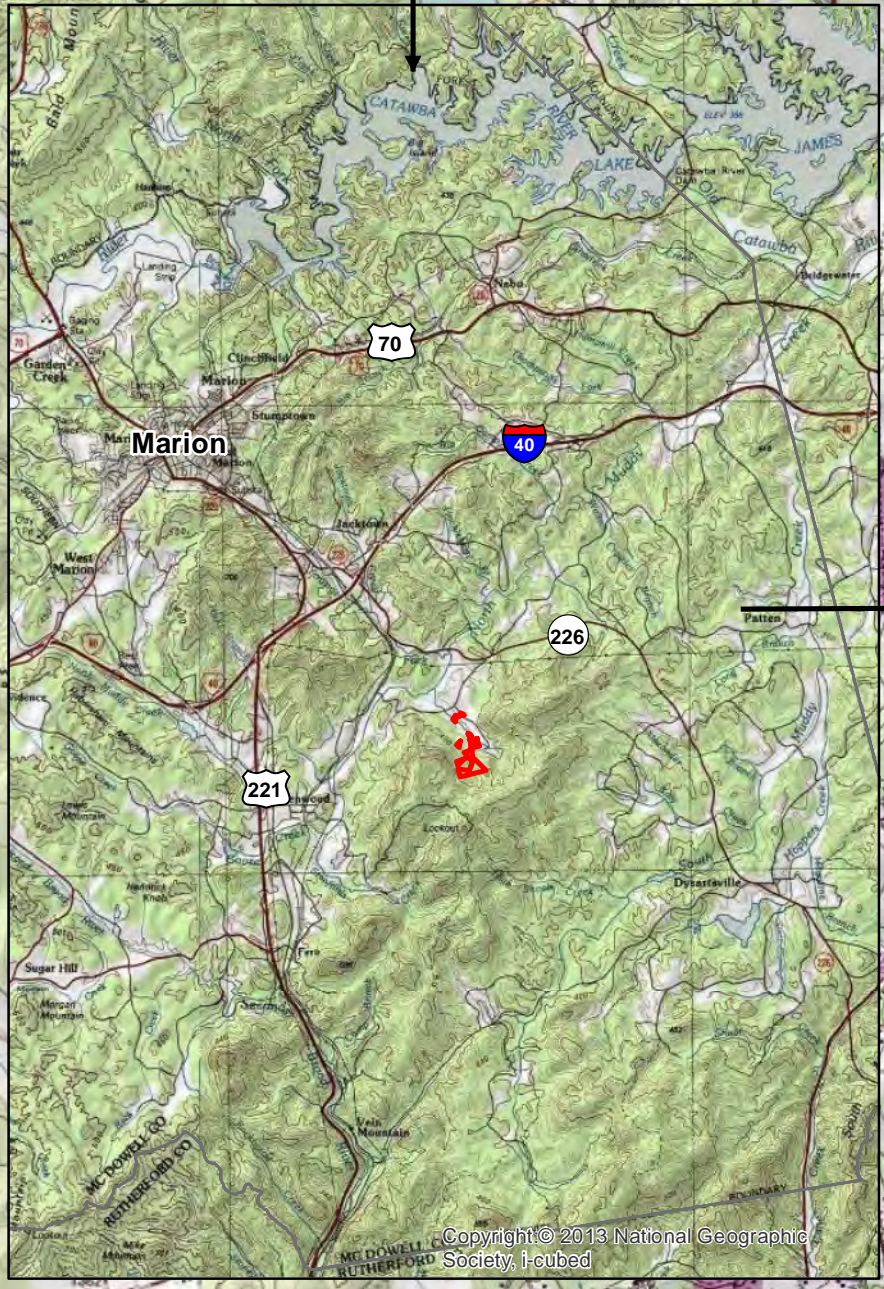
**Appendix A.**  
**Site Location Map and Background Tables**

- Figure 1. Site Location  
Table 1. Project Mitigation Components  
Table 2. Project Activity and Reporting History  
Table 3. Project Contacts Table  
Table 4. Project Attributes Table

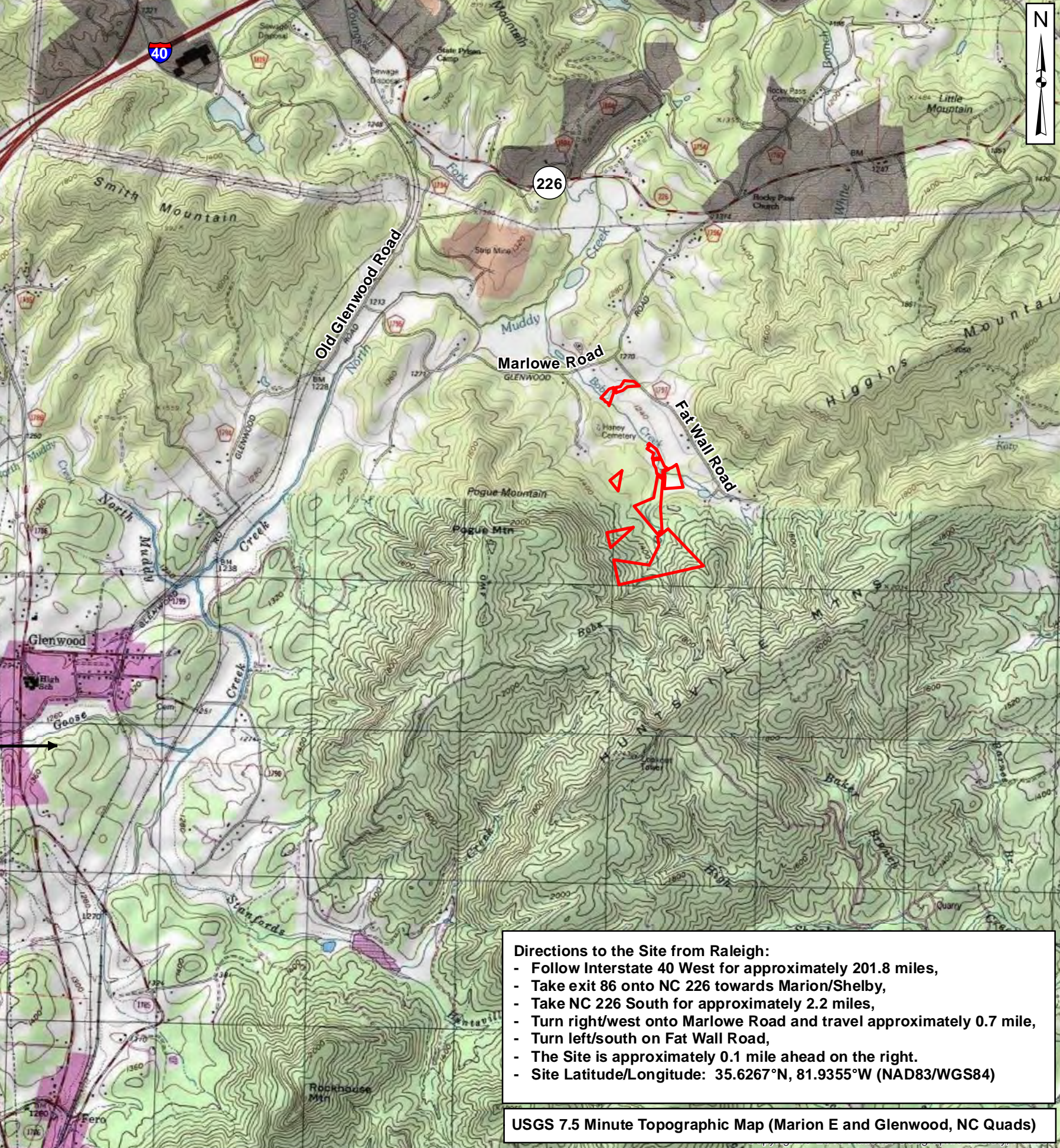




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Prepared for:  
**NC Department of Environmental Quality**  
 Division of Mitigation Services

Project:  
**BOBS CREEK**  
 McDowell County, NC

Title:  
**SITE LOCATION**

Drawn by: **KRJ**

Date: **APR 2016**

Scale: **1:30000**

Project No.: **12-004.21**

**Directions to the Site from Raleigh:**

- Follow Interstate 40 West for approximately 201.8 miles,
- Take exit 86 onto NC 226 towards Marion/Shelby,
- Take NC 226 South for approximately 2.2 miles,
- Turn right/west onto Marlowe Road and travel approximately 0.7 mile,
- Turn left/south on Fat Wall Road,
- The Site is approximately 0.1 mile ahead on the right.
- Site Latitude/Longitude: 35.6267°N, 81.9355°W (NAD83/WGS84)

**USGS 7.5 Minute Topographic Map (Marion E and Glenwood, NC Quads)**

**FIGURE**  
**1**



**Table 1. Project Components and Mitigation Credits**  
**Bobs Creek Mitigation Site/ DMS Number 92879**

Mitigation Credit Summations							
Stream	Riparian Wetland	Nonriparian Wetland	Buffer		Nitrogen Offset	Phosphorous Offset	
2607	0.07	---	---		---	---	
Projects Components							
Project Component –or–Reach ID	Stationing	Existing Footage or Acreage	Restoration Footage or Acreage	Restoration Level/Equivalent	Mitigation Ratio	Mitigation Credits	Comment
Bobs Creek <i>Bob Creek As-built Plan Stationing</i>	39+86 – 43+21 <i>(09+90 – 13+25)</i>	3315	335 <i>335</i>	Restoration (PI)	1:1	335	Channel moved away from terrace and around existing mature vegetation.
Bobs Creek	36+74 – 37+21 37+89 – 38+67 39+14 – 39+50		161	Enhance I	1.5:1	107	Bankfull bench excavation, channel structures, and vegetative plantings on degraded banks.
Bobs Creek	37+21 – 37+89 38+67 – 39+14 39+50 – 39+86		151	Enhance II	2.5:1	60	Exclusionary fencing and permanent conservation easement. The easement break at 39+86 has been removed from credit summation.
Bobs Creek	10+00 – 36+74		2674	Preservation	5:1	535	Two easement breaks have been removed from credit summation.
UT 1 Bobs Creek	10+00 – 20+60	1060	1060	Preservation	5:1	212	---
UT 2 Bobs Creek	10+00 – 15+90	590	590	Preservation	5:1	118	---
UT 3 Bobs Creek	10+00 – 15+30	530	530	Preservation	5:1	106	The easement break has been removed from credit summation.
UT 4 Bobs Creek	10+00 – 16+51 10+00 – 10+75	726	726	Preservation	5:1	145	
UT 5 Bobs Creek	10+00 – 12+24	224	224	Preservation	5:1	45	---
UT 6 Bobs Creek	10+17 – 10+37 10+73 – 10+78 12+50 – 12+76	369	51	Enhance II	2.5:1	20	Vegetative plantings on degraded meanders and matting.
UT 6 Bobs Creek	10+00 – 10+17 10+37 – 10+73 10+78 – 12+50 12+76 – 13+37		286	Preservation	5:1	57	---
UT 7 Bobs Creek	15+23 – 15+48	682	25	Enhance I	1.5:1	17	Bankfull bench excavation, channel structures, and vegetative plantings on degraded banks.
UT 7 Bobs Creek	10+00 – 15+23 15+48 – 16+36		611	Preservation	5:1	122	The easement break at the crossing has been removed from credit summation.

UT 8 Bobs Creek Bob Creek As-built Plan Stationing	11+58 – 13+35 (10+00 – 11+77) 15+22 – 16+95 (10+00 – 11+73) 17+85 – 19+39 (13+16 – 14+70)	985	504	Restoration (PI)	1:1	504	Channel moved away from valley side slope, and around mature vegetation in Upstream Reach. New channel location in new valley in Downstream Reach. The easement break at the crossing in the downstream reach has been removed from credit summation.
UT 8 Bobs Creek Bob Creek As-built Plan Stationing	16+95 – 17+85 (12+26 – 13+16)		90	Restoration (PII)	1:1	90	Channel moved approximately 100 feet to the west of existing location to historic valley.
UT 8 Bobs Creek	10+93 – 11+25 14+45 – 14+65		52	Enhance I	1.5:1	35	Bankfull bench excavation, channel structure, and vegetative plantings on degraded banks.
UT 8 Bobs Creek	11+25 – 11+58 13+35 – 14+45 14+65 – 15+22		200	Enhance II	2.5:1	80	Vegetative plantings on degraded meanders and matting.
UT 8 Bobs Creek	10+00 – 10+93		93	Preservation	5:1	19	---
Wetlands	---	0.35	0.35	Preservation	5:1	0.07	---

**Length and Area Summations**

Restoration Level	Stream (linear footage)	Riparian Wetland (acreage)		Nonriparian Wetland (acreage)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	929	--		--		
Enhancement (Level I)	238	--		--		
Enhancement (Level II)	402	--		--		
Preservation	6,794	<b>0.35</b>		--		
<b>Totals</b>	<b>8,363</b>	<b>0.35</b>		--		
<b>Mitigation Units</b>	<b>2,607 SMUs</b>	<b>0.07 Riparian WMUs</b>		<b>0.00 Nonriparian WMUs</b>		

**BMP Elements**

Element	Location	Purpose/Function	Notes

**Table 2. Project Activity and Reporting History  
Bobs Creek Mitigation Site/ DMS Number 92879**

<b>Activity or Deliverable</b>	<b>Data Collection Complete</b>	<b>Completion or Delivery</b>
Project Institution		
Mitigation Plan	April 2009	December 2009
Permits Issued		
Final Design – Construction Plans		April 2014
Construction	--	December 2015
Temporary S&E Mix applied to Entire Project Site	--	December 2015
Permanent Seed Mix applied to the Entire Project Site	--	December 2015
Bare Root; Containerized; and B&B Plantings for the Entire Project Site	--	December 2015
Baseline Monitoring Document (Year 0 Monitoring Baseline)	April 2016	July 2016
Repair	--	October 2016
Year 1 Monitoring	November 2016	December 2016
Year 2 Monitoring	November 2017	December 2017
Year 2 Vegetation Monitoring	August 30, 2017	--
Year 2 Geomorphology Monitoring	February 20, 2017	--
Year 3 Monitoring	November 2018	November 2018
Year 3 Vegetation Monitoring	September 25, 2018	--
Year 3 Geomorphology Monitoring	March 22, 2018	--
Year 4 Monitoring		
Year 5 Monitoring		

**Table 3. Project Contact Table**  
**Bobs Creek Mitigation Site/ DMS Number 92879**

<b>Designer</b>	Florence & Hutcheson Engineering (Now HDR) 5121 Kingdom Way, Suite 100 Raleigh, NC 27607 Kevin Williams (919) 851-6066
<b>Construction Plans and Sediment and Erosion Control Plans</b>	Florence & Hutcheson Engineering (Now HDR) 5121 Kingdom Way, Suite 100 Raleigh, NC 27607 Kevin Williams (919) 851-6066
<b>Construction Contractor</b>	Carolina Environmental Contracting, Inc. Mount Airy, NC (336) 320-3849
<b>Planting Contractor</b>	Keller Environmental 7291 Haymarket Lane Raleigh, NC 27615 Jay Keller (919) 749-8259
<b>As-built Surveyor</b>	Turner Land Surveying, PLLC 3719 Benson Drive Raleigh, NC 27609 Elisabeth Turner (919) 827-0745
<b>Baseline Data Collection</b>	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis (919) 215-1693



**Table 4. Project Baseline Information and Attributes  
Bobs Creek Mitigation Site/ DMS Number 92879**

Project Information						
Project name	Bobs Creek Mitigation Site					
Project county	McDowell County, North Carolina					
Project area (Acres)	31.8					
Project coordinates (lat/long)	35.6567°N, 81.9355°W					
Project Watershed Summary Information						
Physiographic region	Blue Ridge					
Project river basin	Catawba River Basin					
USGS hydrologic unit (8 digit)	03050101					
NCDWQ Sub-basin	03-08-30					
Project drainage area (acres)	930					
% Drainage area impervious	1					
CGIA land use classification	---					
Reach Summary Information						
Parameters	Bobs Creek	UT's to Bobs Creek				
		UT 1	UT 2/3	UT 4/5	UT 6/7	UT 8
Length of reach (linear feet)	3321	1060	590/530	726/224	337/636	939
Valley classification	VIII	II	II	II	II & VII	II
Drainage area (acres)	930	1	20/120	20/40	440/45	60
NCDWQ stream identification score	46.5	24	39/24	27/34	27/41.5	33.5
NCDWQ water quality classification	C	C	C	C	C	C
Morphological description (stream type)	B & C & F4	B4	B4	E & C4 / A & B4	B4 / C4 & E4	B&C&G4
Design Rosgen stream type	C4	B4	B4	E & C4 / B4	B4 / C4 & E4	E & C4
Evolutionary trend						
Design approach (P1, P2, P3, E, etc.)	PI, EI, EII, & P	P	P	P	EI, EII, P	PI, PII, EI, EII, P
Underlying mapped soils	Tate/Chestnut/Ashe	Tate	Tate/Evard/Cowee	Tate/Evard	Iotla	Iotla
Drainage class	Well	Well	Well	Well	SW Poor	SW Poor
Soil hydric status	Nonhydric	Nonhydric	Nonhydric	Nonhydric	Nonhydric	Nonhydric
Slope	0.0173	0.191	0.258/ 0.286	0.086/ 0.255	0.039/ 0.047	0.0342
FEMA classification	Zone AE	Zone X	Zone X	Zone X	Zone X	Zone X
Native vegetation community	Forest/Pasture	Forest	Forest	Forest	Forest	Pasture
% Composition of exotic invasive spp.	<5	<5	<5	<5	<5	<5

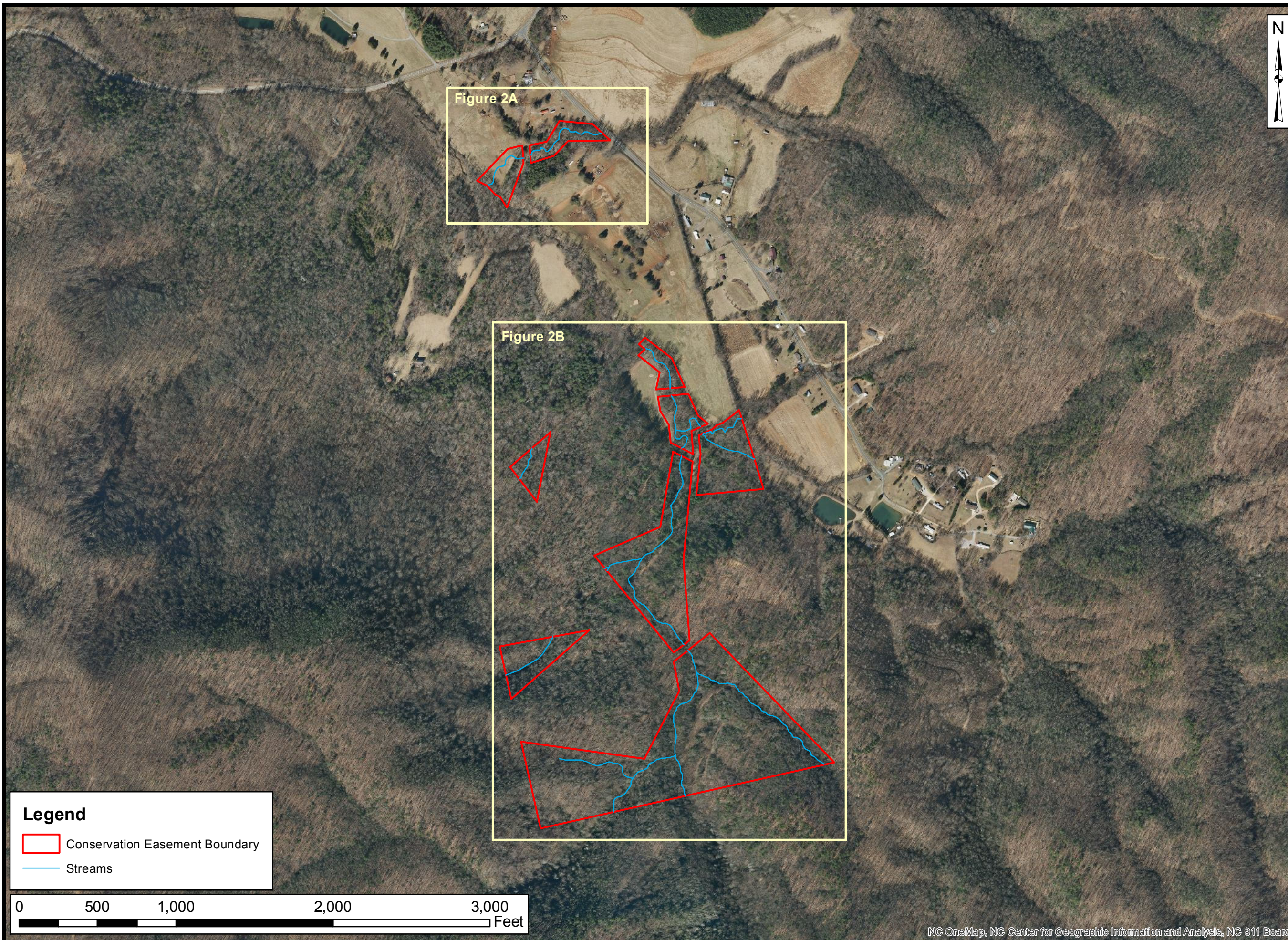
**Table 4. Project Baseline Information and Attributes (continued)**  
**Bobs Creek Mitigation Site/ DMS Number 92879**

<b>Wetland Summary Information</b>			
<b>Parameters</b>	<b>Wetlands</b>		
Size of wetland (acres)	0.35		
Wetland type	Riparian Riverine		
Mapped soil series	Tate Loam (Wehadkee)		
Drainage class	Well (poorly)		
Soil hydric status	Nonhydric (hydric)		
Source of hydrology	Overbank and groundwater		
Hydrologic impairment	None		
Native vegetation community	Forested		
% Composition of exotic invasive spp.	<5		
<b>Regulatory Considerations</b>			
<b>Regulation</b>	<b>Applicable?</b>	<b>Resolved?</b>	<b>Supporting Documentation</b>
Waters of the US – Section 404	Yes	Yes	SAW-2009-917
Waters of the US – Section 401	Yes	Yes	SAW-2009-917
Endangered Species Act	Yes	Yes	No Effect – CE Document
Historic Preservation Act	Yes	Yes	CE Document
Coastal Zone Management Act (CZMA/CAMA)	No	NA	NA
FEMA Floodplain Compliance	Yes	Yes	No Rise
Essential Fisheries Habitat	No	NA	NA

**Appendix B**  
**Visual Assessment Data**

Figures 2, 2A-2B. Current Conditions Plan View  
Figures 3, 3A-3B. Project Assets  
Tables 5A-5B. Visual Stream Morphology Stability Assessment  
Table 6. Vegetation Condition Assessment  
Stream Fixed Station Photo Points  
Vegetation Plot Photos





Prepared for:  
**NC Department of Environmental Quality**  
**Division of Mitigation Services**

Project:  
**Bob's Creek Stream Restoration Project**  
**DMS Project # 92879**  
 McDowell County, NC

Title:  
**Current Conditions Plan View**



Drawn by: KRJ

Date: NOV 2018

Scale: 1:7000

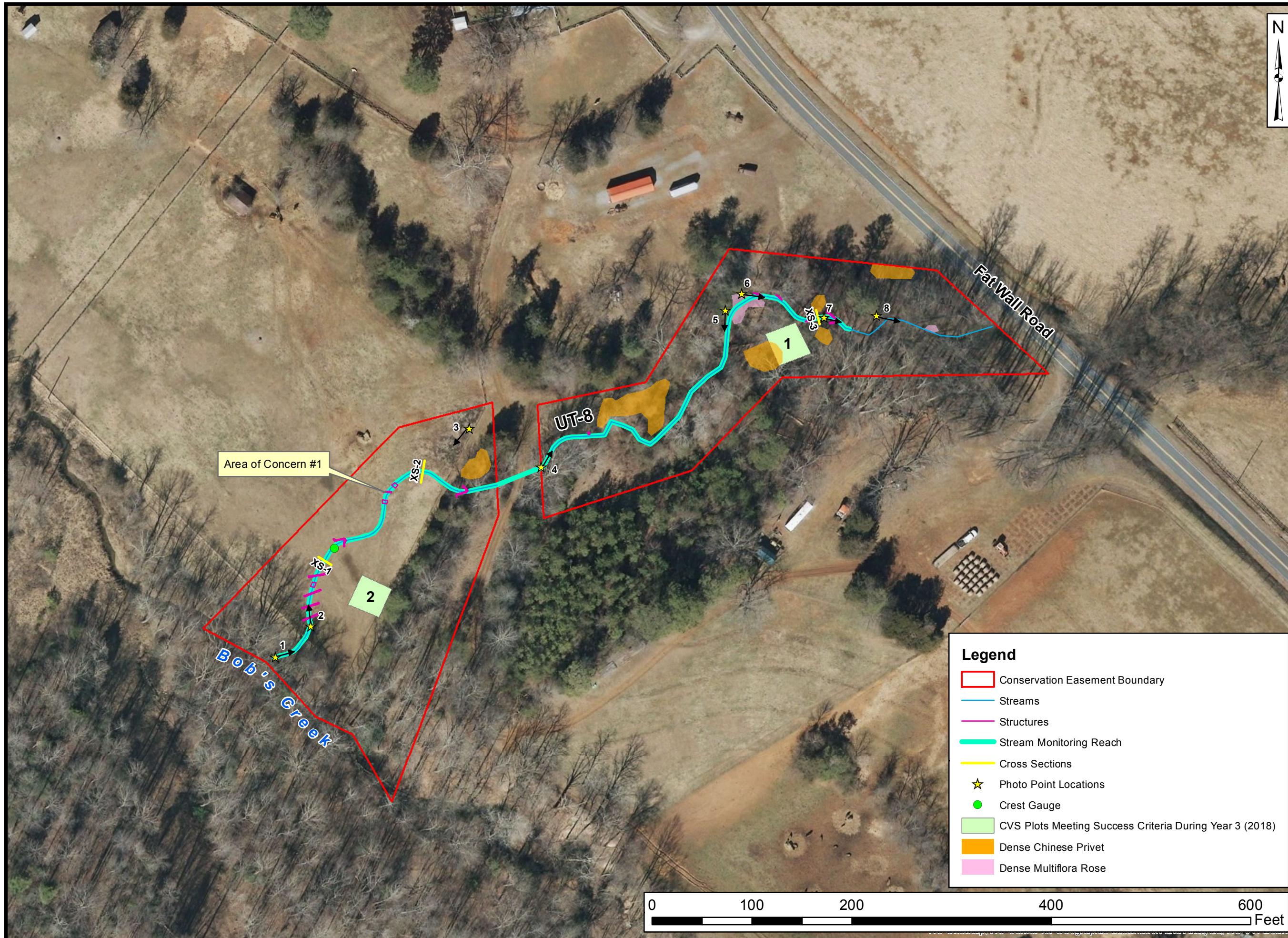
Project No.: 12-004.21

FIGURE  
**2**

**Legend**  
 Conservation Easement Boundary  
 Streams

0 500 1,000 2,000 3,000 Feet





Prepared for:  
**NC Department of Environmental Quality**  
**Division of Mitigation Services**

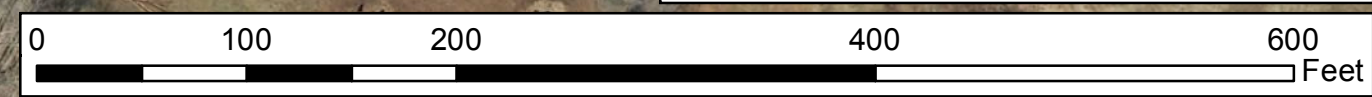
Project:  
**Bob's Creek Stream Restoration Project**  
**DMS Project # 92879**  
 McDowell County, NC

Title:  
**Current Conditions Plan View**

Drawn by: KRJ  
 Date: NOV 2018  
 Scale: 1:1100  
 Project No.: 12-004.21

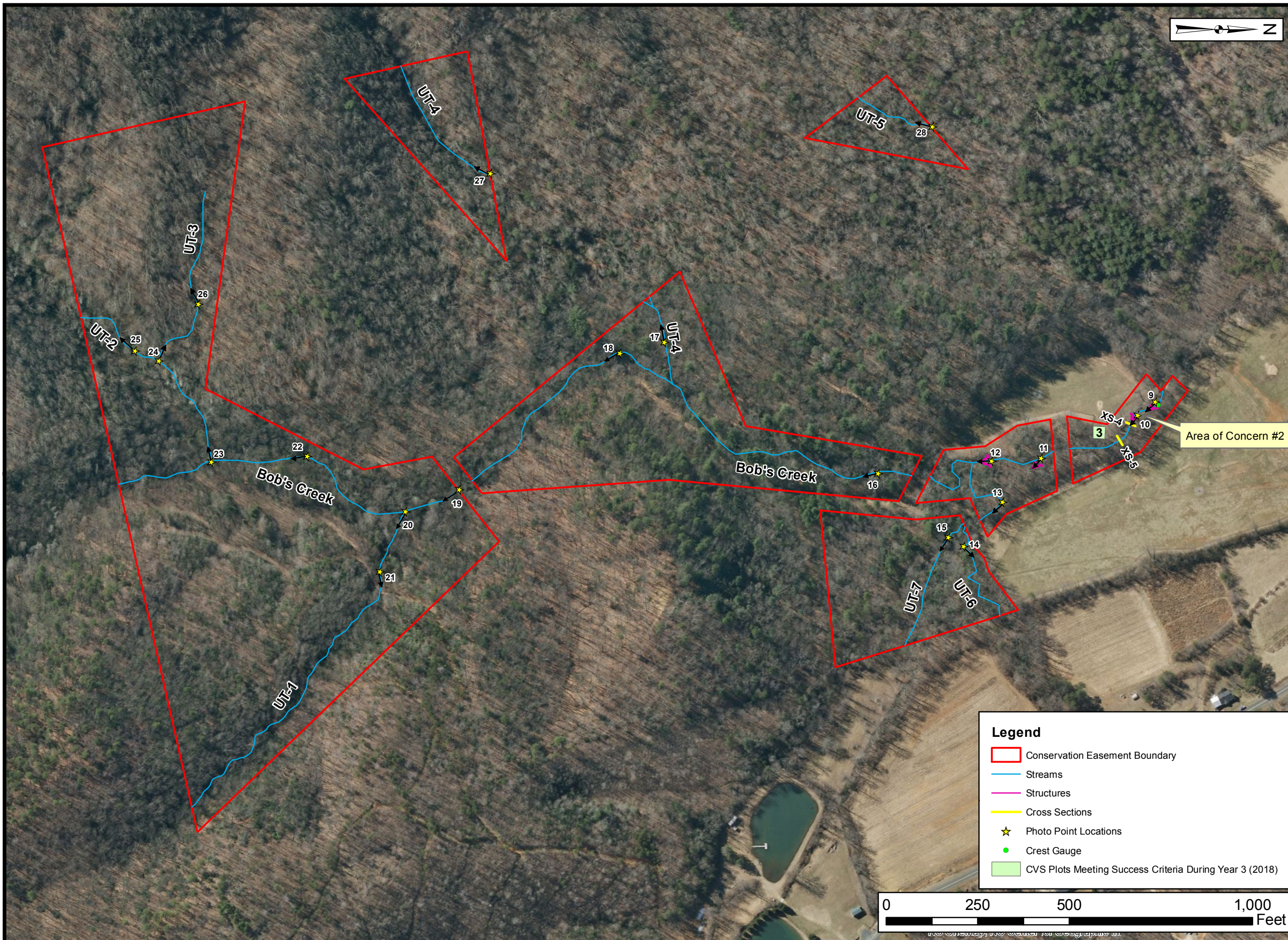
**Legend**

- Conservation Easement Boundary
- Streams
- Structures
- Stream Monitoring Reach
- Cross Sections
- ★ Photo Point Locations
- Crest Gauge
- CVS Plots Meeting Success Criteria During Year 3 (2018)
- Dense Chinese Privet
- Dense Multiflora Rose



**FIGURE**  
**2A**





Prepared for:  
**NC Department of Environmental Quality**  
 Division of Mitigation Services

Project:  
**Bob's Creek Stream Restoration Project**  
**DMS Project # 92879**

McDowell County, NC

Title:  
**Current Conditions Plan View**

Drawn by: KRJ

Date: NOV 2018

Scale: 1:3000

Project No.: 12-004.21

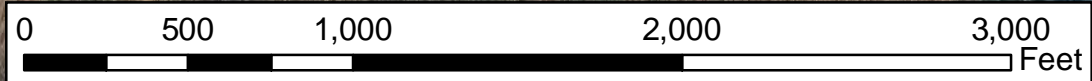
FIGURE  
**2B**





**Legend**

- Conservation Easement Boundary
- Stream Restoration
- Stream Enhancement (level I)
- Stream Enhancement (level II)
- Stream Preservation
- Wetland Preservation



Prepared for:  
**NC Department of  
 Environmental  
 Quality**  
**Division of  
 Mitigation  
 Services**

Project:  
**Bob's Creek  
 Stream Restoration  
 Project**  
**DMS Project  
 # 92879**

McDowell County, NC

Title:  
  
**Project Assets**

Drawn by: KRJ

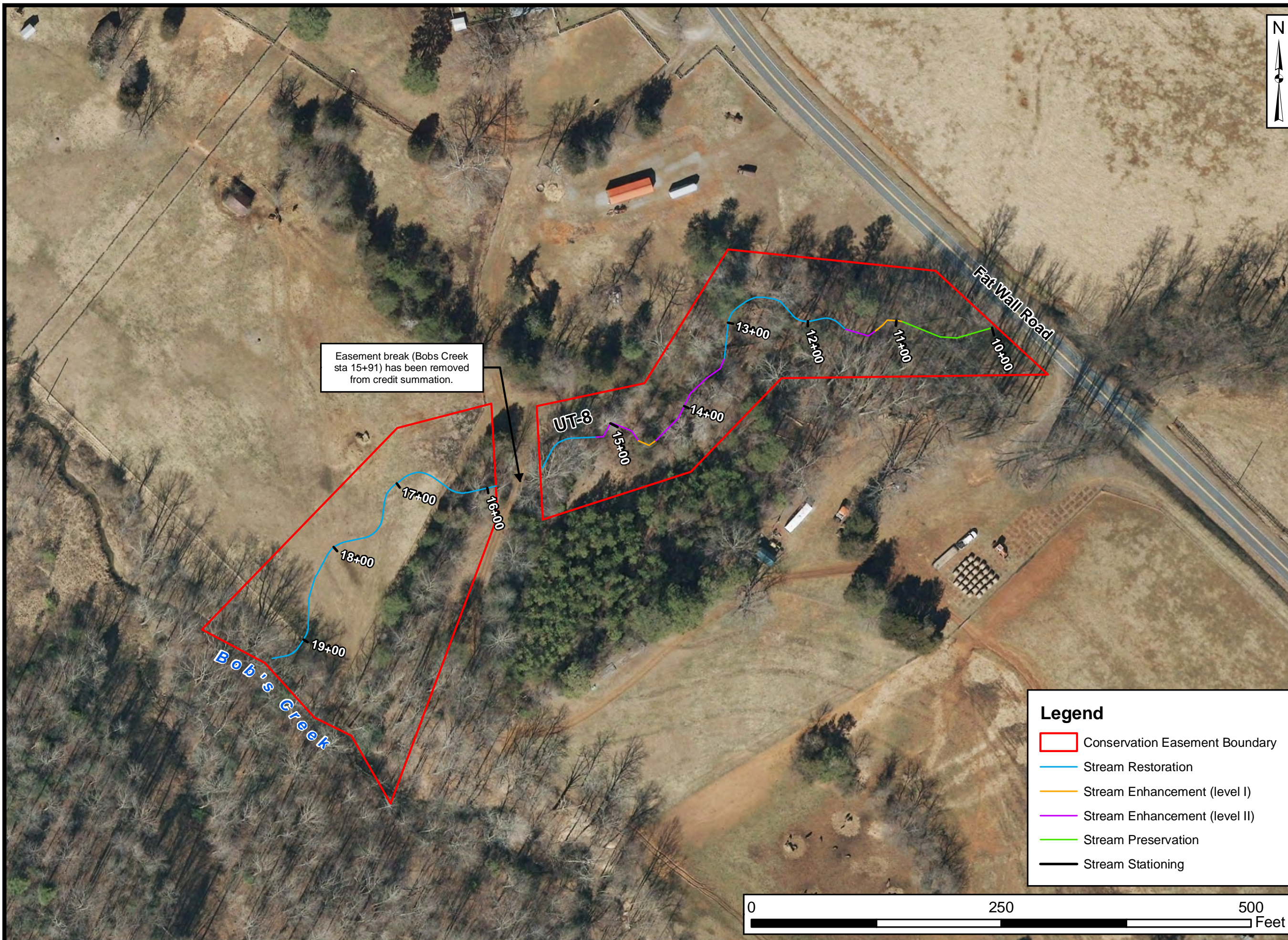
Date: JUN 2016

Scale: 1:7000

Project No.: 12-004.21

FIGURE  
**3**





Easement break (Bobs Creek sta 15+91) has been removed from credit summation.

**Legend**

- Conservation Easement Boundary
- Stream Restoration
- Stream Enhancement (level I)
- Stream Enhancement (level II)
- Stream Preservation
- Stream Stationing



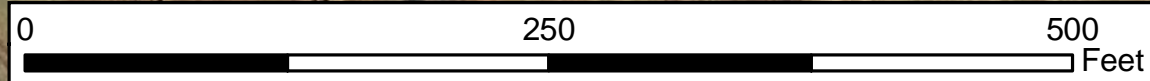
Prepared for:  
**NC Department of Environmental Quality**  
 Division of Mitigation Services

Project:  
**Bob's Creek Stream Restoration Project**  
**DMS Project # 92879**  
 McDowell County, NC

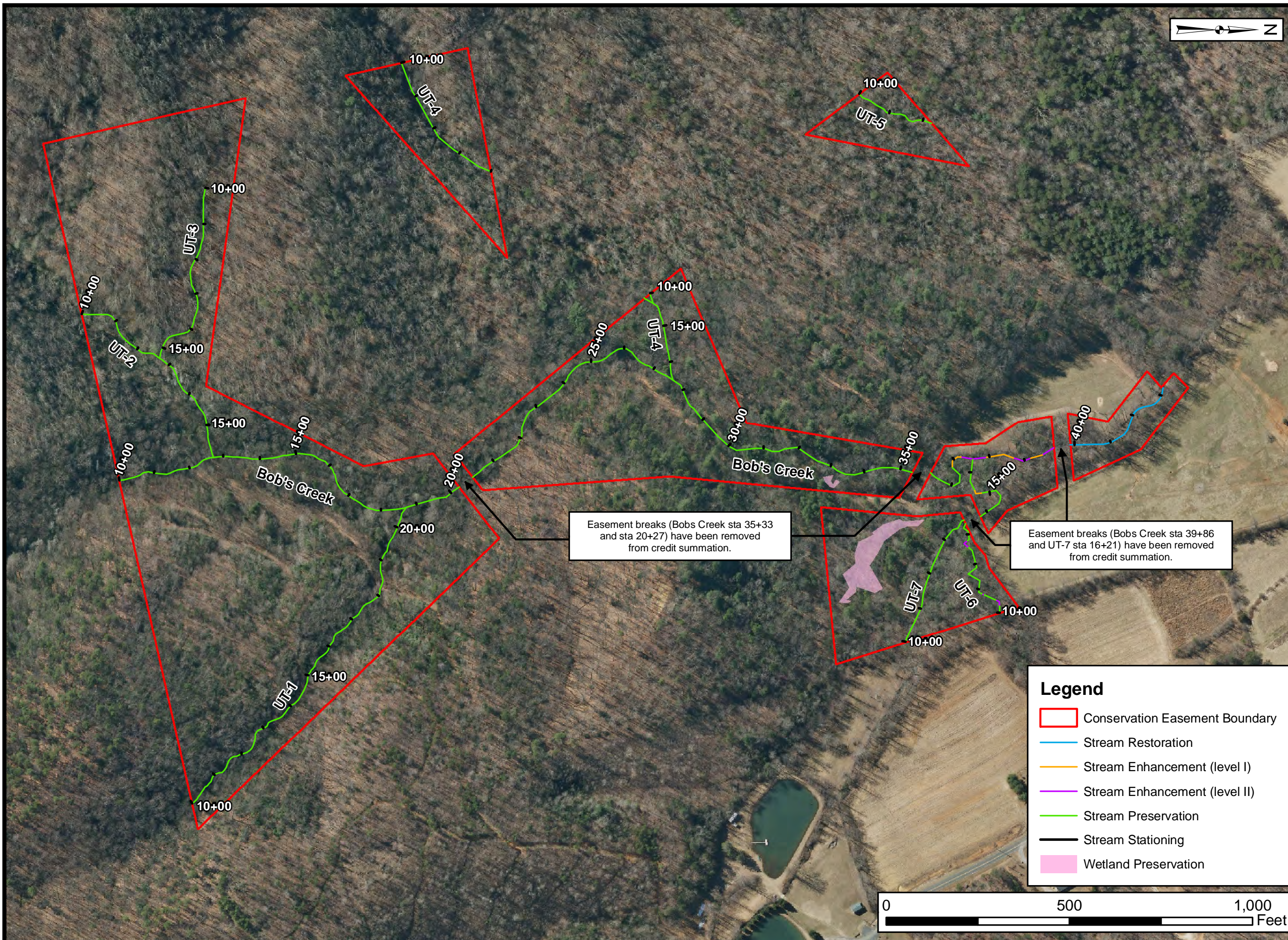
Title:  
**Project Assets**

Drawn by: KRJ  
 Date: JUN 2016  
 Scale: 1:1100  
 Project No.: 12-004.21

**FIGURE**  
**3A**







Prepared for:  
**NC Department of Environmental Quality**  
**Division of Mitigation Services**

Project:  
**Bob's Creek Stream Restoration Project**  
**DMS Project # 92879**  
 McDowell County, NC

Title:  
**Project Assets**

Drawn by: KRJ  
 Date: JUN 2016  
 Scale: 1:3000  
 Project No.: 12-004.21

**FIGURE 3B**

**Legend**

- Conservation Easement Boundary
- Stream Restoration
- Stream Enhancement (level I)
- Stream Enhancement (level II)
- Stream Preservation
- Stream Stationing
- Wetland Preservation



Table 5A  
 Reach ID  
 Assessed Length

**Visual Stream Morphology Stability Assessment**  
 Bobs Creek  
 647

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended		Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run units)	1. <u>Aggradation</u> - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)				0	0	100%			
		2. <u>Degradation</u> - Evidence of downcutting				0	0	100%			
	2. Riffle Condition	1. <u>Texture/Substrate</u> - Riffle maintains coarser substrate	7	7				100%			
	3. Meander Pool Condition	1. <u>Depth</u> Sufficient (Max Pool Depth : Mean Bankfull Depth $\geq$ 1.6)	6	6				100%			
		2. <u>Length</u> appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle)	6	6				100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	6	6				100%			
2. Thalweg centering at downstream of meander (Glide)		6	6				100%				
<b>Totals</b>											
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion				0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does <b>NOT</b> include undercuts that are modest, appear sustainable and are providing habitat.				0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse				1	60	95%			95%
<b>Totals</b>											
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	6	7				86%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	7	7				100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	7	7				100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	6	7				86%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio $\geq$ 1.6 Rootwads/logs providing some cover at base-flow.	7	7				100%			

Table 5B  
 Reach ID  
 Assessed Length

**Visual Stream Morphology Stability Assessment**  
 UT8 to Bobs Creek  
 939

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run units)	1. <u>Aggradation</u> - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. <u>Degradation</u> - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. <u>Texture/Substrate</u> - Riffle maintains coarser substrate	26	26			100%			
	3. Meander Pool Condition	1. <u>Depth</u> Sufficient (Max Pool Depth : Mean Bankfull Depth $\geq$ 1.6)	25	25			100%			
		2. <u>Length</u> appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle)	25	25			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	25	25			100%			
		2. Thalweg centering at downstream of meander (Glide)	25	25			100%			
<b>Totals</b>					0	0	100%	0	0	100%
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does <b>NOT</b> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	22	22			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	21	22			95%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	21	22			95%			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	22	22			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth : Mean Bankfull Depth ratio $\geq$ 1.6 Rootwads/logs providing some cover at base-flow.	22	22			100%			

**Table 6**

**Vegetation Condition Assessment**

**Bobs Creek Mitigation Project**

**Planted Acreage<sup>1</sup>**

**2.1**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	None	0.1 acres	none	0	0.00	0.0%
2. Low Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
2B. Low Planted Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
<b>Total</b>				0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	N/A	0	0.00	0.0%
<b>Cumulative Total</b>				0	0.00	0.0%

**Easement Acreage<sup>2</sup>**

**42.7**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern <sup>4</sup>	Dense Chinese privet and multiflora rose populations	1000 SF	orange and pink polygons	8	0.11	0.3%
5. Easement Encroachment Areas <sup>3</sup>	None	none	none	0	0.00	0.0%

<sup>1</sup> = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

<sup>2</sup> = The acreage within the easement boundaries.

<sup>3</sup> = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

<sup>4</sup> = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern species are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by DMS such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likely trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly early in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolizing invasives polygons, particularly for situations where the condition for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.



**Bobs Creek  
Fixed Station Photographs  
Taken September 2018**

Photo Point 1 – UT-8

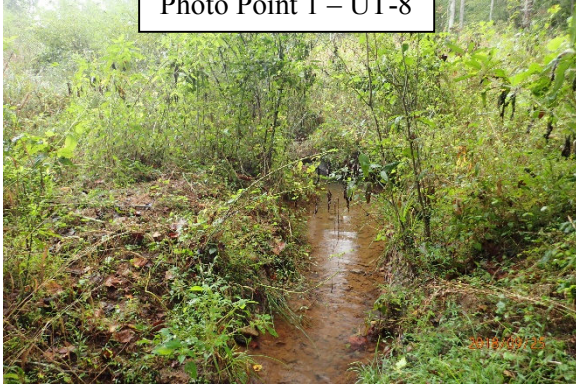


Photo Point 2 – UT-8



Photo Point 3 – UT-8



Photo Point 4 – UT-8

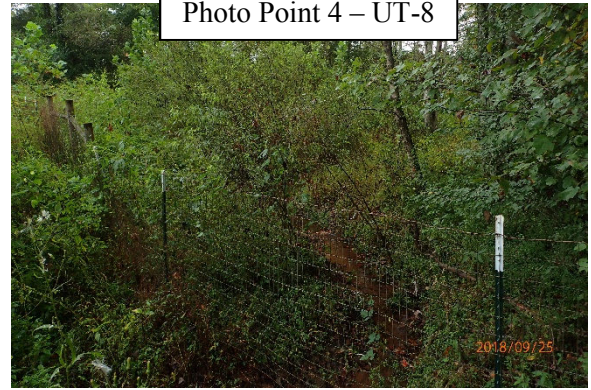


Photo Point 5 – UT-8



Photo Point 6 – UT-8





**Bobs Creek  
Fixed Station Photographs (continued)  
Taken September 2018**

Photo Point 7 – UT-8



Photo Point 8 – UT-8



Photo Point 9 – Bob's Creek



Photo Point 10 – Bob's Creek

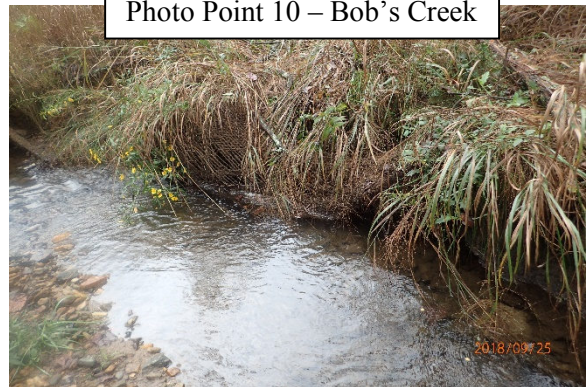
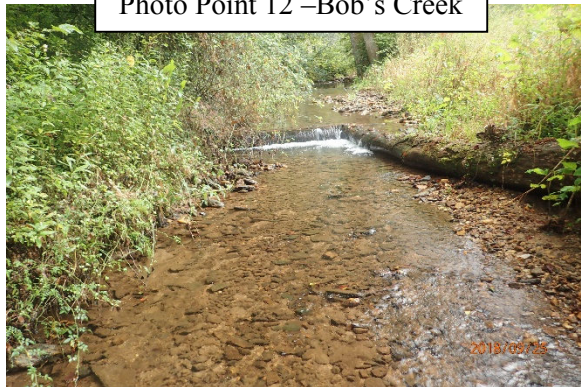


Photo Point 11 – Bob's Creek



Photo Point 12 – Bob's Creek





**Bobs Creek  
Fixed Station Photographs (continued)  
Taken September 2018**

Photo Point 13 – UT-7



Photo Point 14 – UT-6



Photo Point 15 – UT-7



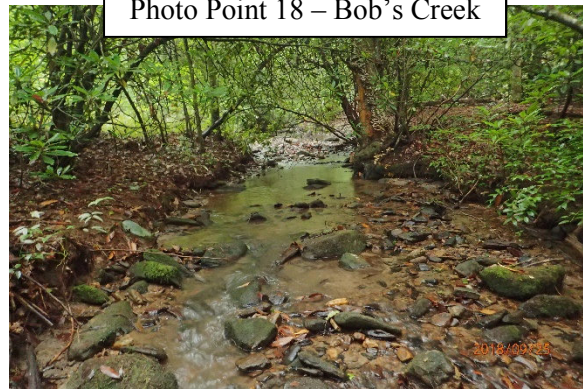
Photo Point 16 – Bob's Creek



Photo Point 17 - UT-4



Photo Point 18 – Bob's Creek





**Bobs Creek  
Fixed Station Photographs (continued)  
Taken September 2018**

Photo Point 19 – Bob’s Creek



Photo Point 20 – UT-1



Photo Point 21 – UT-1



Photo Point 22 – Bob’s Creek



Photo Point 23 – UT-2



Photo Point 24 – UT-3



**Bobs Creek  
Fixed Station Photographs (continued)  
Taken September 2018**

Photo Point 25 – UT-2



Photo Point 26 – UT-3



Photo Point 27 – UT-4

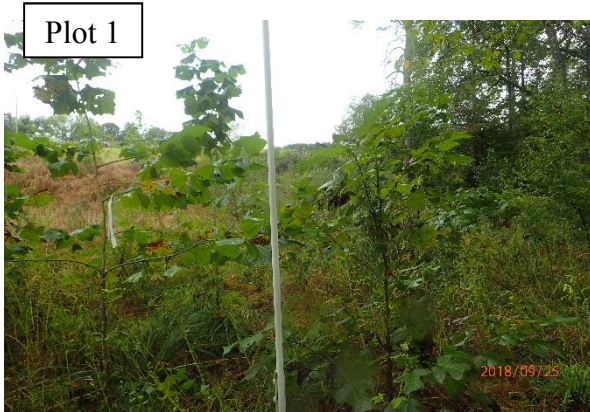


Photo Point 28 – UT-5





**Bobs Creek  
Vegetation Monitoring Photographs  
Taken September 2018**



**Appendix C.**  
**Vegetation Plot Data**

- Table 7. Vegetation Plot Success Summary  
Table 8. CVS Vegetation Plot Metadata  
Table 9. Total Planted Stems by Plot and Species

**Table 7. Vegetation Plot Success Summary**

Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
1	Yes	100%
2	Yes	
3	Yes	

**Table 8. CVS Vegetation Plot Metadata**

<b>Report Prepared By</b>	Corri Faquin
<b>Date Prepared</b>	9/27/2018 15:37
<b>database name</b>	Axiom-BobsCreek-2017-A-v2.3.1.mdb
<b>database location</b>	S:\Business\Projects\12\12-004 EEP Monitoring\12-004.21 Neighbors Bob\Bobs Creek\2018 MY-03\CVS
<b>computer name</b>	Keenan-PC
<b>file size</b>	58728448
<b>DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----</b>	
<b>Metadata</b>	Description of database file, the report worksheets, and a summary of project(s) and project data.
<b>Proj, planted</b>	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
<b>Proj, total stems</b>	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
<b>Plots</b>	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
<b>Vigor</b>	Frequency distribution of vigor classes for stems for all plots.
<b>Vigor by Spp</b>	Frequency distribution of vigor classes listed by species.
<b>Damage</b>	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
<b>Damage by Spp</b>	Damage values tallied by type for each species.
<b>Damage by Plot</b>	Damage values tallied by type for each plot.
<b>Planted Stems by Plot and Spp</b>	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
<b>ALL Stems by Plot and spp</b>	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
<b>PROJECT SUMMARY-----</b>	
<b>Project Code</b>	92879
<b>Project Name</b>	Bobs Creek
<b>River Basin</b>	Catawba
<b>length(ft)</b>	
<b>stream-to-edge width (ft)</b>	
<b>Required Plots (calculated)</b>	
<b>Sampled Plots</b>	3



Table 9. Total Planted Stems by Plot and Species  
 EEP Project Code 92879. Project Name: Bobs Creek

Scientific Name	Common Name	Species Type	Current Plot Data (MY3 2018)									Annual Means											
			92879-01-0001			92879-01-0002			92879-01-0003			MY3 (2018)			MY2 (2017)			MY1 (2016)			MY0 (2016)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree				1	1	1			3	1	1	4	1	1	5	1	1	6	2	2	25
Diospyros virginiana	common persimmon	Tree				1	1	1				1	1	1	1	1	1	2	2	2	4	4	4
Fraxinus pennsylvanica	green ash	Tree																1	1	1	1	1	1
Liriodendron tulipifera	tuliptree	Tree			5			4						9			8			3			
Nyssa	tupelo	Tree	1	1	1							1	1	1	1	1	1	1	1	1			
Nyssa sylvatica	blackgum	Tree	4	4	4	5	5	5				9	9	9	9	9	9	9	9	9	11	11	11
Platanus occidentalis	American sycamore	Tree	3	3	9	1	1	2	4	4	11	8	8	22	8	8	25	8	8	16	10	10	10
Quercus nigra	water oak	Tree	2	2	2	1	1	1				3	3	3	2	2	2	4	4	4	5	5	5
Quercus phellos	willow oak	Tree	1	1	1	2	2	2	4	4	4	7	7	7	8	8	8	6	6	6	5	5	5
Stem count			11	11	22	11	11	16	8	8	18	30	30	56	30	30	59	32	32	48	38	38	61
size (ares)			1			1			1			3			3			3			3		
size (ACRES)			0.02			0.02			0.02			0.07			0.07			0.07			0.07		
Species count			5	5	6	6	6	7	2	2	3	7	7	8	7	7	8	8	8	9	7	7	7
Stems per ACRE			445.2	445.2	890.3	445.2	445.2	647.5	323.7	323.7	728.4	404.7	404.7	755.4	404.7	404.7	795.9	431.7	431.7	647.5	512.6	512.6	822.9

Color for Density

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

- PnoLS = Planted excluding livestakes
- P-all = Planting including livestakes
- T = All planted and natural recruits including livestakes
- T includes natural recruits

**Appendix D.**  
**Stream Measurements and Geomorphology Data**

Cross Section Plots  
Longitudinal Profile Plots  
Substrate Plots

Tables 10A-10B. Baseline Stream Data Summary  
Tables 11A-11B. Monitoring Data-Dimensional Data Summary











<b>Site</b>	Bobs Creek
<b>Project Number:</b>	92879
<b>XS ID</b>	XS - 4, Riffle
<b>Reach</b>	Bobs Creek
<b>Date:</b>	3/22/2018
<b>Field Crew:</b>	Perkinson, Jernigan

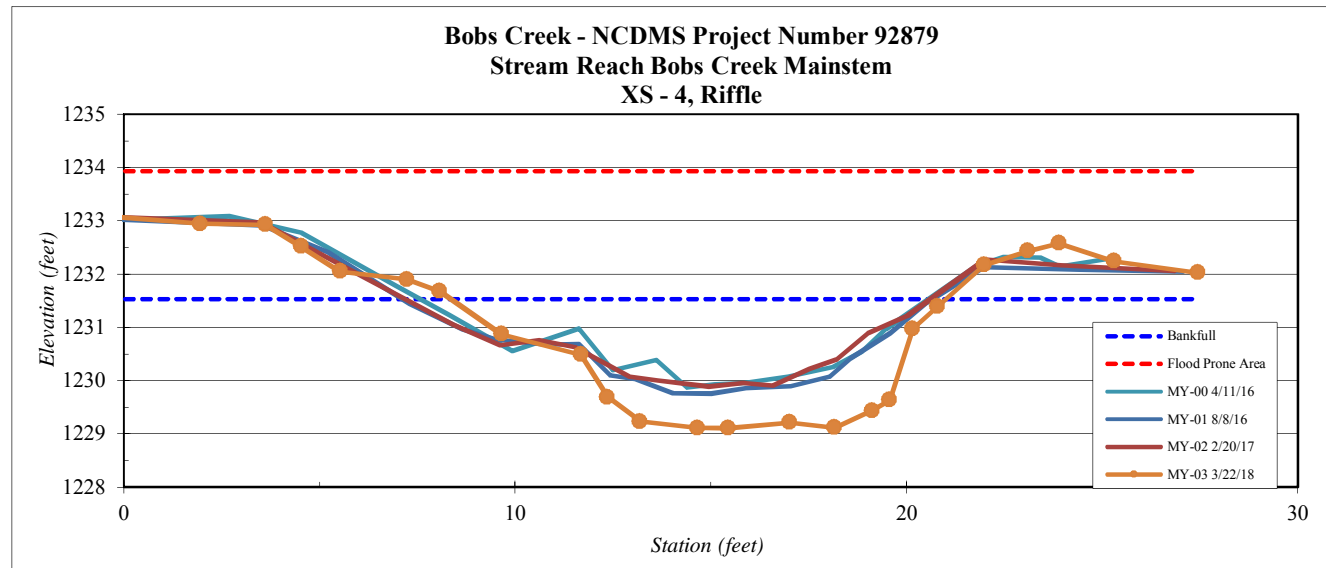


XS 4 Looking Upstream

Station	Elevation
-0.40	1233.08
1.96	1232.94
3.63	1232.92
4.54	1232.52
5.53	1232.05
7.23	1231.90
8.08	1231.68
9.65	1230.87
11.68	1230.49
12.36	1229.69
13.19	1229.23
14.66	1229.11
15.45	1229.10
17.02	1229.21
18.17	1229.11
19.1	1229.43
19.6	1229.63
20.2	1230.97
20.8	1231.38
22.0	1232.16
23.1	1232.43
23.9	1232.58
25.3	1232.24
27.5	1232.02

SUMMARY DATA	
<b>Bankfull Elevation:</b>	1231.5
<b>Bankfull Cross-Sectional Area:</b>	20.7
<b>Bankfull Width:</b>	12.6
<b>Flood Prone Area Elevation:</b>	1233.9
<b>Flood Prone Width:</b>	150.0
<b>Max Depth at Bankfull:</b>	2.4
<b>Low Bank Height:</b>	2.9
<b>Mean Depth at Bankfull:</b>	1.6
<b>W / D Ratio:</b>	7.7
<b>Entrenchment Ratio:</b>	11.9
<b>Bank Height Ratio:</b>	1.2

<b>Stream Type</b>	E
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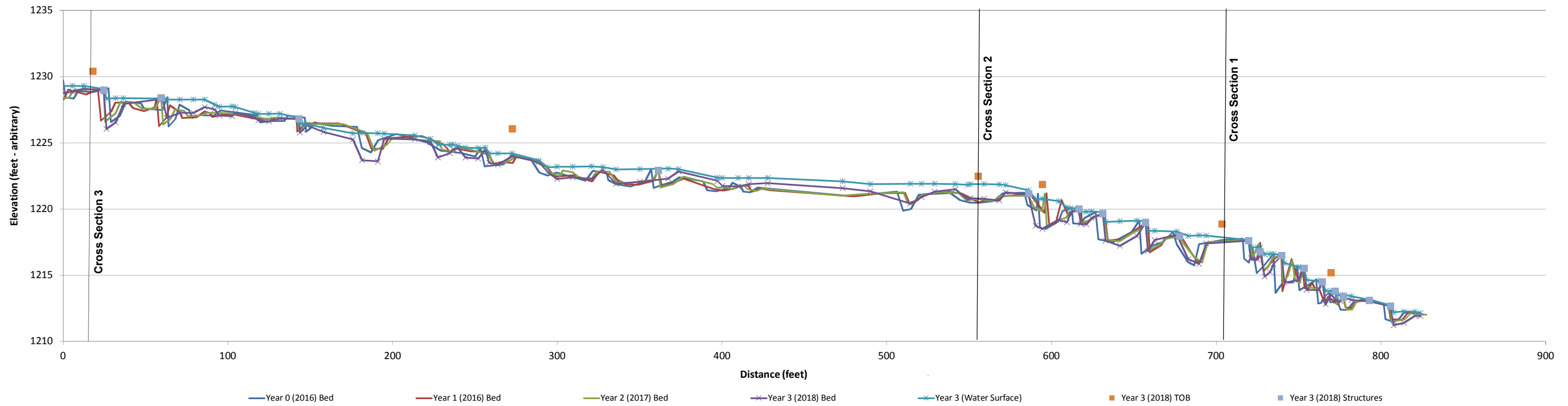


**Project Name** Bobs Creek - Profile  
**Reach** UT 8 Station 00+00 - 09+00  
**Feature** Profile  
**Date** 3/22/18  
**Crew** Perkinson, Butler

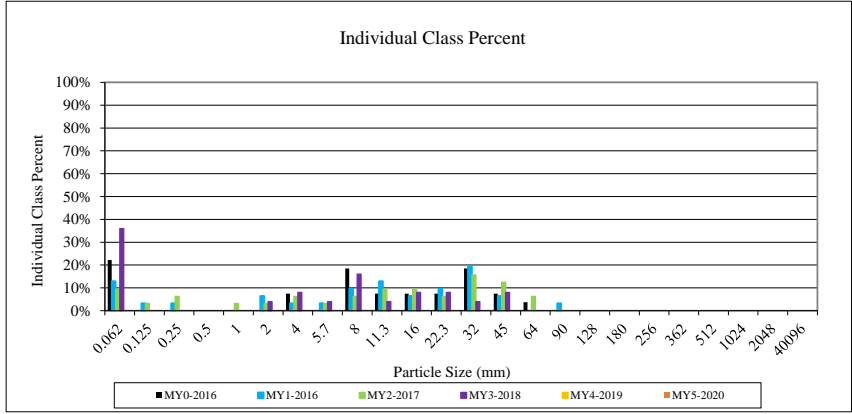
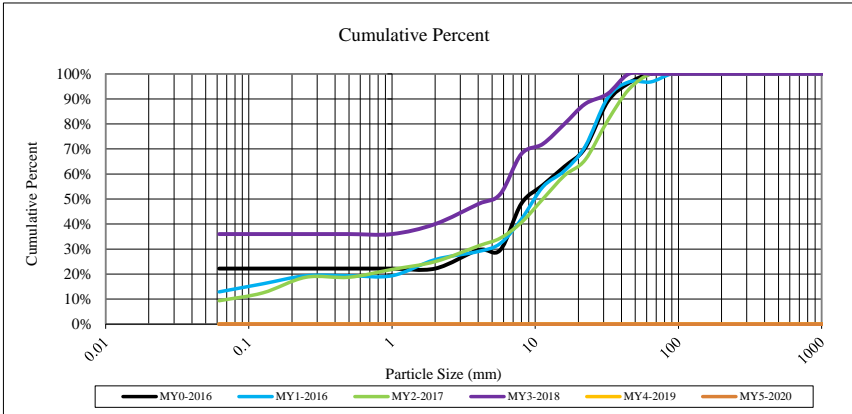
2016 Year 0 Monitoring \Survey			2016 Year 1 Monitoring \Survey			2017 Year 2 Monitoring \Survey			2018 Year 3 Monitoring \Survey			2019 Year 4 Monitoring \Survey		
Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation
824.0	1212.1	1212.4	824.0	1212.1	1212.3	827.6	1212.0	1212.2	824.1	1211.9	1212.1			
813.9	1212.2	1212.5	817.0	1212.3	1212.4	818.1	1212.1	1212.4	820.9	1211.9	1212.2			
811.2	1211.7	1212.5	812.8	1211.6	1212.4	814.4	1211.6	1212.4	813.9	1211.4	1212.3			
808.0	1211.5	1212.5	805.9	1211.7	1212.4	806.6	1211.5	1212.4	807.7	1211.2	1212.2			
802.8	1211.7	1212.5	804.7	1212.7	1212.8	805.4	1212.7	1212.8	805.7	1212.7	1212.7			
801.7	1212.8	1212.9	792.3	1213.2	1213.2	793.0	1213.1	1213.1	792.9	1213.0	1213.1			
789.2	1213.2	1213.3	784.4	1212.9	1213.2	785.0	1213.0	1213.2	782.3	1213.1	1213.4			
782.8	1212.9	1213.3	781.5	1212.5	1213.2	782.5	1212.4	1213.2	777.9	1213.3	1213.5			
779.3	1212.4	1213.3	778.4	1212.6	1213.2	779.2	1212.4	1213.1	775.4	1213.0	1213.5			
775.3	1212.4	1213.3	776.8	1213.4	1213.4	777.2	1213.3	1213.4	772.9	1213.0	1213.5			
772.9	1213.3	1213.5	774.0	1212.8	1213.5	775.2	1213.0	1213.4	769.8	1213.6	1213.8			
771.3	1213.0	1213.5	768.0	1213.4	1213.5	773.1	1212.8	1213.4	766.5	1212.8	1213.8			
769.2	1213.0	1213.5	766.1	1212.9	1213.5	772.2	1213.8		764.3	1214.5	1214.5			
768.5	1213.7		762.4	1214.0	1214.5	767.9	1213.2	1213.5	762.1	1213.9	1214.5			
765.0	1213.3	1213.6	760.6	1213.9	1214.4	766.3	1212.8	1213.5	754.8	1213.9	1214.6			
763.8	1212.9	1213.6	758.2	1214.4		764.9	1214.5	1214.6	753.3	1215.5	1215.5			
762.0	1212.9	1213.6	756.0	1214.0	1214.6	762.2	1213.9	1214.6	751.4	1215.0	1215.6			
760.6	1214.6		753.6	1214.0	1214.6	754.9	1214.1	1214.6	749.9	1214.6	1215.6			
755.7	1214.2	1214.7	752.3	1215.6		753.2	1215.6	1215.6	741.4	1214.4	1215.9			
753.8	1214.1	1214.7	750.1	1214.5	1215.3	750.7	1214.4	1215.6	739.8	1216.5	1216.5			
750.6	1213.9	1214.7	745.8	1216.2		747.9	1214.7	1215.6	734.8	1215.8	1216.6			
749.0	1215.7		740.3	1213.8	1215.2	746.2	1216.1		732.8	1215.2	1216.6			
746.8	1214.5	1215.6	739.5	1216.6	1216.6	743.5	1214.9	1215.6	729.3	1214.9	1216.6			
743.5	1214.4	1215.6	735.3	1216.2	1216.6	740.4	1214.5	1215.6	726.7	1216.8	1217.1			
742.0		1216.2	732.1	1215.8	1216.6	739.6	1216.5	1216.6	725.2	1216.2	1217.1			
739.5	1214.3	1215.7	728.8	1215.3	1216.6	734.5	1216.3	1216.6	721.0	1216.3	1217.1			
736.0	1213.6	1215.7	726.7	1217.5		731.2	1215.6	1216.6	719.6	1217.6	1217.7			
734.9	1216.6	1216.7	724.6	1216.2	1216.7	728.9	1215.5	1216.6	693.9	1217.4	1218.0			

	2016	2016	2017	2018	2019
Avg. Water Surface Slope	0.0212	0.0210	0.0211	0.0223	
Riffle Length	17	20	17	16	
Avg. Riffle Slope	0.0172	0.0175	0.0132	0.0195	
Pool Length	15	13	12	17	
Pool to Pool Spacing	26	28	26	30	

Bobs Creek Year 3 (2018) Profile - Tributary 8 Station 00+00 to 09+00



Project Name: Bobs Creek - UT 8					
Cross-Section: 1					
Feature: Riffle					
2018					
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	9	36%	36%
Sand	very fine sand	0.125	0	0%	36%
	fine sand	0.250	0	0%	36%
	medium sand	0.50	0	0%	36%
	coarse sand	1.00	0	0%	36%
	very coarse sand	2.0	1	4%	40%
Gravel	very fine gravel	4.0	2	8%	48%
	fine gravel	5.7	1	4%	52%
	fine gravel	8.0	4	16%	68%
	medium gravel	11.3	1	4%	72%
	medium gravel	16.0	2	8%	80%
	course gravel	22.3	2	8%	88%
	course gravel	32.0	1	4%	92%
	very coarse gravel	45	2	8%	100%
	very coarse gravel	64	0	0%	100%
Cobble	small cobble	90	0	0%	100%
	medium cobble	128	0	0%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
<b>TOTAL % of whole count</b>			25	100%	100%
Summary Data					
D50	4.9				
D84	19.1				
D95	36				

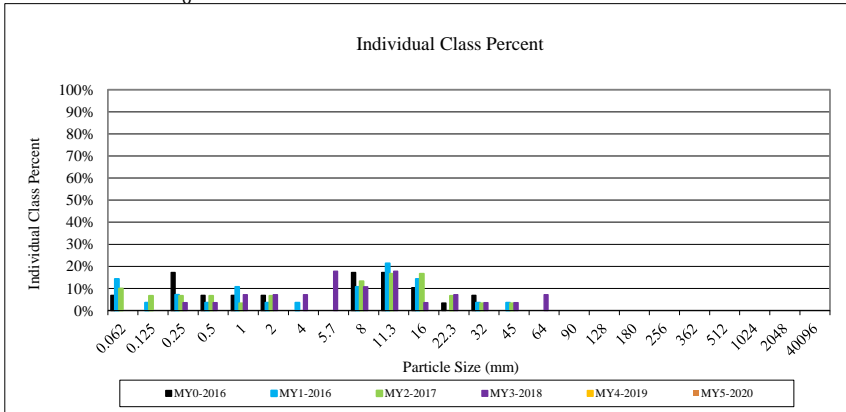
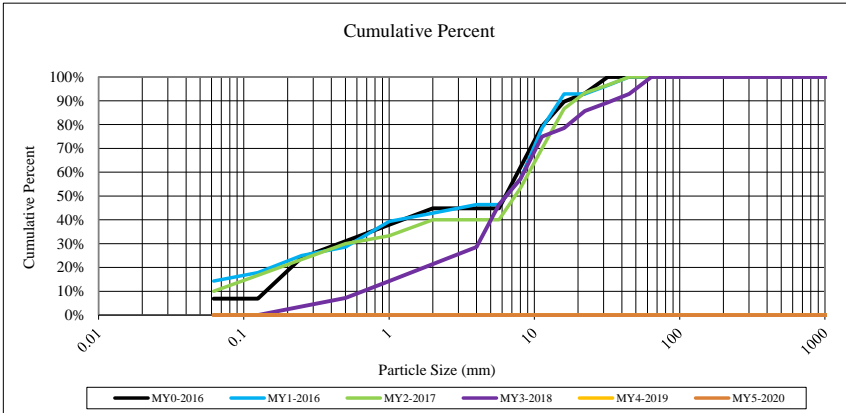




Project Name: Bobs Creek - UT 8						
Cross-Section: 3						
Feature: Riffle						
			2018			
Description	Material	Size (mm)	Total #	Item %	Cum %	
Silt/Clay	silt/clay	0.062	0	0%	0%	
	very fine sand	0.125	0	0%	0%	
Sand	fine sand	0.250	1	4%	4%	
	medium sand	0.50	1	4%	7%	
	coarse sand	1.00	2	7%	14%	
	very coarse sand	2.0	2	7%	21%	
	very fine gravel	4.0	2	7%	29%	
Gravel	fine gravel	5.7	5	18%	46%	
	fine gravel	8.0	3	11%	57%	
	medium gravel	11.3	5	18%	75%	
	medium gravel	16.0	1	4%	79%	
	course gravel	22.3	2	7%	86%	
	course gravel	32.0	1	4%	89%	
	very coarse gravel	45	1	4%	93%	
	very coarse gravel	64	2	7%	100%	
	Cobble	small cobble	90	0	0%	100%
		medium cobble	128	0	0%	100%
large cobble		180	0	0%	100%	
very large cobble		256	0	0%	100%	
Boulder	small boulder	362	0	0%	100%	
	small boulder	512	0	0%	100%	
	medium boulder	1024	0	0%	100%	
	large boulder	2048	0	0%	100%	
Bedrock	bedrock	40096	0	0%	100%	
<b>TOTAL % of whole count</b>			28	100%	100%	

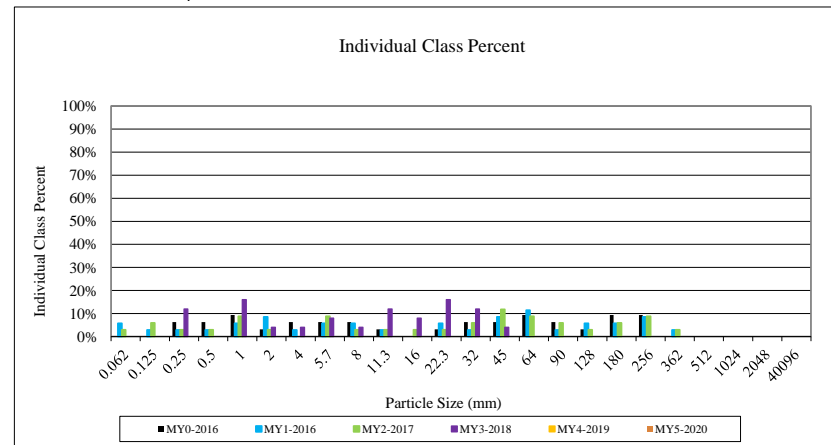
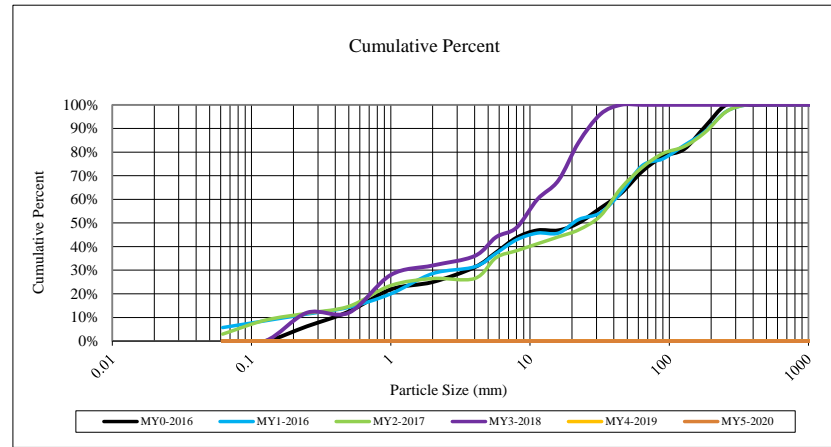
  

Summary Data	
D50	6.5
D84	21
D95	50



Project Name: Bobs Creek					
Cross-Section: 4					
Feature: Riffle					
			2018		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	0	0%	0%
Sand	very fine sand	0.125	0	0%	0%
	fine sand	0.250	3	12%	12%
	medium sand	0.50	0	0%	12%
	coarse sand	1.00	4	16%	28%
	very coarse sand	2.0	1	4%	32%
Gravel	very fine gravel	4.0	1	4%	36%
	fine gravel	5.7	2	8%	44%
	fine gravel	8.0	1	4%	48%
	medium gravel	11.3	3	12%	60%
	medium gravel	16.0	2	8%	68%
	course gravel	22.3	4	16%	84%
	course gravel	32.0	3	12%	96%
	very coarse gravel	45	1	4%	100%
	very coarse gravel	64	0	0%	100%
	Cobble	small cobble	90	0	0%
medium cobble		128	0	0%	100%
large cobble		180	0	0%	100%
very large cobble		256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
<b>TOTAL % of whole count</b>			25	100%	100%

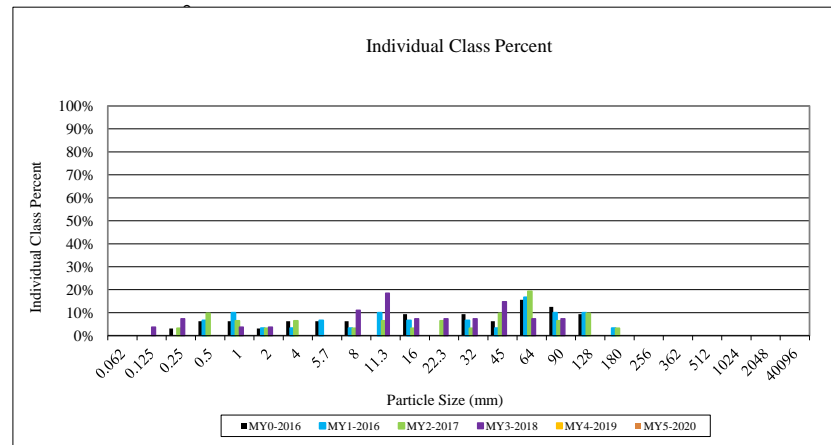
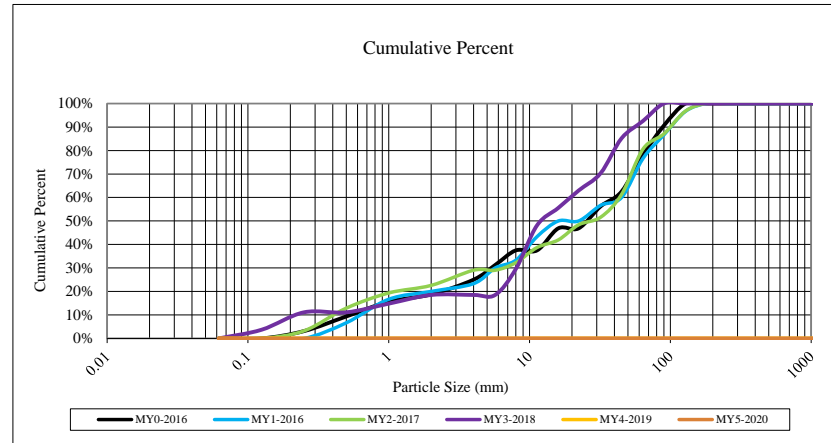
Summary Data	
D50	8.5
D84	22.3
D95	31





Project Name: Bobs Creek					
Cross-Section: 5					
Feature: Riffle					
			2018		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	0	0%	0%
Sand	very fine sand	0.125	1	4%	4%
	fine sand	0.250	2	7%	11%
	medium sand	0.50	0	0%	11%
	coarse sand	1.00	1	4%	15%
	very coarse sand	2.0	1	4%	19%
Gravel	very fine gravel	4.0	0	0%	19%
	fine gravel	5.7	0	0%	19%
	fine gravel	8.0	3	11%	30%
	medium gravel	11.3	5	19%	48%
	medium gravel	16.0	2	7%	56%
	course gravel	22.3	2	7%	63%
	course gravel	32.0	2	7%	70%
	very coarse gravel	45	4	15%	85%
	very coarse gravel	64	2	7%	93%
	very coarse gravel	90	2	7%	100%
Cobble	small cobble	90	2	7%	100%
	medium cobble	128	0	0%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
<b>TOTAL % of whole count</b>			27	100%	100%

Summary Data	
D50	12
D84	43
D95	70



**Table 10a. Baseline Stream Data Summary (Bob's Creek - UT 8)**  
**Bob's Creek Mitigation Project - NCDMS Project Number 92633**

Parameter	Gauge	Regional Curve			Pre-Existing Condition (UT 8)					Reference Reach(es) Data					Design (UT 8)			Monitoring Baseline (UT 8)						
		LL	UL	Eq.	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Max	Med	Min	Mean	Med	Max	SD	n	
<b>Dimension and Substrate - Riffle Only</b>																								
BF Width (ft)					5.0			7.8			5.6						8.0	8.3		8.7	9	3		
Floodprone Width (ft)					7.8			20.0			13				20	25				100		3		
BF Mean Depth (ft)					0.6			0.9			0.5						0.8	0.8		0.9	0.9	3		
BF Max Depth (ft)					0.9			1.2			0.7						1.0	1.2		1.5	1.7	3		
BF Cross Sectional Area (ft <sup>2</sup> )					3.7			4.7			3.0						5.9	6.6		7.5	8.3	3		
Width/Depth Ratio					5.3			13.6			10.5						10.5	10.0		10.2	10.4	3		
Entrenchment Ratio					1.6			2.6			2.3				2.5	3.1			11.1		11.6	12.0	3	
Bank Height Ratio					1.1			7.3			1.0						1.0				1.0		3	
<b>Profile</b>																								
Riffle length (ft)																			3.5	16.9	12	84.6	17.4	21
Riffle slope (ft/ft)					0.035			0.045			0.0480						0.0060	0.0119	0.0172	0.0155	0.0418	0.0117	19	
Pool length (ft)																			4.4	14.7	12.8	37.5	8.6	32
Pool Max depth (ft)					1.5			2.6			0.9						1.9			1.9			1	
Pool spacing (ft)					15.3			45.2		14.0			33.9		8.0	37.1			4.4	25.8	24.8	94.8	17.6	32
<b>Pattern</b>																								
Channel Beltwidth (ft)					23			33		17			25		24	48			24			48		2
Radius of Curvature (ft)					4			12		10			13		16	32			16			32		2
Rc:Bankfull width (ft/ft)					0.6			2.3		1.8			2.3		2	4			2			4		2
Meander Wavelength (ft)					32			65		31			38		40	80			40			80		2
Meander Width ratio					3			6.6		5.6			6.8		50	10			50			10		2
<b>Transport parameters</b>																								
Reach Shear Stress (competency) lbs/ft <sup>2</sup>																								
Max part size (mm) mobilized at bankfull																								
Stream Power (transport capacity) W/m <sup>2</sup>																								
<b>Additional Reach Parameters</b>																								
Rosgen Classification					B/C/G					E/C					E/C			E/C						
Bankfull Velocity (fps)					3.2-4.0																			
Bankfull Discharge (cfs)					15																			
Valley Length (ft)					----					----														
Channel Thalweg Length (ft)					----					----								824						
Sinuosity					1.11 - 1.18					1.28					1.11 - 1.17			1.11 - 1.17						
Water Surface Slope (ft/ft)					0.0148 - 0.0172					0.048					0.004			0.0212						
BF slope (ft/ft)					----					----					----			----						
Bankfull Floodplain Area (acres)					----					----					----			----						
% of Reach with Eroding Banks					----					----					----			----						
Channel Stability or Habitat Metric					----					----					----			----						
Biological or Other					----					----					----			----						



**Table 10b. Baseline Stream Data Summary (Bob's Creek)**  
**Bob's Creek Mitigation Project - NCDMS Project Number 92633**

Parameter	Gauge	Regional Curve			Pre-Existing Condition (Bobs Cr)					Reference Reach(es) Data					Design (Bobs Cr)			Monitoring Baseline (Bobs Cr)				
		LL	UL	Eq.	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Max	Med	Min	Mean	Med	Max	SD
<b>Dimension and Substrate - Riffle Only</b>																						
BF Width (ft)					14.5			25.5			12.7					17.5	15.2			17		2
Floodprone Width (ft)					29.8			45.2			150					100			150			2
BF Mean Depth (ft)					1.1			1.2			0.9					1.3	1.3			1.5		2
BF Max Depth (ft)					1.4			2.0			1.2					1.7	2.2			2.3		2
BF Cross Sectional Area (ft <sup>2</sup> )					17.4			29.0			11.4					22.3	19.9			25.2		2
Width/Depth Ratio					12.1			22.3			14.1					14.0	11.3			11.7		2
Entrenchment Ratio					1.2			3.1			11.8					5.7	8.8			9.9		2
Bank Height Ratio					1.2			1.8			1.0					1.0			1.0			2
<b>Profile</b>																						
Riffle length (ft)																						
Riffle slope (ft/ft)							0.0239				0.0344					0.0105						
Pool length (ft)																						
Pool Max depth (ft)							3.3				2.2					3.3						
Pool spacing (ft)					43.8			171.6		38.8			64.7		53.7	89.4						
<b>Pattern</b>																						
Channel Beltwidth (ft)					36			55		30.5			32		43.8	105			43.8		105	2
Radius of Curvature (ft)					7			30		14.5			20		40.3	70			40.3		70	2
Rc:Bankfull width (ft/ft)					0.3			2.1		1.1			1.6		2.3	4			2.3		4	2
Meander Wavelength (ft)					100			145		95			98		87.5	175			87.5		175	2
Meander Width ratio					1.41			3.8		7.5			7.7		5	10			5		10	2
<b>Transport parameters</b>																						
Reach Shear Stress (competency) lbs/ft <sup>2</sup>																						
Max part size (mm) mobilized at bankfull																						
Stream Power (transport capacity) W/m <sup>2</sup>																						
<b>Additional Reach Parameters</b>																						
Rosgen Classification					B/C/F					C					C			E/C				
Bankfull Velocity (fps)					3.79-6.32																	
Bankfull Discharge (cfs)					110																	
Valley Length (ft)					----					----												
Channel Thalweg Length (ft)					----					----								371				
Sinuosity					1.17					1.22					1.13			1.13				
Water Surface Slope (ft/ft)					0.0149					0.0205					0.007							
BF slope (ft/ft)					----					----					----			----				
Bankfull Floodplain Area (acres)					----					----					----			----				
% of Reach with Eroding Banks					----					----					----			----				
Channel Stability or Habitat Metric					----					----					----			----				
Biological or Other					----					----					----			----				

Table 11a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)

Bob's Creek Mitigation Project - NCDMS Project Number 92879

Parameter	Cross Section 1 (UT 8)							Cross Section 2 (UT 8)							Cross Section 3 (UT 8)							Cross Section 4 (Bobs Creek)							Cross Section 5 (Bobs Creek)						
	Riffle							Pool							Riffle							Riffle							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	8.3	8.7	8.5	8.7				11.9	12.4	11.0	12.7				9.0	9.7	9.6	9.6				15.2	15.7	15.6	12.6				17.0	17.3	17.4	15.9			
Floodprone Width (ft) (approx)	100.0	100.0	100.0	100.0				NA	NA	NA	NA				100.0	100.0	100.0	100.0				150.0	150.0	150.0	150.0				150.0	150.0	150.0	150.0			
BF Mean Depth (ft)	0.8	0.8	0.8	0.7				0.9	0.8	0.9	0.7				0.9	0.9	0.9	0.9				1.3	1.4	1.3	1.6				1.5	1.5	1.4	1.6			
BF Max Depth (ft)	1.2	1.2	1.1	1.1				1.9	1.8	1.8	1.9				1.7	1.8	1.7	1.8				2.2	2.3	2.1	2.4				2.3	2.2	2.2	2.3			
Low Bank Height (ft)	1.2	1.2	1.1	1.1				1.9	1.8	1.8	1.9				1.7	1.8	1.7	1.8				2.2	2.3	2.1	2.9				2.3	2.2	2.2	2.6			
BF Cross Sectional Area (ft <sup>2</sup> )	6.6	6.7	6.4	6.4				10.4	10.1	9.5	9.5				8.3	9.0	8.8	8.8				19.9	22.0	20.7	20.7				25.2	25.5	25.2	25.2			
Width/Depth Ratio	10.4	11.3	11.3	11.8				NA	NA	NA	NA				9.8	10.5	10.5	10.5				11.6	11.2	11.8	7.7				11.5	11.7	12.0	10.0			
Entrenchment Ratio	12.0	11.5	11.8	11.5				NA	NA	NA	NA				11.1	10.3	10.4	10.4				9.9	9.6	9.6	11.9				8.8	8.7	8.6	9.4			
Bank Height Ratio	1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.2				1.0	1.0	1.0	1.1			
d50 (mm)	8.7	9.8	11.0	4.9				----	----	----	----				6.5	6.6	7.4	6.5				22.0	20.3	26.5	8.5				24.9	22.0	26.5	12.0			

Table 11b. Monitoring Data - Stream Reach Data Summary

Bob's Creek Mitigation Project - NCDMS Project Number 92879

Parameter	Baseline (UT 8)						MY-1 (UT 8)						MY-2 (UT 8)						MY-3 (UT 8)						MY-4 (UT 8)						MY-5 (UT 8)					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
<b>Dimension and Substrate - Riffle Only</b>																																				
BF Width (ft)	8.3	8.7		9		2	8.7	9.2		9.7		2	8.5	9.1		9.6		2	8.7		9.2	9.6		2												
Floodprone Width (ft)		100				2		100				2		100				2			100			2												
BF Mean Depth (ft)	0.8	0.9		0.9		2	0.8	0.9		0.9		2	0.8	0.9		0.9		2	0.7		0.8	0.9		2												
BF Max Depth (ft)	1.2	1.5		1.7		2	1.2	1.5		1.8		2	1.1	1.4		1.7		2	1.1		1.5	1.8		2												
Low Bank Height (ft)	1.0	1.0		1.0		2	1.0	1.0		1.0		2	1.0	1.0		1.0		2	1.1		1.5	1.8		2												
BF Cross Sectional Area (ft <sup>2</sup> )	6.6	7.5		8.3		2	6.7	7.9		9.0		2	6.4	7.6		8.8		2	6.4		7.6	8.8		2												
Width/Depth Ratio	10.0	10.2		10.4		2	10.8	10.8		10.9		2	10.6	10.6		10.7		2	10.5		11.1	11.8		2												
Entrenchment Ratio	11.1	11.6		12.0		2	10.3	10.9		11.5		2	10.4	11.1		11.8		2	10.4		11.0	11.5		2												
Bank Height Ratio		1.0				2		1.0				2		1.0				2			1.0			2												
<b>Profile</b>																																				
Riffle length (ft)	3.5	16.9	12	84.6	17.4	21	3	20	18	88	18	25	4	17	16	55	13	25	2	16	12	74	15	23												
Riffle slope (ft/ft)	0.0119	0.0172	0.0155	0.0418	0.0117	19	0.0000	0.0175	0.0146	0.0524	0.0147	22	0.0000	0.0132	0.0102	0.0344	0.0105	24	0.0010	0.0195	0.0181	0.0632	0.02	23.00												
Pool length (ft)	4	15	13	38	9	32	6	13	11	32	7	29	3	12	11	30	6	32	5	17	15	39	10	28												
Pool Max depth (ft)			1.9			1			1.8		1			1.8		1			1.9			1.0														
Pool spacing (ft)	4	26	25	95	18	32	6	28	24	95	18	30	5	21	26	96	19	32	6	30	28	93	19	28												
<b>Pattern</b>																																				
Channel Beltwidth (ft)	24			48		2																														
Radius of Curvature (ft)	16			32		2																														
Rc:Bankfull width (ft/ft)	2			4		2																														
Meander Wavelength (ft)	40			80		2																														
Meander Width ratio	50			10		2																														
<b>Additional Reach Parameters</b>																																				
Rosgen Classification	E/C-type						E/C-type						E/C-type						E/C-type																	
Channel Thalweg Length (ft)	824						861						860						860																	
Sinuosity	1.11 - 1.17						1.11 - 1.17						1.11 - 1.17						1.11 - 1.17																	
Water Surface Slope (Channel) (ft/ft)	0.0212						0.021						0.0211						0.0223																	
BF slope (ft/ft)	----						----						----						----																	
Ri%/RU%P%/G%/S%																																				
SC%/SA%/G%/C%/B%BE%																																				
d16/d35/d50/d84/d95																																				
% of Reach with Eroding Banks	0						0						0						0																	
Channel Stability or Habitat Metric																																				
Biological or Other																																				



**Appendix E**  
**Hydrology Data**

Table 12. Verification of Bankfull Events

**Table 12. Verification of Bankfull Events  
Bobs Creek Site (DMS Project Number 92879)**

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
August 17, 2016	July 4, 2016	Crest gauge data along with wrack observed on the TOB of UT8 indicate a bankfull event after approximately 1.88 inches of rain documented* in one day.	1
May 17, 2017	April 23, 2017	Crest gauge data indicates a bankfull event after approximately 1.76 inches of rain documented* in one day.	--
May 9, 2018	April 24, 2018	Crest gauge data along with wrack observed on the floodplain of UT8 indicate a bankfull event after 3.89 inches of rain documented** over two days.	2
September 25, 2018	September 16, 2018	Crest gauge data indicates a bankfull event after 2.42 inches of rain** resulting from the remnants of Hurricane Florence.	--
November 8, 2018	October 11, 2018	Crest gauge data indicates a bankfull event after 2.79 inches of rain** resulting from the remnants of Hurricane Michael.	--

\*Weather Underground 2017

\*\*Weather Underground 2018

Photo 1: Wrack on TOB of UT8



Photo 2: Wrack in Floodplain of UT8

