Mitigation Project Name	**Brown Creek Tributaries Project**	**County**	**Anson**	**USACE Action ID**	**2012-01108**
DMS ID	**95351**	**Date Project Instituted**	**6/13/2012**	**NCDWR Permit No**	**2014-0345**
River Basin	**Yadkin**	**Date Prepared**	**5/22/2018**		
Cataloging Unit	**03040104**				

Credit Release Milestone	Stream Credits						Wetland Credits							
	Scheduled Releases (Stream)	Warm	Cool	Cold	Anticipated Release Year (Stream)	Actual Release Date (Stream)	Scheduled Releases (Forested)	Riparian Riverine	Riparian Non-riverine	Non-riparian	Scheduled Releases (Coastal)	Coastal	Anticipated Release Year (Wetland)	Actual Release Date (Wetland)
Potential Credits (Mitigation Plan)		9,766.470												
Potential Credits (As-Built Survey)		9,857.530												
Potential Credits (IRT Approved)		9,766.467												
1 (Site Establishment)	N/A				N/A	N/A	N/A				N/A		N/A	N/A
2 (Year 0 / As-Built)	30%	2,957.259			2016	1/13/2017	30%				30%		N/A	N/A
3 (Year 1 Monitoring)	10%	976.647			2017	8/8/2017	10%				10%		N/A	N/A
4 (Year 2 Monitoring)	10%	976.647			2017	8/8/2017	10%				15%		N/A	N/A
IRT Adjustment*		-27.320				8/8/2017								
5 (Year 3 Monitoring)	10%	976.647			2018	4/25/2018	15%				20%		N/A	N/A
6 (Year 4 Monitoring)	5%				2019		5%				10%		N/A	N/A
7 (Year 5 Monitoring)	10%				2020		15%				15%		N/A	N/A
8 (Year 6 Monitoring)	5%				2021		5%				N/A		N/A	N/A
9 (Year 7 Monitoring)	10%				2022		10%				N/A		N/A	N/A
Stream Bankfull Standard	10%	976.647			2018	4/25/2018	N/A				N/A			
Total Credits Released to Date		6,836.526												

*NOTE: Adjustment required due to IRT concerns on how the as-built credits were calculated

DEBITS (released credits only)

Ratios	1	1.5	2.5	5	1	3	2	5	1	3	2	5	1	3	2	5
	Stream Restoration	Stream Enhancement I	Stream Enhancement II	Stream Preservation	Riparian Restoration	Riparian Creation	Riparian Enhancement	Riparian Preservation	Nonriparian Restoration	Nonriparian Creation	Nonriparian Enhancement	Nonriparian Preservation	Coastal Marsh Restoration	Coastal Marsh Creation	Coastal Marsh Enhancement	Coastal Marsh Preservation
IRT Adjusted As-Built Amounts (feet and acres)	8,152.000	1,921.000	579.000	511.000												
IRT Adjusted As-Built Amounts (mitigation credits)	8,152.000	1,280.667	231.600	102.200												
Percentage Released	70%	70%	70%	70%												
Released Amounts (feet / acres)	5,706.400	1,344.700	405.300	357.700												
Released Amounts (credits)	5,706.400	896.467	162.120	71.540												
NCDWR Permit / USACE Action ID / Project Name																
Remaining Amounts (feet / acres)	5,706.400	1,344.700	405.300	357.700												
Remaining Amounts (credits)	5,706.400	896.467	162.120	71.540												

Contingencies (if any): None

Signature of Wilmington District Official Approving Credit Release

9/6/18
Date

1 - For NCDMS, no credits are released during the first milestone
2 - For NCDMS projects, the second credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the NCIRT by posting it to the NCDMS Portal, provided the following criteria have been met:
1) Approval of the final Mitigation Plan
2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property
3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan
4) Reciept of necessary DA permit authorization or written DA approval for porjects where DA permit issuance is not required

Brown Creek Tributaries Restoration Project
Final Year 4 Monitoring Report

Anson County, North Carolina

DMS Project ID No. 95351, DEQ Contract No. 004641

USACE Action ID: SAW-2012-01108, DWR Project #14-0345

Yadkin River Basin: 03040104-061030

Project Info:	Monitoring Year: 4 of 7 Year of Data Collection: 2018 Year of Completed Construction: 2015 Submission Date: December 2018
Submitted To:	NC DEQ – Division of Mitigation Services 1652 Mail Service Center Raleigh, NC 27699

Michael Baker
INTERNATIONAL

Michael Baker Engineering, Inc.
8000 Regency Parkway, Ste. 600 | Cary, North Carolina 27518
Office: 919.463.5488 | Fax: 919.463.5490

January 9, 2019

Harry Tsomides
Western Region Project Manager
NCDEQ, Division of Mitigation Services
5 Ravenscroft Drive – Suite 102
Asheville, NC 28801

Subject: Response to DMS Comments for Task 10 Deliverables: Year 4 Monitoring Report
Brown Creek Tributaries Restoration Project, Anson County, North Carolina
Yadkin River Basin – CU# 03040104
DEQ Contract No. 004641, USACE AID SAW-2012-01108, DMS Project #95351

Mr. Tsomides:

Please find below our responses to the NC Division of Mitigation Services' (DMS) review comments letter dated December 10, 2018 in reference to the Brown Creek Tributaries Restoration Project in Anson County, NC. We have subsequently revised the Draft version of the Year 4 Monitoring Report in response to the review comments as outlined below:

1) Executive Summary (visual assessment channel stability paragraph): DMS noted a small section (20 LF) of aggraded stream bed with subsurface flow at a debris jam midway up the Hurricane Creek tributary Reach R3. Please advise on this section and whether it should be cataloged as a stream problem area.

   Response: We are aware of the debris jam located on Hurricane Creek Reach R3. The cause of the jam is the thick mass of tree roots partially blocking the channel that has always been present. It functions as a small knickpoint with an elevation drop below it. It's also trapped debris in front of it before, which we've previously removed. We don't believe much serious aggradation has actually occurred upstream, and we don't think that flow has truly gone subsurface. It's just temporarily backed-up and is finding another way through. It was flowing when we went out to inspect last fall post-hurricanes. We intend to remove the debris jam this winter and clear out the upstream channel a bit to ensure ease of flow, but considered that more as routine maintenance. As such, we weren't identifying this as a Stream Problem Area (SPA).

2) Executive Summary (visual assessment vegetation problem area paragraph): DMS observed areas dominated by dense tall grass along Hurricane Creek. Is it likely the small trees will overcome the grass and become more visible by closeout?

   Response: We certainly believe there is a strong likelihood that the small trees located in that tall grass will start to push up in the next year or so to become more visible. Since project planting, there have been a couple of harsh growing seasons that likely negatively affected plant growth. As noted in the report, we will be amending areas of concern with small amounts of fertilizer in the spring and/or fall of 2019 with the hopes of boosting growth rates.

3) Table 1 (Assets) – Stream R and RE totals should reflect mitigation plan lengths calculated to the nearest tenth; rounding should yield the potential IRT-approved credits following rollback to approved mitigation plan credits (9765.47 SMU). Contact me if you have any questions about this.

Michael Baker
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Response: Table 1 has been revised using decimals to the nearest tenth for each reach such that the total credit sum equals 9,765.5 SMU (as rounded from 9,765.47). However, the mitigation plan itself did not report these numbers, it solely used rounded, whole numbers. Instead, these revised table values were determined using the original spreadsheet created to initially calculate the mitigation plan credit table values. This was explained in the notes in the revised Table 1 to explain the differences between the previously reported values.

As requested, four hardcopies of the final version of the monitoring report are being provided with this submission, along with a CD containing the final e-submission digital files. Copies of this response letter are also included as part of each report. Please do not hesitate to contact me should you have any questions regarding our response submittal.

Sincerely,

Scott King, LSS
Project Manager

Enclosures

Brown Creek Tributaries Restoration Project
Final Year 4 Monitoring Report

Anson County, North Carolina

DMS Project ID No. 95351, DEQ Contract No. 004641

USACE Action ID: SAW-2012-01108, DWR Project #14-0345

Yadkin River Basin: 03040104-061030

Report Prepared and Submitted by Michael Baker Engineering, Inc.

NC Professional Engineering License # F-1084

Michael Baker
INTERNATIONAL

TABLE OF CONTENTS

APPENDICES

* Note: The figures and tables marked above with an asterisk are not included as part of this Year 4 Monitoring Report, but were left listed in the Table of Contents to explain the otherwise out-of-sequence figure/table numbering and appendix designations. For clarity, Michael Baker wishes to preserve the continuity of the labeling for these features between monitoring years to avoid confusion (e.g. to allow Appendix C to always contain vegetation data, and Table 12 to always be the bankfull event table, etc. in each monitoring report). These figures and tables have been included in past reports and will be included again as part of the Year 5 monitoring report for 2019.

1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) restored 8,213 linear feet of perennial stream, enhanced 2,481 linear feet of stream, and preserved 518 linear feet of stream along Hurricane Creek (HC) and unnamed tributaries (UT4) to Brown Creek, a 303(d) listed stream that flows through the Pee Dee National Wildlife Refuge. Baker also planted approximately 33 acres of native riparian vegetation along the restored and enhanced reaches (Reaches HC-R1, HC-R2, and HC-R3 on the Hurricane Creek portion of the project, and UT4-R1a, UT4-R1b, UT4-R2, UT4-R3, UT4-R4a, UT4-R4b, UT4-R5a, and UT4-R5b on the unnamed tributary (UT4) portion of the project). A recorded conservation easement consisting of 43.3 acres protects and preserves all stream reaches, existing wetland areas, and riparian buffers in perpetuity. The Brown Creek Tributaries Restoration Project (Site) is located in Anson County, approximately four miles southeast of the Town of Ansonville (Figure 1). The Site is located in the NC Division of Water Resources (NCDWR) subbasin 03-07-10 and the NC Division of Mitigation Services (DMS) Targeted Local Watershed (TLW) 03040104-061030 of the Yadkin River Basin. The project involved the restoration and enhancement of a rural piedmont stream system (Schafale and Weakley 1990), which had been impaired due to past agricultural conversion and cattle grazing.

Based on the DMS 2009 Lower Yadkin-Pee Dee River Basin Restoration Priority (RBRP) Plan, the Brown Creek Tributaries Restoration Project area is located in an existing targeted local watershed (TLW) within the Yadkin River Basin, although it is not located in a Local Watershed Planning (LWP) area. The TLW selection criteria for the Yadkin Basin specifically targets projects that will address water resource impacts from nonpoint source (NPS) pollution. The restoration strategy for the Yadkin River Basin as a whole targets projects which focus on restoring stream functions by maintaining and enhancing water quality, restoring hydrology, and improving fish and wildlife habitat.

The primary goals of the project were to improve ecologic functions to the impaired areas as described in the DMS 2009 Lower Yadkin-Pee Dee RBRP as identified below:

- Create geomorphically stable conditions along the unnamed tributaries across the site,
- Implement agricultural BMPs to reduce NPS inputs to receiving waters,
- Protect and improve water resources by reducing stream bank erosion, and nutrient and sediment inputs,
- Restore stream and floodplain interaction by connecting historic flow paths and promoting natural flood processes, and
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement.

To accomplish these goals, the following objectives were identified:

- Restore existing incised, eroding, and channelized streams by providing them access to their relic floodplains,
- Prevent cattle from accessing the conservation easement boundary by installing permanent fencing and thus reduce excessive stream bank erosion and undesired nutrient inputs,
- Increase aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated stream bank erosion,

- Plant native species riparian buffer vegetation along stream bank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve stream bank stability and riparian habitat connectivity, and shade the stream to decrease water temperature,
- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature, and
- Control invasive species vegetation within the project area and, if necessary, continue treatments during the monitoring period.

In accordance with the Mitigation Plan and the project-applicable DMS guidance document "Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation" dated 11/7/2011, no formal vegetation plot monitoring was performed, nor were any stream cross-sectional surveys conducted as part of the Year 4 monitoring effort. A visual assessment of the site is emphasized this year, with the full vegetation and cross-section survey work to resume for the Year 5 monitoring in 2019.

From the Year 4 visual inspection monitoring, all stream reaches appear stable and functioning. All stream riffle beds are vertically stable, the pools are maintaining depth, stream banks are stable and vegetating, and in-stream structures are physically intact and performing as designed (Appendix B). No Stream Problem Areas (SPAs) were identified. Previous stream repair work conducted in March of 2017 (as reported in the MY3 report) along sections of scoured/eroded stream banks on UT4-R2 and UT4-R4 have remained stable and are vegetating well as shown in Stream Maintenance and Repair photolog found in Appendix B.

The Year 4 visual inspection monitoring also observed that the planted acreage performance categories were functioning very well overall with no bare or eroding areas to report (Appendix B). Throughout the monitoring year, Baker conducted numerous temporary vegetation transects in areas outside the permanent vegetation plots to help assess project performance. The transects were measured out as 100 ft long by 12 ft wide (for an area roughly similar to that of the veg plots). Any living stem of an acceptable species that was at least 2 ft in height was counted. These stem counts were then converted into stems/acre values for comparison to the vegetation success criteria values. There were 13 transects taken during the Year 4 monitoring season; each one meeting MY5 success criteria of 260 stems/acre, and with an overall average of 455 stems/acre. The location of the transects and their stems/acre values are shown on the CCPV found in Appendix B.

As a result of the visual inspections and assessments, two Vegetation Problem Areas (VPAs) were discovered on the project. The first is an area of low stem density found along the right bank of UT4-R4b approximately 0.24 acres in size. The higher mortality found here is suspected to be the result of the previous two particularly hot and dry growing seasons experienced on the site. The VPA is located on a slightly higher and drier portion of the floodplain as compared to the adjacent, more successful areas. This area will be supplementally planted in the winter of 2018-2019 to ensure vegetative success. The second VPA is an approximately 0.85 acre area of low stem vigor found in the right floodplain of upper HC-R1 where plant heights are shorter than expected. To be clear, adequate plant numbers are found here, they are simply shorter than desired for the end of MY4. The ultimate explanation for this is unknown. Previous soil testing did not reveal any significant deficiencies, and construction did not involve any benching or cutting into subsoil here. Baker speculates that the previous two harsh growing seasons on site simply resulted in slow growing rates here and that another good growing season or two of adequate rainfall will allow them to catch up. This section of the floodplain is much drier than everything else downstream, which likely contributed to reduced growth rates. Baker will also apply a small amount of fertilizer to the plants in the spring and/or fall of 2019 to further encourage growth.

Previously, the Year 3 monitoring report noted two VPAs that were subsequently addressed in 2018. The first were a few areas of observed thin stem densities found along HC-R2 and UT4-R2 totaling approximately 2 acres. In March 2018 these areas were supplementally planted with a total of 220, 1-gallon container sized

trees. The species planted were an approximately equal mix of green ash (*Fraxinus pennsylvanica*), American hornbeam (*Carpinus caroliniana*), sycamore (*Platanus occidentalis*), basswood (*Tilia americana*), persimmon (*Diospyros virginiana*), and silky dogwood (*Cornus amomum*, planted in the wetter portions of the floodplain). A subsequent inspection of this planted area during monitoring activities in October 2018 revealed that the planted stems appeared to be alive and growing well, as numerous stems were quickly and easily identified in the field (including along one temporary vegetation transect) and had leaves and/or bud scars to indicate seasonal growth and all-around vigor. Please see the CCPV in Appendix B for the locations of these supplementally planted areas.

The second VPA consists of two small areas of invasive Chinese privet (*Ligustrum sinsense*) totaling 0.24 acres found scattered in the floodplains on upper HC-R1 and lower UT4-R4. The invasive privet was cut and sprayed in March 2018. The project will continue to be monitored for the presence of privet and treated accordingly. Please see the CCPV in Appendix B for privet treatment locations.

Additionally, field inspections during the year revealed the notable presence of both loblolly pine (*Pinus taeda*) and sweetgum (*Liquidambar styraciflua*) scattered throughout portions of the left floodplain of UT4-R2 and lower UT4-R4b. In June of 2018, these areas were substantially thinned of these species. Future field inspections will continue to note any significant locations of these trees throughout the project and thin as needed. Please see the CCPV in Appendix B for the locations of these plant thinning areas.

Two pebble counts were conducted in Year 4 Monitoring, one each in riffles located along HC-R2 and UT4-R4b. Both show that the bed material size distribution has remained relatively stable as compared to previous years despite the heavy rainfall in 2018, particularly from Hurricane Florence. Pebble count data can be found in Appendix D.

Stream flow for the restored channels was recorded for 2018 through the use of three in-stream flow gauges (pressure transducers) located along reaches UT4-R4b (gauge BTFL1), UT4-R1b (gauge BTFL2), and HC-R1 (gauge HCFL1). The flow gauges documented seasonal flow for Year 4 in these reaches of 94, 63, and 113 consecutive days respectively. Thus, each gauge met the minimum success criteria of 30 consecutive days of flow. All of the flow gauges demonstrated similar flow events relative to recorded rainfall events as demonstrated in the gauge graphs in Appendix E. As Figure 6 shows, rainfall for the previous year totaled 61.5 in, which is above both the historic average (47.0 in) and 70% probable (56.6 in) for Anson County. Hurricane Florence alone is estimated to have rained a total of 20.8 in here during the September 14-17 timeframe.

Two bankfull crest gauges are located in the floodplains along UT4-R2 and HC-R2. During Year 4 monitoring, the crest gauge on HC-R2 documented one post-construction bankfull event of 0.67 ft on 9/17/18 (associated with Hurricane Florence), as corroborated by the HCFL1 flow gauge depths recorded on that same date. The crest gauge on UT4-R2 documented two bankfull events in MY4; the first of 2.26 ft on 9/17/18 (Hurricane Florence), and a second of 0.68 ft on 10/11/18 (associated with Hurricane Michael). The two in-stream flow gauges located on UT4-R4 and UT4-R1 corroborate these findings as well. Additionally, visual evidence of overbank events were readily apparent throughout the site with wrack lines and debris jams commonly observed as shown in site photographs in Appendix B. Complete project crest gauge readings are presented in Table 13 in Appendix E, as are the corroborating flow gauge graphs.

Summary information/data related to the Site and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report Appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report and in the Mitigation Plan available on the North Carolina Division of Mitigation Services (NCDMS) website. Any raw data supporting the tables and figures in the Appendices are available from NCDMS upon request.

This report documents the successful completion of Year 4 monitoring activities for the post-construction monitoring period.

2.0 METHODOLOGY

The seven-year monitoring plan for the Site includes criteria to evaluate the success of the stream and vegetation components of the project. The methodology and report template used to evaluate these components adheres to the DMS monitoring report template guidance document Version 1.3 (dated January 15, 2010), which will continue to serve as the template for subsequent monitoring years. The vegetation monitoring quadrants follow CVS-DMS monitoring levels 1 and 2 in accordance with CVS-DMS Protocol for Recording Vegetation, Version 4.1 (2007).

Stream survey data was collected to a minimum of Class C Vertical and Class A Horizontal Accuracy using a Leica TS06 Total Station and was georeferenced to the NAD83 State Plane Coordinate System, FIPS3200 in US Survey Feet, which was derived from the As-built Survey. This survey system collects point data with an accuracy of less than one tenth of a foot.

The specific locations of monitoring features, such as permanent vegetation plots, permanent cross-sections, flow gauges, and crest gauges are shown on the CCPV Figure 2 found in Appendix B.

The Year 4 visual site assessment data contained in Appendix B was collected in October 2018, unless noted otherwise.

2.1 Stream Assessment

The project involved the restoration and enhancement of a rural piedmont stream system, which had been impaired due to past agricultural conversion and cattle grazing. Restoration practices involved raising the existing streambed and reconnecting the stream to the relic floodplain to restore natural flood regimes to the system. The existing channels abandoned within the restoration areas were partially to completely filled to decrease surface and subsurface drainage and to raise the local water table. Permanent cattle exclusion fencing was provided around all proposed reaches and riparian buffers in which cattle previously had access.

2.1.1 Morphologic Parameters and Channel Stability

A longitudinal profile was surveyed for the entire length of each channel after construction to document the as-built baseline monitoring conditions (Year 0) only. Annual longitudinal profiles will not be conducted during subsequent monitoring years unless channel instability has been documented or remedial actions/repairs are required by the US Army Corps of Engineers (USACE) or DMS.

As per the Mitigation Plan and DMS monitoring guidance for this project, no cross-section survey data were collected for this Monitoring Year 4 assessment. Consequently, none of the cross-sectional survey graphs (Figure 5) or morphology data (Table 11) are presented in Appendix D as in previous monitoring reports.

Particle size distribution assessments (pebble counts) were conducted using the modified Wolman method as described in Applied River Morphology (Rosgen, 1996).

2.1.2 Hydrology

To document seasonal flow in restored intermittent channels, two in-stream automated flow gauges (pressure transducers) were installed on the UT4 site (in UT4-R1b and UT4-R4b), and one was installed on the HC site (in HC-R1). Success criteria are considered to have been met if 30 consecutive days of flow were observed at any point during the monitoring year. The recorded flow data and observed

rainfall graphs for each gauge, along with the flow gauge success summary table are all located in Appendix E.

The occurrence of bankfull events within the monitoring period are documented by the use of two crest gauges, flow camera photographs, and three in-stream flow gauges. One crest gauge is installed at bankfull elevation along on HC-R2 and a second crest gauge is installed along UT4-R2. The flow camera is installed on UT4-R4b at the in-stream flow gauge location along that reach. However, the camera experienced numerous technical issues during the monitoring year and vegetation growth along the subject riffle ultimately enveloped both the camera and the riffle, obscuring the view. So the camera will be replaced and moved to a better location to document flow for Year 5 Monitoring. The Flow camera photographs and visual evidence of bankfull events are found in Appendix B, while all project crest gauge readings are presented in Table 13 in Appendix E.

2.1.3 Photographic Documentation

Representative photographs for Year 4 Monitoring were taken along all reaches for both the Hurricane Creek and UT4 project sites during October 2018 site visits.

A stream flow camera is located along UT4-R4b at the location of the in-stream flow gauge to provide further documentation of seasonal flow.

The photographs of all stream reaches, flow cameras, monitoring gauges (both crest and flow gauges), previous stream repair areas, as well as any vegetation problem areas are all located in Appendix B.

2.2 Vegetation Assessment

In order to determine if the criteria are achieved, vegetation-monitoring quadrants were installed and are monitored across the restoration site in accordance with the CVS-DMS Protocol for Recording Vegetation, Version 4.1 (2007) and the CVS-DMS data entry tool v 2.3.1 (2012). The vegetation monitoring plots were established randomly throughout the planted riparian buffer areas of UT4 and HC as per Monitoring Levels 1 and 2. The size of each individual quadrants are 100 square meters for woody tree species.

However, as stated previously, no formal vegetation plot assessments were conducted as part of the Year 4 monitoring effort, but will resume in Year 5 monitoring.

3.0 REFERENCES

Carolina Vegetation Survey (CVS) and NC Division of Mitigation Services (NCDMS). 2012. CVS-NCDMS Data Entry Tool v. 2.3.1. University of North Carolina, Raleigh, NC.

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

North Carolina Division of Mitigation Services (DMS). 2011. Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation. November 7, 2011.

North Carolina Division of Mitigation Services (DMS). 2010. Procedural Guidance and Content Requirements for DMS Annual Monitoring Reports. Version 1.3 (1/15/2010)

North Carolina Division of Mitigation Services (DMS). 2009. Lower Yadkin-Pee Dee River Basin Restoration Priorities (RBRP) Plan. Updated January 2009.

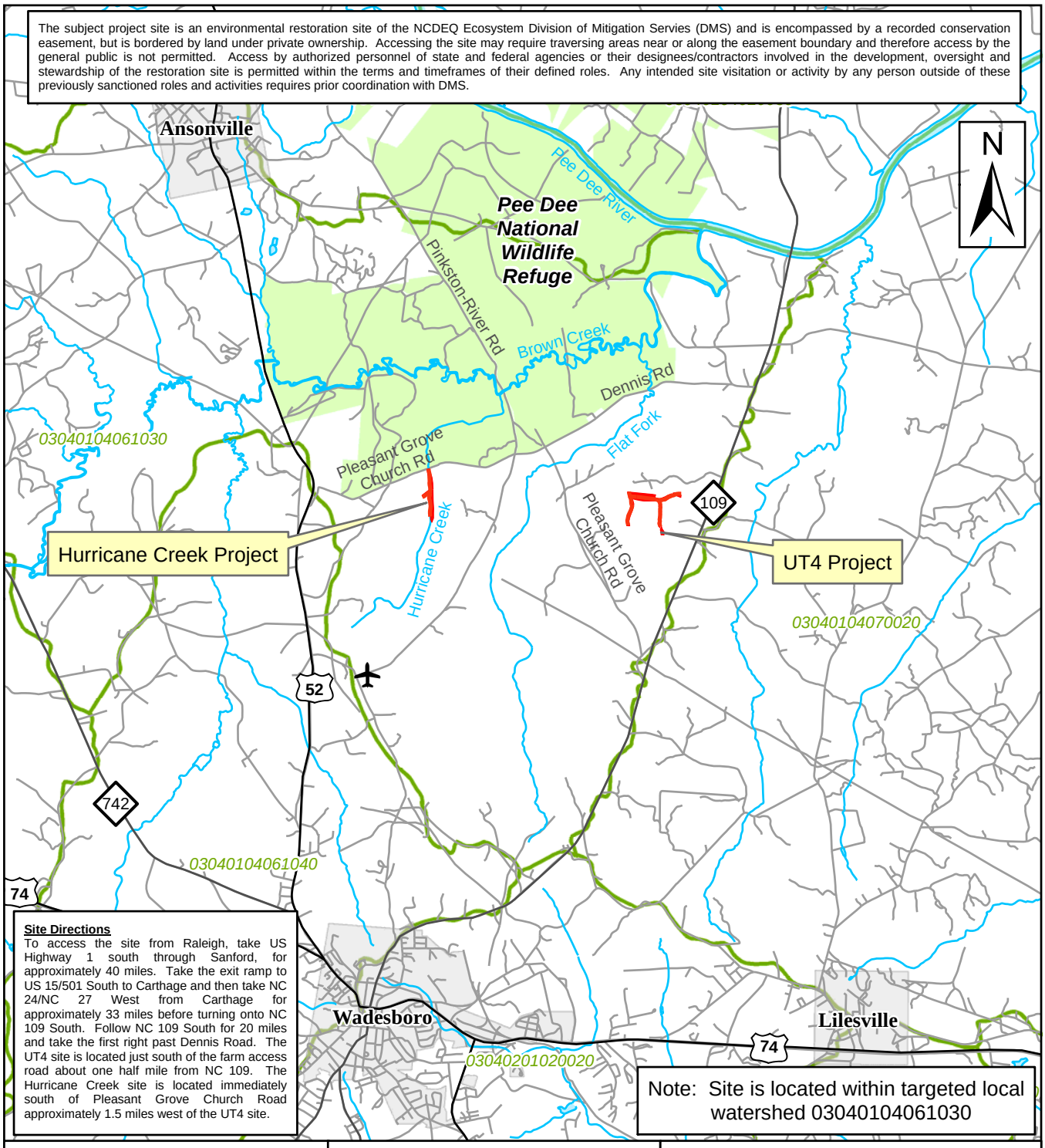
Rosgen, D.L. 1996. Applied River Morphology. Wildlands Hydrology. Pagosa Springs, CO.

Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina, Third Approximation. North Carolina Natural Heritage Program. Division of Parks and Recreation, NC DEQ. Raleigh, NC.

Appendix A

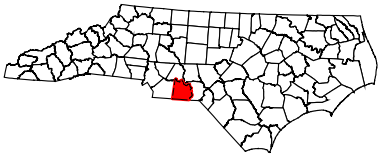
Project Vicinity Map and Background Tables

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



Site Directions
To access the site from Raleigh, take US Highway 1 south through Sanford, for approximately 40 miles. Take the exit ramp to US 15/501 South to Carthage and then take NC 24/NC 27 West from Carthage for approximately 33 miles before turning onto NC 109 South. Follow NC 109 South for 20 miles and take the first right past Dennis Road. The UT4 site is located just south of the farm access road about one half mile from NC 109. The Hurricane Creek site is located immediately south of Pleasant Grove Church Road approximately 1.5 miles west of the UT4 site.

Note: Site is located within targeted local watershed 03040104061030



Anson County

Figure 1
Project Vicinity Map
Brown Creek Tributaries

NCDEQ -
Division of Mitigation Services

Michael Baker INTERNATIONAL

0 0.5 1 2 Miles

Table 1. Project Components and Mitigation Credits

Brown Creek Tributaries Restoration Project: DMS Project No ID. 95351

Mitigation Credits

	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorus Nutrient Offset
Type	R	RE							
Totals	9,663.3	102.2							

Project Components

Project Component or Reach ID	Stationing/ Location [1]	Existing Footage/ Acreage (LF)	Approach	Restoration/ Restoration Equivalent Credits (SMU) from Mitigation Plan[2]	As-Built Restoration Footage or Acreage (LF)	Mitigation Ratio
HC-R1	10+00 - 30+43	1,896	Restoration	2,035.0	2,043	1:1
HC-R2	30+43 - 30+52 & 30+82 - 44+67	1,288	Restoration	1,366.0	1,394	1:1
HC-R3	10+36 - 16+00	579	Enhancement Level II	231.6	564	2.5:1
UT4-R1a	10+00 - 15+18	518	Preservation	102.2	518	5:1
UT4-R1b	11+07 - 19+64	906	Restoration	849.0	858	1:1
UT4-R2	19+64 - 21+11 & 21+42 - 38+23	1,673	Restoration	1,827.0	1,828	1:1
UT4-R3	28+92 - 31+42	244	Restoration	227.0	250	1:1
UT4-R4a	10+00 - 13+96	395	Restoration	395.0	396	1:1
UT4-R4b	14+28 - 25+23 & 25+43 - 28+92	1,392	Restoration	1,452.0	1,444	1:1
UT4-R5a	09+44 - 13+35	386	Enhancement Level I	257.3	391	1.5:1
UT4-R5b	14+40 - 30+22	1,535	Enhancement Level I	1,023.3	1,582	1.5:1

Component Summation

Restoration Level	Stream (LF)	Riparian Wetland (AC)		Non-riparian Wetland (AC)	Buffer (SF)	Upland (AC)
		Riverine	Non-Riverine			
Restoration	8,213					
Enhancement I	1,973					
Enhancement II	564					
Preservation	518					

BMP Elements

Element		Location	Purpose/Function	Notes

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

[1] All powerline easements and cattle/vehicular crossings were excluded from the conservation easement boundary and so no credit reductions are associated with those features.

[2] The SMU credit numbers used here were taken indirectly from the mitigation plan as per DMS/IRT instruction, and vary from those presented in previous monitoring reports. Although these decimal values were not directly presented in the mitigation plan (which only used rounded, whole numbers), the spreadsheet originally created to determine those credits was used to generate these decimal values. The mitigation plan credit numbers were used here to address the differences between the anticipated credits found in the mitigation plan and the final credits reported in the baseline/as-built report, obstensibly a result of survey differences between the use of stream centerline versus thalweg values.

Table 2. Project Activity and Reporting History			
Brown Creek Tributaries Restoration Project: DMS Project No ID. 95351			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Mitigation Plan Prepared	N/A	N/A	Jan-14
Mitigation Plan Amended	N/A	N/A	Mar-14
Mitigation Plan Approved	Nov-13	N/A	Jun-14
Final Design – (at least 90% complete)	N/A	N/A	Jun-14
Construction Begins	Sep-13	N/A	Nov-14
Temporary S&E mix applied to entire project area	Jul-14	N/A	May-15
Permanent seed mix applied to entire project area	Jul-14	N/A	May-15
Planting of live stakes	Jul-14	N/A	May-15 [1]
Planting of bare root trees	Jul-14	N/A	May-15 [1]
End of Construction	Jul-14	N/A	May-15
Survey of As-built conditions (Year 0 Monitoring-baseline)	Jul-14	Jul-15	Jul-15
Baseline Monitoring Report	Feb-15	Jul-15	Nov-16 [2]
Year 1 Monitoring	Dec-15	Feb-16 [3]	Jan-17
Year 2 Monitoring	Dec-16	Nov-16	Jan-17
Year 3 Monitoring	Dec-17	Nov-17	Nov-17
Year 4 Monitoring	Dec-18	Oct-18	Dec-18
Year 5 Monitoring	Dec-19	N/A	N/A
Year 6 Monitoring	Dec-20	N/A	N/A
Year 7 Monitoring	Dec-21	N/A	N/A

[1] All of HC and Reaches R1, R2, and R5 for UT4 were planted in March, while Reaches R3 and R4 were planted in mid-May for UT4.

[2] As-built / Baseline Report submission was delayed due to conservation easement adjustment issues.

[3] Veg plot monitoring was conducted in Nov 2015, while survey data was collected in Feb 2016 to ensure 180 days between the As-Built and MY1 surveys.

Table 3. Project Contacts Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351	
Designer	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 Contact: Scott King, Tel. 919-481-5731
Construction Contractor	
River Works, Inc.	114 W. Main St. Clayton, NC 27520 Contact: Bill Wright, Tel. 919-582-3574
Planting Contractor	
River Works, Inc.	114 W. Main St. Clayton, NC 27520 Contact: George Morris, Tel. 919-582-3574
Seeding Contractor	
River Works, Inc.	114 W. Main St. Clayton, NC 27520 Contact: George Morris, Tel. 919-582-3574
Seed Mix Sources Nursery Stock Suppliers	Green Resources, Tel. 336-855-6363 Mellow Marsh Farm, 919-742-1200 ArborGen, 843-528-3204
Monitoring Performers	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518
	Contact:
Stream Monitoring Point of Contact	Scott King, Tel. 919-481-5731
Vegetation Monitoring Point of Contact	Scott King, Tel. 919-481-5731

Table 4a. Project Attribute Information - Hurricane Creek (Pre-Construction) Brown Creek Tributaries Restoration Project Stream Mitigation Plan - DMS Project No. 95351			
Project Information			
Project Name	Brown Creek Tributaries Restoration Project – Hurricane Creek		
County	Anson		
Project Area (acres)	14.1		
Project Coordinates (latitude and longitude)	35.0498 N, -80.0665 W		
Watershed Summary Information			
Physiographic Province	Piedmont		
Geologic Unit	Triassic Basin		
River Basin	Yadkin		
USGS Hydrologic Unit 8-digit and 14-digit	03040104 / 03040104061030		
NCDWR Sub-basin	03-07-10		
Project Drainage Area (acres)	1,383		
Project Drainage Area Percentage Impervious	2%		
CGIA / NCEEP Land Use Classification	2.01.01.01, 2.03.01, 2.99.01, 3.02 / Forest (69%) Agriculture (15%) Impervious Cover (2%)		
Stream Reach Summary Information			
Parameters	**HC-R1**	**HC-R2**	**HC-R3**
Length of Reach (linear feet)	1,347	1,384	546
Valley Classification (Rosgen)	VII	VII	VII
Drainage Area (acres)	1,077	1,383	119
NCDWR Stream Identification Score	26.5	31	23
NCDWR Water Resources Classification	Class C		
Morphological Description (Rosgen stream type)	Incised E	Incised E	G/Incised Bc
Evolutionary Trend	Incised	Incised E→G→F	Incised B → G → F
Underlying Mapped Soils	ChA	ChA	CrB
Drainage Class	Somewhat poorly drained	Somewhat poorly drained	Moderately well drained
Soil Hydric Status	Hydric	Hydric	Non-Hydric
Average Channel Slope (ft/ft)	0.0035	0.0024	0.0108
FEMA Classification	Zone AE	Zone AE	Zone AE
Native Vegetation Community	Piedmont Small Stream		
Percent Composition of Exotic/Invasive Vegetation	<5%	<5%	<5%
Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes	Categorical Exclusion (Appendix B)
Waters of the United States – Section 401	Yes	Yes	Categorical Exclusion (Appendix B)
Endangered Species Act	No	N/A	Categorical Exclusion (Appendix B)
Historic Preservation Act	No	N/A	Categorical Exclusion (Appendix B)
Coastal Area Management Act (CAMA)	No	N/A	Categorical Exclusion (Appendix B)
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion (Appendix B)
Essential Fisheries Habitat	No	N/A	Categorical Exclusion (Appendix B)

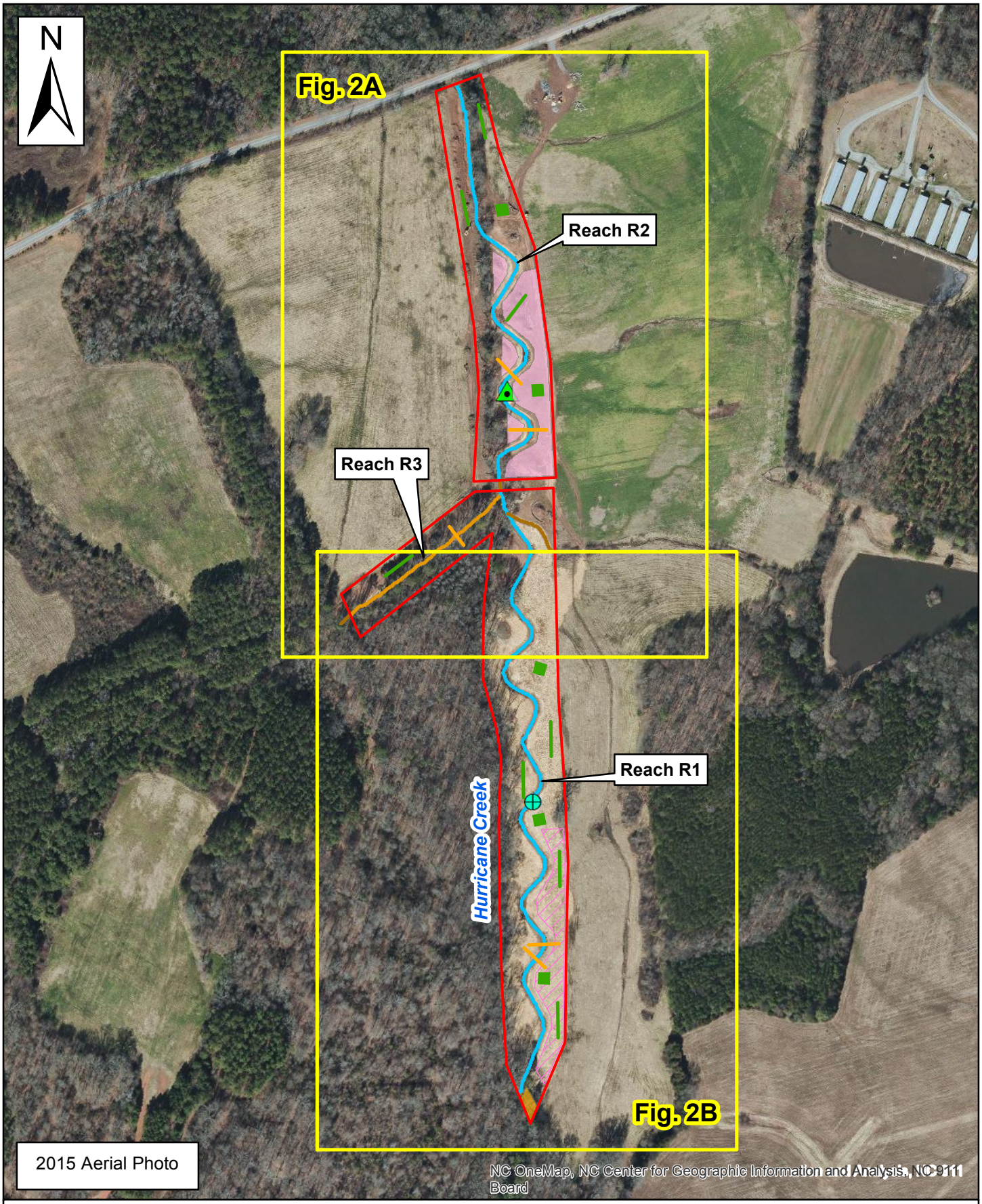
Table 4b. Project Attribute Information - UT4 (Pre-Construction)
Brown Creek Tributaries Restoration Project Stream Mitigation Plan - DMS Project No. 95351

Project Information					
Project Name	Brown Creek Tributaries Restoration Project – UT4				
County	Anson				
Project Area (acres)	29.2				
Project Coordinates (latitude and longitude)	35.0477 N, -80.0274 W				
Watershed Summary Information					
Physiographic Province	Piedmont				
River Basin	Yadkin				
USGS Hydrologic Unit 8-digit and 14-digit	03040104 / 03040104061030				
DWR Sub-basin	03-07-10				
Project Drainage Area (acres)	974				
Project Drainage Area Percent Impervious	<2%				
CGIA / NCEEP Land Use Classification	2.01.01.01, 2.03.01, 2.99.01, 3.02 / Forest (69%) Agriculture (15%) Impervious Cover (<2%)				
Stream Reach Summary Information					
Parameters	**UT4-R1**	**UT4-R2**	**UT4-R3**	**UT4-R4**	**UT4-R5**
Length of Reach (linear feet)	1,417	1,627	242	1,716	1,564
Valley Classification (Rosgen)	VII	VII	VII	VII	VII
Drainage Area (acres)	218	706	974	267	452
NCDWR Stream Identification Score	28.5	29	32	26	23.5
NCDWR Water Resources Classification	Class C				
Morphological Description (Rosgen stream type)	F/G	Incised E	G	G	Incised Bc / C
Evolutionary Trend	Incised E → Gc → F	Bc → G → F	Bc→G→F	Incised E → G → F	Incised E → G → F
Underlying Mapped Soils	ChA	ChA	ChA	ChA, MaB	ChA
Drainage Class	Somewhat poorly drained	Somewhat poorly drained	Somewhat poorly drained	Somewhat poorly drained	Moderately well drained
Soil Hydric Status	Hydric	Hydric	Hydric	Hydric	Hydric
Average Channel Slope (ft/ft)	0.0077	0.0053	0.0009	0.0073	0.0038
FEMA Classification	N/A	Zone AE	Zone AE	Zone AE	N/A
Native Vegetation Community	Piedmont Small Stream				
Percent Composition of Exotic/Invasive Vegetation	<5%	<5%	<5%	<5%	<5%

Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes	Categorical Exclusion (Appendix B)
Waters of the United States – Section 401	Yes	Yes	Categorical Exclusion (Appendix B)
Endangered Species Act	No	N/A	Categorical Exclusion (Appendix B)
Historic Preservation Act	No	N/A	Categorical Exclusion (Appendix B)
Coastal Area Management Act (CAMA)	No	N/A	Categorical Exclusion (Appendix B)
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion (Appendix B)

Appendix B

Visual Assessment Data

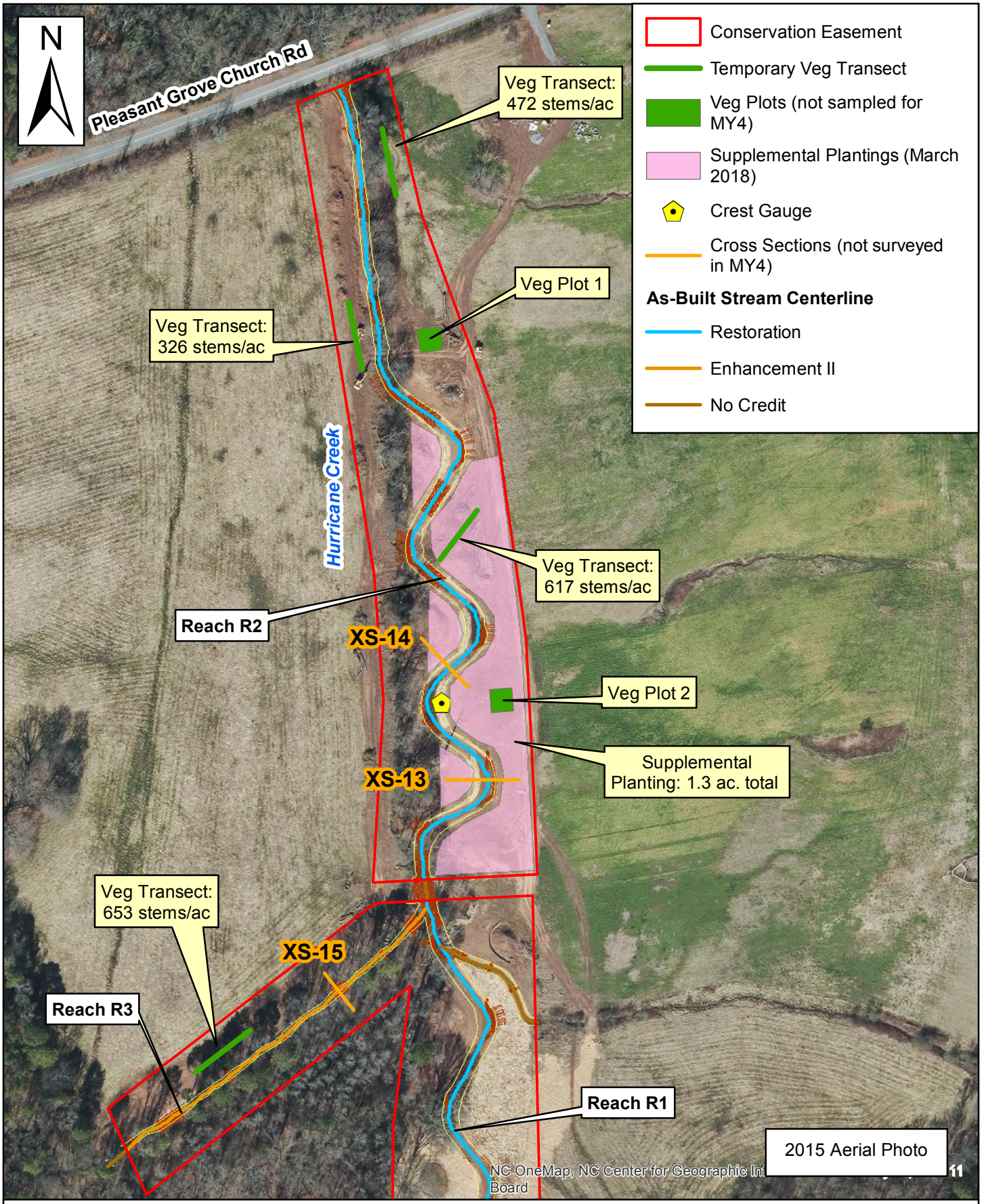


Michael Baker INTERNATIONAL

0 250 500 Feet

DMS Project #95351

Figure 2: Overview Map 1
Current Conditions Plan View
Monitoring Year 4
Hurricane Creek Site

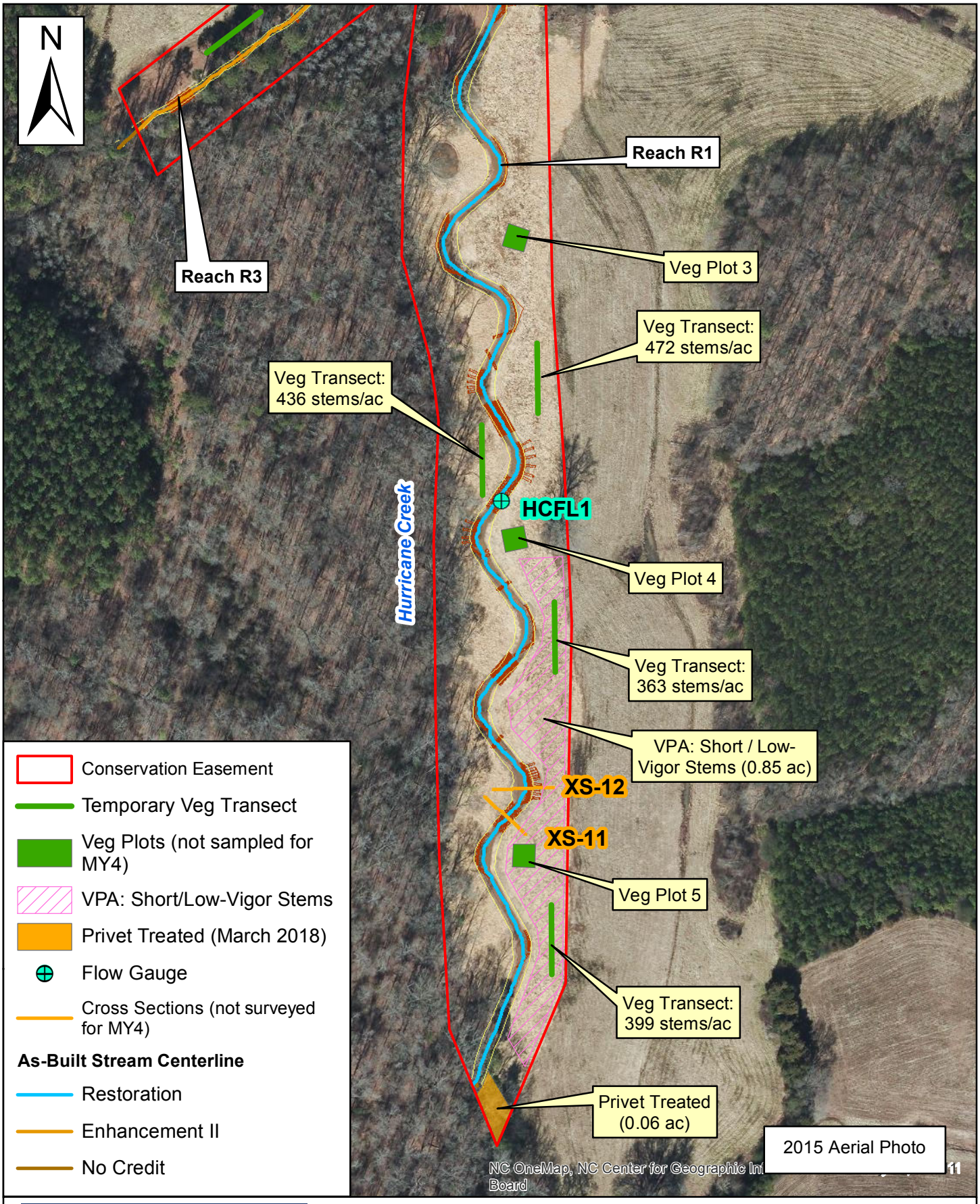


Michael Baker INTERNATIONAL

0 100 200 300 Feet

DMS Project #95351

Figure 2A
Current Conditions Plan View
Monitoring Year 4
Hurricane Creek Site

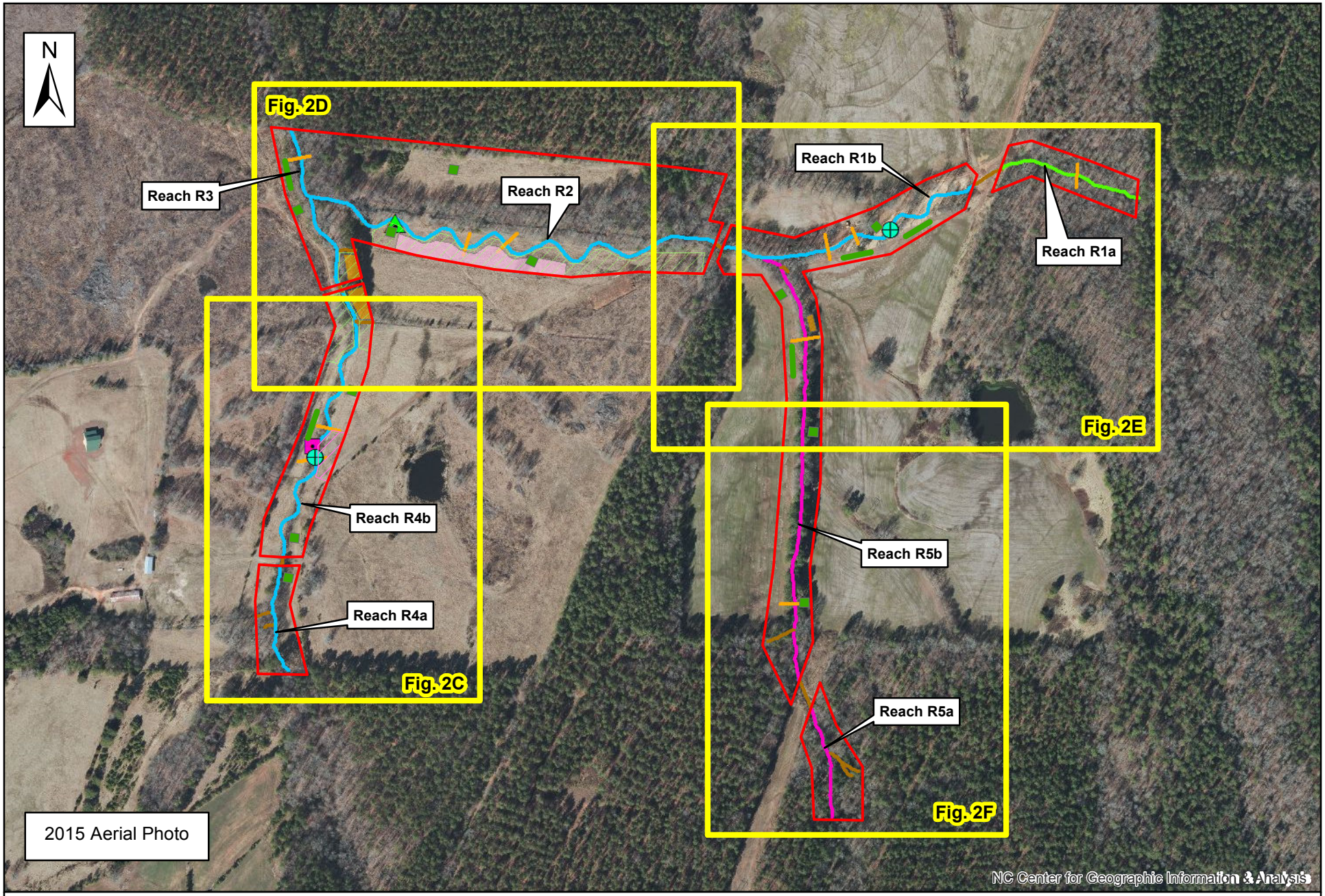


Michael Baker INTERNATIONAL

0 100 200 300 Feet

DMS Project #95351

Figure 2B
Current Conditions Plan View
Monitoring Year 4
Hurricane Creek Site

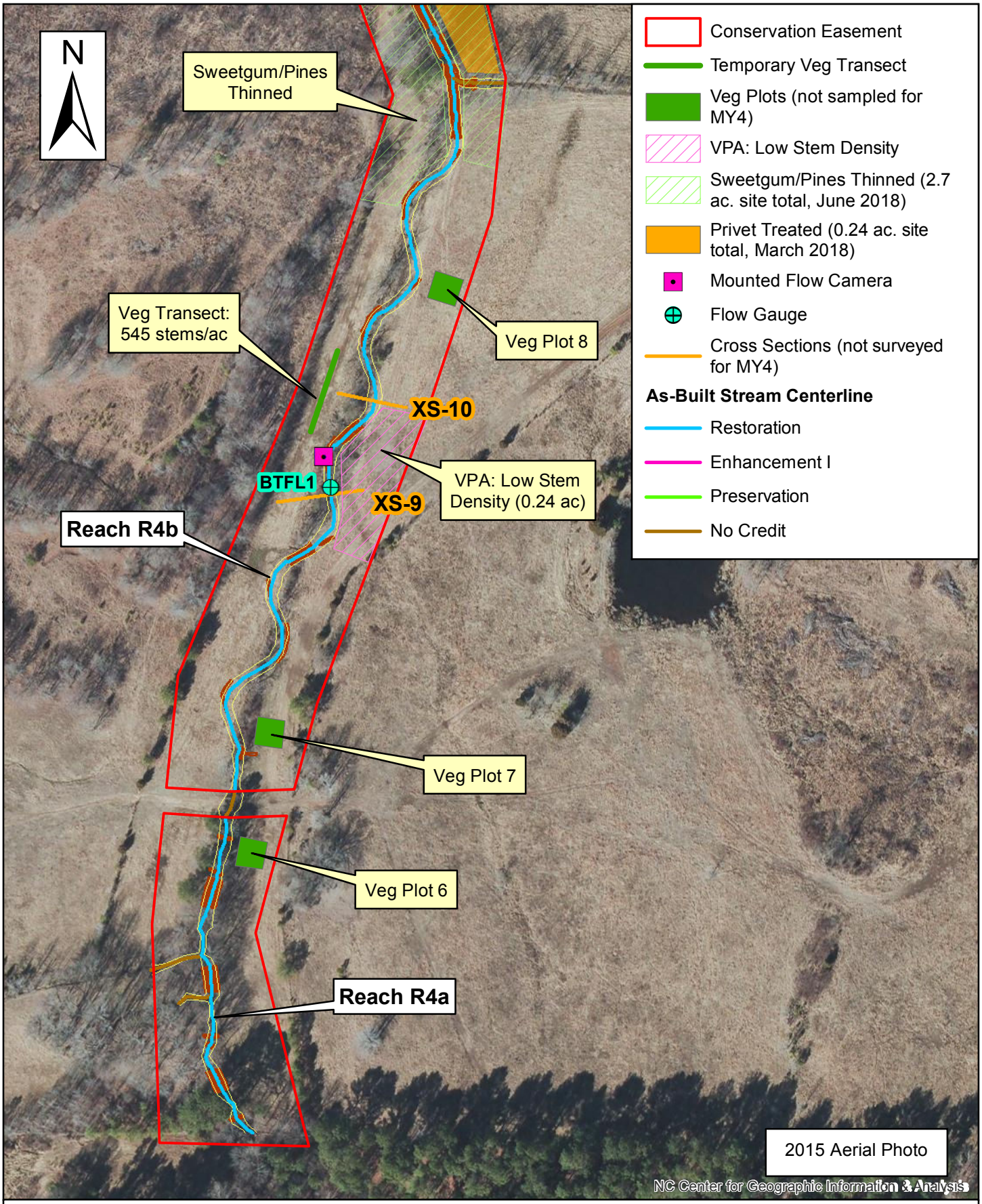


Michael Baker INTERNATIONAL

0 250 500 750 1,000 Feet

DMS Project #95351

Figure 2: Overview Map 2
Current Condition Plan View
Monitoring Year 4
Brown Creek Tribs: UT4 Site

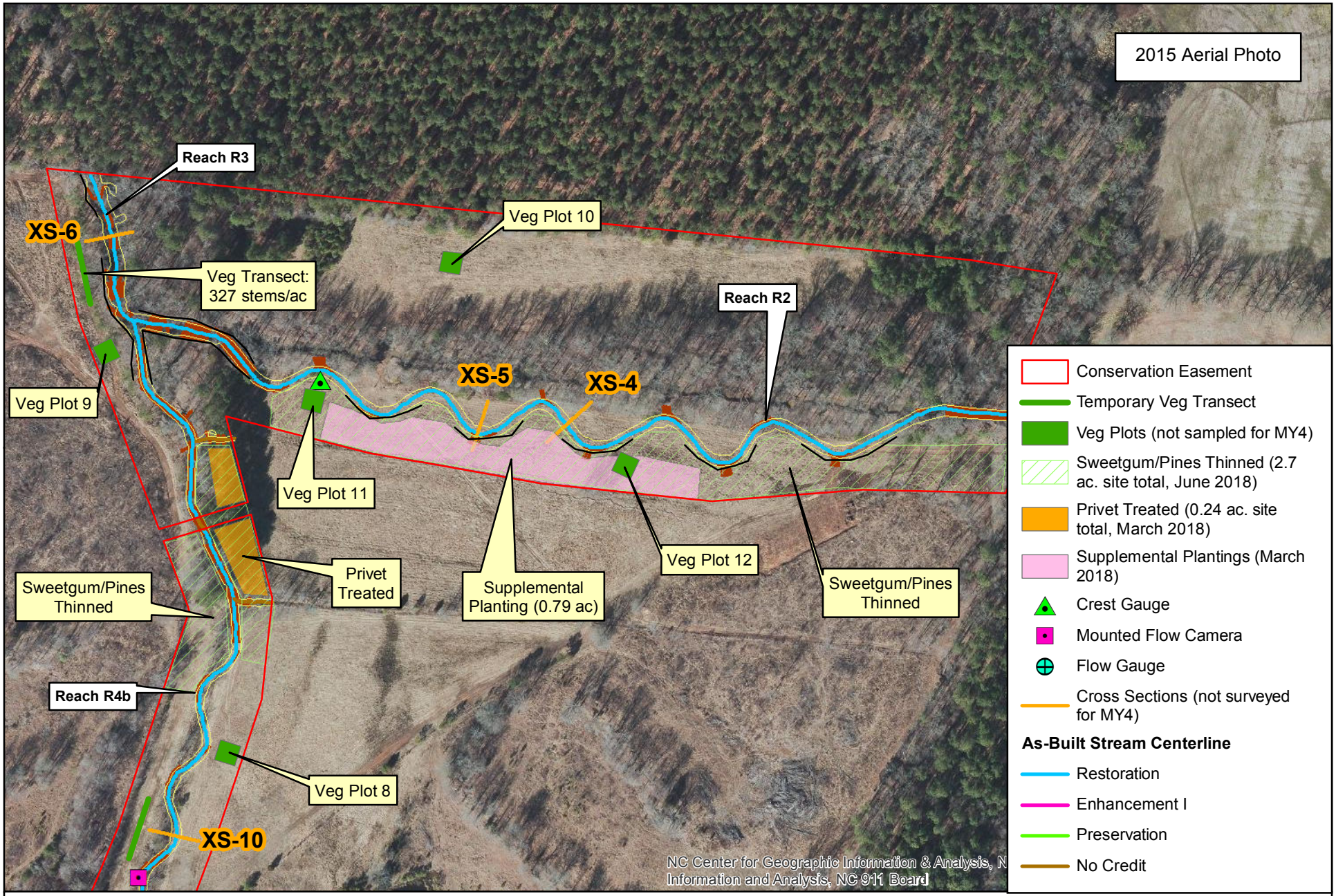


Michael Baker INTERNATIONAL

0 100 200 300 Feet

DMS Project #95351

Figure 2C
Current Condition Plan View
Monitoring Year 4
Brown Creek Tribs: UT4 Site



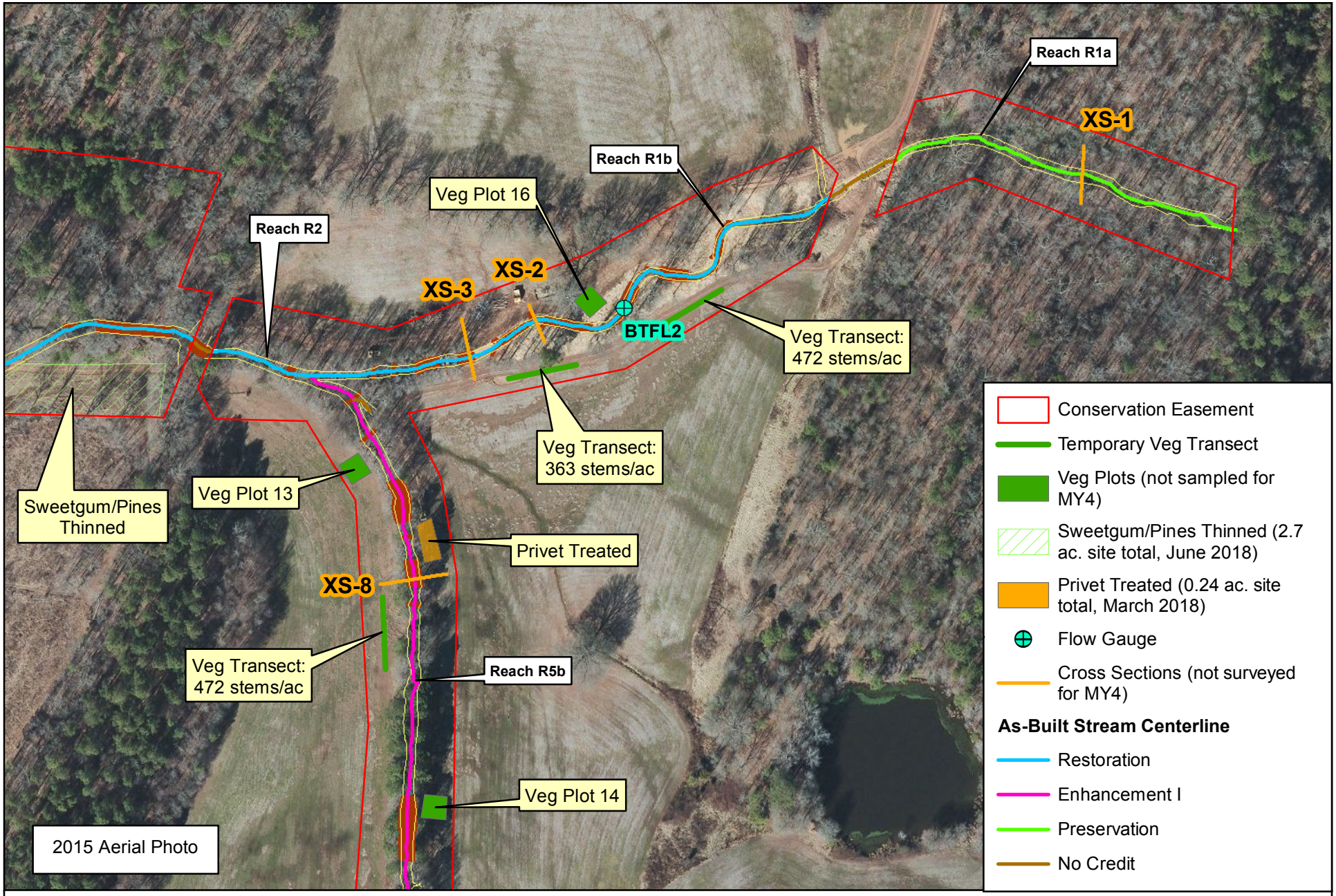
Michael Baker INTERNATIONAL

0 100 200 300 400 500 Feet

DMS Project #95351

N

Figure 2D
Current Condition Plan View
Monitoring Year 4
Brown Creek Tribs: UT4 Site



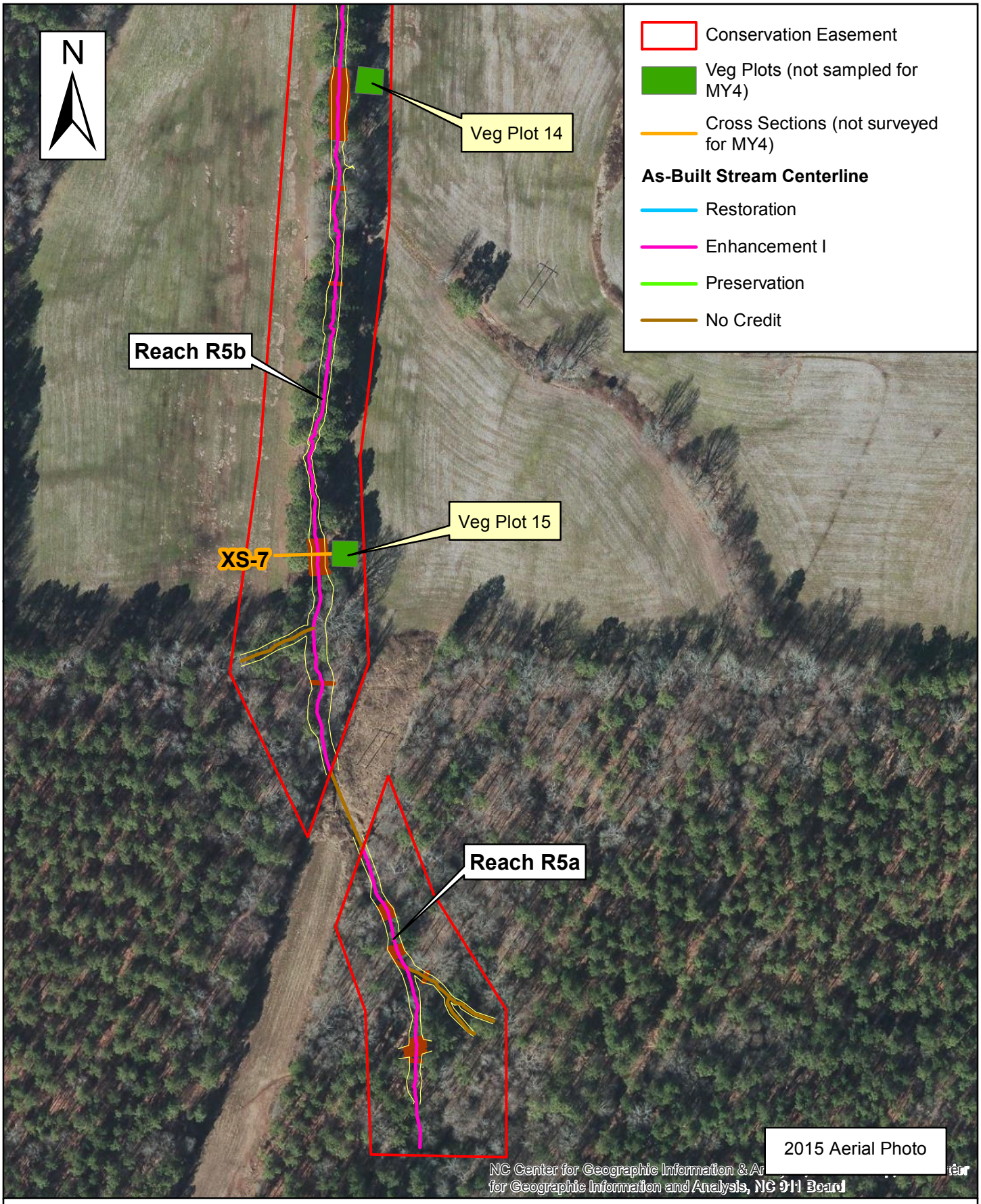
Michael Baker INTERNATIONAL

0 100 200 300 400 500 Feet

DMS Project #95351

N

Figure 2E
Current Condition Plan View
Monitoring Year 4
Brown Creek Tribs: UT4 Site



Michael Baker INTERNATIONAL

0 100 200 300 Feet

DMS Project #95351

Figure 2F
Current Condition Plan View
Monitoring Year 4
Brown Creek Tribs: UT4 Site

Table 5a. Visual Stream Morphology Stability Assessment
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Reach ID: HC-R1

Assessed Length (LF): 2,043

Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	15	15			100%			
	3. Meander Pool Condition	1. Depth	14	14			100%			
		2. Length	14	14			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	15	15			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	14	14			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	37	37			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	13	13			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	18	18			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	37	37			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	27	27			100%			

Table 5a. Visual Stream Morphology Stability Assessment
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Reach ID: HC-R2

Assessed Length (LF): 1,394

Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	10	10			100%			
	3. Meander Pool Condition	1. Depth	9	9			100%			
		2. Length	9	9			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	10	10			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	9	9			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	22	22			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	7	7			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	22	22			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	13	13			100%			

Table 5a. Visual Stream Morphology Stability Assessment
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Reach ID: HC-R3

Assessed Length (LF): 564

Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	5	5			100%			
	3. Meander Pool Condition	1. Depth	6	6			100%			
		2. Length	6	6			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	5	5			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	6	6			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	7	7			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	7	7			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	7	7			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	7	7			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	3	3			100%			

Table 5a. Visual Stream Morphology Stability Assessment
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Reach ID: UT4-R1

Assessed Length (LF): 1,376

Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	9	9			100%			
	3. Meander Pool Condition	1. Depth	10	10			100%			
		2. Length	10	10			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	9	9			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	10	10			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	18	18			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	10	10			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	12	12			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	18	18			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	9	9			100%			

Table 5a. Visual Stream Morphology Stability Assessment
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Reach ID: UT4-R2

Assessed Length (LF): 1,828

Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	15	15			100%			
	3. Meander Pool Condition	1. Depth	16	16			100%			
		2. Length	16	16			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	15	15			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	16	16			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	27	27			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	23	23			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	22	23			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	23	23			100%			

Table 5a. Visual Stream Morphology Stability Assessment
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Reach ID: UT4-R3

Assessed Length (LF): 250

Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	3	3			100%			
	3. Meander Pool Condition	1. Depth	4	4			100%			
		2. Length	4	4			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	3	3			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	4	4			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	6	6			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	3	3			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	6	6			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	3	3			100%			

Table 5a. Visual Stream Morphology Stability Assessment
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Reach ID: UT4-R4

Assessed Length (LF): 1,840

Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	22	22			100%			
	3. Meander Pool Condition	1. Depth	23	23			100%			
		2. Length	23	23			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	22	22			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	23	23			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	47	47			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	28	28			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	29	29			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	47	47			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	28	28			100%			

Table 5a. Visual Stream Morphology Stability Assessment
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Reach ID: UT4-R5

Assessed Length (LF): 1,973

Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	6	6			100%			
	3. Meander Pool Condition	1. Depth	5	5			100%			
		2. Length	5	5			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	6	6			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	5	5			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	16	16			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	15	15			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	14	14			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	16	16			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	10	10			100%			

Table 5b. Stream Problem Areas (SPAs)

Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

SPA #	Feature Issue	Reach ID, Station Number	Suspected Cause	Photo # in Problem Area Photo Log
-	N/A	N/A	N/A	N/A

Notes:

Table 6a. Vegetation Conditions Assessment
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Planted Acreage:	**33.5**					
Vegetation Category	**Definitions**	**Mapping Threshold (acres)**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Planted Acreage**
1. Bare Areas	Very limited cover both woody and herbaceous material.	0.1	N/A	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4 or 5 stem count criteria.	0.1	Fig 2C (pink hatched polygon)	1	0.24	0.7%
			Total	**1**	**0.24**	**0.7%**
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems or a size class that are obviously small given the monitoring year.	0.25	Fig 2B (pink hatched polygon)	1	0.85	2.0%
			Cumulative Total	**2**	**1.09**	**3.3%**
Easement Acreage:	**43.3**					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Easement Acreage**
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale)	1000 ft²	N/A	0	0.00	0.0%
5. Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale)	none	N/A	0	0.00	0.0%

Table 6b. Vegetation Problem Areas (VPAs)
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Feature Issue	Station Number	Area	Suspected Cause
Low stem density	UT4-R4b, Right bank, Station 18+50 to 19+75	~0.24 acres	Mortality from previous harsh growing seasons[1]
Short stems / Low vigor	HC-R1, Right bank, Station 11+00 to 18+00	~0.85 acres	Unknown[2]

Notes:

1 This small area of observed low stem density likely experienced plant mortality during the previous particularly hot and dry growing seasons. It is located in a higher and drier location on the floodplain than the more successful adjacent areas and the plants were likely more stressed as a result.

2 The true cause of the short stems / low vigor observed in the right floodplain of upper HC-R1 is unknown. Previous soil testing did not reveal any significant deficiencies, and construction did not involve benching or cutting down into subsoil in this location. This upper section of the floodplain does appear much drier than the lower sections, which get seasonally wet, and previous growing seasons have been quite hot and dry on the site. Baker speculates that the stems present simply need another growing season of adequate rainfall to catch up in height. A small application of fertilizer will be applied to this location in the spring and/or fall of 2019 to encourage growth.

Stream Station Photographs: UT4 Site

Reach UT4-R4a – View upstream, Station 11+50

Reach UT4-R4a – View downstream, Station 12+40

Reach UT4-R4a – View upstream, Station 13+20

Reach UT4-R4a – View upstream, Station 14+00

Reach UT4-R4b – View downstream, Station 14+75

Reach UT4-R4b – View downstream, Station 17+00

Stream Station Photographs: UT4 Site

Reach UT4-R4b – View upstream, Station 18+20

Reach UT4-R4b – View downstream, Station 18+90

Reach UT4-R4b – View downstream, Station 19+00

Reach UT4-R4b – View downstream, Station 21+00

Reach UT4-R4b – View upstream at Station 22+50

Reach UT4-R4b – View downstream, Station 23+25

Stream Station Photographs: UT4 Site

Reach UT4-R4b – View downstream, Station 24+00

Reach UT4-R4b – View upstream, Station 25+00

Reach UT4-R4b – View downstream, Station 25+75

Reach UT4-R4b – View upstream, Station 27+00

Reach UT4-R4b – View upstream, Station 28+00

Reach UT4-R4b – View downstream, Station 28+00

Stream Station Photographs: UT4 Site

Reach UT4-R3 – View downstream, Station 29+00

Reach UT4-R3 – View downstream, Station 29+50

Reach UT4-R3 – View downstream, Station 30+25

Reach UT4-R3 – View downstream, Station 31+00

Reach UT4-R2 – View upstream at Station 37+50

Reach UT4-R2 – View upstream, Station 37+00

Stream Station Photographs: UT4 Site

Reach UT4-R2 – View upstream, Station 35+50

Reach UT4-R2 – View downstream, Station 33+50

Reach UT4-R2 – View upstream, Station 31+50

Reach UT4-R2 – View downstream, Station 30+50

Reach UT4-R2 – View upstream at Station 29+00

Reach UT4-R2 – View upstream, Station 28+00

Stream Station Photographs: UT4 Site

Reach UT4-R2 – View upstream, Station 26+00

Reach UT4-R2 – View upstream, Station 24+50

Reach UT4-R2 – View downstream, Station 23+00

Reach UT4-R2 – View upstream, Station 23+00

Reach UT4-R2 – View downstream, Station 20+40

Reach UT4-R2 – View upstream, Station 21+00

Stream Station Photographs: UT4 Site

Reach UT4-R2 – View upstream, Station 20+00

Reach UT4-R5b – View upstream, Station 29+00

Reach UT4-R5b – View upstream, Station 28+25

Reach UT4-R5b – View downstream, Station 26+40

Reach UT4-R5b – View upstream, Station 23+50

Reach UT4-R5b – View upstream, Station 20+75

Stream Station Photographs: UT4 Site

Reach UT4-R5b – View upstream, Station 17+50

Reach UT4-R5b – View upstream, Station 15+50

Reach UT4-R5a – View upstream, Station 12+75

Reach UT4-R5a – View upstream, Station 12+00

Reach UT4-R5a – View of side tributary at Station 11+75

Reach UT4-R5a – View upstream, Station 11+50

Stream Station Photographs: UT4 Site

Reach UT4-R5a – View upstream, Station 10+75

Reach UT4-R1a – View upstream, Station 12+40

Reach UT4-R1a – View downstream, Station 12+40

Reach UT4-R1b – View downstream, Station 11+25

Reach UT4-R1b – View downstream, Station 12+75

Reach UT4-R1b – View downstream, Station 13+25

Stream Station Photographs: UT4 Site

Reach UT4-R1b – View upstream, Station 14+25

Reach UT4-R1b – View downstream, Station 15+25

Reach UT4-R1b – View downstream, Station 17+50

Reach UT4-R1b – View upstream, Station 19+00

Stream Station Photographs: Hurricane Creek Site

HC Reach 1, view downstream at Station 10+00

HC Reach 1, view downstream at Station 11+80

HC Reach 1, view downstream at Station 14+50

HC Reach 1, view upstream at Station 17+50

HC Reach 1, view downstream at Station 18+00

HC Reach 1, view upstream at Station 19+25

Stream Station Photographs: Hurricane Creek Site

HC Reach 1, view downstream at Station 19+75

HC Reach 1, view upstream at Station 22+40

HC Reach 1, view downstream at Station 24+00

HC Reach 1, vernal pool at Station 26+25

HC Reach 1, view downstream at Station 29+30

HC Reach 2, view upstream at Station 31+40

Stream Station Photographs: Hurricane Creek Site

HC Reach 2, view upstream at Station 32+75

HC Reach 2, view downstream at Station 33+00

HC Reach 2, view upstream at Station 35+70

HC Reach 2, view downstream at Station 36+00

HC Reach 2, view downstream at Station 39+10

HC Reach 2, view downstream at Station 40+75

Stream Station Photographs: Hurricane Creek Site

HC Reach 2, view upstream at Station 43+75

HC Reach 2, view downstream at Station 44+25

HC Reach 3, view upstream at Station 11+40

HC Reach 3, view downstream at Station 14+00

HC Reach 3, view downstream at Station 15+50

HC Reach 3, view upstream at Station 15+90

Monitoring Gauge Photographs

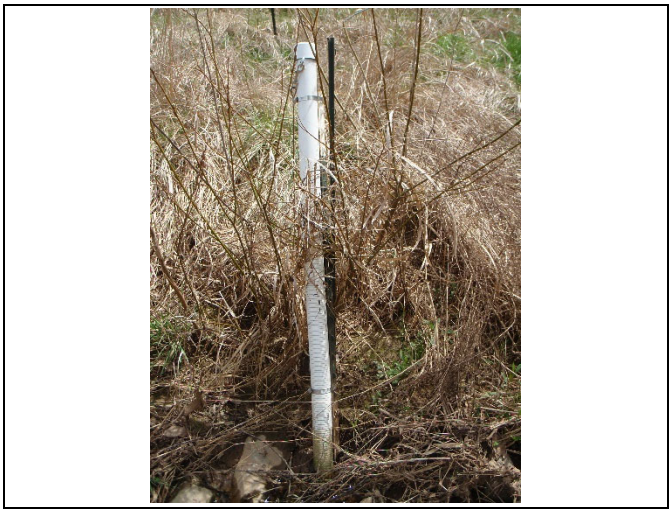
Reach HC-R2: Crest Gauge at Station 31+75

Reach HC-R2: Overbank Event of 0.67' (from Hurricane Florence, photo from 10/3/2018)

Reach HC-R1: Evidence of overbank flooding (wrack lines and debris in floodplain)

Reach HC-R1: Wrack lines and debris in floodplain

Reach HC-R2: Wrack lines and debris in floodplain



Reach UT4-R1: Flow Gauge at Station 19+80

Monitoring Gauge Photographs

Reach UT4-R2: Crest gauge at Station 34+90

Reach UT4-R2: Overbank events of 2.26’ and 0.68’ (photo from 10/15/18)

Reach UT4-R2: Overbank event of 2.26’ (from Hurricane Florence on Sept. 15-17, 2018)

Reach UT4-R2: Overbank event of 0.68’ (from Hurricane Michael on 10/11/18)

Reach UT4-R1b: Wrack lines and debris in floodplain

Reach UT4-R2: Wrack lines and debris in floodplain

Monitoring Gauge Photographs

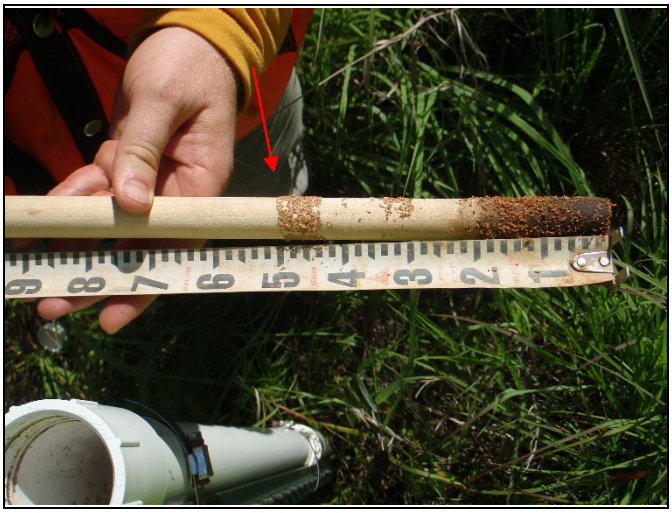
Reach UT4-R2: Fish found in floodplain

Reach UT4-R4a: Debris along fence at crossing

Reach UT4-R5b: Wrack lines and debris in floodplain

Reach UT4-R1b: Flow gauge at Station 14+90

Reach UT4-R4b: Flow gauge at Station 18+90



Reach UT4-R2 Crest Gauge: Overbank event of 0.50 ft recorded from 6/3/2018

Stream Flow Camera Photographs

Reach UT4-R4b: 01/15/18

Reach UT4-R4b: 02/02/18

Reach UT4-R4b: 03/02/18

Reach UT4-R4b: 03/21/18

Reach UT4-R4b: 03/25/18

Reach UT4-R4b: 03/27/18

Vegetation Problem Area Treatment Photographs

Reach HC-R1: Privet cut/sprayed, right floodplain at Station 10+00 (March 2018)

Reach HC-R1: Privet cut/sprayed, right floodplain at Station 10+00 (March 2018)

Reach HC-R1: Privet cut/sprayed, right floodplain at Station 10+00 (March 2018)

Reach HC-R1: Dead privet, Station 10+00 (Oct. 2018)

Reach HC-R1: Dead privet, Station 10+00 (Oct. 2018)

Reach UT4-R5b: Privet that was cut/sprayed (March 2018)

Previous Stream Repair Photographs (from repairs completed in March 2017)

Reach UT4-R4b: Stream bank repair, Station 23+30 (post-repair in March 2017)

Reach UT4-R2: Stream bank repair, Station 31+75 (post-repair in March 2017)

Reach UT4-R4b, Stream bank repair in March 2018

Reach UT4-R2, Stream bank repair in March 2018

Reach UT4-R4b, Stream bank repair in Oct. 2018

Reach UT4-R2, Stream bank repair in Oct. 2018

Michael Baker
INTERNATIONAL

Memo Regarding Brown Creek Tributaries Post Credit Release Meeting IRT Field Meeting

Yadkin 03040104061030
DMS ID: 95351
USACE Action ID: SAW-2012-011108
NCDWR# 14-0345

Memo Date: 5/3/18

Meeting Held: 5/2/18 from 10:00 A.M. to ~1:00 P.M.

This memo and all responses will serve as a record of field discussions including concerns, recommendations for maintenance activities and credit release decisions.

Attendees: Kim Browning (Corps of Engineers), Paul Wiesner, Matthew Reid (DMS), Mac Haupt (DWR), Olivia Munzer (WRC), and Jake Byers (Baker).

The following provides a summary of discussions and conclusions reached by the group.

The group met at the entrance to the site off Pleasant Grove Church Road in Wadesboro, NC in Anson County. A general site overview and map orientation was provided. The group then walked along the channel of UT4 Reach 4. The group stopped at various channel locations and inspected vegetation, flow gauges, and repair areas. It was noted that there was vegetation growing in the channel. Jake and Paul explained that this site is located with the Slate Belt and it was very common for streams of even large drainage areas (>1000 acres) to dry up during the hot summer months. Discussions were held regarding flow gauge datums but more as a general discussion and thoughts on standardizing a methodology. The group walked this reach down to the end and inspected UT4 Reach 3. IRT members questioned a restoration approach here and Jake explained that the approach was included in the approved mitigation plan and was designed to make a stable transition to the stream off-site and to try and save as many mature trees along the banks as possible. The group then made their way up UT4 Reach R2. The group inspected the grade control log jam structure that was installed to step down R2 to make a stable confluence with R3. Olivia said she was concerned about aquatic passage. A bit further up this reach, fish were noted in a pool. The grouped stopped a few hundred feet up this reach and discussed the presence of sweet gums in this areas and pines along lower Reach R4b. The group continued up R2 inspecting repair areas, vegetation, and channel condition. IRT members noted the large size of stone that was used in a repair along a riffle in this section. Jake agreed that the stone was too large but was hopeful that overtime, some voids would fill with finer material and create a more natural looking channel condition. The group made their way to the top of R2 and then walked part of the preservation reach R1a. Little was noted in these areas. The group then walked across the field and inspected a few hundred feet of R5b. Paul and Jake mentioned that the remainder of the reach is essentially in the same condition. Mac noted that the trees along this reach appeared to be larger and healthier. The group then walked back to the vehicles and drove to the downstream end of Hurricane Creek. The group

walked along the left bank of Hurricane Creek Reach 2. Jake told IRT members that this section stays impounded due to the beavers within the adjacent Pee-Dee National Wildlife Refuge. Members noted some areas along the lower portion of this reach in the left buffer appeared to have a low stem density. Jake pointed out some areas that had recently been replanted throughout this reach. Jake also noted that during the previous monitoring year and moving forward, random vegetation transects will be taken. The group proceeded up to Reach R3 and inspected this Enhancement Level II reach with little discussion. This ended the inspection of the site and a summary discussion was held. Below are the notes from this summary.

Kim Browning:

- Noted that some areas of planted vegetation looked sparse and we should keep an eye on it.
- Suggested treating/removing sweet gums and pines along UT4 Reaches R4 and R2.
    - Jake agreed to both suggestions and would plan a treatment regimen for this monitoring year and would supplementally plant as needed based on results from this year's monitoring data.

Mac Haupt:

- Had essentially the same comments as Kim.
- Stated that he agreed that there wasn't anything that could be done about the off-site beavers.

Paul Wiesner:

- Asked Baker to include a brief methodology and the results from any random transects with future monitoring reports.

All agreed to release the full amount of credit requested for this year.

Please let me know if you feel any of the above information is not presented as discussed in the field.

Sincerely,

Jake Byers, PE

Appendix C

Vegetation Plot Data*

***No vegetation plot monitoring was required for Year 4.**

Appendix D

Stream Assessment Data*

***No cross-section stream survey monitoring was required for Year 4.**

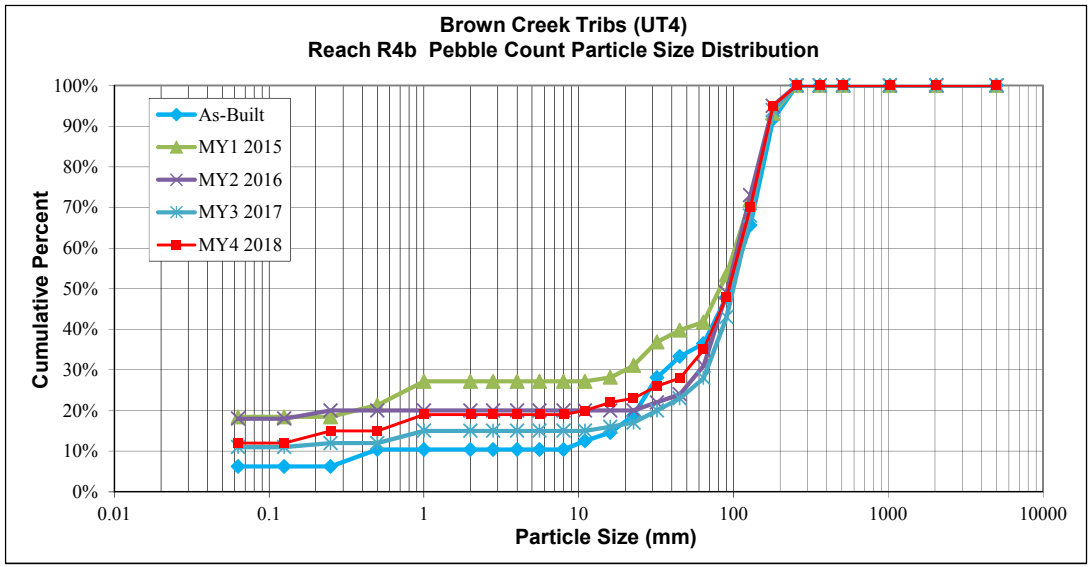
Figure 4.
Pebble Count - Monitoring Year 4
Brown Creek Tribs Mitigation Project, DMS# 95351

SITE OR PROJECT:	Brown Creek Tribs (UT4)
REACH/LOCATION:	Reach R4b (Station 19+25)
FEATURE:	Rock Riffle
DATE:	15-Oct-18

			MY4 2018			Distribution
MATERIAL	**PARTICLE**	**SIZE (mm)**	**Total**	**Class %**	**% Cum**	**Plot Size (mm)**
Silt/Clay	Silt / Clay	< .063	12	12%	12%	0.063
Sand	Very Fine	.063 - .125			12%	0.125
	Fine	.125 - .25	3	3%	15%	0.25
	Medium	.25 - .50			15%	0.50
	Coarse	.50 - 1.0	4	4%	19%	1.0
	Very Coarse	1.0 - 2.0			19%	2.0
Gravel	Very Fine	2.0 - 2.8			19%	2.8
	Very Fine	2.8 - 4.0			19%	4.0
	Fine	4.0 - 5.6			19%	5.6
	Fine	5.6 - 8.0			19%	8.0
	Medium	8.0 - 11.0	1	1%	20%	11.0
	Medium	11.0 - 16.0	2	2%	22%	16.0
	Coarse	16 - 22.6	1	1%	23%	22.6
	Coarse	22.6 - 32	3	3%	26%	32
	Very Coarse	32 - 45	2	2%	28%	45
	Very Coarse	45 - 64	7	7%	35%	64
Cobble	Small	64 - 90	13	13%	48%	90
	Small	90 - 128	22	22%	70%	128
	Large	128 - 180	25	25%	95%	180
	Large	180 - 256	5	5%	100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			100	100%		

Largest particle= 256

Summary Data			
Channel materials			
D16 =	0.6	D84 =	154.9
D35 =	64.0	D95 =	180.0
D50 =	92.9	D100 =	180 - 256



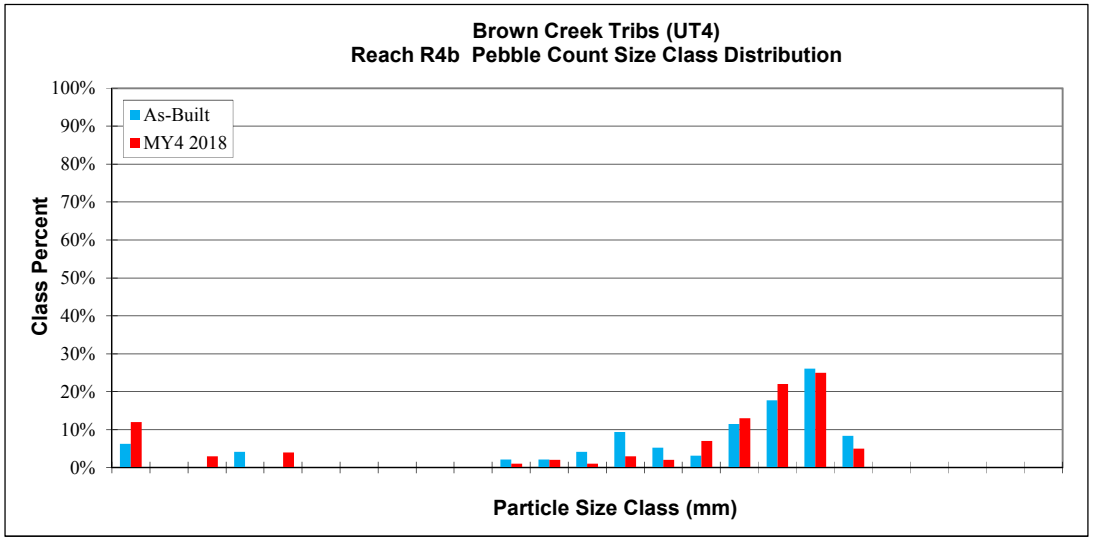


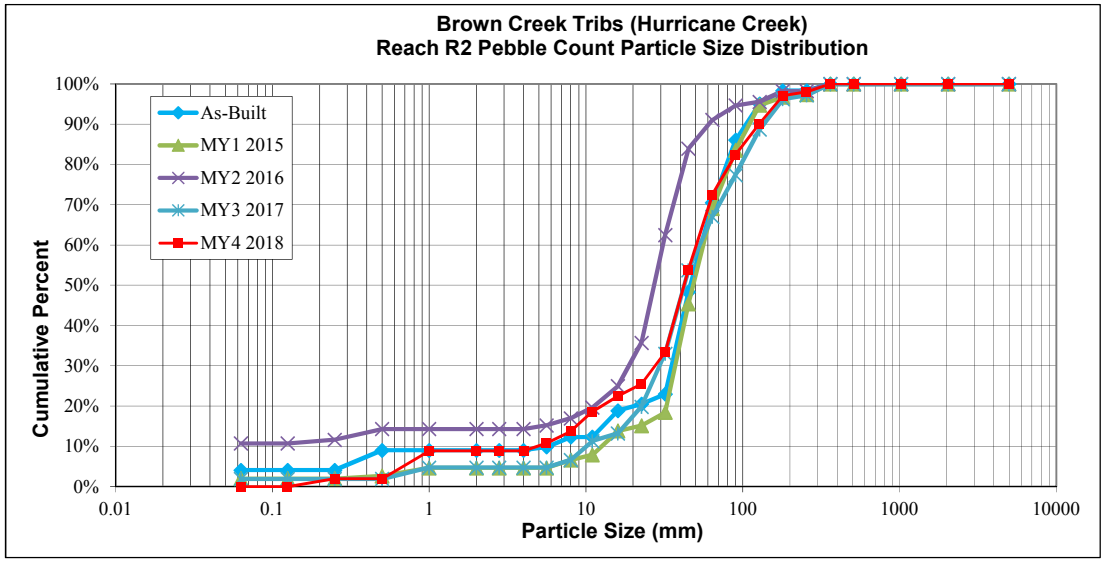
Figure 4.
Pebble Count - Monitoring Year 4
Brown Creek Tribs Mitigation Project, DMS# 95351

SITE OR PROJECT:	Brown Creek Tribs (Hurricane Creek)
REACH/LOCATION:	Reach R2 (Station 38+00)
FEATURE:	Rock Riffle
DATE:	3-Oct-18

			MY4 2018			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25	2	2%	2%	0.25
	Medium	.25 - .50			2%	0.50
	Coarse	.50 - 1.0	7	7%	9%	1.0
	Very Coarse	1.0 - 2.0			9%	2.0
Gravel	Very Fine	2.0 - 2.8			9%	2.8
	Very Fine	2.8 - 4.0			9%	4.0
	Fine	4.0 - 5.6	2	2%	11%	5.6
	Fine	5.6 - 8.0	3	3%	14%	8.0
	Medium	8.0 - 11.0	5	5%	19%	11.0
	Medium	11.0 - 16.0	4	4%	23%	16.0
	Coarse	16 - 22.6	3	3%	25%	22.6
	Coarse	22.6 - 32	8	8%	33%	32
	Very Coarse	32 - 45	21	21%	54%	45
	Very Coarse	45 - 64	19	19%	73%	64
Cobble	Small	64 - 90	10	10%	82%	90
	Small	90 - 128	8	8%	90%	128
	Large	128 - 180	7	7%	97%	180
	Large	180 - 256	1	1%	98%	256
Boulder	Small	256 - 362	2	2%	100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			102	100%		

Largest particle= 256

Summary Data			
Channel materials			
D16 =	9.3	D84 =	96.9
D35 =	32.9	D95 =	162.5
D50 =	42.2	D100 =	256 - 362



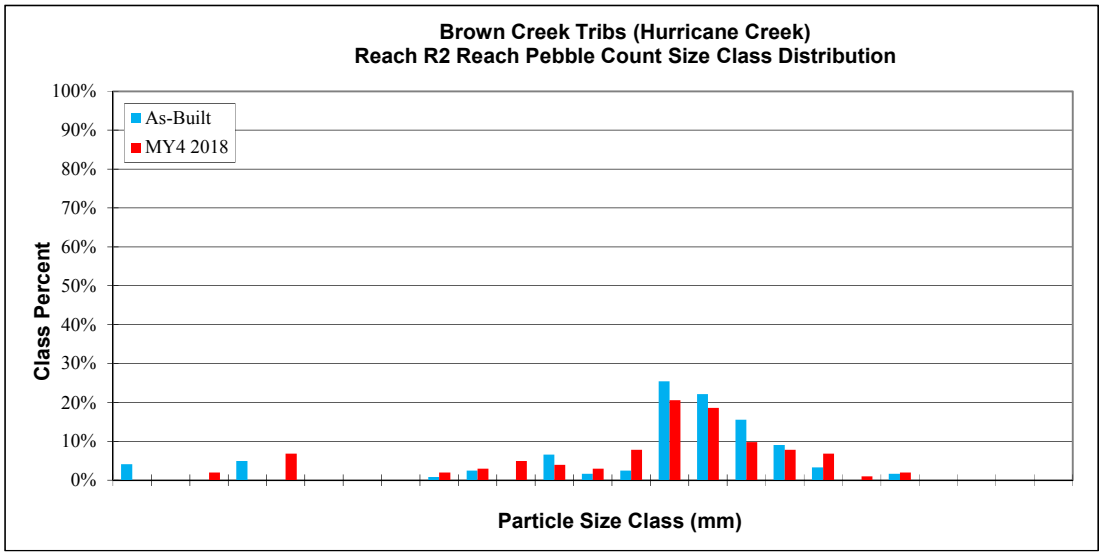


Table 10. Baseline Stream Summary
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351
Hurricane Creek (Reach 1) Length 2,043 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition[1]						Reference Reach(es) Data[3] Richland Creek (Moore County)						Design[4]						As-built					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																												
BF Width (ft)	-----	14.8	14.9	-----	-----	-----	-----	13.5	-----	-----	16.2	-----	-----	16.7	-----	-----	-----	19.1	-----	-----	-----	-----	-----	18.9	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	-----	-----	-----	106.0	-----	-----	50.0	-----	-----	53.0	-----	-----	45.0	-----	-----	79.0	-----	-----	-----	71.2	-----	-----	-----	-----
BF Mean Depth (ft)	-----	1.3	1.8	-----	-----	-----	-----	2.2	-----	-----	0.9	-----	-----	0.9	-----	-----	-----	1.5	-----	-----	-----	-----	-----	1.6	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	2.8	-----	-----	1.4	-----	-----	1.5	-----	-----	-----	1.8	-----	-----	-----	-----	-----	2.5	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	22.5	30.5	-----	-----	-----	-----	30.0	-----	-----	15.0	-----	-----	15.5	-----	-----	-----	28.0	-----	-----	-----	-----	-----	30.4	-----	-----	-----	-----
Width/Depth Ratio	-----	-----	-----	-----	-----	-----	-----	6.0	-----	-----	18.0	-----	-----	18.6	-----	-----	-----	13.0	-----	-----	-----	-----	-----	11.8	-----	-----	-----	-----
Entrenchment Ratio	-----	-----	-----	-----	-----	-----	-----	7.9	-----	-----	3.0	-----	-----	3.3	-----	-----	-----	>2.2	-----	-----	-----	-----	-----	3.8	-----	-----	-----	-----
Bank Height Ratio	-----	-----	-----	-----	-----	-----	-----	1.7	-----	-----	1.6	-----	-----	1.7	-----	-----	-----	1.0	-----	-----	-----	-----	-----	1.0	-----	-----	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	-----	-----	0.6	-----	-----	-----	45.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.9	-----	-----	-----	-----
Pattern																												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	69	-----	-----	140	-----	-----	-----	93.0	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14.3	-----	-----	26.1	-----	-----	39.0	-----	-----	55.0	-----	-----	-----	55.0	-----	-----	-----	-----
Rc / Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5.5	-----	-----	5.7	-----	-----	2.0	-----	-----	3.0	-----	-----	-----	2.9	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	90	-----	-----	94	-----	-----	130.0	-----	-----	230.0	-----	-----	-----	227.0	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.5	-----	-----	2.4	-----	-----	3.5	-----	-----	6.5	-----	-----	-----	4.9	-----	-----	-----	-----
Profile																												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	48.0	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.013	-----	-----	0.0413	-----	-----	-----	0.0170	-----	-----	-----	-----	-----	0.0102	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool to Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	37.3	-----	-----	95.8	-----	-----	80.0	-----	-----	138.0	-----	-----	-----	133.0	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.3	-----	-----	2.5	-----	-----	-----	3.0	-----	-----	-----	-----	-----	4.0	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
[2] d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----			0.13 / 0.33 / 0.6 / 4.5 / 14.1						6.0 / NP,/ 45.0 / 125.0 / NP				-----	-----	-----	-----	-----	-----						
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters																												
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	1.68	-----	-----	-----	-----	-----	1.00	-----	-----	-----	-----	-----	1.68	-----	-----	-----	-----	-----	1.68	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	-----	-----	E	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----	-----	E5/C5	-----	-----	-----	-----	-----	C5	-----	-----
BF Velocity (fps)	-----	2.9	3.9	-----	-----	-----	-----	4.3	-----	-----	-----	-----	-----	N/P	-----	-----	-----	3.9	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	87.4	129.5	194.3	-----	-----	-----	129.5	-----	-----	-----	-----	-----	N/P	-----	-----	-----	110	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1745.5	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	-----	-----	1896	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2043.0	-----	-----
Sinuosity	-----	-----	-----	-----	-----	-----	-----	1.07	-----	-----	-----	-----	-----	1.20	-----	-----	-----	1.2	-----	-----	-----	-----	-----	-----	-----	1.2	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0023	-----	-----	-----	0.0136	-----	-----	-----	-----	-----	0.0120	-----	-----	-----	-----	-----	0.0029	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0025	-----	-----	-----	0.0133	-----	-----	-----	-----	-----	0.0023	-----	-----	-----	-----	-----	0.0034	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

[1] Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively
[2] Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring
[3] Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design
[4] Values were chosen based on previous sand-bed reference reach data and past project evaluations

Table 10. Baseline Stream Summary (continued)
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351
Hurricane Creek (Reach 2) Length 1,394 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition[1]						Reference Reach(es) Data[3] Richland Creek (Moore County)						Design[4]						As-built					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																												
BF Width (ft)	-----	14.8	14.9	-----	-----	-----	-----	16.0	-----	-----	16.2	-----	-----	16.7	-----	-----	-----	20.1	-----	-----	-----	-----	-----	22.5	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	-----	-----	-----	162.0	-----	-----	50.0	-----	-----	53.0	-----	-----	49.0	-----	-----	85.0	-----	-----	-----	69.0	-----	-----	-----	-----
BF Mean Depth (ft)	-----	1.3	1.8	-----	-----	-----	-----	2.2	-----	-----	0.9	-----	-----	0.9	-----	-----	-----	1.6	-----	-----	-----	-----	-----	1.4	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	3.5	-----	-----	1.4	-----	-----	1.5	-----	-----	-----	2.0	-----	-----	-----	-----	-----	2.3	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	22.5	30.5	-----	-----	-----	-----	34.6	-----	-----	15.0	-----	-----	15.5	-----	-----	-----	31.0	-----	-----	-----	-----	-----	31.6	-----	-----	-----	-----
Width/Depth Ratio	-----	-----	-----	-----	-----	-----	-----	7.4	-----	-----	18.0	-----	-----	18.6	-----	-----	-----	13.0	-----	-----	-----	-----	-----	16.1	-----	-----	-----	-----
Entrenchment Ratio	-----	-----	-----	-----	-----	-----	-----	10.1	-----	-----	3.0	-----	-----	3.3	-----	-----	-----	>2.2	-----	-----	-----	-----	-----	3.1	-----	-----	-----	-----
Bank Height Ratio	-----	-----	-----	-----	-----	-----	-----	1.3	-----	-----	1.6	-----	-----	1.7	-----	-----	-----	1.0	-----	-----	-----	-----	-----	1.0	-----	-----	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	-----	-----	0.3	-----	-----	-----	45.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.9	-----	-----	-----	-----
Pattern																												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	74	-----	-----	150	-----	-----	-----	100.0	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14.3	-----	-----	26.1	-----	-----	40.0	-----	-----	60.0	-----	-----	-----	55.0	-----	-----	-----	-----
Rc / Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5.5	-----	-----	5.7	-----	-----	2.0	-----	-----	3.0	-----	-----	-----	2.4	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	90	-----	-----	94	-----	-----	140.0	-----	-----	250.0	-----	-----	-----	230.0	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.5	-----	-----	2.4	-----	-----	3.5	-----	-----	6.5	-----	-----	-----	4.4	-----	-----	-----	-----
Profile																												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	54.0	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.013	-----	-----	0.0413	-----	-----	-----	0.0170	-----	-----	-----	-----	-----	0.0080	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool to Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	37.3	-----	-----	95.8	-----	-----	85.0	-----	-----	149.0	-----	-----	-----	149.0	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.3	-----	-----	2.5	-----	-----	-----	3.2	-----	-----	-----	-----	-----	2.9	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
[2] d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----			0.11 / 0.23 / 0.3 / 1.4 / 4.0						6.0 / NP,/ 45.0 / 125.0 / NP				-----	-----	-----	-----	-----	-----			13.6 / 37.6 / 46.2 / 86.0 / 127.6			
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters																												
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	2.16	-----	-----	-----	-----	-----	1.00	-----	-----	-----	-----	-----	2.16	-----	-----	-----	-----	-----	2.16	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	-----	-----	E	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----	-----	E5/C5	-----	-----	-----	-----	-----	C5	-----	-----
BF Velocity (fps)	-----	2.9	3.9	-----	-----	-----	-----	4.4	-----	-----	-----	-----	-----	N/P	-----	-----	-----	4.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	87.4	129.5	194.3	-----	-----	-----	155.0	-----	-----	-----	-----	-----	N/P	-----	-----	-----	130	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1159.0	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	-----	-----	1288	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1393.0	-----	-----
Sinuosity	-----	-----	-----	-----	-----	-----	-----	1.07	-----	-----	-----	-----	-----	1.20	-----	-----	-----	1.2	-----	-----	-----	-----	-----	-----	-----	1.2	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0023	-----	-----	-----	0.0136	-----	-----	-----	-----	-----	0.0120	-----	-----	-----	-----	-----	0.0029	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0025	-----	-----	-----	0.0133	-----	-----	-----	-----	-----	0.0023	-----	-----	-----	-----	-----	0.0034	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

[1] Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively
[2] Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring
[3] Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design
[4] Values were chosen based on previous sand-bed reference reach data and past project evaluations

Table 10. Baseline Stream Summary (continued)
Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351
Hurricane Creek (Reach 3) Length 564 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition[1]						Reference Reach(es) Data[3] Richland Creek (Moore County)						Design[4]						As-built					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																												
BF Width (ft)	-----	16.6	16.6	-----	-----	-----	-----	5.7	-----	-----	16.2	-----	-----	16.7	-----	-----	-----	9.1	-----	-----	-----	-----	-----	5.9	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	-----	-----	-----	9.1	-----	-----	50.0	-----	-----	53.0	-----	-----	21.0	-----	-----	36.0	-----	-----	-----	10.0	-----	-----	-----	-----
BF Mean Depth (ft)	-----	1.4	1.9	-----	-----	-----	-----	1.0	-----	-----	0.9	-----	-----	0.9	-----	-----	-----	0.8	-----	-----	-----	-----	-----	0.8	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	1.2	-----	-----	1.4	-----	-----	1.5	-----	-----	-----	1.0	-----	-----	-----	-----	-----	1.3	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	26.8	36.2	-----	-----	-----	-----	5.8	-----	-----	15.0	-----	-----	15.5	-----	-----	-----	6.9	-----	-----	-----	-----	-----	4.7	-----	-----	-----	-----
Width/Depth Ratio	-----	-----	-----	-----	-----	-----	-----	5.6	-----	-----	18.0	-----	-----	18.6	-----	-----	-----	12.0	-----	-----	-----	-----	-----	7.3	-----	-----	-----	-----
Entrenchment Ratio	-----	-----	-----	-----	-----	-----	-----	1.6	-----	-----	3.0	-----	-----	3.3	-----	-----	1.8	-----	-----	2.2	-----	-----	-----	1.6	-----	-----	-----	-----
Bank Height Ratio	-----	-----	-----	-----	-----	-----	-----	2.0	-----	-----	1.6	-----	-----	1.7	-----	-----	-----	1.0	-----	-----	-----	-----	-----	2.3	-----	-----	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	1.0	-----	-----	-----	-----	-----	45.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern																												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14.3	-----	-----	26.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rc / Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5.5	-----	-----	5.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	90	-----	-----	94	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.5	-----	-----	2.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Profile																												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	79.0	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.013	-----	-----	0.0413	-----	-----	-----	0.0050	-----	-----	-----	-----	-----	0.0046	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	----	-----	-----	-----	-----	-----	-----	-----	-----
Pool to Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	37.3	-----	-----	95.8	-----	-----	18.0	-----	-----	50.0	-----	-----	-----	80.0	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.3	-----	-----	2.5	-----	-----	-----	2.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
[2] d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----			(0.29/ 0.63 / 1.0/ 3.4 / 6.7)						6.0 / NP,/ 45.0 / 125.0 / NP				-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters																												
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	0.19	-----	-----	-----	-----	-----	1.00	-----	-----	-----	-----	-----	0.19	-----	-----	-----	-----	-----	0.19	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	-----	-----	E	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----	-----	B5c	-----	-----	-----	-----	-----	B5c	-----	-----
BF Velocity (fps)	-----	3.0	4.4	-----	-----	-----	-----	4.5	-----	-----	-----	-----	-----	N/P	-----	-----	-----	3.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	106.1	155.0	231.8	-----	-----	-----	26.5	-----	-----	-----	-----	-----	N/P	-----	-----	-----	22	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	559.0	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	-----	-----	579	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	564.0	-----	-----
Sinuosity	-----	-----	-----	-----	-----	-----	-----	1.02	-----	-----	-----	-----	-----	1.20	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.01	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0078	-----	-----	-----	0.0136	-----	-----	-----	-----	-----	0.0160	-----	-----	-----	-----	-----	0.0047	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.008	-----	-----	-----	0.0133	-----	-----	-----	-----	-----	0.0025	-----	-----	-----	-----	-----	0.0047	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

[1] Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively
[2] Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring
[3] Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design
[4] Values were chosen based on previous sand-bed reference reach data and past project evaluations

Table 10. Baseline Stream Summary (continued)
Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351

UT4 (Reach 1) Length 1,376 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition[1]						Reference Reach(es) Data[3] Richland Creek (Moore County)						Design[4]						As-built					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																												
BF Width (ft)	-----	7.1	7.5	-----	8.6	-----	-----	11.7	-----	-----	16.2	-----	-----	16.7	-----	-----	-----	11.4	-----	-----	-----	-----	-----	14.0	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	12.7	-----	-----	15.6	-----	-----	50.0	-----	-----	53.0	-----	-----	26.0	-----	-----	46.0	-----	-----	-----	89.2	-----	-----	-----	-----
BF Mean Depth (ft)	-----	0.9	1.1	-----	0.9	-----	-----	1.3	-----	-----	0.9	-----	-----	0.9	-----	-----	-----	0.9	-----	-----	-----	-----	-----	1.0	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	1.2	-----	-----	1.9	-----	-----	1.4	-----	-----	1.5	-----	-----	-----	1.1	-----	-----	-----	-----	-----	1.8	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	7.4	10.3	-----	10.5	-----	-----	11.3	-----	-----	15.0	-----	-----	15.5	-----	-----	-----	10.0	-----	-----	-----	-----	-----	14.1	-----	-----	-----	-----
Width/Depth Ratio	-----	-----	-----	-----	6.5	-----	-----	13.2	-----	-----	18.0	-----	-----	18.6	-----	-----	-----	13	-----	-----	-----	-----	-----	13.8	-----	-----	-----	-----
Entrenchment Ratio	-----	-----	-----	-----	1.3	-----	-----	1.5	-----	-----	3.0	-----	-----	3.3	-----	-----	-----	>2.2	-----	-----	-----	-----	-----	6.4	-----	-----	-----	-----
Bank Height Ratio	-----	-----	-----	-----	2.1	-----	-----	2.4	-----	-----	1.6	-----	-----	1.7	-----	-----	-----	1.0	-----	-----	-----	-----	-----	1.0	-----	-----	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	2.1	-----		-----	-----	-----	45.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern																												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	40.0	-----	-----	80.0	-----	-----	-----	60.0	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14.3	-----	-----	26.1	-----	-----	23.0	-----	-----	34.0	-----	-----	-----	40.0	-----	-----	-----	-----
Rc / Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5.5	-----	-----	5.7	-----	-----	2.0	-----	-----	3.0	-----	-----	-----	2.9	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	90	-----	-----	94	-----	-----	70.0	-----	-----	90.0	-----	-----	-----	146.0	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.5	-----	-----	2.4	-----	-----	3.5	-----	-----	7.0	-----	-----	-----	4.3	-----	-----	-----	-----
Profile																												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	37.2	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.013	-----	-----	0.0413	-----	-----	-----	0.0078	-----	-----	-----	-----	-----	0.0153	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool to Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	37.3	-----	-----	95.8	-----	-----	39	-----	-----	80	-----	-----	-----	78.0	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.3	-----	-----	2.5	-----	-----	-----	2.4	-----	-----	-----	-----	-----	2.2	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
[2] d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	0.06 / 0.34 / 2.12 / 36.6 / 101.8 (R2)						6.0 / NP,/ 45.0 / 125.0 / NP						-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters																												
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	0.34	-----	-----	-----	-----	-----	1.00	-----	-----	-----	-----	-----	0.34	-----	-----	-----	-----	-----	0.34	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	G	-----	-----	F	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----	-----	C5/B5	-----	-----	-----	-----	-----	C5	-----	-----
BF Velocity (fps)	-----	2.4	3.9	-----	3.6	-----	-----	3.9	-----	-----	-----	-----	-----	N/P	-----	-----	-----	3.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	25.2	40.9	63.0	-----	-----	-----	41.0	-----	-----	-----	-----	-----	N/P	-----	-----	-----	37	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	784	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	-----	-----	1,417	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	858	-----	-----
Sinuosity	-----	-----	-----	-----	-----	-----	-----	1.15	-----	-----	-----	-----	-----	1.20	-----	-----	-----	1.11	-----	-----	-----	-----	-----	-----	-----	1.09	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0058	-----	-----	-----	0.0136	-----	-----	-----	-----	-----	0.0058	-----	-----	-----	-----	-----	0.0101	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0067	-----	-----	-----	0.0133	-----	-----	-----	-----	-----	0.0067	-----	-----	-----	-----	-----	0.0113	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

[1] Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively
[2] Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring
[3] Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design
[4] Values were chosen based on previous sand-bed reference reach data and past project evaluations

Table 10. Baseline Stream Summary (continued)
Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351

UT4 (Reach 2) Length 1,828 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition[1]						Reference Reach(es) Data[3] Richland Creek (Moore County)						Design[4]						As-built					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																												
BF Width (ft)	-----	12.2	12.4	-----	-----	-----	-----	13.8	-----	-----	16.2	-----	-----	16.7	-----	-----	-----	16.5	-----	-----	-----	-----	-----	15.9	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	-----	-----	-----	36.6	-----	-----	50.0	-----	-----	53.0	-----	-----	38.0	-----	-----	66.0	-----	-----	-----	95.2	-----	-----	-----	-----
BF Mean Depth (ft)	-----	1.6	1.2	-----	-----	-----	-----	1.7	-----	-----	0.9	-----	-----	0.9	-----	-----	-----	1.3	-----	-----	-----	-----	-----	1.2	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	2.5	-----	-----	1.4	-----	-----	1.5	-----	-----	-----	1.6	-----	-----	-----	-----	-----	1.7	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	16.7	22.9	-----	-----	-----	-----	23.8	-----	-----	15.0	-----	-----	15.5	-----	-----	-----	21.0	-----	-----	-----	-----	-----	19.0	-----	-----	-----	-----
Width/Depth Ratio	-----	-----	-----	-----	-----	-----	-----	8.0	-----	-----	18.0	-----	-----	18.6	-----	-----	-----	13	-----	-----	-----	-----	-----	13.3	-----	-----	-----	-----
Entrenchment Ratio	-----	-----	-----	-----	-----	-----	-----	2.7	-----	-----	3.0	-----	-----	3.3	-----	-----	-----	>2.2	-----	-----	-----	-----	-----	6.0	-----	-----	-----	-----
Bank Height Ratio	-----	-----	-----	-----	-----	-----	-----	1.5	-----	-----	1.6	-----	-----	1.7	-----	-----	-----	1.0	-----	-----	-----	-----	-----	1.0	-----	-----	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	2.1	-----	-----	-----	-----	-----	45.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern																												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	60.0	-----	-----	100.0	-----	-----	-----	75.0	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14.3	-----	-----	26.1	-----	-----	33.0	-----	-----	50.0	-----	-----	-----	46.3	-----	-----	-----	-----
Rc / Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5.5	-----	-----	5.7	-----	-----	2.0	-----	-----	3.0	-----	-----	-----	2.9	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	90	-----	-----	94	-----	-----	115.0	-----	-----	180.0	-----	-----	-----	173.0	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.5	-----	-----	2.4	-----	-----	3.5	-----	-----	6.0	-----	-----	-----	10.9	-----	-----	-----	-----
Profile																												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	51.0	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.013	-----	-----	0.0413	-----	-----	-----	0.0040	-----	-----	-----	-----	-----	0.0043	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool to Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	37.3	-----	-----	95.8	-----	-----	32	-----	-----	65	-----	-----	-----	105.0	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.3	-----	-----	2.5	-----	-----	-----	1.8	-----	-----	-----	-----	-----	3.3	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
[2] d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	0.06 / 0.34 / 2.12 / 36.6 / 101.8 (R2)						6.0 / NP,/ 45.0 / 125.0 / NP						-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters																												
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	1.10	-----	-----	-----	-----	-----	1.00	-----	-----	-----	-----	-----	1.10	-----	-----	-----	-----	-----	1.10	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	-----	-----	F	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----	-----	C5	-----	-----	-----	-----	-----	C5	-----	-----
BF Velocity (fps)	-----	2.6	4.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	3.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	62.8	95.6	144.3	-----	-----	-----	95.6	-----	-----	-----	-----	-----	N/P	-----	-----	-----	80.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1590.34	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	-----	-----	1,673	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1827	-----	-----
Sinuosity	-----	-----	-----	-----	-----	-----	-----	1.15	-----	-----	-----	-----	-----	1.20	-----	-----	-----	1.19	-----	-----	-----	-----	-----	-----	-----	1.15	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0058	-----	-----	-----	0.0136	-----	-----	-----	-----	-----	0.0034	-----	-----	-----	-----	-----	0.0034	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0067	-----	-----	-----	0.0133	-----	-----	-----	-----	-----	0.0063	-----	-----	-----	-----	-----	0.0039	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

[1] Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively
[2] Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring
[3] Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design
[4] Values were chosen based on previous sand-bed reference reach data and past project evaluations

Table 10. Baseline Stream Summary (continued)
Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351

UT4 (Reach 3) Length 250 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition[1]						Reference Reach(es) Data[3] Richland Creek (Moore County)						Design[4]						As-built[5]					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																												
BF Width (ft)	-----	14.1	14.2	-----	-----	-----	-----	13.1	-----	-----	16.2	-----	-----	16.7	-----	-----	-----	19.8	-----	-----	-----	-----	-----	15.4	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	-----	-----	-----	18.3	-----	-----	50.0	-----	-----	53.0	-----	-----	44.0	-----	-----	76.0	-----	-----	-----	21.0	-----	-----	-----	-----
BF Mean Depth (ft)	-----	1.3	1.7	-----	-----	-----	-----	2.2	-----	-----	0.9	-----	-----	0.9	-----	-----	-----	1.4	-----	-----	-----	-----	-----	2.4	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	3.2	-----	-----	1.4	-----	-----	1.5	-----	-----	-----	1.7	-----	-----	-----	-----	-----	3.2	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	21.0	28.5	-----	-----	-----	-----	28.7	-----	-----	15.0	-----	-----	15.5	-----	-----	-----	28.0	-----	-----	-----	-----	-----	36.8	-----	-----	-----	-----
Width/Depth Ratio	-----	-----	-----	-----	-----	-----	-----	6.0	-----	-----	18.0	-----	-----	18.6	-----	-----	-----	13	-----	-----	-----	-----	-----	6.4	-----	-----	-----	-----
Entrenchment Ratio	-----	-----	-----	-----	-----	-----	-----	1.4	-----	-----	3.0	-----	-----	3.3	-----	-----	1.8	-----	-----	2.2	-----	-----	-----	1.4	-----	-----	-----	-----
Bank Height Ratio	-----	-----	-----	-----	-----	-----	-----	2.3	-----	-----	1.6	-----	-----	1.7	-----	-----	-----	1.0	-----	-----	-----	-----	-----	1.7	-----	-----	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	0.48	-----	-----	-----	-----	-----	45.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern																												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/A	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14.3	-----	-----	26.1	-----	-----	N/A	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----
Rc / Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5.5	-----	-----	5.7	-----	-----	2.0	-----	-----	3.0	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	90	-----	-----	94	-----	-----	N/A	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.5	-----	-----	2.4	-----	-----	N/A	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----
Profile																												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	20.0	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.013	-----	-----	0.0413	-----	-----	-----	0.0130	-----	-----	-----	-----	-----	0.0153	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool to Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	37.3	-----	-----	95.8	-----	-----	45	-----	-----	80	-----	-----	-----	50.0	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.3	-----	-----	2.5	-----	-----	-----	3.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
[2] d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----			0.06 / 0.15 / 0.48 / 10.3 / 130.2						6.0 / NP,/ 45.0 / 125.0 / NP				-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters																												
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	1.52	-----	-----	-----	-----	-----	1.00	-----	-----	-----	-----	-----	1.52	-----	-----	-----	-----	-----	1.52	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	-----	-----	G	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----	-----	B5c	-----	-----	-----	-----	-----	G5c	-----	-----
BF Velocity (fps)	-----	2.8	4.1	-----	-----	-----	-----	4.1	-----	-----	-----	-----	-----	N/P	-----	-----	-----	3.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	80.7	120.5	181.1	-----	-----	-----	120.5	-----	-----	-----	-----	-----	N/P	-----	-----	-----	103.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	237	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	-----	-----	244	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	250	-----	-----
Sinuosity	-----	-----	-----	-----	-----	-----	-----	1.15	-----	-----	-----	-----	-----	1.20	-----	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	1.05	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0058	-----	-----	-----	0.0136	-----	-----	-----	-----	-----	0.0078	-----	-----	-----	-----	-----	0.0056	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0067	-----	-----	-----	0.0133	-----	-----	-----	-----	-----	0.0080	-----	-----	-----	-----	-----	0.0058	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

[1] Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively
[2] Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring
[3] Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design
[4] Values were chosen based on previous sand-bed reference reach data and on past project evaluations
[5] Ultimately, a Rosgen "G" stream type was maintained for this reach due to its stable location with mature trees eastablished along its banks

Table 10. Baseline Stream Summary (continued)
Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351

UT4 (Reach 4) Length 1,840 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition[1]						Reference Reach(es) Data[3] Richland Creek (Moore County)						Design[4]						As-built					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																												
BF Width (ft)	-----	7.8	8.2	-----	-----	-----	-----	7.7	-----	-----	16.2	-----	-----	16.7	-----	-----	-----	12.0	-----	-----	-----	-----	-----	11.6	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	-----	-----	-----	10.9	-----	-----	50.0	-----	-----	53.0	-----	-----	28.0	-----	-----	48.0	-----	-----	-----	75.9	-----	-----	-----	-----
BF Mean Depth (ft)	-----	0.9	1.1	-----	-----	-----	-----	1.6	-----	-----	0.9	-----	-----	0.9	-----	-----	-----	0.9	-----	-----	-----	-----	-----	0.8	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	2.1	-----	-----	1.4	-----	-----	1.5	-----	-----	-----	1.1	-----	-----	-----	-----	-----	1.1	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	8.5	11.8	-----	-----	-----	-----	12	-----	-----	15.0	-----	-----	15.5	-----	-----	-----	11.0	-----	-----	-----	-----	-----	9.5	-----	-----	-----	-----
Width/Depth Ratio	-----	-----	-----	-----	-----	-----	-----	5.0	-----	-----	18.0	-----	-----	18.6	-----	-----	-----	13	-----	-----	-----	-----	-----	14.1	-----	-----	-----	-----
Entrenchment Ratio	-----	-----	-----	-----	-----	-----	-----	1.1	-----	-----	3.0	-----	-----	3.3	-----	-----	-----	>2.2	-----	-----	-----	-----	-----	6.5	-----	-----	-----	-----
Bank Height Ratio	-----	-----	-----	-----	-----	-----	-----	3.1	-----	-----	1.6	-----	-----	1.7	-----	-----	-----	1.0	-----	-----	-----	-----	-----	1.0	-----	-----	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	1.50	-----	-----	-----	-----	-----	45.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.3	-----	-----	-----	-----
Pattern																												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	40	-----	-----	70	-----	-----	-----	55.0	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14.3	-----	-----	26.1	-----	-----	24.0	-----	-----	36.0	-----	-----	-----	48.3	-----	-----	-----	-----
Rc / Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5.5	-----	-----	5.7	-----	-----	2.0	-----	-----	3.0	-----	-----	-----	4.2	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	90	-----	-----	94	-----	-----	84.0	-----	-----	140.0	-----	-----	-----	150.0	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.5	-----	-----	2.4	-----	-----	7.0	-----	-----	12.0	-----	-----	-----	13.0	-----	-----	-----	-----
Profile																												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.013	-----	-----	0.0413	-----	-----	-----	0.0100	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool to Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	37.3	-----	-----	95.8	-----	-----	42	-----	-----	82	-----	-----	-----	-----	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.3	-----	-----	2.5	-----	-----	-----	2.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
[2] d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----		0.13 / 0.43 / 1.5 / 14.2 / 22.6						6.0 / NP / 45.0 / 125.0 / NP					-----	-----	-----	-----	-----	-----		11.1 / 23.8 / 36.6 / 60.1 / 126.3				
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters																												
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	0.42	-----	-----	-----	-----	-----	1.00	-----	-----	-----	-----	-----	0.42	-----	-----	-----	-----	-----	0.42	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	-----	-----	G	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----	-----	C5/B5c	-----	-----	-----	-----	-----	C5	-----	-----
BF Velocity (fps)	-----	2.5	3.9	-----	-----	-----	-----	3.9	-----	-----	-----	-----	-----	N/P	-----	-----	-----	3.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	29.5	47.3	73.4	-----	-----	-----	47.4	-----	-----	-----	-----	-----	N/P	-----	-----	-----	40.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1657	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	-----	-----	1,787	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1840	-----	-----
Sinuosity	-----	-----	-----	-----	-----	-----	-----	1.15	-----	-----	-----	-----	-----	1.20	-----	-----	-----	1.12	-----	-----	-----	-----	-----	-----	-----	1.11	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0058	-----	-----	-----	0.0136	-----	-----	-----	-----	-----	0.0063	-----	-----	-----	-----	-----	0.0054	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0067	-----	-----	-----	0.0133	-----	-----	-----	-----	-----	0.0069	-----	-----	-----	-----	-----	0.0062	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

[1] Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively
[2] Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring
[3] Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design
[4] Values were chosen based on previous sand-bed reference reach data and past project evaluations

Table 10. Baseline Stream Summary (continued)
Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351

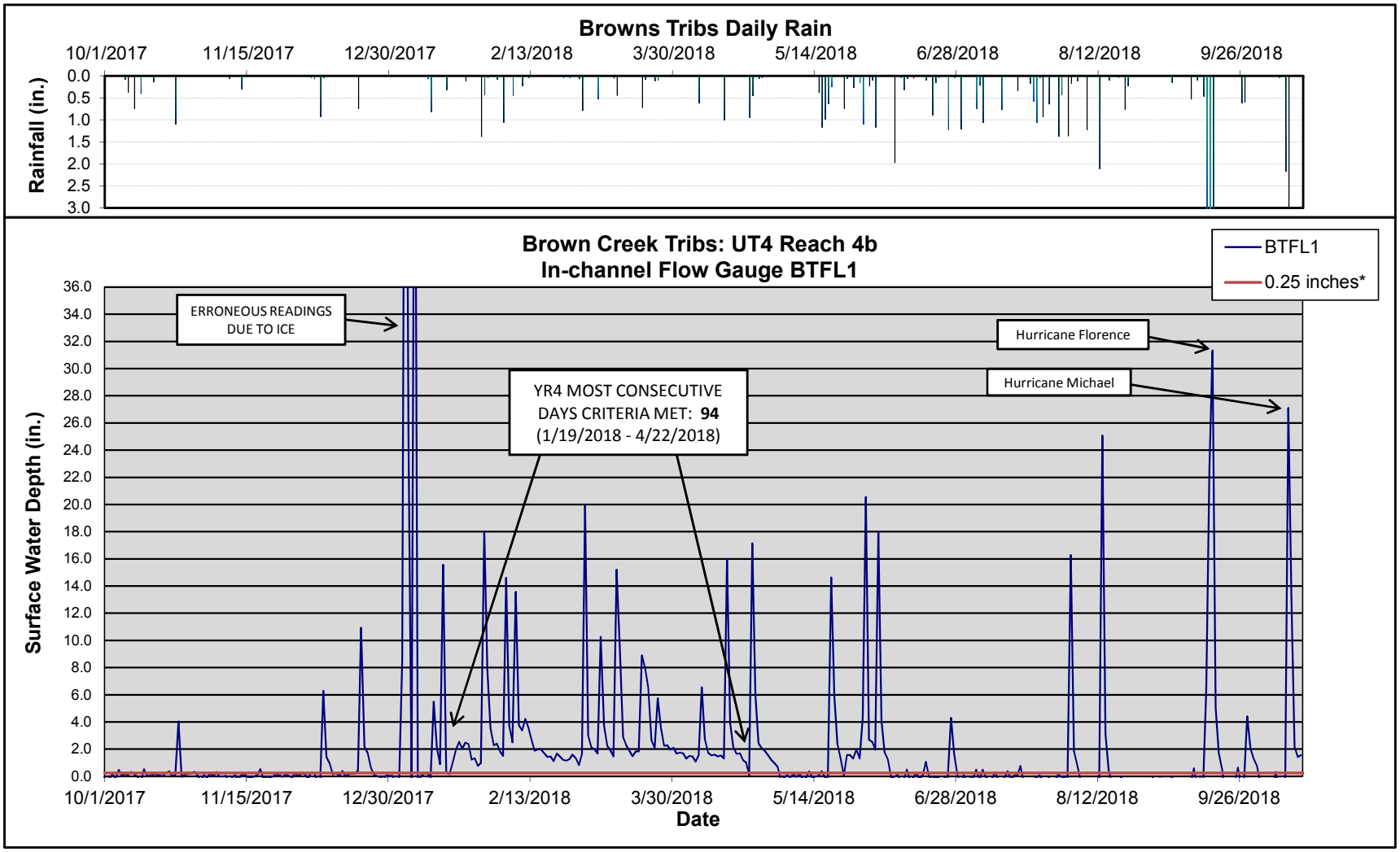
UT4 (Reach 5) Length 1,973 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition[1]						Reference Reach(es) Data[3] Richland Creek (Moore County)						Design[4]						As-built					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																												
BF Width (ft)	-----	9.9	10.2	-----	16.8	-----	-----	23.5	-----	-----	16.2	-----	-----	16.7	-----	-----	-----	13.9	-----	-----	-----	-----	-----	16.2	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	33.6	-----	-----	94.3	-----	-----	50.0	-----	-----	53.0	-----	-----	32.0	-----	-----	55.0	-----	-----	-----	69.4	-----	-----	-----	-----
BF Mean Depth (ft)	-----	1.0	1.3	-----	0.7	-----	-----	0.7	-----	-----	0.9	-----	-----	0.9	-----	-----	-----	1.2	-----	-----	-----	-----	-----	1.8	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	1.3	-----	-----	2.4	-----	-----	1.4	-----	-----	1.5	-----	-----	-----	1.5	-----	-----	-----	-----	-----	2.7	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	12.3	16.9	-----	11.2	-----	-----	15.4	-----	-----	15.0	-----	-----	15.5	-----	-----	-----	16.0	-----	-----	-----	-----	-----	28.4	-----	-----	-----	-----
Width/Depth Ratio	-----	-----	-----	-----	25.2	-----	-----	36.0	-----	-----	18.0	-----	-----	18.6	-----	-----	-----	12	-----	-----	-----	-----	-----	9.3	-----	-----	-----	-----
Entrenchment Ratio	-----	-----	-----	-----	2.0	-----	-----	4.0	-----	-----	3.0	-----	-----	3.3	-----	-----	-----	>2.2	-----	-----	-----	-----	-----	4.3	-----	-----	-----	-----
Bank Height Ratio	-----	-----	-----	-----	1.0	-----	-----	1.7	-----	-----	1.6	-----	-----	1.7	-----	-----	-----	1.0	-----	-----	-----	-----	-----	1.0	-----	-----	-----	-----
d50 (mm)	-----	-----	-----	-----	-----	1.30	-----	-----	-----	-----	-----	45.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern																												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/A	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	14.3	-----	-----	26.1	-----	-----	N/A	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----
Rc / Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5.5	-----	-----	5.7	-----	-----	N/A	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	90	-----	-----	94	-----	-----	N/A	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.5	-----	-----	2.4	-----	-----	N/A	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	-----
Profile																												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	46.0	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.013	-----	-----	0.0413	-----	-----	-----	0.0050	-----	-----	-----	-----	-----	0.0086	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool to Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	37.3	-----	-----	95.8	-----	-----	50	-----	-----	90	-----	-----	-----	101.0	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.3	-----	-----	2.5	-----	-----	-----	2.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	N/P	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
[2] d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----			0.30 / 0.70 / 1.3 / 5.5 / 8.4						6.0 / NP,/ 45.0 / 125.0 / NP				-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters																												
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	0.71	-----	-----	-----	-----	-----	1.00	-----	-----	-----	-----	-----	0.71	-----	-----	-----	-----	-----	0.71	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	-----	-----	E/Bc	-----	-----	-----	-----	-----	C4	-----	-----	-----	-----	-----	C5/E5	-----	-----	-----	-----	-----	E5	-----	-----
BF Velocity (fps)	-----	2.9	4.5	-----	-----	-----	-----	4.5	-----	-----	-----	-----	-----	N/P	-----	-----	-----	3.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Discharge (cfs)	-----	44.4	69.2	106.1	-----	-----	-----	69.3	-----	-----	-----	-----	-----	N/P	-----	-----	-----	60.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valley Length	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1838	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	-----	-----	1,921	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1916	-----	-----
Sinuosity	-----	-----	-----	-----	-----	-----	-----	1.08	-----	-----	-----	-----	-----	1.20	-----	-----	-----	N/A	-----	-----	-----	-----	-----	-----	-----	1.04	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0033	-----	-----	-----	0.0136	-----	-----	-----	-----	-----	0.0033	-----	-----	-----	-----	-----	0.0053	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0035	-----	-----	-----	0.0133	-----	-----	-----	-----	-----	0.0035	-----	-----	-----	-----	-----	0.0061	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

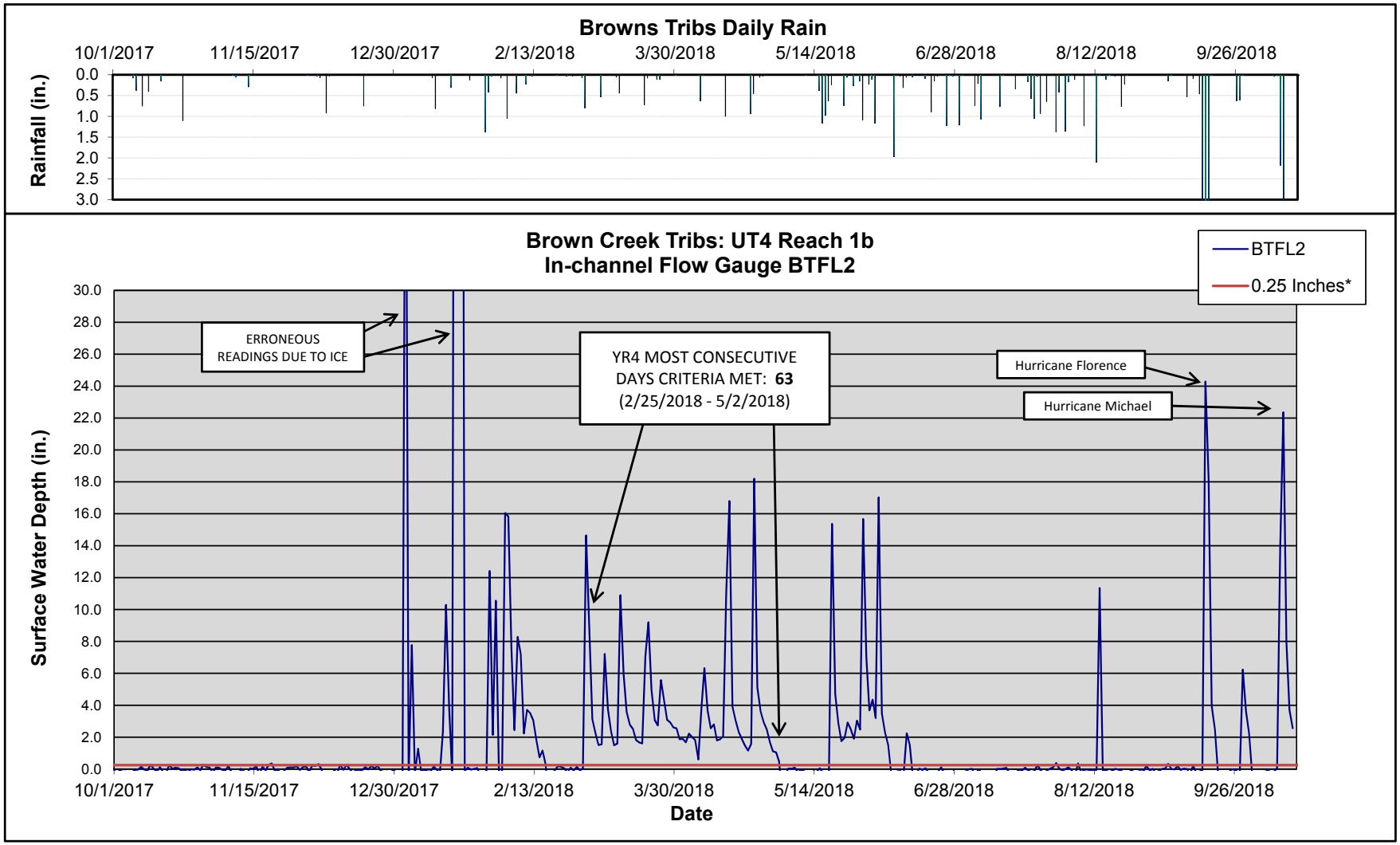
[1] Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively
[2] Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring
[3] Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design
[4] Values were chosen based on previous sand-bed reference reach data and past project evaluations

Appendix E

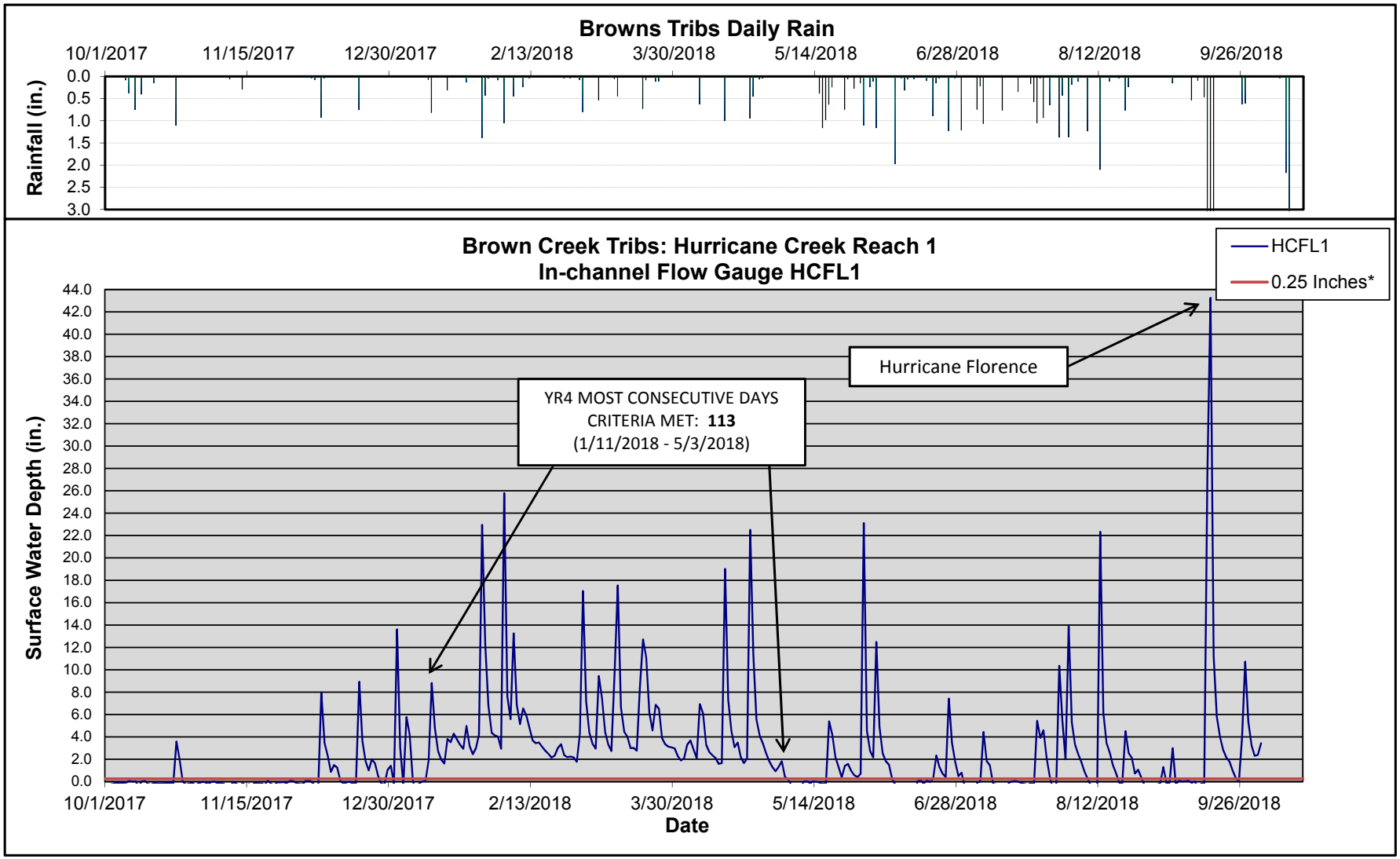
Hydrologic Data



* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.

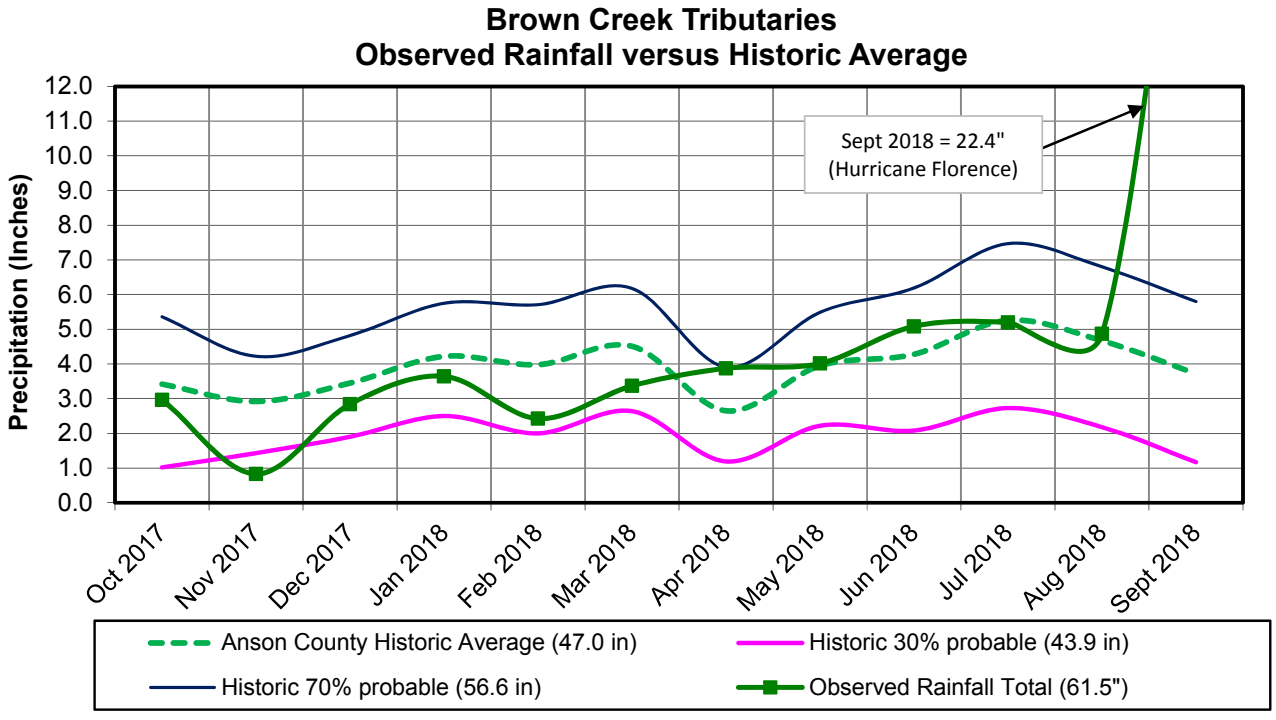


* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.



* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.

Figure 6. Observed Rainfall versus Historic Average



Note: Historic average annual rainfall for Anson County is 47.0", while a total of 61.5" was recorded over the previous 12 months.

Table 12. Flow Gauge Success
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Flow Gauge ID	Most Consecutive Days Meeting Criteria[1]							Cumulative Days Meeting Criteria[2]						
	Year 1 (2015)	Year 2 (2016)	Year 3 (2017)	Year 4 (2018)	Year 5 (2019)	Year 6 (2020)	Year 7 (2021)	Year 1 (2015)	Year 2 (2016)	Year 3 (2017)	Year 4 (2018)	Year 5 (2019)	Year 6 (2020)	Year 7 (2021)
UT4 Flow Gauges (Installed July 17, 2015)														
BTFL1	37	77	58	94				37	77	152	185			
BTFL2	92	106	34	63				92	106	113	135			
Hurricane Creek Flow Gauge (Installed July 19, 2016)														
HCFL1[3]	N/A	12	64	113				N/A	12	154	186			

Notes:
[1]Indicates the single greatest number of consecutive days within the monitoring year where flow was measured.
[2]Indicates the total number of days within the monitoring year where flow was measured.
[3]The Hurricane Creek Flow Gauge (HCFL1) was installed in Reach HC-R1 on July 19, 2016 to document in-channel stream flow.
Flow success criteria for the Site is stated as: **A restored stream reach will be considered at least intermittent when the flow duration occurs for a minimum of 30 consecutive days.**
Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.

Table 13. Verification of Bankfull Events
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351

Date of Data Collection	Estimated Occurrence of Bankfull Event	Method of Data Collection	Crest Gauge Reading (Hurricane Creek-R2)	Crest Gauge Reading (UT4-R2)
MY1 (2015)				
10/29/2015	10/3/2015	Crest Gauge	0.94'	
11/4/2015	10/3/2015	Crest Gauge		0.83'
MY2 (2016)				
2/17/2016	2/3/2016	Crest Gauge	1.05'	
7/19/2016	6/29/2016	Crest Gauge	0.19'	0.28'
11/3/2016	10/8/2016	Crest Gauge	1.1'	0.97'
MY3 (2017)				
9/19/2017	7/18/2017	Crest Gauge	0.33'	
MY4 (2018)				
6/5/2018	6/2/2018*	Crest Gauge		0.50'
10/3/2018	9/17/2018*	Crest Gauge	0.67'	
10/15/2018	9/17/2018*	Crest Gauge		2.26'
10/15/2018	10/11/2018*	Crest Gauge		0.68'

* See flow gauge graphs in Appendix E for corresponding flow depth spikes on these dates (The September and October events are associated with Hurricanes Florence and Michael).