

# Brown Creek Tributaries Restoration Project Final Year 5 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: 5 of 7  
Year of Data Collection: 2019  
Year of Completed Construction: 2015  
Submission Date: February 2020

Submitted To:

NC DEQ – Division of Mitigation Services  
1652 Mail Service Center  
Raleigh, NC 27699

Mitigation Project Name Brown Creek Tributaries Project  
 DMS ID 95351  
 River Basin Yadkin  
 Cataloging Unit 03040104

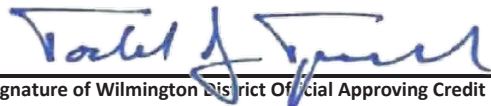
County Anson  
 Date Project Instituted 6/13/2012  
 Date Prepared 6/14/2019

USACE Action ID 2012-01108  
 NCDWR Permit No 2014-0345

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)		9,766.466												
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	N/A				N/A		N/A	N/A
3 (Year 1 Monitoring)	10%	976.647			2017	8/8/2017	N/A				N/A		N/A	N/A
4 (Year 2 Monitoring)	10%	976.647			2017	8/8/2017	N/A				N/A		N/A	N/A
IRT Adjustment*		-27.320				8/8/2017								
5 (Year 3 Monitoring)	10%	976.647			2018	4/25/2018	N/A				N/A		N/A	N/A
6 (Year 4 Monitoring)	5%	488.323			2019	4/26/2019	N/A				N/A		N/A	N/A
7 (Year 5 Monitoring)	10%				2020		N/A				N/A		N/A	N/A
8 (Year 6 Monitoring)	5%				2021		N/A				N/A		N/A	N/A
9 (Year 7 Monitoring)	10%				2022		N/A				N/A		N/A	N/A
Stream Bankfull Standard	10%	976.647			2018	4/25/2018	N/A				N/A			
<b>Total Credits Released to Date</b>		<b>7,324.849</b>												

**NOTES:**  
 8/8/2017: Adjustment required due to IRT concerns on how the as-built credits were calculated

**CONTINGENCIES:**



Signature of Wilmington District Official Approving Credit Release

27 Sept 2019

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) Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required
- 3 - A 10% reserve of credits is to be held back until the bankfull event performance standard has been met



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Yadkin River Basin: 03040104-061030

Report Prepared and Submitted by Michael Baker Engineering, Inc.

NC Professional Engineering License # F-1084

**Michael Baker**

**I N T E R N A T I O N A L**



February 26, 2020

Kelly Phillips, Project Manager  
NCDEQ – Division of Mitigation Services  
610 East Center Avenue, Suite 301  
 Mooresville, NC 28115  
919-723-7565

**Subject:** Response to DMS Comments for Task 11 Deliverables: Year 5 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. Phillips:

Please find below our responses to the NC Division of Mitigation Services' (DMS) review comments letter dated January 22, 2020 in reference to the Brown Creek Tributaries Restoration Project in Anson County, NC. We have subsequently revised the Draft version of the Year 5 Monitoring Report in response to the review comments as outlined below:

General Comments from Field Inspection:

-The crossing gates between R4A and R4B and Hurricane Creek have been left open leaving evidence of direct cattle impacts during recent site visits. Please rectify this issue with the landowner.

**Response:** Baker had not previously seen or observed any evidence that the gates on Hurricane Creek had been opened in several years, with tall weeds growing within the rock crossing. The original landowner for this parcel passed away last year and his son (who owns parcels on the UT4 section of the project, but which don't have gated crossings) has taken over the property. After a recent inspection of the gates on site, we found that one has a damaged hinge and will be repaired as soon as possible, and we will talk with the current landowner about the issue. Of note, we found no evidence that cattle had ventured into the actual conservation easement itself, just within the crossing. No hoofprints, manure, or damage of any sort was observed.

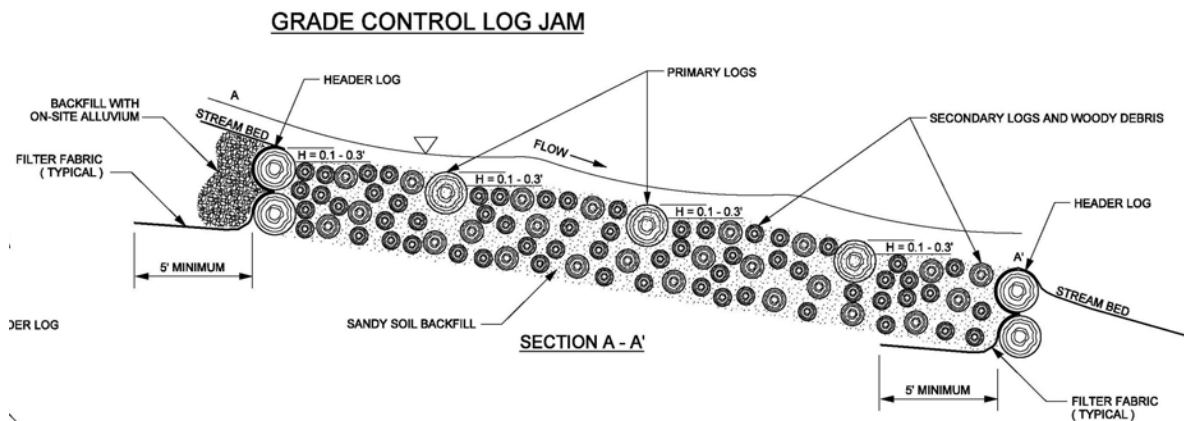
-Please update aerials if more recent imagery is available.

**Response:** The aerials used in the CCPV are from the most recent available imagery (from 2019) but were incorrectly reported as being from 2015. Revisions were made to the CCPV.

-Please inspect the Log Jam structure on UT4 – Reach 2 extending downstream from Station 36+00 toward the confluence with UT4 – Reach 4B. The substrate within the structure appears to be scoured leaving behind perched logs positioned above baseflow. The uppermost log appears to have filter fabric installed and may currently be serving to prevent headcutting upstream through the scoured structures.

**Response:** There are actually three Log Jam structures in that section of lower UT4-R2. The two grade control components located at the top and bottom of the structures consist of two large logs (header and footer) with filter fabric (see structure design diagram below). The interior of the

structure consists of a few larger ‘primary’ logs along with a layered mass of secondary brush and limbs of various sizes backfilled with sandy soil. After field inspection, the scour observed is located within this interior section of the structure, which is a normal, expected part of the evolution of these structures. They have been like this for several years now. Storm events the first year after construction caused the greatest change but has been quite stable since then. The grade control logs are still functioning well with no undercutting observed, and the majority of the interior layered woody brush and soil are still present. The interior still has a significant amount of woody brush and limbs submerged and has even developed a range of habitats within it as small pools have formed in locations as well as sections where gravel and small rock have washed down. The perched wood observed by DMS represent only a fraction of the overall amount of wood present in the structure and are only above seasonal stream baseflow by a few inches and still provides habitat and acts as a snag capturing sticks and leaves. Overall, the structures are stable and are performing well in their designed functions as both stream habitat and as grade control features for this lower section of R2 as it drops significant elevation to meet R3.



-Recent beaver chews were observed along UT4 – Reach 5B Station 20+00 and at the lower end of Hurricane Creek Station 44+00. A beaver dam was located at the lower end of Hurricane Creek Reach 1 a few yards upstream of the confluence with Hurricane Creek Reach 3.

**Response:** Baker recently inspected these areas in the field after receiving these comments from DMS. The beaver dam on Hurricane Creek was found and has been removed. On UT4-R5B, we observed the beaver chews on the black willow in the adjacent wetland area, but no sign of an actual dam was found fortunately. Both sites will continue to be closely inspected for new beaver activity in the future.

-A small amount of scalloping of the easement is occurring in the planted field to the north of UT4 Reach 1B at approximate Station 11+20. The green cover crop planted between T-Posts and within the easement is visible in the attached photograph. Please take measures to prevent the encroachment and correct any vegetative concerns due to the activity.

**Response:** Baker inspected this area in the field after receiving these comments from DMS. It does appear that approximately 700 ft<sup>2</sup> of area within the easement has been planted with cover crop. Two additional T-posts were installed along the easement boundary with horsetape connecting them to more clearly mark the easement boundary. The landowner will also be made aware of the issue. Riparian seed mix was placed out to reestablish more appropriate herbaceous vegetation. The area is almost entirely located under the canopy of two very large oak trees, which appear to have suppressed or stunted tree growth underneath them in all directions. See photos below:



-A permanent hunting stand has been constructed within the easement along UT4 – Reach 5B on the western easement boundary approximately mid-way up the reach. The stand will need to be relocated outside the easement because new permanent structures are not allowed in the easement.

**Response: This hunting stand will be pulled out. The landowner assumed that since it was not anchored or affixed into the ground (i.e. no concrete or burial of posts) it did not count as a ‘permanent’ structure, but has been notified that it needs to be removed.**

Report Comments:

-Executive Summary: DMS concurs with the plan to thin the pine and sweetgum present throughout the site. Also, please maintain treatment of the exotic invasive vegetation since privet was observed in multiple areas.

**Response: Absolutely. As noted in the report, Baker will continue to thin the pine and sweetgum as well as treat the identified areas of privet on the project.**

2.1.2 Hydrology - It is stated in the Hydrology section, when describing recently installed gauges, that “Success criteria are considered to have been met if 30 consecutive days of flow were observed at any point during the monitoring year.” Please restate; please note that success criteria are established in the approved mitigation plan; any monitoring features or data collected subsequently should be considered supportive data.

**Response: This section was restated as advised.**

Table 2 Project Activity and Reporting History - 2019 planting maintenance activities have not been included in Table 2. All maintenance and site work performed during the monitoring period (e.g., planting, thinning, beaver/debris jam removal) should be captured in Table 2.

**Response: Table 2 has been revised as requested.**

Digital Support File Review:

- DMS has as-built stream features, but needs features that represent the creditable assets reported in the asset table. Please provide DMS with stream features that represent these creditable assets, and that are segmented as reported in the asset table.

**Response: After close review of the as-built stream shapefile, the features do accurately represent the as-built lengths as shown in the as-built survey and sealed plan sheets, and as presented in the ‘As-Built Restoration Footage’ column in the credit/asset Table 1. As per DMS/IRT instruction in previous monitoring years, the restoration credits shown in Table 1 are taken from the Mitigation Plan and are**

not directly connected to the surveyed as-built lengths but rather to the original approved design lengths as explained in footnote 2 on Table 1.

However, the shapefile does show the non-creditable segments of several reaches (though they were called out in a separate row in the attribute table and were not included in the length calculations), and several reaches have two separate GIS segments due to easement breaks. So, to reduce confusion, the shapefile was reconfigured so that reach segments were combined and the attribute table is more clear. This revised shapefile is included in the final e-submission documents. We apologize for the confusion the old file caused.

- CVS tool has x y coordinates for MY5 that exceed the bounds of the selected plot dimensions. Please ensure that these coordinates are correct and check the selected plot dimensions for accuracy. Also, please include survey dates for all plots and monitoring years.

**Response:** Baker received this comment on many of our projects and spoke with DMS Science and Analysis staff to discuss further. The plot dimensions recorded in CVS were confirmed as correct for each plot. The X/Y grid coordinate portion of the CVS entry tool has always been used for internal purposes at Baker. We have used it to identify the plant plot and number (e.g. 4-15 means plot 4, plant 15) and not for internal plant location, as CVS does not otherwise provide an easy way to carry over clear plant ID numbering from year to year. Using the X/Y coordinate entry this way saves significant time each year during monitoring and helps eliminate errors by reducing confusion. We have long regarded it as a mild flaw in the CVS tool but have found this easy workaround to be a perfectly suitable rectification. Baker is happy to provide DMS with a copy of our internal veg plot maps showing individual plant locations and ID's within each plot with the revised final e-submission files. Based on our conversations with DMS staff, we have been given permission to continue to use the tool in this modified manner for the remainder of this project, but will use the X/Y grid entry tool as intended on all future projects.

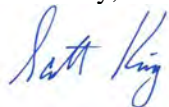
Upon review of the CVS file, the veg plot survey dates had not been entered for MY5 and so we have revised the file accordingly. Our apologies for the oversight. We checked to confirm that all previous monitoring years did have survey dates recorded for each monitoring year. The revised CVS file has been included with the final e-submission files.

- DMS needs the raw stream gage data that were used to create in-channel streamflow figures. In this file, please label any probe or benchmark elevations, the raw and corrected readings of the water elevations and any offsets applied. DMS needs to be able to clearly identify these key elevations before incorporating these into the DMS database permitting independent calculation/verification. The DMS Excel template is an example of what is needed for reference and is required for use as part of RFPs within the last several years.

**Response:** Baker has provided all raw stream flow gauge data with the final revised e-submission.

As requested, four hardcopies of the final version of the monitoring report are being provided with this submission, and the final revised e-submission digital files will be sent to you via a secure ftp link. 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, PWS  
Project Manager

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## 1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) restored 8,213 linear feet (LF) of perennial stream, enhanced 2,481 LF of stream, and preserved 518 LF 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 (AC) 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 Plan 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.

The Year 5 monitoring survey data of the fifteen cross-sections indicates that those stream sections are stable and any minor fluctuations in their geometry from previous years are within the lateral/vertical performance range. All reaches are geomorphically stable and performing as designed, as confirmed by the visual stability assessment. 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. No Stream Problem Areas (SPAs) were identified.

Based on the Year 5 vegetation plot monitoring data collected during August and October of 2019, the average planted stem density is 551 stems per acre. Thus, the vegetation data demonstrate that the project as a whole is meeting the minimum success criteria of 260 trees per acre by the end of Year 5, as well as being on track to meet the success criteria of 210 trees per acre by the end of Year 7.

There were however a few Vegetation Problem Areas (VPAs) documented on the project during Year 5 monitoring. First, there were five areas of scattered Chinese privet (*Ligustrum sinsense*) observed and documented on site: two areas in the upper easement of HC-R1, one along HC-R3, and one each on UT4-R4b and UT4-R5b. The areas total approximately 0.80 acres but contain only scattered privet, not dense thickets, and still contain numerous planted species within them. These areas will be fully treated in 2020.

The other VPAs are two areas of low stem densities observed in portions of the floodplain along HC-R2 and UT4-R2 totally approximately 0.37 acres (see photographs in Appendix B). These are sub-sections of larger areas that had been noted as having thin densities in the past and have previously been supplementally planted. Most of the additional plantings have successfully established and appear to be growing well. However, these smaller sub-sections have each experienced high mortality. The area on HC-R2 clearly appears to have had difficulty due to very wet conditions from runoff flow coming from a wet swale in the adjacent pasture leading to extended periods of saturation and ponding throughout the year (see swale in aerial photo in Figure 2A). Although scattered, short plants were found here (and Vegetation Plot 2 located within it passed in MY5), the area as a whole appears to have a low stem density as compared to the surrounding areas. As such, additional 3 and/or 5-gallon container plants of more water-tolerant species will be supplementally planted in this area in the winter of 2019-2020. The area on UT4-R2 has no obvious explanation for its high mortality, though the area is a little drier than the more successful adjacent areas nearer the stream. Regardless, an additional supplemental planting of 3 and/or 5-gallon container plants will be conducted in this area in the winter of 2019-2020.

Previously, there were two VPAs identified for the project in the Year 4 monitoring report. The first was an area of low stem vigor observed in the upper section of HC-R1. Applications of fertilizer were made in the spring of 2019 to the short stems, which along with an additional growing season, has resulted in substantial plant growth in this area as shown in the photographs found in Appendix B. Fertilizer will again be added in 2020 to further boost growth rates. The second VPA was an area of low stem density (0.24 acres) found along UT4-R4b. This area was supplementally planted in January 2019 with approximately 50 bareroot stems and 10 1-gallon containers of an equal mix of tulip poplar (*Liriodendron tulipifera*), river birch (*Betula nigra*), white oak (*Quercus alba*), and sycamore (*Platanus occidentalis*). An assessment of the area in November of 2019

revealed that most of the stems appear to have survived and, while still fairly short, had leaves and/or bud scars to indicate seasonal growth and all-around vigor. They will be fertilized in the spring of 2020 to help boost their growth rate.

Additionally, field inspections during the year revealed the notable presence of both loblolly pine (*Pinus taeda*) and sweetgum (*Liquidambar styraciflua*) scattered throughout significant portions of the project buffer, in particular HC-R1, UT4-R2, and UT4-R4b. These species will be substantially thinned in 2020.

Two pebble counts were conducted in Year 5 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. Pebble count data can be found in Appendix D.

Stream flow for the restored channels was recorded for 2019 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 5 in these reaches of 49, 121, and 116 consecutive days respectively, thus all meeting a minimum of 30 days of consecutive flow, as they have all done in each previous monitoring year. The flow gauges demonstrated similar flow events relative to recorded rainfall events on site as demonstrated in the gauge graphs in Appendix E. It should also be noted that as Figure 6 demonstrates, the observed monthly rainfall data for the project over the past 12 months has been fairly dry as compared to historic averages, despite how wet the past winter of 2018-2019 was for the area. A total of 38.3 inches of rainfall was observed on the site, while Anson County averages 47.0 inches of annual rainfall, for a deficit of 8.7 inches. The drier than average conditions persisted from this past spring through fall. The NC Drought Management Advisory Council indicated that for significant periods of time in the past year Anson County has been in Abnormally Dry (D0) or Moderate Drought (D1) conditions. Most notably, the site was still under a D1 Moderate Drought at the time the stream station photo-points were taken in early November 2019. Appendix E contains more details on the observed and historic rainfall data for the Site.

Two bankfull crest gauges are located along UT4-R2 and HC-R2. During Year 5 monitoring, the crest gauge on HC-R2 documented two post-construction bankfull events on 3/3/19 and 8/3/19, as confirmed by the HCFL1 flow gauge depths recorded on those same dates (see flow gauge graph in Appendix E). The crest gauge on UT4-R2 also recorded two bankfull events in MY5 on 3/21/19 and 5/12/19, as confirmed by the two in-stream flow gauges on UT4-R4 and UT4-R1. Visual evidence such as wrack lines and debris jams were also discovered along UT4-R2 as shown in photographs in Appendix B. There have been a total of eight recorded bankfull events at each of the two crest gauges during the monitoring period, and the project met the stated bankfull event success criteria in MY2 (2016). Complete project crest gauge readings are presented in Table 13.

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 5 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 guidance documents “Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation” (DMS 2011), and to the monitoring report template document Version 1.3 (DMS 2010), which will continue to serve as the templates 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 vegetation plots, permanent cross-sections, flow gauges, and crest gauges are shown on the CCPV Figure 2 found in Appendix B.

The Year 3 vegetation data was collected in August and October of 2019, while the cross-section survey data was collected in October of 2019. Visual site assessment data contained in Appendix B was collected in November 2019, 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 conditions for Monitoring 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.

Cross-sections were classified using the Rosgen Stream Classification System (Rosgen 1994) and all monitored cross-sections fall within the quantitative parameters defined for channels of their design stream type. Cross-sections were also compared to all previous cross-section survey data to evaluate changes between construction and the current condition. Morphological survey data is presented in Appendix D.

Particle size distribution assessments (pebble counts) were conducted using the modified Wolman method as described in Applied River Morphology (Rosgen, 1996). Two pebble counts were conducted in MY5 and can be found in Appendix D.

### **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 established in the mitigation plan and all flow and photographic data collected on site are considered supportive data. 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 cork crest gauges, water level readings from the three installed flow gauges, photographs of reach flow, as well as by visual evidence observed in the floodplain. One crest gauge is installed at bankfull elevation along HC-R2 and a second crest gauge is installed along UT4-R2. Both crest gauges recorded two overbank events in MY5 as confirmed by flow gauge readings. Complete project crest gauge readings are presented in Table 13 found in Appendix E and all photographic documentation can be found in Appendix B.

### **2.1.3 Photographic Documentation**

Reference photograph transects were taken at each permanent cross-section during the survey work in October 2019. The survey tape was centered in the photographs of the bank. The water line was located in the lower edge of the frame, and as much of the bank as possible is included in each photograph.

Representative photographs for Monitoring Year 5 were taken along all reaches and vegetation plots for both the Hurricane Creek and UT4 project sites during November 2019 site visits. As previously noted, the site was under a D1 Moderate Drought at the time the stream station photo-points were taken.

A stream flow camera located on UT4-R4b provides some further documentation of seasonal flow and shows water in the channel throughout the late winter and early spring of 2019, confirming the results collected from the in-stream flow gauge found in the same location. However, once again, the flow camera experienced technical difficulties resulting in the loss of photographs. It will be replaced in early 2020 with a newer model camera and relocated to a new position to better document seasonal flow in the channel.

The photographs of stream reaches, flow cameras, vegetation plots, monitoring gauges (both crest and flow gauges), as well as the 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.

Based on the Year 5 vegetation plot monitoring data collected during August and October of 2019, the average planted stem density is 551 stems per acre. Thus, the vegetation data demonstrate that the project as a whole is meeting the minimum success criteria of 260 trees per acre by the end of Year 5, as well as being on track to meet the success criteria of 210 trees per acre by the end of Year 7.

Complete Year 5 vegetation assessment information is provided in Appendix C.

## **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.

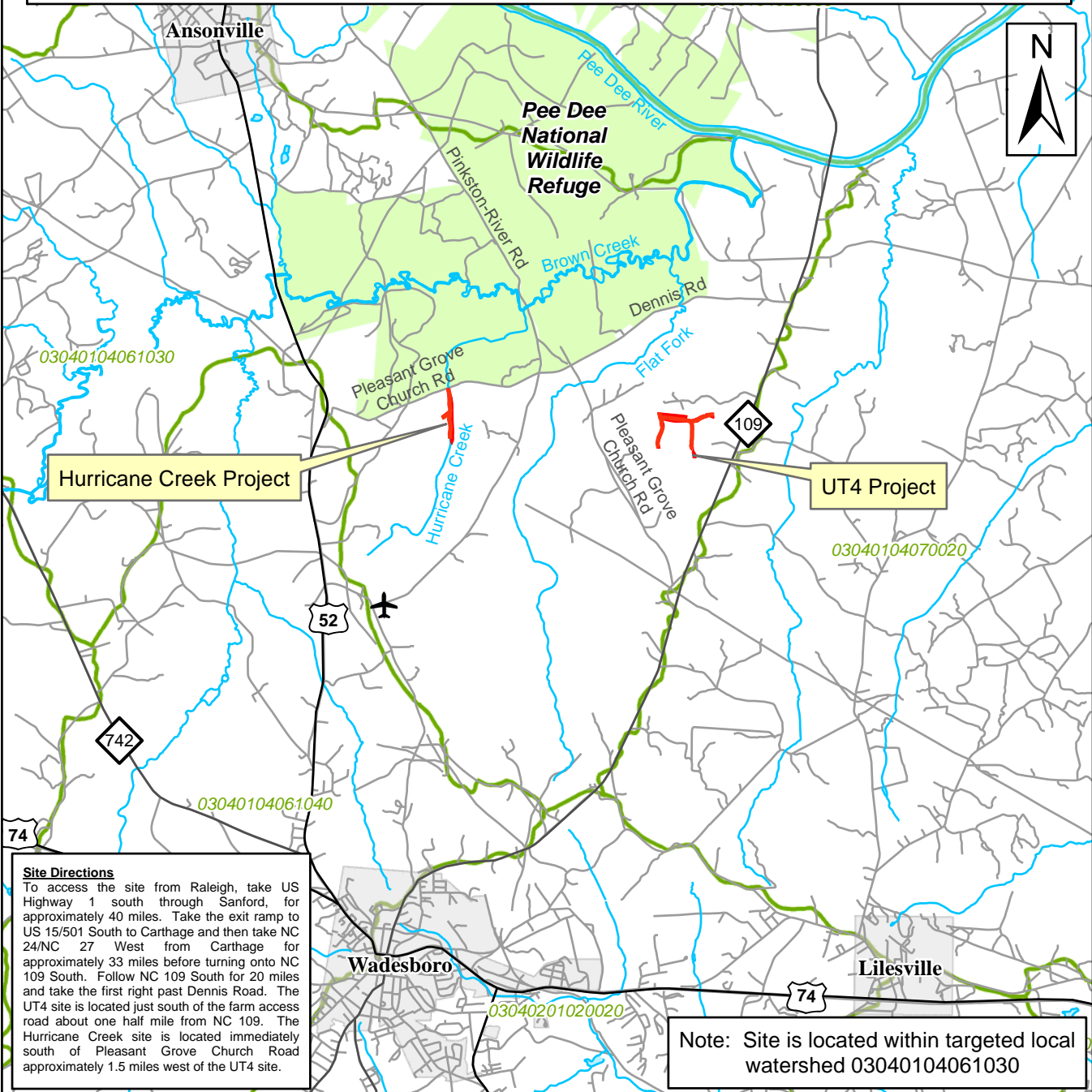
- North Carolina Division of Mitigation Services (DMS). 2011. Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation. November 7, 2011.
- North Carolina Division of Mitigation Services (DMS). 2010. Procedural Guidance and Content Requirements for DMS Annual Monitoring 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**

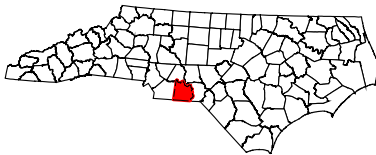
## **Project Vicinity Map and Background Tables**

The subject project site is an environmental restoration site of the NCDEQ Ecosystem Division of Mitigation Services (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.

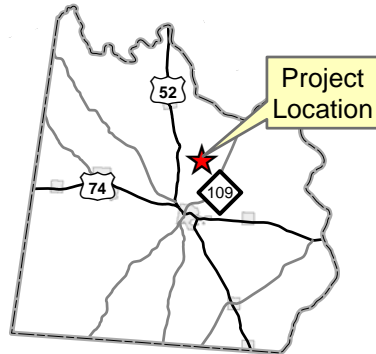


**Site Directions**

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.



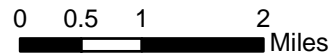
Anson County



Project Location

Figure 1  
Project Vicinity Map  
Brown Creek Tributaries

NCDEQ -  
Division of Mitigation Services



<b>Table 1. Project Components and Mitigation Credits</b>									
<b>Brown Creek Tributaries Restoration Project: DMS Project No ID. 95351</b>									
<b>Mitigation Credits</b>									
	<b>Stream</b>		<b>Riparian Wetland</b>		<b>Non-riparian Wetland</b>		<b>Buffer</b>	<b>Nitrogen Nutrient Offset</b>	<b>Phosphorus Nutrient Offset</b>
Type	R	RE							
Totals	9,663.3	102.2							
<b>Project Components</b>									
<b>Project Component or Reach ID</b>	<b>Stationing/ Location <sup>1</sup></b>		<b>Existing Footage/ Acreage (LF)</b>	<b>Approach</b>	<b>Restoration/ Restoration Equivalent Credits (SMU) from Mitigation Plan <sup>2</sup></b>	<b>As-Built Restoration Footage or Acreage (LF)</b>	<b>Mitigation Ratio</b>		
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		
<b>Component Summation</b>									
<b>Restoration Level</b>	<b>Stream (LF)</b>		<b>Riparian Wetland (AC)</b>		<b>Non-riparian Wetland (AC)</b>	<b>Buffer (SF)</b>	<b>Upland (AC)</b>		
			Riverine	Non-Riverine					
Restoration	8,213								
Enhancement I	1,973								
Enhancement II	564								
Preservation	518								
<b>BMP Elements</b>									
<b>Element</b>		<b>Location</b>	<b>Purpose/Function</b>	<b>Notes</b>					
<b>BMP Elements:</b> 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									

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

<sup>2</sup> The SMU credit numbers used here were taken indirectly from the mitigation plan as per DMS/IRT instruction, and vary from those presented in earlier 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, ostensibly a result of survey differences between the use of stream centerline versus thalweg values.

<b>Table 2. Project Activity and Reporting History</b>			
<b>Brown Creek Tributaries Restoration Project: DMS Project No ID. 95351</b>			
<b>Activity or Report</b>	<b>Scheduled Completion</b>	<b>Data Collection Complete</b>	<b>Actual Completion or Delivery</b>
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 <sup>1</sup>
Planting of bare root trees	Jul-14	N/A	May-15 <sup>1</sup>
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 <sup>2</sup>
Year 1 Monitoring	Dec-15	Feb-16 <sup>3</sup>	Jan-17
Year 2 Monitoring	Dec-16	Nov-16	Jan-17
Privet treated: HC-R3	Treated September 2016		
Stream repairs: Crossing rebuilt on lower UT4-R4b, 3 riffles rebuilt along UT4-R2, J-hook replacement on UT4-R3, bank maintenance/repair on UT4-R2, UT4-R3, and UT4-R5a	Repairs made in June 2016		
Year 3 Monitoring	Dec-17	Nov-17	Nov-17
Stream repairs: Eroding banks regraded & geolifts rebuilt on UT4-R2 (Station 31+75), and on UT4-R4b (Station 23+20)	Repairs made March 2017		
Supplemental planting on upper UT4-R4b	Replanted in January 2017		
Privet treated: HC-R3	Treated January 2017		
Year 4 Monitoring	Dec-18	Oct-18	Dec-18
Supplemental planting on upper HC-R2, UT4-R2	Replanted March 2018		
Privet treated on upper HC-R1 and lower UT4-R4b	Treated March 2018		
Pines/sweetgum thinned on UT4-R4b and UT4-R2	Thinned in June 2018		
Year 5 Monitoring	Dec-19	Nov-19	Feb-20 (Final)
Low vigor planted stems fertilized on HC-R1	Fertilized in March and October 2019		
Year 6 Monitoring	Dec-20	N/A	N/A
Year 7 Monitoring	Dec-21	N/A	N/A

<sup>1</sup> 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.

<sup>2</sup> As-built / Baseline Report submission was delayed due to conservation easement adjustment issues.

<sup>3</sup> 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.

<b>Table 3. Project Contacts</b>	
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>	
<b>Designer</b>	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 <u>Contact:</u> Scott King, Tel. 919-481-5731
<b>Construction Contractor</b>	
River Works, Inc.	114 W. Main St. Clayton, NC 27520 <u>Contact:</u> Stephen Carroll, Tel. 919-428-8368
<b>Planting Contractor</b>	
River Works, Inc.	114 W. Main St. Clayton, NC 27520 <u>Contact:</u> Stephen Carroll, Tel. 919-428-8368
<b>Seeding Contractor</b>	
River Works, Inc.	114 W. Main St. Clayton, NC 27520 <u>Contact:</u> Stephen Carroll, Tel. 919-428-8368
Seed Mix Sources	Green Resources, Tel. 336-855-6363
Nursery Stock Suppliers	Mellow Marsh Farm, 919-742-1200 ArborGen, 843-528-3204
<b>Monitoring Performers</b>	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 <u>Contact:</u> Scott King, Tel. 919-481-5731
Stream Monitoring Point of Contact	Scott King, Tel. 919-481-5731
Vegetation Monitoring Point of Contact	Scott King, Tel. 919-481-5731

<b>Table 4a. Project Attribute Information - Hurricane Creek (Pre-Construction)</b>			
<b>Brown Creek Tributaries Restoration Project Stream Mitigation Plan - DMS Project No. 95351</b>			
<b>Project Information</b>			
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		
<b>Watershed Summary Information</b>			
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%)		
<b>Stream Reach Summary Information</b>			
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%
<b>Regulatory Considerations</b>			
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)

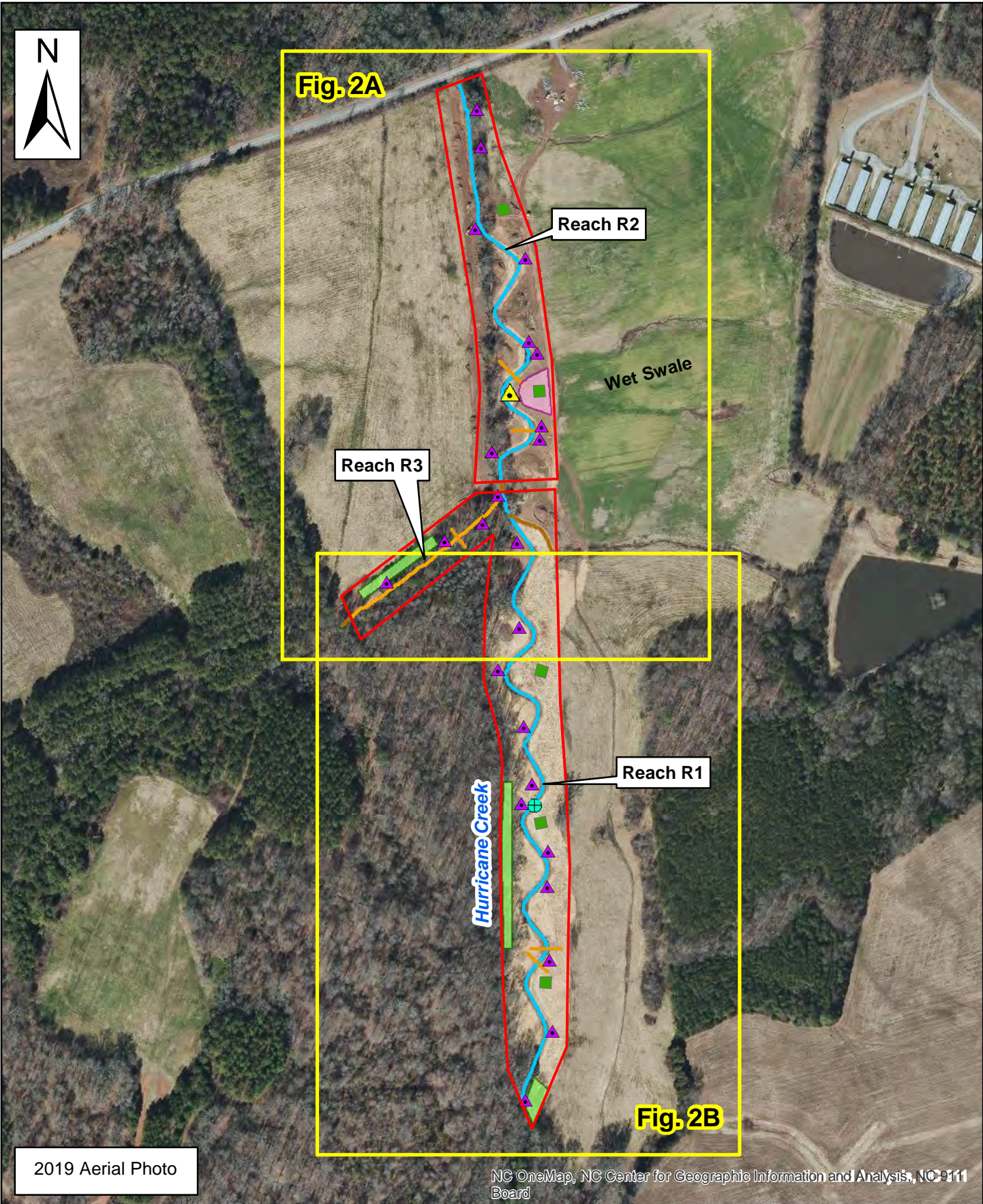


<b>Table 4b. Project Attribute Information - UT4 (Pre-Construction)</b>					
<b>Brown Creek Tributaries Restoration Project Stream Mitigation Plan - DMS Project No. 95351</b>					
<b>Project Information</b>					
Project Name	Brown Creek Tributaries Restoration Project – UT4				
County	Anson				
Project Area (acres)	29.2				
Project Coordinates (latitude and longitude)	35.0477 N, -80.0274 W				
<b>Watershed Summary Information</b>					
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%)				
<b>Stream Reach Summary Information</b>					
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%
<b>Regulatory Considerations</b>					
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)		

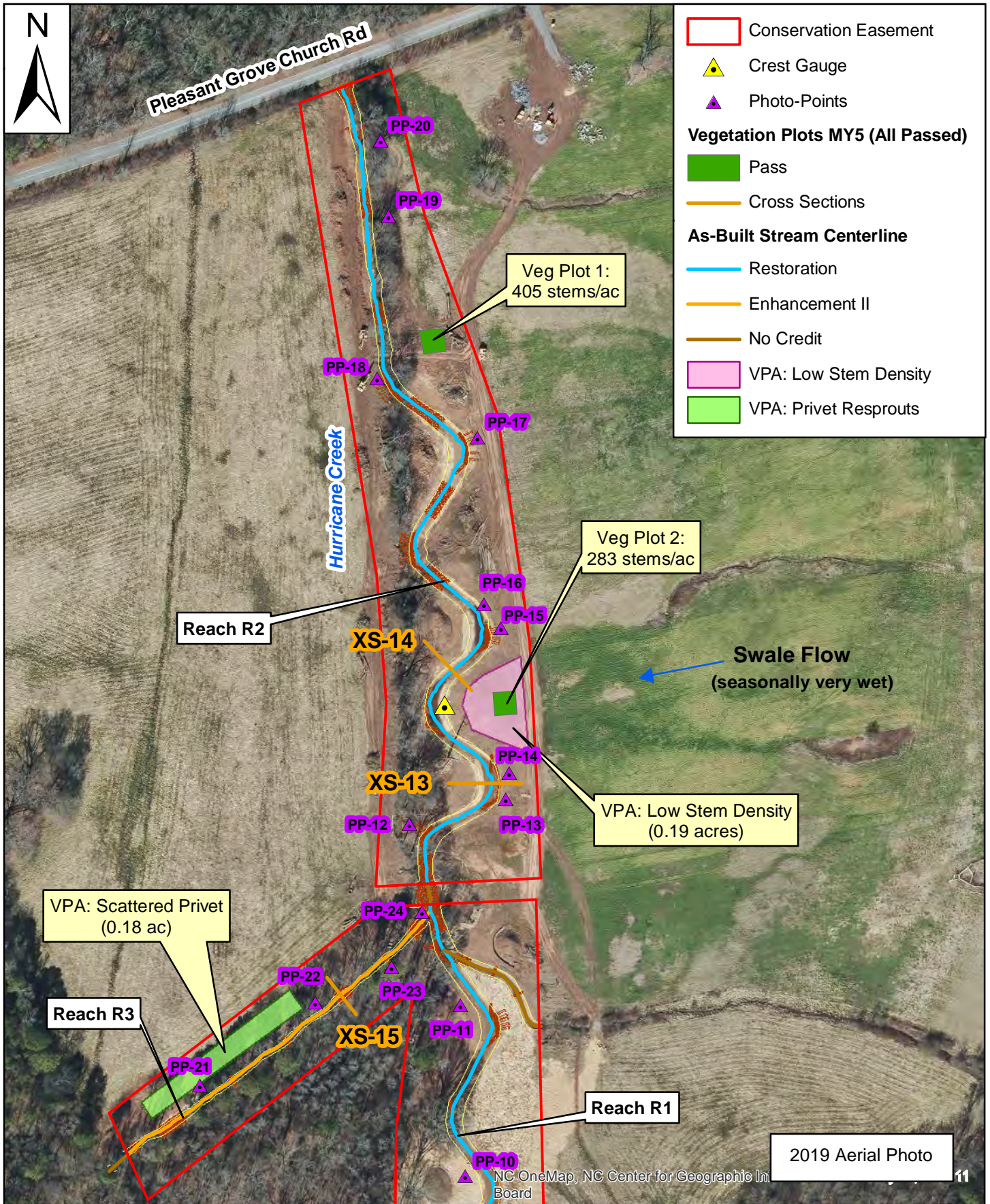
# **Appendix B**

## **Visual Assessment Data**

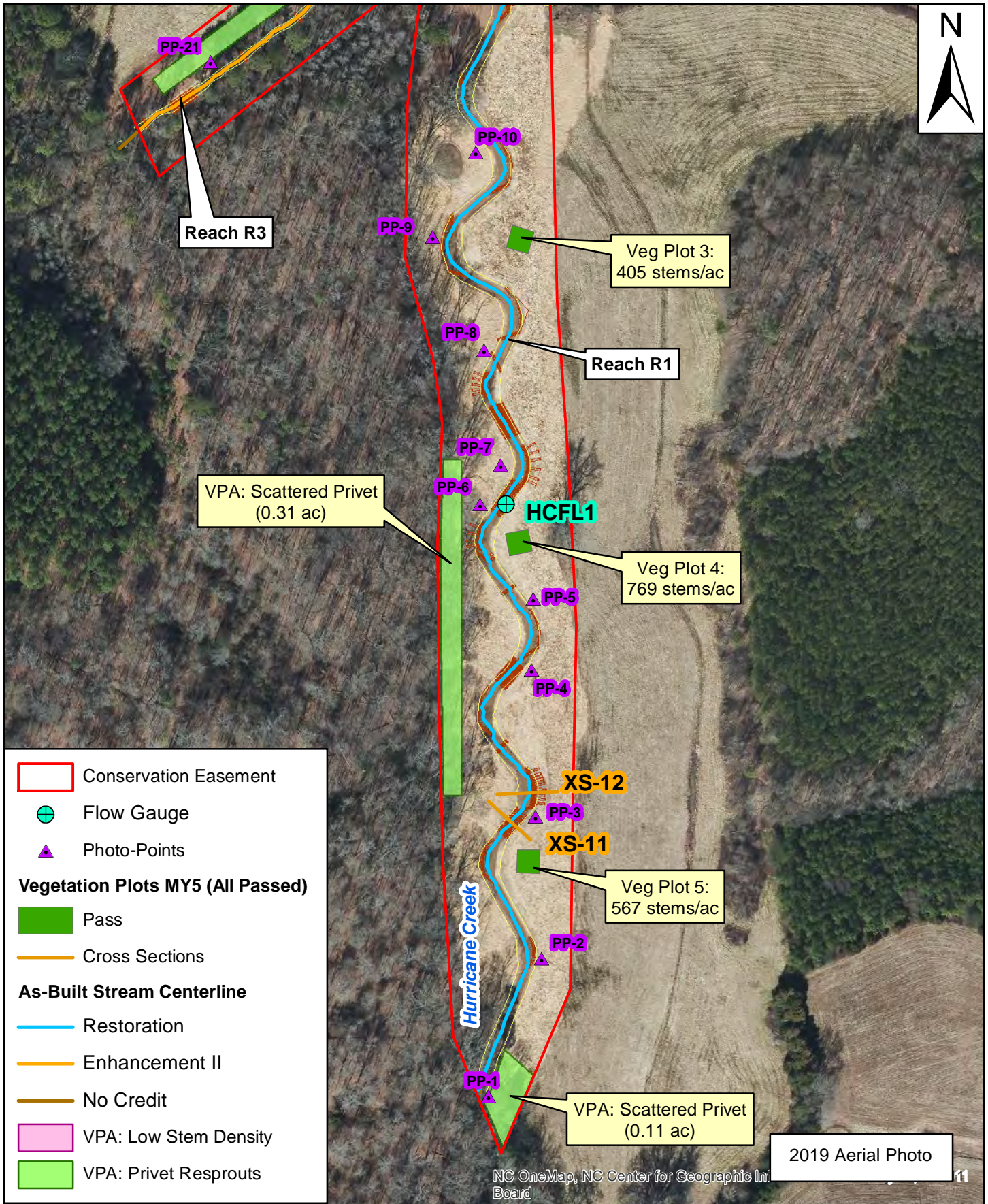




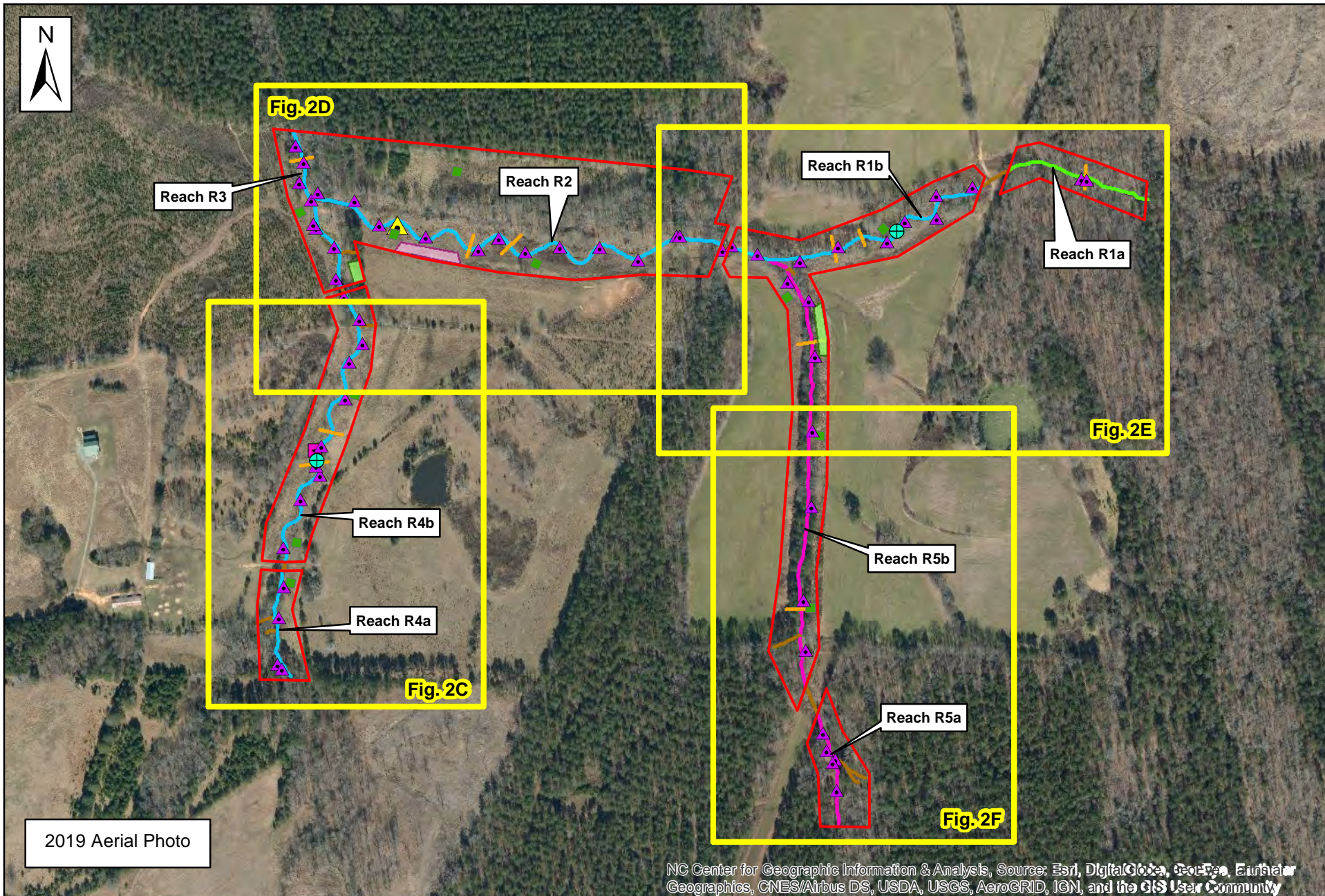




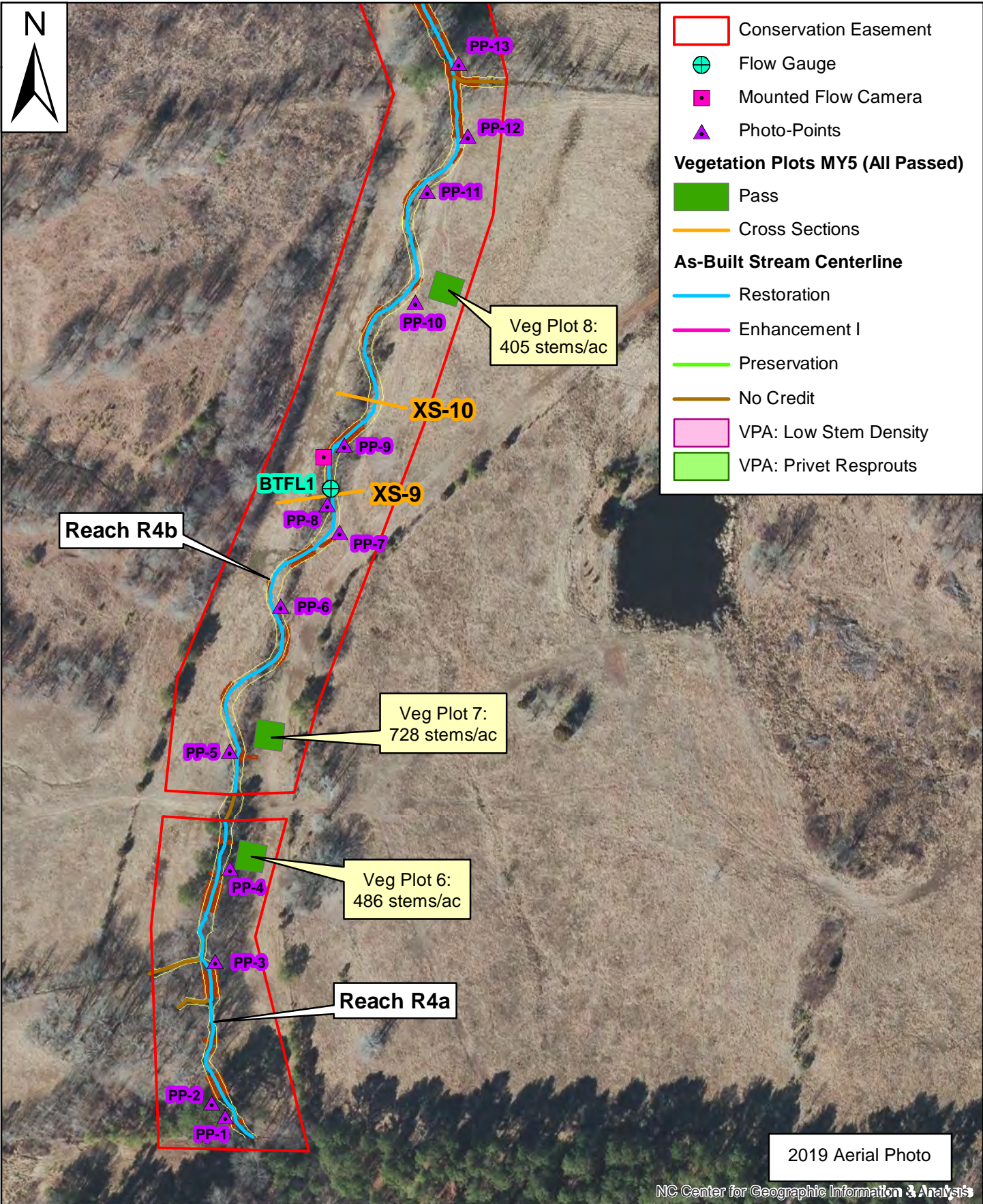




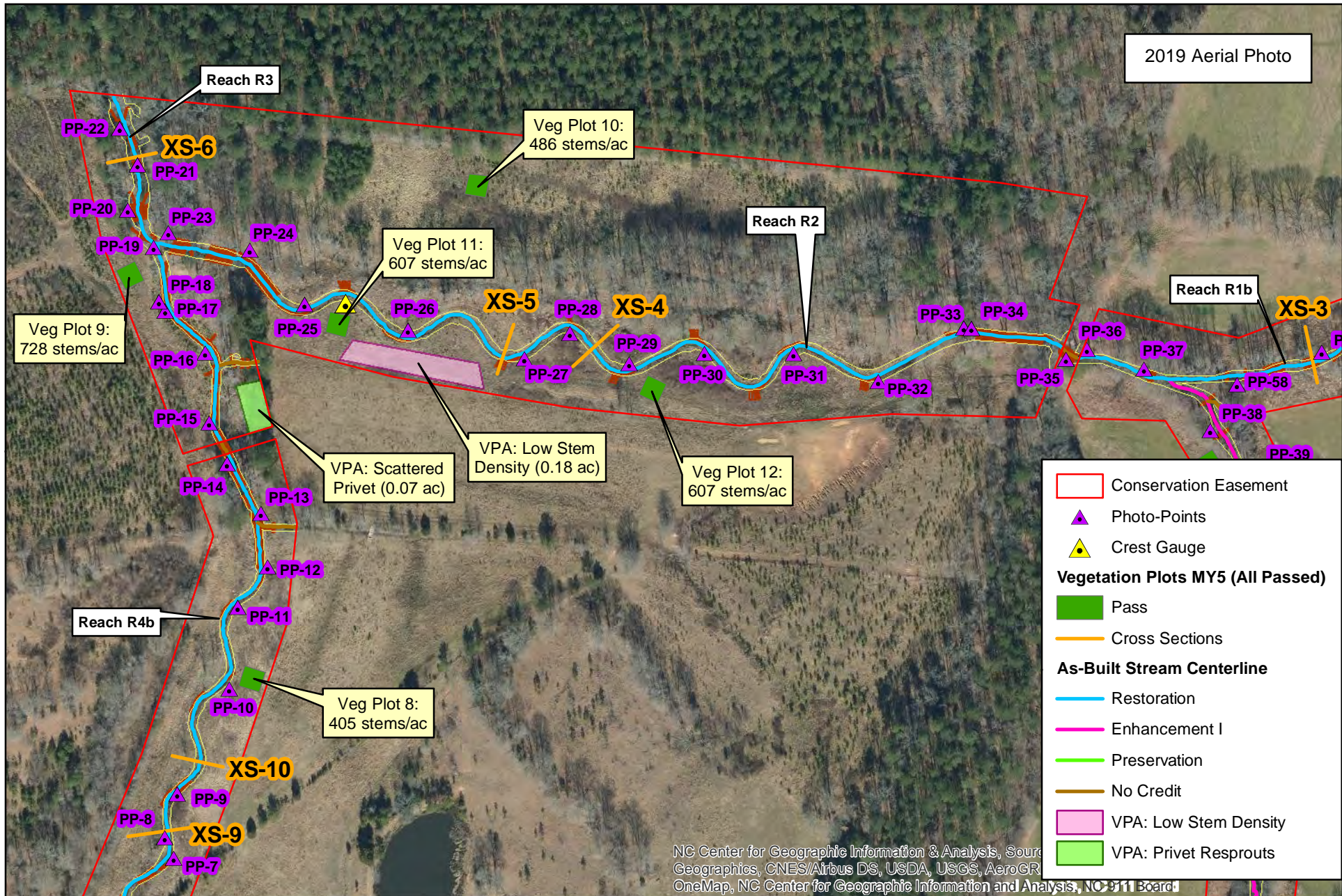




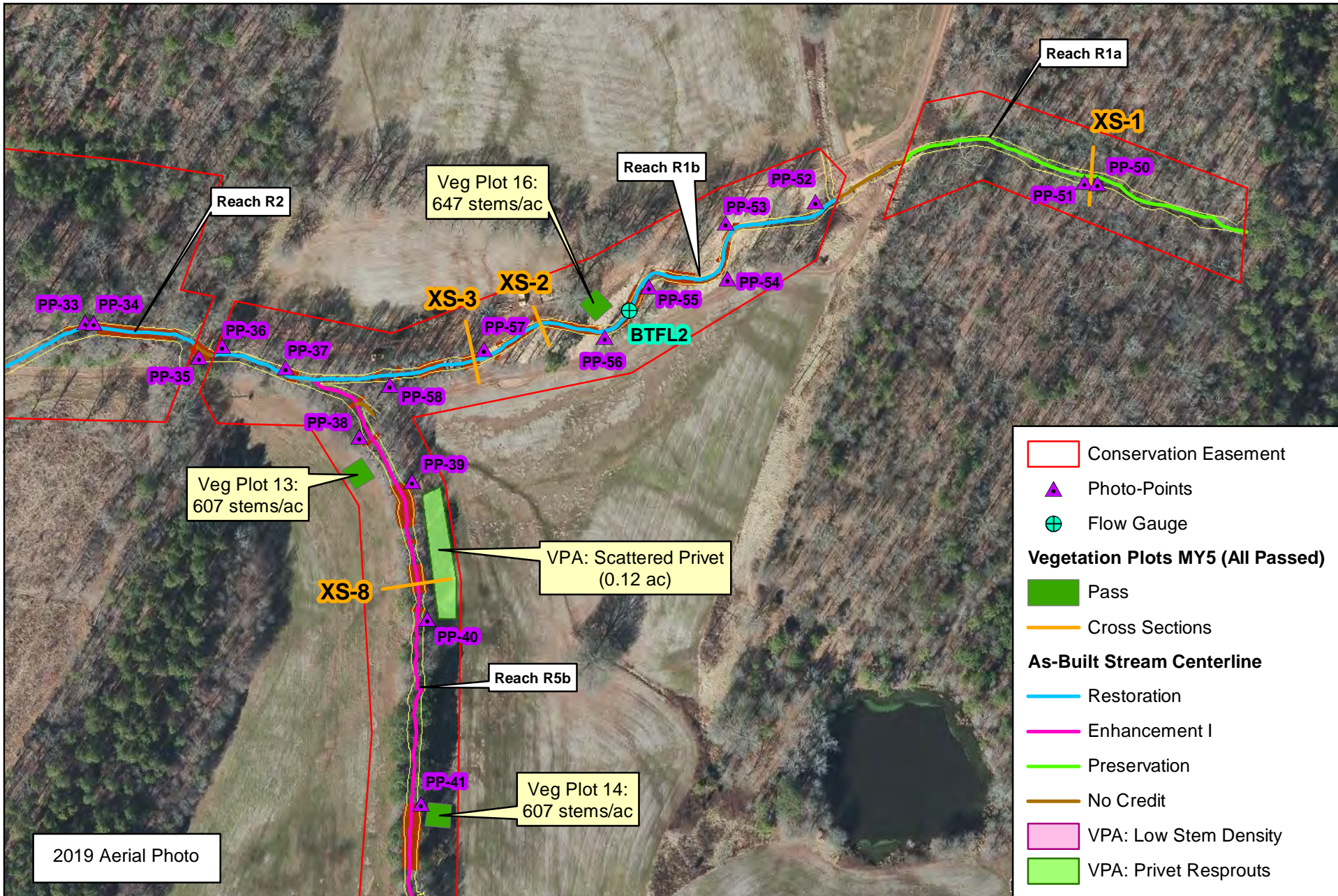




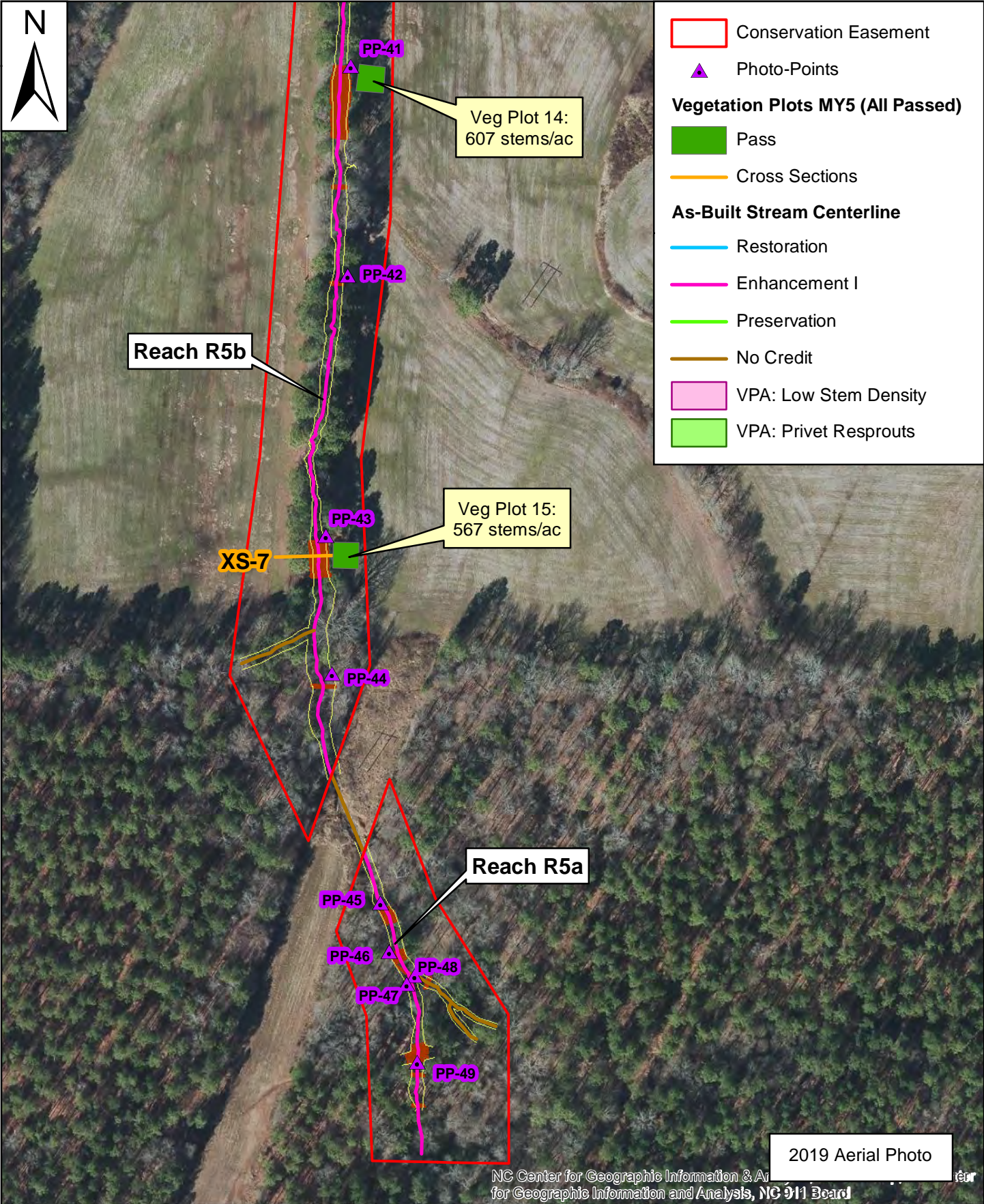












- Conservation Easement
- ▲ Photo-Points
- Vegetation Plots MY5 (All Passed)**
- Pass
- Cross Sections
- As-Built Stream Centerline**
- Restoration
- Enhancement I
- Preservation
- No Credit
- VPA: Low Stem Density
- VPA: Privet Resprouts

Reach R5b

Veg Plot 14:  
607 stems/ac

Veg Plot 15:  
567 stems/ac

XS-7

Reach R5a

2019 Aerial Photo

NC Center for Geographic Information & Analysis, NC 911 Board

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%				
		1. Depth	14	14			100%				
	3. Meander Pool Condition	2. Length	14	14			100%				
		1. Thalweg centering at upstream of meander bend (Run)	15	15			100%				
4. Thalweg Position	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%	
						<b>Totals</b>	0	0	100%	0	0
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
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%
					<b>Totals</b>	0	0	100%	0	0
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%			
		1. Depth	6	6			100%			
	3. Meander Pool Condition	2. Length	6	6			100%			
		1. Thalweg centering at upstream of meander bend (Run)	5	5			100%			
4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	6	6			100%				
	<b>Totals</b>									
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	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%
<b>Totals</b>										
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%			
		1. Depth	10	10			100%			
	3. Meander Pool Condition	2. Length	10	10			100%			
		1. Thalweg centering at upstream of meander bend (Run)	9	9			100%			
	4. Thalweg Position	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%
	<b>Totals</b>					0	0	100%	0	0
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%			
		1. Depth	16	16			100%			
	3. Meander Pool Condition	2. Length	16	16			100%			
		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%
	<b>Totals</b>					0	0	100%	0	0
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%			
		1. Depth	4	4			100%			
	3. Meander Pool Condition	2. Length	4	4			100%			
		1. Thalweg centering at upstream of meander bend (Run)	3	3			100%			
4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	4	4			100%				
	<b>Totals</b>									
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	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%
<b>Totals</b>										
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%			
		1. Depth	23	23			100%			
	3. Meander Pool Condition	2. Length	23	23			100%			
		1. Thalweg centering at upstream of meander bend (Run)	22	22			100%			
4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	23	23			100%				
	<b>Totals</b>									
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	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%
<b>Totals</b>										
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%				
		1. Depth	5	5			100%				
	3. Meander Pool Condition	2. Length	5	5			100%				
		1. Thalweg centering at upstream of meander bend (Run)	6	6			100%				
4. Thalweg Position	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%	
					<b>Totals</b>	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%				

<b>Table 5b. Stream Problem Areas (SPAs)</b>				
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>				
<b>SPA #</b>	<b>Feature Issue</b>	<b>Reach ID, Station Number</b>	<b>Suspected Cause</b>	<b>Photo # in Problem Area Photo Log</b>
-	N/A	N/A	N/A	N/A
Notes:				

<b>Table 6a. Vegetation Conditions Assessment</b>						
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>						
<b>Planted Acreage:</b>	<b>33.5</b>					
<b>Vegetation Category</b>	<b>Definitions</b>	<b>Mapping Threshold (acres)</b>	<b>CCPV Depiction</b>	<b>Number of Polygons</b>	<b>Combined Acreage</b>	<b>% of Planted Acreage</b>
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	Pink Polygons	2	0.37	1.1%
<b>Total</b>				<b>2</b>	<b>0.37</b>	<b>1.1%</b>
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	N/A	0	0.00	0.0%
<b>Cumulative Total</b>				<b>2</b>	<b>0.37</b>	<b>1.1%</b>
<b>Easement Acreage:</b>	<b>43.3</b>					
<b>Vegetation Category</b>	<b>Definitions</b>	<b>Mapping Threshold</b>	<b>CCPV Depiction</b>	<b>Number of Polygons</b>	<b>Combined Acreage</b>	<b>% of Easement Acreage</b>
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale)	1000 ft <sup>2</sup>	Green Polygons	5	0.80	1.8%
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%

<b>Table 6b. Vegetation Problem Areas (VPAs)</b>			
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>			
<b>Feature Issue</b>	<b>Station Number</b>	<b>Area</b>	<b>Suspected Cause</b>
Low stem density	UT4-R2, Left bank, Station 32+00 to 35+00	~0.18 acres	None readily identifiable <sup>1</sup>
	HC-R2, Right bank, Station 33+50 to 35+00	~0.19 acres	Extreme wet conditions <sup>2</sup>
Privet ( <i>Ligustrum sinense</i> )	UT4: R4b Right bank, Station X+Y to X+Y, and R5b Right bank, Station X+Y to S+Y	Combined ~0.80 acres	Scattered resprouts
	HC: R1 Left bank, Stations 10+00 to 11+00 and 15+00 to 21+00, and R3 Left bank, Station 11+00 to 13+50		
Notes:			
<p>1 This area of observed low stem density is located in a relatively higher and drier location on the floodplain than the more successful adjacent areas and the soil is particularly dense here (though no benching or cutting down of soil was conducted here during construction), though this is just speculation and the exact reason for the observed mortality is not readily identifiable. The area appears to meet MY5 success criteria, though just barely, so additional supplemental planted will be put out in the winter of 2019-2020 to ensure this area meets vegetative success at MY7.</p>			
<p>2 This area has experienced a fairly high mortality rate due to extreme wetness and extended ponding as a result of periodic flow from large drainage swales located in the adjacent pasture (see aerial photo in CCPV Figure 2A). It has also likely stunted the growth of the surviving species. However, this area still meets stem density requirements for MY5, though just barely. Nevertheless, additional, more water-tolerant species will be supplementally planted here in the winter of 2019-2020 to ensure vegetative success is met by MY7.</p>			



MY5 Stream Station Photo-Points: Hurricane Creek Site (taken 11/7/19)



PP-1: HC Reach 1, view downstream at Station 10+00



PP-2: HC Reach 1, view downstream at Station 11+80



PP-3: HC Reach 1, view downstream at Station 14+50



PP-4: HC Reach 1, view upstream at Station 17+50



PP-5: HC Reach 1, view downstream at Station 18+00



PP-6: HC Reach 1, view upstream at Station 19+50



MY5 Stream Station Photo-Points: Hurricane Creek Site (taken 11/7/19)



PP-7: HC Reach 1, view downstream at Station 19+75



PP-8: HC Reach 1, view upstream at Station 22+40



PP-9: HC Reach 1, view downstream at Station 24+00



PP-10: HC Reach 1, vernal pool at Station 26+25



PP-11: HC Reach 1, view downstream at Station 29+30



PP-12: HC Reach 2, view upstream at Station 31+40



MY5 Stream Station Photo-Points: Hurricane Creek Site (taken 11/7/19)



PP-13: HC Reach 2, view upstream at Station 32+75



PP-14: HC Reach 2, view downstream at Station 33+00



PP-15: HC Reach 2, view upstream at Station 35+70



PP-16: HC Reach 2, view downstream at Station 36+00



PP-17: HC Reach 2, view downstream at Station 39+10



PP-18: HC Reach 2, view downstream at Station 40+75



MY5 Stream Station Photo-Points: Hurricane Creek Site (taken 11/7/19)



PP-19: HC Reach 2, view upstream at Station 43+75



PP-20: HC Reach 2, view downstream at Station 44+25



PP-21: HC Reach 3, view upstream at Station 11+40



PP-22: HC Reach 3, view downstream at Station 14+00



PP-23: HC Reach 3, view downstream at Station 15+50



PP-24: HC Reach 3, view upstream at Station 15+90



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-1: Reach UT4-R4a – View upstream, Station 11+50



PP-2: Reach UT4-R4a – View downstream, Station 12+40



PP-3: Reach UT4-R4a – View upstream, Station 13+20



PP-4: Reach UT4-R4a – View upstream, Station 14+00



PP-5: Reach UT4-R4b – View downstream, Station 14+75



PP-6: Reach UT4-R4b – View downstream, Station 17+00



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-7: Reach UT4-R4b – View upstream, Station 18+20



PP-8: Reach UT4-R4b – View downstream, Station 18+90



PP-9: Reach UT4-R4b – View downstream, Station 19+00



PP-10: Reach UT4-R4b – View downstream, Station 21+00



PP-11: Reach UT4-R4b – View upstream at Station 22+50



PP-12: Reach UT4-R4b – View downstream, Station 23+25



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-13: Reach UT4-R4b – View downstream, Station 24+00



PP-14: Reach UT4-R4b – View upstream, Station 25+00



PP-15: Reach UT4-R4b – View downstream, Station 25+75



PP-16: Reach UT4-R4b – View upstream, Station 27+00



PP-17: Reach UT4-R4b – View upstream, Station 28+00



PP-18: Reach UT4-R4b – View downstream, Station 28+00



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-19: Reach UT4-R3 – View downstream, Station 29+00



PP-20: Reach UT4-R3 – View downstream, Station 29+50



PP-21: Reach UT4-R3 – View downstream, Station 30+25



PP-22: Reach UT4-R3 – View downstream, Station 31+00



PP-23: Reach UT4-R2 – View upstream at Station 37+50



PP-24: Reach UT4-R2 – View upstream, Station 37+00



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-25: Reach UT4-R2 – View upstream, Station 35+50



PP-26: Reach UT4-R2 – View downstream, Station 33+50



PP-27: Reach UT4-R2 – View upstream, Station 31+50



PP-28: Reach UT4-R2 – View downstream, Station 30+50



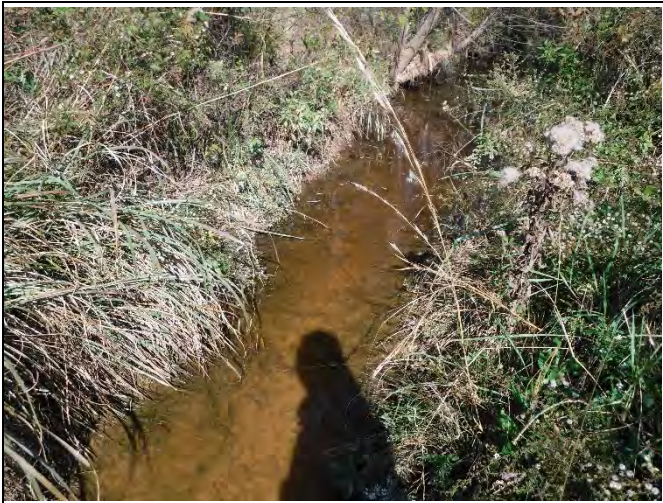
PP-29: Reach UT4-R2 – View upstream at Station 29+00



PP-30: Reach UT4-R2 – View upstream, Station 28+00



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-31: Reach UT4-R2 – View upstream, Station 26+00



PP-32: Reach UT4-R2 – View upstream, Station 24+50



PP-33: Reach UT4-R2 – View downstream, Station 23+00



PP-34: Reach UT4-R2 – View upstream, Station 23+00



PP-35: Reach UT4-R2 – View downstream, Station 20+40



PP-36: Reach UT4-R2 – View upstream, Station 21+00



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-37: Reach UT4-R2 – View upstream, Station 20+00



PP-38: Reach UT4-R5b – View upstream, Station 29+00



PP-39: Reach UT4-R5b – View upstream, Station 28+25



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



PP-41: Reach UT4-R5b – View upstream, Station 23+50



PP-42: Reach UT4-R5b – View upstream, Station 20+75



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-43: Reach UT4-R5b – View upstream, Station 17+50



PP-44: Reach UT4-R5b – View upstream, Station 15+50



PP-45: Reach UT4-R5a – View upstream, Station 12+75



PP-46: Reach UT4-R5a – View upstream, Station 12+00



PP-47: Reach UT4-R5a – Side tributary at Station 11+75



PP-48: Reach UT4-R5a – View upstream, Station 11+50



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-49: Reach UT4-R5a – View upstream, Station 10+75



PP-50: Reach UT4-R1a – View upstream, Station 12+40



PP-51: Reach UT4-R1a – View downstream, Station 12+40



PP-52: Reach UT4-R1b – View downstream, Station 11+25



PP-53: Reach UT4-R1b – View downstream, Station 12+75



PP-54: Reach UT4-R1b – View downstream, Station 13+25



MY5 Stream Station Photo-Points: UT4 Site (taken 11/6/19)



PP-55: Reach UT4-R1b – View downstream, Station 14+25



PP-56: Reach UT4-R1b – View downstream, Station 15+25



PP-57: Reach UT4-R1b – View downstream, Station 17+50



PP-58: Reach UT4-R1b – View upstream, Station 19+00



MY5 Vegetation Plot Photographs



Vegetation Plot 1 – HC-R2



Vegetation Plot 2 – HC-R2



Vegetation Plot 3 – HC-R1



Vegetation Plot 4 – HC-R1



Vegetation Plot 5– HC-R1  
(pines to be thinned)



Vegetation Plot 6 – UT4-R4



MY5 Vegetation Plot Photographs



Vegetation Plot 7 – UT4-R4



Vegetation Plot 8 – UT4-R4



Vegetation Plot 9 – UT4-R3



Vegetation Plot 10 – UT4-R2  
(pines/sweetgum to be thinned)



Vegetation Plot 11 – UT4-R2  
(pines/sweetgum to be thinned)



Vegetation Plot 12 – UT4-R2



MY5 Vegetation Plot Photographs



Vegetation Plot 13 – UT4-R5



Vegetation Plot 14 – UT4-R5



Vegetation Plot 15 – UT4-R5



Vegetation Plot 16 – UT4-R1



MY5 Monitoring Gauge Photographs



Crest Gauge Reach UT4-R2: Overbank event of 1.09'  
(photo from 4/11/19)



Reach UT4-R2: Evidence of overbank event  
(photo from 4/11/19)



Crest Gauge Reach HC-R1: Overbank event of 1.72'  
(photo from 4/12/19)



Crest Gauge Reach HC-R1: Close-up of gauge reading  
(photo from 4/12/19)



Crest Gauge Reach UT4-R2: Overbank event of 0.58'  
(photo from 10/16/19)



Crest Gauge Reach HC-R1: Overbank event of 0.60'  
(photo from 8/8/19)



MY5 Monitoring Gauge Photographs



Crest Gauge Reach HC-R1: Close-up of gauge reading (photo from 8/8/19)



Flow Gauge in upper Reach HC-R1 (photo 4/12/19)



Flow Gauge in Reach UT4-R4b (photo 4/11/19)



Flow Gauge in Reach UT4-R2 (photo 11/6/19)



MY5 Vegetation Problem Area Photographs



Privet (*Ligustrum sinense*) on upper Reach HC-R1  
(photo from 11/7/19)



Privet (*Ligustrum sinense*) on Reach HC-R1  
(photo from 11/7/19)



Privet (*Ligustrum sinense*) on Reach HC-R3  
(photo from 11/7/19)



Low stem density on UT4-R2 (photo from 11/6/19)



Low stem density on HC-R2 (photo from 11/7/19)



Previously reported low-vigor area on upper HC-R1  
(photo from 11/7/19)



MY5 Vegetation Problem Area Photographs



Previously reported low-vigor area on upper HC-R1  
(photo from 11/7/19)



Previously reported low-vigor area on upper HC-R1  
(photo from 11/7/19)



MY5 Additional Flow Photographs



Flow camera showing flow in riffle on Reach UT4-R4b  
(photo from 1/12/19)



Flow Camera showing flow in riffle on Reach UT4-R4b  
(photo from 3/19/19)



Flow camera showing flow in riffle on Reach UT4-R4b  
(photo from 3/29/19)



Photo showing flow on upper Reach HC-R3  
(photo from 4/12/19)



Photo showing flow on middle Reach HC-R3  
(photo from 4/12/19)



Photo showing flow on middle Reach HC-R3  
(photo from 4/12/19)



MY5 Additional Flow Photographs



Photo showing flow on middle Reach UT4-R2  
(photo from 4/11/19)



Photo showing flow on upper Reach UT4-R2  
(photo from 4/11/19)



Photo showing flow at crossing on upper Reach  
UT4-R2 (photo from 4/11/19)



Photo showing flow on middle Reach UT4-R1B  
(photo from 4/11/19)



# **Appendix C**

## **Vegetation Plot Data**



<b>Table 7. Vegetation Plot Criteria Attainment</b>			
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>			
<b>Plot ID</b>	<b>Vegetation Survival Threshold Met?</b>	<b>Total/Planted Stem Count*</b>	<b>Tract Mean</b>
1	Y	405/648	551
2	Y	283/688	
3	Y	405/607	
4	Y	769/931	
5	Y	567/769	
6	Y	486/809	
7	Y	728/728	
8	Y	405/688	
9	Y	728/809	
10	Y	486/890	
11	Y	607/728	
12	Y	607/769	
13	Y	607/607	
14	Y	607/809	
15	Y	567/809	
16	Y	648/809	

Note: \*Total/Planted Stem Count reflects the changes in stem density based on the total current density of planted stems (Total), and the density of stems at the time of the As-Built Survey (Planted).



<b>Table 8. CVS Vegetation Metadata</b>	
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>	
<b>Report Prepared By</b>	Drew Powers
<b>Date Prepared</b>	10/21/2019 11:00
<b>database name</b>	MichaelBaker_2018_BrownCrkTribs_95351.mdb
<b>database location</b>	\\CARYFS1.bkr.mbakercorp.com\PROJECTS\128975\Monitoring\Veg Plots\Year 5_2019
<b>computer name</b>	CARYLAPOWERS1
<b>file size</b>	67538944
<b>DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----</b>	
<b>Metadata</b>	Description of database file, the report worksheets, and a summary of project(s) and project data.
<b>Proj, planted</b>	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
<b>Proj, total stems</b>	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
<b>Plots</b>	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
<b>Vigor</b>	Frequency distribution of vigor classes for stems for all plots.
<b>Vigor by Spp</b>	Frequency distribution of vigor classes listed by species.
<b>Damage</b>	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
<b>Damage by Spp</b>	Damage values tallied by type for each species.
<b>Damage by Plot</b>	Damage values tallied by type for each plot.
<b>Planted Stems by Plot and Spp</b>	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
<b>ALL Stems by Plot and spp</b>	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
<b>PROJECT SUMMARY-----</b>	
<b>Project Code</b>	95351
<b>project Name</b>	Brown Creek Tributaries
<b>Description</b>	
<b>River Basin</b>	Yadkin-Pee Dee
<b>length(ft)</b>	3716
<b>stream-to-edge width (ft)</b>	50
<b>area (sq m)</b>	34519.28
<b>Required Plots (calculated)</b>	10
<b>Sampled Plots</b>	16

**Table 9a. CVS Stem Count of Planted Stems by Plot and Species**  
**Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351**

Comment	Species	SpType	CommonName	Total Planted Stems		avg# stems	plot 95351-01-0001-year:5	plot 95351-01-0002-year:5	plot 95351-01-0003-year:5	plot 95351-01-0004-year:5	plot 95351-01-0005-year:5	plot 95351-01-0006-year:5	plot 95351-01-0007-year:5	plot 95351-01-0008-year:5	plot 95351-01-0009-year:5	plot 95351-01-0010-year:3	plot 95351-01-0011-year:5	plot 95351-01-0012-year:5	plot 95351-01-0013-year:5	plot 95351-01-0014-year:5	plot 95351-01-0015-year:5	plot 95351-01-0016-year:5
				# plots	avg# stems																	
	<i>Alnus serrulata</i>	Shrub Tree	hazel alder	5	4	1.25			1	2				1				1				
	<i>Asimina triloba</i>	Shrub Tree	pawpaw	2	2	1															1	1
	<i>Betula nigra</i>	Tree	river birch	37	14	2.64	4	4	1	3	2	1		4	5	3	4	1		3	1	3
	<i>Carpinus caroliniana</i>	Shrub Tree	American hornbeam	6	5	1.2	1						1				2		1	1		
	<i>Cornus amomum</i>	Shrub	silky dogwood	1	1	1			1													
	<i>Diospyros virginiana</i>	Tree	common persimmon	11	7	1.57			3	1		1	3						1	1	1	
	<i>Fraxinus pennsylvanica</i>	Tree	green ash	45	15	3	2	3	5	1	2	4	5	2	5	2		5	2	2	2	3
	<i>Hamamelis virginiana</i>	Shrub Tree	American witchhazel	4	2	2												2		2		
	<i>Itea virginica</i>	Shrub	Virginia sweetspire	1	1	1				1												
	<i>Lindera benzoin</i>	Shrub Tree	northern spicebush																			
	<i>Liriodendron tulipifera</i>	Tree	tuliptree	4	4	1			1	1							1		1			
	<i>Nyssa sylvatica</i>	Tree	blackgum	13	7	1.86								1	4	1	1	2	1	2	2	2
	<i>Platanus occidentalis</i>	Tree	American sycamore	29	13	2.23			1	2	2	1	7	2	1	2	2	4	3	1		1
	<i>Quercus alba</i>	Tree	white oak	12	10	1.2		1		1	1	2		1	2		1	1	1	1	1	
	<i>Quercus lyrata</i>	Tree	Overcup oak	1	1	1								1								
	<i>Quercus michauxii</i>	Tree	swamp chestnut oak	19	11	1.73	1		1	2		3	1	1		1	1	4	3			1
	<i>Quercus nigra</i>	Tree	water oak	1	1	1		1														
	<i>Quercus phellos</i>	Tree	willow oak	10	7	1.43	1		1	2	1		1		1							3
	<i>Viburnum dentatum</i>	Shrub Tree	southern arrowwood	17	9	1.89	1		4	3	1				1	2			1	3	1	
<b>TOT: 0</b>	<b>18</b>	<b>18</b>	<b>18</b>	<b>218</b>	<b>18</b>		<b>10</b>	<b>7</b>	<b>10</b>	<b>19</b>	<b>14</b>	<b>12</b>	<b>18</b>	<b>10</b>	<b>18</b>	<b>12</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>16</b>



**Table 9b. Total Stem Counts for Each Species Arranged by Plot**  
**Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351**

Botanical Name	Common Name	Plots																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
<b>Tree Species</b>																		
<i>Betula nigra</i>	river birch	4	4	1	3	3	1		4	5	3	4	1		3	1	3	
<i>Fraxinus pennsylvanica</i>	green ash	3	4	15	1	2	7	10	2	5	2		10	7	2	2	8	
<i>Liriodendron tulipifera</i>	tulip poplar				1	1						1		1				
<i>Nyssa sylvatica</i>	blackgum										1	4	1	1	2	2	2	
<i>Plantanus occidentalis</i>	sycamore			1	2	2	1	7	2	1	2	2	4	3	1		1	
<i>Quercus alba</i>	white oak			1		1	1	2		1	2		1	1	1	1		
<i>Quercus lyrata</i>	overcup oak									1								
<i>Quercus michauxii</i>	swamp chestnut oak	1			1	2		3	1	1		1	1	4	3		1	
<i>Quercus nigra</i>	water oak			1														
<i>Quercus phellos</i>	willow oak	1		1	3	1				1		1					8	
<i>Ulmus americana</i>	American elm	1		5	5	3	2					4		5			10	
<b>Shrub Species</b>																		
<i>Alnus serrulata</i>	hazel alder				1		2				1			1				
<i>Asimina triloba</i>	paw paw															1	1	
<i>Carpinus caroliniana</i>	ironwood	1							1				2		1	1		
<i>Cornus ammomum</i>	silkly dogwood				1				1									
<i>Diospyros virginiana</i>	persimmon				3		5		1	3		2			1	1	1	
<i>Hamamelis virginiana</i>	witch hazel												2			2		
<i>Itea virginica</i>	Virginia sweetspire						1											
<i>Viburnum dentatum</i>	arrowwood viburnum	1			4	3	1				1	2			1	3	1	
<b>Total Stems Per Plot Year 5* (October 2019)</b>		<b>12</b>	<b>8</b>	<b>25</b>	<b>25</b>	<b>18</b>	<b>21</b>	<b>24</b>	<b>10</b>	<b>18</b>	<b>12</b>	<b>21</b>	<b>20</b>	<b>25</b>	<b>15</b>	<b>14</b>	<b>36</b>	
<b>Total Stems/Acre Year 5* (October 2019)</b>		<b>486</b>	<b>324</b>	<b>1012</b>	<b>1012</b>	<b>728</b>	<b>850</b>	<b>971</b>	<b>405</b>	<b>728</b>	<b>486</b>	<b>850</b>	<b>809</b>	<b>1012</b>	<b>607</b>	<b>567</b>	<b>1457</b>	<b>769</b>
<b>Total Stems/Acre Year 3 (September 2017)</b>		567	243	445	809	728	567	728	567	688	648	648	486	850	648	728	769	632
<b>Total Stems/Acre Year 2 (November 2016)</b>		486	364	405	850	688	567	202	486	647	769	647	607	607	688	728	728	592
<b>Total Stems/Acre Year 1 (November 2015)</b>		648	567	607	931	728	769	405	688	809	850	728	769	607	769	809	769	716
<b>Total Stems/ Acre for Year 0 As-Built (Baseline Data)</b>		648	688	607	931	769	809	728	688	809	890	728	769	607	809	809	809	756

\*Note: Monitoring Year 5 (2019) includes volunteer species data, which was only fully collected and reported here for the first time, whereas previous monitoring years only reported planted species data.





**Table 9d. Vegetation Summary and Totals**  
**Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351**

**Year 5 (14-OCT-2019)**  
**Vegetation Plot Summary Information**

Plot #	Riparian Buffer Stems <sup>1</sup>	Stream/Wetland Stems <sup>2</sup>	Live Stakes	Invasives	Volunteers <sup>3</sup>	Total <sup>4</sup>	Unknown Growth Form
1	n/a	10	0	0	2	12	0
2	n/a	7	0	0	1	8	0
3	n/a	10	0	0	15	25	0
4	n/a	19	0	0	6	25	0
5	n/a	14	0	0	4	18	0
6	n/a	12	0	0	9	21	0
7	n/a	18	0	0	6	24	0
8	n/a	10	0	0	0	10	0
9	n/a	18	0	0	0	18	0
10	n/a	12	0	0	0	12	0
11	n/a	15	0	0	4	19	0
12	n/a	15	0	0	5	20	0
13	n/a	15	0	0	10	25	0
14	n/a	15	0	0	0	15	0
15	n/a	14	0	0	0	14	0
16	n/a	16	0	0	20	36	0

**Wetland/Stream Vegetation Totals (per acre)**

Plot #	Stream/Wetland Stems <sup>2</sup>	Volunteers <sup>3</sup>	Total <sup>4</sup>	Success Criteria Met?
1	405	81	486	Yes
2	283	40	324	Yes
3	405	607	1012	Yes
4	769	243	1012	Yes
5	567	162	728	Yes
6	486	364	850	Yes
7	728	243	971	Yes
8	405	0	405	Yes
9	728	0	728	Yes
10	486	0	486	Yes
11	607	162	850	Yes
12	607	202	809	Yes
13	607	405	1012	Yes
14	607	0	607	Yes
15	567	0	567	Yes
16	647	809	1457	Yes
<b>Project Avg</b>	<b>551</b>	<b>213</b>	<b>769</b>	<b>Yes</b>

**Stem Class      Characteristics**

<sup>1</sup>Buffer Stems      Native planted hardwood trees. Does NOT include shrubs. No pines. No vines.

<sup>2</sup>Stream/ Wetland Stems      Native planted woody stems. Includes shrubs, does NOT include live stakes. No vines

<sup>3</sup>Volunteers      Native woody stems. Not planted. No vines.

<sup>4</sup>Total      Planted + volunteer native woody stems. Includes live stakes. Excl. exotics. Excl. vines.

**Color Key**

Exceeds requirements by 10%

Fails to meet requirements by more than 10%

Exceeds requirements, but by less than 10%

# **Appendix D**

## **Stream Assessment Data**



**Figure 3. Cross-Sections with Annual Overlays**

**Permanent Cross-Section 1**  
Year 5 Data - Collected October 2019

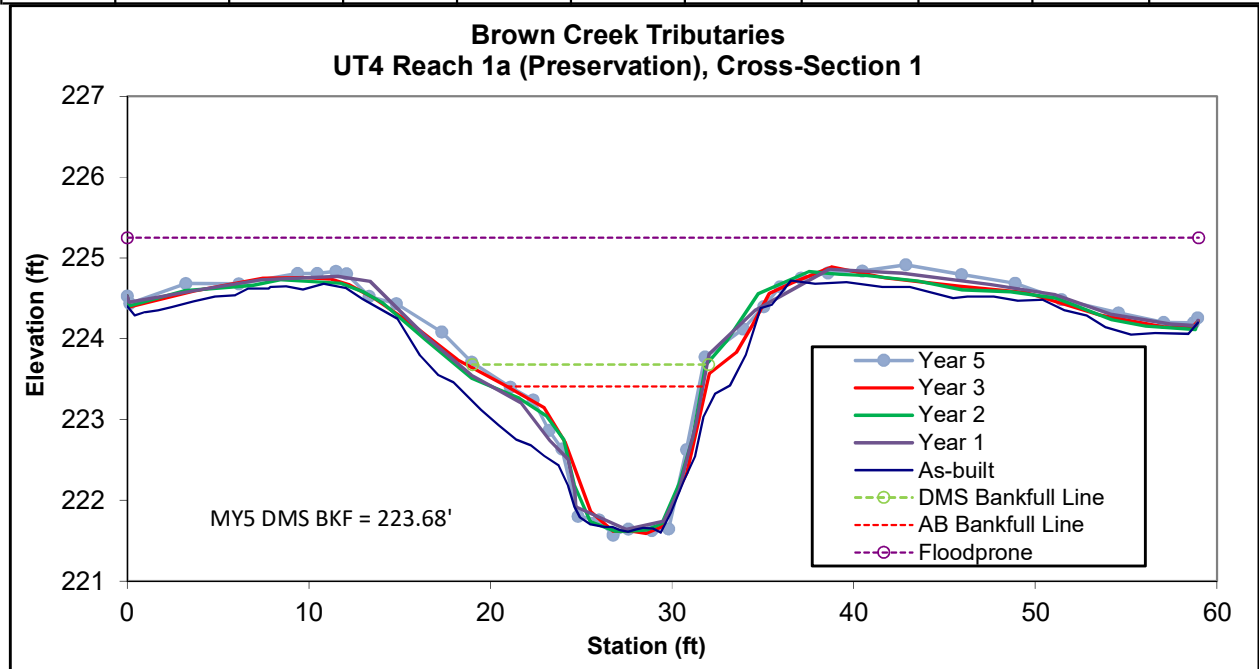


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	12.2	10.5	1.2	1.8	9.0	1.0	5.6	223.41	223.77



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

**Permanent Cross-Section 2**  
Year 5 Data - Collected October 2019

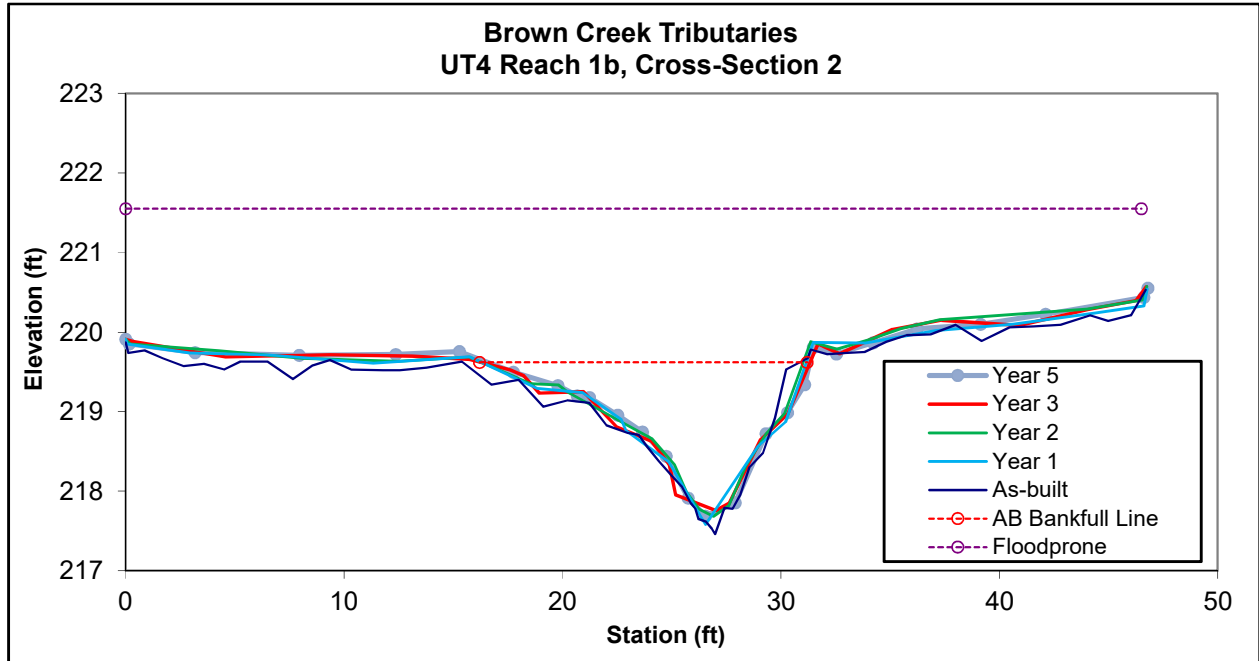


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	12.2	14.8	0.8	1.9	17.9	-	-	219.62	219.75





### Permanent Cross-Section 3

Year 5 Data - Collected October 2019

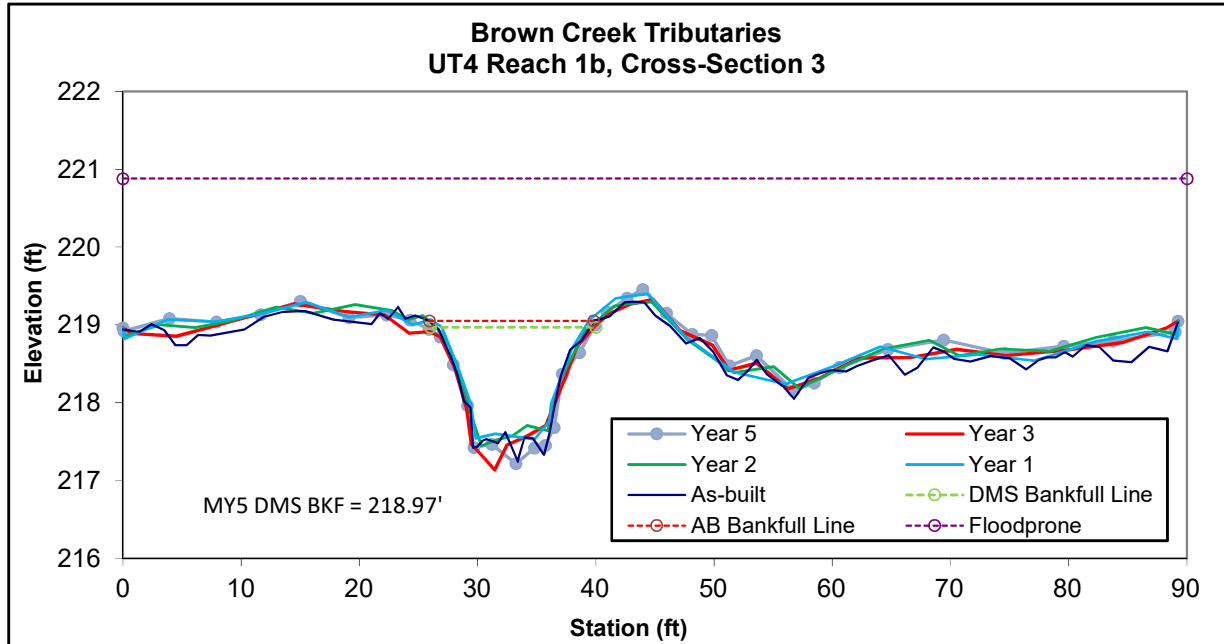


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	15.4	15.8	1.0	1.8	16.1	1.0	5.7	219.05	218.95



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

**Permanent Cross-Section 4**  
Year 5 Data - Collected October 2019

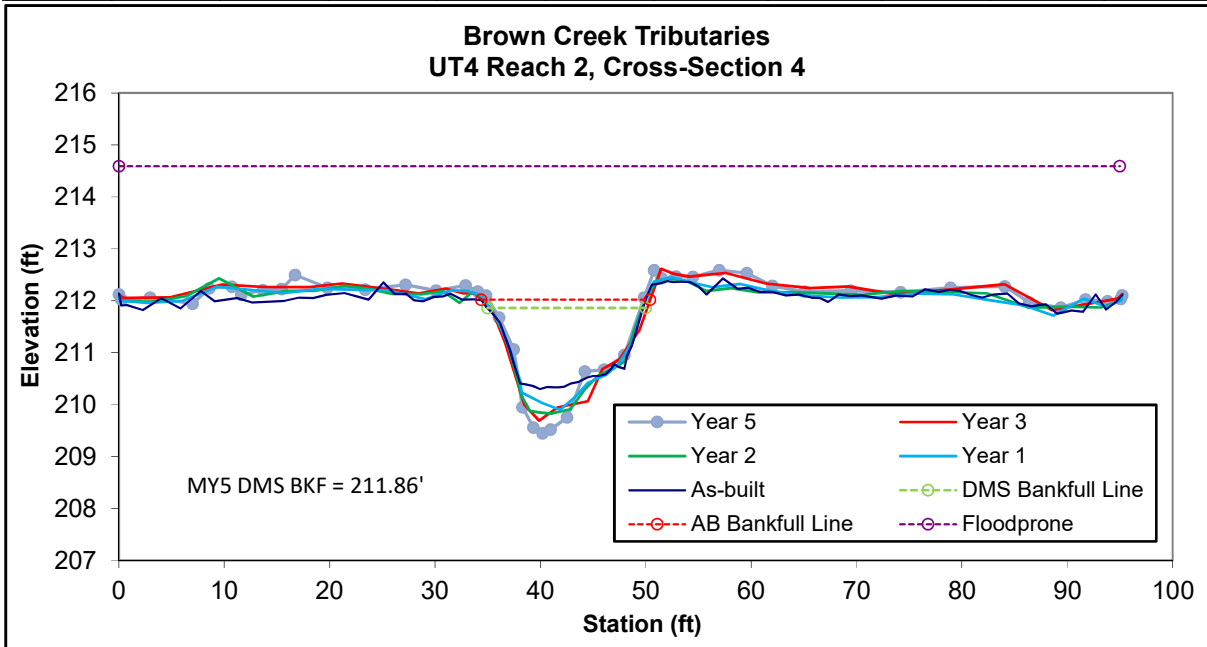


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	21.4	14.7	1.5	2.6	10.1	1.1	6.5	212.02	212.10



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.



**Permanent Cross-Section 5**  
 Year 5 Data - Collected October 2019

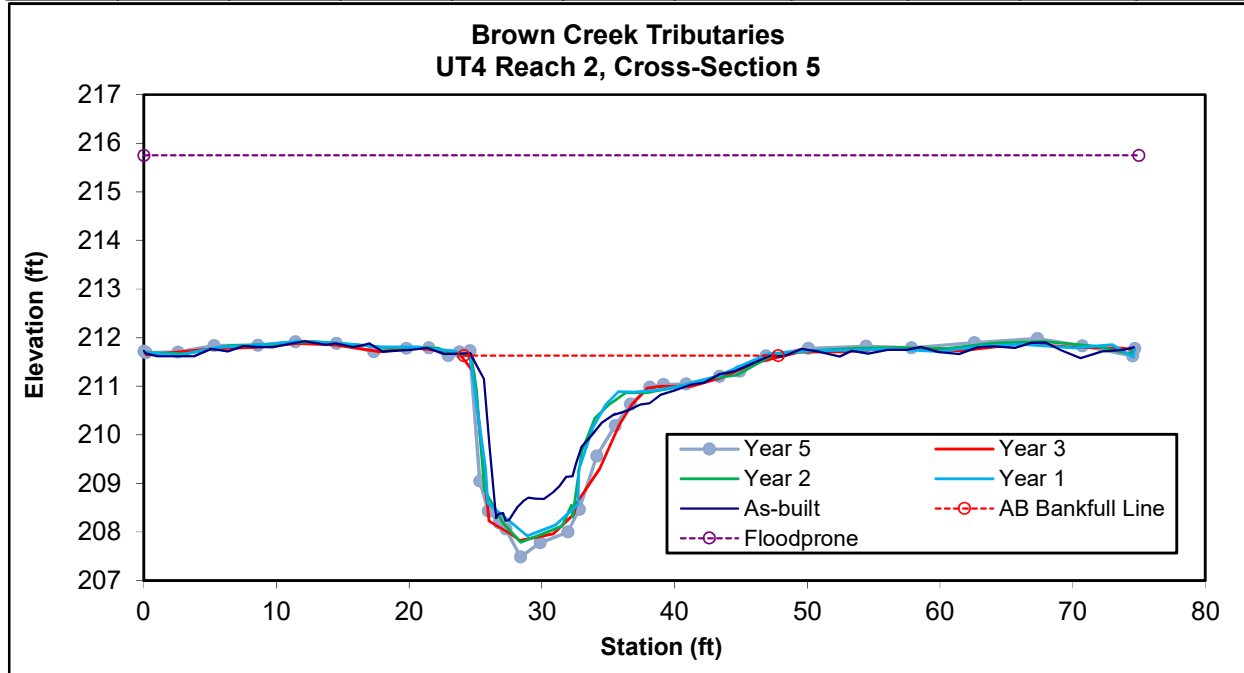


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	40.2	22.2	1.8	4.1	12.3	-	-	211.63	211.63



**Permanent Cross-Section 6**  
Year 5 Data - Collected October 2019

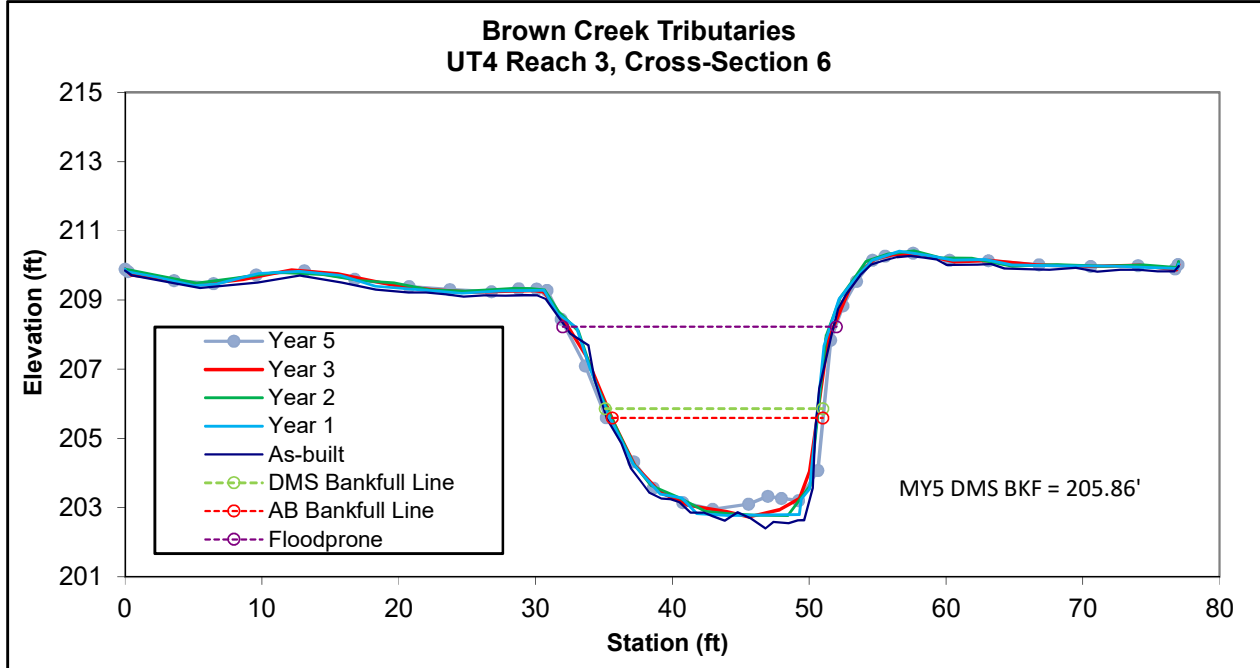


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	G	32.3	15.8	2.0	2.6	7.8	2.2	1.3	205.59	209.28



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.



**Permanent Cross-Section 7**  
Year 5 Data - Collected October 2019

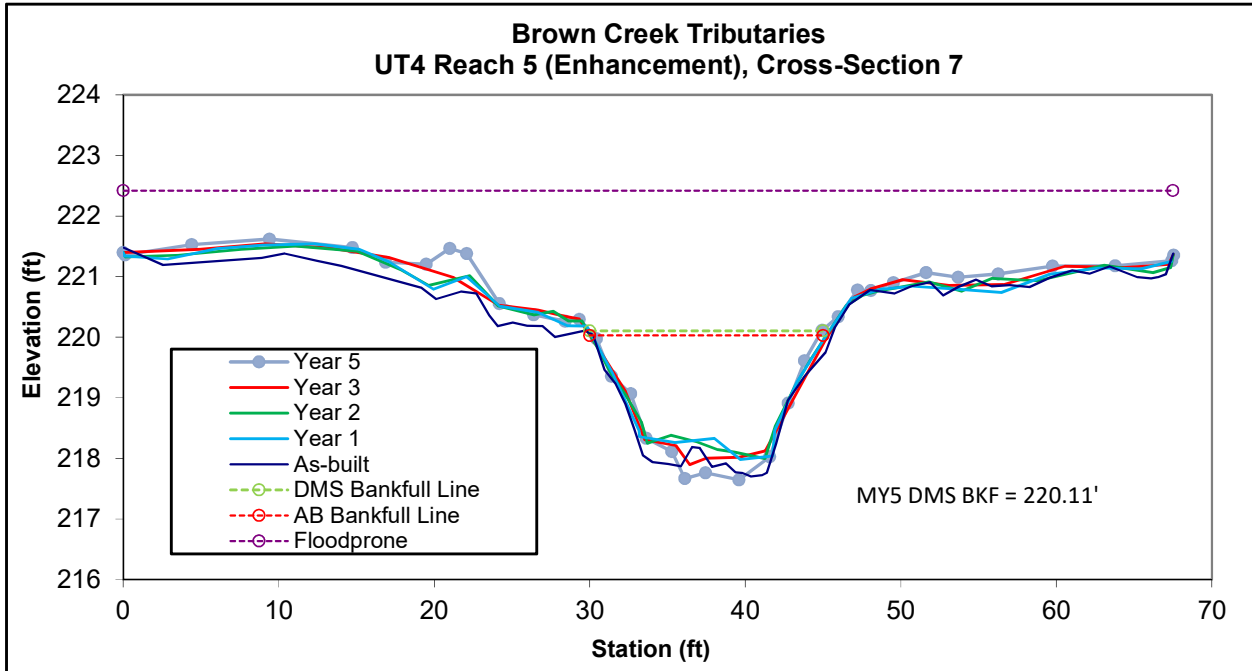


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	22.8	14.5	1.6	2.4	9.3	1.1	4.6	220.03	220.29



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

**Permanent Cross-Section 8**  
Year 5 Data - Collected October 2019

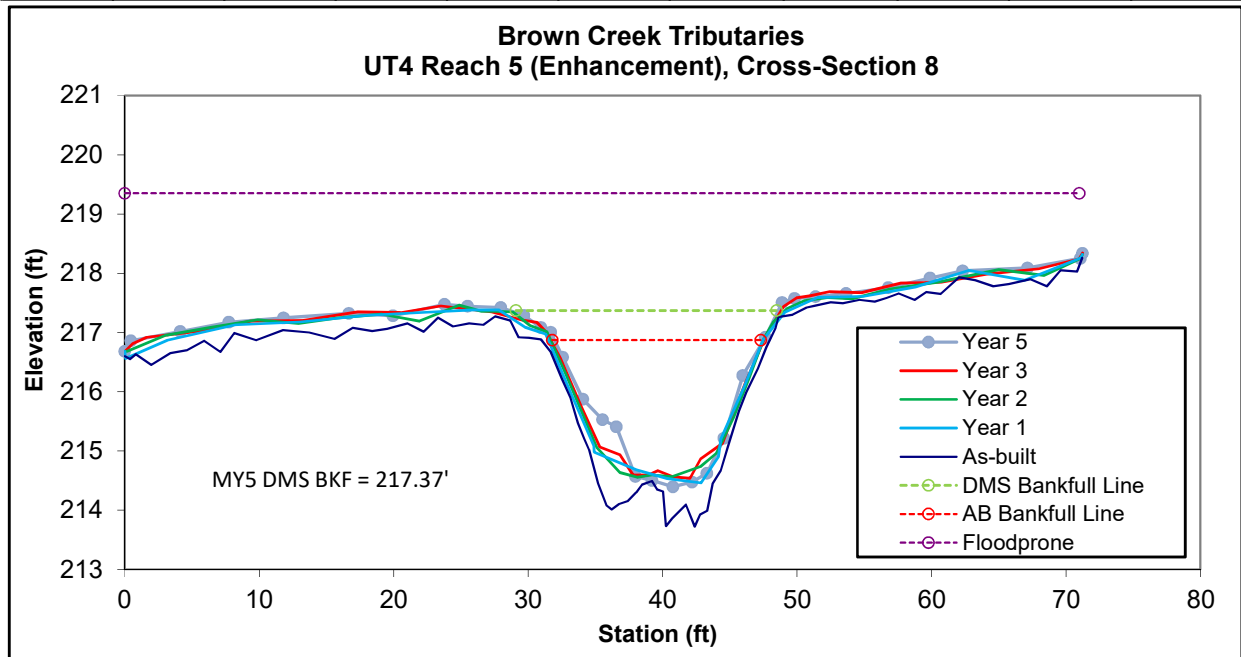


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	24.1	15.6	1.5	2.5	10.1	1.0	4.6	216.87	217.29



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.



**Permanent Cross-Section 9**  
Year 5 Data - Collected October 2019

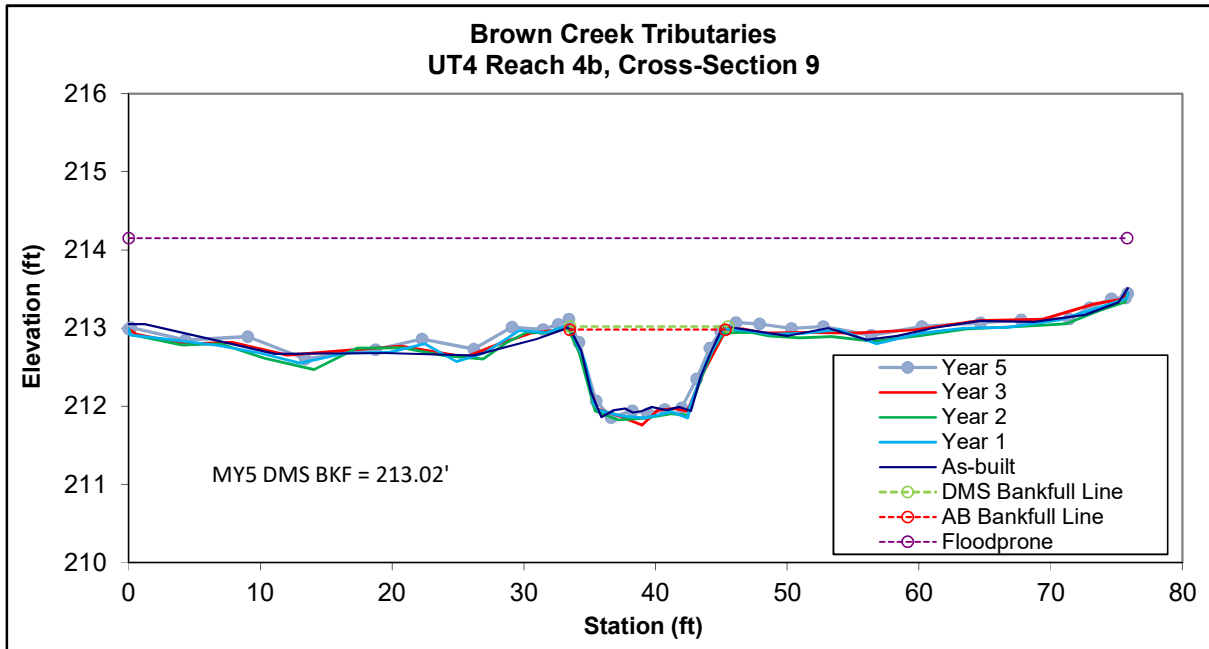


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	9.2	11.3	0.8	1.1	14.3	1.0	6.7	212.98	212.96



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

**Permanent Cross-Section 10**  
Year 5 Data - Collected October 2019

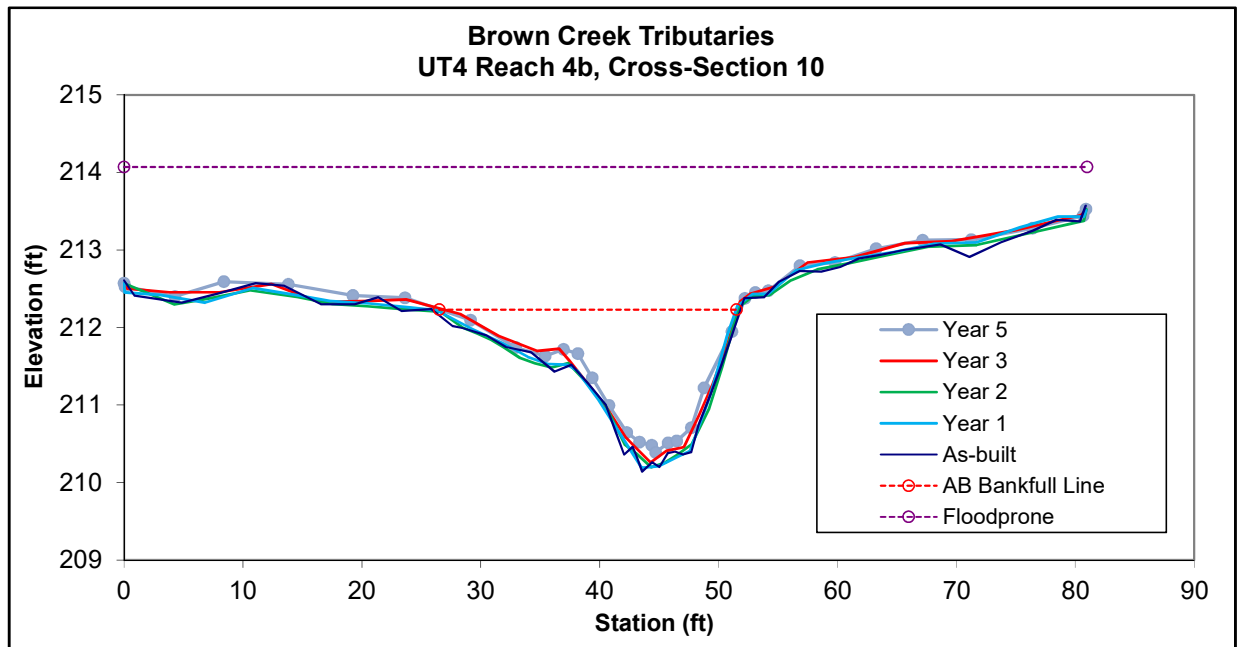


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	20.9	25.3	0.8	1.8	30.7	-	-	212.23	212.37





**Permanent Cross-Section 11**  
Year 5 Data - Collected October 2019

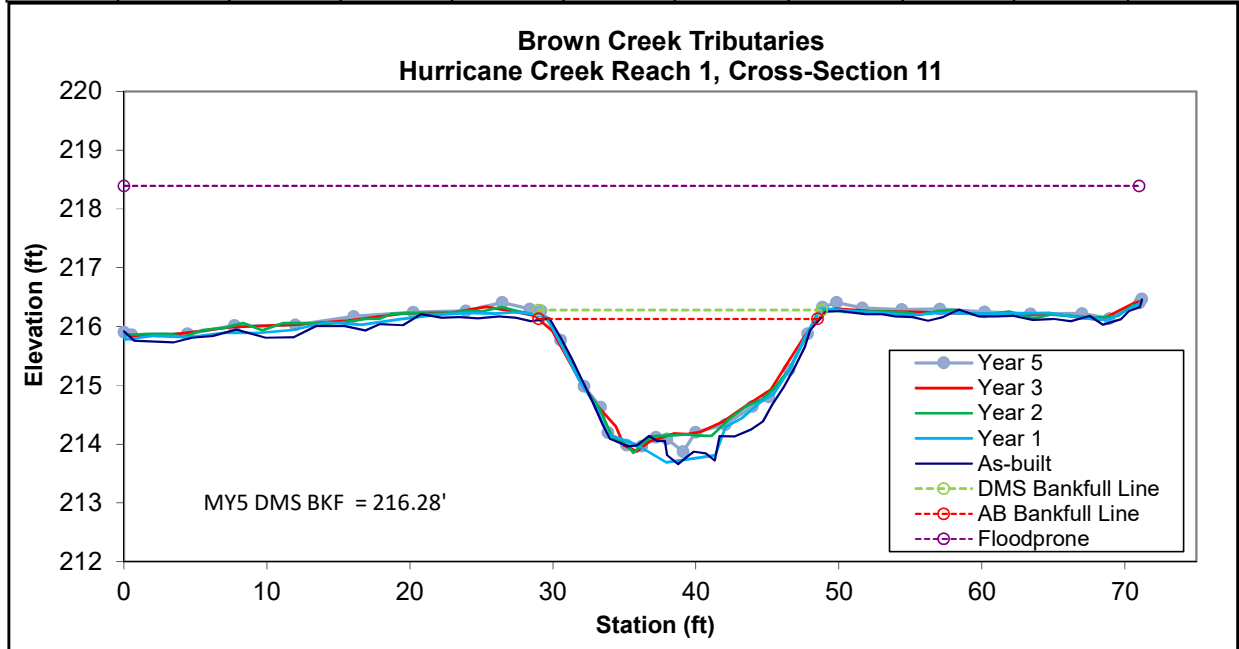


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	27.6	18.9	1.5	2.3	12.9	1.0	3.8	216.13	216.27



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

**Permanent Cross-Section 12**  
Year 5 Data - Collected October 2019

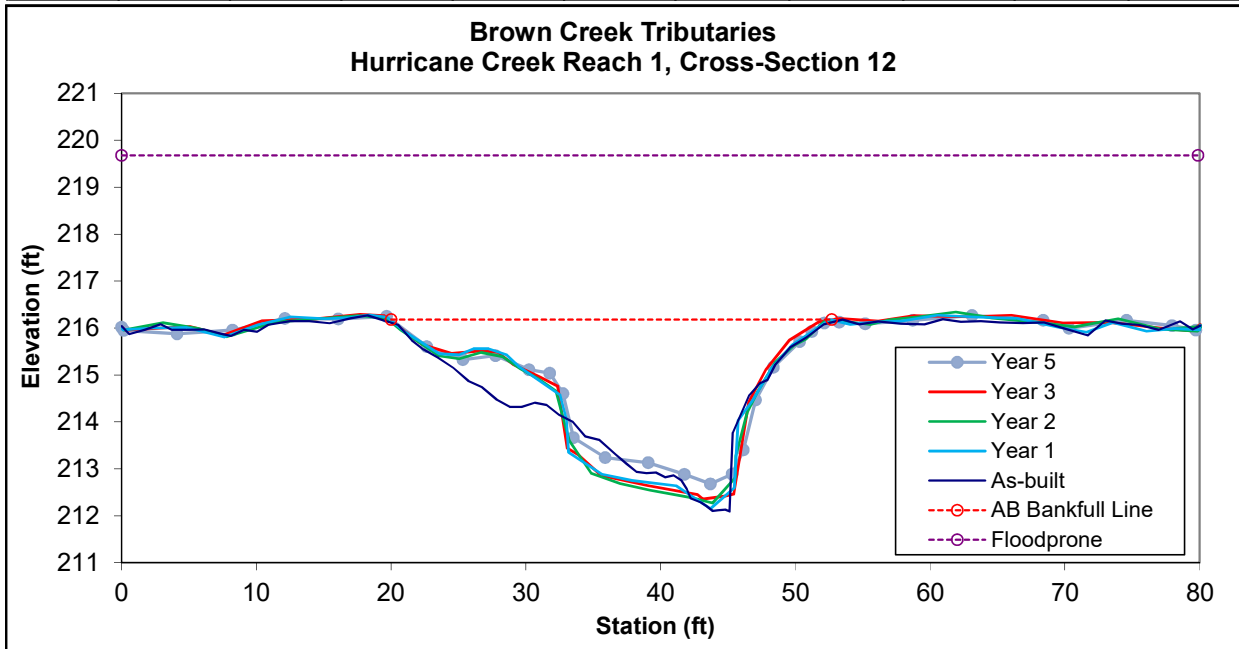


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	56.5	33.3	1.7	3.5	19.6	-	-	216.18	216.25





**Permanent Cross-Section 13**  
Year 5 Data - Collected October 2019

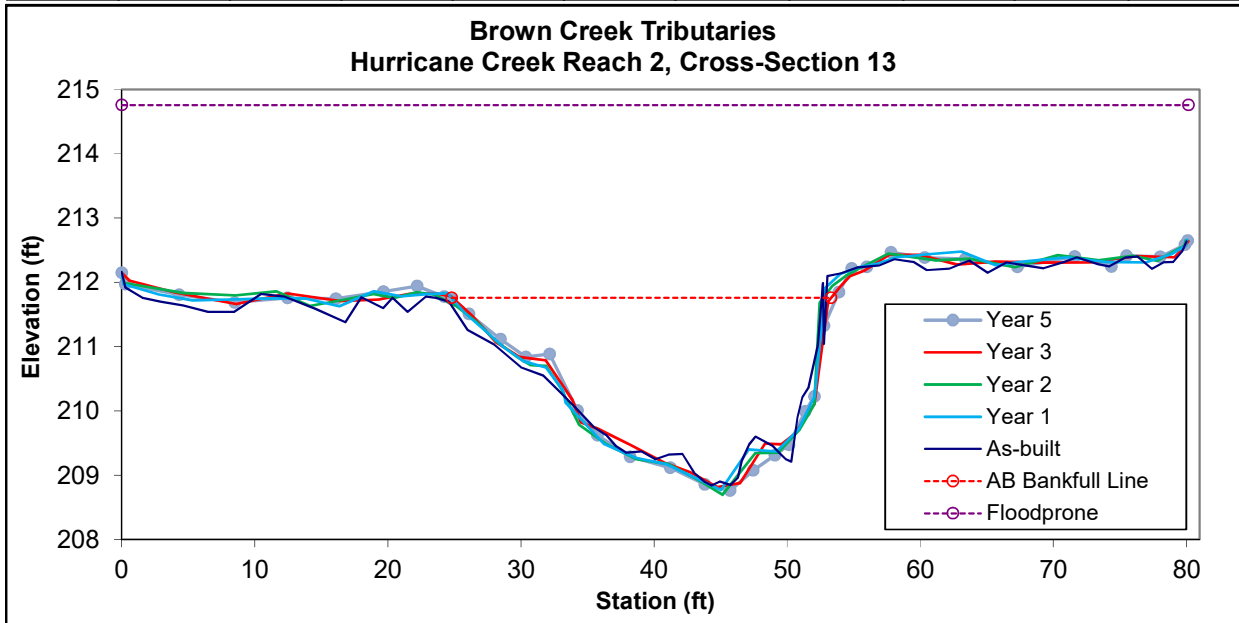


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	52.3	29.2	1.8	3.0	16.3	-	-	211.76	211.94



**Permanent Cross-Section 14**  
Year 5 Data - Collected October 2019

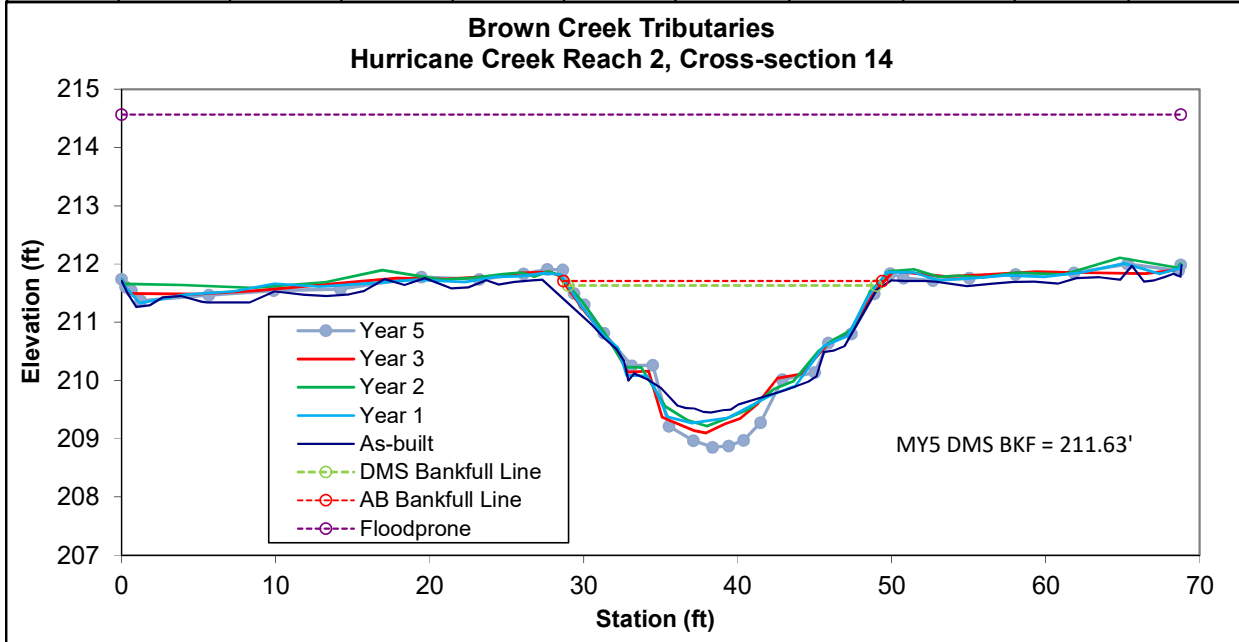


**Looking at the Left Bank**



**Looking at the Right Bank**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	33.4	20.6	1.6	2.9	12.7	1.1	3.3	211.71	211.84



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.



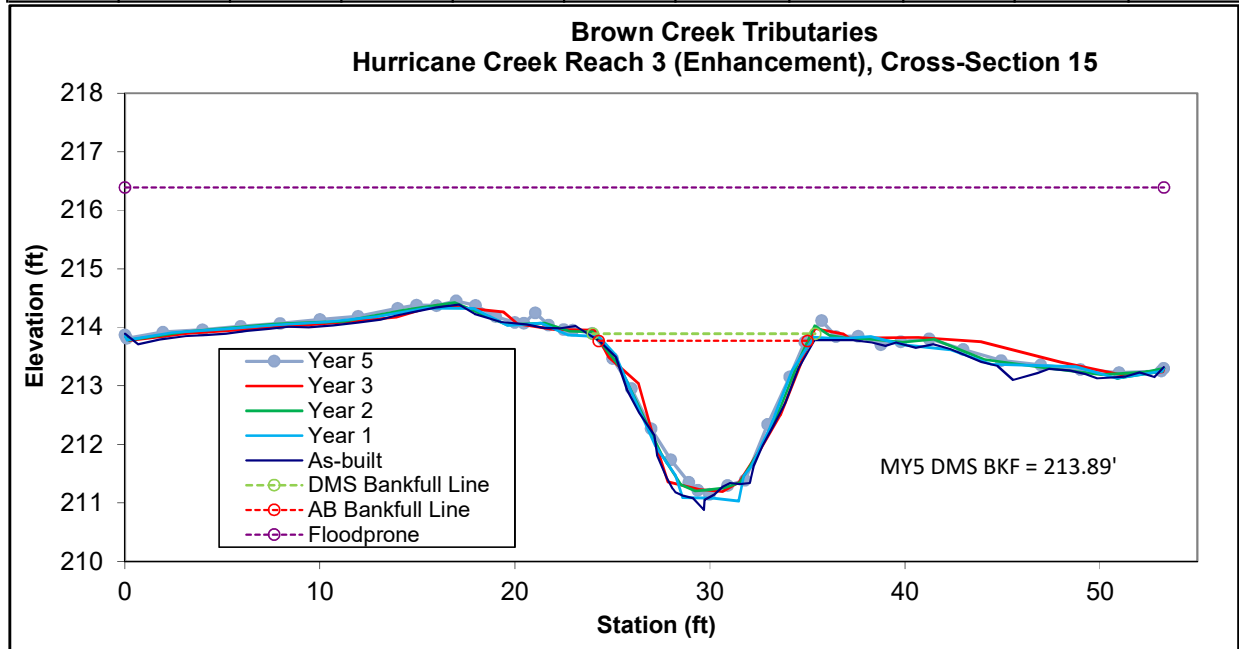
**Permanent Cross-Section 15**  
Year 5 Data - Collected October 2019



Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	16.6	12.2	1.4	2.6	9.0	1.0	4.4	213.77	213.90



Note: Per DMS/IRT request, bank height ratio for MY5 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

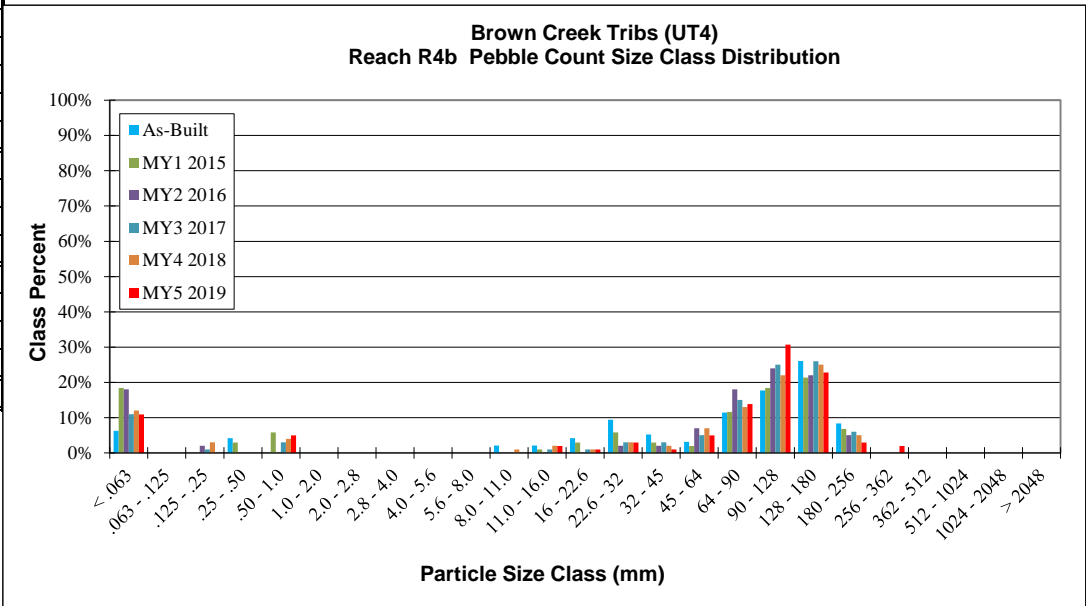
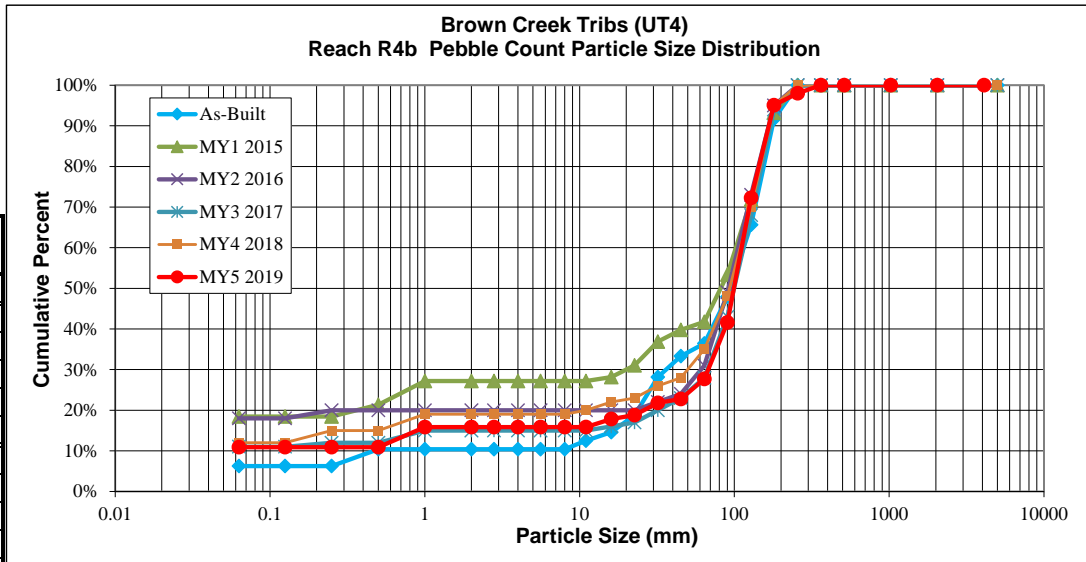
**Figure 4.**  
**Pebble Count - Monitoring Year 5**  
**Brown Creek Tribs Mitigation Project, DMS# 95351**

SITE OR PROJECT:	Brown Creek Tribs (UT4)
REACH/LOCATION:	Reach R4b (Station 19+25)
FEATURE:	Rock Riffle
DATE:	06-Nov-19

			MY5 2019			Distribution Plot Size (mm)
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	
Silt/Clay	Silt / Clay	<.063	11	11%	11%	0.063
Sand	Very Fine	.063 - .125			11%	0.125
	Fine	.125 - .25			11%	0.25
	Medium	.25 - .50			11%	0.50
	Coarse	.50 - 1.0	5	5%	16%	1.0
	Very Coarse	1.0 - 2.0			16%	2.0
Gravel	Very Fine	2.0 - 2.8			16%	2.8
	Very Fine	2.8 - 4.0			16%	4.0
	Fine	4.0 - 5.6			16%	5.6
	Fine	5.6 - 8.0			16%	8.0
	Medium	8.0 - 11.0			16%	11.0
	Medium	11.0 - 16.0	2	2%	18%	16.0
	Coarse	16 - 22.6	1	1%	19%	22.6
	Coarse	22.6 - 32	3	3%	22%	32
	Very Coarse	32 - 45	1	1%	23%	45
	Very Coarse	45 - 64	5	5%	28%	64
Cobble	Small	64 - 90	14	14%	42%	90
	Small	90 - 128	31	31%	72%	128
	Large	128 - 180	23	23%	95%	180
	Large	180 - 256	3	3%	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			101	100%		

Largest particle= 256-362

Summary Data			
Channel materials			
D16 =	11.3	D84 =	152.6
D35 =	76.5	D95 =	179.9
D50 =	99.1	D100 =	256 - 362





**Figure 4.**  
**Pebble Count - Monitoring Year 5**  
**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:		07-Nov-19				
		MYS 2019			Distribution	
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063	6	5%	5%	0.063
Sand	Very Fine	.063 - .125			5%	0.125
	Fine	.125 - .25			5%	0.25
	Medium	.25 - .50			5%	0.50
	Coarse	.50 - 1.0	4	4%	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			9%	5.6
	Fine	5.6 - 8.0	2	2%	11%	8.0
	Medium	8.0 - 11.0	4	4%	14%	11.0
	Medium	11.0 - 16.0	4	4%	18%	16.0
	Coarse	16 - 22.6	8	7%	25%	22.6
	Coarse	22.6 - 32	20	18%	43%	32
	Very Coarse	32 - 45	28	25%	68%	45
	Very Coarse	45 - 64	19	17%	86%	64
Cobble	Small	64 - 90	6	5%	91%	90
	Small	90 - 128	4	4%	95%	128
	Large	128 - 180	2	2%	96%	180
	Large	180 - 256	2	2%	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			111	100%		

Largest particle= 256-362

Summary Data			
Channel materials			
D16 =	13.0	D84 =	61.9
D35 =	27.3	D95 =	138.2
D50 =	35.1	D100 =	256 - 362

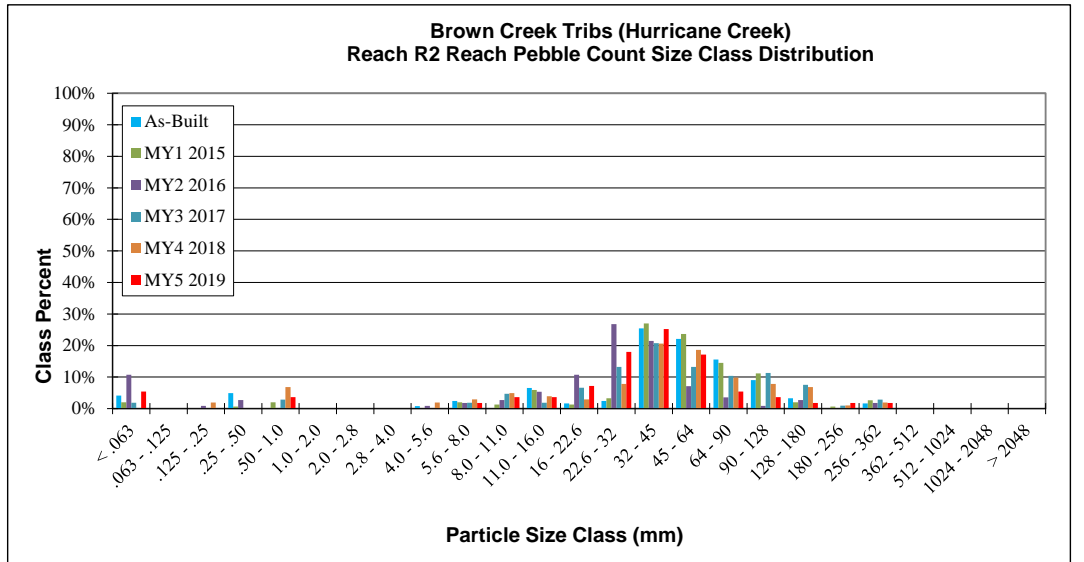
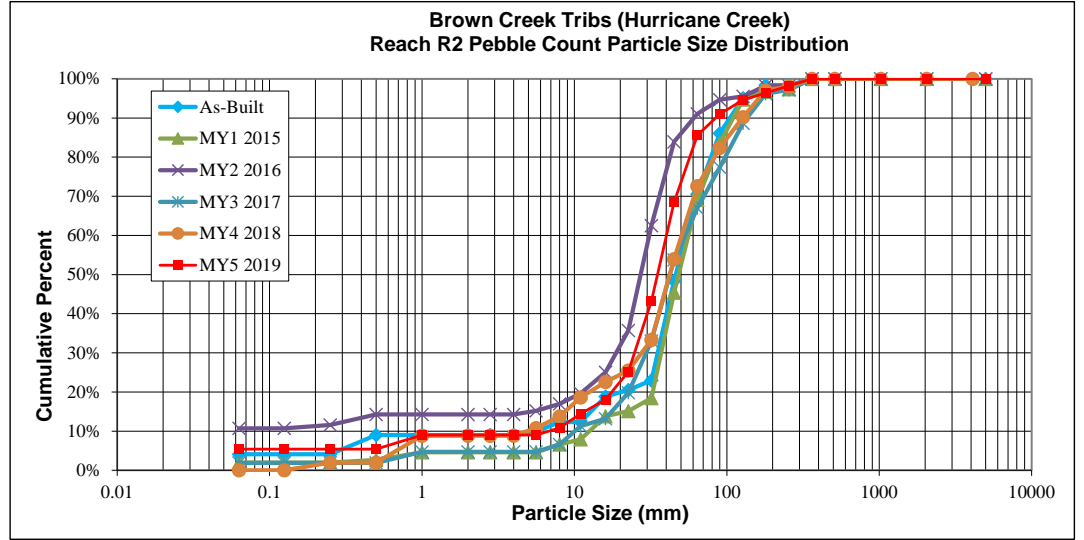


Table 10. Baseline Stream Summary																												
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351																												
Hurricane Creek (Reach 1) Length 2,043 ft																												
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built					
											Richland Creek (Moore County)																	
		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
<b>Dimension and Substrate - Riffle</b>																												
	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 <sup>2</sup> )	----	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	----	----	----		
<b>Pattern</b>																												
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	69	----	----	140	----	----	93.0	----	----	----		
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	39.0	----	----	55.0	----	----	55.0	----	----	----		
	Re / 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	----	----	----		
<b>Profile</b>																												
	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 <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----		
<b>Substrate and Transport Parameters</b>																												
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	<sup>2</sup> 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 <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Additional Reach Parameters</b>																												
	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) <sup>2</sup>	----	----	----	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively  
<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring  
<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design  
<sup>4</sup> 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 <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built					
											Richland Creek (Moore County)																	
		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
<b>Dimension and Substrate - Riffle</b>																												
	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 <sup>2</sup> )	----	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	----	----	----	----
<b>Pattern</b>																												
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	74	----	----	150	----	----	----	100.0	----	----	----	----
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	40.0	----	----	60.0	----	----	----	55.0	----	----	----	----
	Re / 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	----	----	----	----
<b>Profile</b>																												
	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 <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Substrate and Transport Parameters</b>																												
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	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 <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																												
	Drainage Area (SM)	----	----	----	----	----	2.16	----	----	----	----	----	----	1.00	----	----	----	----	----	2.16	----	----	----	2.16	----	----	----	
	Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Rosgen Classification	----	----	----	----	----	E	----	----	----	----	----	C4	----	----	----	----	----	ES/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) <sup>2</sup>	----	----	----	----	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively

<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring

<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design

<sup>4</sup> 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 <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built							
											Richland Creek (Moore County)																			
		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		
<b>Dimension and Substrate - Riffle</b>																														
	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 <sup>2</sup> )	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Pattern</b>																														
	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Profile</b>																														
	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 <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																														
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	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 <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																														
	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) <sup>2</sup>	----	----	----	----	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively

<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring

<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design

<sup>4</sup> 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 <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built						
											Richland Creek (Moore County)																		
					Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n							Min	Mean	Med	Max	SD	n	
<b>Dimension and Substrate - Riffle</b>																													
	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	0.9	----	----	----	1.0	----	----	----	----	----	
	BF Max Depth (ft)	----	----	----	----	1.2	----	----	1.9	----	----	1.4	----	----	1.5	----	----	1.1	1.1	----	----	----	1.8	----	----	----	----	----	
	BF Cross-sectional Area (ft <sup>2</sup> )	----	7.4	10.3	----	10.5	----	----	11.3	----	----	15.0	----	----	15.5	----	----	10.0	10.0	----	----	----	14.1	----	----	----	----	----	
	Width/Depth Ratio	----	----	----	----	6.5	----	----	13.2	----	----	18.0	----	----	18.6	----	----	13	13	----	----	----	13.8	----	----	----	----	----	
	Entrenchment Ratio	----	----	----	----	1.3	----	----	1.5	----	----	3.0	----	----	3.3	----	----	>2.2	>2.2	----	----	----	6.4	----	----	----	----	----	
	Bank Height Ratio	----	----	----	----	2.1	----	----	2.4	----	----	1.6	----	----	1.7	----	----	1.0	1.0	----	----	----	1.0	----	----	----	----	----	
	d50 (mm)	----	----	----	----	----	2.1	----	----	----	----	45.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Pattern</b>																													
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	40.0	----	----	80.0	----	----	60.0	----	----	----	----	----	
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	23.0	----	----	34.0	----	----	40.0	----	----	----	----	----	
	Re / 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	----	----	----	----	----	
<b>Profile</b>																													
	Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	37.2	----	----	----	----	----	
	Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	0.013	----	----	0.0413	----	----	0.0078	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	2.4	----	----	----	2.2	----	----	----	----	----	----	
	Pool Volume (ft <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																													
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	<sup>2</sup> 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 <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																													
	Drainage Area (SM)	----	----	----	----	----	----	0.34	----	----	----	----	----	1.00	----	----	----	0.34	0.34	----	----	0.34	----	----	0.34	----	----	----	----
	Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Rosgen Classification	----	----	----	----	G	----	----	F	----	----	----	----	C4	----	----	----	C5/B5	C5/B5	----	----	C5	----	----	C5	----	----	----	
	BF Velocity (fps)	----	2.4	3.9	----	3.6	----	----	3.9	----	----	----	----	N/P	----	----	3.7	3.7	----	----	----	----	----	----	----	----	----	----	
	BF Discharge (cfs)	----	25.2	40.9	63.0	----	----	----	41.0	----	----	----	----	N/P	----	----	37	37	----	----	----	----	----	----	----	----	----	----	
	Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Channel length (ft) <sup>2</sup>	----	----	----	----	----	----	1,417	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	858	----	----	----
	Sinuosity	----	----	----	----	----	----	1.15	----	----	----	----	----	1.20	----	----	1.11	1.11	----	----	----	1.09	----	----	1.09	----	----	----	
	Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0058	----	----	0.0136	0.0136	0.0136	----	----	0.0058	0.0058	0.0058	0.0058	0.0058	0.0058	0.0101	0.0101	0.0101	0.0101	0.0101	0.0101	0.0101	0.0101
	BF slope (ft/ft)	----	----	----	----	----	----	0.0067	----	----	0.0133	0.0133	0.0133	----	----	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113	0.0113
	Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively

<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring

<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design

<sup>4</sup> 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 <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built						
											Richland Creek (Moore County)																		
		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	
<b>Dimension and Substrate - Riffle</b>																													
	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 <sup>2</sup> )	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Pattern</b>																													
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	60.0	----	----	100.0	----	----	75.0	----	----	----	----	----	75.0	----	----	----	----	----	
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	33.0	----	----	50.0	----	----	----	46.3	----	----	----	----	----	
	Re / 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	----	----	----	----	----	
<b>Profile</b>																													
	Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	51.0	----	----	----	----	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 <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																													
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	<sup>2</sup> 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 <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Additional Reach Parameters</b>																													
	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) <sup>2</sup>	----	----	----	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively  
<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring  
<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design  
<sup>4</sup> 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 <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built <sup>5</sup>						
											Richland Creek (Moore County)																		
		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	
<b>Dimension and Substrate - Riffle</b>																													
	BF Width (ft)	----	14.1	14.2	----	----	----	----	13.1	----	----	----	16.7	----	----	----	----	19.8	----	----	----	----	----	----	15.4	----	----	----	
	Floodprone Width (ft)	----	----	----	----	----	----	18.3	----	----	----	----	53.0	----	----	----	----	44.0	----	----	76.0	----	----	----	21.0	----	----	----	
	BF Mean Depth (ft)	----	1.3	1.7	----	----	----	2.2	----	----	----	----	0.9	----	----	----	----	1.4	----	----	----	----	----	----	2.4	----	----	----	
	BF Max Depth (ft)	----	----	----	----	----	----	3.2	----	----	----	----	1.4	----	----	----	----	1.7	----	----	----	----	----	----	3.2	----	----	----	
	BF Cross-sectional Area (ft <sup>2</sup> )	----	21.0	28.5	----	----	----	28.7	----	----	----	----	15.0	----	----	----	----	28.0	----	----	----	----	----	----	36.8	----	----	----	
	Width/Depth Ratio	----	----	----	----	----	----	6.0	----	----	----	----	18.0	----	----	----	----	13	----	----	----	----	----	----	6.4	----	----	----	
	Entrenchment Ratio	----	----	----	----	----	----	1.4	----	----	----	----	3.0	----	----	----	----	1.8	----	----	2.2	----	----	----	1.4	----	----	----	
	Bank Height Ratio	----	----	----	----	----	----	2.3	----	----	----	----	1.6	----	----	----	----	1.0	----	----	----	----	----	----	1.7	----	----	----	
	d50 (mm)	----	----	----	----	0.48	----	----	----	----	----	45.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Pattern</b>																													
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	----
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	N/A	----	----	N/A	----	----	----	----	----	----	----	----
	Re / 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	----	----	----	----	----	----	----	----
<b>Profile</b>																													
	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 <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Substrate and Transport Parameters</b>																													
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	<sup>2</sup> 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 <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																													
	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) <sup>2</sup>	----	----	----	----	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively  
<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring  
<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design  
<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and on past project evaluations  
<sup>5</sup> Ultimately, a Rosgen "G" stream type was maintained for this reach due to its stable location with mature trees established 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 <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built						
											Richland Creek (Moore County)																		
		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	
<b>Dimension and Substrate - Riffle</b>																													
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 <sup>2</sup> )	----	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	----	----	----	----	
<b>Pattern</b>																													
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	40	----	----	70	----	----	----	55.0	----	----	----	----	
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	24.0	----	----	36.0	----	----	----	48.3	----	----	----	----	
Re / 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	----	----	----	----	
<b>Profile</b>																													
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 <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Substrate and Transport Parameters</b>																													
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<sup>2</sup> 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 <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																													
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) <sup>2</sup>	----	----	----	----	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively  
<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring  
<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design  
<sup>4</sup> 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 <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built					
											Richland Creek (Moore County)																	
					Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
<b>Dimension and Substrate - Riffle</b>																												
	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 <sup>2</sup> )	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Pattern</b>																												
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	N/A	----	----	N/A	----	----	----	----	----	----	
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	N/A	----	----	N/A	----	----	----	----	----	----	
	Re / 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	----	----	----	----	----	----	
<b>Profile</b>																												
	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 <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																												
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	<sup>2</sup> 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 <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																												
	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) <sup>2</sup>	----	----	----	----	----	----	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	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively

<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring

<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design

<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and past project evaluations

Table 11. Cross-section Morphology Data																						
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351																						
Stream Reach		UT4 Reach 1 (1,482 LF)																				
		Cross-section X-1 (Riffle)						Cross-section X-2 (Pool)						Cross-section X-3 (Riffle)								
Dimension and substrate		Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)		14.9	11.6	11.6	11.0	-	10.5		15.4	14.9	14.7	15.1	-	14.8		14.0	13.2	14.2	15.9	-	15.8	
BF Mean Depth (ft)		1.0	1.1	1.0	1.1	-	1.2		0.9	0.8	0.8	0.8	-	0.8		1.0	1.0	0.9	0.8	-	1.0	
Width/Depth Ratio		14.6	11.0	11.2	10.3	-	9.0		17.7	18.0	18.0	18.2	-	17.9		13.8	13.6	15.2	18.1	-	16.1	
BF Cross-sectional Area (ft²)		15.3	12.4	12.0	11.8	-	12.2		13.4	12.3	12.1	12.5	-	12.2		14.1	12.7	13.1	13.3	-	15.4	
BF Max Depth (ft)		1.8	1.8	1.8	1.8	-	1.8		2.2	2.0	1.9	1.9	-	1.9		1.8	1.5	1.6	1.8	-	1.8	
Width of Floodprone Area (ft)		59.0	59.0	58.9	59.0	-	59.0		46.7	46.8	46.8	46.7	-	46.8		89.2	89.3	89.3	89.2	-	89.2	
Entrenchment Ratio		3.9	5.1	5.1	5.4	-	5.6		3.0	3.1	3.2	3.1	-	-		6.4	6.8	6.3	5.9	-	5.7	
Bank Height Ratio		1.0	1.1	1.1	1.0	-	1.0		1.0	1.0	1.0	0.9	-	-		1.0	1.0	1.0	1.0	-	1.0	
Wetted Perimeter (ft)		17.0	13.8	13.7	12.0	-	11.7		17.2	16.6	16.4	15.9	-	15.5		16.0	15.1	16.0	16.6	-	16.6	
Hydraulic Radius (ft)		0.9	0.9	0.9	1.0	-	1.0		0.8	0.7	0.7	0.8	-	0.8		0.9	0.8	0.8	0.8	-	0.9	
d50 (mm)		-							-							-						
Stream Reach		UT4 Reach 2 (1,859 LF)												UT4 Reach 3 (250 LF)								
		Cross-section X-4 (Riffle)						Cross-section X-5 (Pool)						Cross-section X-6 (Riffle)								
Dimension and substrate		Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)		15.9	15.3	15.3	16.0	-	14.7		22.4	22.4	22.7	24.4	-	22.2		15.4	15.1	15.0	15.0	-	15.8	
BF Mean Depth (ft)		1.19	1.4	1.4	1.4	-	1.5		1.39	1.6	1.6	1.6	-	1.8		2.4	2.3	2.2	2.2	-	2.0	
Width/Depth Ratio		13.3	11.3	10.8	11.5	-	10.1		16.1	14.4	14.4	14.9	-	12.3		6.4	6.7	6.8	6.8	-	7.8	
BF Cross-sectional Area (ft²)		19.0	20.7	21.6	22.2	-	21.4		31.2	34.8	35.9	39.9	-	40.2		36.8	34.2	33.5	32.8	-	32.3	
BF Max Depth (ft)		1.7	2.1	2.2	2.3	-	2.6		3.4	3.7	3.8	3.8	-	4.1		3.2	2.8	2.8	2.9	-	2.6	
Width of Floodprone Area (ft)		95.2	95.2	95.2	95.2	-	95.2		74.6	74.7	74.6	74.7	-	74.7		21.0	19.4	19.3	19.9	-	20.1	
Entrenchment Ratio		6.0	6.2	6.2	6.0	-	6.5		3.3	3.3	3.3	3.1	-	-		1.3	1.3	1.3	1.3	-	1.3	
Bank Height Ratio		1.0	1.0	1.0	1.1	-	1.1		1.0	1.0	1.0	1.0	-	-		2.1	2.3	2.3	2.3	-	2.2	
Wetted Perimeter (ft)		18.3	18.0	18.1	17.0	-	16.1		25.2	25.5	25.9	27.4	-	22.5		18.5	17.9	19.5	17.1	-	17.9	
Hydraulic Radius (ft)		1.0	1.1	1.2	1.3	-	1.3		1.2	1.4	1.4	1.5	-	1.6		2.0	1.9	1.7	1.9	-	1.8	
d50 (mm)		-							-							-						

Note: Per DMS/IRT request, bank height ratio has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation.



Table 11 continued. Cross-section Morphology Data																												
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351																												
Stream Reach	UT4 Reach 5 (2,022 LF)														UT4 Reach 4 (1,892 LF)													
	Cross-section X-7 (Riffle)							Cross-section X-8 (Riffle)							Cross-section X-9 (Riffle)						Cross-section X-10 (Pool)							
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	15.9	15.5	15.2	15.3	-	14.5		17.0	16.0	15.8	15.9	-	15.6		11.6	11.6	12.3	12.0	-	11.3		25.9	25.7	27.6	24.7	-	25.3	
BF Mean Depth (ft)	1.6	1.4	1.3	1.4	-	1.6		1.9	1.7	1.7	1.6	-	1.5		0.8	0.8	0.8	0.8	-	0.8		1.0	1.0	0.9	0.9	-	0.8	
Width/Depth Ratio	10.1	11.0	11.4	10.9	-	9.3		8.8	9.6	9.6	10.0	-	1.0		14.1	13.8	15.7	14.6	-	14.3		27.1	27.1	30.5	27.4	-	30.7	
BF Cross-sectional Area (ft²)	25.0	21.8	20.3	21.6	-	22.8		32.8	26.5	26.0	25.1	-	24.1		9.6	9.7	9.7	9.9	-	9.2		24.8	24.4	25.0	22.2	-	20.9	
BF Max Depth (ft)	2.4	2.1	2.0	2.1	-	2.4		3.2	1.7	2.3	2.3	-	2.5		1.1	1.1	1.1	1.2	-	1.1		2.1	2.0	2.0	2.0	-	1.8	
Width of Floodprone Area (ft)	67.5	67.5	67.5	67.5	-	67.5		71.2	71.2	71.2	71.2	-	71.2		75.9	75.9	75.9	75.9	-	75.8		80.9	80.9	80.9	80.9	-	80.9	
Entrenchment Ratio	4.3	4.4	4.4	4.4	-	4.6		4.2	4.5	4.5	4.5	-	4.6		6.6	6.6	6.2	6.3	-	6.7		3.1	3.1	2.9	3.3	-	-	
Bank Height Ratio	1.0	1.0	1.1	1.1	-	1.1		1.0	1.0	1.1	1.1	-	1.0		1.0	1.0	1.0	1.0	-	1.0		1.0	1.0	1.0	0.7	-	-	
Wetted Perimeter (ft)	19.0	18.3	17.9	16.2	-	15.7		20.9	19.3	19.1	16.9	-	16.7		13.2	13.3	13.9	12.4	-	11.8		27.9	27.6	29.4	25.2	-	25.8	
Hydraulic Radius (ft)	1.3	1.2	1.1	1.3	-	1.4		1.6	1.4	1.4	1.5	-	1.4		0.7	0.7	0.7	0.8	-	0.8		0.9	0.9	0.9	0.9	-	0.8	
d50 (mm)	-							-							-							-						
Stream Reach	Hurricane Creek Reach 1 (2,043 LF)														Hurricane Creek Reach 2 (1,424 LF)													
	Cross-section X-11 (Riffle)							Cross-section X-12 (Pool)							Cross-section X-13 (Pool)						Cross-section X-14 (Riffle)							
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	18.9	18.7	18.5	19.9	-	18.9		34.3	32.7	37.3	33.2	-	33.3		29.0	28.0	28.8	28.5	-	29.2		22.5	20.5	20.5	20.9	-	20.6	
BF Mean Depth (ft)	1.61	1.59	1.50	1.34	-	1.50		1.84	1.85	1.67	1.83	-	1.70		1.77	1.86	1.83	1.81	-	1.80		1.40	1.53	1.49	1.52	-	1.60	
Width/Depth Ratio	11.8	11.8	12.5	14.8	-	12.9		18.6	17.6	22.3	18.1	-	19.6		16.4	15.1	15.8	15.7	-	16.3		16.1	13.4	13.7	13.8	-	12.7	
BF Cross-sectional Area (ft²)	30.4	29.8	27.3	26.6	-	27.6		63.2	60.6	62.5	60.8	-	56.5		51.5	52.0	52.7	51.5	-	52.3		31.6	31.3	30.6	31.7	-	33.4	
BF Max Depth (ft)	2.47	2.44	2.30	2.25	-	2.30		4.09	4.03	3.91	3.83	-	3.50		2.92	2.99	3.06	2.94	-	3.00		2.26	2.44	2.49	2.61	-	2.90	
Width of Floodprone Area (ft)	71.2	71.2	71.2	71.2	-	71.2		80.1	80.1	80.1	80.1	-	80.1		80.0	80.1	80.1	80.2	-	80.1		68.8	68.8	68.8	68.8	-	69.8	
Entrenchment Ratio	3.8	3.8	3.9	3.6	-	3.8		2.3	2.5	2.1	2.4	-	-		2.8	2.9	2.8	2.8	-	-		3.1	3.4	3.4	3.3	-	3.3	
Bank Height Ratio	1.0	1.0	1.1	1.0	-	1.0		1.0	1.0	1.0	1.0	-	-		1.0	1.0	1.0	1.0	-	-		1.0	1.0	1.0	0.9	-	1.1	
Wetted Perimeter (ft)	22.1	21.9	21.5	20.6	-	19.7		38.0	36.4	40.7	36.7	-	34.9		32.6	31.7	32.5	29.8	-	30.4		25.3	23.5	23.5	21.9	-	21.8	
Hydraulic Radius (ft)	1.4	1.4	1.3	1.3	-	1.4		1.7	1.7	1.5	1.7	-	1.6		1.6	1.6	1.6	1.7	-	1.7		1.2	1.3	1.3	1.5	-	1.5	
d50 (mm)	-							-							-							-						
Stream Reach	Hurricane Creek Reach 3 (600 LF)																											
	Cross-section X-15 (Riffle)																											
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+																					
BF Width (ft)	11.1	10.7	10.7	10.8	-	12.2																						
BF Mean Depth (ft)	1.7	1.6	1.6	1.6	-	1.4																						
Width/Depth Ratio	6.7	6.5	6.7	6.8	-	9.0																						
BF Cross-sectional Area (ft²)	18.2	17.6	17.1	17.1	-	16.6																						
BF Max Depth (ft)	2.9	2.7	2.6	2.6	-	2.6																						
Width of Floodprone Area (ft)	53.3	53.3	53.3	53.3	-	53.3																						
Entrenchment Ratio	4.8	5.0	5.0	5.0	-	4.4																						
Bank Height Ratio	1.0	1.0	1.0	1.1	-	1.0																						
Wetted Perimeter (ft)	14.4	14.0	13.9	12.2	-	13.7																						
Hydraulic Radius (ft)	1.3	1.3	1.2	1.4	-	1.2																						
d50 (mm)	-																											

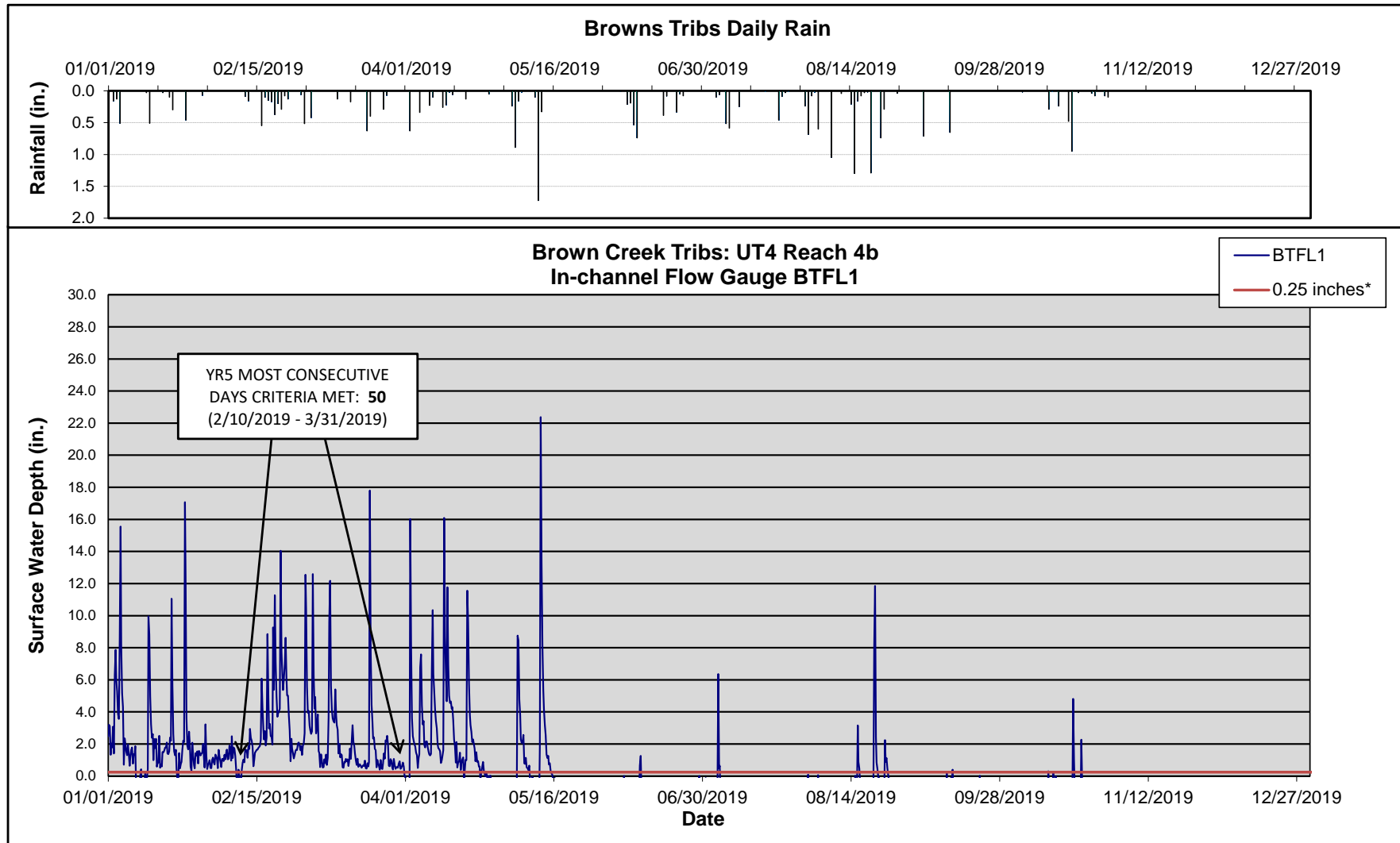
Note: Per DMS/IRT request, bank height ratio has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation.

# **Appendix E**

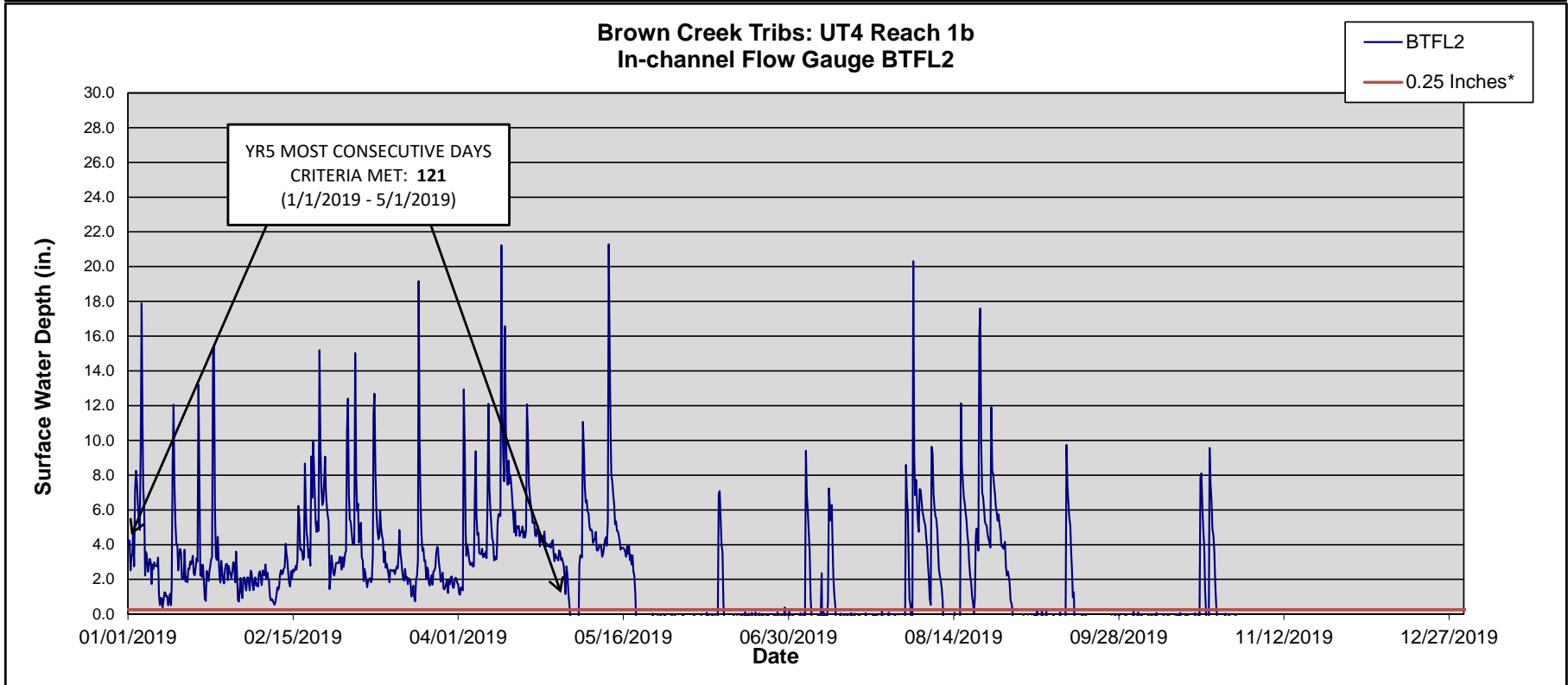
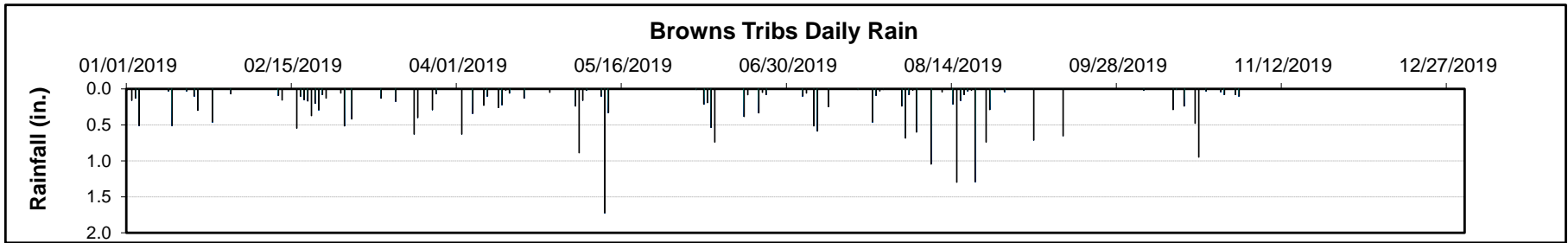
## **Hydrologic Data**



**Figure 5. Flow Gauge Graphs**

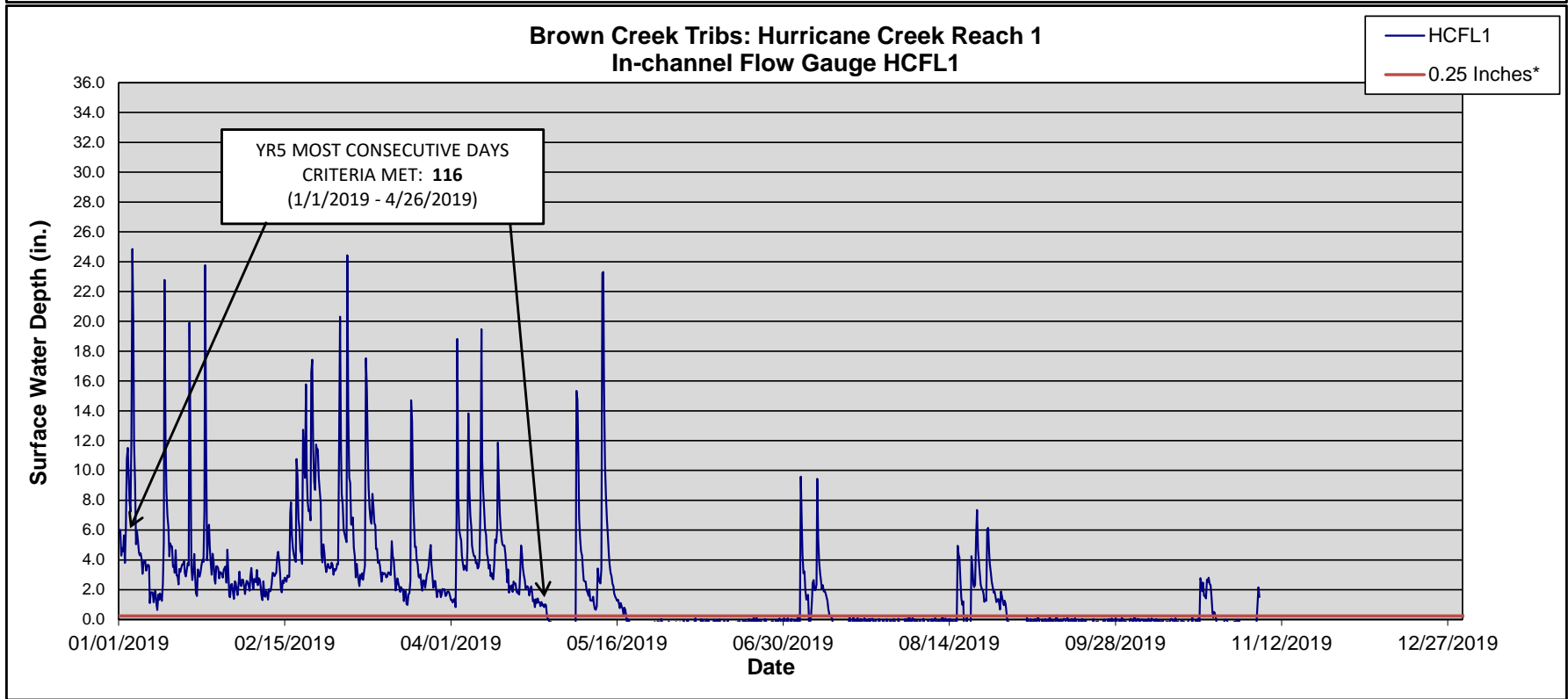
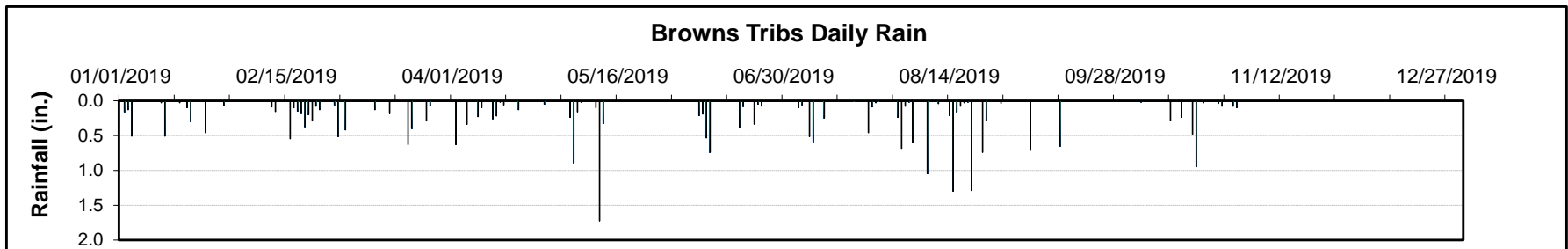


\* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.



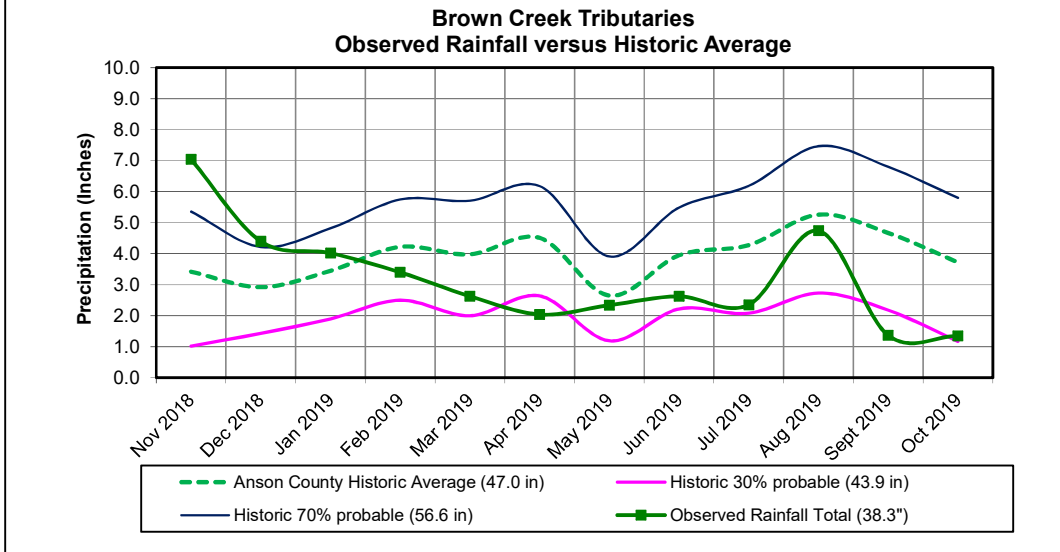
\* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.



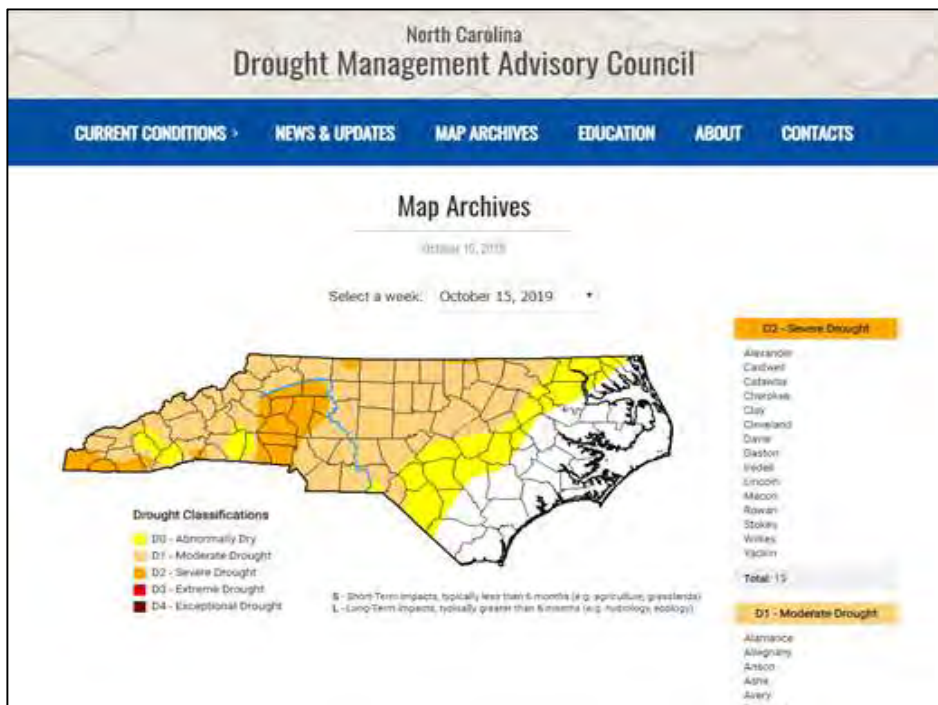


\* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.

Figure 6. Observed Rainfall versus Historic Average



Note: Historic average annual rainfall for Anson County is 47.0", while a total of 38.3" was recorded over the previous 12 months.



Note: The project site in Anson County did experience drought conditions throughout much of the summer and fall months resulting in a D1 - Moderate Drought as of October 15, 2019 ([www.ncdrought.org](http://www.ncdrought.org))



<b>Table 12. Flow Gauge Success</b>														
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>														
Flow Gauge ID	Most Consecutive Days Meeting Criteria <sup>1</sup>							Cumulative Days Meeting Criteria <sup>2</sup>						
	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)
<b>UT4 Flow Gauges (Installed July 17, 2015)</b>														
BTFL1	37	77	58	94	50			37	77	152	185	129		
BTFL2	92	106	34	63	121			92	106	113	135	180		
<b>Hurricane Creek Flow Gauge (Installed July 19, 2016)</b>														
HCFL1 <sup>3</sup>	N/A	12	64	113	116			N/A	12	154	186	156		
<p>Notes:</p> <p><sup>1</sup>Indicates the single greatest number of consecutive days within the monitoring year where flow was measured.</p> <p><sup>2</sup>Indicates the total number of days within the monitoring year where flow was measured.</p> <p><sup>3</sup>The Hurricane Creek Flow Gauge (HCFL1) was installed in Reach HC-R1 on July 19, 2016 to document in-channel stream flow.</p> <p>Flow success criteria for the Site is stated as: <b>A restored stream reach will be considered at least intermittent when the flow duration occurs for a minimum of 30 consecutive days.</b></p> <p>Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.</p>														

<b>Table 13. Verification of Bankfull Events</b>				
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>				
Date of Data Collection	Estimated Occurrence of Bankfull Event	Method of Data Collection	Crest Gauge Reading (Hurricane Creek-R2)	Crest Gauge Reading (UT4-R2)
<b>MY1 (2015)</b>				
10/29/2015	10/03/2015	Crest Gauge	0.94'	
11/04/2015	10/03/2015	Crest Gauge		0.83'
<b>MY2 (2016)</b>				
02/17/2016	02/03/2016	Crest Gauge	1.05'	
07/19/2016	06/29/2016	Crest Gauge	0.19'	0.28'
11/03/2016	10/08/2016	Crest Gauge	1.1'	0.97'
<b>MY3 (2017)</b>				
09/19/2017	07/18/2017	Crest Gauge	0.33'	
<b>MY4 (2018)</b>				
06/05/2018	06/02/2018	Crest Gauge		0.50'
10/03/2018	09/17/2018	Crest Gauge	0.67'	
10/15/2018	09/17/2018	Crest Gauge		2.26'
10/15/2018	10/11/2018	Crest Gauge		0.68'
<b>MY5 (2019)</b>				
04/11/2019	03/21/2019*	Crest Gauge		1.09'
04/12/2019	03/03/2019*	Crest Gauge	1.72'	
08/08/2019	05/12/2019*	Crest Gauge	0.60'	
10/16/2019	08/03/2019*	Crest Gauge		0.58'

\* See flow gauge graphs in Appendix E for corresponding flow depth spikes on these dates.