SUTHER STREAM & WETLAND RESTORATION SITE -- DMS #370
Cabarrus County NC -- PeeDee River HUC# 03040105-020060

MY-5 (2016) ANNUAL MONITORING REPORT

North Carolina Department of Environmental Quality
Division of Mitigation Services (DENR-DMS) -- Contract # 5764

Data Collected: Sept 2016 **Final Report Submitted: Jan 2017**

NC Department of Environmental Quality
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Appendix D. Stream Geomorphology Data

Appendix E. Stream and Wetland Hydrology Data

1.0. Project Summary

1.1. Goals & Objectives

The Suther Stream and Wetland Restoration Project (Suther Site, DMS # 370) lies along Dutch Buffalo Creek and an unnamed tributary in northeastern Cabarrus County NC. The site lies within the Yadkin-Pee Dee watershed (HUC #03040105-020060). This project includes restoration, enhancement and preservation of ditched and drained riparian wetlands, restoration of a channelized tributary, and enhancement and preservation along the main stem of Dutch Buffalo Creek. Project construction, planting, and the as-built survey were completed in late 2009, and annual monitoring was conducted in 2010 and 2011. During 2012-2013 DMS reevaluated the site with respect to project assets, necessary actions, and monitoring goals. Therefore, contracted site monitoring was temporarily suspended, and then resumed in 2014 by Mogensen Mitigation Inc (MMI-RJGA includes the former Robert J. Goldstein & Associates) and will continue through 2017 (MY6) and project close-out in 2018. The 2014 to 2017 monitoring protocol includes additional stream and wetland gauges and main channel cross-sections as shown on the CCPV. Specific **goals** for the Suther project, listed in the 2007 Restoration Plan include:

- Stabilize and protect degraded stream banks along the main reach of Dutch Buffalo Creek.
- Enhance the upper reach of Dutch Buffalo Creek by fencing out livestock and vegetating streambanks where necessary.
- Restore a natural, stable dimension, pattern, and profile along one unnamed tributary using natural channel design techniques.
- Improve stable habitats for macroinvertebrate and fish communities.
- Restore and/or enhance natural hydrology, vegetation, and soil composition in wetlands.
- Provide alternate cattle watering sources and road access across Dutch Buffalo Creek.
- Improve the aesthetics of the stream.

To meet these goals, the following **objectives** have been established for the Suther Site project. The revised lengths and acreages below and in Table 1 reflect the Nov 2016 Mitigation Plan Addendum.

- Enhance approximately 2,763 linear feet along the main channel's upper reach.
- Preserve approximately 3,413 linear feet along the main channel's lower and upper reaches.
- Relocate approximately 608 linear feet of unnamed tributary into a Rosgen C/E stream type.
- Preserve approximately 10.99 acres, enhance approximately 3.67 acres, and restore approximately 4.84 acres of riparian wetland area.
- Construct access crossings across the main channel and tributary of Dutch Buffalo Creek.
- Create an alternative livestock watering source that prevents livestock from accessing the stream.

1.2. Project Success Criteria

1.2.1. Stream Morphology and Stability Success

Stream morphology monitoring during the first two years (Jacobs, 2010 to 2011) was conducted along the restored tributary (608 lin. ft) that included four cross-sections. No morphologic survey was conducted on the main channel of Dutch Buffalo Creek during MY1 or MY2. In 2013 DMS staff installed eleven sets of bank erosion pins along the main channel upstream of the restored tributary (between stations 22+00 and 31+00). The revised monitoring scope for 2014 to 2016 includes the restored UT longitudinal profile (608 lin. ft), two of the original four cross-sections on the UT, all remaining bank pins (some were lost between 2013 and 2014), and six new cross-sections along Dutch Buffalo Creek between stations 21+00 and 45+00. The bank pins and new cross-sections were added to assess the stability of the enhancement reach.

The annual profile and cross-section measurements along the restored tributary should indicate only minor changes from the 2010 as-built data. Any future changes that occur will be evaluated to determine whether they indicate unstable conditions or whether they are within the range of expected natural channel adjustment. Substrate particle samples should generally shift towards coarser materials (based on D50 and D84 sizes at riffle cross-sections).

1.2.2. Vegetation Success

Jacobs Engineering established and monitored seven CVS vegetation plots during 2010 and 2011. No vegetation data were collected during 2012 or 2013, and in April 2014 DMS staff determined that no CVS vegetation plot data collection would be necessary prior to supplemental planting in areas exhibiting low planted stem survival. Consequently, no CVS plot data were collected during 2014 or 2015. Replanting of the upper field (western wetland restoration area) was conducted in early 2016 as directed by the DMS project manager. In September 2016 MMI-RJGA installed six new CVS plots (10m x 10m) in the upper field area, and collected CVS Level 2 woody stem data from the six new plots (#8 through #13) plus three of the original plots (#1, #2, #7) as directed by the DMS project manager.

To achieve vegetative success criteria the average number of planted stems per acre must exceed or meet 320 stems/acre after the third year of monitoring, 288 stems/acre after four years, and 260 stems/acre after the fifth year of project monitoring. High threat invasive species as defined in Version 1.3 of the EEP Monitoring Template should be limited in their spatial extent and density such that survival and diversity of native woody trees and shrubs is not compromised.

1.2.3. Hydrology Success

Stream and wetland hydrology attainment will be monitored in accordance with USACE standards. A continuous stage recorder (Onset Hobo pressure transducer) was installed on the DBC main stem on 10 April 2014, and was moved to the restored tributary on 07 Aug 2015 to better document stage and duration on this tributary. At the end of the five year monitoring period, two or more bankfull events must occur in separate years within the restoration reach. For wetland restoration or enhancement areas, the target hydrologic success criterion is saturation or inundation within 12 inches of the ground surface for at least eight percent of the growing season in Cabarrus County, which is 18 consecutive days (March 23 to November 7 = 229 days x 8% = 18 days).

1.3. Project Setting & Pre-Restoration Conditions

The Suther Stream and Wetland Restoration Site is located in Cabarrus County, North Carolina, northeast of the City of Concord. The site is located within the Yadkin – Pee Dee River Watershed (USGS HUC 03040105, DWQ Sub-basin 30712). A Vicinity Map is included in Appendix A. The surrounding land use is primarily agricultural with cattle grazing, row crops, and rural residential development. Dutch Buffalo Creek (DBC) is a third order stream with an approximate drainage area of 23 square miles at the farthest downstream point of the project. The restored UT to Dutch Buffalo Creek (UT) is a first order stream with an approximate drainage area of 0.3 square miles.

Prior to restoration in 2009, much of the project site was managed for cattle grazing, including the dredging and straightening of one tributary along with 3 ditched areas. Riparian vegetation along the tributaries was removed as a result of channelization and livestock impacts. The riparian zones along the main channel of DBC include mature forest with a sparse understory, and bank erosion impacts in some locations due to the long term livestock exposure and upstream changes in watershed land-use and hydrology. The DBC main stem is large (152 ft^2 average cross-sectional area) and the upper reach is enlarged in many areas, with steep banks and erosion on approximately 18% of the bank footage. The stream and buffer are now protected from livestock by a fenced conservation easement.

1.4. Project Components and Mitigation Assets

The Suther project consists of stream enhancement and preservation along a large incised stream and 608 feet of restoration along a channelized intermittent tributary. Three areas of wetland at the upper, middle, and lower reaches of the project include restoration, enhancement and preservation. The specific mitigation components and quantities are listed in Table 1 (Appendix A) and reflect the proposed asset revisions presented in the Mitigation Plan Addendum submitted to the IRT in Nov 2016.

1.5. Project Design Approach

The project design was developed by Jacobs Engineering in 2007 (was Jordan Jones & Goulding prior to 2010), constructed and planted during Nov-Dec 2009 by River Works Inc., and monitored for two years (2010 and 2011) by Jacobs Engineering. During 2012 and 2013 no formal monitoring or reports were produced, but DMS staff conducted limited monitoring and instrument maintenance. Routine monitoring was resumed in 2014 by Mogensen Mitigation Inc / Robert J. Goldstein & Associates (MMI-RJGA) and will continue through 2017 (MY6) and project close-out in 2018.

The stream restoration effort consists of Enhancement Level II along the upper portion of the DBC main stem, and a combination of P1 and PII restoration applied along the UT to Dutch Buffalo Creek. Stream bed elevations and high banks on the main stem made any attempt at a P1 restoration impossible. The value of existing mature forest in stabilizing banks combined with the large size of the channel and changing nature of the watershed made it likely that there would be little functional benefit in exchange

for a high level of construction impact and risk, thereby making any other traditional, sanctioned, creditable restoration approaches inadvisable. Therefore, the protection of the property and exclusion of cattle was determined to be the most feasible and advisable approach for the upper portion of the DBC main stem. The project also includes preservation, restoration and enhancement of wetlands, and re-establishment of native riparian vegetation.

The wetland restoration and enhancement areas and the areas of ditch filling on the DBC floodplain were planted with native species similar to those found in reference wetlands to achieve a Piedmont/Mountain Bottomland Forest community (Schafale and Weakley, 1990). Similarly, the restored tributary stream banks and adjacent riparian areas were stabilized and planted with suitable species to maintain a Piedmont/Low Mountain Alluvial Forest (Schafale and Weakley, 1990). With the exception of the drainage ditches, minimal grading (fill or cut) occurred for the wetland restoration and enhancement areas. Top soil taken from cut areas along the stream was reserved for the top soil dressing utilized for ditch filling. The soil along the stream banks was naturally fertile due to its alluvial nature, so this top soil was well suited for planting. In addition, soil disking was conducted to ensure adequate drainage and beneficial micro-topography for planting and drainage.

1.6. 2016 Current Conditions and Performance Summary

MMI-RJGA scientists collected monitoring data at the Suther Site during spring and fall of 2016 (MY-5). Based on the data and photographic documentation provided in the attached appendices, the project is generally performing as expected, given the site characteristics and incised channel constraints. Some minor concerns in specific areas are described below.

1.6.1. Stream Assessment: Dutch Buffalo Creek

Observations during March to Sep 2016 along the Dutch Buffalo Creek (DBC) enhancement reach (main stem station 17+61 to 53+72) indicate little change from MMI's previous visits in 2014 and 2015, or from the photos and description provided in the MY-2 (2011) monitoring report by Jordan Jones & Goulding (May 2012). Most of the stream bed remains dominated by shifting sand and silt, with few areas of gravel or cobble. Limited areas with larger rocks (cobble to boulder) are mostly embedded with sand and silt. The creek had moderate flow during spring and early summer, and minimal flow with extensive areas of exposed stream bed during September. Roughly 40 to 50 percent of the stream bed area appeared dry on the surface in between isolated pools, although hyporheic flow was presumably continuous through the sandy bed. Some additional bank erosion, tree falls, and slumping were observed in areas with near-vertical banks, similar to the conditions reported in 2014-2015 (Table 5). In September, beavers had rebuilt their dam across DBC at station 17+50 just upstream of the enhancement reach, at the same location as in previous years. The beaver dam was not present during visits in Dec 2015 and spring 2016, apparently washed out by high flows in late 2015. The dam has appeared and disappeared twice in the same location between 2014 and 2016.

Twenty-two of the 32 bank erosion pins along the DBC enhancement reach exhibited some new erosion in March and/or Sept 2016, ranging from 0.1 to 1.0 feet of new pin exposure (Table 9). Four pins showed no new erosion during the past year, and six pins were not found. Most of the new erosion was

recorded in March, following heavy storms in Dec 2015; additional erosion during March to Sept 2016 was relatively minor. The annualized average bank retreat rate for all bank erosion pins found is 0.23 ft/yr (based on the 42 month period from Mar 2013 to Sep 2016); similar to last year's value.

The six cross-sections on DBC (Figure 3) show negligible change from 2014 and 2015. Cross-section #2 deepened by about one foot at the toe of the steep left bank, on the outer bend of a pool. The scour pool observed in September 2015 at the confluence of Dutch Buffalo Cr and the restored tributary (DBC station 39+60), just below cross-section #6, has filled in during the past year.

The Dutch Buffalo Creek preservation reach (main stem station 53+72 to 100+50) appears unchanged since 2014. This reach has generally well-forested stream banks, and channel dimensions appear more appropriate (less incised and over-widened) than in the enhancement reach upstream. Bank undercutting is present along many segments, but good tree root density on the banks and presumably lower shear stresses during storm events apparently result in less bank slumping and erosion.

1.6.2. Stream Assessment: Restored Tributary of DBC

The 2016 condition of the restored tributary (UT-1) appears similar to the 2011 monitoring photos and the 2014 and 2015 reported condition. The stream pattern, profile, and dimension are maintaining vertical and lateral stability over most of the restored reach, and the cross-vanes and constructed riffles are performing as designed. Stream-bank vegetation density appears adequate in most areas, although growth of planted stems is slow, probably due to the mature hardwood canopy surrounding the planted riparian areas. The lowermost 15 feet of the channel adjacent to DBC remains poorly vegetated and erosion-prone. High flow events and the mature canopy in this steeply incised segment of DBC makes establishment of woody stems difficult in this area.

The Hobo pressure gauge was moved from DBC to UT-1 (station 4+82) on August 7, 2015, as requested by the DMS project manager. It was initially installed with the sensor 0.7 ft above the thalweg in a pool to record moderate and high flow events, then shifted downward to 0.1 ft above the stream bed on March 24, 2016 to record lower flows. Pressure differences of 0.04 psi or greater between the Hobo gauges (creek vs ambient) appear to be reliable as water depth indicators; random variation between the gauges during dry periods is less than 0.03 psi. The 0.04 psi threshold indicator for standing water in the creek corresponds to 0.1 ft of water depth above the sensor. From 07 Aug 2015 to 24 Mar 2016 (230 days), the Hobo gauge at the higher position in the creek recorded water in the channel (0.8 ft deep or more) on 37 days, or 16% of this period. From 24 Mar 2016 to 12 Sep 2016 (172 days), the Hobo gauge shifted to the lower position recorded standing or flowing water (0.2 ft deep or more) continuously from March 24 to June 8 (77 days). From June 9 to September 12 there was usually less than 0.2 ft of water in the pool at the gauge (below detection limit), except for brief peaks of a few hours each. See figure in appendix. The channel had no standing or flowing water during the geomorphic survey in Sep 2016. In-channel vegetation growth (grasses and herbs) is abundant, but is not significantly impeding flow or causing channel over-widening. Minor wash-out of fabric and was observed at some of the close-spaced step-pools along the lowermost 80 feet of this reach. No further bank slumping or structural problems were observed beyond the conditions reported in 2015. 99 percent of the bank length remains stable, as in previous years (Table 5).

1.6.3. Wetlands Assessment

Wetland areas have been re-numbered to match the Mitigation Plan Addendum (Nov 2016). The ditch plugs and grade-control steps installed in the ditches draining wetlands C and B appear to be stable and performing as designed, with minimal erosion. All wetlands showed extensive ponding and/or shallow saturation during the Mar 2016 field visit, but were dry in Sep 2016, with water tables deeper than 18 inches in most areas. Wetland area C1/C3, a former pasture pre-project, was replanted in March 2016 and now has adequate woody stem density (planted and volunteers combined) to meet the MY5 success criterion of 260 stems/ac. All other wetlands in the project area were forested pre-project, although their understory and groundcover strata were sparse due to grazing. Understory and groundcover vegetation in wetlands appear to be increasing due to cattle exclude fencing, but some damage from feral hog rooting continues, as reported in 2014 and 2015.

The wetland boundaries mapped in the CCPV figures reflect the pre-restoration boundaries. Wetland hydrology as measured with RDS groundwater gauges indicates hydrologic success at four of the six gauges in restoration area C3 (Table 13). Gauges #12 and 13 did not meet success criteria, and the C3 restoration area boundary has been modified to exclude the northwestern portion where those two gauges are located.

The proposed wetland enhancement area B3 (previously mapped as AB2) did not meet hydrologic success criteria from 2010 to 2013. The two GW gauges in B3 (4-Old and 5-Old) were moved northeast in 2014 into area B1/B4, and area B3 will not be included as a final credit asset. The proposed wetland enhancement area B2 (previously mapped as AB3) also did not meet hydrologic success criteria from 2010 to 2016, based on GW gauges 9 and 10, and will not be included as a final credit asset. Four of the five GW gauges in wetland area B1/B4 (preservation and enhancement areas) met hydrologic success criteria every year, and the fifth gauge (#8) met criteria in 3 of 5 years.

Evidence of feral hogs living in the former pasture area, in both the wetland and non-wetland portions, is similar to that reported in 2014 and 2015. Hog rooting activity was also noted in several areas along the banks of DBC and the restored tributary. Moderate grazing damage was also noted along the forested stream enhancement area along DBC downstream of the pasture, apparently from deer and/or feral hogs.

1.6.4. Vegetation and Easement Assessment

Planted and volunteer native trees are continuing to gradually reclaim the former pasture at the upper end of the project (south of DBC station 3+00 to 14+00), although grasses, herbs and blackberries still comprise the predominant cover in this area. With supplemental planting of 1400 additional trees (24" to 42" tall) by HARP in March 2016 (159 Green Ash, 308 Tulip Poplar, 158 River Birch, 288 Water Oak, 159 Red Maple, 308 Sycamore, and 20 Tag Alder), all of the pasture area including wetland C1 now has sufficient native woody density to exceed the 260 stems per acre average density success criterion for MY-5. The eight CVS vegetation plots in this area (two existing plus six new plots installed this year) have native woody stem densities of 800 to 4600 stems per acre.

The previous contractor provided a planted species list, but no data sheets or x,y coordinates for the original planted trees (Dec 2009). Since all of the planted species occur naturally in the surrounding forests, it was not feasible for MMI to distinguish planted trees from volunteer trees in the CVS plots several years later (other than a few species that were not reported as planted). Consequently, all native trees found in plots were recorded and entered into the CVS data tool using the Level 2 protocol of size categories and stem numbers. Species reported as planted in 2009 or 2016 are designated by fill color in Table 8.

The riparian restoration area along both sides of the restored tributary UT-1 remains dominated by grasses and herbs, with planted and volunteer tree seedlings and saplings gradually becoming more prominent. The current average density of planted and volunteer native trees in this area exceeds the 260 stems per acre average density success criterion for MY-4. Growth of the planted trees is slow, probably due to shading from the mature canopy which surrounds the channel and planted areas. The single CVS vegetation plot in this area (VP7) had eight native tree species and a density of 2670 trees per acre, with river birch, musclewood, elm, and sweetgum as the dominant species.

The livestock exclusion fencing around the conservation areas appears to be effective in keeping cattle out of the stream beyond these crossings. Some segments of the easement boundary have no fence, but no livestock are kept in these adjoining areas.

1.6.5. Hydrology Assessment

Groundwater table depth data from 17 RDS groundwater gauges installed in April 2014 are presented in Appendix E, Table 13. Nine of the eleven gauges in wetland area C (upper, western portion of project) achieved the required hydrologic success criteria of 18 consecutive days (eight percent of the 229-day growing season) in 2016. The two northwesternmost gauges (#12 & 13) failed to meet hydrologic success in 2016 and previous years, and the C3 restoration area boundary has been revised to exclude this area.

The four groundwater gauges in wetland area B1/B4 all achieved success criteria in 2016. The one remaining well in area B2 (previously mapped as AB3) failed to meet success criteria this year and last year, and area B2 has been deleted from the project assets. Area B3 (previously mapped as AB2) has also been deleted from the project assets; the groundwater gauges in this area were removed in April 2014.

The Suther site rain gauge data for 2016 appear consistent with other available rain gauge data in Cabarrus County. Total rainfall recorded onsite from Jan to Oct 2016 was 28.4 inches, about 0.9 inch less than the City of Concord's rain gauge at the Rocky River wastewater plant. Rainfall during Jan to Apr was below normal, May was higher than normal, and Jun to Oct was within normal range (between 30^{th} and 70^{th} percentiles).

Bankfull flow is assessed using a pair of Hobo pressure loggers, one installed in a slotted pipe the creek channel and the other installed at a nearby upland site above maximum flood-stage. The in-channel logger was installed in Dutch Buffalo Creek 200 ft upstream from the restored tributary mouth from

April 2014 to August 2015, then moved to a pool on the restored tributary at the request of the DMS project manager. It was initially installed 0.7 ft above the tributary thalweg to record high flow events, then shifted downward to 0.1 ft above the thalweg on 28 March 2016 to record all significant flow events. From 28 Mar 2016 to 12 Sep 2016, the tributary had standing or flowing water (at least 4 inches deep in the pool) on 63 days, or 37% of the period of record. At least four over-bank flow events were recorded on the restored tributary in 2016, on Feb 16, Feb 24, May 3, and May 21 (Table 12).

2.0. Monitoring Methods

Monitoring methodologies follow the CVS-EEP Level 2 Vegetation Monitoring Protocol for Recording Vegetation (Lee *et al.* 2008). Photos were taken with digital cameras and are available electronically. A Trimble Geo XT mapping-grade GPS unit was used to locate groundwater gauges, stream cross-sections, other monitoring features and problem areas.

An HP 48G+ calculator was used to download the Infinity rain gauge, an Aceeca Meazura PDA was used to download the RDS groundwater gauges, and an Onset Hobo Data Shuttle was used to download the Onset Hobo pressure transducers. CCPV graphics were prepared using ESRI ArcGIS.

2.1. Vegetation Methodologies

Six new CVS vegetation plots (10 x 10 meters) installed in 2016 plus three of the original CVS plots were monitored according to the CVS-EEP Level 2 Vegetation Monitoring Protocol Version 4.2 (Lee *et al.* 2008) starting in MY 4. Plot corners are marked with 1" diameter steel pipe and flagging tape. Native tree and shrub species in plots were counted and assigned to height or diameter categories following the protocol for volunteer stems. Due the elapsed years without vegetation monitoring it was not feasible to distinguish planted stems from volunteer stems.

2.2. Wetland Methodologies

All seventeen RDS groundwater monitoring gauges were downloaded quarterly throughout the year, most recently in September 2016. Consecutive days of saturation within 12 inches of the ground surface and success criteria are summarized in Table 13. Raw data for these gauges is provided in a spreadsheet in the electronic support files. Wetland delineation in Sep 2016 was conducted following the Eastern Mountains and Piedmont Regional Supplement to the Federal Wetlands Delineation Manual.

2.3. Stream Methodologies

The UT longitudinal profile was surveyed using a Trimble RDK survey-grade GPS unit, and cross-sections along the UT and DBC were surveyed with an automatic level and rod. The survey data locations were plotted using ARC GIS 10.0 and Excel. Cross-sectional data was based on a linear alignment between end points marked by metal pins. Measurements at each cross-section include points at point of origin, bankfull, top of bank, toe of slope and thalweg for each stream side supplemented with photos. Long-pro measurements include thalweg, and water surface taken at the head of feature (i.e. riffle, run, pool glide) in addition to pool depths. In addition, visual and photographic assessment of

in-stream structures was conducted to determine overall project success. Stream assessment data are included in Appendix D with cross-sections and monitored stream reaches indicated on maps in Appendix B. In addition, MMI used manual crest stage gauges to verify bankfull events.

3.0. References

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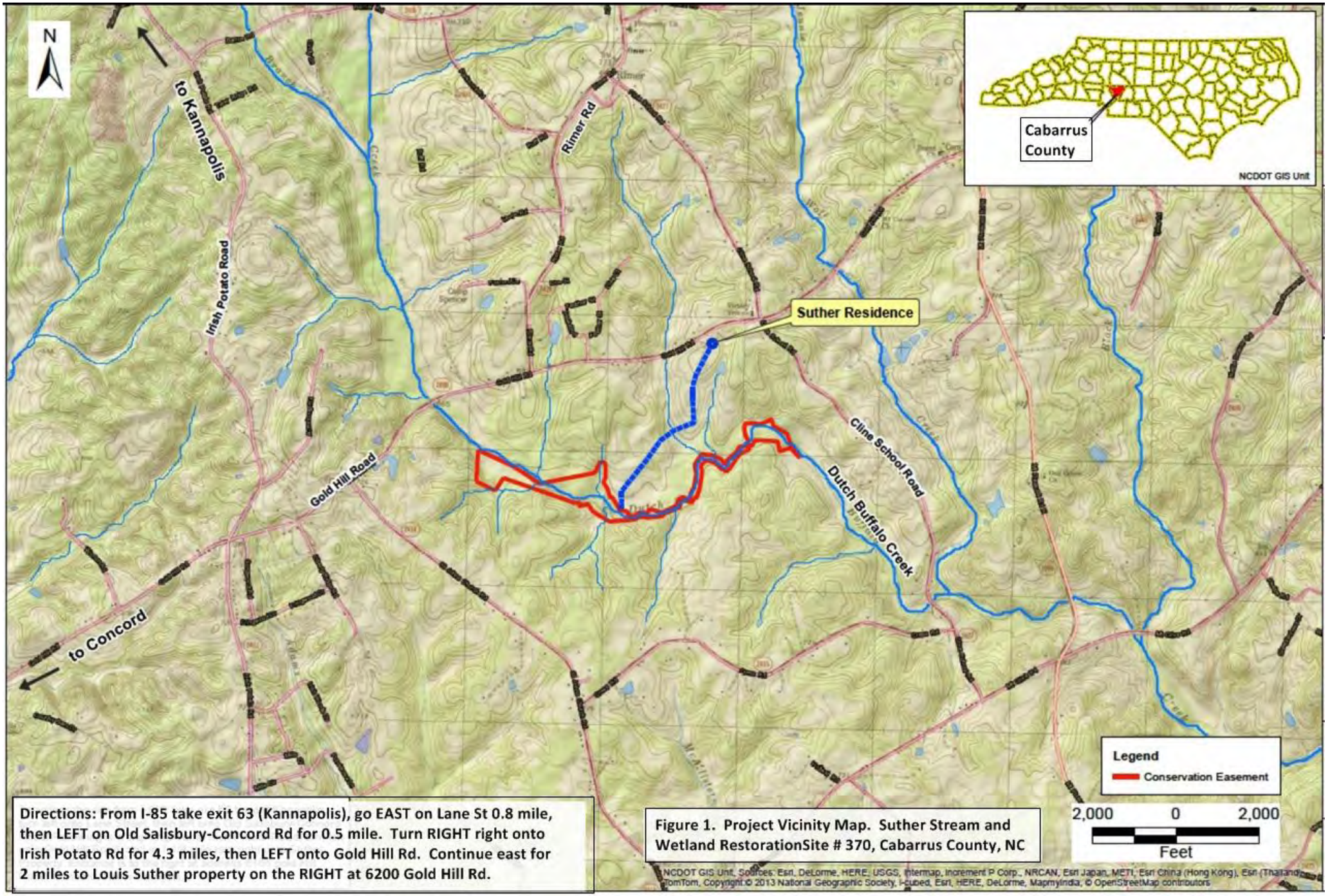


Figure 1. Project Vicinity Map. Suther Stream and Wetland RestorationSite # 370, Cabarrus County, NC

Appendix A. Project Background Tables

Table 1. Project Components and Mitigation Credits
Suther Site # 370: Dutch Buffalo Cr Stream and Wetland Restoration, Cabarrus Co.

Reach ID	Existing Footage/ Acreage	As-Built Stationing/ Location	Mitigation Approach	As Built Footage/ Acreage	Creditable Footage/ Acreage	Mitigation Ratio	Credits (SMU/WMU)	NOTES
Upper Dutch Buffalo Creek	1,761	0+00 to 17+61	N/A	1,761	0	N/A	0	One sided main channel easement abutting wetland C
Upper Dutch Buffalo Creek	3,611	17+61 to 53+72	Enhancement II	3,004	2,763	2.5:1	1,105.2	Livestock exclusion and limited understory planting
Lower Dutch Buffalo Creek	4,678	53+72 to 100+50	Preservation	4,678	3,413	5:1	682.6	Livestock exclusion and conservation of more stable reach
Unnamed Tributary	608	0+00 to 6+08	Restoration (P1/P2)	608	608	1:1	608	Channel restoration with use of grade control and bank protection structures.
Wetland Group A	1.67*	Downstream area	Preservation	1.64	1.64	5:1	0.33	Some easement fencing
Wetland Group B	10.01*	B-1	Preservation	7.83	7.83	5:1	1.57	Fenced and livestock excluded; no intervention; wetland B-4 1.36 acreage removed from original 9.19 ac to yield 7.83 ac.
		B-2	Enhancement	N/A	N/A	N/A	0	Omitted from credits due to non-attainment of hydrology criteria
		B-3	Enhancement	N/A	N/A	N/A	0	Not included in orignal JD; omitted from credits
		B-4	Enhancement	1.36	1.36	2:1	0.68	Ditches plugged, livestock excluded, and and hydrology improved
Wetland Group C	4.34*	C-1	Enhancement	2.31	2.31	2:1	1.16	Planting and ditch plugging
		C-2	Preservation	1.52	1.52	5:1	0.30	Easement-protected riparian wetland
		C-3	Restoration	5.32	4.84	1:1	4.84	Northwest corner cut out due to GW-12 and GW-13 non-attainment

***Acreage derived from 2007 jurisdictional determination; does not include wetland restoration area C-3.**

Note - Credits revised per 11/21/16 Mitigation Plan Addendum memo.

Mitigation Approach Components Summary	Stream (lin. ft)	Riparian Wetland (acres)
Restoration	608	4.84
Enhancement	N/A	3.67
Enhancement I	0	N/A
Enhancement II	2,763	N/A
Preservation	3,413	10.99

Mitigation Assets Summary	Overall Credits
Stream Credits	2,395.8
Riparian Wetland Credits	8.87

Table 2. Project Activities and Timeline Suther Site # 370: Dutch Buffalo Cr Stream and Wetland Restoration, Cabarrus Co.	
Activity or Milestone	**Month, Year**
Project Site Identified by EcoScience (for NCDOT)	**Nov 2001**
Feasibility Study by EcoScience (for NCDOT)	**May 2002**
Option Agreement Signed	**Jun 2004**
Conservation Easement Signed	**Sep 2005**
Transfer - NCDOT to NCEEP	**Mar 2006**
Project Instituted	**Jul 2006**
Mitigation (Restoration) Plan	**Sep 2007**
Permitted (NCDWR #08-0134)	**Feb 2008**
Permitted (USACE #SAW-2008-0218)	**Mar 2008**
Construction Completed	**Nov 2009**
Monitoring - Year 0	**Dec 2009**
MY0/Baseline Report	**Jan 2010**
Monitoring – Report Year 1	**Dec 2010**
Monitoring - Report Year 2	**Dec 2011**
GW gage additions (17)	**April 2014**
Monitoring - Report Year 3	**Sep 2014**
Monitoring - Report Year 4	**Oct 2015**
Supplemental Planting – Wetland C	**Mar 2016**
Mitigation Plan Addendum	**Nov 2016**
Monitoring - Report Year 5	**Dec 2016**
Monitoring - Report Year 6	**Nov 2017***
Closeout Submission	**Jun 2018***
*** planned schedule**	

Table 3. Project Contacts Table Suther Site # 370: Dutch Buffalo Cr Stream and Wetland Restoration, Cabarrus Co.	
Designer Matthew Clabaugh, PE	Jacobs Engineering Group (Jordan, Jones & Goulding) 6801 Governors Lake Parkway Norcross, GA 30071 770-455-8555
Construction Will Pedersen	River Works, Inc. 8000 Regency Parkway, Suite 200 Cary, NC 27511 919-459-9001
Planting & Seeding Contractor	River Works, Inc. (2009 original planting)
Suplemental Planting	H.A.R.P. (2015 replanting)
Monitoring Performers: **MY-0 to MY-2 (2009-2011)** Allison Nichols	Jacobs Engineering Group (Jordan, Jones & Goulding) 6801 Governors Lake Parkway Norcross, GA 30071
Monitoring Performers: **MY-3 to MY-6 (2014-2017)** Gerald Pottern, Rich Mogensen	Mogensen Mitigation Inc (MMI-RJGA) 104 East Chestnut Ave, Wake Forest NC 27587 (formerly Robert J Goldstein & Associates)
Stream Monitoring, POC	Gerald Pottern, 919-556-8845 gpottern@RJGAcarolina.com
Vegetation Monitoring, POC	
Wetland Monitoring, POC	

Table 4. Project Baseline Information and Attributes Suther Site # 370: Dutch Buffalo Cr Stream and Wetland Restoration, Cabarrus County				
Project Location Information				
Project Name		Suther Site, Dutch Buffalo Cr Stream and Wetland Restoration Project		
County		Cabarrus County, North Carolina		
Project Area (acres)		66		
Project Coordinates (latitude and longitude)		35° 27' 05" N, 80° 29' 32" W		
Project Watershed Summary Information				
Physiographic Province		Piedmont		
River Basin		Yadkin PeeDee		
USGS 8-digit Hydrologic Unit	3040105	USGS Hydrologic Unit 14-digit	03040105020060	
DWQ Sub-basin		03-07-12		
Project Drainage Area (sq mi)		21.3		
Project Drainage Area Percentage Impervious		3%		
CGIA Land Use Classification		Cultivated (3.00); Mixed Upland Hardwoods (10.00)		
Reach Summary Information				
Parameters		**Dutch Buffalo Creek**	**UT Dutch Buffalo Cr**	
Length of Reach (linear feet)		10,050	608	
Valley Classification		VIII		
Drainage Area (sq.mi.)		21.3	0.31	
NCDWQ stream identification score		13-17-11-(4.5)		
NCDWQ Water Quality Classification		WS-II; HQW,CA		
Morphological Description (stream type)		Perennial	Intermittent	
Evolutionary trend		C→G→F→C	E→Gc→F→C→E	
Underlying mapped soils		Altavista, Cecil, Chewacala, Cullen, Enon, Pacolet, Mecklenburg		
Drainage class**		MWD, WD, SPD, WD, WD, WD, WD		
Soil Hydric status		Class B (Chewacla and Altavista)		
Slope		0.0011	0.0093	
FEMA Classification		100-year floodplain on Dutch Buffalo Cr		
Native vegetation community		Piedmont/Mountain Bottomland Forest; Piedmont/Low Mountain Alluvial Forest		
Percent composition of exotic invasive vegetation		10	80	
Wetland Summary Information				
Parameters		**Main Channel**	**UT**	
Size of Wetland (acres)		11.55	1.67	
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)		riparian riverine	riparian riverine	
Mapped Soil Series		Chewacla Loam		
Drainage class		SPD	SPD	
Soil Hydric Status		B	B	
Source of Hydrology		streamflow, groundwater	streamflow, stormwater	
Hydrologic Impairment		ditching	ditching	
Native vegetation community		Piedmont/Mountain Bottomland Forest & Piedmont/Low Mountain Alluvial Forest	Piedmont/Low Mountain Alluvial Forest	
Percent composition of exotic invasive plants		5	5	
Regulatory Considerations				
Regulation & Agency		**Applicable?**	**Resolved?**	**Documentation**
Waters of the US Section 404 (US-ACOE)		Yes	Yes	Approved JD, NWP 27
Waters of the US Section 401 (NC-DEQ)		Yes	Yes	Approved 401 Certificate
Endangered Species Act (US-FWS)		No	N/A	N/A
Historic Preservation Act (SHPO)		No	N/A	N/A
Coastal Area Management Act (CAMA)		No	N/A	N/A
FEMA Floodplain Compliance (FEMA)		No	N/A	N/A
Essential Fisheries Habitat (NMFS)		No	N/A	N/A

*Beaver activity was observed along the main channel of Dutch Buffalo Creek during the early stages of the design phase and has not impacted the UT. No beaver activity was observed during 2009-2012 post-construction monitoring.

"N/A": items do not apply / "-": items are unavailable / "U": items are unknown

SPD: Somewhat Poorly Drained; MWD: Moderately Well Drained; WD: Well Drained

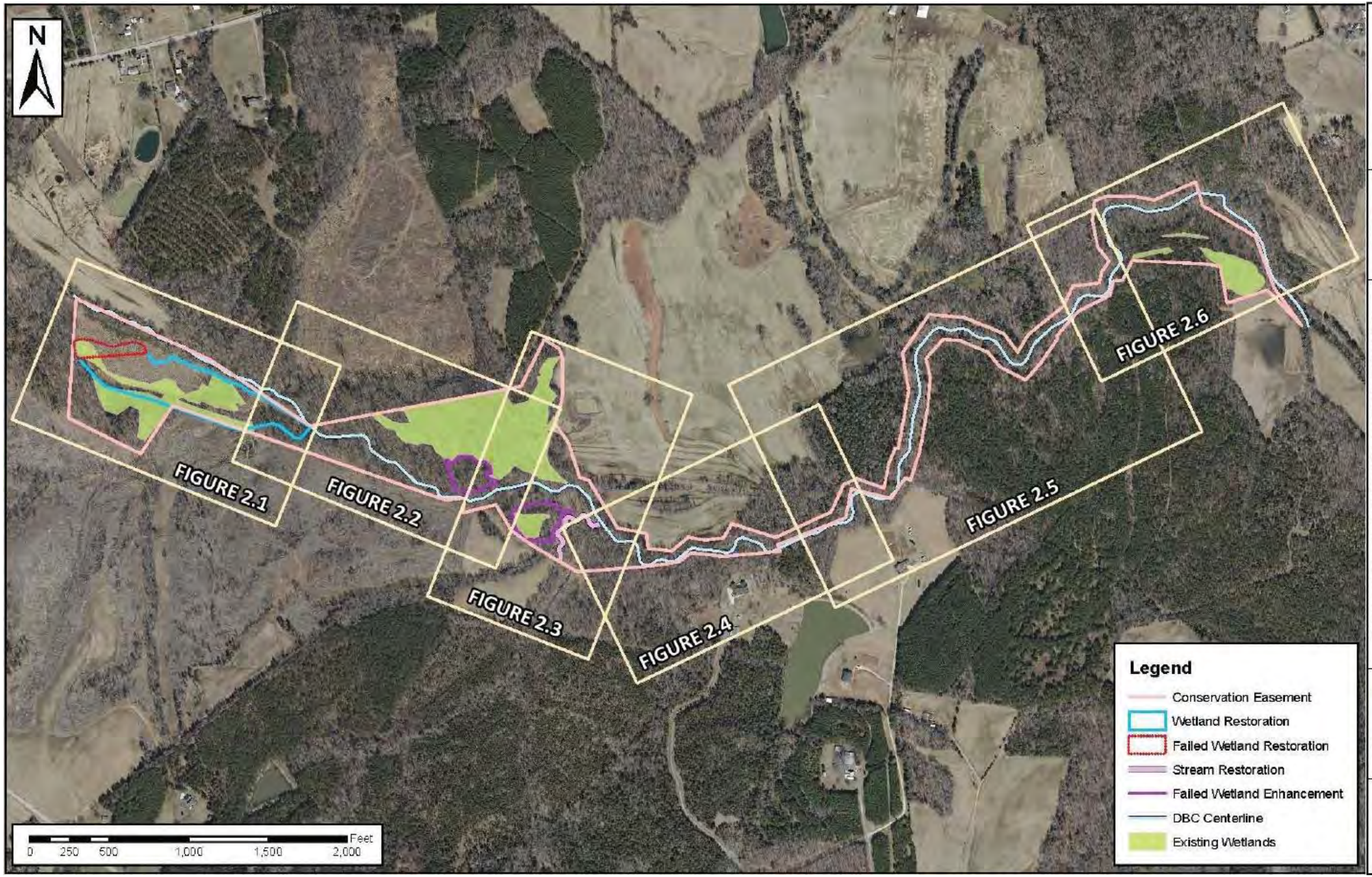
**Drainage classes correspond to the underlying mapped soils listed.

Appendix B. Visual Assessment Data

Figure 2.0-2.6. Current Conditions Plan View (CCPV)
Table 5. Visual Stream Stability Assessment
Table 6. Vegetation Condition Assessment

Stream Fixed Photopoints: Dutch Buffalo Cr & Tributary
Problem Areas, Erosion, & Wetland Photos
Bank Erosion Pins Photos

e-Table: Stream & Vegetation Problem Areas



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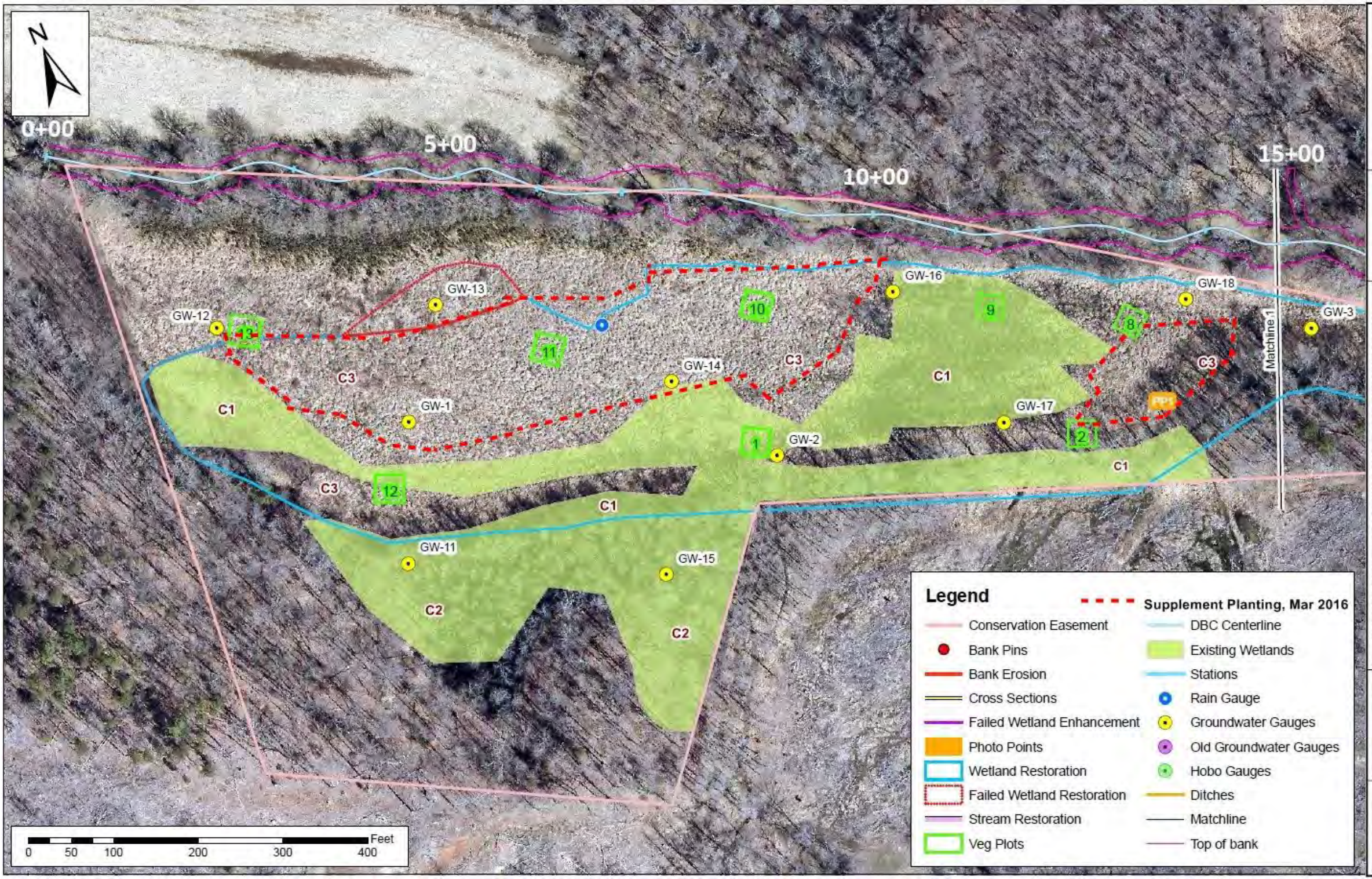
SUTHER SITE STREAM AND WETLAND RESTORATION
YADKIN-PEEDEE USGS-HUC #03040105
CABARRUS COUNTY
NORTH CAROLINA

NC Environmental Quality

FIGURE 2.0
SEPT 2016
MY5 of 5



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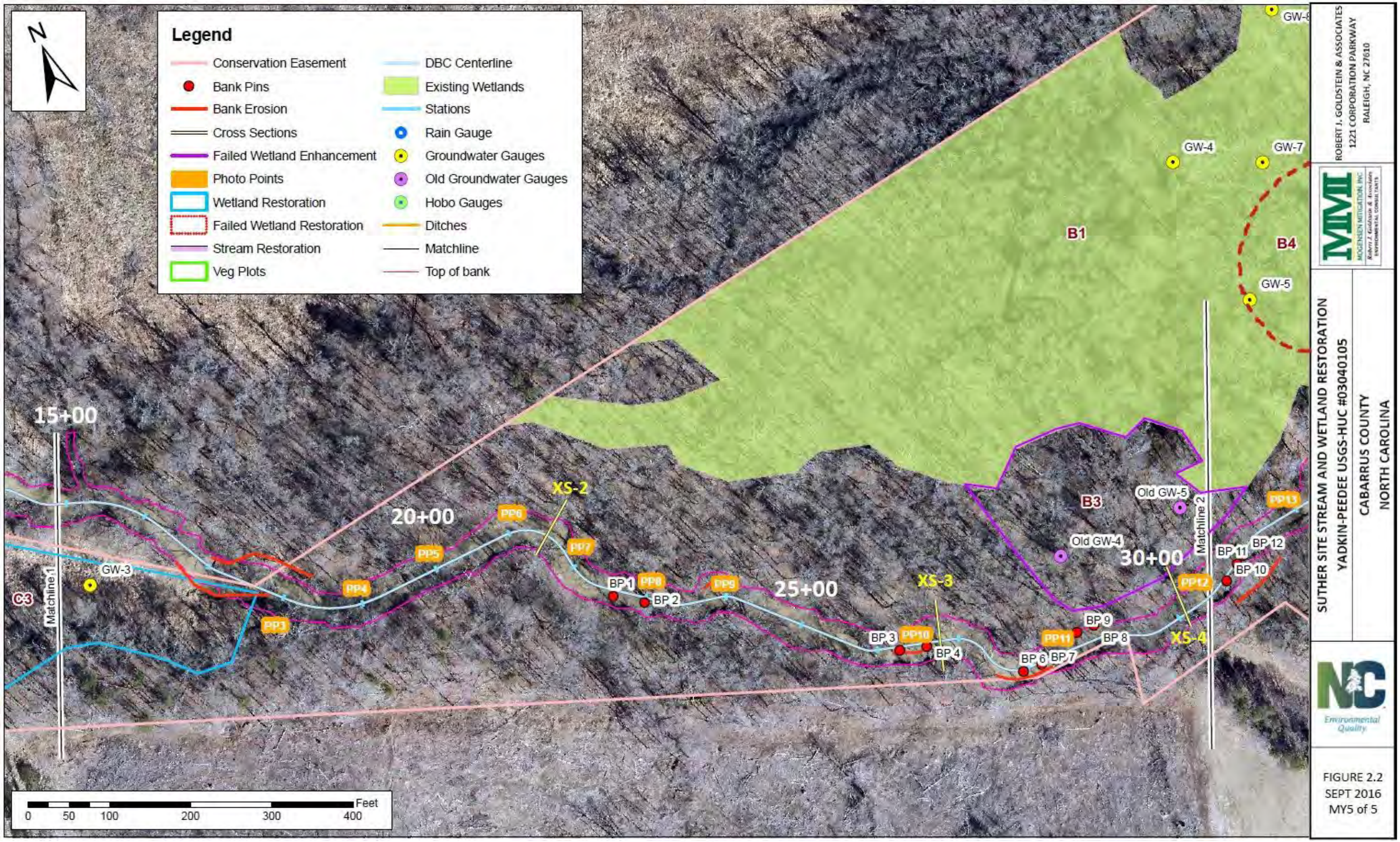
CABARRUS COUNTY
NORTH CAROLINA

NC Environmental Quality

FIGURE 2.1
SEPT 2016
MY5 of 5



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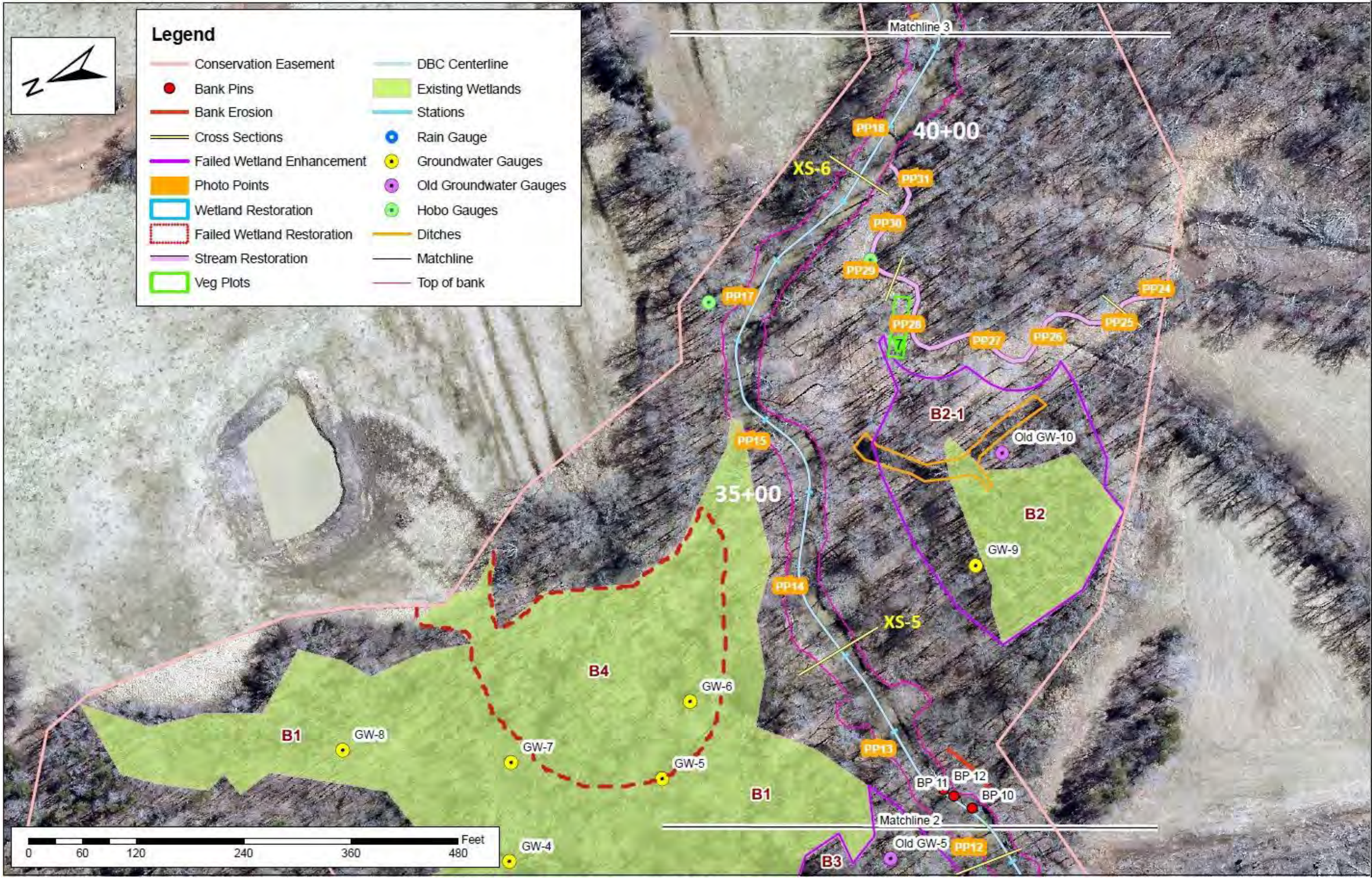
CABARRUS COUNTY
NORTH CAROLINA

NC Environmental Quality

FIGURE 2.2
SEPT 2016
MY5 of 5



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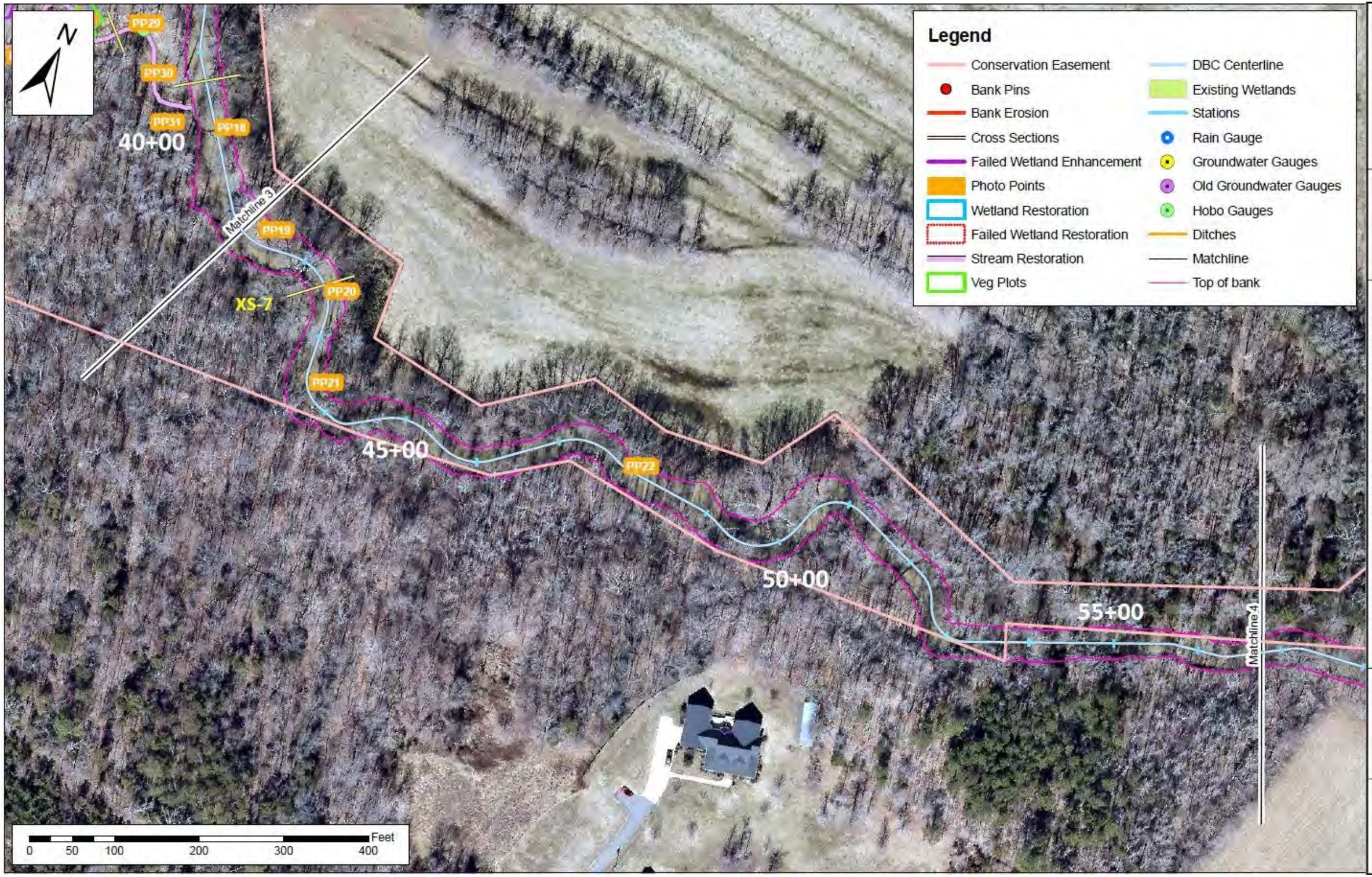
YADKIN-PEEDEE USGS-HUC #03040105
CABARRUS COUNTY
NORTH CAROLINA

NC Environmental Quality

FIGURE 2.3
SEPT 2016
MY5 of 5



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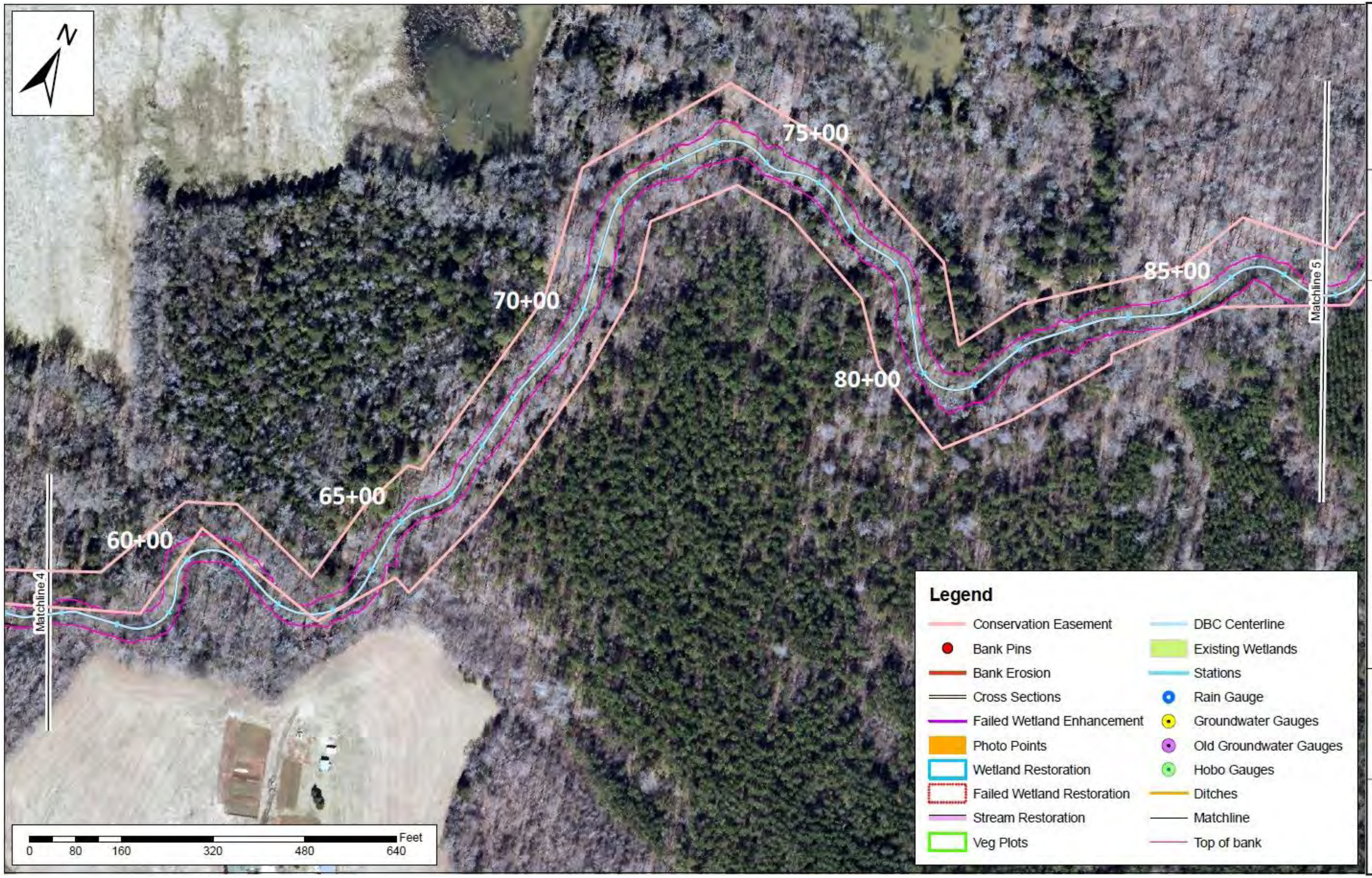
YADKIN-PEEDEE USGS-HUC #03040105
CABARRUS COUNTY
NORTH CAROLINA

NC Environmental Quality

FIGURE 2.4
SEPT 2016
MY5 of 5



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NORTH CAROLINA

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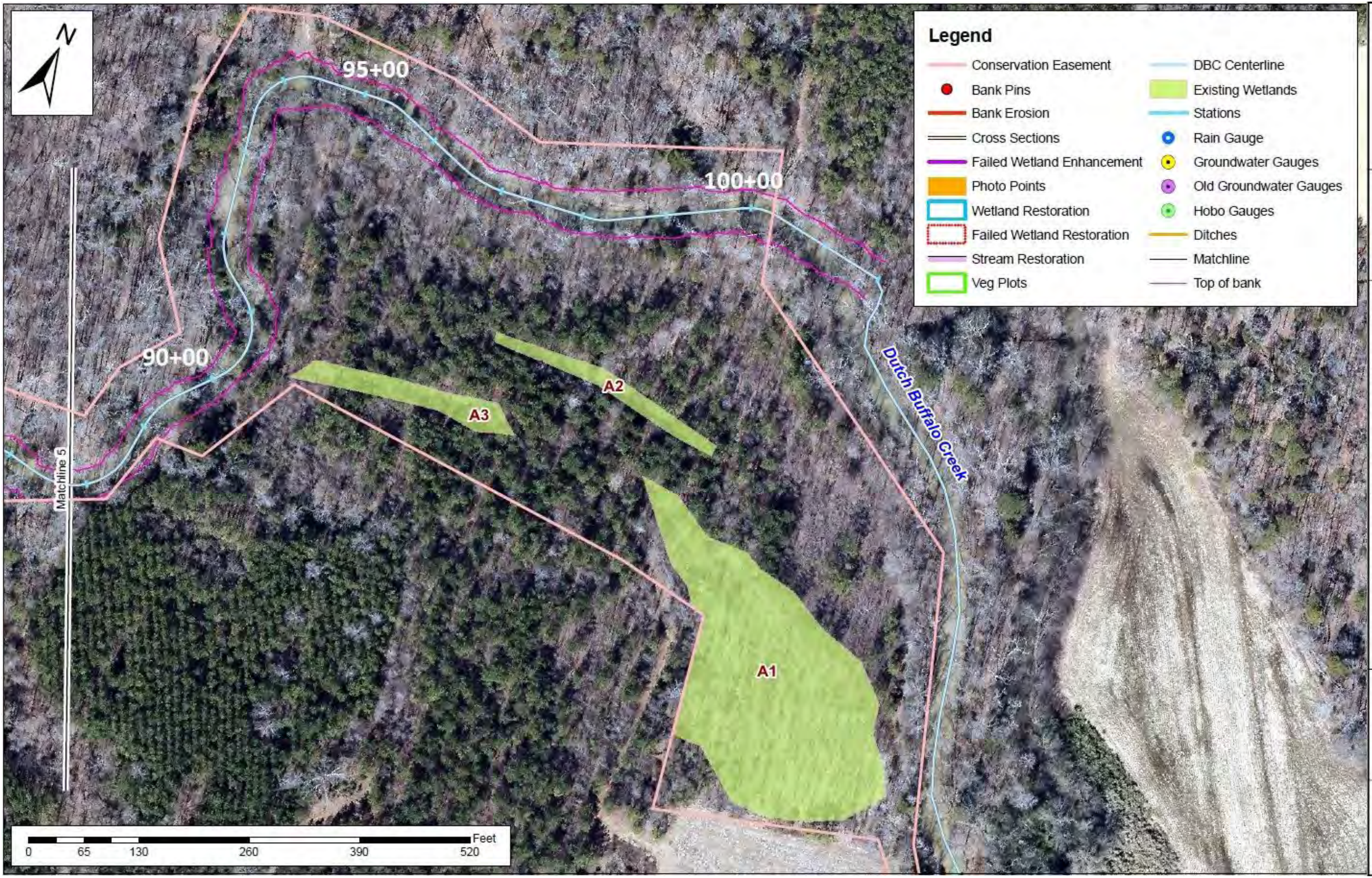
FIGURE 2.5
SEPT 2016
MY5 of 5



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YADKIN-PEEDEE USGS-HUC #03040105
CABARRUS COUNTY
NORTH CAROLINA

NC Environmental Quality

FIGURE 2.6
SEPT 2016
MY5 of 5

Table 5a. Visual Stream Stability Assessment -- Main Stem Dutch Buffalo Creek Enhancement (2,763 lin.ft = 5,526 bank ft)
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration: EEP Project # 370
Monitoring Year 5 of 5 (2016)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	N/A*	N/A*			N/A*			
	3. Meander Pool Condition	Depth Sufficient	N/A*	N/A*			N/A*			
		Length Appropriate	N/A*	N/A*			N/A*			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	N/A*	N/A*			N/A*			
		Thalweg centering at downstream of meander bend (Glide)	N/A*	N/A*			N/A*			
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			18	1303	76%	14	1031	95%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely Does NOT include undercuts that are modest, appear sustainable and are providing habitat			3	160	97%	0	0	98%
	3. Mass Wasting	Bank slumping, calving, or collapse			2	110	98%	0	0	98%
				Totals	23	1573	72%	14	1031	90%
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	N/A*	N/A*			N/A*			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	N/A*	N/A*			N/A*			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms	N/A*	N/A*			N/A*			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%	N/A*	N/A*			N/A*			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow	N/A*	N/A*			N/A*			

The Dutch Buffalo Creek Enhancement II channel is incised and eroded. No channel restoration was performed on this reach.

*No engineered structures were installed within the Dutch Buffalo Creek Enhancement II segment.

Table 5b. Visual Stream Stability Assessment -- UT Dutch Buffalo Creek
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration: Project # 370
Monitoring Year 5 of 5 (2016) Restored Tributary Length = 608 lin.ft = 1,216 bank feet

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	7	7			100%			
	3. Meander Pool Condition*	Depth Sufficient *	-	-			N/A			
		Length Appropriate	8	8			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	7	7			100%			
		Thalweg centering at downstream of meander bend (Glide)	7	7			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			1	8	99%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	1	8	99%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	7	8			88%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms	6	8			75%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%	8	8			100%			
	4. Habitat*	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow	-	-			N/A			

* Survey performed during dry conditions in channel. Parameter not assessed due to lack of water.

Piping: Two step-pools near the lower end of this reach have minor fabric washout and piping.

Table 6: Vegetation Condition Assessment Table
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration: Project # 370
Monitoring Year 5 of 5 (2016)

Planted Acreage **25.14**

Vegetation Problem Category	Definitions	Mapping Threshold (acres)	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1	N/A	0	0	0%
Low Stem Density Areas **	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1	N/A	0	0	0%
			Total	**0**	**0**	**0%**
Areas of Poor Growth Rates or Vigor **	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25	N/A	0	0	0%
			Cumulative Total	0	0	**0%**

Easement Acreage **67.32**

Vegetation Problem Category	Definitions	Mapping Threshold (SF)	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern ***	Areas of points (if too small to render as polygons at map scale).	1000	N/A	0	0	0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	N/A	0	0	0%

Data are based on observations made between March and September 2016.

** Competition from tall grasses, herbs, and Rubus may be limiting planted tree survival and growth in Area C1/C3. Shading from adjacent forest plus competion from grasses and herbs may be limiting planted tree survival and growth in the streamside zones adjacent to the restored tributary. However, there are sufficient woody stems to preclude any "Problem Areas" mapping.

*** Several areas contain invasive groundover and shrub vegetation (*Microstegium, Lonicera, Ligustrum, Rosa*) but these are mostly beneath existing forest canopy and are not of concern.

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 01, facing north west: 2010

Photo Point 01, facing west: Sept 2016

Photo Point 02, Upstream: 2010

Photo Point 02, Upstream: Sept 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 03, Upstream: 2010

Photo Point 03, Upstream: Sept 2016

Photo Point 03 DBC, Upstream: 2010

Photo Point 03 DBC, Upstream: Sept 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 04, Downstream: 2010

Photo Point 04, Downstream: Mar 2016

Photo Point 05, Upstream: 2010

Photo Point 05, Upstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 06, Upstream: 2010

Photo Point 06, Upstream: Mar 2016

Photo Point 07, Downstream: 2010

Photo Point 07, Upstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 08, Upstream: 2010

Photo Point 08, Upstream: Mar 2016

Photo Point 09, Upstream: 2010

Photo Point 09, Upstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 10, Downstream: 2010

Photo Point 010, Downstream: Mar 2016

Photo Point 11, Upstream: 2010

Photo Point 11, Upstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 12, Upstream: 2010

Photo Point 12, Usptream: Mar 2016

Photo Point 13, Upstream: 2010

Photo Point 13, Upstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 14, Downstream: 2010

Photo Point 14, Downstream: Mar 2016

Photo Point 15, Upstream: 2010

Photo Point 15, Upstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 17, Upstream: 2010

Photo Point 17, Upstream: Mar 2016

Photo Point 18, Upstream: 2010

Photo Point 18, Upstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 19, Downstream: 2010

Photo Point 19, Downstream: Mar 2016

Photo Point 20, Downstream: 2010

Photo Point 20, Downstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 21, Downstream: 2010

Photo Point 21, Downstream : Mar 2016

Photo Point 22, Upstream: 2010

Photo Point 22, Upstream: 2015

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 24, Upstream: 2010

Photo Point 24, Upstream: Mar 2016

Photo Point 25, Upstream: 2010

Photo Point 25, Upstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 26, Upstream: 2010

Photo Point 26, Upstream: Mar 2016

Photo Point 27, Downstream: 2010

Photo Point 27, Downstream: Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 28, Upstream: 2010

Photo Point 28, Usptream: Mar 2016

Photo Point 29, Upstream: 2010

Photo Point 29, Upstream (Hobo Gauge): Mar 2016

MY5 Assessment Fixed Photopoints - 2016 - Suther Stream Mitigation Site # 370

Photo Point 30, Upstream: 2010

Photo Point 30, Upstream: Mar 2016

Photo Point 31, Upstream: 2010

Photo Point 31, Upstream: Mar 2016

Problem Areas, Erosion, Hobo Gauge Photos: Suther Site # 370, Cabarrus County -- Photos Sep 2016 unless dated otherwise

Bank erosion at step-pool: Tributary station 5+30, Sept 2015

Hog-rooting along streambank: Tributary station 3+40, May 2015

Hobo gauge at DBC sta 37+60, 4/2014 to 8/2015 (photo Sept 2014)

Hobo gauge moved to Trib sta 4+82 on 07 Aug 2015

Problem Area Photos, Bank Erosion: Suther Site # 370, Cabarrus County -- Photos Sep 2016 unless dated otherwise

Mowed area: SW of Groundwater Gauge 2 (Facing NW), Sept 2016

Mowed area: SW of Groundwater Gauge 2 (Facing East), Sept 2016

Beaver Dam: Trbutary Station 17+40, Sept 2016

Beaver Dam: Trbutary Station 17+40, Sept 2016

Problem Area Photos, Bank Erosion: Suther Site # 370, Cabarrus County -- Photos Sep 2016 unless dated otherwise

Bank Erosion: East of Bank Pins, Sept 2016

Bank Erosion: Tributary Station 23+50, Sept 2016

DBC construction crossing, Station 32+50, Sept 2016

DBC construction crossing, Station 32+50, Sept 2016

Wetland C1/C3: Suther Site # 370, Cabarrus County -- Photos Sep 2016 unless dated otherwise

Dry wetland, W of Veg Plot 9, Sept 2016

Moss Trim Lines & Soil Surface Cracks: W of Veg Plot 9, Sept 2016

Moss Trim Lines: W of Veg Plot 9, Sept 2016

Ditch: SW of Veg Plot 1, Sept 2016

Bank Erosion Pin Photos: Suther Site # 370, Cabarrus County -- Photos Sep 2016 unless dated otherwise

Bank Pin 1, Sept 2016

Bank Pin 2, Sept 2016

Bank Pin 3, Sept 2016

Bank Pin 4, Sept 2016

Bank Erosion Pin Photos: Suther Site # 370, Cabarrus County -- Photos Sep 2016 unless dated otherwise

Bank Pin 6, Sept 2016

Bank Pin 7, Sept 2016

Bank Pin 8, Sept 2016

Bank Pin 9, Sept 2016

Bank Erosion Pin Photos: Suther Site # 370, Cabarrus County -- Photos Sep 2016 unless dated otherwise

Bank Pin 10, Sept 2016

Bank Pins 11 &12, Sept 2016

Appendix C: Vegetation Plot Data

Table 7. CVS Plot Stem Density and Success Summary
Table 8. CVS Plot Stem Counts, Densities, and Annual Means

Table 7. CVS Plot Stem Density and Success Summary
Suther Site (#370) Cabarrus County, MY-5 (Sept 2016)

CVS Plot #	Stream + Wetland Planted + Volunteer Native Stems		Invasive Woody Stems	Success Criteria Met?
	per plot	per acre		
1	39	1578	0	Yes
2	114	4613	0	Yes
7	66	2671	0	Yes
8	40	1619	0	Yes
9	109	4411	0	Yes
10	20	809	0	Yes
11	25	1012	0	Yes
12	41	1659	0	Yes
13	20	809	0	Yes
Project Avg	53	2131	0	Yes

NOTE: The previous contractor provided a planted species list, but no data sheets or x,y coordinates for the original planted trees (Dec 2009). Since all of the planted species occur naturally in the surrounding forests, it was not feasible for MMI to distinguish planted trees from volunteer trees in the CVS plots several years later (other than a few species that were not reported as planted). Consequently, all native trees found in plots were recorded and entered into the CVS data tool using the Level 2 protocol of size categories and stem numbers. Planted species are designated by fill color in Table 8.

Table 8a. CVS Plot Stem Counts and Density by Plot (Current Year) and Annual Means for All Plots.
Suther Site DMS# 370, Cabarrus County NC

			Current Plot Data (MY5 2016)														
			370-01-0001			370-01-0002			370-01-0007			370-01-0008			370-01-0009		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer negundo	boxelder	Tree												3			30
Acer rubrum	red maple	Tree			3									5			31
Alnus serrulata	hazel alder	Shrub			2			3									
Betula nigra	river birch	Tree			2			46			47						1
Carpinus caroliniana	American hornbeam	Tree									5						
Cornus amomum	silky dogwood	Shrub			3			2			2			4			1
Diospyros virginiana	common persimmon	Tree									2			2			
Fraxinus pennsylvanica	green ash	Tree			19			3						10			35
Juniperus virginiana	eastern redcedar	Tree						1									
Lindera benzoin	northern spicebush	Shrub						1			1						
Liquidambar styraciflua	sweetgum	Tree			2			20			3						5
Liriodendron tulipifera	tuliptree	Tree						1									
Platanus occidentalis	American sycamore	Tree						31			2			8			
Quercus michauxii	swamp chestnut oak	Tree			1												
Quercus phellos	willow oak	Tree						1									
Salix nigra	black willow	Tree			1												
Ulmus alata	winged elm	Tree												4			
Ulmus americana	American elm	Tree			5			4			4			4			6
Viburnum dentatum	southern arrowwood	Shrub			1			1									
		Stem count	0	0	39	0	0	114	0	0	66	0	0	40	0	0	109
		size (ares)	1			1			1			1			1		
tan = species planted Dec 2009 or Mar 2016		**acres**	0.0247			0.0247			0.0247			0.0247			0.0247		
		Species count	0	0	10	0	0	12	0	0	8	0	0	8	0	0	7
		Stems per ACRE	0	0	1578	0	0	4613	0	0	2671	0	0	1619	0	0	4411

Color for Density

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

NOTE: Original planted trees were not marked or mapped by x,y coordinates by the previous contractor. It was not feasible to distinguish planted trees from volunteer trees. Consequently, all native trees both planted and volunteer were recorded using the "volunteer" protocol, and are listed as "Total".

Table 8b. CVS Plot Stem Counts and Density by Plot (Current Year) and Annual Means for All Plots.
Suther Site DMS# 370, Cabarrus County NC

Scientific Name	Common Name	Species Type	370-01-0010			370-01-0011			370-01-0012			370-01-0013			Tot	Annual Means MY5 (2016)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T		PnoLS	P-all	T
Acer negundo	boxelder	Tree			4			1			1			3	42			4.7
Acer rubrum	red maple	Tree			2										41			4.6
Alnus serrulata	hazel alder	Shrub			3			4			1			1	14			1.6
Betula nigra	river birch	Tree									3				99			11.0
Carpinus caroliniana	American hornbeam	Tree													5			0.6
Cornus amomum	silky dogwood	Shrub			1										13			1.4
Diospyros virginiana	common persimmon	Tree													4			0.4
Fraxinus pennsylvanica	green ash	Tree			3			8			24			5	107			11.9
Juniperus virginiana	eastern redcedar	Tree													1			0.1
Lindera benzoin	northern spicebush	Shrub													2			0.2
Liquidambar styraciflua	sweetgum	Tree						4			6				40			4.4
Liriodendron tulipifera	tuliptree	Tree			3										4			0.4
Platanus occidentalis	American sycamore	Tree			4			3							48			5.3
Quercus michauxii	swamp chestnut oak	Tree						1							2			0.2
Quercus phellos	willow oak	Tree									1				2			0.2
Salix nigra	black willow	Tree													1			0.1
Ulmus alata	winged elm	Tree						1			1			11	17			1.9
Ulmus americana	American elm	Tree						3			4				30			3.3
Viburnum dentatum	southern arrowwood	Shrub													2			0.2
		Stem count	0	0	20	0	0	25	0	0	41	0	0	20	474	0	0	52.7
		size (ares)	1			1			1			1			9	9		
tan = species planted Dec 2009 or Mar 2016		**acres**	0.0247			0.0247			0.0247			0.0247				0.2224		
		Species count	0	0	7	0	0	8	0	0	8	0	0	4	19	0	0	19
		Stems per ACRE	0	0	809	0	0	1012	0	0	1659	0	0	809		0	0	2131

Color for Density

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

NOTE: Original planted trees were not marked or mapped by x,y coordinates by the previous contractor. It was not feasible to distinguish planted trees from volunteer trees. Consequently, all native trees both planted and volunteer were recorded using the "volunteer" protocol, and are listed as "Total".

Appendix D. Stream Survey Data

Figure 3.1-3.8. Stream Cross-Section Survey Plots
Figure 4. Stream Longitudinal Profile Survey Plot
Figure 5.1-5.4. Substrate Pebble Count Plots
Table 9. Bank Erosion Pin Exposure Data
Table 10.1-10.2. Baseline Stream Morphology Data Summary
Table 11.1. Stream Cross-Section Morphology Data Summary
Table 11.2. Stream Longitudinal Morphology Data Summary

e-Table: Raw Survey Data LongPro & Xsec Spreadsheet
e-Table: Raw Pebble Count Data Spreadsheet

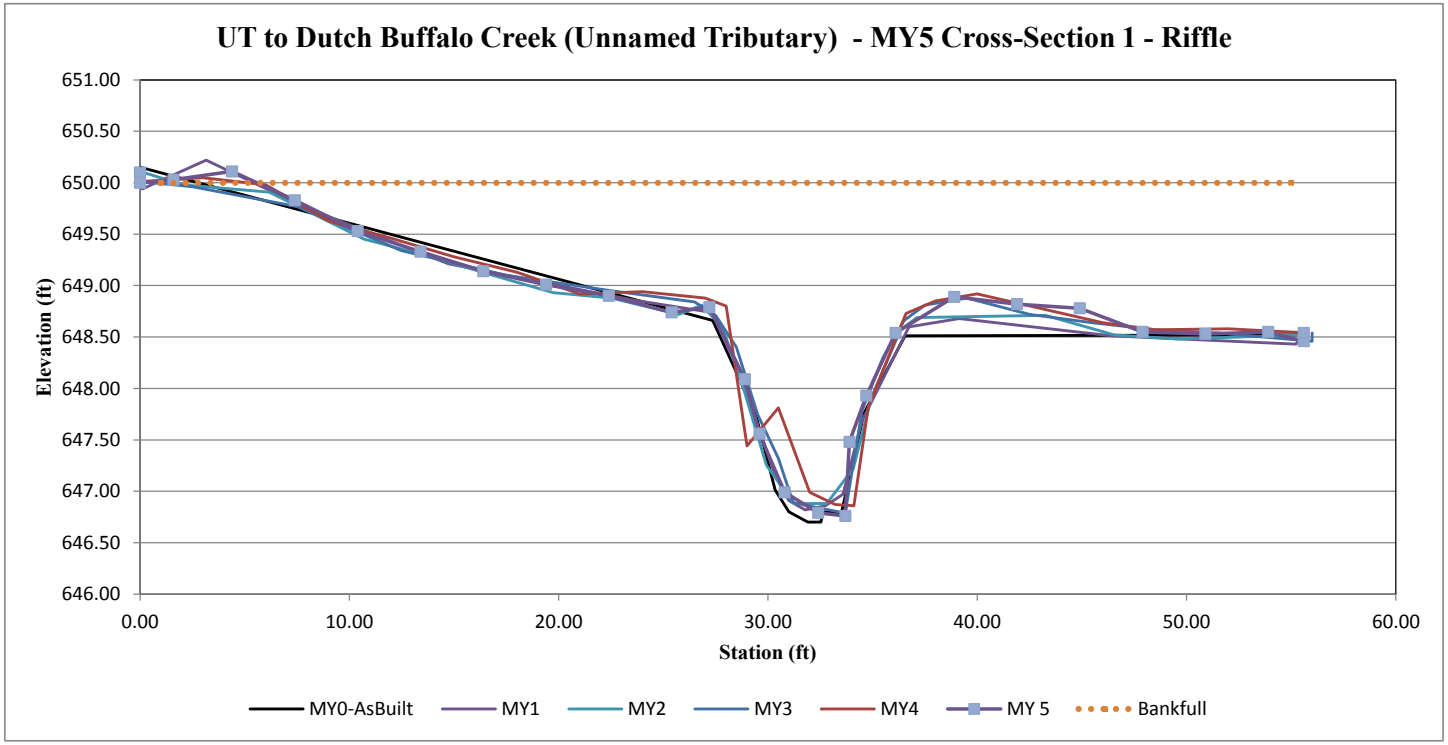
Appendix D. Stream Survey Data
Figure 3.1: Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Unnamed Tributary to Dutch Buffalo Creek
Monitoring Year 5of 5

Trib XS-1: Upstream

Trib XS-1: Downstream

Project Name	DBC (Suther)	
DMS Project Number	370	
Cross-Section ID	UT-1, XS-1, Riffle	
Survey Date	9/2016	
SUMMARY DATA		
Bankfull Elevation (ft)		648.54
Bankfull Cross-Sectional Area (ft^2)		8.65
Bankfull Width (ft)		8.90
Flood Prone Area Elevation (ft)		650.59
Flood Prone Width (ft)		56.00
Bankfull Mean Depth (ft)		0.97
Bankfull Max Depth (ft)		1.90
W/D Ratio		9.16
Entrenchment Ratio		6.29
Bank Height Ratio		0.92

Station	Elevation	Notes
0.0	650.1	TLP
0.0	650	BLP
1.6	650.03	
4.4	650.11	
7.4	649.83	
10.4	649.53	
13.4	649.33	
16.4	649.14	
19.4	649.01	
22.4	648.9	
25.4	648.74	
27.2	648.79	TLB
28.9	648.09	
29.6	647.56	
30.8	646.99	BLB
32.4	646.79	THW
33.7	646.76	BRB
33.9	647.48	
34.7	647.93	
36.1	648.54	TRB
38.9	648.89	
41.9	648.82	
44.9	648.78	
47.9	648.55	
50.9	648.53	
53.9	648.55	
55.6	648.46	BRP
55.6	648.54	TRP



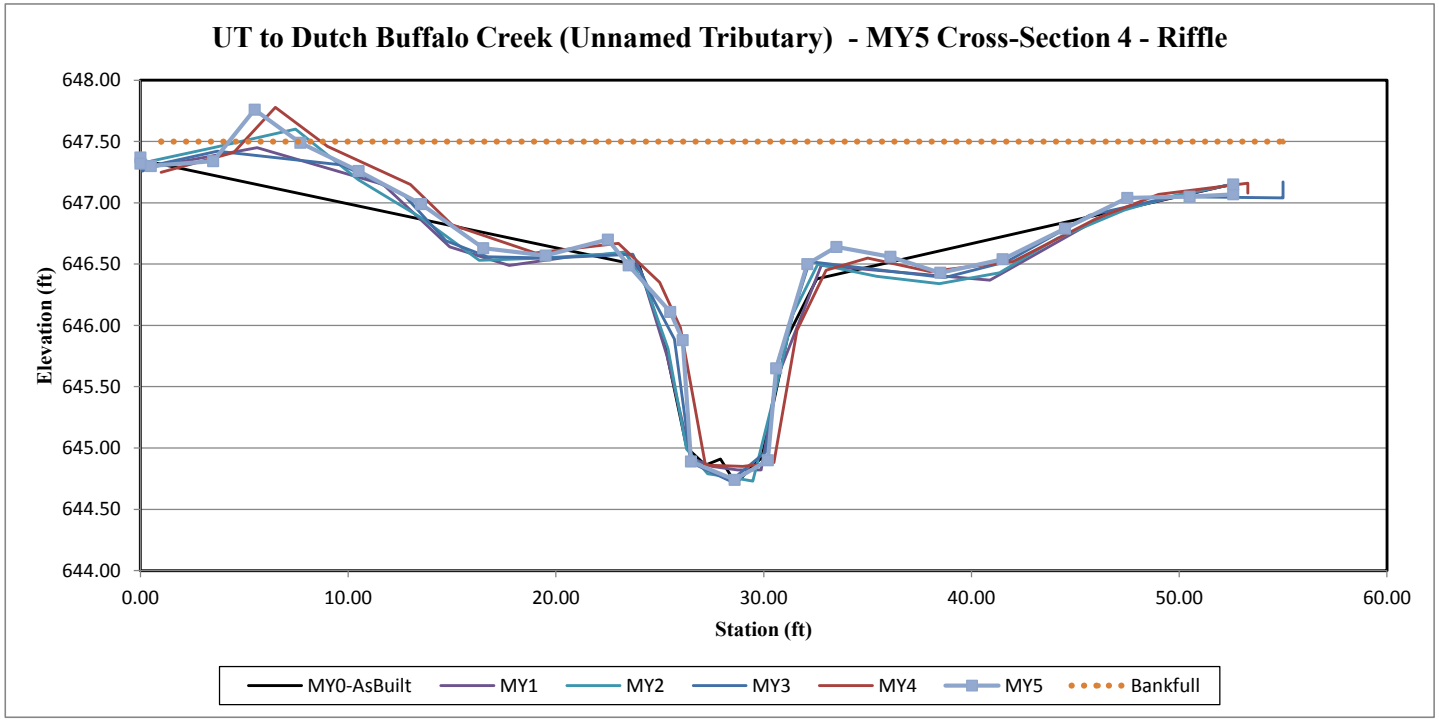
Appendix D. Stream Survey Data
Figure 3.2: Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Unnamed Tributary to Dutch Buffalo Creek
Monitoring Year 5 of 5

Project Name	**DBC (Suther)**
DMS Project Number	**370**
Cross-Section ID	**UT-1, XS-4, Riffle**
Survey Date	**9/2016**
SUMMARY DATA	
Bankfull Elevation (ft)	646.5
Bankfull Cross-Sectional Area (ft^2)	8.62
Bankfull Width (ft)	8.60
Flood Prone Area Elevation (ft)	648.14
Flood Prone Width (ft)	55.00
Bankfull Mean Depth (ft)	1.00
Bankfull Max Depth (ft)	1.70
W/D Ratio	8.58
Entrenchment Ratio	6.40
Bank Height Ratio	1.04

Trib XS-4: Upstream

Trib XS-4: Downstream

Station	Elevation	Notes
0	647.37	TLP
0	647.32	BLP
0.5	647.3	
3.5	647.34	
5.5	647.76	
7.7	647.49	
10.5	647.26	
13.5	646.99	
16.5	646.63	
19.5	646.57	
22.5	646.7	
23.5	646.49	TLB
25.5	646.11	
26.1	645.88	
26.5	644.89	BLB
28.6	644.74	THW
30.2	644.9	BRB
30.6	645.65	
32.1	646.5	TRB
33.5	646.64	
36.1	646.56	
38.5	646.43	
41.5	646.54	
44.5	646.79	
47.5	647.04	
50.5	647.05	
52.6	647.07	BRP
52.6	647.15	TRP



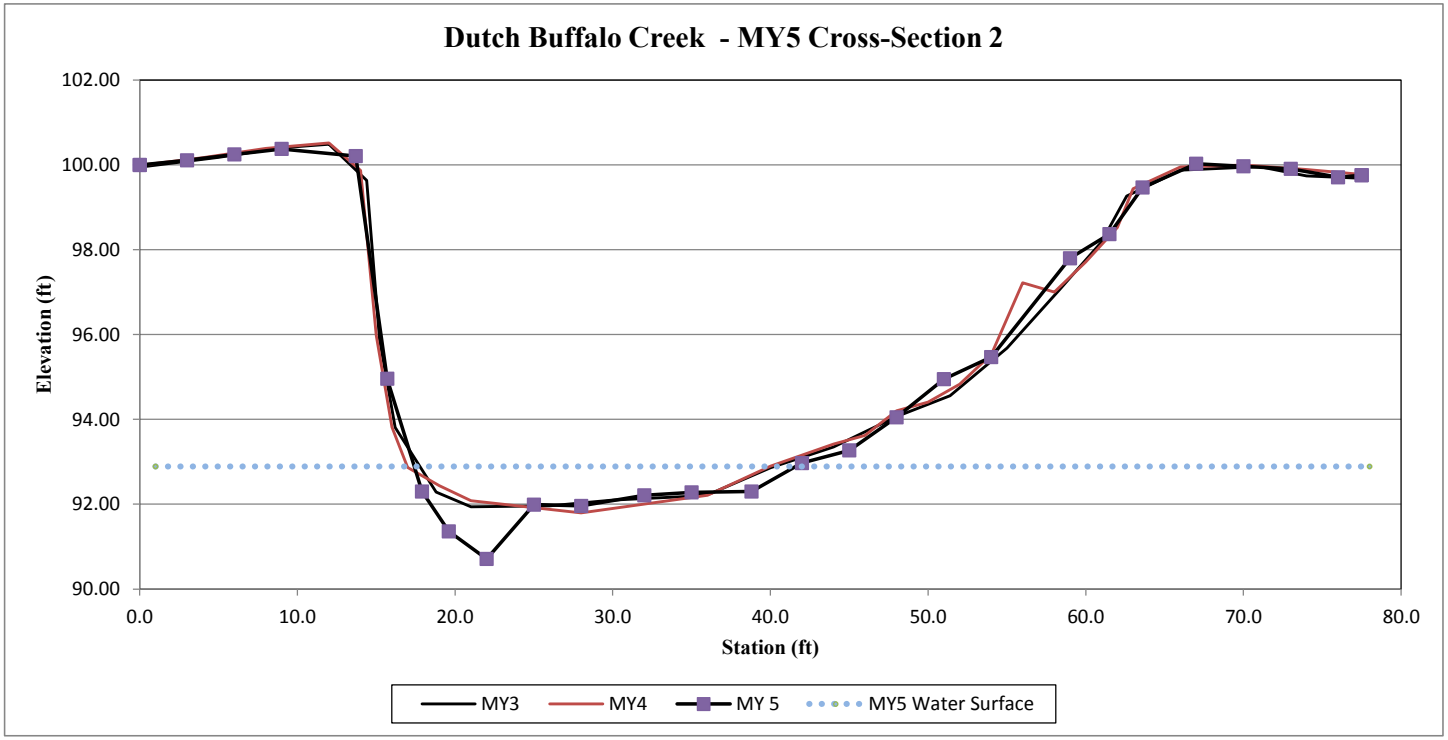
Appendix D. Stream Survey Data
Figure 3.3: Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 5 of 5

Project Name	DBC (Suther)
DMS Project Number	370
Cross-Section ID	DBCr, XS-2, Pool
Survey Date	9/2016
SUMMARY DATA	
Bankfull Elevation (ft)	99.47
Bankfull Cross-Sectional Area (ft^2)	280.10
Bankfull Width (ft)	49.90
Flood Prone Area Elevation (ft)	109.11
Flood Prone Width (ft)	77.00
Bankfull Mean Depth (ft)	5.61
Bankfull Max Depth (ft)	8.07
W/D Ratio	8.89
Entrenchment Ratio	1.54
Bank Height Ratio	0.81

XS-2: Upstream

XS-2: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.0	100.00	BLP
3.0	100.11	
6.0	100.25	
9.0	100.38	
13.7	100.21	TLB
15.7	94.96	
17.9	92.30	BLB, LEW
19.6	91.36	
22.0	90.71	THW
25.0	91.99	
28.0	91.96	
32.0	92.21	
35.0	92.28	
38.8	92.30	REW
42.0	92.97	
45.0	93.27	
48.0	94.05	
51.0	94.95	
54.0	95.47	BRB
59.0	97.80	
61.5	98.37	
63.6	99.47	TRB
67.0	100.03	
70.0	99.97	
73.0	99.91	
76.0	99.71	
77.5	99.76	TRP
77.5	99.76	BRP



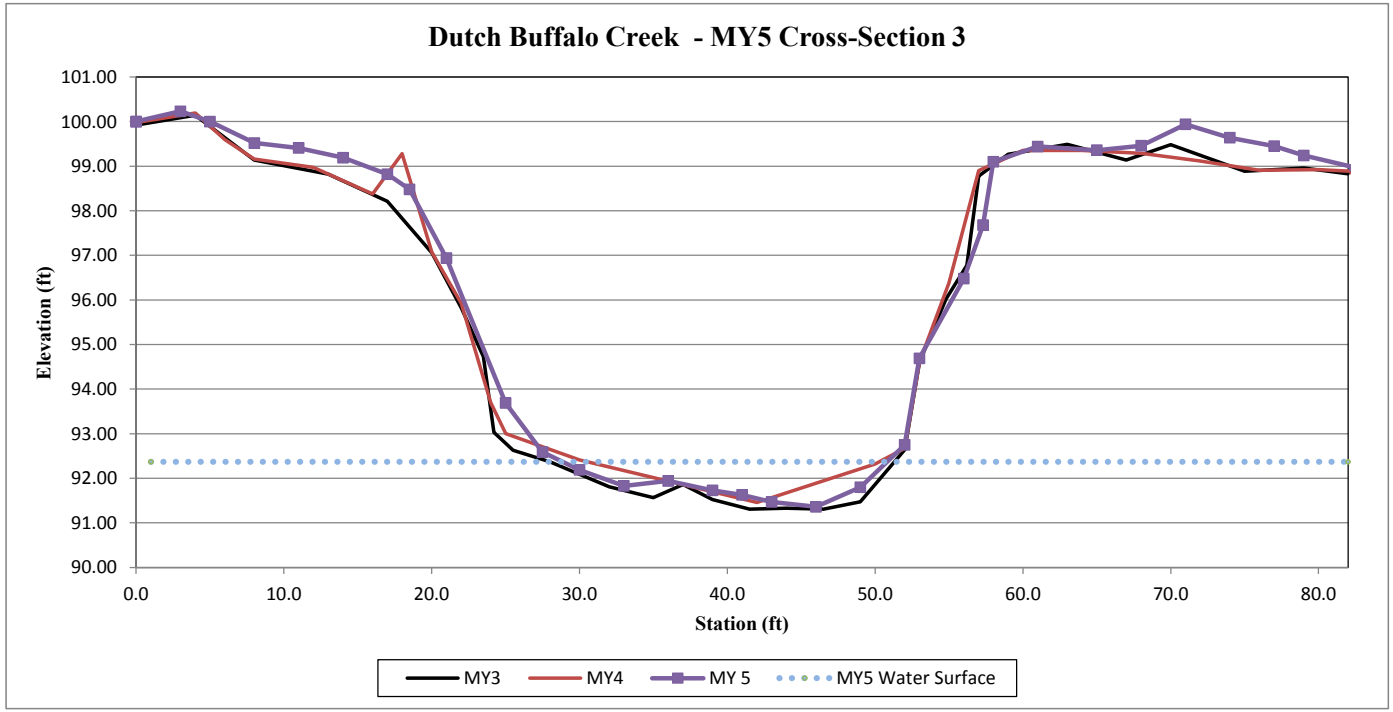
Appendix D. Stream Survey Data
Figure 3.4: Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 5 of 5

Project Name	**DBC (Suther)**
DMS Project Number	**370**
Cross-Section ID	**DBCr, XS-3, Pool**
Survey Date	**9/2016**
SUMMARY DATA	
Bankfull Elevation (ft)	98.48
Bankfull Cross-Sectional Area (ft^2)	205.70
Bankfull Width (ft)	39.50
Flood Prone Area Elevation (ft)	107.37
Flood Prone Width (ft)	82.00
Bankfull Mean Depth (ft)	5.21
Bankfull Max Depth (ft)	7.82
W/D Ratio	7.59
Entrenchment Ratio	2.08
Bank Height Ratio	0.86

XS-3: Upstream

XS-3: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.0	100.00	BLP
3.0	100.23	
5.0	100.00	
8.0	99.52	
11.0	99.41	
14.0	99.19	
17.0	98.82	
18.5	98.48	TLB
21.0	96.94	
25.0	93.69	
27.5	92.59	BLB, LEW
30.0	92.19	
33.0	91.83	
36.0	91.94	
39.0	91.73	
41.0	91.63	
43.0	91.47	
46.0	91.36	THW
49.0	91.80	
52.0	92.75	BRB, REW
53.0	94.69	
56.0	96.48	
57.3	97.68	
58.0	99.10	TRB
61.0	99.44	
65.0	99.36	
68	99.46	
71	99.94	
74	99.64	
77	99.45	
79	99.24	
82.4	98.98	BRP
82.2	98.93	TRP



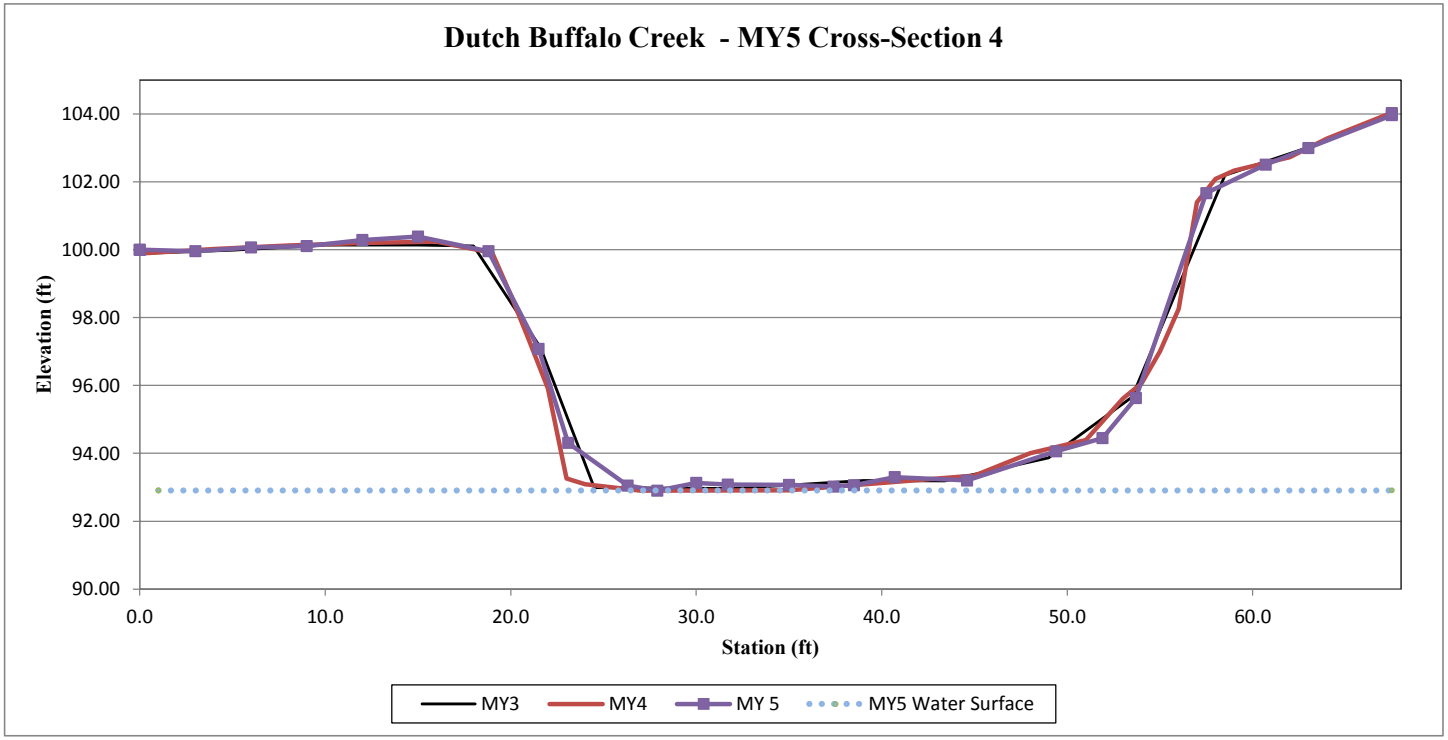
Appendix D. Stream Survey Data
Figure 3.5: Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 5 of 5

Project Name	**DBC (Suther)**
DMS Project Number	**370**
Cross-Section ID	**DBCr, XS-4, Riffle**
Survey Date	**9/2016**
SUMMARY DATA	
Bankfull Elevation (ft)	99.96
Bankfull Cross-Sectional Area (ft^2)	215.60
Bankfull Width (ft)	38.70
Flood Prone Area Elevation (ft)	107.04
Flood Prone Width (ft)	68.00
Bankfull Mean Depth (ft)	5.57
Bankfull Max Depth (ft)	7.01
W/D Ratio	6.95
Entrenchment Ratio	1.76
Bank Height Ratio	0.99

XS-4: Upstream

XS-4: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.0	100.00	BLP
3.0	99.96	
6.0	100.07	
9.0	100.11	
12.0	100.29	
15.0	100.39	
18.8	99.96	TLB
21.5	97.08	
23.1	94.31	BLB
26.3	93.05	LEW
27.9	92.90	
30.0	93.13	
31.7	93.08	THW
35.0	93.07	
37.4	93.02	
38.5	93.06	REW
40.7	93.30	
44.6	93.20	
49.4	94.06	
51.9	94.45	BRB
53.7	95.63	
57.5	101.67	TRB
60.7	102.51	
63.0	103.00	
67.5	103.97	BRP
67.5	104.03	TRP



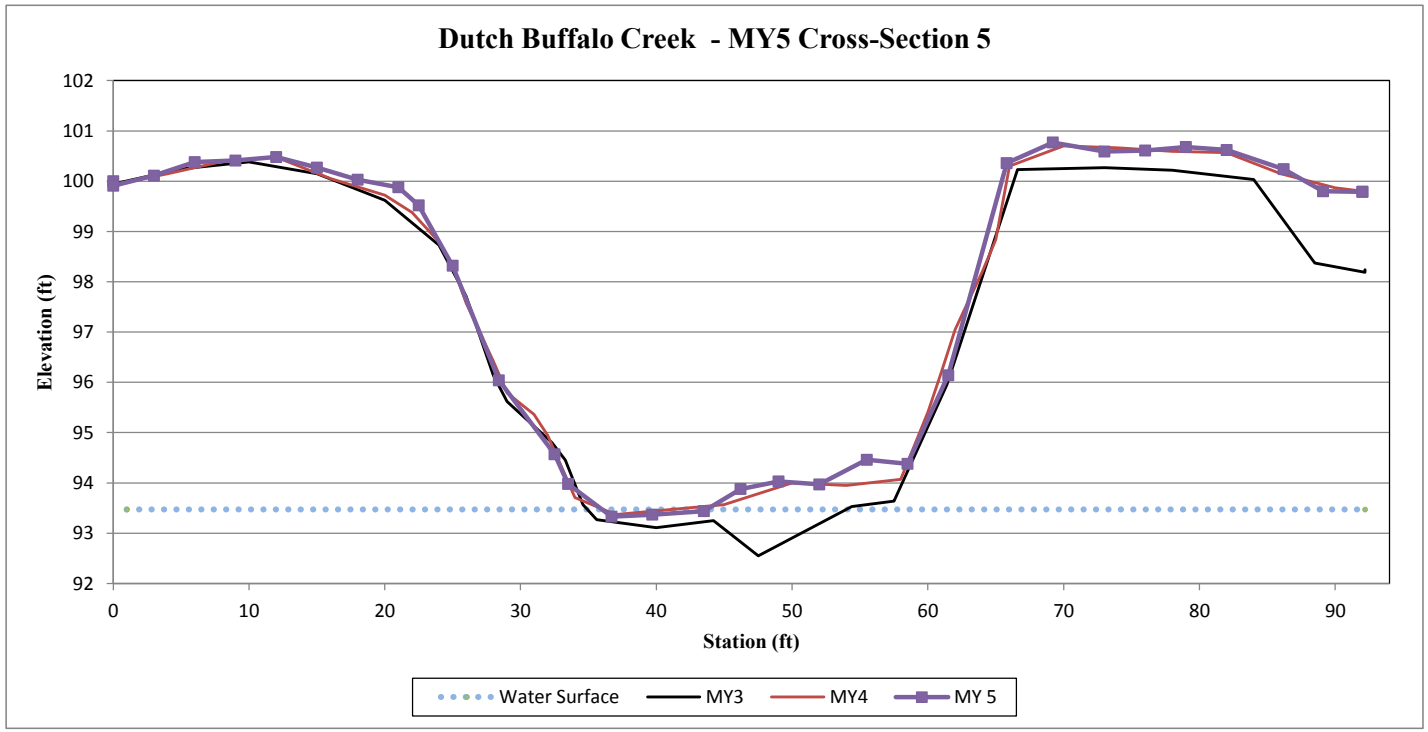
Appendix D. Stream Survey Data
Figure 3.6: Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 5 of 5

Project Name	**DBC (Suther)**
DMS Project Number	**370**
Cross-Section ID	**DBCr, XS-5, Riffle**
Survey Date	**9/2016**
SUMMARY DATA	
Bankfull Elevation (ft)	99.52
Bankfull Cross-Sectional Area (ft^2)	192.90
Bankfull Width (ft)	43.30
Flood Prone Area Elevation (ft)	104.21
Flood Prone Width (ft)	92.00
Bankfull Mean Depth (ft)	4.45
Bankfull Max Depth (ft)	5.42
W/D Ratio	9.72
Entrenchment Ratio	2.12
Bank Height Ratio	1.13

XS-5: Upstream

XS-5: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.0	99.91	BLP
3.0	100.11	
6.0	100.38	
9.0	100.41	
12.0	100.48	
15.0	100.27	
18.0	100.03	
21.0	99.88	
22.5	99.52	TLB
25.0	98.32	
28.4	96.04	BLB
32.5	94.57	
33.5	93.98	
36.7	93.33	LEW
39.7	93.37	THW
43.5	93.44	REW
46.2	93.88	
49.0	94.03	
52.0	93.97	
55.5	94.46	
58.5	94.38	BRB
61.5	96.14	
65.8	100.36	TRB
69.2	100.77	
73.0	100.59	
76.0	100.61	
79.0	100.68	
82.0	100.62	
86.2	100.24	
89.1	99.80	
92.0	99.79	BRP
92.0	99.79	TRP



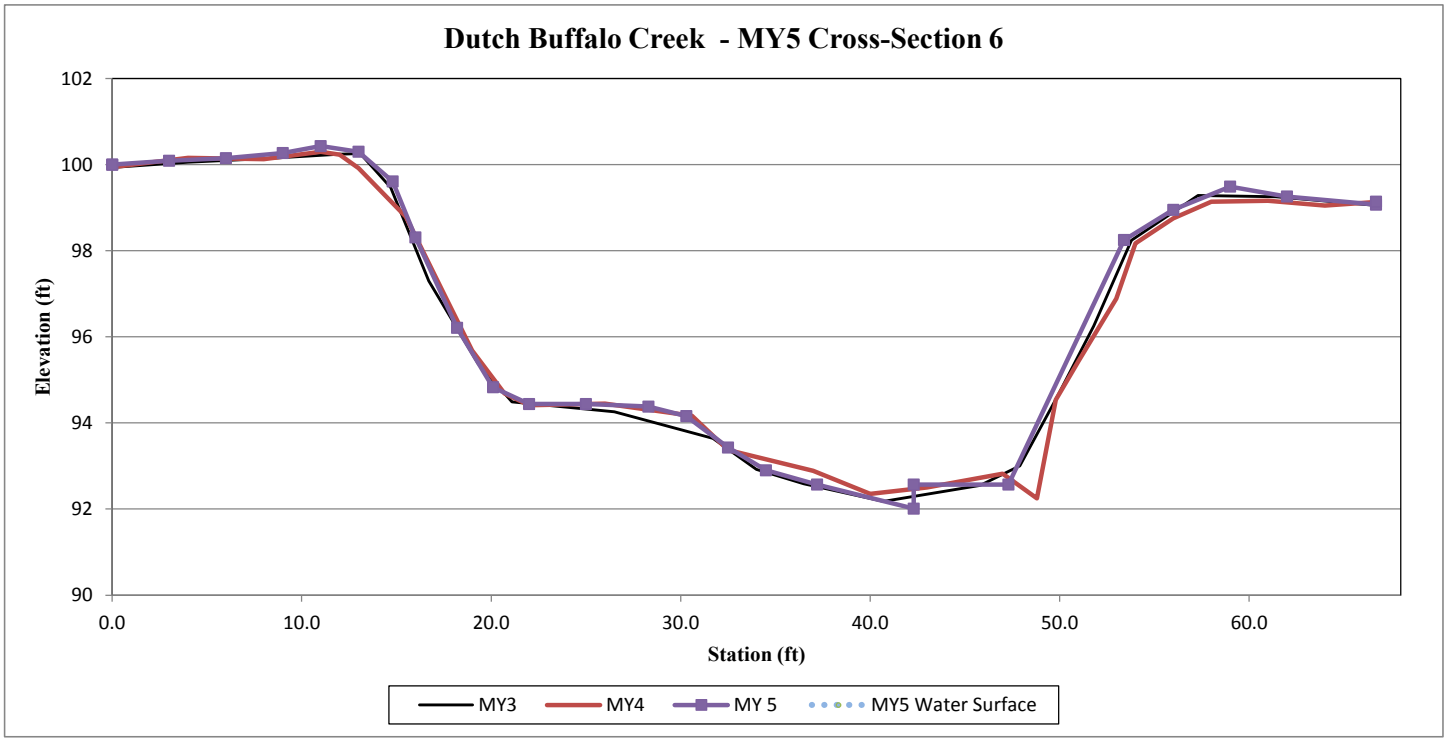
Appendix D. Stream Survey Data
Figure 3.7: Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 5 of 5

Project Name	**DBC (Suther)**
DMS Project Number	**370**
Cross-Section ID	**DBCr, XS-6, Riffle**
Survey Date	**9/2016**
SUMMARY DATA	
Bankfull Elevation (ft)	98.25
Bankfull Cross-Sectional Area (ft^2)	157.30
Bankfull Width (ft)	38.60
Flood Prone Area Elevation (ft)	109.19
Flood Prone Width (ft)	67.00
Bankfull Mean Depth (ft)	4.08
Bankfull Max Depth (ft)	7.88
W/D Ratio	9.47
Entrenchment Ratio	1.74
Bank Height Ratio	0.61

XS-6: Upstream

XS-6: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.0	100.00	BLP
3.0	100.09	
6.0	100.15	
9.0	100.27	
11.0	100.43	
13.0	100.30	
14.8	99.61	TLB
16.0	98.31	
18.2	96.21	
20.1	94.83	BLB
22.0	94.44	
25.0	94.44	
28.3	94.38	
30.3	94.16	
32.5	93.43	
34.5	92.90	
37.2	92.57	LEW
42.3	92.01	THW
42.3	92.57	WS
47.3	92.57	REW
53.4	98.25	TRB
56.0	98.95	
59.0	99.49	
62.0	99.26	
66.7	99.07	BRP
66.7	99.14	TRP



Appendix D. Stream Survey Data
Figure 3.8: Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 5 of 5

Project Name	**DBC (Suther)**
DMS Project Number	**370**
Cross-Section ID	**DBCr, XS-7, Pool**
Survey Date	**9/2016**
SUMMARY DATA	
Bankfull Elevation (ft)	99.27
Bankfull Cross-Sectional Area (ft^2)	195.30
Bankfull Width (ft)	34.80
Flood Prone Area Elevation (ft)	117.25
Flood Prone Width (ft)	83.00
Bankfull Mean Depth (ft)	5.61
Bankfull Max Depth (ft)	8.99
W/D Ratio	6.20
Entrenchment Ratio	2.39
Bank Height Ratio	0.00

XS-7: Upstream

XS-7: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.0	99.96	BLP
2.7	99.99	
7.6	99.87	
10.0	100.06	
13.0	100.14	
15.6	99.57	TLB
16.2	92.36	BLB, LEW
25.3	91.04	THW
32.0	92.36	REW
35.0	93.24	BRB
38.0	94.13	
41.0	95.17	
43.2	95.64	
46.7	97.46	
50.4	99.27	TRB
56.0	99.91	
59.0	99.82	
62.0	99.43	
64.8	99.30	
69.0	99.19	
72.0	99.03	
75.0	98.97	
78.0	99.08	
82.8	99.61	BRP
82.8	99.62	TRP

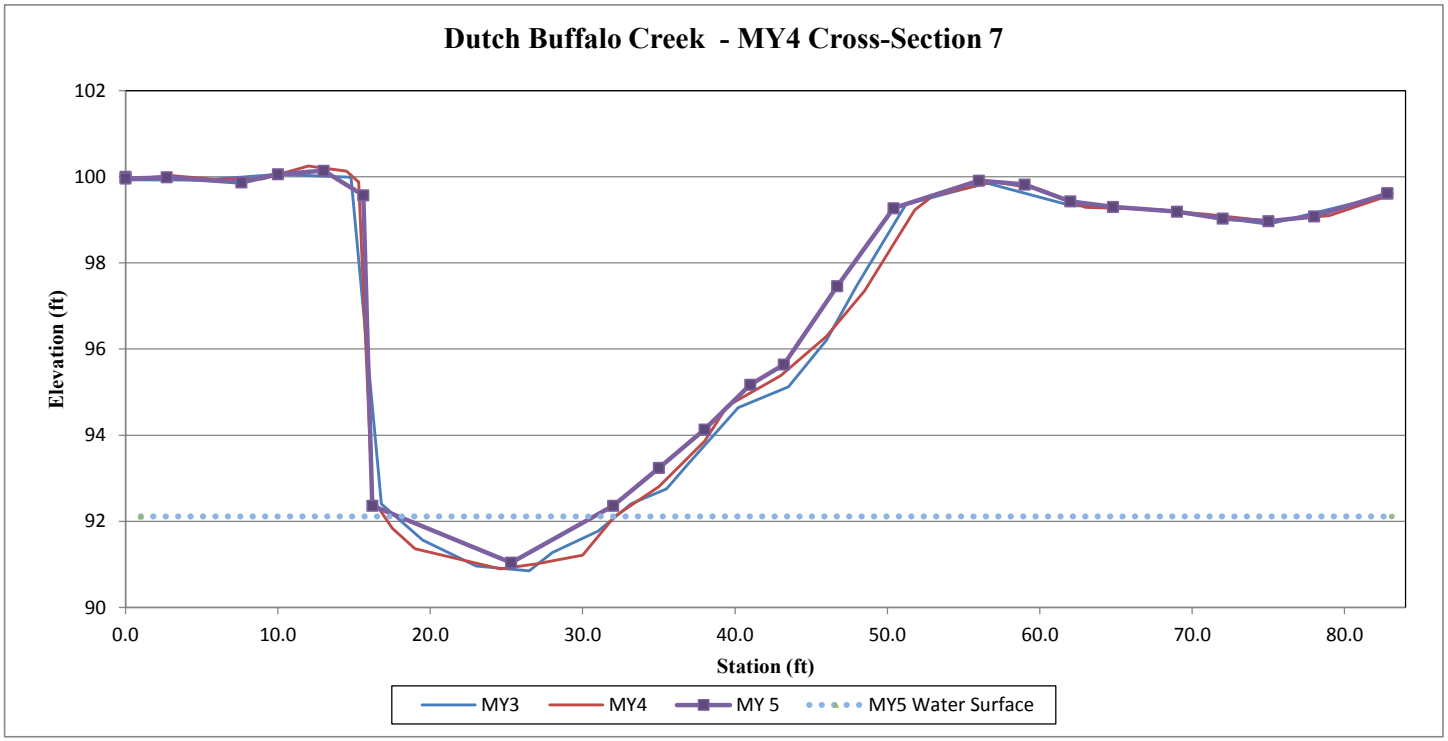
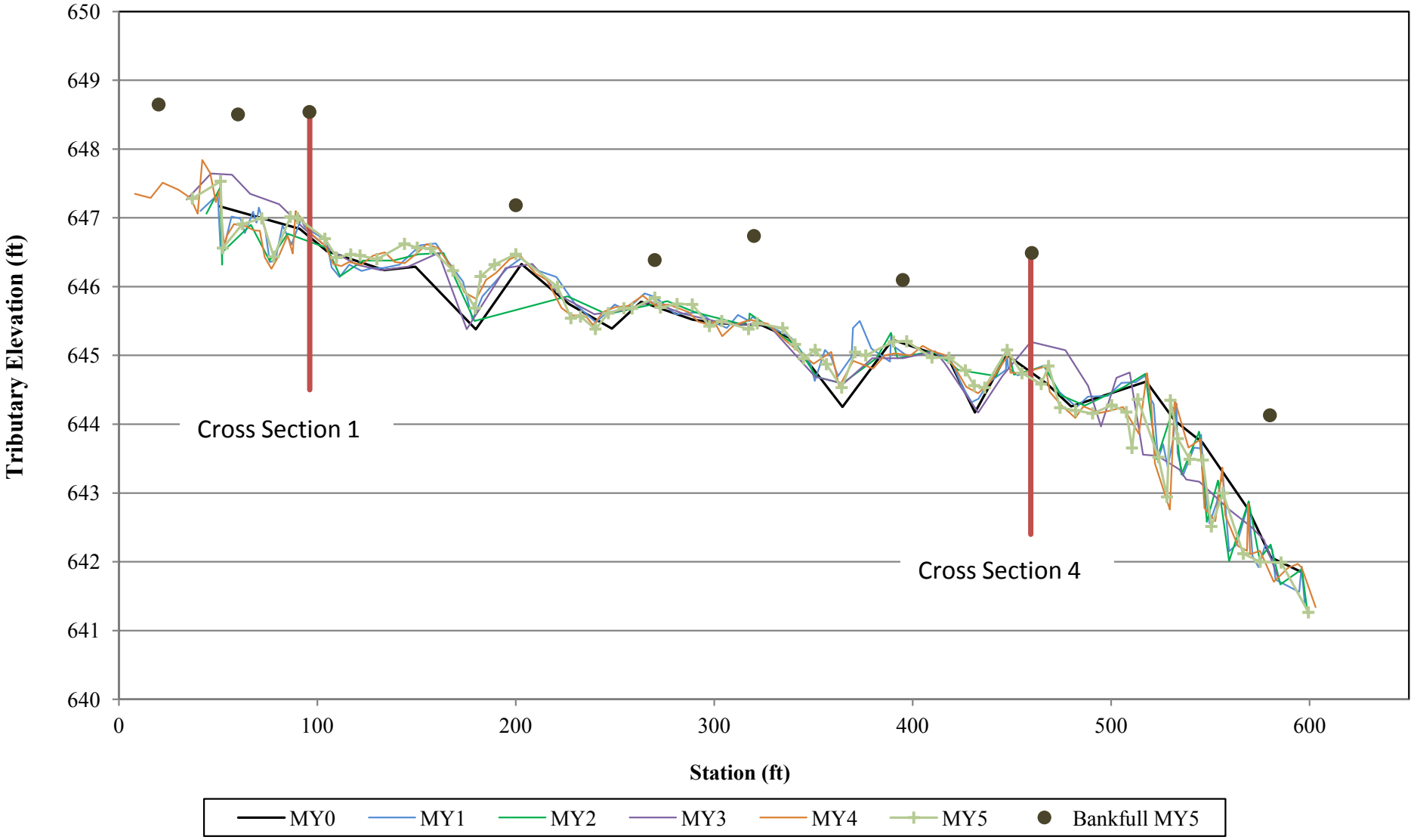


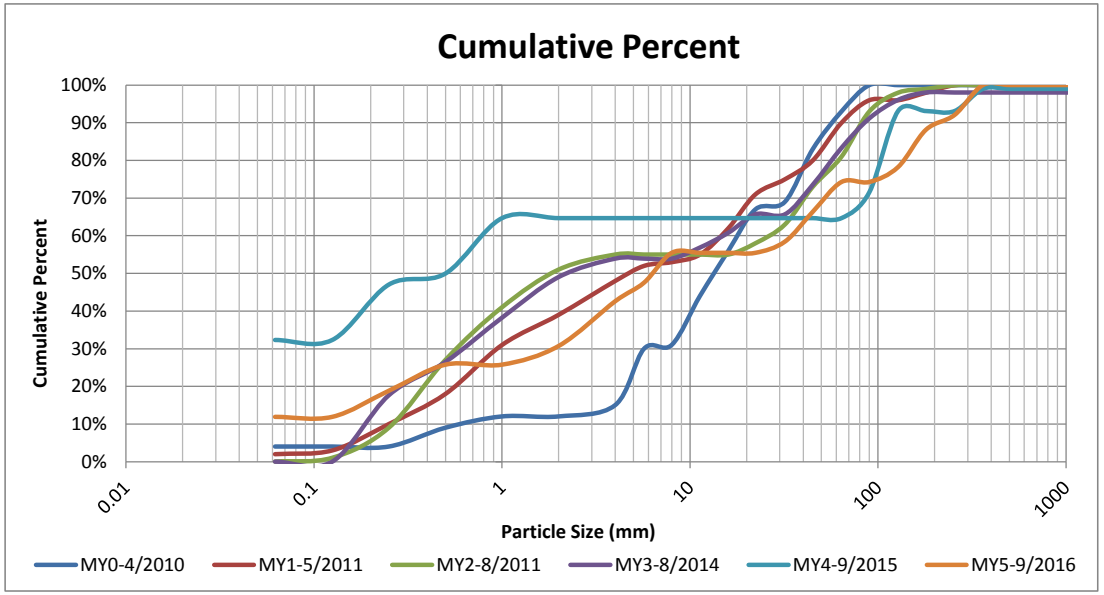
Figure 4. Longitudinal Profile - Unnamed Tributary to Dutch Buffalo Creek MY5 2016

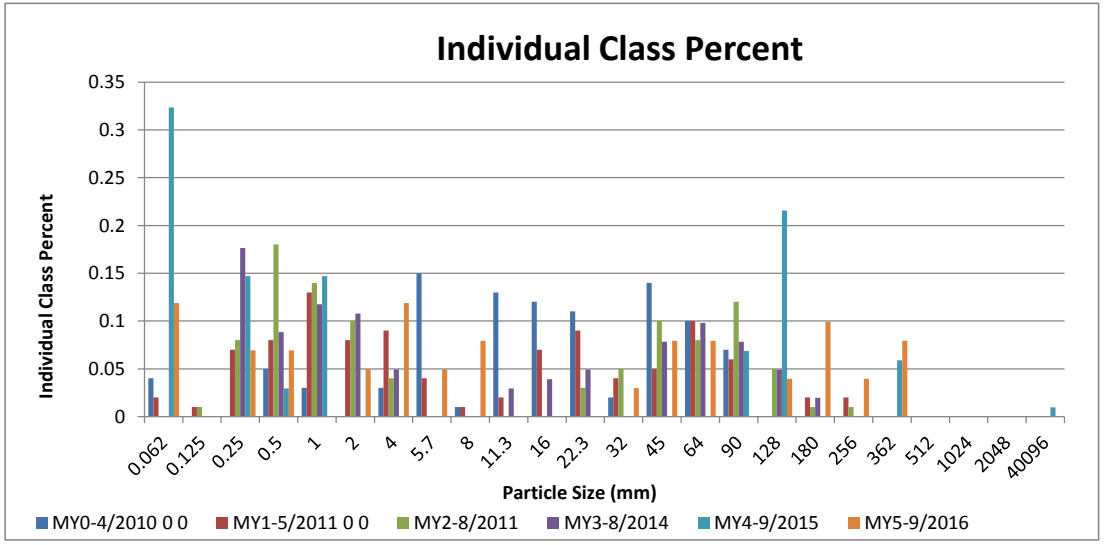


Appendix D. Stream Survey Data -- Suther Site Project #370
Figure 5.1. Pebble Count Plots & Data -- Sep 2016 (MY5)
UT to Dutch Buffalo Creek -- Tributary Cross-Section 1

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section 1: RIFFLE					
			MY5-9/2016		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	12	12%	12%
Sand	very fine sand	0.125	0	0%	12%
	fine sand	0.250	7	7%	19%
	medium sand	0.500	7	7%	26%
	coarse sand	1.000	0	0%	26%
	very coarse sand	2.000	5	5%	31%
Gravel	very fine gravel	4.000	12	12%	43%
	fine gravel	5.700	5	5%	48%
	fine gravel	8.000	8	8%	55%
	medium gravel	11.300	0	0%	55%
	medium gravel	16.000	0	0%	55%
	course gravel	22.300	0	0%	55%
	course gravel	32.000	3	3%	58%
	very coarse gravel	45.000	8	8%	66%
	very coarse gravel	64.000	8	8%	74%
Cobble	small cobble	90.000	0	0%	74%
	medium cobble	128.000	4	4%	78%
	large cobble	180.000	10	10%	88%
	very large cobble	256.000	4	4%	92%
Boulder	small boulder	362.000	8	8%	100%
	small boulder	512.000	0	0%	100%
	medium boulder	1024.000	0	0%	100%
	large boulder	2048.000	0	0%	100%
Bedrock	bedrock	40096.000	0	0%	100%
TOTAL % of whole count			101	100%	100%

2015 Particle Size Summary (mm)	
D50	7
D84	159
D95	296

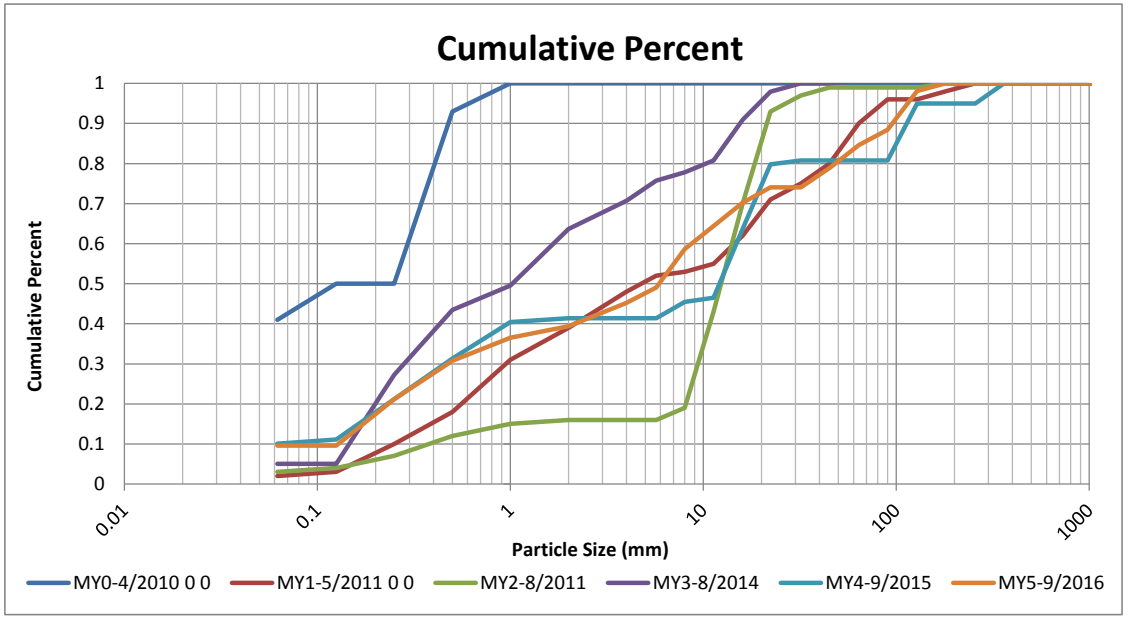


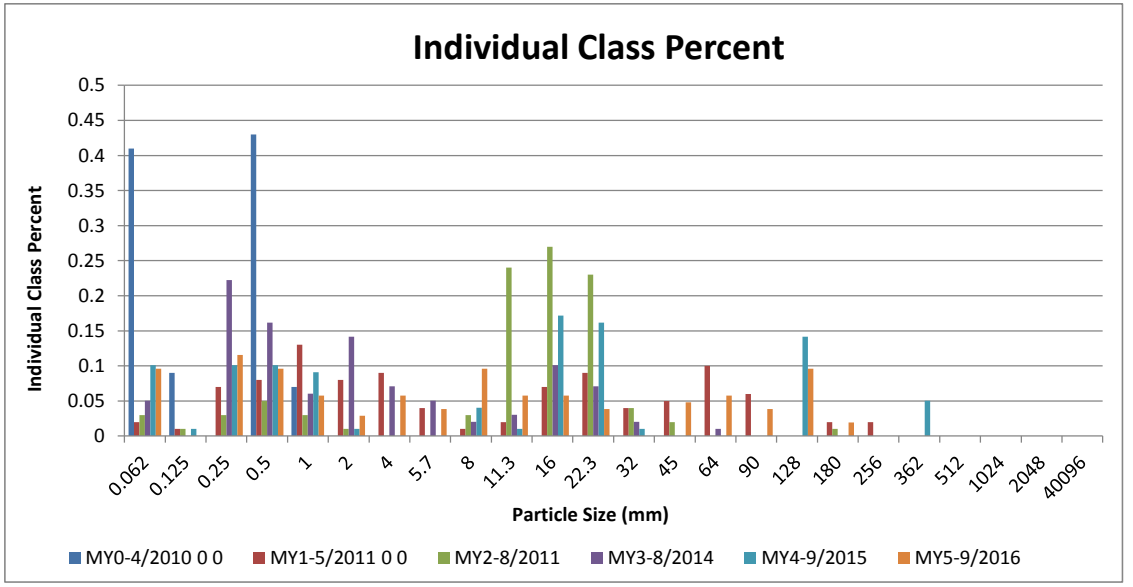


Appendix D. Stream Survey Data -- Suther Site Project #370
Figure 5.2. Pebble Count Plots & Data -- Sep 2016 (MY5)
UT to Dutch Buffalo Creek -- Tributary Cross-Section 2

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section 2: POOL					
			MY5-9/2016		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	10	10%	10%
Sand	very fine sand	0.125	0	0%	10%
	fine sand	0.250	12	12%	21%
	medium sand	0.50	10	10%	31%
	coarse sand	1.00	6	6%	37%
	very coarse sand	2.0	3	3%	39%
Gravel	very fine gravel	4.0	6	6%	45%
	fine gravel	5.7	4	4%	49%
	fine gravel	8.0	10	10%	59%
	medium gravel	11.3	6	6%	64%
	medium gravel	16.0	6	6%	70%
	coarse gravel	22.3	4	4%	74%
	coarse gravel	32.0	0	0%	74%
	very coarse gravel	45	5	5%	79%
	very coarse gravel	64	6	6%	85%
Cobble	small cobble	90	4	4%	88%
	medium cobble	128	10	10%	98%
	large cobble	180	2	2%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count			104	100%	100%

2015 Particle Size Summary (mm)	
D50	6
D84	61
D95	115

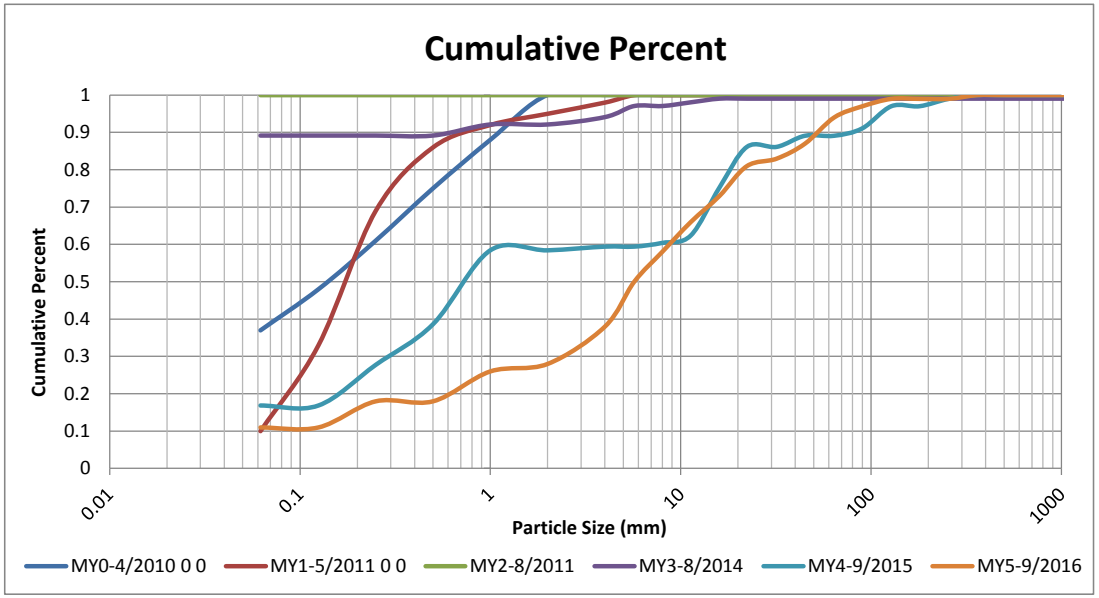


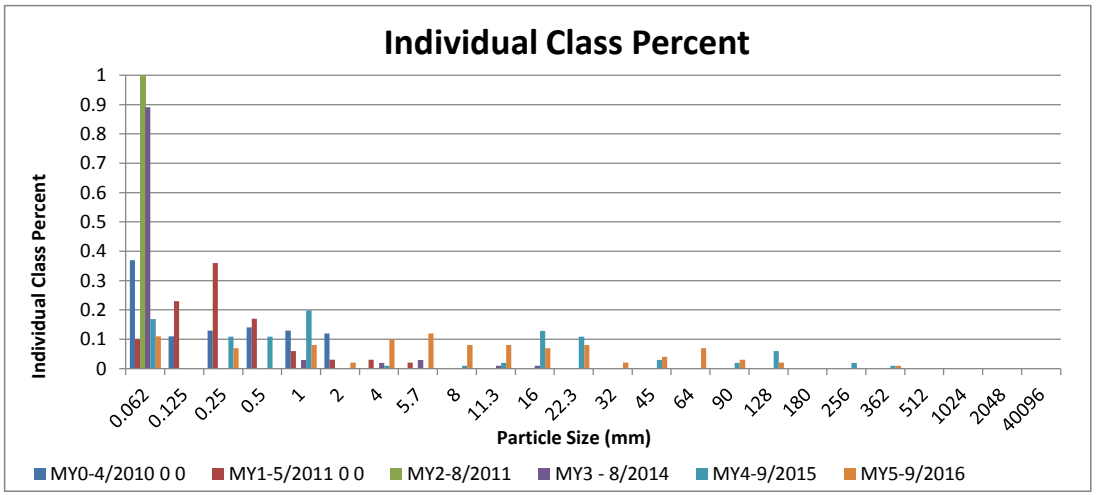


Appendix D. Stream Survey Data -- Suther Site Project #370
Figure 5.3. Pebble Count Plots & Data -- Sep 2016 (MY5)
UT to Dutch Buffalo Creek -- Tributary Cross-Section 3

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section 3: POOL					
			MY5-9/2016		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	11	11%	11%
Sand	very fine sand	0.125	0	0%	11%
	fine sand	0.250	7	7%	18%
	medium sand	0.50	0	0%	18%
	coarse sand	1.00	8	8%	26%
	very coarse sand	2.0	2	2%	28%
Gravel	very fine gravel	4.0	10	10%	38%
	fine gravel	5.7	12	12%	50%
	fine gravel	8.0	8	8%	58%
	medium gravel	11.3	8	8%	66%
	medium gravel	16.0	7	7%	73%
	coarse gravel	22.3	8	8%	81%
	coarse gravel	32.0	2	2%	83%
	very coarse gravel	45	4	4%	87%
	very coarse gravel	64	7	7%	94%
Cobble	small cobble	90	3	3%	97%
	medium cobble	128	2	2%	99%
	large cobble	180	0	0%	99%
	very large cobble	256	0	0%	99%
Boulder	small boulder	362	1	1%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count			100	100%	100%

2015 Particle Size Summary (mm)	
D50	6
D84	35
D95	73

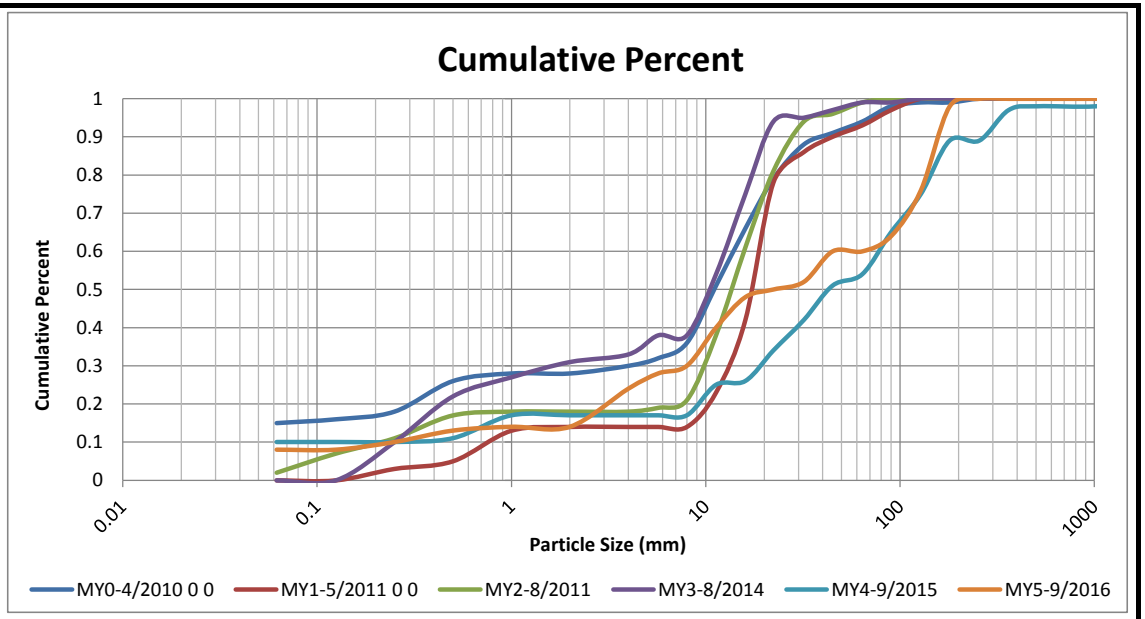




Appendix D. Stream Survey Data -- Suther Site Project #370
Figure 5.4. Pebble Count Plots & Data -- Sep 2016 (MY5)
UT to Dutch Buffalo Creek -- Tributary Cross-Section 4

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section 4: RIFFLE					
			MY5-9/2016		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	8	8%	8%
Sand	very fine sand	0.125	0	0%	8%
	fine sand	0.250	2	2%	10%
	medium sand	0.50	3	3%	13%
	coarse sand	1.00	1	1%	14%
	very coarse sand	2.0	0	0%	14%
Gravel	very fine gravel	4.0	10	10%	24%
	fine gravel	5.7	4	4%	28%
	fine gravel	8.0	2	2%	30%
	medium gravel	11.3	10	10%	40%
	medium gravel	16.0	8	8%	48%
	coarse gravel	22.3	2	2%	50%
	coarse gravel	32.0	2	2%	52%
	very coarse gravel	45	8	8%	60%
	very coarse gravel	64	0	0%	60%
Cobble	small cobble	90	4	4%	64%
	medium cobble	128	12	12%	76%
	large cobble	180	22	22%	98%
	very large cobble	256	2	2%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count			100	100%	100%

2015 Particle Size Summary (mm)	
D50	22
D84	147
D95	173



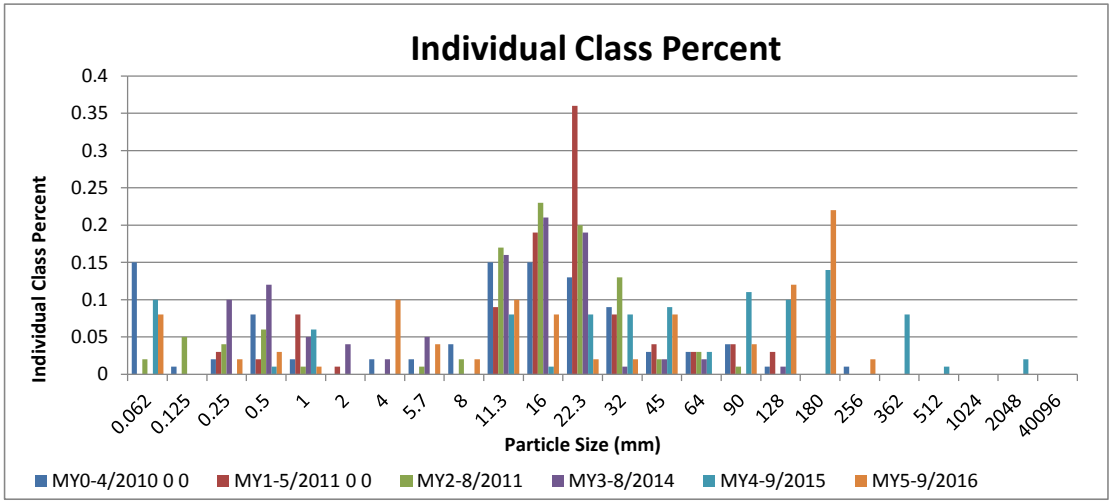


Table 9. Suther Site (Dutch Buffalo Cr) stream-bank erosion pins, length (feet) of exposed pins by date.

Pins	Sta+Bank	Height	13-Nov-13			10-Apr-14 (high flow)			22-Aug-14			4-May-15			2-Sep-15			24-Mar-16			12-Sep-16			Cumulative Retreat	Annualized Rate
			Exposed	New Ero	RemEx	Exposed	New Ero	RemEx	Exposed	New Ero	RemEx	Exposed	New Ero	RemEx	Exposed	New Ero	RemEx	Exposed	New Ero	RemEx	Exposed	New Ero	RemEx	(Feet)	(Feet/Yr)
A1	**22+70-R**	Upper, 4'	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.15	0.15	0.00	0.00	0.15	0.00	0.00	0.15	0.00	0.15	0.00	0.00	0.00	0.25	0.07
inst: 02-18-2013		Middle, 2'	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.00	0.20	0.20	0.00	0.20	0.00	0.00	0.20	0.00	0.20	0.15	0.00	0.15	0.35	0.10
		Lower, 0'	0.00	0.00	0.00	NF	NF	NF	0.90	0.90	0.00	0.10	0.10	0.00	0.10	0.00	0.00	0.10	0.00	0.10	0.05	0.00	0.05	1.00	0.29
																								A1 ave	**0.53**	**0.15**
A2	**23+00-R**	Upper, 4'	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.00	0.00	0.00	0.50	0.15
inst: 02-18-2013		Middle, 2'	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.25	0.00	0.25	0.30	0.09
		Lower, 0'	0.00	0.00	0.00	NF	NF	NF	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.25	0.00	0.25	0.35	0.10
																								A2 ave	**0.38**	**0.11**
A3	**26+00-R**	Upper, 4'	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.70	0.70	0.20	0.20	0.00	0.20	0.45	0.25	0.45	0.50	0.05	0.50	1.50	0.44
inst: 03-19-2013		Middle, 2'	0.00	0.00	0.00	0.50	0.50	0.00	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	0.25	0.25	0.25	0.75	0.22
		Lower, 0'	0.50	0.50	0.00	0.50	0.50	0.00	0.25	0.25	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.25	0.25	0.27	0.65	0.38	0.65	1.98	0.57
																								A3 ave	**1.41**	**0.41**
A4	**26+30-R**	Upper, 4'	0.00	0.00	0.00	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	*na*	*na*
inst: 03-19-2013		Middle, 2'	0.33	0.33	0.33	NF	NF	NF	NF	NF	NF	**pin re-installed**		0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.00	0.05	0.38	0.11
		Lower, 0'	NF	NF	NF	NF	NF	NF	NF	NF	NF	0.90	0.90	0.00	0.00	0.00	0.00	0.75	0.75	0.75	0.60	0.00	0.60	1.65	0.48
																								A4 ave	**1.02**	**0.29**
A6	**27+90-R**	Upper, 4'	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.15	0.15	0.00	0.15	0.25	0.07
inst: 03-19-2013		Middle, 2'	0.00	0.00	0.00	0.20	0.20	0.00	0.10	0.10	0.00	0.20	0.20	0.20	0.20	0.00	0.20	0.35	0.15	0.35	0.35	0.00	0.35	0.65	0.19
		Lower **(a)**	0.30	0.00	0.30	0.30	0.00	0.30	0.30	0.00	0.30	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	0.00	0.00
																								A6 ave	**0.30**	**0.09**
A7	**28+20-R**	Upper, 4'	0.50	0.50	0.00	0.92	0.92	0.00	0.00	0.00	0.00	0.30	0.30	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.15	0.15	0.15	2.87	0.83
inst: 03-19-2013		Middle, 2'	0.50	0.50	0.00	0.98	0.98	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.40	0.40	0.40	0.00	0.40	1.98	0.57
		Lower, 0'	0.50	0.50	0.00	1.30	1.30	0.00	0.20	0.20	0.00	NF	NF	NF	NF	NF	NF	NF	NF	NF	0.40	0.40	0.40	2.40	0.70
																								A7 ave	**2.42**	**0.70**
A8	**28+50-L**	Upper, 5'	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.00	NF	NF	NF	NF	NF	NF	NF	NF	NF	0.05	0.05	0.05	0.15	0.04
inst: 02-18-2013		Middle, 3'	0.00	0.00	0.00	0.09	0.09	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.10	NF	NF	NF	0.24	0.07
		Lower, 1'	0.00	0.00	0.00	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NF	NF	NF	NF	NF	NF	0.30	0.09
																								A8 ave	**0.23**	**0.07**
A9	**28+80-L**	Upper, 5'	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.00	0.20	0.25	0.07
inst: 02-18-2013		Middle, 3'	0.00	0.00	0.00	0.18	0.18	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.25	0.00	0.25	0.68	0.20
		Lower, 1'	0.00	0.00	0.00	0.15	0.15	0.00	0.10	0.10	0.00	0.45	0.45	0.00	0.00	0.00	0.00	NF	NF	NF	0.00	0.00	0.00	0.70	0.20
																								A9 ave	**0.54**	**0.16**
A10	**30+30-R**	Upper, 5'	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.10	0.00	0.10	0.25	0.15	0.25	0.25	0.00	0.25	0.35	0.10
inst: 03-19-2013		Middle, 3'	0.00	0.00	0.00	0.21	0.21	0.00	0.00	0.00	0.00	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	0.21	0.06
		(No Lower Pin Installed; Bedrock)																						**A10 ave**	**0.28**	**0.08**
A11	**30+60-R**	Upper, 4'	0.25	0.25	0.00	0.27	0.27	0.00	0.00	0.00	0.00	0.15	0.15	0.15	0.15	0.00	0.15	0.40	0.25	0.38	0.40	0.02	0.40	0.94	0.27
inst: 03-19-2013		Middle, 2'	0.10	0.10	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.00	0.20	0.30	0.10	0.30	0.30	0.00	0.30	0.65	0.19
		Lower, 0'	0.10	0.10	0.00	0.48	0.48	0.00	0.00	0.00	0.00	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	0.58	0.17
																								A11 ave	**0.72**	**0.21**
A12	**30+90-R**	Upper, 4'	0.83	0.83	0.00	0.37	0.37	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.00	0.20	0.52	0.32	0.52	0.60	0.08	0.60	1.80	0.52
inst: 03-19-2013		Middle, 2'	0.25	0.25	0.00	0.97	0.97	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.10	0.00	0.10	0.17	0.07	0.17	0.15	0.00	0.15	1.39	0.40
		Lower, 0'	0.00	0.00	0.00	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	0.00	0.00
																								A12 ave	**1.06**	**0.31**
months / years from Mar 2013			8 months = 0.67 year			13 months = 1.08 year			17 months = 1.42 year			26 months = 2.17 yr			30 months = 2.50 yr			37 months = 3.08 yr			42 months = 3.50 yr			**Reach Av**	**0.79**	**0.23**

NOTES

NF = Pin Not Found on monitoring date. **RemEx** = Remaining exposed pin (ft) after measuring and pounding in, if possible.

(a) A6 Lower Pin installed with 0.33 ft exposed due to bedrock. **(b)** A4 Pins lost or inaccessible due to tree fall/bank slump during winter 2013-14

Appendix D. Table 10.1. Baseline Stream Data Summary: Dimension, Pattern, Profile, and Transport Parameters																									
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration Project # 370																									
Unnammed Tributary to Dutch Buffalo (608 linear feet)																									
Parameter	**Gauge**	**Regional Curve**			Pre-Existing Condition						Reference Reach Data						Design			Monitoring Baseline					
Dimension and Substrate - Riffle	-	**LL**	**UL**	**Eq.**	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Med	Max	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	-	6.83	7.55	7.19	-	8.68	-	-	-	10	-	8.3	-	-	-	-	-	9	-	8.34	8.60	8.60	8.85	-	2
Floodprone Width (ft)					-	9.8	-	-	-	10	-	130	-	-	-	-	-	150	-	52.52	54.05	54.05	55.57	-	2
Bankfull Mean Depth (ft)	-	0.98	1.08	1.03	-	1.17	-	-	-	10	-	1.3	-	-	-	-	-	1	-	1.00	1.02	1.02	1.04	-	2
Bankfull Max Depth (ft)	-				-	1.49	-	-	-	10	-	1.9	-	-	-	-	-	1.5	-	1.67	1.74	1.74	1.81	-	2
Bankfull Cross-Sectional Area (ft^2)	-	9.18	10.14	9.66	-	10.17	-	-	-	10	-	10.95	-	-	-	-	-	9	-	8.30	8.77	8.77	9.24	-	2
Width/Depth Ratio	-				-	7.42	-	-	-	10	-	6.4	-	-	-	-	-	9	-	8.34	8.43	8.43	8.51	-	2
Entrenchment Ratio	-				-	1.13	-	-	-	10	-	15.66	-	-	-	-	-	16.67	-	6.28	6.29	6.29	6.30	-	2
Bank Height Ratio	-				-	2.53	-	-	-	10	-	1.2	-	-	-	-	-	1.0	-	1.0	1.0	1.0	1.0	-	2
Pattern																									
Channel Beltwidth (ft)					2.5	-	-	19.4	-	46	33	51	-	69	-	2	33.3	57.15	81	33.3	57.15	57.15	81	-	-
Radius of Curvature (ft)					10.38	-	-	37.99	-	76	12	15.5	-	19	-	2	22.5	24.75	27	22.5	24.75	24.75	27	-	-
Rc:Bankfull width (ft/ft)					1.2	-	-	4.38	-	76		8.3	-		-	1	2.5	2.75	3	2.5	2.75	3	-	-	-
Meander Wavelength (ft)					43	-	-	109	-	50	60	64.5	-	69	-	2	57.6	91.80	126	57.6	91.8	91.8	126	-	-
Meander Width Ratio					0.29	-	-	2.24	-	46	4	6.15	-	8.3	-	2	3.7	6.35	9	3.7	6.35	6.35	9	-	-
Profile																									
Riffle Length (ft)					6.76	-	-	41.57	-	4	5.4	-	-	23	-	2	14.4	33.40	52.4	13.76	-	-	19.36	-	-
Riffle Slope (ft/ft)					0.003	-	-	0.0386	-	4	0.016	-	-	0.024	-		0.014	0.02	0.024	0.00142	-	-	0.0111	-	-
Pool Length (ft)					5.89	-	-	37.56	-	7	7.8	-	-	35	-	2	54.12	64.72	75.32	10.32	-	-	31.4	-	-
Pool Max Depth (ft)						1.79	-	-	-	7		2.4	-	-	-	-	1	1.40	1.8	-	-	-	-	-	-
Pool Spacing (ft)					17.35	-	-	125.66	-	7	40.3	-	-	60	-	-	44.1	54.45	64.8	10.32	-	-	52.04	-	-
Transport Parameters																									
Reach Shear Stress (competency) lb/ft^2					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankful					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m^2					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																									
Rosgen Classification	-				G5c						E4						C/E4			E4					
Bankful Velocity (fps)	-	-	-	-	3.8						3.5						3.65			3.65					
Bankful Discharge (cfs)	-	-	-	-	39.04*						38						39.04*			39.04*					
Valley Length (ft)					-						-						-			-					
Channel Thalweg Length (ft)					608						608						608			608					
Sinuosity (ft)					1.24						1.8						1.13			1.16					
Water Surface Slope (ft/ft)	-				0.008						0.005						0.006			0.008					
BF slope (ft/ft)	-				0.008						0.005						0.006			0.008					
Bankful Floodplain Area (acres)					0.14						1.81						2.09			0.75					
% of Reach with Eroding Banks					-						-						-			0					
Channel Stability or Habitat Metric					-						-						-			-					
Biological or Other					-						-						-			-					

*Calculated using Flowmaster

Appendix D. Table 10.2. Baseline Stream Data Summary: Substrate, Bed, Bank and Hydrologic Containment Parameters				
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration Project # 370				
Unnammed Tributary to Dutch Buffalo (608 linear feet)				
Parameter	**Pre-Existing Condition**	**Reference Reach Data**	**Design**	**As-built/Baseline**
Ri%/Ru%/P%/G%/S%	-	-	-	-
SC% / Sa% / G% / C% / B% / Be%	-	-	-	24.5/35.75/36.75/3.25/0/0
d16 / d35 / d50 / d84 / d95 (mm)	0.12/0.83/2.36/11.03/22.6	-	-	1.45/5.85/8.29/25.06/47.52
Entrenchment Class <1.5/1.5-1.99/2.0-4.9/5.0-9.9/>10	100% <1.5 (1.13)	100% > 10 (15.66)	100% > 10 (16.67)	5.0 < 100% < 9.9 (5.35, 6.30)
Incision Class <1.2/1.2-1.49/1.5-1.99/>2.0	(2.53) 100% > 2.0	1.2 = (1.2) 100% <1.49	(1.0) 100%< 1.2	(1.0) 100%< 1.2

Table 11.1. Cross Sectional Morphology Monitoring Data Summary												
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration Project # 370												
Unnammed Tributary to Dutch Buffalo (608 linear feet)												
PARAMETER		Cross-Section 1 (Riffle)						Cross-Section 2 (Riffle)				
DIMENSION	Baseline	MY1-2010	MY2-2011	MY3-2014	MY4-2015	MY5-2016	Baseline	MY1-2010	MY2-2011	MY3-2014	MY4-2015	MY5-2016
Bankfull Width (ft)	8.9	8.7	8.3	9.0	8.6	8.9	9.6	9.7	9.4	NA	NA	NA
Floodprone Width (ft)	55.6	55.6	55.8	56.0	56.0	56.0	53.3	53.2	53.3	NA	NA	NA
Bankfull Mean Depth	1.0	1.1	1.1	1.1	0.6	1.0	1.1	1.0	1.0	NA	NA	NA
Bankfull Max Depth (ft)	1.8	1.7	1.6	1.9	1.9	1.9	1.7	1.6	1.6	NA	NA	NA
Bankfull Cross-sectional Area (ft^2)	9.2	8.8	8.8	9.8	10.9	8.7	10.2	9.4	9.4	NA	NA	NA
Bankfull Width/Depth Ratio	8.5	8.6	7.8	8.2	15.1	9.2	9.1	10.0	9.3	NA	NA	NA
Bankfull Entrenchment Ratio	6.3	6.4	6.7	6.2	6.5	6.3	5.6	5.5	5.7	NA	NA	NA
Bankfull Bankheight Ratio	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	NA	NA	NA
Cross Sectional Area between end pins (ft^2)	75.0	69.6	75.5	71.3	68.2	69.5	12.0	9.8	19.1	NA	NA	NA
d50 (mm)	13.7	4.9	1.9	2.0	0.5	7.0	0.1	11.6	12.5	NA	NA	NA
PARAMETER		Cross-Section 3 (Pool)						Cross-Section 4 (Riffle)				
DIMENSION	Baseline	MY1-2010	MY2-2011	MY3-2014	MY4-2015	MY5-2016	Baseline	MY1-2010	MY2-2011	MY3-2014	MY4-2015	MY5-2016
Bankfull Width (ft)	11.0	10.5	10.4	NA	NA	NA	8.3	8.3	8.2	8.5	8.0	8.6
Floodprone Width (ft)	59.0	58.0	55.3	NA	NA	NA	52.5	52.5	55.1	55.00	55.0	55.0
Bankfull Mean Depth	0.8	0.7	0.7	NA	NA	NA	1.0	1.0	1.0	1.1	0.9	1.0
Bankfull Max Depth (ft)	8.9	8.7	1.6	NA	NA	NA	1.7	1.7	1.7	1.8	1.5	1.7
Bankfull Cross-sectional Area (ft^2)	9.3	7.5	7.6	NA	NA	NA	8.3	8.4	8.3	8.7	8.8	8.6
Bankfull Width/Depth Ratio	13.1	14.8	14.3	NA	NA	NA	8.3	8.2	8.1	7.7	9.0	8.6
Bankfull Entrenchment Ratio	5.4	5.5	5.3	NA	NA	NA	6.3	6.3	6.8	6.5	6.8	6.4
Bankfull Bankheight Ratio	1.0	1.0	1.0	NA	NA	NA	1.0	1.0	1.0	1.0	1.0	1.0
Cross Sectional Area between end pins (ft^2)	49.8	35.4	53.4	NA	NA	NA	39.6	36.3	41.3	39.7	37.2	36.9
d50 (mm)	0.1	0.2	0.03	NA	NA	NA	11.1	17.5	13.8	10.2	43.6	22.0

Table 11.2.A. Stream Reach Morphology Monitoring Data Summary
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration Project # 370
Unnammed Tributary to Dutch Buffalo Creek (608 linear feet)

Parameter	Baseline - 2009						MY 1 - 2010						MY 2 - 2011					
DIMENSION	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	8.34	8.60	8.60	8.85	-	3	8.31	8.52	8.52	8.72	-	3	8.16	8.59	8.28	9.34	0.65	3
Floodprone Width (ft)	52.5	54.0	54.0	55.6	-	3	52.5	54.1	54.1	55.6	-	3	53.3	54.7	55.1	55.8	1.26	3
Bankfull Mean Depth (ft)	1.00	1.02	1.02	1.04	-	3	1.01	1.01	1.01	1.01	-	3	1.01	1.03	1.01	1.06	0.03	3
Bankfull Max Depth (ft)	1.67	1.74	1.74	1.81	-	3	1.56	1.63	1.63	1.70	-	3	1.62	1.64	1.64	1.65	0.02	3
BKF X-section Area (ft2)	8.30	8.77	8.77	9.24	-	3	8.42	8.62	8.62	8.82	-	3	8.27	8.82	8.77	9.42	0.58	3
Width /Depth Ratio	8.34	8.43	8.43	8.51	-	3	8.23	8.43	8.43	8.63	-	3	7.81	8.38	8.08	9.25	0.77	3
Entrenchment Ratio	6.28	6.29	6.29	6.30	-	3	6.32	6.35	6.35	6.38	-	3	5.71	6.40	6.74	6.75	0.60	3
Bank Height Ratio	1.00	1.00	1.00	1.00	-	3	1.00	1.00	1.00	1.00	-	3	1.00	1.00	1.00	1.00	0.00	3
Bankfull Velocity (fps)	4.70	4.45	4.45	4.23	-	3	4.64	4.53	4.53	4.43	-	3	4.14	4.44	4.45	4.72	0.29	3
PROFILE	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Riffle Length (ft)	13.76	21.29	21.29	28.82	-	2	16.07	22.09	22.09	28.11	-	3	9.01	16.90	17.46	22.53	5.05	6
Riffle Slope (ft/ft)	0.0014	0.0100	0.0100	0.0186	-	2	0.0092	0.0101	0.0101	0.0110	-	3	0.0093	0.0203	0.0158	0.0472	0.0140	6
Pool Length (ft)	10.32	31.83	31.83	53.33	-	2	18.30	27.90	27.90	37.49	-	3	15.77	38.02	40.93	61.57	15.69	8
Pool Max depth	1.72	1.82	1.82	1.91	-	2	1.62	1.63	1.63	1.63	-	2	1.95	2.29	2.17	2.80	0.30	9
Pool Spacing (ft)	10.32	42.80	42.80	75.27	-	2	19.98	23.64	23.64	27.29	-	3	25.45	54.46	58.32	77.41	18.41	8
PATTERN	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Channel Beltwidth (ft)	33.30	57.15	57.15	81.00	-	5	33.30	57.15	57.15	81.00	-	5	33.30	57.15	57.15	81.00	-	5
Radius of Curvature (ft)	22.50	24.75	24.75	27.00	-	9	22.50	24.75	24.75	27.00	-	9	22.50	24.75	24.75	27.00	-	9
Meander Wavelength (ft)	57.60	91.80	91.80	126.00	-	7	57.60	91.80	91.80	126.00	-	7	57.60	91.80	91.80	126.00	-	7
Meander Width Ratio	3.70	6.35	6.35	9.00	-	-	3.70	6.35	6.35	9.00	-	-	3.70	6.35	6.35	9.00	-	-
ADDITIONAL REACH PARAMETERS																		
Rosgen Classification	E4						E4						E4					
BF slope (ft/ft)	0						0.008						0.006					
Ri%/Ru%/P%/G%/S%	-	-	-	-	-		29.0	1.2	38.1	-	0.2		17.0	-	50.0	-	0.2	
SC%/Sa%/G%/C%/B%/Be%																		
d16 / d35 / d50 / d84 / d95																		
% reach w eroding banks	0						4						0					
Channel Stability or Habitat Metric	-						-						-					
Biological or Other	-						-						-					

> BKF velocity based on 39.04 cfs design flow

Table 11.2.B. Stream Reach Morphology Monitoring Data Summary

Parameter	MY 3 - 2014						MY 4 - 2015						MY 5 - 2016					
DIMENSION	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	8.50	8.75	8.75	9.00	0.35	2	8.00	8.30	8.30	8.60	0.65	2	8.60	8.75	8.75	8.90	0.21	2
Floodprone Width (ft)	55.00	55.50	55.50	56.00	0.71	2	55.0	55.5	55.5	56.0	0.95	2	55.00	55.50	55.50	56.00	0.71	2
Bankfull Mean Depth (ft)	1.10	1.10	1.10	1.10	0.00	2	0.57	0.73	0.73	0.88	0.03	2	0.97	0.99	0.99	1.00	0.02	2
Bankfull Max Depth (ft)	1.79	1.83	1.83	1.87	0.06	2	1.50	1.68	1.68	1.86	0.02	2	1.70	1.80	1.80	1.90	0.14	2
BKF X-section Area (ft2)	8.70	9.26	9.26	9.81	0.78	2	8.88	9.39	9.39	9.90	0.58	2	8.62	8.64	8.64	8.65	0.02	2
Width /Depth Ratio	7.73	7.95	7.95	8.18	0.32	2	9.09	12.09	12.09	15.09	0.77	2	8.58	8.87	8.87	9.16	0.41	2
Entrenchment Ratio	6.22	6.35	6.35	6.47	0.18	2	6.51	6.70	6.70	6.88	0.60	2	6.29	6.35	6.35	6.40	0.08	2
Bank Height Ratio	1.00	1.00	1.00	1.00	0.01	2	1.00	1.00	1.00	1.00	0.00	2	0.92	0.98	0.98	1.04	0.08	2
Bankfull Velocity (fps)	3.98	4.47	4.45	4.49	0.30	2	3.94	4.17	4.17	4.40	0.29	2	4.49	4.51	4.51	4.54	0.04	2
PROFILE	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Riffle Length (ft)	12.32	20.09	21.99	26.49	5.05	3	10.40	20.07	18.59	26.77	9.16	6	4.30	6.38	6.47	8.48	1.37	6
Riffle Slope (ft/ft)	0.0066	0.0135	0.0120	0.0256	0.014	3	0.0069	0.0187	0.0183	0.0297	0.012	6	0.0063	0.0856	0.0698	0.2244	0.076	6
Pool Length (ft)	14.80	32.58	33.55	59.50	15.69	4	14.80	36.08	37.64	57.36	13.62	8	14.80	36.08	37.64	57.36	13.62	8
Pool Max depth	1.63	1.93	1.89	2.21	0.40	4	1.45	1.71	1.65	2.23	0.36	8	1.45	1.71	1.65	2.23	0.36	8
Pool Spacing (ft)	18.58	43.20	41.58	59.99	18.41	4	10.70	34.45	38.95	58.20	17.23	8	27.62	66.47	74.02	99.05	28.76	8
PATTERN	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Channel Beltwidth (ft)	33.30	57.15	57.15	81.00	-	5	33.30	57.15	57.15	81.00	-	5	33.30	57.15	57.15	81.00	-	5
Radius of Curvature (ft)	22.50	24.75	24.75	27.00	-	9	22.50	24.75	24.75	27.00	-	9	22.50	24.75	24.75	27.00	-	9
Meander Wavelength (ft)	57.60	91.80	91.80	126.00	-	7	57.60	91.80	91.80	126.00	-	7	57.60	91.80	91.80	126.00	-	7
Meander Width Ratio	3.70	6.35	6.35	9.00	-	-	3.70	6.35	6.35	9.00	-	-	3.70	6.35	6.35	9.00	-	-
ADDITIONAL REACH PARAMETERS																		
Rosgen Classification	E4						E4						E4					
BF slope (ft/ft)	0.008						0.007						0.008					
Ri%/Ru%/P%/G%/S%	29.0	-	38.0	-	0.2		29.0	-	38.0	-	0.2		29.0	-	38.0	-	0.2	
SC%/Sa%/G%/C%/B%/Be%																		
d16 / d35 / d50 / d84 / d95																		
% reach w eroding banks	4						4						4					
Channel Stability or Habitat Metric	-						-						-					
Biological or Other	-						-						-					

> BKF velocity based on 39.04 cfs design flow

Appendix E. Stream & Wetland Hydrology Data

Figure 6. Monthly Rainfall Data with Percentiles
Figure 7.1- 7.5. Groundwater Gage Plots with Precipitation Data
Table 12. Verification of Bankfull Events
Table 13. Wetland Hydrology Criteria Attainment

e-Table: Rain Gage and Stream Gage Raw Data
e-Table: Groundwater Gage Raw Data

Figure 6. Monthly Rainfall Totals for 2016, with 30th and 70th Percentile Climate Normals, Concord, NC

Month 2016	Monthly Total Precip, inches	1980-2010 Monthly Climate Normals	
		30th P*	70th P*
Jan-16	1.45	2.55	4.92
Feb-16	2.89	2.59	4.67
Mar-16	0.95	3.42	5.57
Apr-16	1.38	2.16	4.02
May-16	5.42	2.29	4.12
Jun-16	3.08	3.01	5.48
Jul-16	3.72	3.42	5.20
Aug-16	4.64	3.04	5.53
Sep-16	3.15	2.61	5.07
Oct-16	2.65	2.50	4.57
Nov-16		2.47	3.81
Dec-16		2.35	3.69

Monthly rainfall totals at Rocky River WWTP, USGS Gauge# 351943080323145 (9 miles SSW of Suther site)
Monthly Climate values are based on the 30 year period from 1980 to 2010 at Concord Airport, Cabarrus Co.

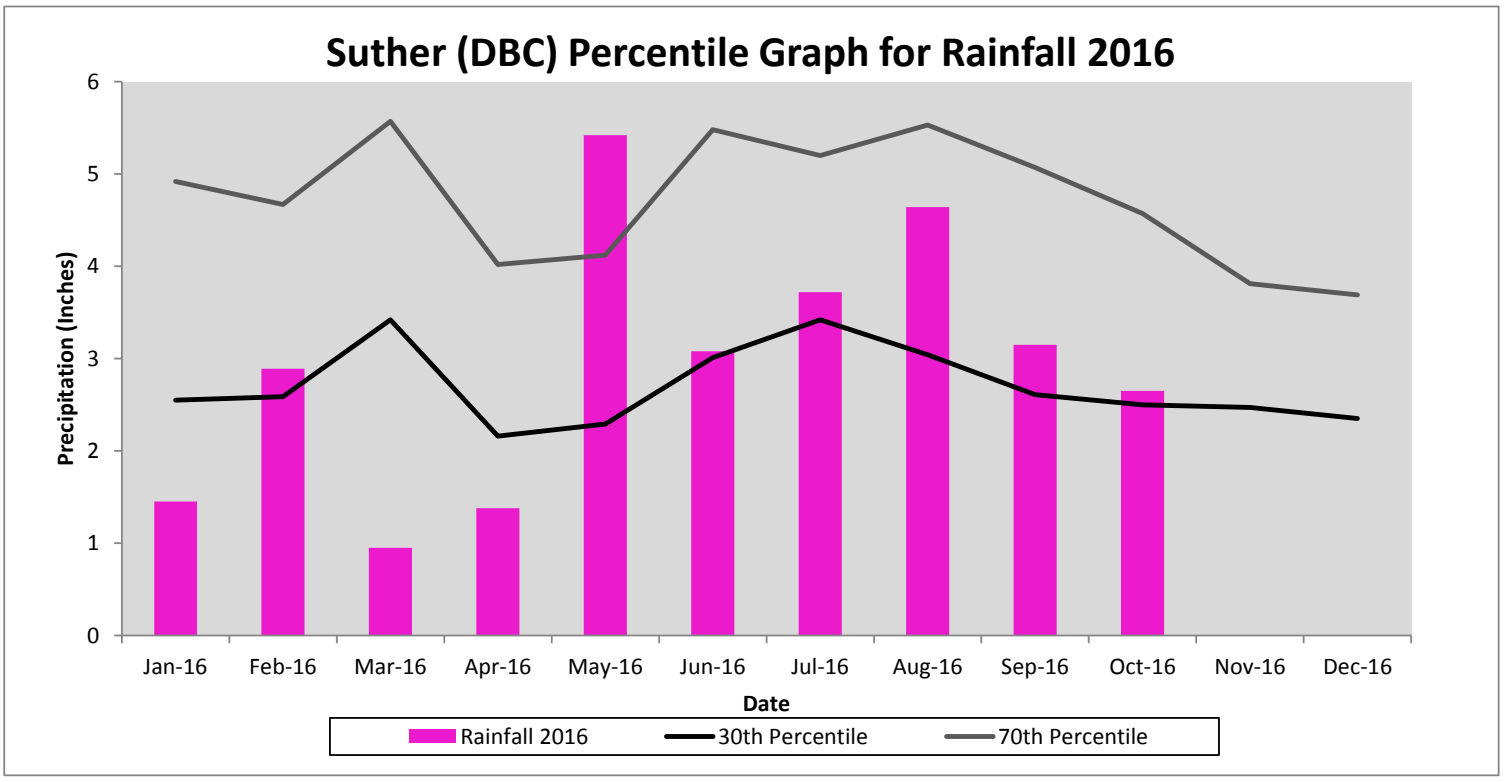
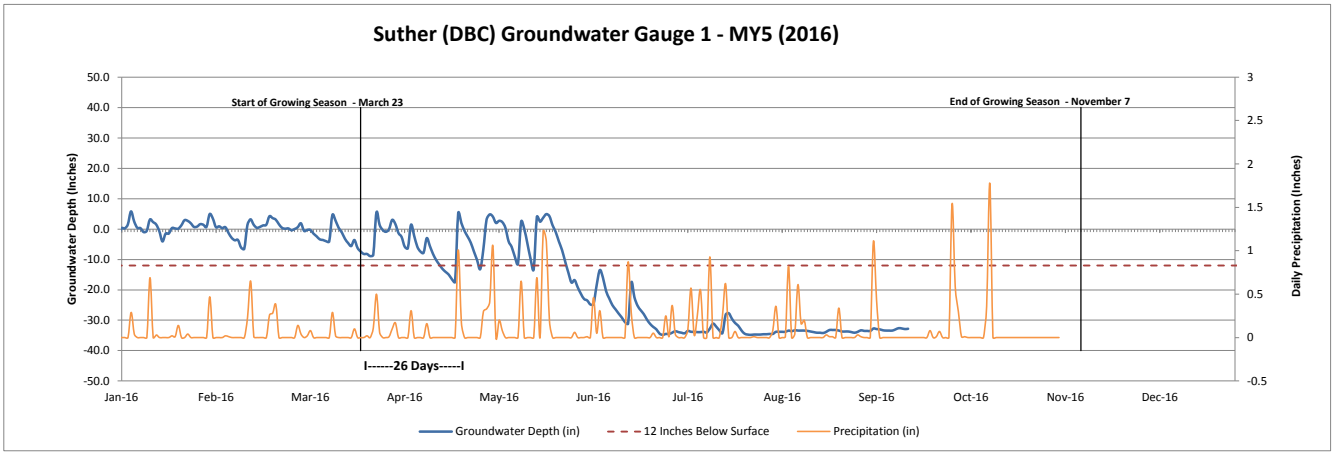
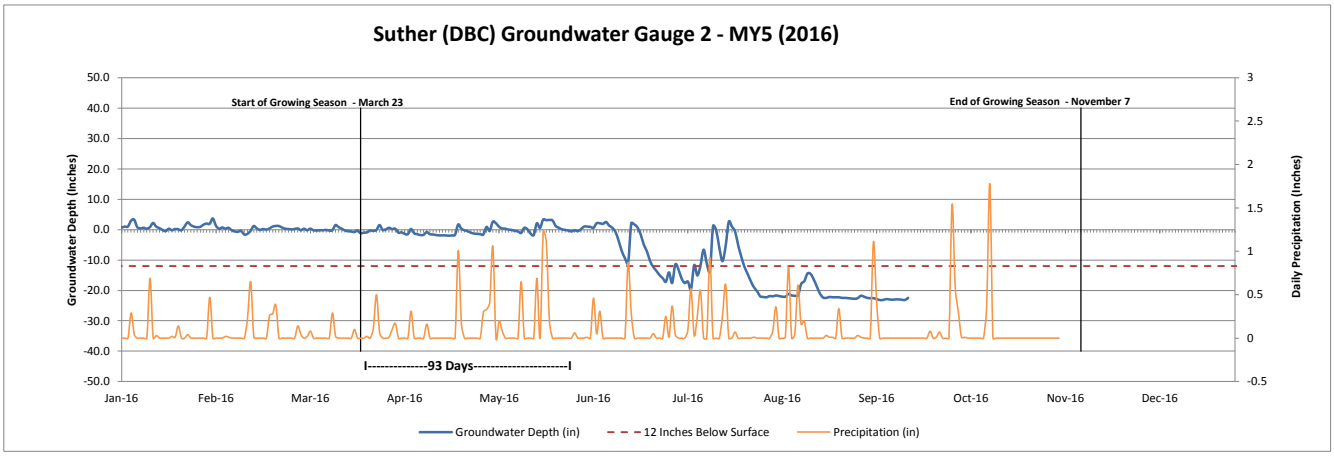
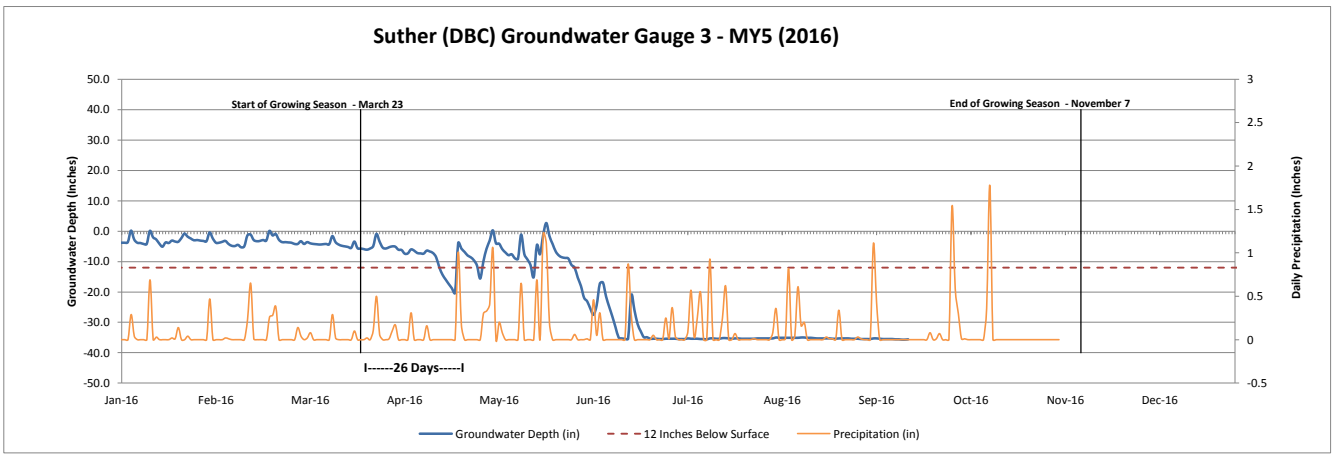


Figure T‰. Groundwater Wells and Daily Precipitation Data, 2016 (MY5): Suther Site #370.







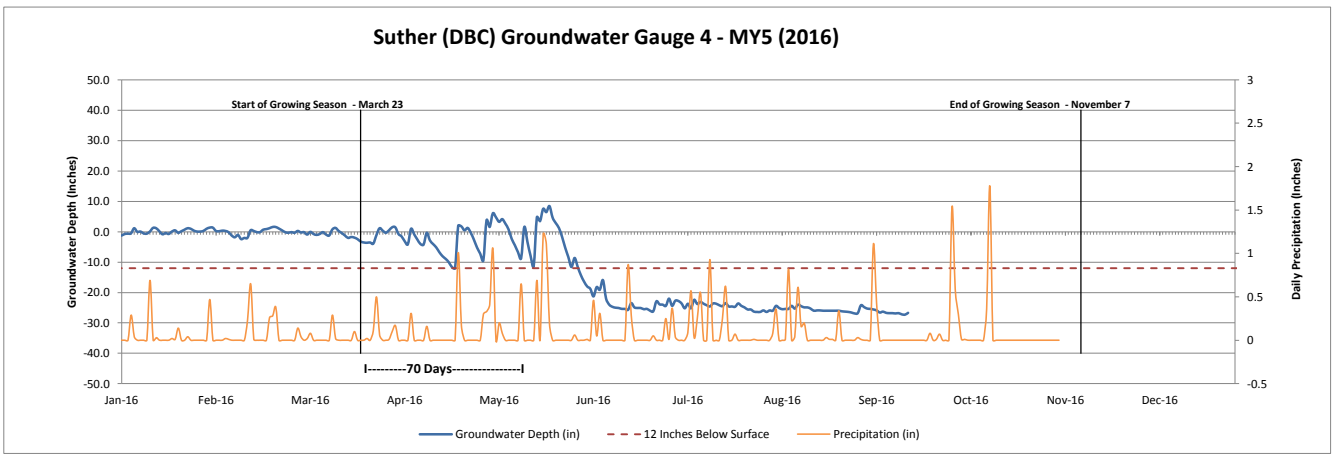
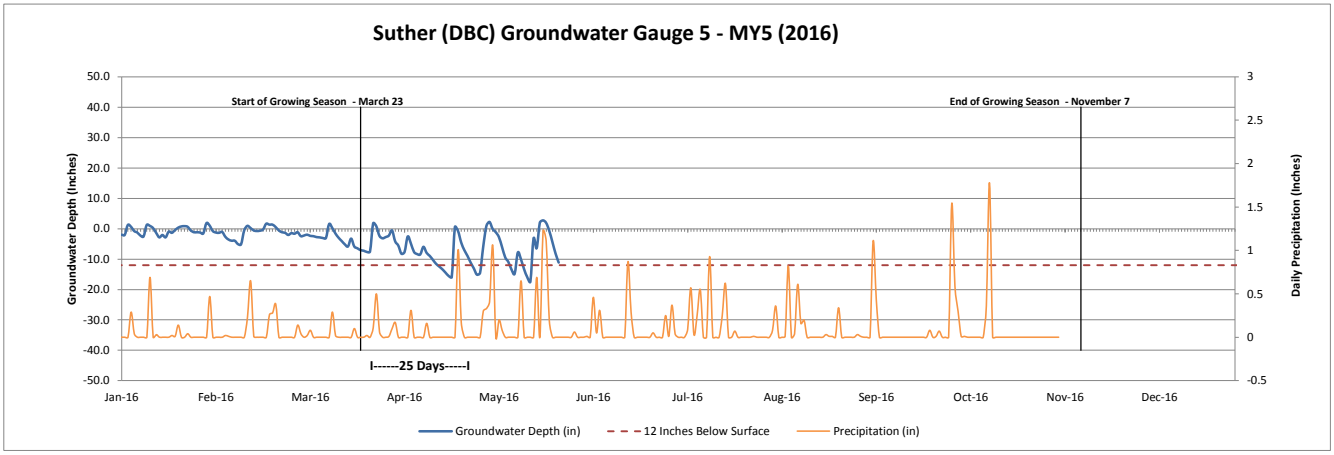
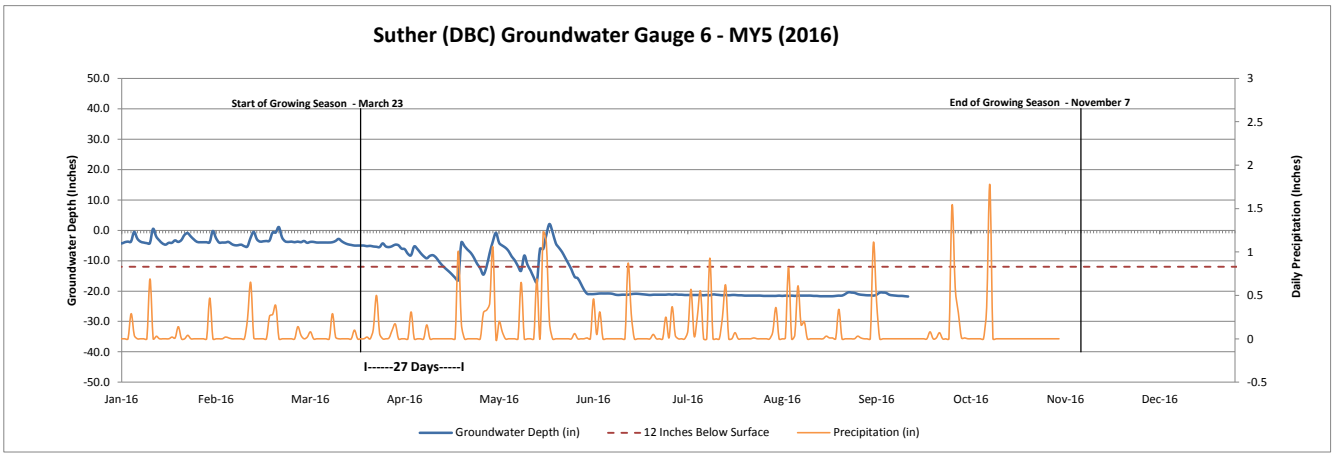
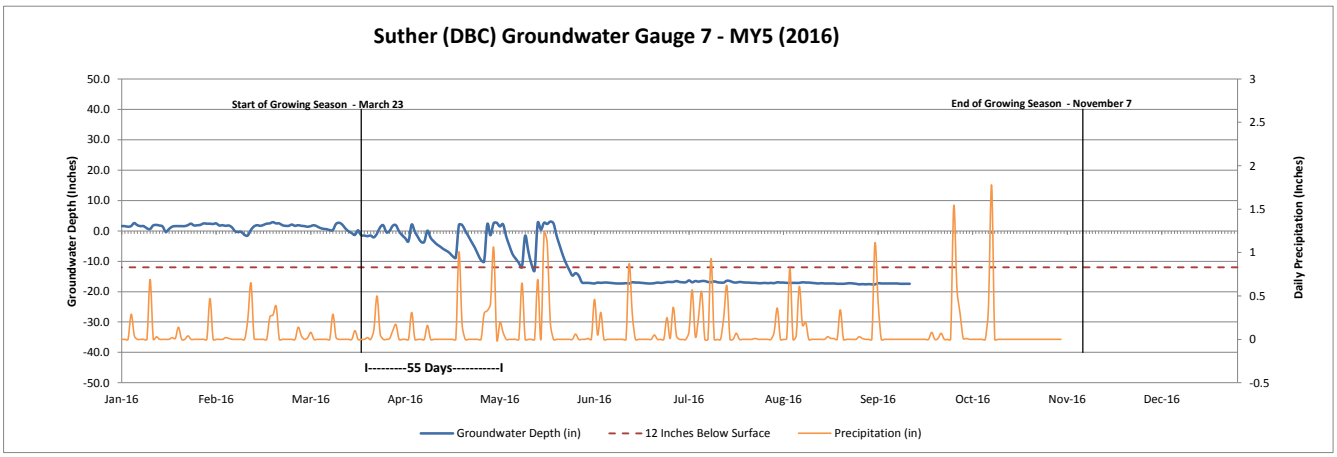


Figure T.H. Groundwater Wells and Daily Precipitation Data, 2016 (MY5): Suther Site #370.







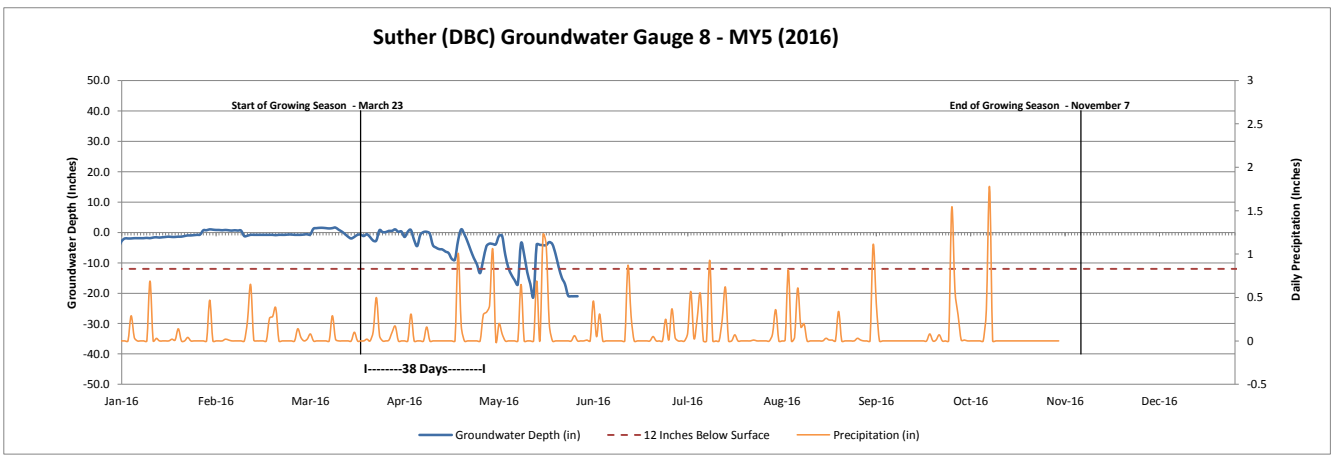
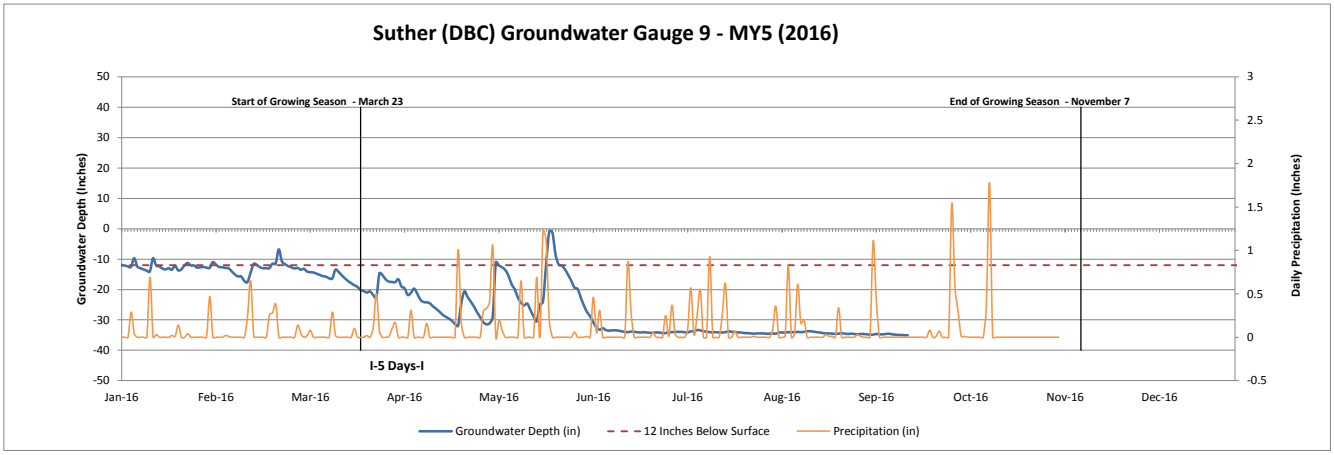
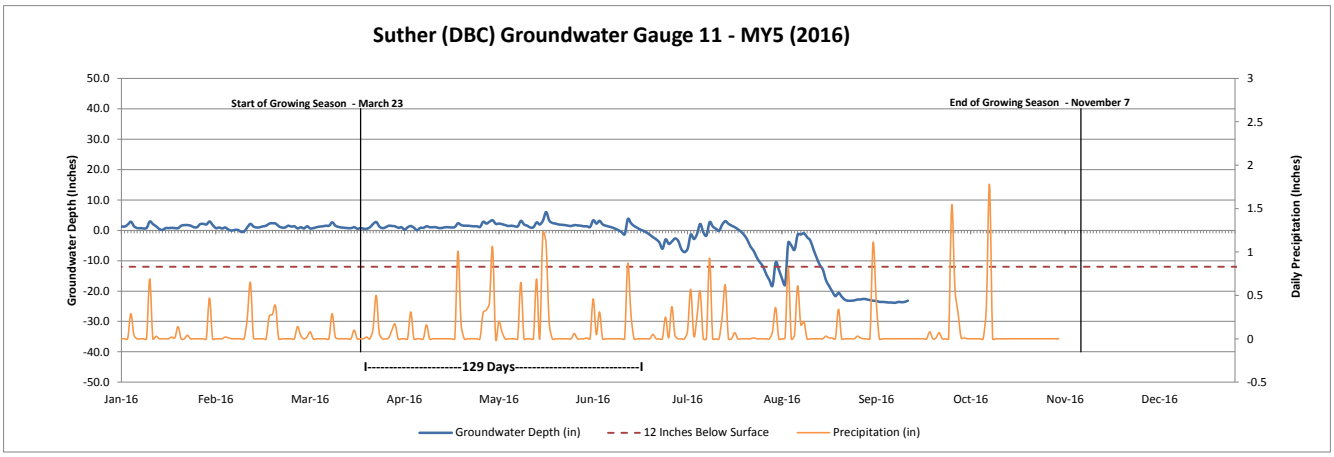
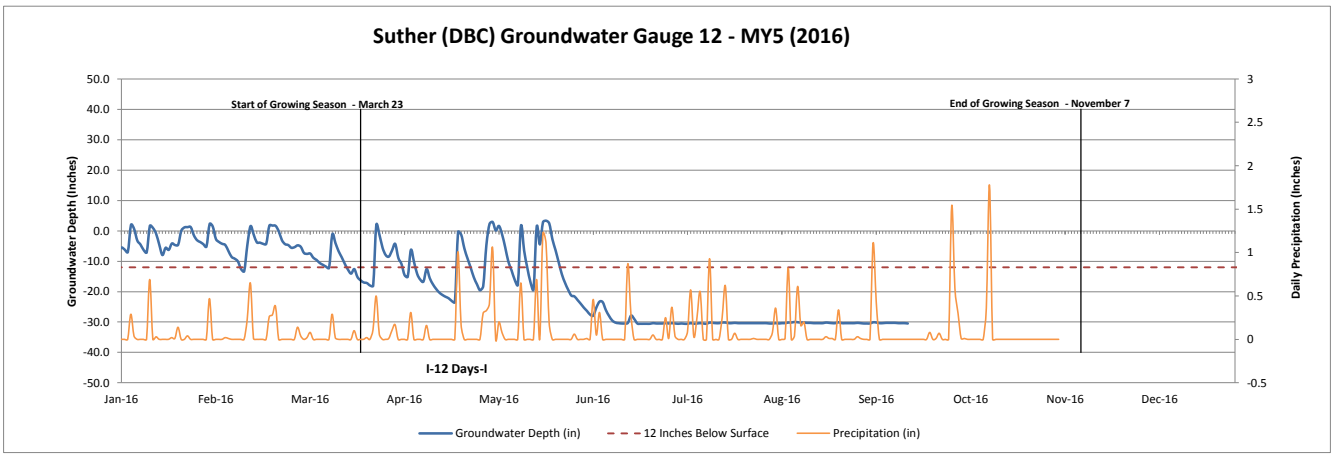


Figure T.O. Groundwater Wells and Daily Precipitation Data, 2016 (MY5): Suther Site #370.







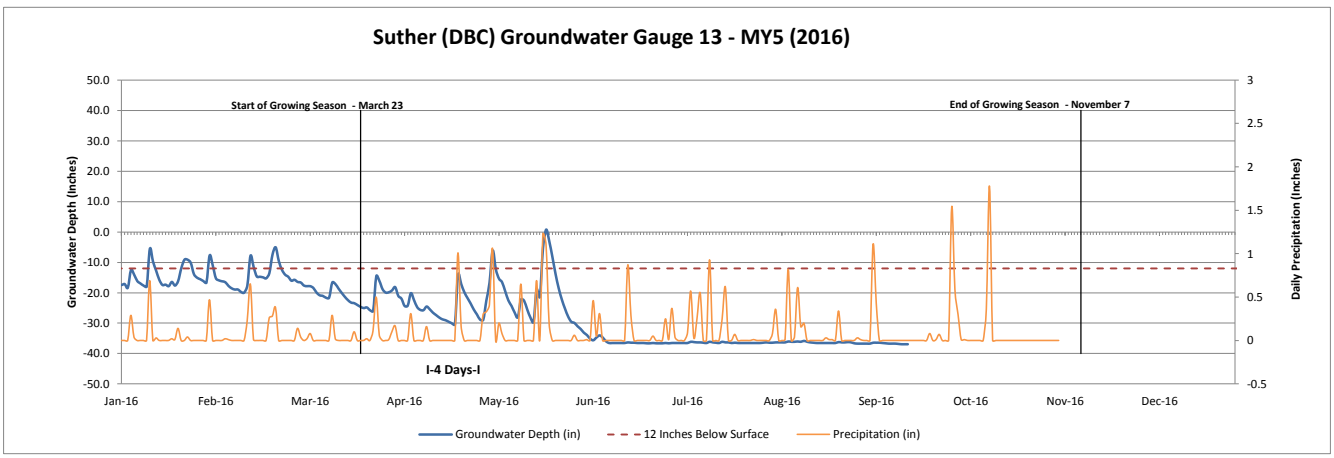
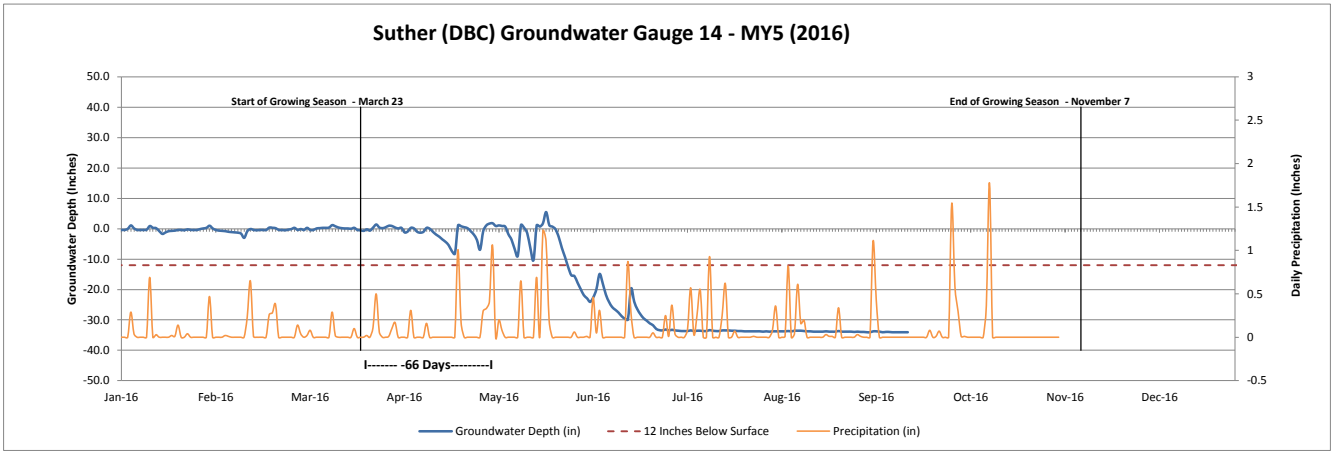
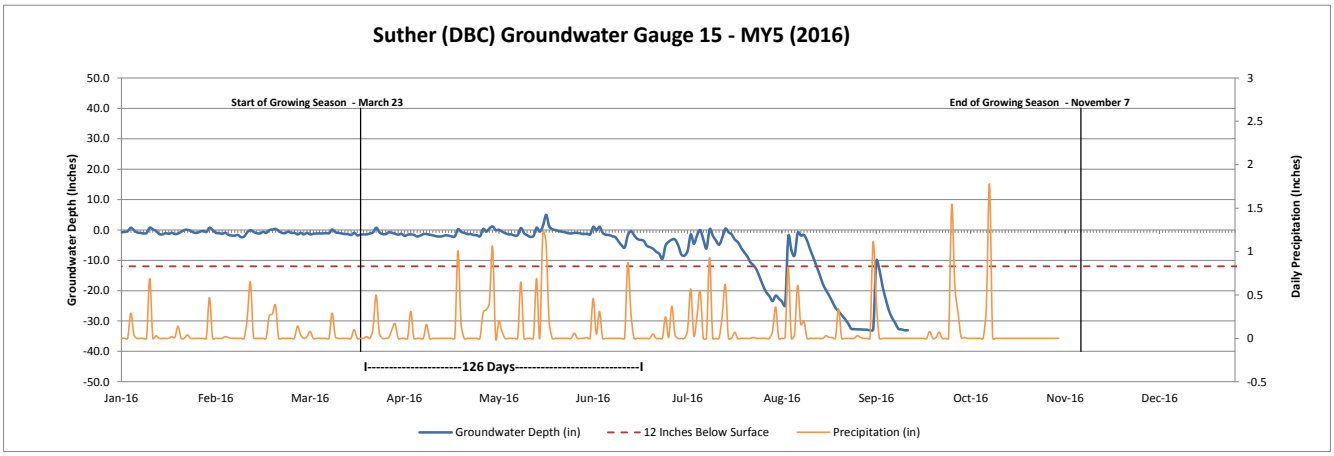
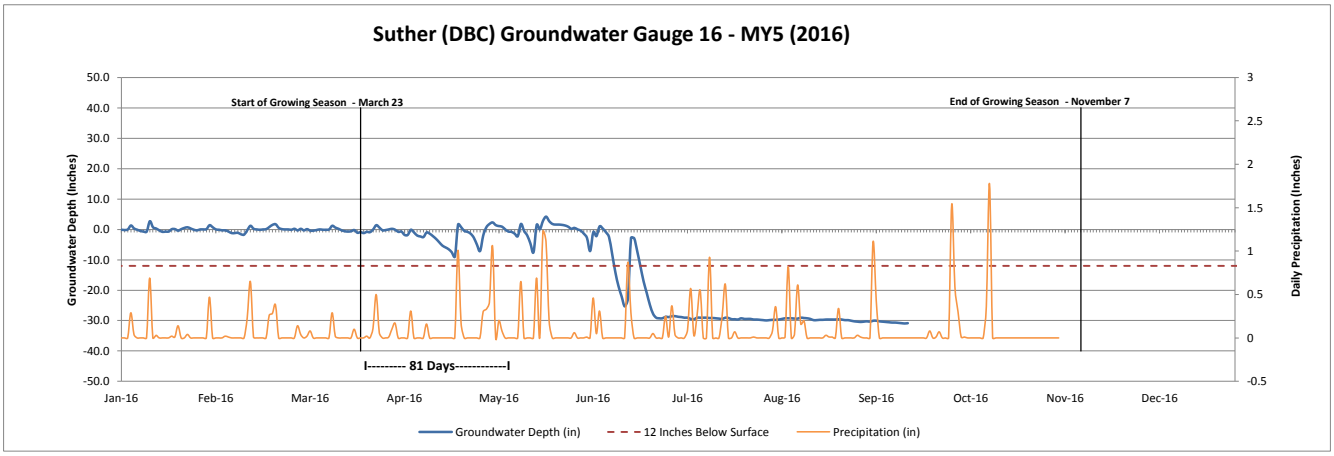


Figure T14. Groundwater Wells and Daily Precipitation Data, 2016 (MY5): Suther Site #370.







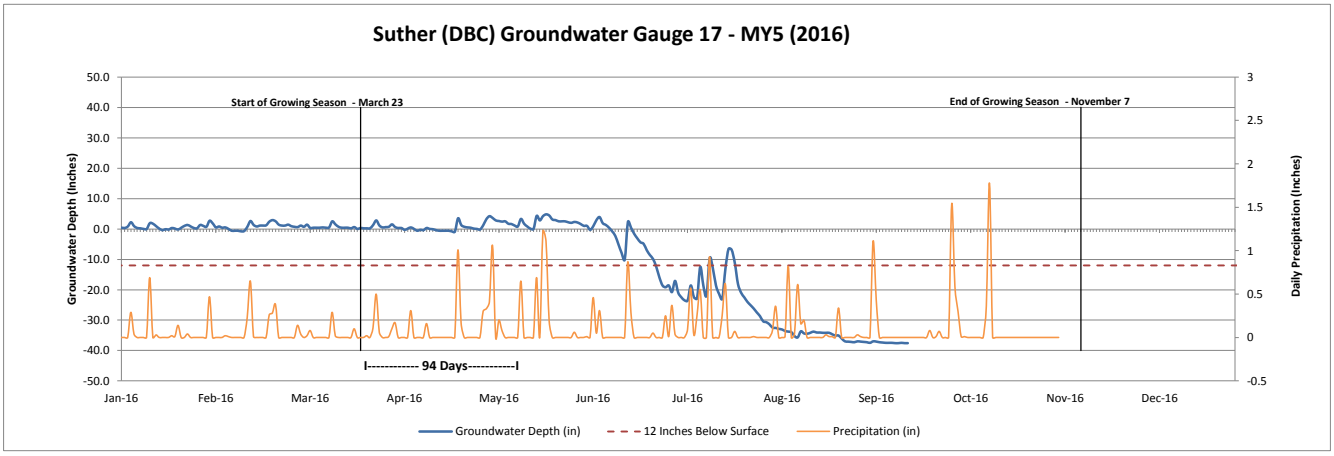
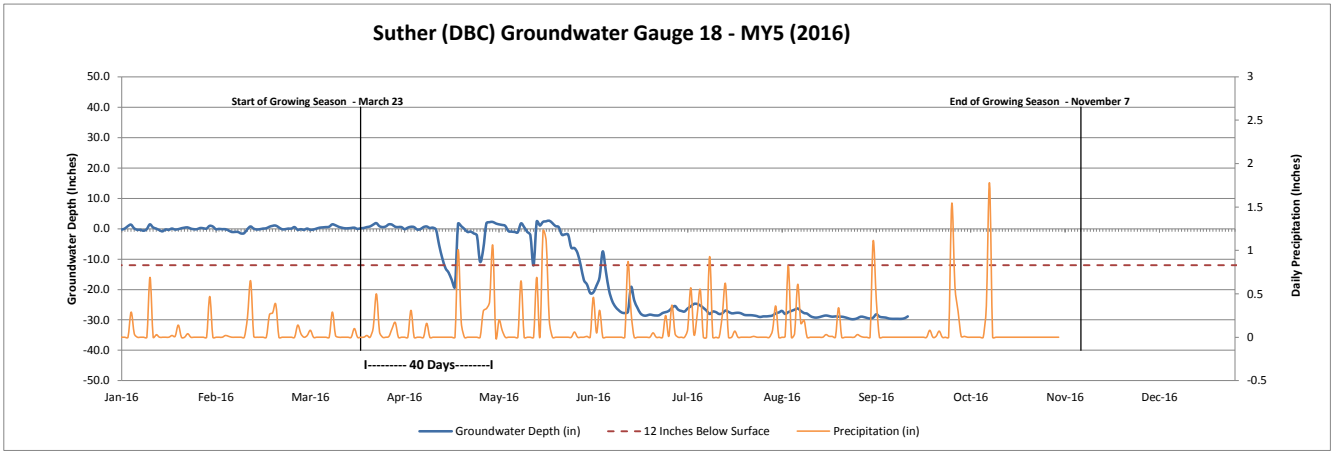
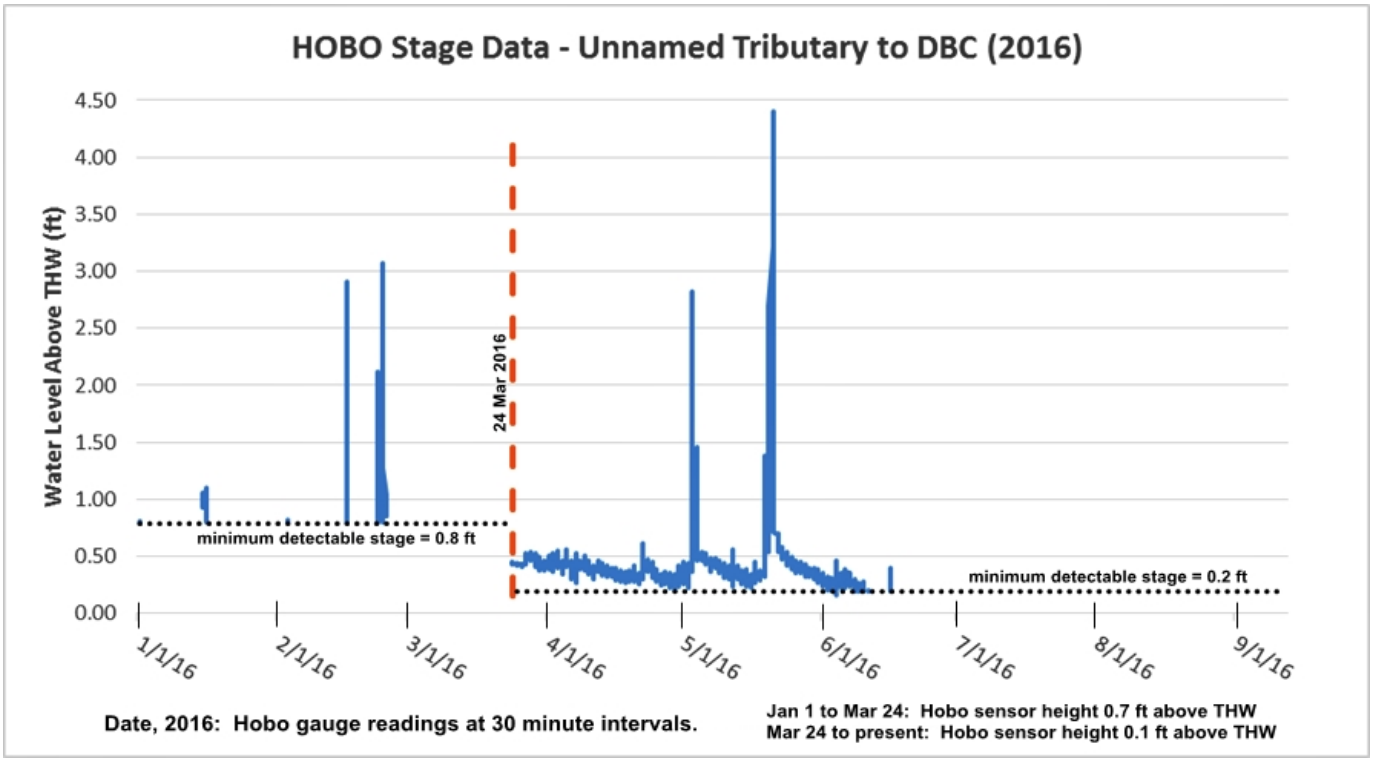


Figure 11p. Groundwater Wells and Daily Precipitation Data, 2016 (MY5): Suther Site #370.





Appendix E - Hydrologic Data -- Suther Site DMS # 370

Table 12. Bankfull Flow Events in Dutch Buffalo Creek and Restored Tributary

Data Collected	Event Date	Method	Trib Stage Feet above BKF Elev	DBCr Stage Feet above THW Elev
5/19/2011	10/2010 - 5/2011	Crest Gauge @ DBCr	--	> 6.0
6/23/2011	5/2011 - 6/2011	Crest Gauge @ DBCr	--	> 6.0
4/10/2014	4/07/2014	Matted vegetation	> 0.5	> 6.0
9/15/2014	4/15/2014	Hobo @ DBC = 4.9 ft	0.9	6.5
9/15/2014	4/19/2014	Hobo @ DBC = 5.7 ft	1.7	7.3
5/3/2015	3/5/2015	Hobo @ DBC = 4.8 ft	0.8	6.4
5/3/2015	4/20/2015	Hobo @ DBC = 5.5 ft	1.5	7.1
9/1/2015	8/19/2015	Hobo @ Trib = 2.2 ft	0.7	--
12/13/2015	10/3/2015	Hobo @ Trib = 3.8 ft	2.4	--
12/13/2015	11/2/2015	Hobo @ Trib = 3.4 ft	2.0	--
12/13/2015	11/10/2015	Hobo @ Trib = 4.1 ft	2.7	--
12/13/2015	11/19/2015	Hobo @ Trib = 3.0 ft	1.6	--
3/28/2016	12/17/2015	Hobo @ Trib = 2.4 ft	0.8	--
3/28/2016	12/24/2015	Hobo @ Trib = 3.8 ft	2.2	--
3/28/2016	12/30/2015	Hobo @ Trib = 5.1 ft	3.6	--
3/28/2016	2/16/2016	Hobo @ Trib = 2.2 ft	0.7	--
3/28/2016	2/24/2016	Hobo @ Trib = 2.4 ft	0.8	--
9/12/2016	5/3/2016	Hobo @ Trib = 2.7 ft	0.6	--
9/12/2016	5/21/2016	Hobo @ Trib = 4.3 ft	2.2	--

Hobo Gauge installed on DBC from 10 Apr 2014 to 07 Aug 2015. Major flow events with gauge height > 4.0 ft in DBC (approx 5.6 ft above THW) are reported in this Table, coinciding with bankfull flow events in the restored tributary. Dutch Buffalo Creek is severely incised and bankfull indicators are unclear, but BKF appears to be roughly 3 ft below top of bank, or 5 ft above THW.

Hobo Gauge installed on Restored Tributary from 07 Aug 2015 to present. Major flow events with gauge height > 2.1 ft above THW are reported in this Table, coinciding with bankfull flow events. See Hobo gauge raw data (Excel spreadsheet in Support Files) for records of smaller flow events.

Hobo Sensor in DBCr 4/2014 - 8/2015 = 1.6 ft above THW. ToB = 7.9 ft above THW. THW = 640.4 ft
Hobo Sensor in Trib 8/2015 - 3/2016 = 0.7 ft above THW. BKF = 2.1 ft above THW. THW = 644.3 ft
Hobo Sensor in Trib 3/2016 - 9/2016 = 0.1 ft above THW. BKF = 2.1 ft above THW. THW = 644.3 ft

Wrack deposits on floodplain near Tributary station 01+50, 13 Sep 2016

Appendix E - Hydrologic Data: Suther Site DMS # 370

Table 13. Wetland GW Gauge Success Attainment, 2010-2016

Wetland ID # new	Pre-Con Gauge #	Post-Con Gauge #	MY-01 (2010)			MY-02 (2011)			MY-xx (2012)			MY-xx (2013)			MY-03 (2014)			MY-04 (2015)			MY-05 (2016)			Multi-YR success	
			Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	meets	# Yrs /Tot
B1		**GW4-N**	--	--	--	--	--	--	--	--	--	--	--	--	28	12	YES	44	19	YES	70	31	YES	Y	3 / 3
	PG-2	**GW7**	--	--	--	41	18	YES	39	17	YES	57	25	YES	59	26	YES	49	21	YES	55	24	YES	Y	6 / 6
	PG-1	**GW8**	--	--	--	18	8	YES	3	1	NO	*MAL*	-	*Unk*	24	10	YES	12	5	NO	38	16	YES	Y	3 / 5
B4		**GW5-N**	--	--	--	--	--	--	--	--	--	--	--	--	25	11	YES	*MAL*	-	*Unk*	25	11	YES	Y	2 / 2
	PG-3	**GW6**	46	20	YES	64	28	YES	32	14	YES	56	24	YES	40	17	YES	43	19	YES	27	12	YES	Y	7 / 7
B2	PG-4	**GW9**	10	4	NO	3	1	NO	6	3	NO	13	6	NO	23	10	YES	6	3	NO	5	2	NO	N	1 / 7
		GW10	20	9	YES	9	4	NO	9	4	NO	*MAL*	--	*Unk*	--	--	--	--	--	--	--	--	--	N	1 / 3
B3	PG-9	**GW4-O**	4	2	NO	0	0	NO	3	1	NO	9	4	NO	--	--	--	--	--	--	--	--	--	N	0 / 4
	PG-10	**GW5-O**	0	0	NO	3	1	NO	7	3	NO	15	7	NO	--	--	--	--	--	--	--	--	--	N	0 / 4
C1		**GW2**	52	23	YES	71	31	YES	44	19	YES	*MAL*	-	*Unk*	*MAL*	-	*Unk*	62	27	YES	93	41	YES	Y	5 / 5
	C-1	**GW14**													29	13	YES	49	21	YES	66	29	YES	Y	3 / 3
		GW17													46	20	YES	57	25	YES	94	41	YES	Y	3 / 3
C2		**GW11**													78	34	YES	87	38	YES	129	56	YES	Y	3 / 3
		GW15													71	31	YES	84	37	YES	126	55	YES	Y	3 / 3
C3	PG-8	**GW1**	20	9	YES	63	28	YES	43	19	YES	66	29	YES	39	17	YES	41	18	YES	26	11	YES	Y	7 / 7
	PG-6	**GW3**	19	8	YES	12	5	NO	17	7	NO	26	11	YES	38	17	YES	44	19	YES	26	11	YES	Y	5 / 7
		GW12													11	5	NO	14	6	NO	12	5	NO	N	0 / 3
		GW13													*MAL*	-	*Unk*	5	2	NO	4	2	NO	N	0 / 3
		GW16													30	13	YES	51	22	YES	81	35	YES	Y	3 / 3
		GW18													28	12	YES	46	20	YES	40	17	YES	Y	3 / 3

Growing season = Mar 23 to Nov 7 = 229 days. Wetland Success Criterion = 8% of growing season = 18 consecutive days (Yes or No)
MAL = GW gage malfunction; data not usable. 2010 and 2011 data and success copied from Jacobs MY2 report (2012).

GW Well History: Nov 2009 original wells 1 thru 10 installed by JJG/Jacobs, maintained thru fall 2011.
No data downloaded during 2012 to 2013; wells 2, 8, and 10 stopped recording during this period.
10 Apr 2014: MMI-RJGA replaced old wells 1 to 9 and installed new wells 11 to 18 at locations selected by EEP.

Gages 1,2,3,6,7,8,9 - Replaced in original locations with reconditioned RDS GW gages
Gage 4 – Replaced 450 ft NNE of original location with reconditioned RDS GW gage [O =old; N= new]
Gage 5 – Replaced 250 ft NNE of original location with reconditioned RDS GW gage [O =old; N= new]
Gage 10 – Removed permanently; not replaced.
Gages 11 to 18 – New well locations installed with reconditioned RDS GW gages

Wetland Credit Types & Acreages: B1 = Preservation (7.83 ac); B2 = Enhancement (Deleted); B3 = Enhancement (Deleted); B4 = Enhancement (1.36 ac); C1 = Enhancement (2.31 ac); C2 = Preservation (1.52 ac); C3 = Restoration (4.84 ac).