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

MY-6 (2017) ANNUAL MONITORING REPORT

North Carolina Department of Environmental Quality
Division of Mitigation Services (DENR-DMS) -- Contract # 5764
USACE Action ID # SAW-2008-0218 **NCDWR Project # 20080134**

Data Collected: October 2017 **Final Report: January 2018**

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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 (Figure 1). 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 (Table 1).

The project was constructed and planted during Nov-Dec 2009, and monitored for two years (2010 and 2011) by Jordan Jones & Goulding (Jacobs Engineering). During 2012-2013 EEP reevaluated the site with respect to project assets and monitoring needs, and installed bank erosion pins. Contracted site monitoring was temporarily suspended during this time. Routine monitoring was resumed in 2014 (MY3) by Robert J. Goldstein & Associates (now Mogensen Mitigation, Inc) and will continue through 2017 (MY6) and project close-out in 2018 (Table 2, Table 3). The 2014 to 2017 monitoring protocol includes a new stream stage gage, eight additional wetland gages, and six new channel cross-sections, installed in April 2014 as shown on the CCPV figures. 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 Dutch Buffalo Creek upper reach.
- Preserve approximately 3,413 linear feet along Dutch Buffalo Creek upper and lower reaches.
- Restore 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 cross-sections along Dutch Buffalo Creek between stations 21+00 and 45+00. The six DBC cross-sections follow the numbering assigned in the MY2 (2011) report (XS-2 through XS-7) although they were not surveyed until 2014. 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 six year monitoring period (revised from five years), two or

more bankfull events must occur in separate years within the restoration reach, and tributary flow should be present for 30 consecutive days per year or more to demonstrate intermittent flow. 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, about seven miles northeast of downtown Concord, N.C. The site is located within the Yadkin – Pee Dee River Watershed (USGS HUC 03040105, DWQ Sub-basin 30712). A vicinity map (Figure 1) 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 (Table 4).

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 includes stream enhancement and preservation along 8,289 feet of Dutch Buffalo Creek and 608 feet of stream restoration (relocated channel) along a channelized intermittent tributary. The Mitigation Plan Addendum (November 2016, Appendix F) reduced the creditable reaches for enhancement and preservation along Dutch Buffalo Creek in areas with insufficient riparian buffer width and two 60-ft wide farm road crossings. Three areas of adjacent riparian wetlands along the lower reach (wetland group A), middle reach (wetland group B), and upper reach (wetland group C) of Dutch Buffalo Creek include wetland restoration (4.84 ac), enhancement (3.67 ac) and preservation (10.99 ac) components. Some of these creditable areas were also adjusted in 2016 according to hydrologic restoration success and failure areas and minor mapping corrections. The final mitigation assets and credits listed in Table 1 (Appendix A) reflect the adjustments presented in the Mitigation Plan Addendum approved by 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, and installed bank erosion monitoring pins. 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 DBC 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. 2017 Current Conditions and Performance Summary

MMI scientists collected monitoring data at the Suther Site during spring and fall of 2017 (MY-6). 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 April to Oct 2017 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 to 2016, 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 both the spring and fall data collection periods. Some additional bank erosion, tree falls, and slumping were observed in areas with near-vertical banks, similar

to the conditions reported in 2014-2016 (Table 5). No beaver dam was observed this year at the usual location near station 17+50, but recent beaver feeding activity along the banks and floodplain was evident during both spring and fall visits. Five of the six cross-sections on DBC show no apparent change from previous years' surveys (Figure 5). Cross-section #6 shows evidence of a low-flow thalweg and sand bar developing, with the thalweg migrating slightly toward the left (north) bank. The channel side-slopes at this site show no change from previous years.

Eighteen of the 32 bank erosion pins along the DBC enhancement reach exhibited some new erosion in April and/or October 2017, ranging from 0.05 ft to 0.80 ft of new pin exposure (Table 12). At site BP-3 the two upper pins were lost due to bank slumping, and the bottom pin (previously exposed 0.70 ft in April) at this site was buried under slumped bank material. Two pins not found in 2015-2016 were found in October 2017, also under slumped bank material. Most of the new erosion this year occurred in between the April and October monitoring visits. The annualized average bank retreat rate for all bank erosion pins found is 0.22 ft/yr (based on the 55 month period from Mar 2013 to Oct 2017); similar to last year's value.

The Dutch Buffalo Creek preservation reach (main stem station 53+72 to 100+50) appears essentially unchanged since our initial inspection in 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. Vertical banks and moderate undercutting are present along many segments, but good tree root density on the banks and presumably lower shear stresses during storm events apparently result in less active bank slumping and erosion.

The Mitigation Plan Addendum Memo (Appendix F) reduces the creditable stream length along both the enhancement and preservation reaches where the easement fence is close to the stream bank. Much of the adjacent forests immediately beyond the easement fence has been clearcut over the past four years, leaving minimal riparian forest cover along these segments where the easement boundary is only a few feet beyond in the stream bank. Creditable and non-credit generating stream segments along DBC are depicted in Appendix B, Figure 2.0-2.6.

1.6.2. Stream Assessment: Restored Tributary of DBC

The restored tributary (UT-1) appears similar in 2017 to the previous years' 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. The lowermost 15 feet of UT-1 adjacent to DBC still has low woody stem density along the banks and remains prone to alternating cycles of erosion and deposition, depending on flow conditions in both streams. This year the lowermost segment of UT-1 appeared aggraded with sand and silt, whereas in 2016 a deep scour pool had formed at the confluence. The deeply incised condition and steep banks along DBC combined with a heavy sediment load during high flow events and shade from floodplain trees makes establishment of woody stems on the banks difficult in this confluence 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 installed in UT-1 initially 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. A pressure differences of 0.04 psi or greater between the two pressure loggers (creek vs ambient) corresponds to 0.1 ft of water depth above the sensor (= 0.2 ft above channel bed), as is used as the minimum detectable stage limit for indicating flow (Table 13). During Mar to Dec 2016, the longest continuous flow period recorded in UT-1 was 77 days (Mar 24 to Jun 09), and during Jan to Oct 2017, the longest continuous flow period recorded was 128 days (Jan 11 to May 18). Three bankfull flow events (recorded stage > 2.1 ft above sensor) were recorded during 2016 and ten bankfull flow events were recorded in 2017.

The restored channel had no visible flow and few isolated puddles in pools during the geomorphic survey in Oct 2017. 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 was observed at two of the step-pools along the lowermost 80 feet of this reach in 2014-2015, but these appear to have stabilized and no further erosion or structural problems were observed during 2016 and 2017 (Table 5).

1.6.3. Wetlands Assessment

Wetland areas have been re-numbered and asset areas and credits revised to match the IRT-approved Mitigation Plan Addendum Memo developed in Nov 2016 by DMS with the Interagency Review Team (Appendix F). These changes include eliminating approximately 0.25 acre from the proposed wetland restoration area C3, eliminating the proposed wetland enhancement areas B2 and B3, and reassigning the eastern 1.36 acre portion of wetland B1 from preservation to enhancement (now relabeled as B4) due to hydrologic enhancement from ditch plugging in that area.

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 March field visit, but were relatively dry in Oct 2017, 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 had forest canopy pre-project, although the 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, 2015 and 2016.

Wetland hydrology as measured with RDS groundwater gauges indicates hydrologic success (18 consecutive growing season days of saturation within 12" of ground surface) at eight of the nine gauges in Wetland C1/C3 restoration & enhancement areas (Table 14). Gauge #13 did not meet success criteria, and the C3 restoration area boundary has been modified to exclude the non-attaining northwestern portion (Figure 2.1). Much of the soils in Section C3 exhibit borderline hydric A/B characteristics typified by problem piedmont soils, but the hydrology in these areas is regularly meeting or exceeding hydrologic requirements.

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 (Old-4 and Old-5) were moved northeast in 2014 into area B1/B4, and area B3 is now deleted from credit assets (Figure 2.2). The proposed

wetland enhancement area B2 (previously mapped as AB3) also did not meet hydrologic success criteria from 2010 to 2017, based on GW gauges 9 and 10, and is also deleted from the credit assets (Figure 2.3). All of the five GW gauges in wetland area B1/B4 (preservation and enhancement areas) met hydrologic success criteria this year. Four gauges met criteria every year, and the fifth gauge (#8) met criteria in 4 of 6 years.

Evidence of rooting by feral hogs in the former pasture area and in the forests along DBC and the restored tributary, in both wetland and non-wetland areas, is similar to that reported in 2014 to 2016. Moderate grazing damage was also noted along the forested stream enhancement area along DBC downstream of the pasture and along UT-1, apparently from deer and other herbivores.

1.6.4. Vegetation and Easement Assessment

Planted and volunteer native trees are continuing to 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 in March 2016, 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 1100 to 6400 stems per acre, far exceeding success criteria (Table 7).

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. Excluding the non-planted species, there are 10 or more stems of planted species (404 stems/ac) in every plot.

The riparian restoration area along both sides of the restored tributary UT-1 was dominated by grasses and herbs for the first few years, but planted and volunteer woody stems are now a 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-5. Growth of the planted trees is slow, probably due to shading from the mature canopy which surrounds the channel and planted areas. The two CVS vegetation plots in this area (VP6 and VP7) each have 8 or 9 species of native hardwoods and stem densities of 890 and 1900 trees per acre, respectively.

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 14. Eight of the nine gauges in the wetland restoration and enhancement area C1/C3 (upper, western portion of project) achieved the required hydrologic success criteria of 18 consecutive days (eight percent of the 229-day growing season) in 2017 (Figure 9). Gauge #13 failed to meet hydrologic success in 2017 and previous years, and the C3 restoration area boundary has been revised to exclude this area (Figure 2.1). Groundwater monitoring in the forested wetland preservation area C2 was discontinued; this area's two gauges easily met success criteria during every year from 2014 to 2016.

The five groundwater gauges in wetland preservation and enhancement areas B1/B4 all achieved success criteria in 2017. The one remaining well in area B2 (GW #9) failed to meet success criteria this year and most previous years; area B2 has thus been dropped from the project assets. Area B3 (previously mapped as AB2) has also been dropped from the project assets; the two groundwater gauges in that area were removed in April 2014 and moved into area B1.

The Suther site rain gauge data for 2017 appear generally consistent with other available rain gauge data in Cabarrus County (CoCoRaHs, NWS, and USGS rain gauges). Total rainfall recorded onsite from Jan to Oct 2017 was 40.2 inches (Figure 8). Rainfall during Feb, Mar and Jul was below the normal 30th percentile, but other months had normal (30th to 70th percentile) or above normal rainfall.

Bankfull flow and baseflow in UT-1 is assessed using a pair of Hobo pressure loggers, one installed in a slotted pipe the creek channel and the other (ambient gauge) is attached to a nearby tree above maximum flood-stage. The data logger was moved from Dutch Buffalo Creek to a pool on the lower one-third of UT-1 in Aug 2015. For the first seven months it was set to record medium to high flow events (0.8 ft minimum depth), and in March 2016 it was reinstalled lower in the channel to record baseflow duration (0.2 ft minimum depth). During 2016, the longest continuous flow period recorded in UT-1 was 77 days (Mar 24 to Jun 09), and during 2017, the longest continuous flow period recorded was 128 days (Jan 11 to May 18). Three bankfull flow events (recorded stage > 2.1 ft above sensor) were recorded during 2016 and ten bankfull flow events were recorded in 2017 (Table 13).

2.0. Monitoring Methods

Monitoring methods 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 Monitoring Methods

Six new CVS vegetation plots (10 x 10 meters) installed in 2016 plus four 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 Monitoring Methods

All seventeen RDS groundwater monitoring gauges were downloaded quarterly throughout the year, most recently in October 2017. Consecutive days of saturation within 12 inches of the ground surface and success criteria are summarized in Table 14. Raw data for these gauges is provided in a spreadsheet in the electronic support files. A wetland re-delineation in Sep 2016 was conducted following the Eastern Mountains and Piedmont Regional Supplement to the Federal Wetlands Delineation Manual.

2.3. Stream Monitoring Methods

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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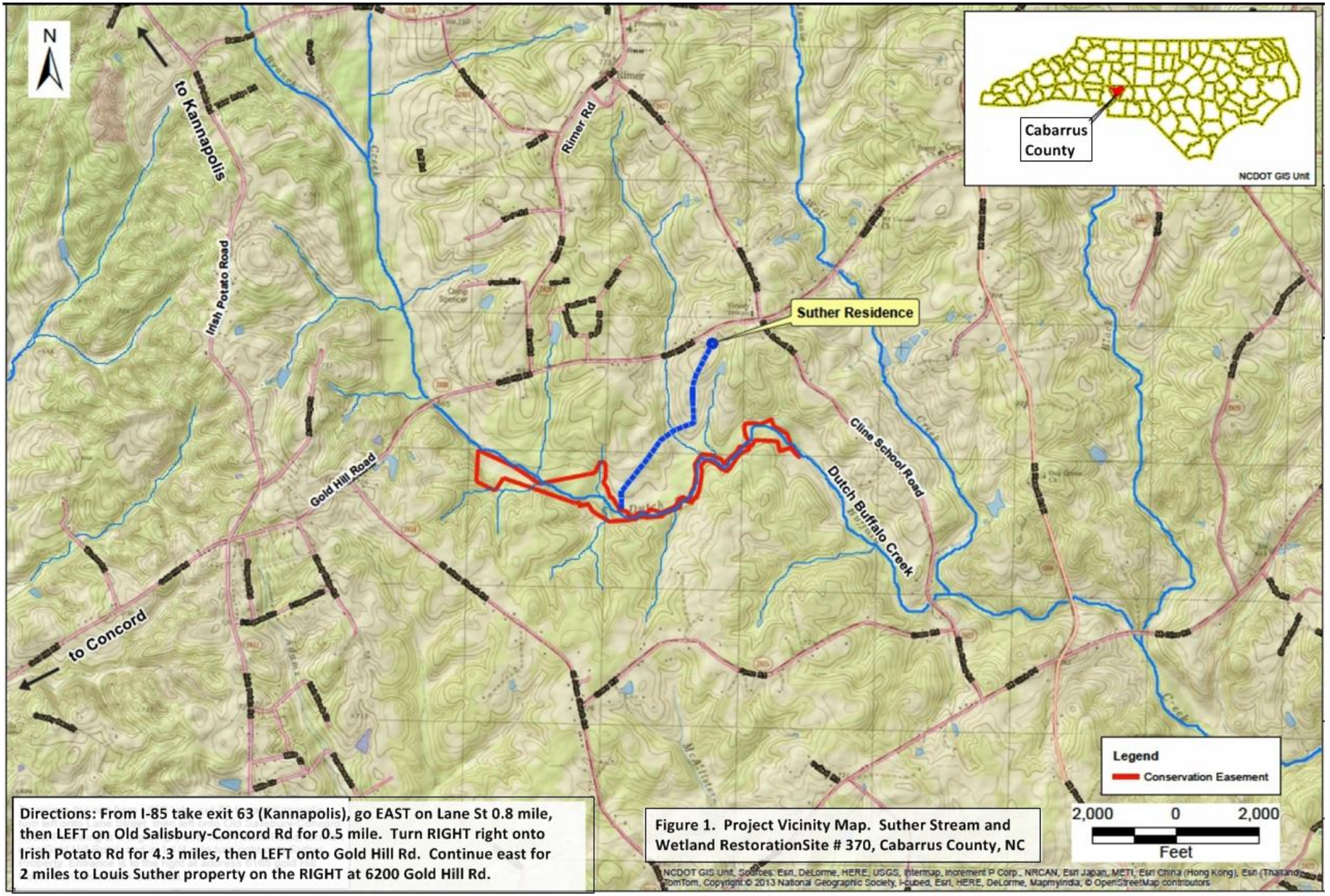

Directions: From I-85 take exit 63 (Kannapolis), go EAST on Lane St 0.8 mile, then LEFT on Old Salisbury-Concord Rd for 0.5 mile. Turn RIGHT right onto Irish Potato Rd for 4.3 miles, then LEFT onto Gold Hill Rd. Continue east for 2 miles to Louis Suther property on the RIGHT at 6200 Gold Hill Rd.

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

Appendix A. Project Background Tables

Table 1. Project Components & Mitigation Credits
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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	2763 **	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	3413 **	5:1	682.6	Livestock exclusion to easement in preservation reach from unfenced crossings
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 *	A1-A3	Preservation	1.64	1.64	5:1	0.33	Some easement fencing; 0.03 acre removed was outside the easement boundary.
Wetland Group B	10.01 *	B-1	Preservation	7.83	7.83	5:1	1.57	Fenced and livestock excluded; wetland B-4 (1.36 acre) is split off from B-1 due to hydrologic enhancement from ditch plugging.
		B-2	Enhancement	1.34	0	N/A	0	Omitted from credits due to non-attainment of hydrology criteria
		B-3	Enhancement	1.10	0	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 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

*** Wetland acreage derived from 2007 jurisdictional determination.**

**** Note - Credits revised per the 11/21/16 Mitigation Plan Addendum memo and reflect the removal of all crossings and single sided easement segments. Some of these segments were not identified and removed at the As-built report. The 2016 memo corrected this oversight.**

Stream reaches with one-sided buffer and two farm road crossings are excluded from credit.

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	**Jan 2018**
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.
*** USACE Action ID # SAW-2008-0218 issued 27 March 2008.

Appendix B. Visual Assessment Data

Figure 2.0. Current Conditions Plan View (CCPV) Key Map
Figure 2.1-2.6. Current Conditions Plan View Inset Maps

Table 5.0. Stream Morphology Visual Assessment: Dutch Buffalo Cr
Table 5.1. Stream Morphology Visual Assessment: Tributary UT-1
Table 6. Vegetation Condition Visual Assessment
e-Table: Stream & Vegetation Problem Areas

Figure 3. Photos: Stream Photo Points, Dutch Buffalo Cr and UT-1
Figure 4. Photos: CVS Vegetation Plots & Other Photos

N

Legend

- Wetland Preservation
- Wetland Enhancement
- Wetland Enhancement Dropped, No Credit
- Wetland Restoration
- Wetland Restoration Dropped, No Credit
- Conservation Easement
- Dutch Buffalo Cr Enhancement E2
- Dutch Buffalo Cr single-sided: No Credit
- Dutch Buffalo Cr Preservation
- UT-1 Dutch Buffalo Restoration

FIGURE 2.1
FIGURE 2.2
FIGURE 2.3
FIGURE 2.4
FIGURE 2.5
FIGURE 2.6

0 250 500 1,000 1,500 2,000 Feet

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NORTH CAROLINA

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FIGURE 2.0
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MY6 of 6

Legend

- Invasive Areas (small clumps, not to scale)
- Rain Gauge
- Groundwater Gauges
- Photo Points
- Stations
- Bank Erosion
- Conservation Easement
- Veg Plots
- Cross Sections
- Top of bank
- Ditch Features
- Wetland Preservation
- Wetland Enhancement
- Wetland Restoration
- Proposed Restoration Dropped
- Dutch Buffalo Cr Enhancement E2
- Dutch Buffalo Cr single-sided: No Credit
- Matchline

Sta 0+00
Sta 5+00
Sta 10+00
Sta 16+00
Matchline 1

Wetland C3
Wetland C1
Wetland C2
Rosa multiflora
GW-1
GW-2
GW-3
GW-11
GW-12
GW-13
GW-14
GW-15
GW-16
GW-17
GW-18
PP1
1
2
8
9
10
11
12
13

0 100 200 400 600 800 Feet

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FIGURE 2.1
NOV 2017
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Legend

- Bank Pins
- Groundwater Gauges
- Old Groundwater Gauges
- Photo Points
- Stations
- Bank Erosion
- Conservation Easement
- Cross Sections
- Top of bank
- Ditch Features
- Wetland Preservation
- Wetland Enhancement
- Wetland Enhancement Dropped, No Credit
- Wetland Restoration
- Dutch Buffalo Cr Enhancement E2
- Dutch Buffalo Cr single-sided: No Credit
- Matchline

N

GW-8
GW-4
GW-7
Wetland B4
Wetland B1
GW-5
GW-6
DBC XS-5
Wetland B3
Old GW-5
Old GW-4
DBC XS-4
Matchline 2
PP13
BP 12
BP 11
BP 10
PP12
Sta 32+00
DBC XS-2
PP6
PP7
PP5
PP4
Sta 20+00
BP 1
PP8
BP 2
PP9
DBC XS-3
Sta 25+00
BP 3
PP10
BP 4
PP11
BP 9
BP 8
BP 6
BP 7
Sta 30+00
Sta 16+00
GW-18
GW-3
Matchline 1
Wetland C3
PP3
PP1

0 100 200 400 600 800 Feet

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FIGURE 2.2
NOV 2017
MY6 of 6

Legend

- Bank Pins
- Groundwater Gauges
- Old Groundwater Gauges
- Hobo Gauges
- Photo Points
- Stations
- Bank Erosion
- Conservation Easement
- Cross Sections
- Top of bank
- Ditch Features
- Wetland Preservation
- Wetland Enhancement
- Wetland Enhancement Dropped, No Credit
- Dutch Buffalo Cr Enhancement E2
- UT-1 Dutch Buffalo Restoration
- Matchline

PP20
DBC XS-7
Matchline 3
sta 41+00
PP18
DBC XS-6
PP31
PP30
UT-1 XS-4
PP29
UT-1 XS-1
PP17
6
PP24
PP28
PP25
PP27
PP26
7
sta 37+00
PP15
Old GW-10
Wetland B2
GW-9
PP14
DBC XS-5
Wetland B4
GW-6
sta 32+00
GW-8
GW-7
PP13
GW-5
BP 11
BP 12
BP 10
Wetland B1
Matchline 2
GW-4
PP12
DBC XS-4
Wetland B3
Old GW-5

0 50 100 200 300 400 Feet

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FIGURE 2.3
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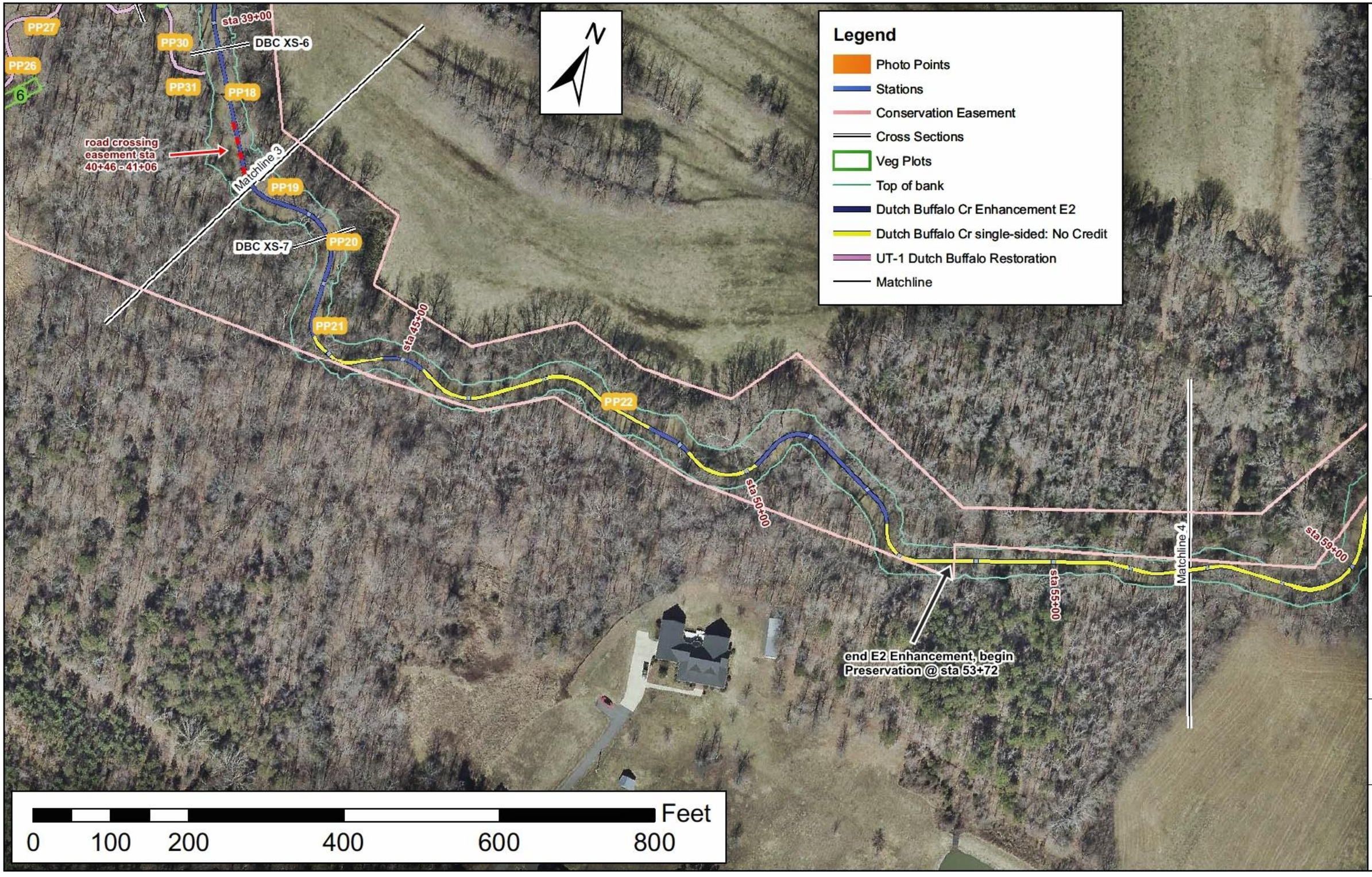

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FIGURE 2.4
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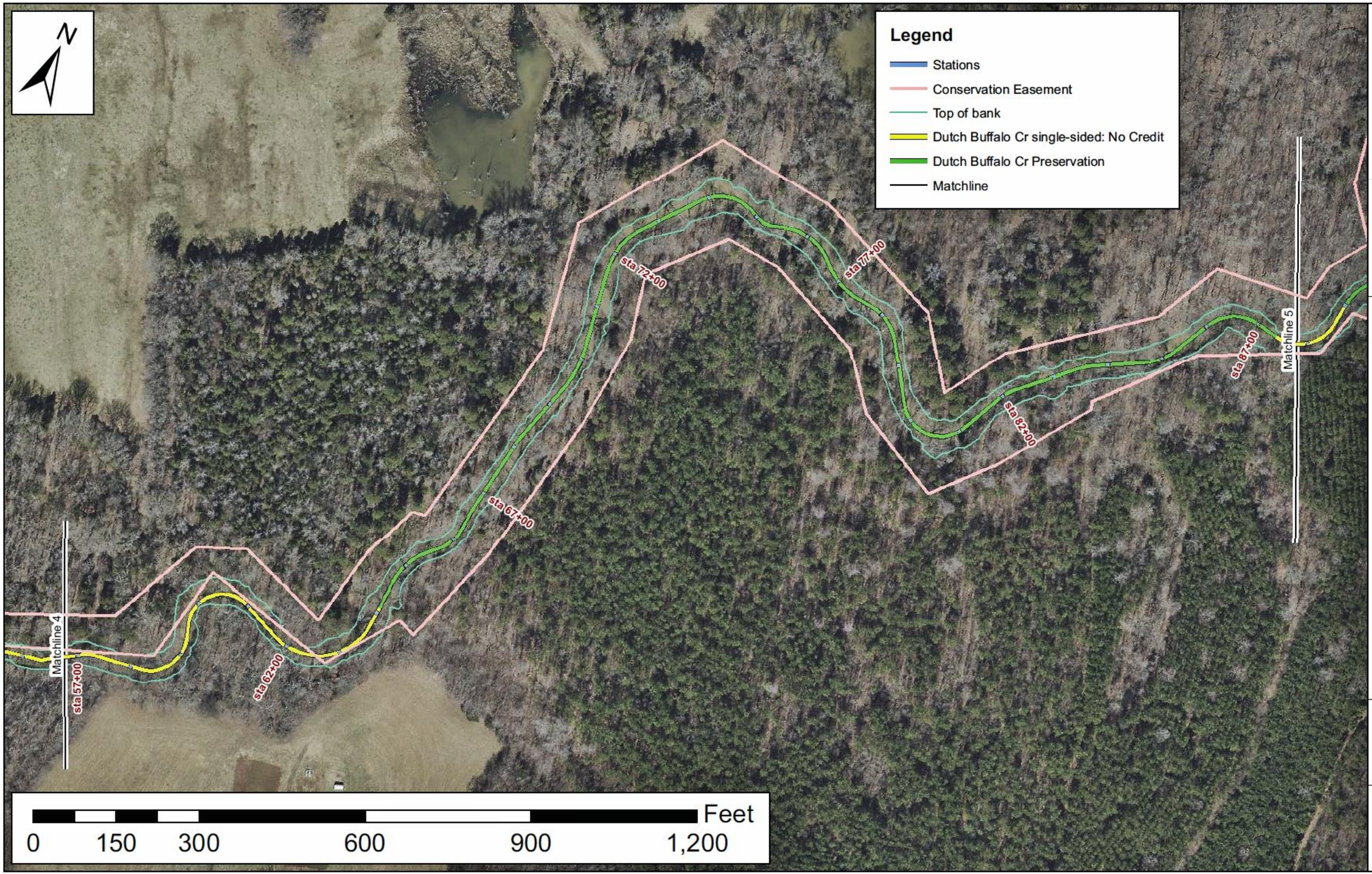

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FIGURE 2.5
NOV 2017
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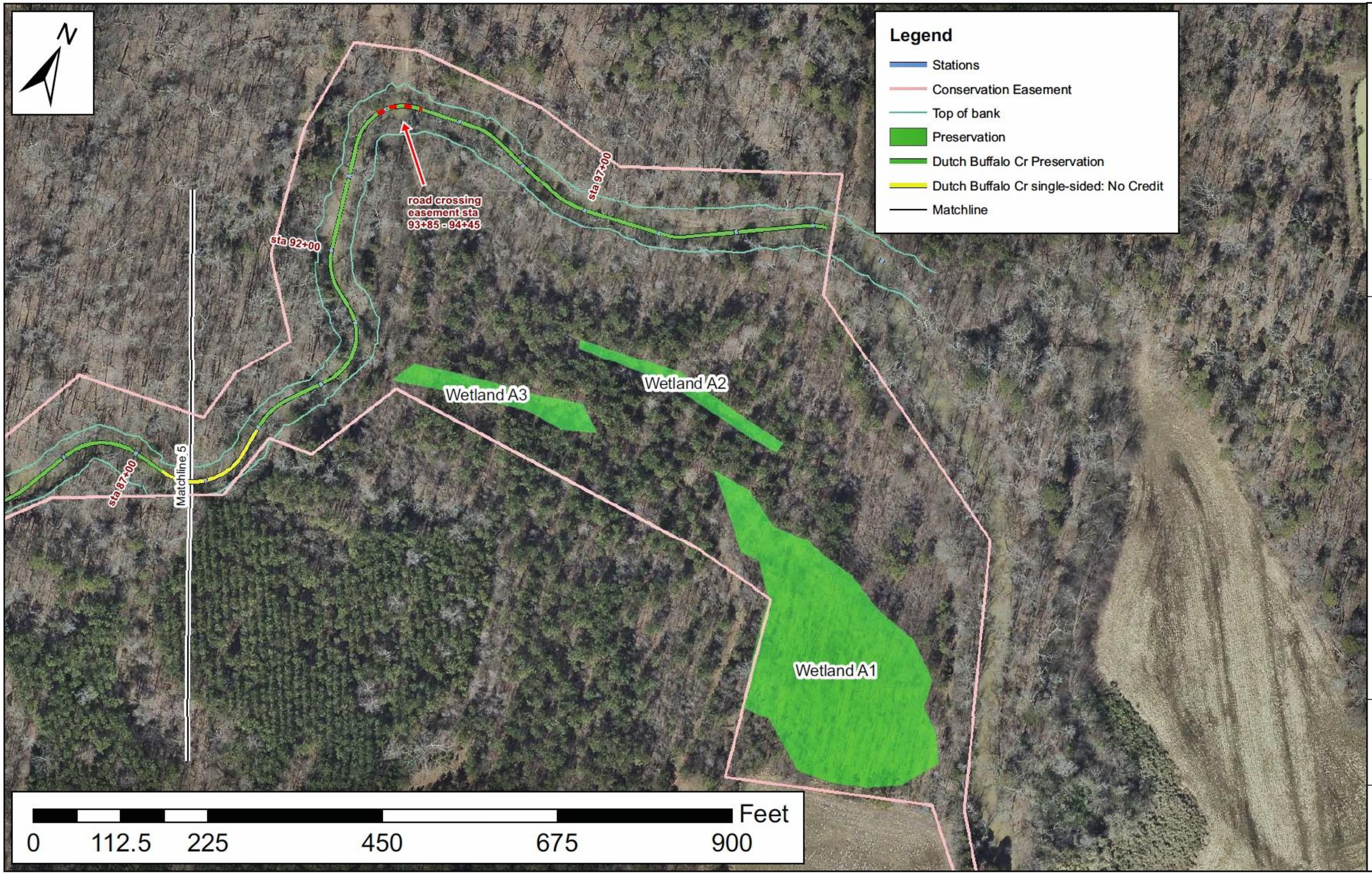

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Environmental Quality

FIGURE 2.6
NOV 2017
MY6 of 6

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			0	0	100%	0	0	N/A*
	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			5	630	89%	4	510	98%
	3. Mass Wasting	Bank slumping, calving, or collapse			1	20	100%	0	0	98%
				Totals	6	650	88%	4	510	97%
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			0	0	100%	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	0	0	100%	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	8	8			100%			
	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 6 of 6 (2017)

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	4	0.23	0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	N/A	0	0	0%

Data based on multiple field visits between March and October 2017.

** Competition from tall grasses, herbs, and Rubus may be limiting planted tree survival and growth in Area C1/C3, but all areas currently have 260 stems/acre or more average density.

*** Mapped occurrences of Rosa multiflora and Ligustrum sinense in Area C1/C3 (former field) are small and do not appear to threaten forest recovery. Other scattered occurrences of invasives beneath mature forest canopy along Dutch Buffalo Cr and UT-1 are not of concern and were not mapped.

Problem Areas Inventory Table -- Suther Site (Dutch Buffalo Cr) Project # 370
Monitoring Year 6 of 6 (OCT 2017)

Stream: Dutch Buffalo Creek Enhancement Reach (Station 17+61 to 53+72 = 3,611 lin.ft; Creditable = 2,763 ft)			
Feature Issue	**Station & Bank**	**Length (ft)**	**Suspected Cause**
Bank Erosion	21+80 - 23+70 RB	190	Incision, high vertical banks
Bank Erosion	24+10 - 25+80 LB	170	Incision, high vertical banks
Bank Erosion	25+40 - 26+40 RB	100	Incision, high vertical banks
Bank Erosion	27+50 - 28+70 LB	120	Incision, high vertical banks, clearcut close to bank
Bank Erosion	30+70 - 31+40 LB	70	Incision, high vertical banks
	Total bank length	650	

Stream: UT Dutch Buffalo Creek Restoration Reach (Station 00+00 to 06+08 = 608 lin.ft)			
Feature Issue	**Station & Bank**	**Length (ft)**	**Suspected Cause**
None			Segments previously described as eroding or piping (fabric wash-outs) have stabilized and are not threatening channel stability.

Vegetation: Along Dutch Buffalo Creek Main Stem and Adjacent Wetlands			
Feature Issue	**Station & Bank**	**Area (ac)**	**Suspected Cause**
None			Areas previously noted as "low woody density" now have at least 260 woody stems per ac (planted + volunteers)

Vegetation: Along Restored UT to Dutch Buffalo Creek			
Feature Issue	**Station & Bank**	**Area (ac)**	**Suspected Cause**
None			Areas previously noted as "low woody density" now have at least 260 woody stems per ac (planted + volunteers)

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 01, facing north west: 2010

Photo Point 01, facing west: Oct 2017

Photo Point 02, Upstream: 2010

Photo Point 02, Upstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 03, Upstream: 2010

Photo Point 03, Upstream: Oct 2017

Photo Point 03 DBC, Upstream: 2010

Photo Point 03 DBC, Upstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 04, Downstream: 2010

Photo Point 04, Downstream: Oct 2017

Photo Point 05, Upstream: 2010

Photo Point 05, Upstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 06, Upstream: 2010

Photo Point 06, Upstream: Oct 2017

Photo Point 07, Downstream: 2010

Photo Point 07, Upstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 08, Upstream: 2010

Photo Point 08, Upstream: Oct 2016

Photo Point 09, Upstream: 2010

Photo Point 09, Upstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 10, Downstream: 2010

Photo Point 010, Downstream: Oct 2017

Photo Point 11, Upstream: 2010

Photo Point 11, Upstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 12, Upstream: 2010

Photo Point 12, Usptream: Oct 2017

Photo Point 13, Upstream: 2010

Photo Point 13, Upstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 14, Downstream: 2010

Photo Point 14, Downstream: Oct 2017

Photo Point 15, Upstream: 2010

Photo Point 15, Upstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 17, Upstream: 2010

Photo Point 17, Upstream: Oct 2017

Photo Point 18, Upstream: 2010

Photo Point 18, Upstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 19, Downstream: 2010

Photo Point 19, Downstream: Oct 2017

Photo Point 20, Downstream: 2010

Photo Point 20, Downstream: Oct 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 21, Downstream: 2010

Photo Point 21, Downstream : Oct 2017

Photo Point 22, Upstream: 2010

Photo Point 22, Upstream: 2015

MY6 Assessment Photos - 2017 - 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

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 26, Upstream: 2010

Photo Point 26, Upstream: April 2017

Photo Point 27, Downstream: 2010

Photo Point 27, Downstream: April 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 28, Upstream: 2010

Photo Point 28, Usptream: April 2017

Photo Point 29, Upstream: 2010

Photo Point 29, Upstream (Hobo Gauge): April 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

Photo Point 30, Upstream: 2010

Photo Point 30, Upstream: April 2017

Photo Point 31, Upstream: 2010

Photo Point 31, Upstream: April 2017

MY6 Assessment Photos - 2017 - Suther Stream Mitigation Site # 370

UT1 (Upstream) at Confluence with DBC: Oct 2017

UT1 (Downstream) at Confluence with DBC: Oct 2017

Vegetation Plots: Suther Site # 370, Cabarrus County 2017

CVS VegPlot-1: MY-0 2009

CVS VegPlot-1: MY-6 2017

CVS VegPlot-2: MY-0 2009

CVS VegPlot-2: MY-6 2017

Vegetation Plots: Suther Site # 370, Cabarrus County 2017

CVS VegPlot-6: MY-0 2009

CVS VegPlot-6: MY-6 2017

CVS VegPlot-7: MY-0 2009

CVS VegPlot-7: MY-6 2017

Vegetation Plots: Suther Site # 370, Cabarrus County 2017

CVS VegPlot-8: MY-5 2016

CVS VegPlot-8: MY-6 2017

CVS VegPlot-9: MY-5 2016

CVS VegPlot-9: MY-6 2017

Vegetation Plots: Suther Site # 370, Cabarrus County 2017

CVS VegPlot-10: MY-5 2016

CVS VegPlot-10: MY-6 2017

CVS VegPlot-11: MY-5 2016

CVS VegPlot-11: MY-6 2017

Vegetation Plots: Suther Site # 370, Cabarrus County 2017

CVS VegPlot-12: MY-5 2016

CVS VegPlot-12: MY-6 2017

CVS VegPlot-13: MY-5 2016

CVS VegPlot-13: MY-6 2017

Appendix C: Vegetation Plot Data

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

[CVS Data Entry Tool and Scanned Field Data Sheets are provided on CD]

Table 7. CVS Plot Stem Density and Success Summary
Suther Site (#370) Cabarrus County, MY-6 (Sept 2017)

CVS Plot #	Stream + Wetland Planted + Volunteer Native Stems		Invasive Woody Stems	Success Criteria Met?
	per plot	per acre		
1	39	1578	0	Yes
2	160	6474	0	Yes
6	22	890	0	Yes
7	47	1902	0	Yes
8	37	1497	0	Yes
9	76	3075	0	Yes
10	30	1214	0	Yes
11	28	1133	0	Yes
12	57	2306	0	Yes
13	31	1254	0	Yes
Project Avg	53	2132	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 (MY6 2017)																	
			370-01-0001			370-01-0002			370-01-0006			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	PnoLS	P-all	T
Acer negundo	boxelder	Tree			2			16			1			2			1			30
Acer rubrum	red maple	Tree			9			30									8			4
Alnus serrulata	hazel alder	Shrub			1			5						1						
Asimina triloba	paw paw	Tree						1			7			1						
Betula nigra	river birch	Tree			2			30						32			1			1
Carpinus caroliniana	American hornbeam	Tree			3						2			4						
Cornus amomum	silky dogwood	Shrub			1			1												2
Diospyros virginiana	common persimmon	Tree									1						9			
Fraxinus pennsylvanica	green ash	Tree			16						2			3			9			30
Juniperus virginiana	eastern redcedar	Tree						1												
Lindera benzoin	northern spicebush	Shrub												1						
Liquidambar styraciflua	sweetgum	Tree			1			30			1						2			7
Liriodendron tulipifera	tuliptree	Tree						2												
Nyssa sylvatica	black tupelo	Tree												2						
Platanus occidentalis	American sycamore	Tree						30			7						1			
Quercus michauxii	swamp chestnut oak	Tree			1									1						
Quercus phellos	willow oak	Tree						1												
Robinia psuedoaccacia	black locust	Tree																		
Salix nigra	black willow	Tree			1															
Ulmus alata	winged elm	Tree						3									1			1
Ulmus americana	American elm	Tree			1			10			1						5			1
Viburnum dentatum	southern arrowwood	Shrub			1															
	Stem count		0	0	39	0	0	160	0	0	22	0	0	47	0	0	37	0	0	76
	size (ares)		1			1			1			1			1			1		
tan = species planted Dec 2009 or Mar 2016	**acres**		0.0247			0.0247			0.0247			0.0247			0.0247			0.0247		
	Species count		0	0	12	0	0	13	0	0	8	0	0	9	0	0	9	0	0	8
	Stems per ACRE		0	0	1578	0	0	6475	0	0	890	0	0	1902	0	0	1497	0	0	3076

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

			Current Plot Data (MY6 2017)													Annual Means					
		Species	370-01-0010			370-01-0011			370-01-0012			370-01-0013			Tot	MY5 (2016)			MY6 (2017)		
Scientific Name	Common Name	Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T		PnoLS	P-all	T	PnoLS	P-all	T
Acer negundo	boxelder	Tree			20						7			11	90			4.7			9.0
Acer rubrum	red maple	Tree			2						6			1	60			4.6			6.0
Alnus serrulata	hazel alder	Shrub												3	10			1.6			1.0
Asimina triloba	paw paw	Tree													9						0.9
Betula nigra	river birch	Tree													66			11.0			6.6
Carpinus caroliniana	American hornbeam	Tree													9			0.6			0.9
Cornus amomum	silky dogwood	Shrub						1							5			1.4			0.5
Diospyros virginiana	common persimmon	Tree													10			0.4			1.0
Fraxinus pennsylvanica	green ash	Tree			2			11			30			6	109			11.9			10.9
Juniperus virginiana	eastern redcedar	Tree													1			0.1			0.1
Lindera benzoin	northern spicebush	Shrub													1			0.2			0.1
Liquidambar styraciflua	sweetgum	Tree						4			4				49			4.4			4.9
Liriodendron tulipifera	tuliptree	Tree			1										3			0.4			0.3
Nyssa sylvatica	black tupelo	Tree													2						0.2
Platanus occidentalis	American sycamore	Tree			3			5							46			5.3			4.6
Quercus michauxii	swamp chestnut oak	Tree						1							3			0.2			0.3
Quercus phellos	willow oak	Tree													1			0.2			0.1
Robinia psuedoaccacia	black locust	Tree												1	1						0.1
Salix nigra	black willow	Tree													1			0.1			0.1
Ulmus alata	winged elm	Tree									2			9	16			1.9			1.6
Ulmus americana	American elm	Tree						6			7				31			3.3			3.1
Viburnum dentatum	southern arrowwood	Shrub			2						1				4			0.2			0.4
	Stem count		0	0	30	0	0	28	0	0	57	0	0	31	527	0	0	52.7	0	0	52.7
	size (ares)		1			1			1			1			9	9			10			
tan = species planted Dec 2009 or Mar 2016	**acres**		0.0247			0.0247			0.0247			0.0247				0.2224			0.2471		
	Species count		0	0	6	0	0	6	0	0	7	0	0	6	19	0	0	19	0	0	22
	Stems per ACRE		0	0	1214	0	0	1133	0	0	2307	0	0	1255		0	0	2131	0	0	2133

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 Geomorphology Data

Figure 5.0 - 5.7. Stream Cross-Section Survey Plots
Figure 6. Stream Longitudinal Profile Survey Plot
Figure 7.0 - 7.3. Substrate Pebble Count Plots

Table 9.1 -9.2 Baseline Stream Morphology Data Summary
Table 10. Stream Cross-Section Morphology Data Summary
Table 11.1 -11.2. Stream Longitudinal Morphology Data Summary
Table 12. Bank Erosion Pin Data Summary

[Raw Geomorph Survey Data & Pebble Count Data provided on CD]

Appendix D. Stream Survey Data
Figure 5.0. Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
UT-1 Tributary to Dutch Buffalo Creek
Monitoring Year 6 of 6

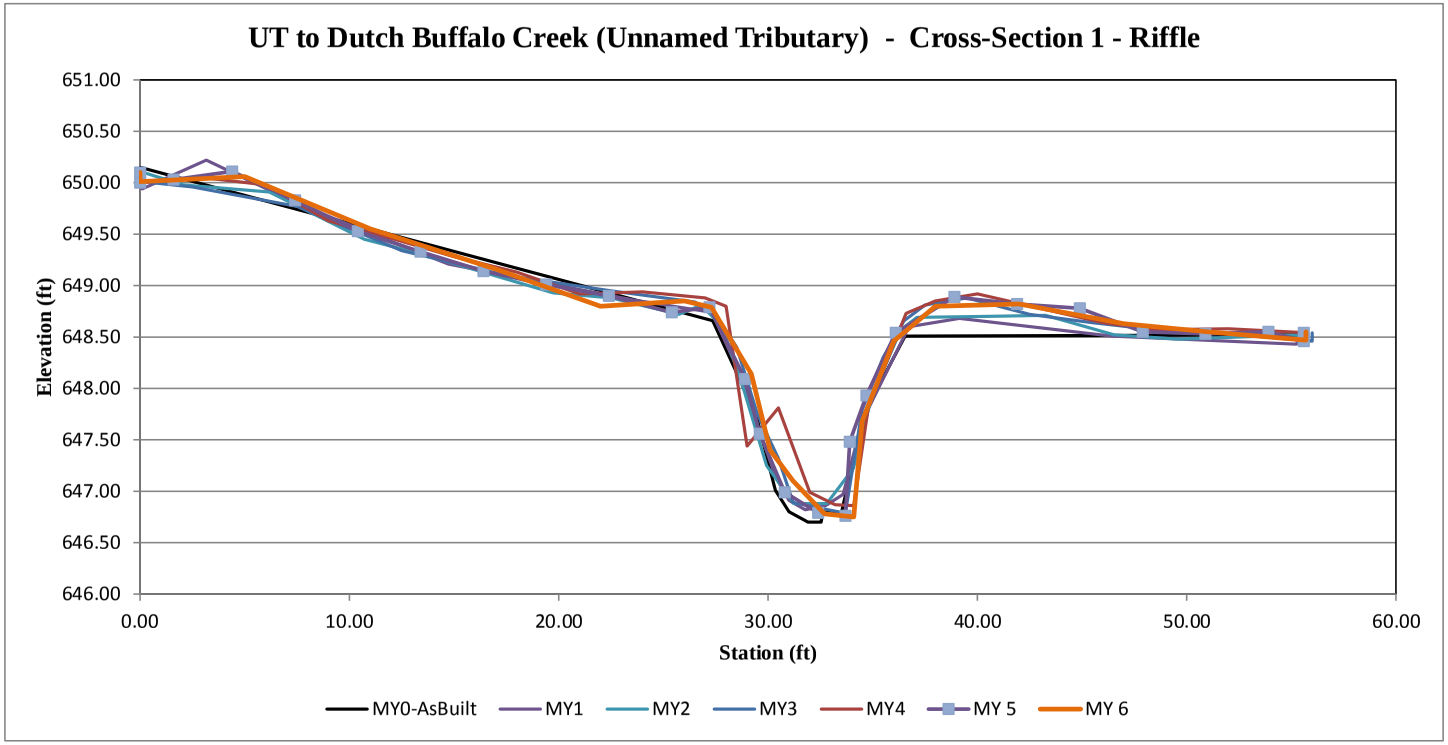
Project Name	DBC (Suther)	
DMS Project Number	370	
Cross-Section ID	UT-1, XS-1, Riffle	
Survey Date	10/2017	
SUMMARY DATA		
Bankfull Elevation (ft)		648.46
Bankfull Cross-Sectional Area (ft^2)		7.80
Bankfull Width (ft)		8.70
Flood Prone Area Elevation (ft)		650.14
Flood Prone Width (ft)		56.00
Bankfull Mean Depth (ft)		0.90
Bankfull Max Depth (ft)		1.68
W/D Ratio		9.70
Entrenchment Ratio		6.44
Bank Height Ratio		1.00

Trib XS-1: Upstream

Trib XS-1: Downstream

Station	Elevation	Notes
0.0	650.1	TLP
0.0	650.01	BLP
5.0	650.06	
11.0	649.55	
17.0	649.16	
22.0	648.8	
26.0	648.85	
27.3	648.79	TLB
29.2	648.14	
30.1	647.4	
31.2	647.1	BLB
32.7	646.78	THW
34.1	646.75	BRB
34.5	647.68	
36.0	648.46	TRB
38.0	648.8	
42.0	648.82	
47.0	648.63	
51.0	648.55	
55.7	648.47	BRP
55.7	648.55	TRP

10.7



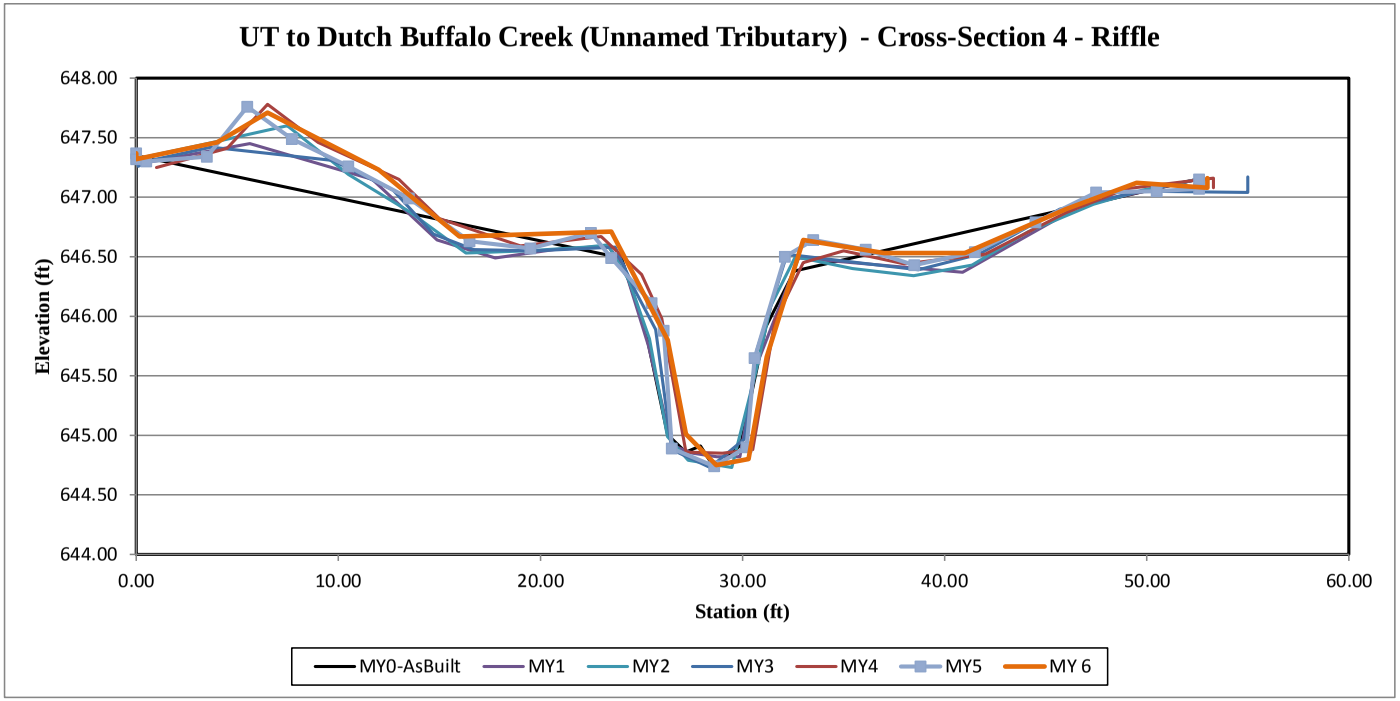
Appendix D. Stream Survey Data
Figure 5.1. Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
UT-1 Tributary to Dutch Buffalo Creek
Monitoring Year 6 of 6

Project Name	DBC (Suther)	
DMS Project Number	370	
Cross-Section ID	UT-1, XS-4, Riffle	
Survey Date	10/2017	
SUMMARY DATA		
Bankfull Elevation (ft)		646.64
Bankfull Cross-Sectional Area (ft^2)		10.70
Bankfull Width (ft)		9.50
Flood Prone Area Elevation (ft)		648.53
Flood Prone Width (ft)		55.00
Bankfull Mean Depth (ft)		1.13
Bankfull Max Depth (ft)		1.89
W/D Ratio		8.43
Entrenchment Ratio		5.79
Bank Height Ratio		1.00

Trib XS-4: Upstream

Trib XS-4: Downstream

Station	Elevation	Notes
0	647.37	TLP
0	647.32	BLP
4.0	647.46	
6.5	647.71	
12.0	647.23	
16.0	646.67	
23.5	646.71	TLB
26.3	645.8	
27.2	645.01	BLB
28.7	644.75	THW
30.3	644.8	BRB
31.2	645.66	
33.0	646.64	TRB
37.0	646.53	
41.0	646.53	
46.0	646.9	
49.5	647.12	
53.0	647.08	BRP
53.0	647.16	TRP



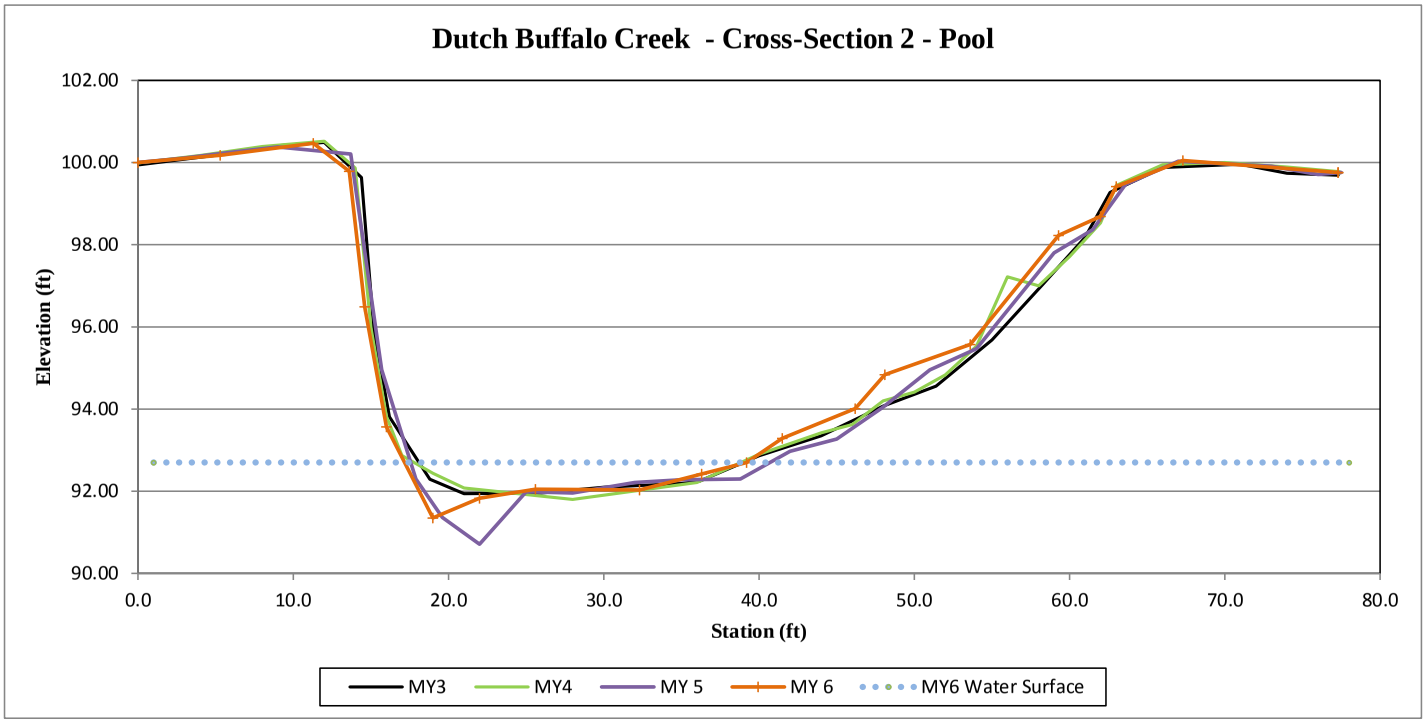
Appendix D. Stream Survey Data
Figure 5.2. Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 6 of 6

XS-2: Upstream

XS-2: Downstream

Project Name	DBC (Suther)
DMS Project Number	370
Cross-Section ID	DBCr, XS-2, Pool
Survey Date	10/2017
SUMMARY DATA	
Bankfull Elevation (ft)	99.42
Bankfull Cross-Sectional Area (ft^2)	268.80
Bankfull Width (ft)	49.40
Flood Prone Area Elevation (ft)	107.01
Flood Prone Width (ft)	77.00
Bankfull Mean Depth (ft)	5.44
Bankfull Max Depth (ft)	7.59
W/D Ratio	9.08
Entrenchment Ratio	1.56
Bank Height Ratio	1.00

Station	Elevation	Notes
0.0	100.00	LPIN
5.3	100.18	
11.3	100.47	
13.6	99.79	TLB
14.6	96.49	
16.0	93.57	
19.0	91.35	BLB
22.0	91.83	THW
25.6	92.05	
32.3	92.03	
36.3	92.42	
39.2	92.70	BRB/REW
41.5	93.29	
46.2	94.01	
48.1	94.84	
53.6	95.57	
59.3	98.23	
62.0	98.69	
63.0	99.42	TRB
67.3	100.05	
77.3	99.76	
77.3	99.76	RPIN



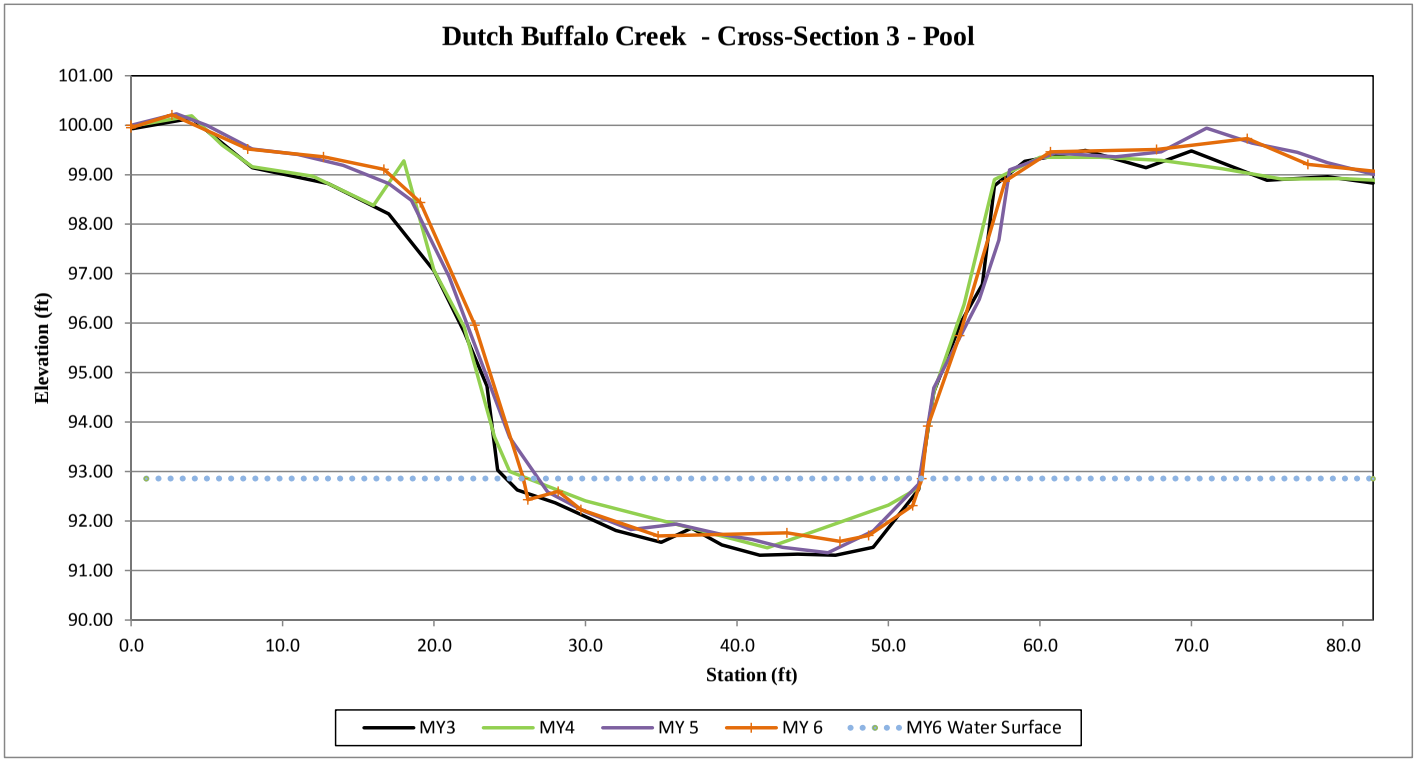
Appendix D. Stream Survey Data
Figure 5.3. Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 6 of 6

Project Name	DBC (Suther)
DMS Project Number	370
Cross-Section ID	DBCr, XS-3, Pool
Survey Date	10/2017
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

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	
68.0	99.46	
71.0	99.94	
74.0	99.64	
77.0	99.45	
79.0	99.24	
82.4	98.98	BRP
82.2	98.93	TRP

XS-3: Upstream

XS-3: Downstream



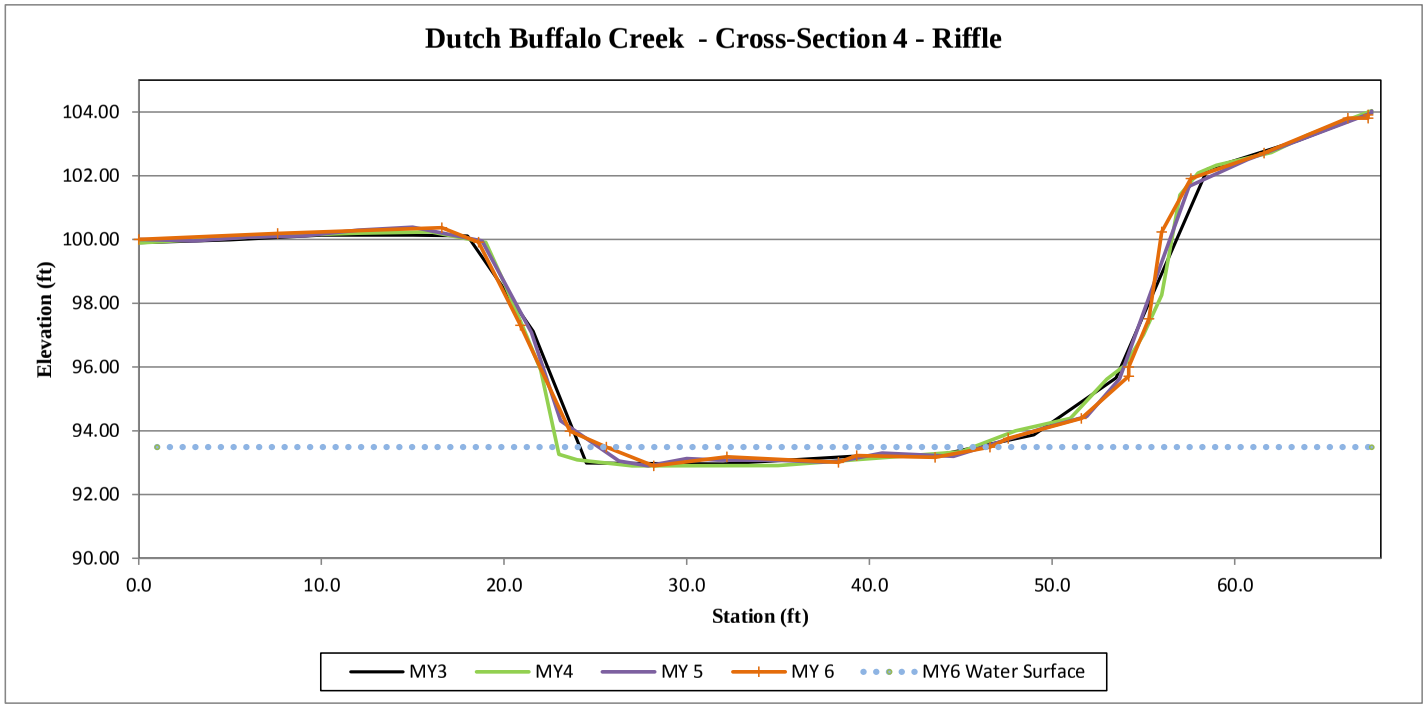
Appendix D. Stream Survey Data
Figure 5.4. Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 6 of 6

Project Name	**DBC (Suther)**
DMS Project Number	**370**
Cross-Section ID	**DBCr, XS-4, Riffle**
Survey Date	**10/2017**
SUMMARY DATA	
Bankfull Elevation (ft)	99.92
Bankfull Cross-Sectional Area (ft^2)	215.60
Bankfull Width (ft)	39.00
Flood Prone Area Elevation (ft)	106.94
Flood Prone Width (ft)	68.00
Bankfull Mean Depth (ft)	5.53
Bankfull Max Depth (ft)	7.02
W/D Ratio	7.05
Entrenchment Ratio	1.74
Bank Height Ratio	1.00

XS-4: Upstream

XS-4: Downstream

Station	Elevation	Notes
0.0	100.00	LPIN
7.6	100.19	
16.6	100.37	
18.6	99.92	TLB
20.9	97.31	
23.6	93.99	
25.6	93.49	LEW
28.2	92.90	THW
32.2	93.18	
38.3	93.01	
39.3	93.22	
43.6	93.17	
46.6	93.49	REW
47.6	93.76	
51.6	94.39	BRB
54.2	95.71	
54.2	96.00	
55.3	97.51	
56.0	100.24	
57.6	101.91	TRB
61.6	102.71	
66.2	103.81	
67.3	103.81	BRP
67.3	103.91	TRP



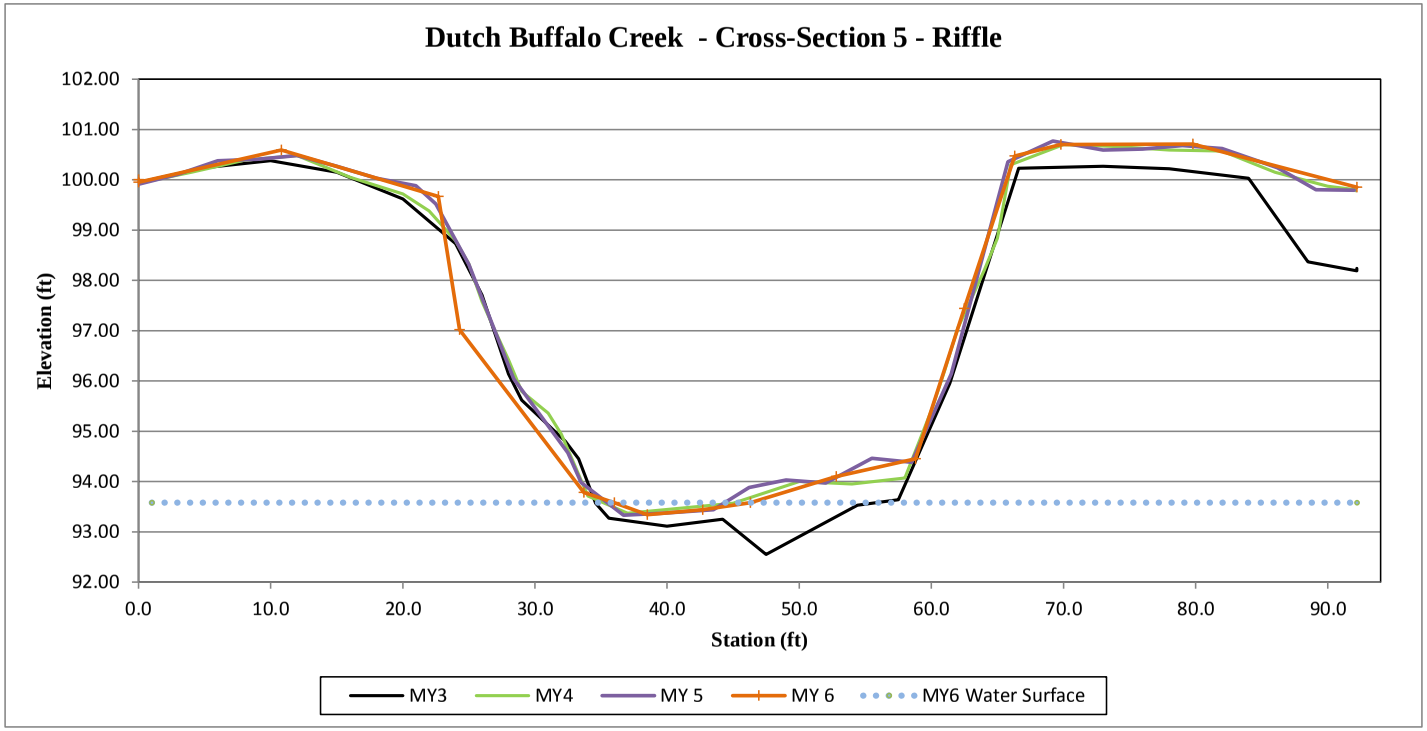
Appendix D. Stream Survey Data
Figure 5.5. Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 6 of 6

Project Name	DBC (Suther)
DMS Project Number	370
Cross-Section ID	DBCr, XS-5, Riffle
Survey Date	10/2017
SUMMARY DATA	
Bankfull Elevation (ft)	99.67
Bankfull Cross-Sectional Area (ft^2)	207.30
Bankfull Width (ft)	43.60
Flood Prone Area Elevation (ft)	106.00
Flood Prone Width (ft)	92.00
Bankfull Mean Depth (ft)	4.75
Bankfull Max Depth (ft)	6.33
W/D Ratio	9.17
Entrenchment Ratio	2.11
Bank Height Ratio	1.00

XS-5: Upstream

XS-5: Downstream

Station	Elevation	Notes
0.0	100	TLP
0.0	99.95	BLP
10.8	100.59	
22.7	99.67	TLB
24.3	97.02	
33.7	93.78	BLB
36.0	93.58	LEW
38.5	93.34	THW
42.7	93.44	
46.3	93.58	REW
52.8	94.1	
58.8	94.45	BRB
62.5	97.44	
66.3	100.47	TRB
69.8	100.7	
79.8	100.71	
92.2	99.85	RPIN



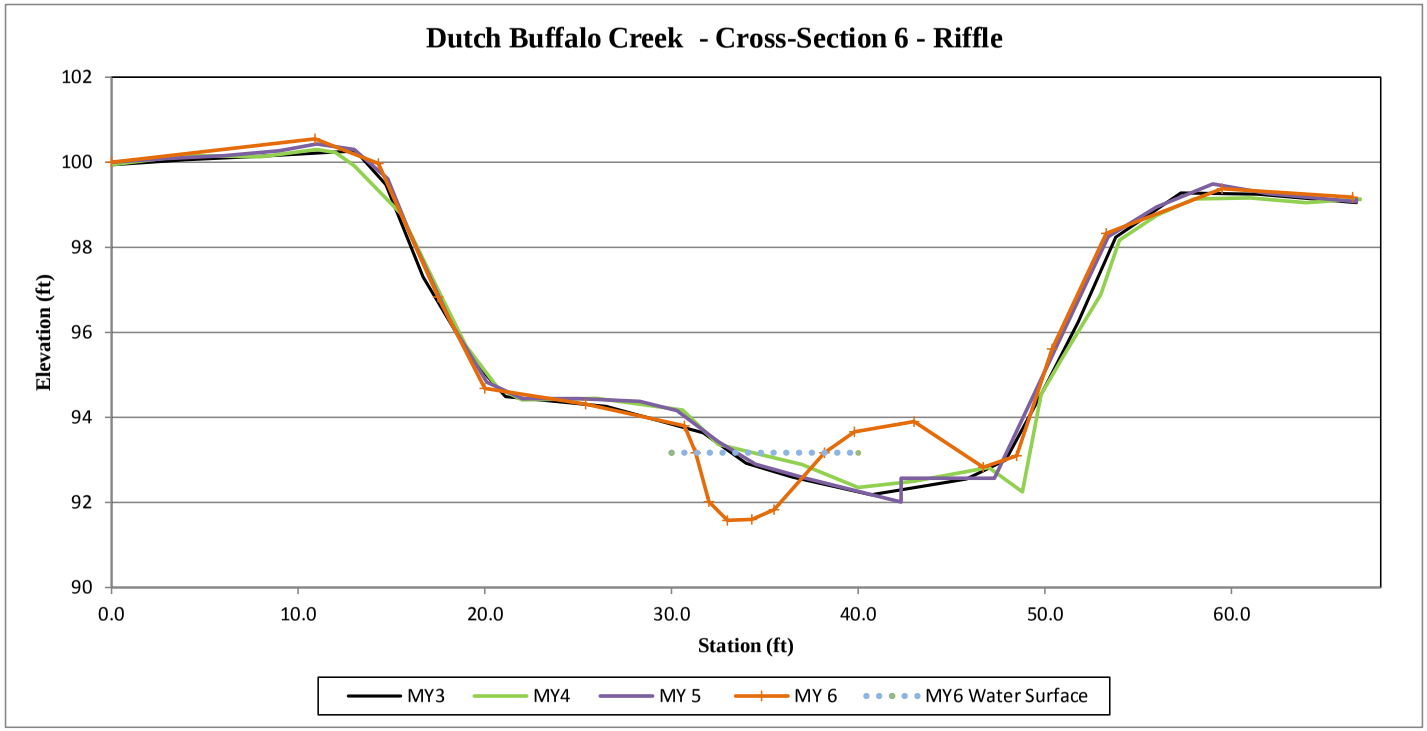
Appendix D. Stream Survey Data
Figure 5.6. Cross-Section Plots and Raw Data Tables
Dutch Buffalo Creek (Suther) Stream and Wetland Restoration/DMS Project No. 370
Dutch Buffalo Creek Cross Sectional Profile
Monitoring Year 6 of 6

Project Name	**DBC (Suther)**
DMS Project Number	**370**
Cross-Section ID	**DBCr, XS-6, Riffle**
Survey Date	**10/2017**
SUMMARY DATA	
Bankfull Elevation (ft)	98.33
Bankfull Cross-Sectional Area (ft^2)	158.80
Bankfull Width (ft)	39.00
Flood Prone Area Elevation (ft)	105.08
Flood Prone Width (ft)	67.00
Bankfull Mean Depth (ft)	4.07
Bankfull Max Depth (ft)	6.75
W/D Ratio	9.58
Entrenchment Ratio	1.72
Bank Height Ratio	1.00

XS-6: Upstream

XS-6: Downstream

Station	Elevation	Notes
0.0	100.00	LPIN
10.9	100.55	
14.3	99.97	TLB
17.5	96.83	
20.0	94.68	BLB
25.4	94.31	
30.7	93.80	
31.3	93.17	LEW
32.0	92.02	
33.0	91.58	THW
34.3	91.60	
35.5	91.83	
38.2	93.17	REW
39.8	93.66	
43.0	93.90	
46.7	92.83	
48.5	93.10	BRB
50.4	95.61	
53.3	98.33	TRB
59.5	99.38	
66.5	99.18	RPIN



Appendix D. Stream Survey Data
Figure 5.7. 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 6 of 6

Project Name	**DBC (Suther)**
DMS Project Number	**370**
Cross-Section ID	**DBCr, XS-7, Pool**
Survey Date	**10/2017**
SUMMARY DATA	
Bankfull Elevation (ft)	99.42
Bankfull Cross-Sectional Area (ft^2)	209.00
Bankfull Width (ft)	34.90
Flood Prone Area Elevation (ft)	108.06
Flood Prone Width (ft)	83.00
Bankfull Mean Depth (ft)	5.99
Bankfull Max Depth (ft)	8.64
W/D Ratio	5.83
Entrenchment Ratio	2.38
Bank Height Ratio	1.00

XS-7: Upstream

XS-7: Downstream

Station	Elevation	Notes
0.0	100.00	LPIN
8.1	99.93	
15.2	99.91	TLB
16.3	92.51	BLB
18.6	91.63	
23.1	90.78	THW
28.1	90.83	
31.1	91.78	
32.6	92.72	
34.0	93.12	REW
36.1	93.81	
39.1	94.59	
41.7	95.47	
43.6	96.54	
48.1	98.54	
50.1	99.42	TRB
54.1	99.84	
60.1	99.73	
64.1	99.33	
70.1	99.18	
76.1	98.97	
79.1	99.19	
83.1	99.63	BRP
83.1	99.62	TRP

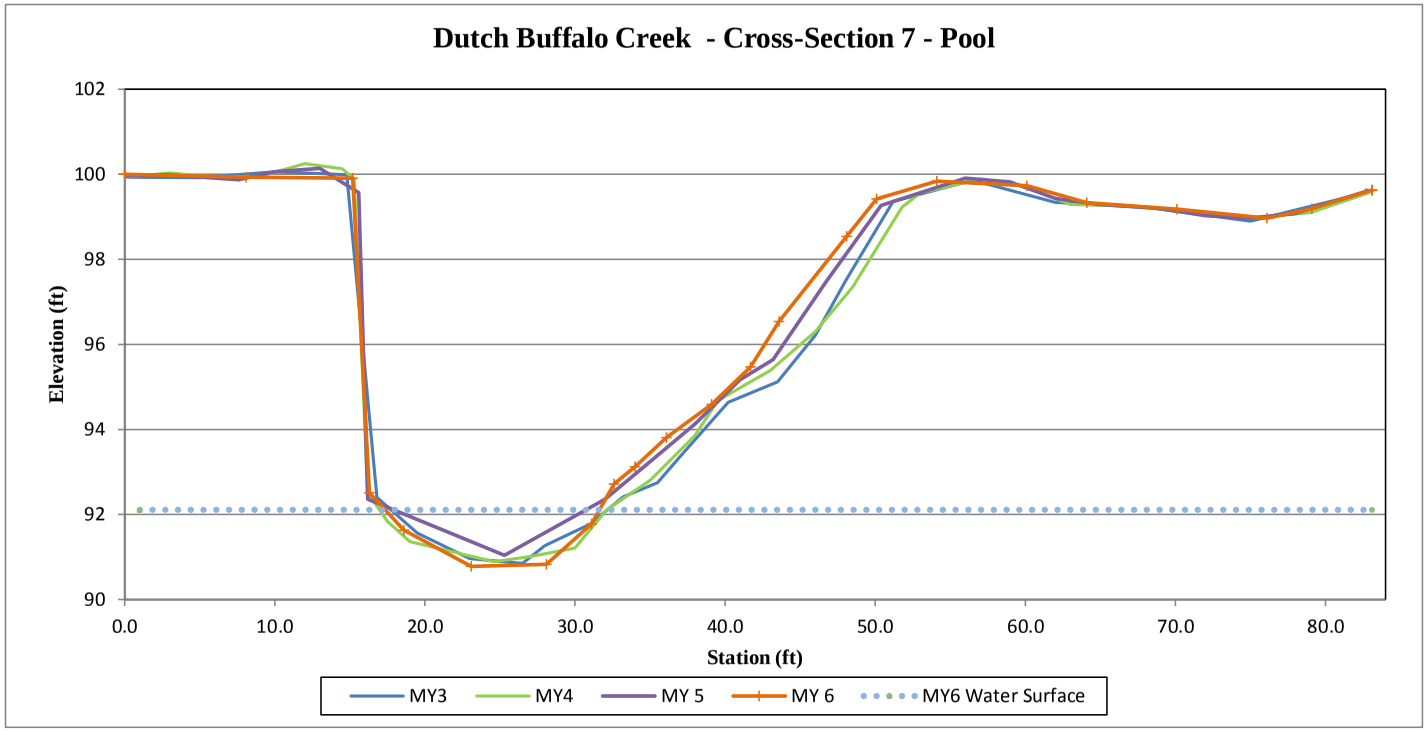
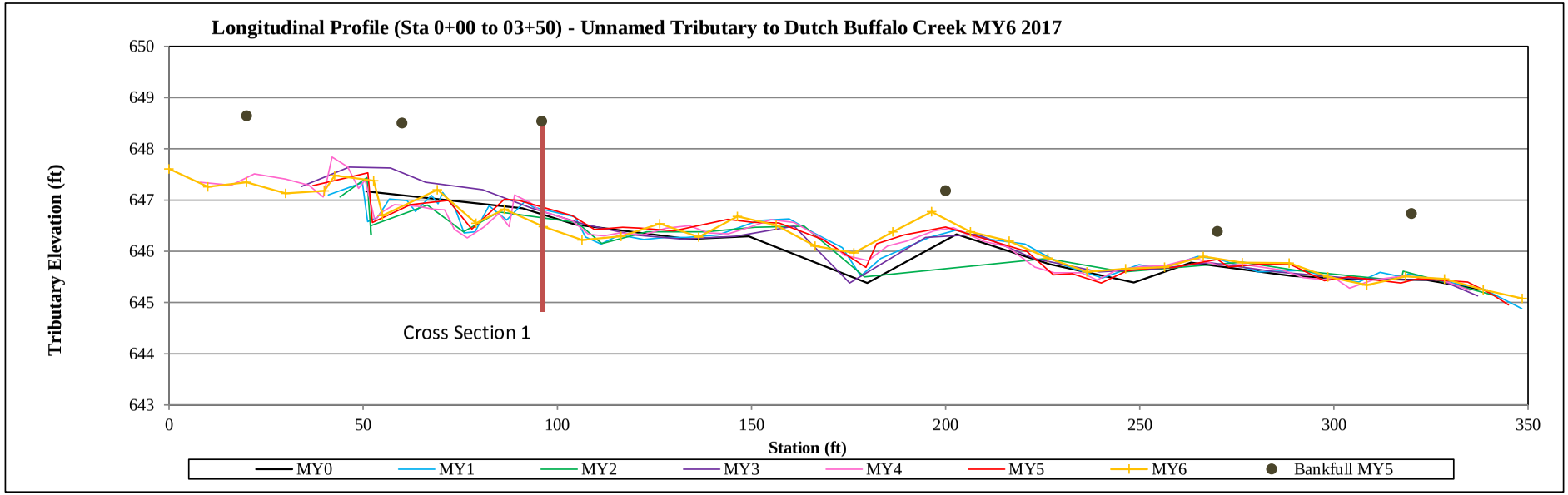
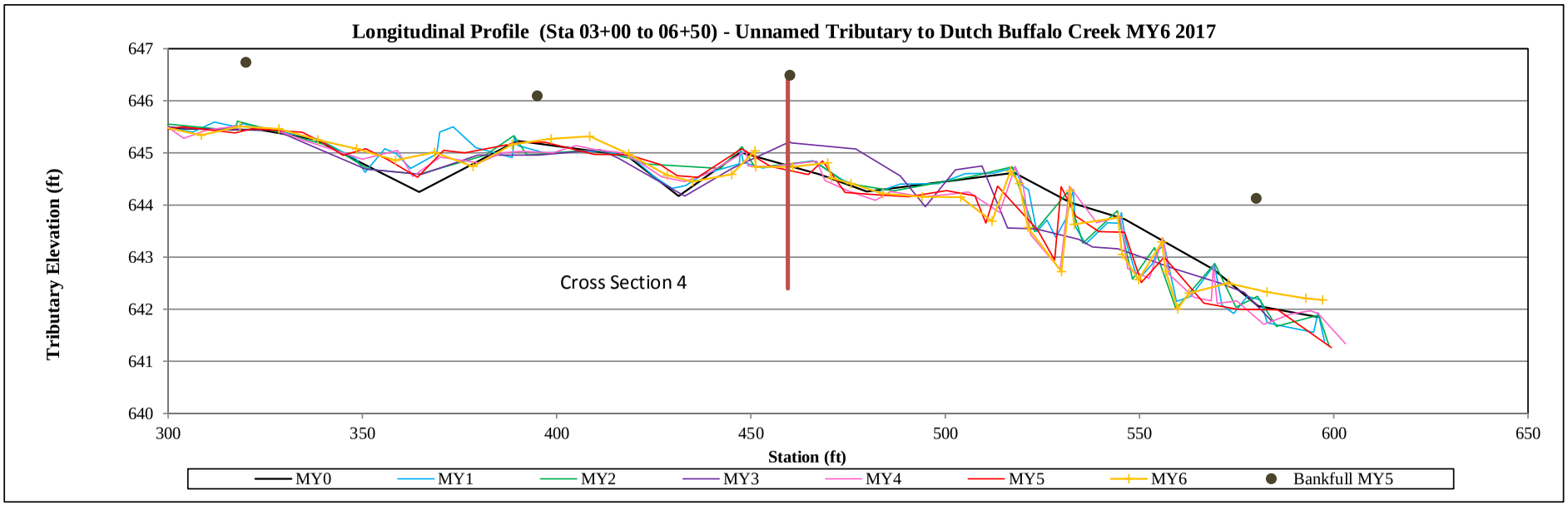


Figure 6. UT-1 Longitudinal Profile with Annual Overlays
Dutch Buffalo Creek Stream and Wetland Restoration DMS Project No. 370
Monitoring Year 6 of 6, October 2017 (no water in trib)

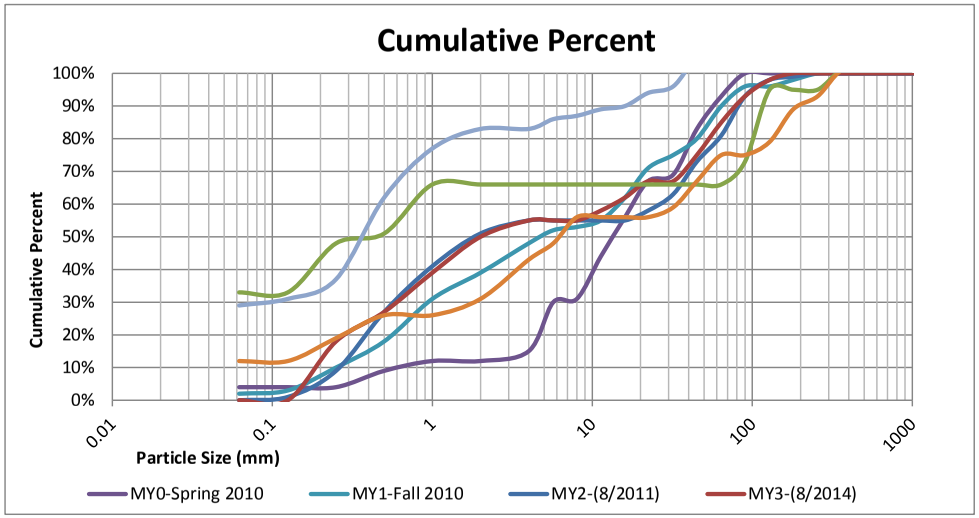


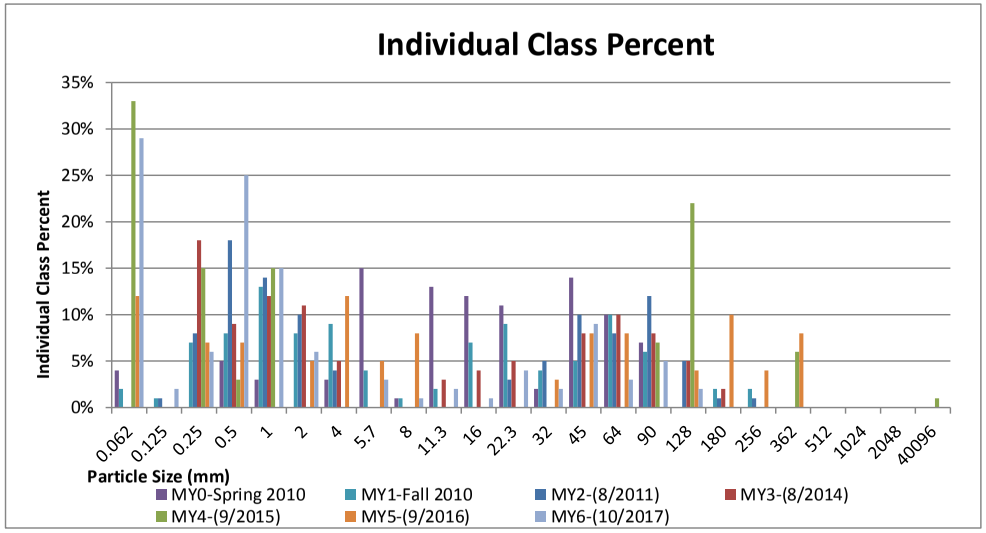


Appendix D: Stream Survey Data - Suther Site Project #370
Figure 7.0. Pebble Count Plots with Annual Overlays
UT to Dutch Buffalo Creek - Cross Section 1
Monitoring Year 6

Project Name: Suther (DBC)					
Reach: UT to Dutch Buffal Creek					
Feature: Riffle (XS 1)					
			MY6-(10/2017)		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	29	29%	29%
Sand	very fine sand	0.125	2	2%	31%
	fine sand	0.250	6	6%	37%
	medium sand	0.50	25	25%	62%
	coarse sand	1.00	15	15%	77%
	very coarse sand	2.0	6	6%	83%
Gravel	very fine gravel	4.0	0	0%	83%
	fine gravel	5.7	3	3%	86%
	fine gravel	8.0	1	1%	87%
	medium gravel	11.3	2	2%	89%
	medium gravel	16.0	1	1%	90%
	course gravel	22.3	4	4%	94%
	course gravel	32.0	2	2%	96%
	very coarse gravel	45	9	9%	100%
	very coarse gravel	64	3	3%	100%
Cobble	small cobble	90	5	5%	100%
	medium cobble	128	2	2%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count		-	115	100%	100%

Summary Data	
D50	0.4
D84	4.2
D95	30.0

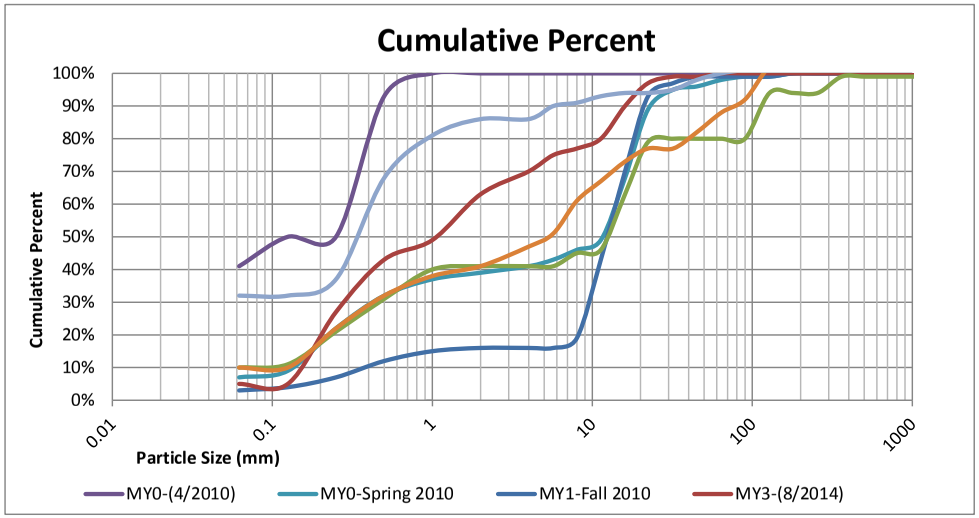


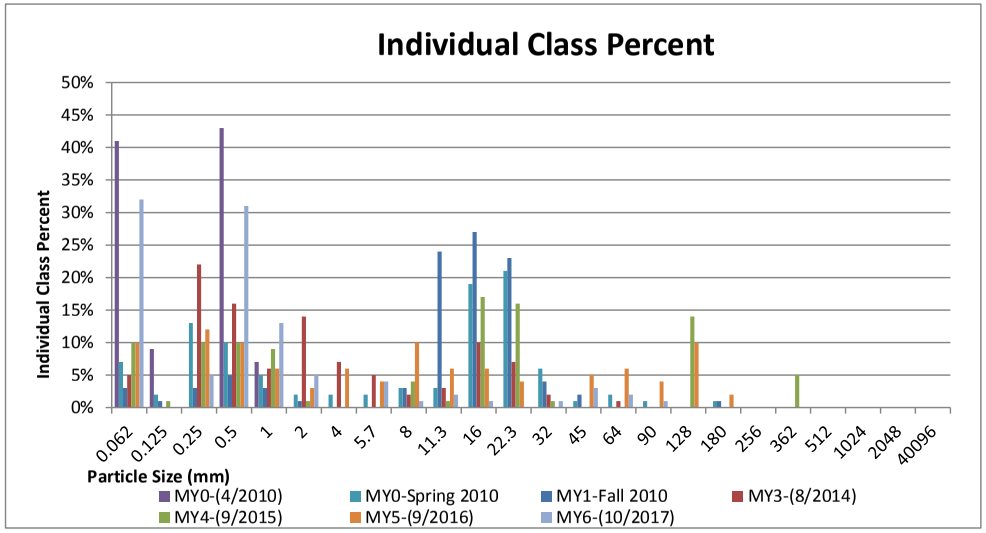


Appendix D: Stream Survey Data - Suther Site Project #370
Figure 7.1. Pebble Count Plots with Annual Overlays
UT to Dutch Buffalo Creek - Cross Section 2
Monitoring Year 6

Project Name: Suther (DBC)					
Reach: UT to Dutch Buffal Creek					
Feature: Pool (XS 2)					
			MY6-(10/2017)		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	32	32%	32%
Sand	very fine sand	0.125	0	0%	32%
	fine sand	0.250	5	5%	37%
	medium sand	0.50	31	31%	68%
	coarse sand	1.00	13	13%	81%
	very coarse sand	2.0	5	5%	86%
Gravel	very fine gravel	4.0	0	0%	86%
	fine gravel	5.7	4	4%	90%
	fine gravel	8.0	1	1%	91%
	medium gravel	11.3	2	2%	93%
	medium gravel	16.0	1	1%	94%
	course gravel	22.3	0	0%	94%
	course gravel	32.0	1	1%	95%
	very coarse gravel	45	3	3%	98%
	very coarse gravel	64	2	2%	100%
Cobble	small cobble	90	1	1%	100%
	medium cobble	128	0	0%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count		-	101	100%	100%

Summary Data	
D50	0.4
D84	1.5
D95	32.0

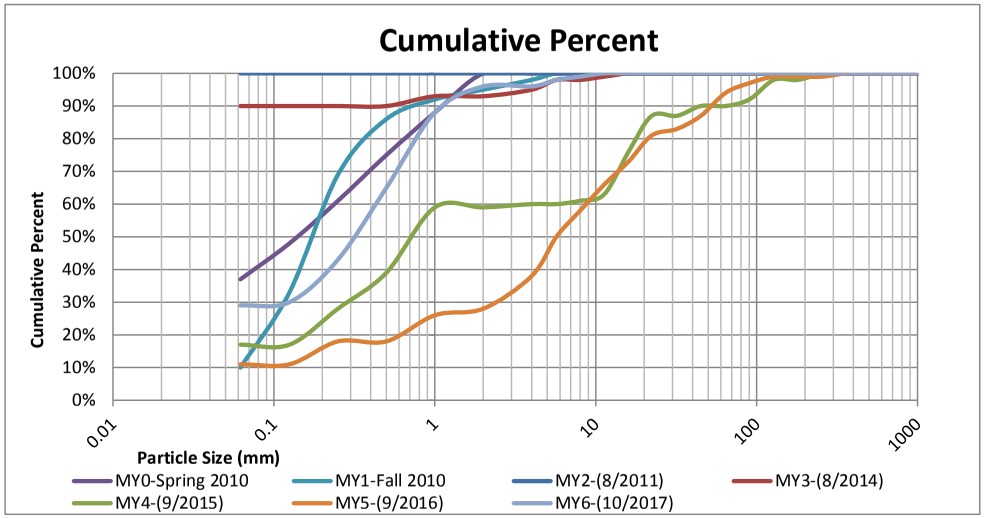


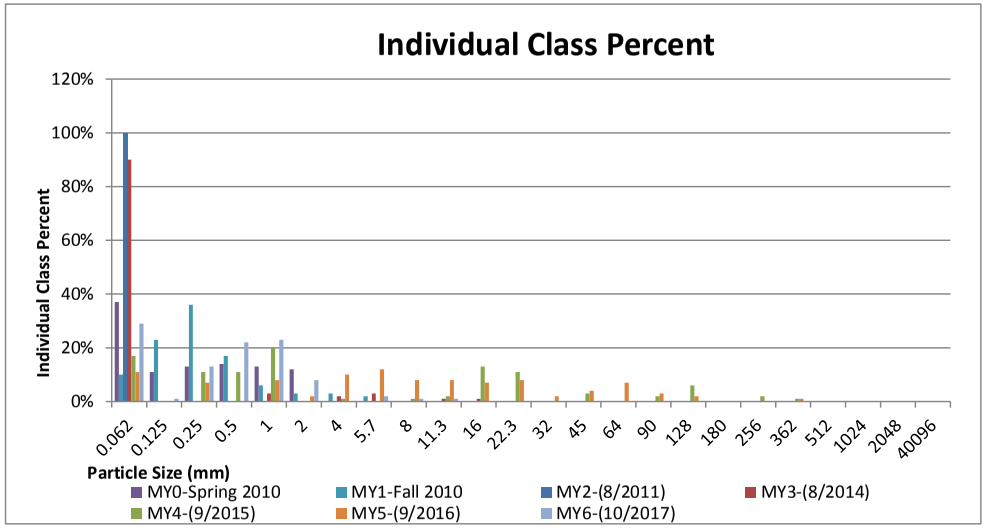


Appendix D: Stream Survey Data - Suther Site Project #370
Figure 7.2. Pebble Count Plots with Annual Overlays
UT to Dutch Buffalo Creek - Cross Section 3
Monitoring Year 6

Project Name: Suther (DBC)					
Reach: UT to Dutch Buffal Creek					
Feature: Pool (XS 3)					
			MY6-(10/2017)		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	29	29%	29%
Sand	very fine sand	0.125	1	1%	30%
	fine sand	0.250	13	13%	43%
	medium sand	0.50	22	22%	65%
	coarse sand	1.00	23	23%	88%
	very coarse sand	2.0	8	8%	96%
Gravel	very fine gravel	4.0	0	0%	96%
	fine gravel	5.7	2	2%	98%
	fine gravel	8.0	1	1%	99%
	medium gravel	11.3	1	1%	100%
	medium gravel	16.0	0	0%	100%
	course gravel	22.3	0	0%	100%
	course gravel	32.0	0	0%	100%
	very coarse gravel	45	0	0%	100%
	very coarse gravel	64	0	0%	100%
Cobble	small cobble	90	0	0%	100%
	medium cobble	128	0	0%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count		-	100	100%	100%

Summary Data	
D50	0.3
D84	0.9
D95	1.8

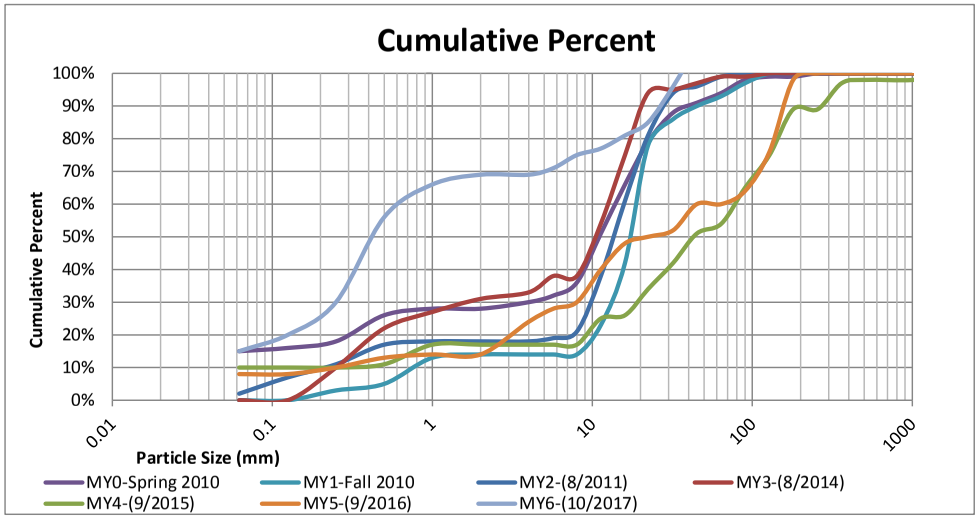


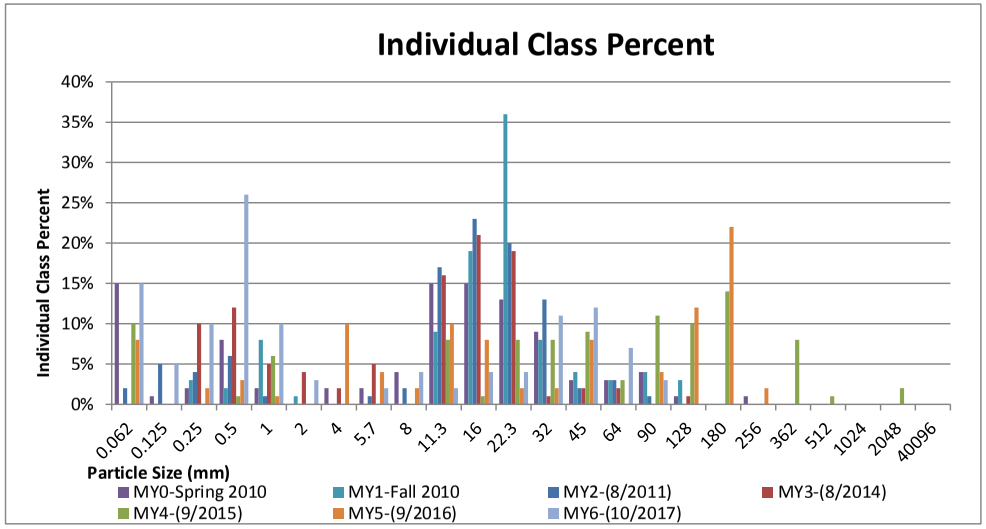


Appendix D: Stream Survey Data - Suther Site Project #370
Figure 7.3. Pebble Count Plots with Annual Overlays
UT to Dutch Buffalo Creek - Cross Section 4
Monitoring Year 6

Project Name: Suther (DBC)					
Reach: UT to Dutch Buffal Creek					
Feature: Riffle (XS 4)					
			MY6-(10/2017)		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	15	15%	15%
Sand	very fine sand	0.125	5	5%	20%
	fine sand	0.250	10	10%	30%
	medium sand	0.50	26	26%	56%
	coarse sand	1.00	10	10%	66%
	very coarse sand	2.0	3	3%	69%
Gravel	very fine gravel	4.0	0	0%	69%
	fine gravel	5.7	2	2%	71%
	fine gravel	8.0	4	4%	75%
	medium gravel	11.3	2	2%	77%
	medium gravel	16.0	4	4%	81%
	course gravel	22.3	4	4%	85%
	course gravel	32.0	11	11%	96%
	very coarse gravel	45	12	12%	100%
	very coarse gravel	64	7	7%	100%
Cobble	small cobble	90	3	3%	100%
	medium cobble	128	0	0%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count		-	118	100%	100%

Summary Data	
D50	0.4
D84	25.0
D95	30.0





Appendix D. Table 9.1. 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 9.2. 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 10. 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	MY6-2017	Baseline	MY1-2010	MY2-2011	MY3-2014	MY4-2015	MY5-2016	MY6-2017
Bankfull Width (ft)	8.9	8.7	8.3	9.0	8.6	8.9	8.7	9.6	9.7	9.4	*NA*	*NA*	*NA*	*NA*
Floodprone Width (ft)	55.6	55.6	55.8	56.0	56.0	56.0	56.0	53.3	53.2	53.3	*NA*	*NA*	*NA*	*NA*
Bankfull Mean Depth	1.0	1.1	1.1	1.1	0.6	1.0	0.9	1.1	1.0	1.0	*NA*	*NA*	*NA*	*NA*
Bankfull Max Depth (ft)	1.8	1.7	1.6	1.9	1.9	1.9	1.7	1.7	1.6	1.6	*NA*	*NA*	*NA*	*NA*
Bankfull Cross-sectional Area (ft^2)	9.2	8.8	8.8	9.8	10.9	8.7	7.8	10.2	9.4	9.4	*NA*	*NA*	*NA*	*NA*
Bankfull Width/Depth Ratio	8.5	8.6	7.8	8.2	15.1	9.2	9.7	9.1	10.0	9.3	*NA*	*NA*	*NA*	*NA*
Bankfull Entrenchment Ratio	6.3	6.4	6.7	6.2	6.5	6.3	6.4	5.6	5.5	5.7	*NA*	*NA*	*NA*	*NA*
Bankfull Bankheight Ratio	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	*NA*	*NA*	*NA*	*NA*
Cross Sectional Area between end pins (ft^2)	75.0	69.6	75.5	71.3	68.2	69.5	69.4	12.0	9.8	19.1	*NA*	*NA*	*NA*	*NA*
d50 (mm)	13.7	4.9	1.9	2.0	0.5	7.0	0.4	0.1	11.6	12.5	*NA*	*NA*	*NA*	*NA*

PARAMETER		Cross-Section 3 (Pool) **							Cross-Section 4 (Riffle)					
DIMENSION	Baseline	MY1-2010	MY2-2011	MY3-2014	MY4-2015	MY5-2016	MY6-2017	Baseline	MY1-2010	MY2-2011	MY3-2014	MY4-2015	MY5-2016	MY6-2017
Bankfull Width (ft)	11.0	10.5	10.4	*NA*	*NA*	*NA*	*NA*	8.3	8.3	8.2	8.5	8.0	8.6	9.5
Floodprone Width (ft)	59.0	58.0	55.3	*NA*	*NA*	*NA*	*NA*	52.5	52.5	55.1	55.00	55.0	55.0	55.0
Bankfull Mean Depth	0.8	0.7	0.7	*NA*	*NA*	*NA*	*NA*	1.0	1.0	1.0	1.1	0.9	1.0	1.1
Bankfull Max Depth (ft)	8.9	8.7	1.6	*NA*	*NA*	*NA*	*NA*	1.7	1.7	1.7	1.8	1.5	1.7	1.9
Bankfull Cross-sectional Area (ft^2)	9.3	7.5	7.6	*NA*	*NA*	*NA*	*NA*	8.3	8.4	8.3	8.7	8.8	8.6	10.7
Bankfull Width/Depth Ratio	13.1	14.8	14.3	*NA*	*NA*	*NA*	*NA*	8.3	8.2	8.1	7.7	9.0	8.6	8.4
Bankfull Entrenchment Ratio	5.4	5.5	5.3	*NA*	*NA*	*NA*	*NA*	6.3	6.3	6.8	6.5	6.8	6.4	5.8
Bankfull Bankheight Ratio	1.0	1.0	1.0	*NA*	*NA*	*NA*	*NA*	1.0	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*	*NA*	39.6	36.3	41.3	39.7	37.2	36.9	35.8
d50 (mm)	0.1	0.2	0.03	*NA*	*NA*	*NA*	*NA*	11.1	17.5	13.8	10.2	43.6	22.0	0.4

** UT-1 Cross-sections 2 and 3 were not included in the monitoring scope for MY-3 to MY-6 and were not surveyed.

Table 11.1. Stream Reach Morphology Monitoring Data Summary: Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration Project # 370
UT-1 Unnammed Tributary to Dutch Buffalo Creek (608 linear feet)

Parameter	Baseline - 2009						MY 1 - 2010						MY 2 - 2011						MY 3 - 2014					
DIMENSION	Min	Mean	Med	Max	SD	n	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	8.50	8.75	8.75	9.00	0.35	2
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	55.0	55.5	55.5	56.0	0.71	2
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	1.10	1.10	1.10	1.10	0.00	2
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	1.79	1.83	1.83	1.87	0.06	2
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	8.70	9.26	9.26	9.81	0.78	2
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	7.73	7.95	7.95	8.18	0.32	2
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	6.22	6.35	6.35	6.47	0.18	2
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	1.00	1.00	1.00	1.00	0.01	2
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	3.98	4.47	4.45	4.49	0.30	2
PROFILE	Min	Mean	Med	Max	SD	n	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	12.32	20.09	21.99	26.49	5.05	3
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	0.014	6	0.0066	0.0135	0.0120	0.0256	0.014	3
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	15.7	8	14.80	32.58	33.55	59.50	15.69	4
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	1.63	1.93	1.89	2.21	0.40	4
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	18.4	8	18.58	43.20	41.58	59.99	18.41	4
PATTERN	Min	Mean	Med	Max	SD	n	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	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	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	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	-	-	3.70	6.35	6.35	9.00	-	-
ADDITIONAL REACH PARAMETERS																								
Rosgen Classification	E4						E4						E4						E4					
BF slope (ft/ft)	0						0.008						0.006						0.008					
Ri%/Ru%/P%/G%/S%	-	-	-	-	-		29.0	1.2	38.1	-	0.2		17.0	-	50.0	-	0.2		29.0	-	38.0	-	0.2	
SC%/Sa%/G%/C%/B%/Be%																								
d16 / d35 / d50 / d84 / d95																								
% reach w eroding banks	0						4						0						4					
Channel Stability or Habitat Metric	-						-						-						-					
Biological or Other	-						-						-						-					

> BKF velocity based on 39.04 cfs design flow. Three riffle cross-sections (xs-1, 2, 4) were monitored in MY0 to MY2. Two riffle cross-sections (XS-1, 4) were monitored in MY3 to MY6.

Table 11.2. Stream Reach Morphology Monitoring Data Summary: Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration Project # 370
UT-1 Unnammed Tributary to Dutch Buffalo Creek (608 linear feet)

Parameter	Baseline - 2009						MY4 - 2015						MY 5 - 2016						MY 6 - 2017					
DIMENSION	Min	Mean	Med	Max	SD	n	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	8.00	8.30	8.30	8.60	0.65	2	8.60	8.75	8.75	8.90	0.21	2	8.70	9.10	9.10	9.50	0.57	2
Floodprone Width (ft)	52.5	54.0	54.0	55.6	-	3	55.0	55.5	55.5	56.0	0.95	2	55.00	55.50	55.50	56.00	0.71	2	55.00	55.50	55.50	56.00	0.71	2
Bankfull Mean Depth (ft)	1.00	1.02	1.02	1.04	-	3	0.57	0.73	0.73	0.88	0.03	2	0.97	0.99	0.99	1.00	0.02	2	0.90	1.00	1.00	1.10	0.14	2
Bankfull Max Depth (ft)	1.67	1.74	1.74	1.81	-	3	1.50	1.68	1.68	1.86	0.02	2	1.70	1.80	1.80	1.90	0.14	2	1.70	1.80	1.80	1.90	0.14	2
BKF X-section Area (ft2)	8.30	8.77	8.77	9.24	-	3	8.88	9.39	9.39	9.90	0.58	2	8.62	8.64	8.64	8.65	0.02	2	7.80	9.25	9.25	10.70	2.05	2
Width /Depth Ratio	8.34	8.43	8.43	8.51	-	3	9.09	12.09	12.09	15.09	0.77	2	8.58	8.87	8.87	9.16	0.41	2	8.40	9.05	9.05	9.70	0.92	2
Entrenchment Ratio	6.28	6.29	6.29	6.30	-	3	6.51	6.70	6.70	6.88	0.60	2	6.29	6.35	6.35	6.40	0.08	2	5.80	6.10	6.10	6.40	0.42	2
Bank Height Ratio	1.00	1.00	1.00	1.00	-	3	1.00	1.00	1.00	1.00	0.00	2	0.92	0.98	0.98	1.04	0.08	2	1.00	1.00	1.00	1.00	0.00	2
Bankfull Velocity (fps)	4.70	4.45	4.45	4.23	-	3	3.94	4.17	4.17	4.40	0.29	2	4.49	4.51	4.51	4.54	0.04	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	Min	Mean	Med	Max	SD	n
Riffle Length (ft)	13.76	21.29	21.29	28.82	-	2	10.40	20.07	18.59	26.77	9.16	6	4.30	6.38	6.47	8.48	1.37	6	4.30	6.38	6.47	8.48	1.37	6
Riffle Slope (ft/ft)	0.0014	0.0100	0.0100	0.0186	-	2	0.0069	0.0187	0.0183	0.0297	0.012	6	0.0063	0.0856	0.0698	0.2244	0.076	6	0.0063	0.0856	0.0698	0.2244	0.076	6
Pool Length (ft)	10.32	31.83	31.83	53.33	-	2	14.80	36.08	37.64	57.36	13.62	8	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	1.72	1.82	1.82	1.91	-	2	1.45	1.71	1.65	2.23	0.36	8	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)	10.32	42.80	42.80	75.27	-	2	10.70	34.45	38.95	58.20	17.23	8	27.62	66.47	74.02	99.05	28.76	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	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	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	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	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	-	-	3.70	6.35	6.35	9.00	-	-
ADDITIONAL REACH PARAMETERS																								
Rosgen Classification	E4						E4						E4						E4					
BF slope (ft/ft)	0						0.007						0.008						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	0						4						4						4					
Channel Stability or Habitat Metric	-						-						-						-					
Biological or Other	-						-						-						-					

> BKF velocity based on 39.04 cfs design flow. Three riffle cross-sections (xs-1, 2, 4) were monitored in MY0 to MY2. Two riffle cross-sections (XS-1, 4) were monitored in MY3 to MY6.

Table 12. Suther Site (Dutch Buffalo Cr) stream-bank erosion pins, length (feet) of exposed pins by date, 2013-2017.

			13-Nov-13			10-Apr-14 (high flow)			22-Aug-14			4-May-15			2-Sep-15			24-Mar-16			12-Sep-16			10-Apr-17			25-Oct-17				Cumulativ Retreat	Annualiz Rate
Pins	Sta+Bank	Height	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	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	0.00	0.00	0.00	0.05	0.05	0.05		0.30	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	0.20	0.35	0.40	0.05	0.40		0.60	0.13
		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	0.30	0.25	0.30	0.30	0.00	0.30		1.25	0.28
																														A1 ave	**0.72**	**0.16**
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	0.00	0.00	0.00	0.00	0.00	0.00		0.50	0.11
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	0.40	0.15	0.40	0.70	0.30	0.70		0.75	0.16
		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	0.25	0.00	0.25	0.25	0.00	0.25		0.35	0.08
																														A2 ave	**0.53**	**0.12**
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	0.70	0.20	0.70	NF	1.00	NF		2.70	0.59
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	0.65	0.40	0.65	NF	1.00	NF		2.15	0.47
		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	0.70	0.05	0.70	0 *S	0.00	0 *S		2.03	0.45
																														A3 ave	**2.29**	**0.50**
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	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	0.20	0.15	0.20	NF	NF	NF		0.53	0.12
		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	0.60	0.00	0.60	0.60	0.00	0.60		1.65	0.36
																														A4 ave	**1.09**	**0.24**
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	0.15	0.00	0.15	0.35	0.20	0.35		0.45	0.10
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	0.40	0.05	0.40	0.50	0.10	0.50		0.80	0.18
		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	NF	NF	NF	0 *S	0.00	0 *S		0.00	0.00
																														A6 ave	**0.42**	**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	0.20	0.05	0.20	0.20	0.00	0.20		2.92	0.64
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	0.50	0.10	0.50	1.00	0.50	1.00		2.58	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	0.45	0.05	0.45	0.70	0.25	0.70		2.70	0.59
																														A7 ave	**2.73**	**0.60**
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	NF	NF	NF	NF	NF	NF		0.15	0.03
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	NF	NF	NF	0 *S	0.00	0 *S		0.24	0.05
		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	NF	NF	NF	NF	NF	NF		0.30	0.07
																														A8 ave	**0.23**	**0.05**
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	0.60	0.40	0.60	1.00	0.40	1.00		1.05	0.23
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	0.45	0.20	0.45	0.55	0.10	0.55		0.98	0.22
		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	NF	NF	NF	0.00	0.00	0.00		0.70	0.15
																														A9 ave	**0.91**	**0.20**
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	0.40	0.15	0.40	0.50	0.10	0.50		0.60	0.13
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	NF	NF	NF	NF *S	NF	NF *S		0.21	0.05
		(No Lower Pin Installed; Bedrock)																												A10 ave	**0.41**	**0.09**
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	0.40	0.00	0.40	0.60	0.20	0.60		1.14	0.25
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	0.40	0.10	0.40	0.40	0.00	0.40		0.75	0.17
		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	NF	NF	NF	NF *S	NF	NF *S		0.58	0.13
																														A11 ave	**0.82**	**0.18**
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	0.65	0.05	0.65	0.70	0.05	0.70		1.90	0.42
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	0.25	0.10	0.25	0.35	0.10	0.35		1.59	0.35
		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	NF	NF	NF	NF *S	NF	NF *S		0.00	0.00
																														A12 ave	**1.16**	**0.26**
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			49 months = 4.08 yr			55 months = 4.58 yr			i		
																														Averag	**1.02**	**0.22**

NOTES

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

*S = buried under slump

(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 E. Stream & Wetland Hydrology Data

Figure 8. Monthly Rainfall Data with Percentiles
Figure 9.0 -9.14. Groundwater Gage and Rainfall Data Plots
Table 13. Bankfull Flow Events Data Summary
Table 14. Wetland Hydrology Attainment Summary

[Hydrology gauges (wells, rain, stream) raw data provided on CD]

Figure 8. Monthly Rainfall Totals for 2017, with 30th and 70th Percentile Climate Normals, Concord, NC

Month 2017	NC-CB-23 Monthly Total Precip, inches	On-Site Monthly Total Precip, inches	1980-2010 Monthly Climate Normals	
			30th P*	70th P*
Jan-17	4.87	4.31	2.55	4.92
Feb-17	0.95	0.83	2.59	4.67
Mar-17	2.49	3.08	3.42	5.57
Apr-17	6.32	6.12	2.16	4.02
May-17	7.57	6.85	2.29	4.12
Jun-17	5.64	5.87	3.01	5.48
Jul-17	2.68	2.88	3.42	5.20
Aug-17	4.61	4.75	3.04	5.53
Sep-17	2.29	2.8	2.61	5.07
Oct-17	3.01	2.79	2.50	4.57
Nov-17	*NA*	*NA*	2.47	3.81
Dec-17	*NA*	*NA*	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.

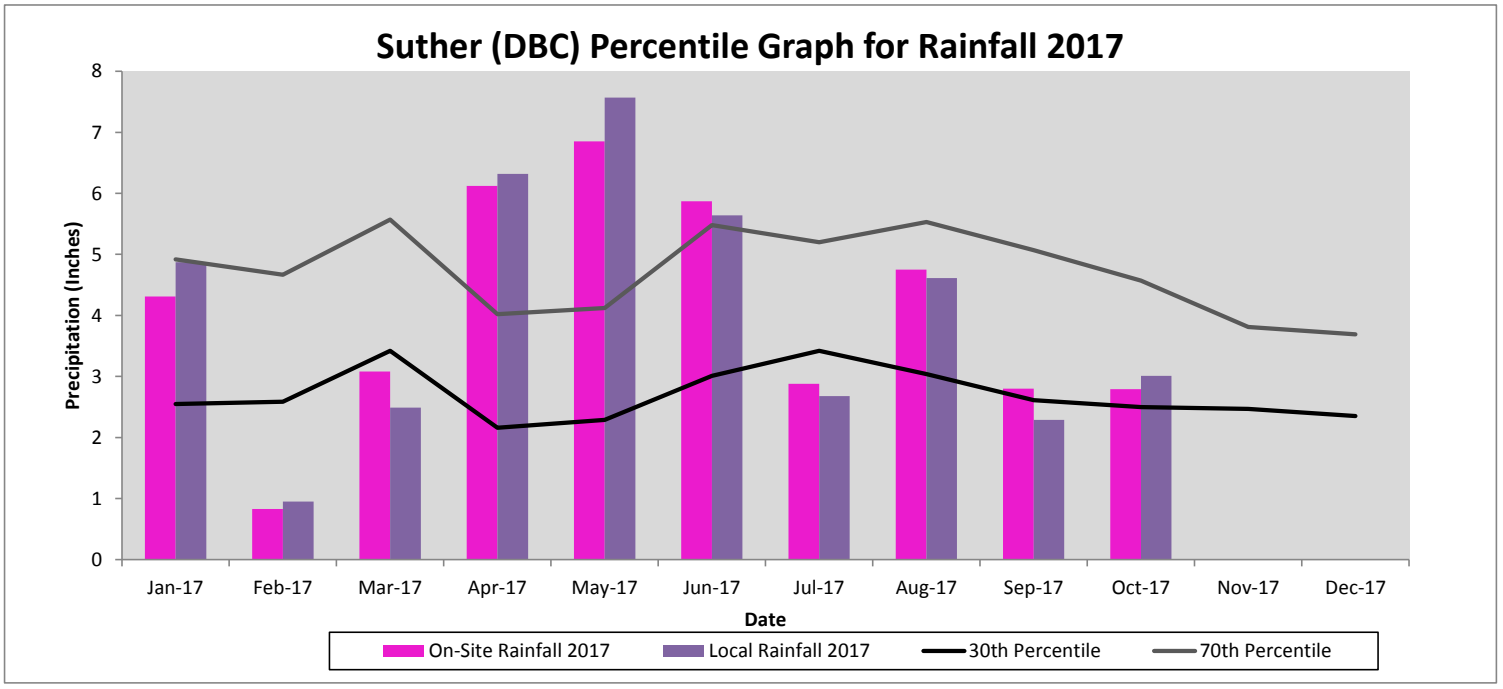


Figure 9.0 Suther (DBC) Groundwater Gauge 1 - MY6 (2017)

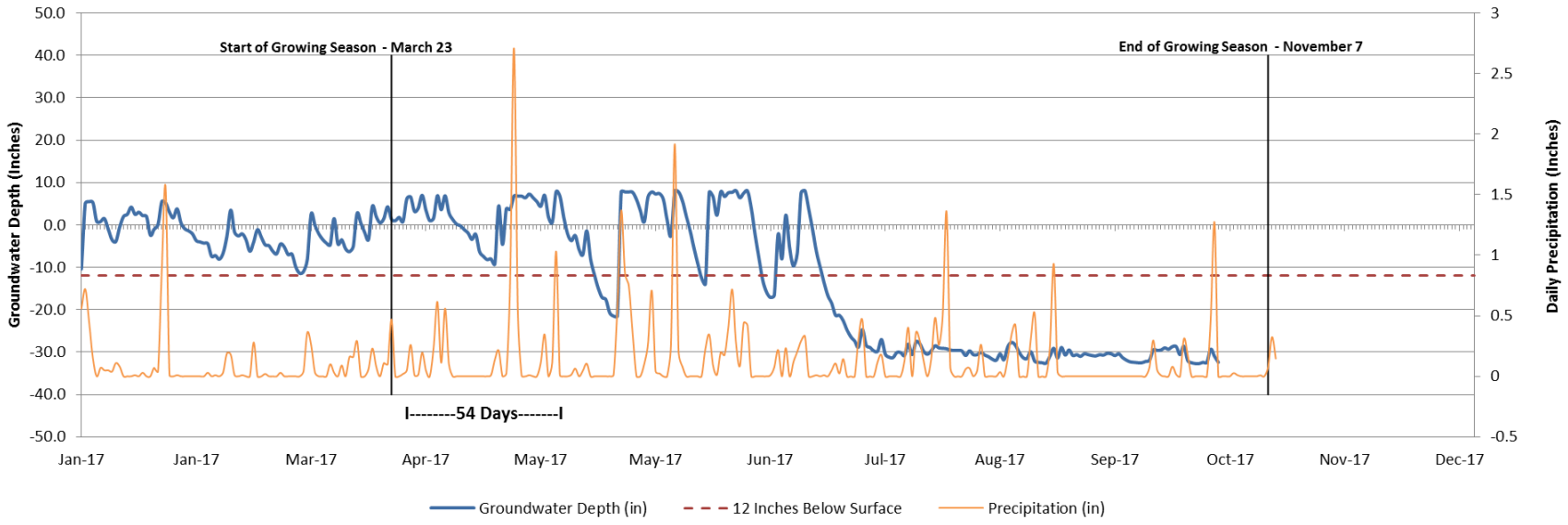


Figure 9.1 Suther (DBC) Groundwater Gauge 2 - MY6 (2017)

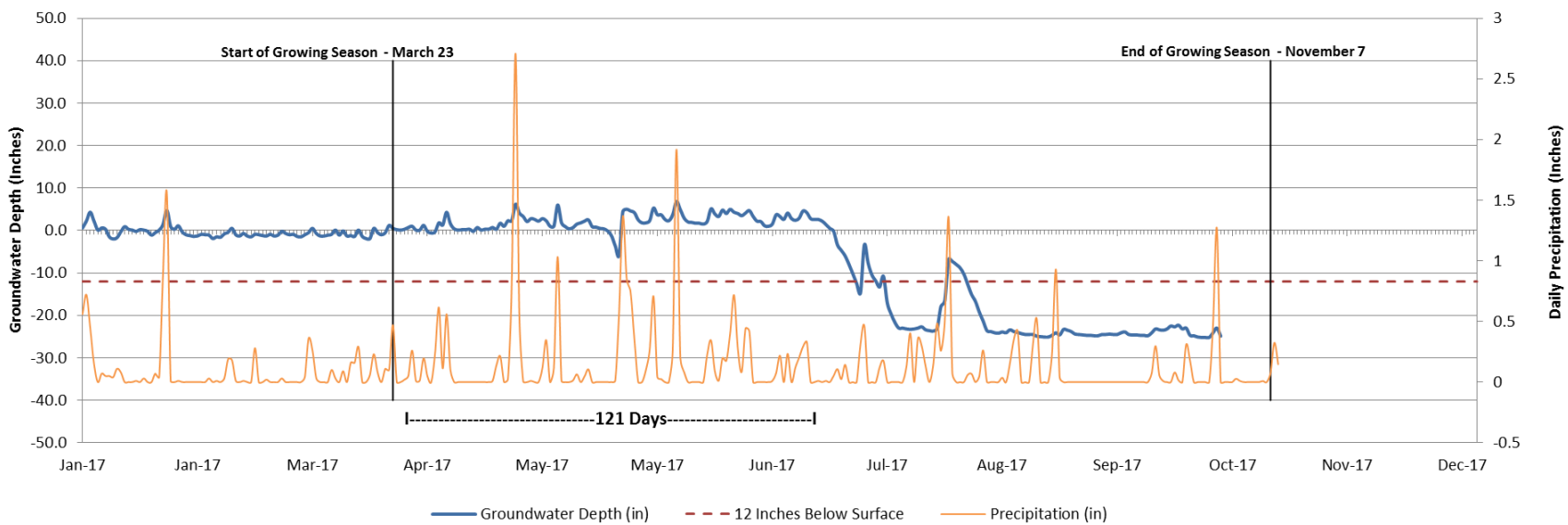


Figure 9.2 Suther (DBC) Groundwater Gauge 3 - MY6 (2017)

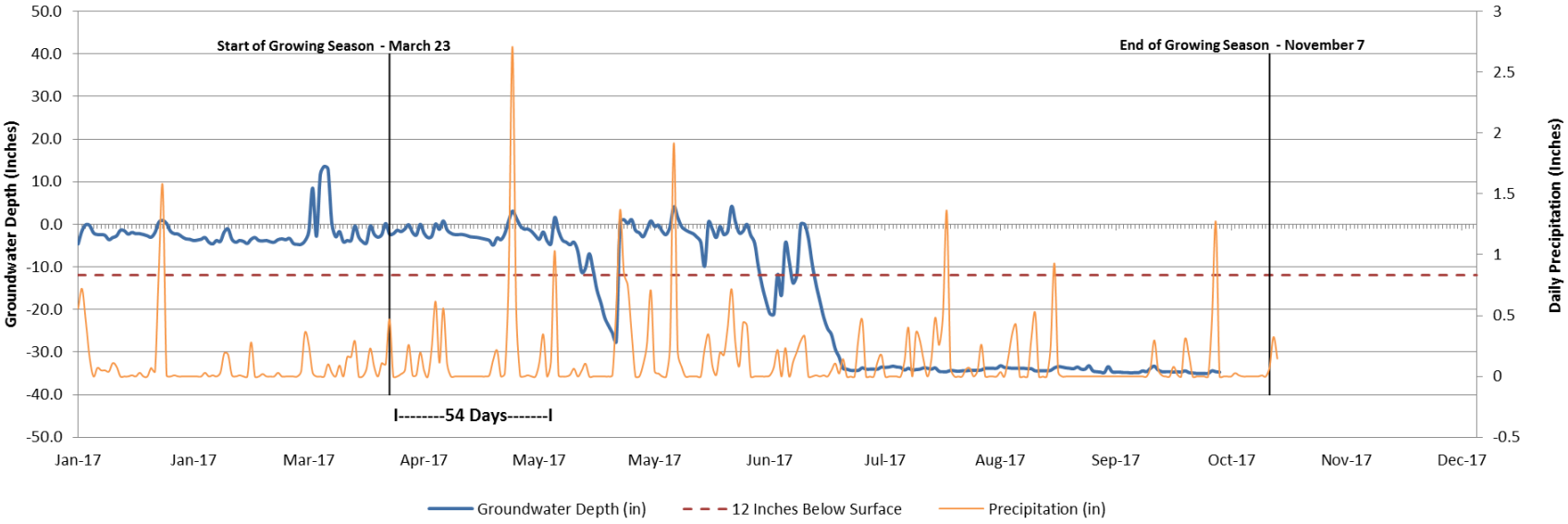


Figure 9.3 Suther (DBC) Groundwater Gauge 4 - MY6 (2017)

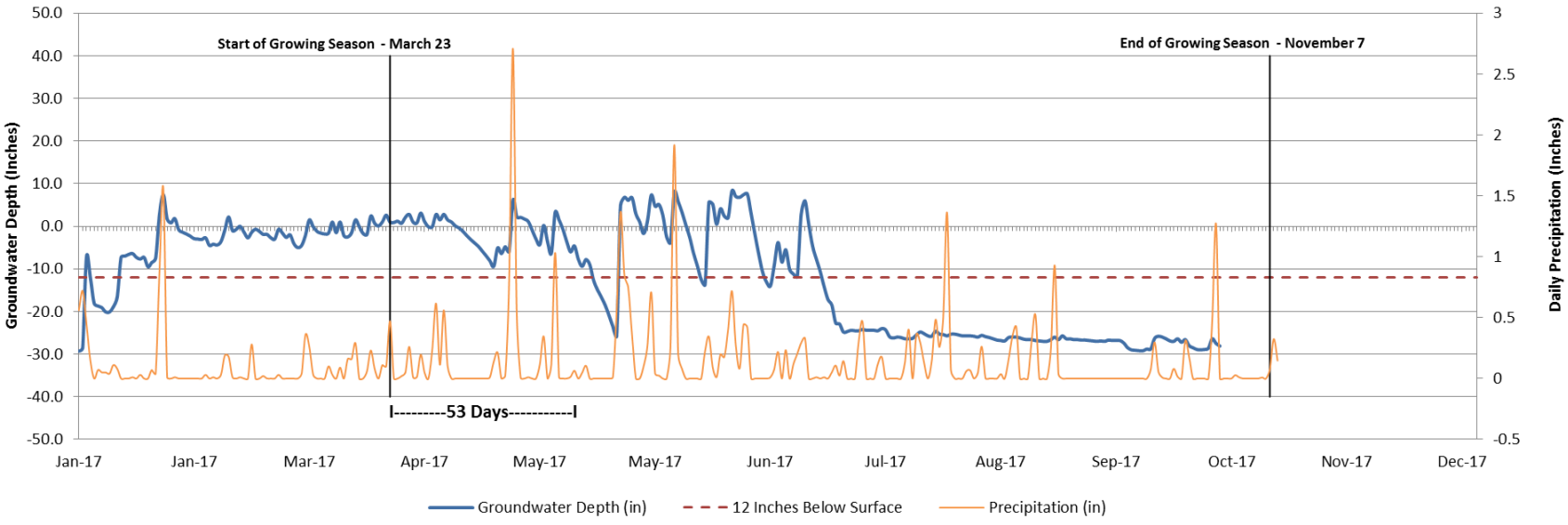


Figure 9.4 Suther (DBC) Groundwater Gauge 5 - MY6 (2017)

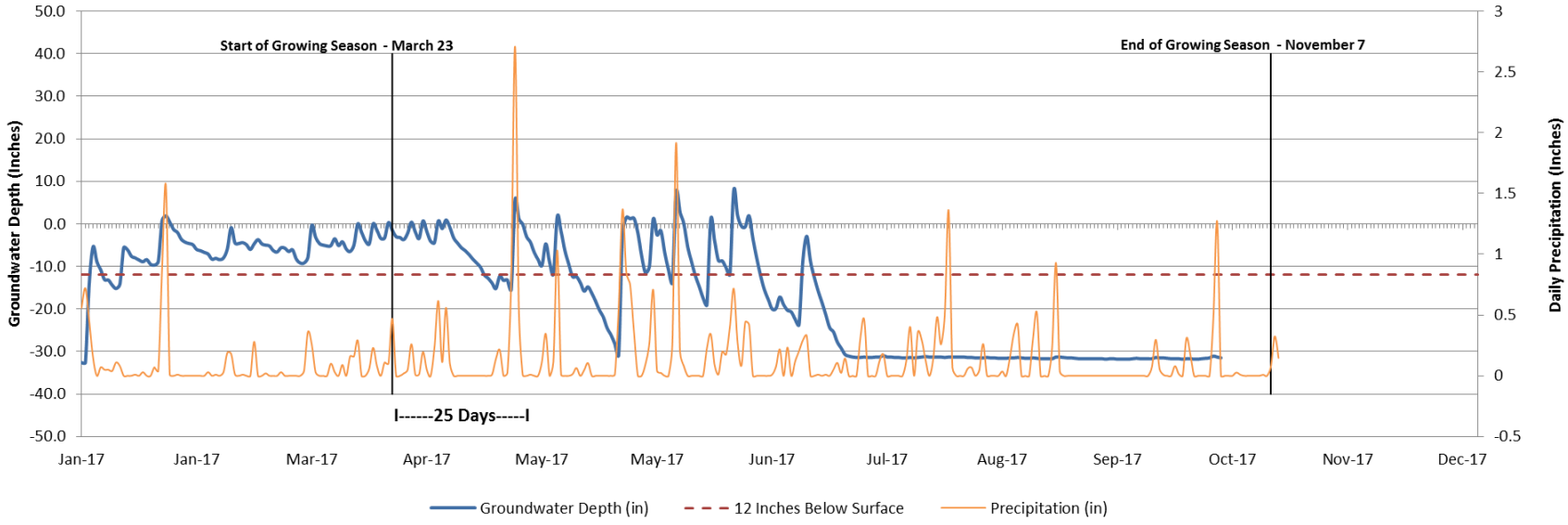


Figure 9.5 Suther (DBC) Groundwater Gauge 6 - MY6 (2017)

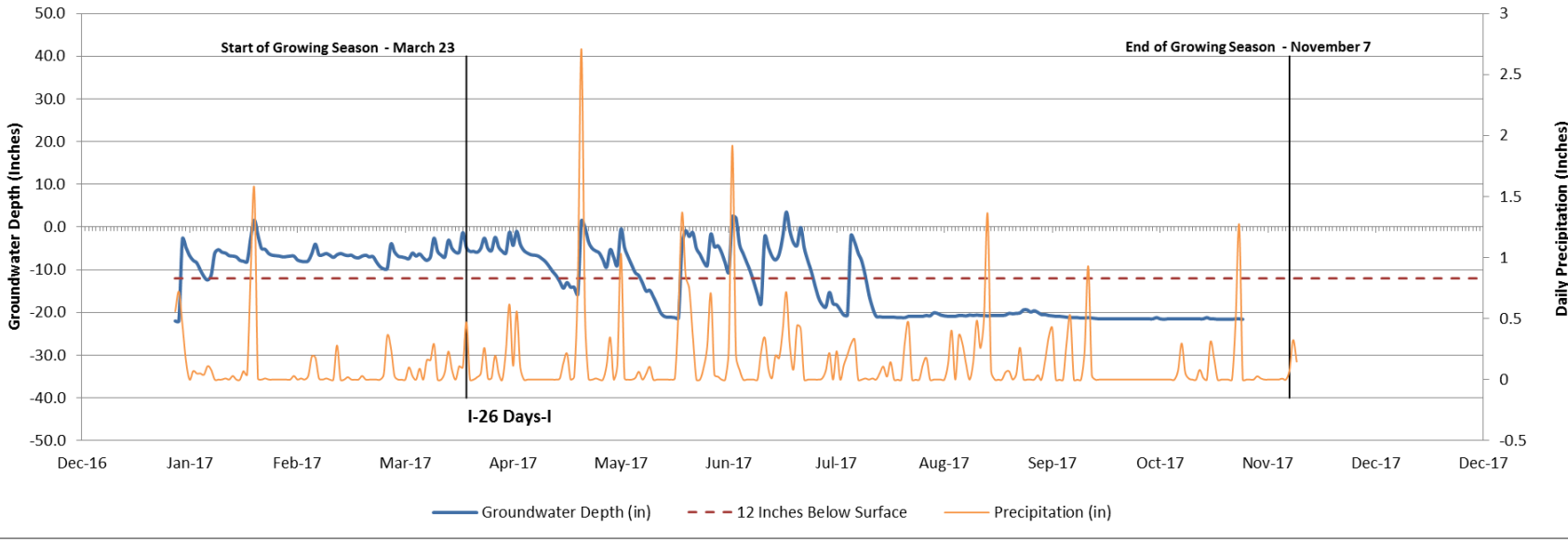


Figure 9.6 Suther (DBC) Groundwater Gauge 7 - MY6 (2017)

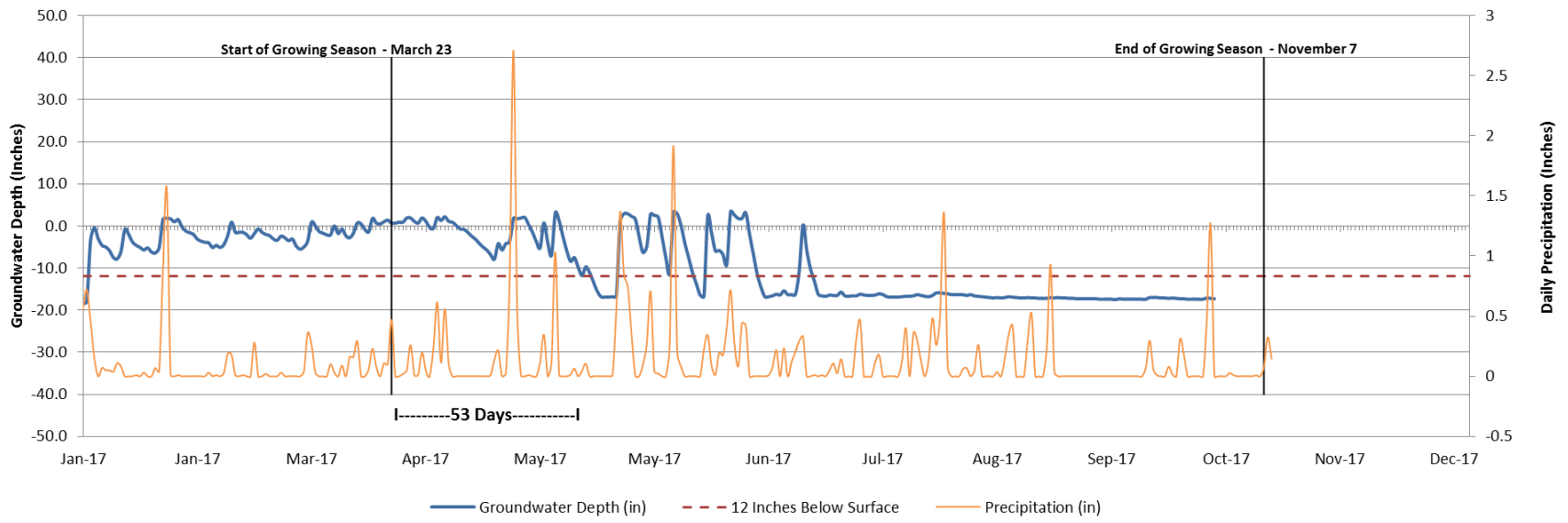


Figure 9.7 Suther (DBC) Groundwater Gauge 8 - MY6 (2017)

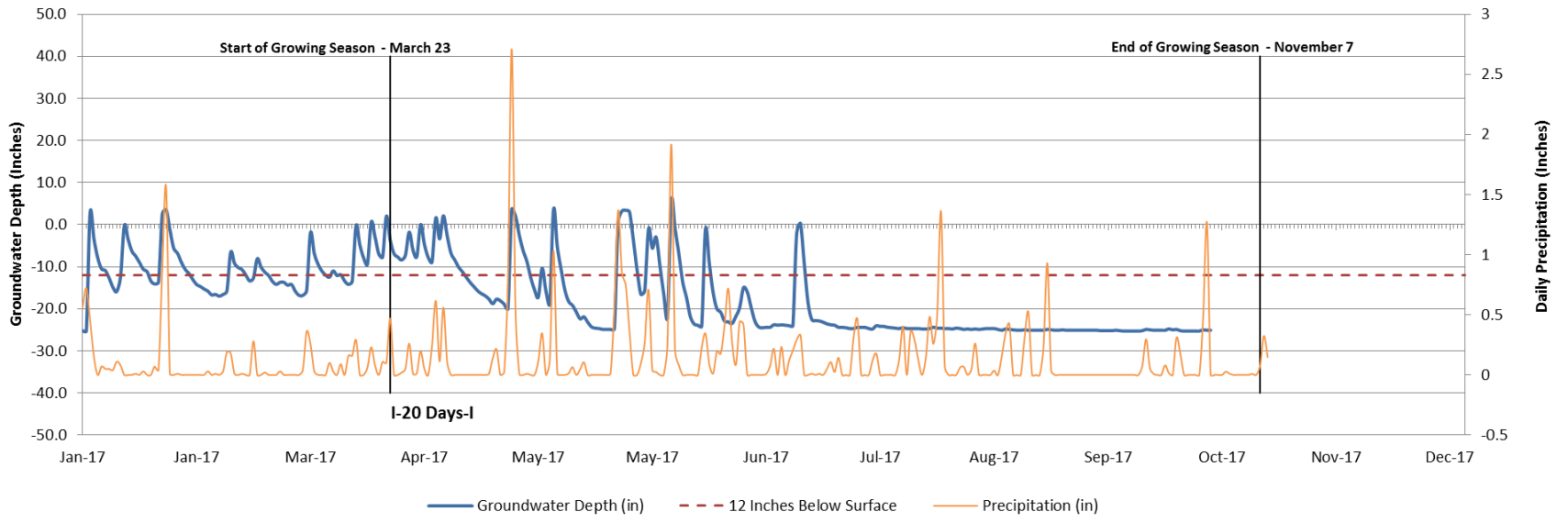


Figure 9.8 Suther (DBC) Groundwater Gauge 9 - MY6 (2017)

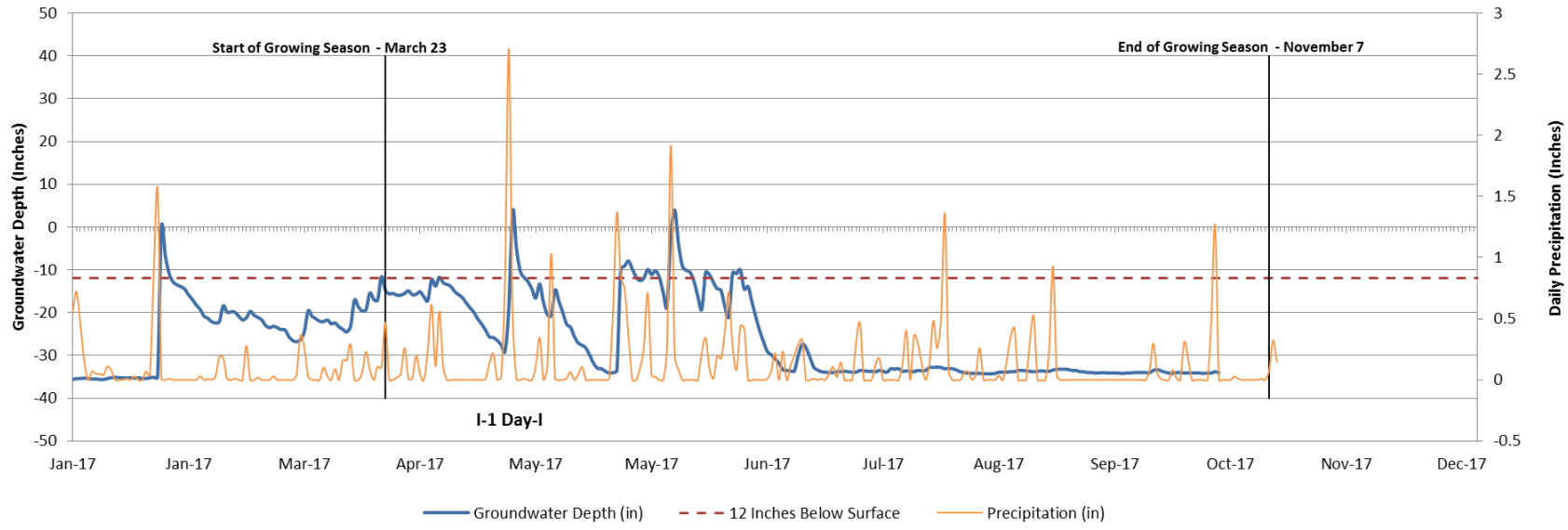


Figure 9.9 Suther (DBC) Groundwater Gauge 12 - MY6 (2017)

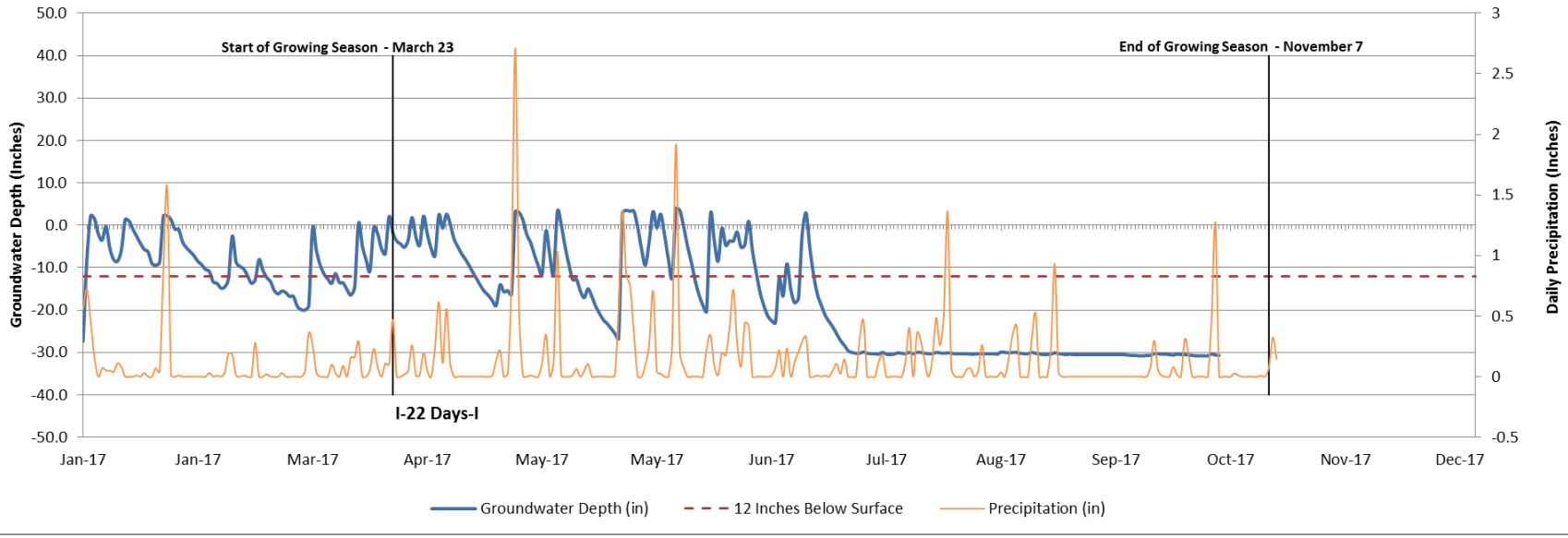


Figure 9.10 Suther (DBC) Groundwater Gauge 13 - MY6 (2017)

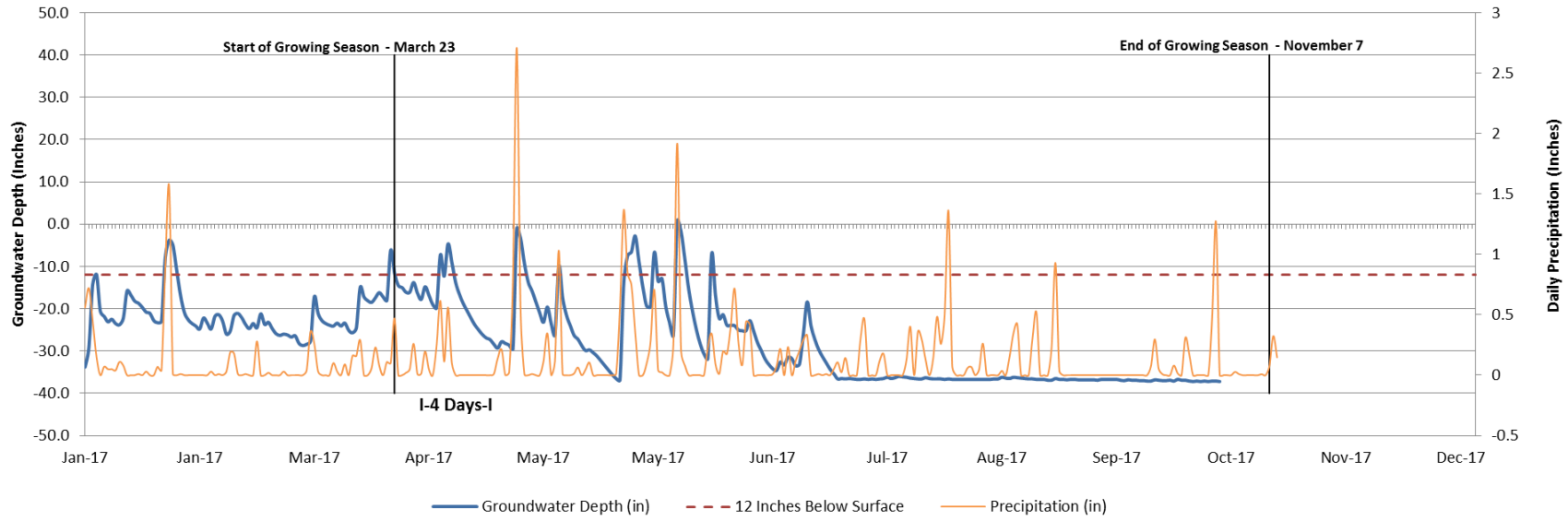


Figure 9.11 Suther (DBC) Groundwater Gauge 14 - MY6 (2017)

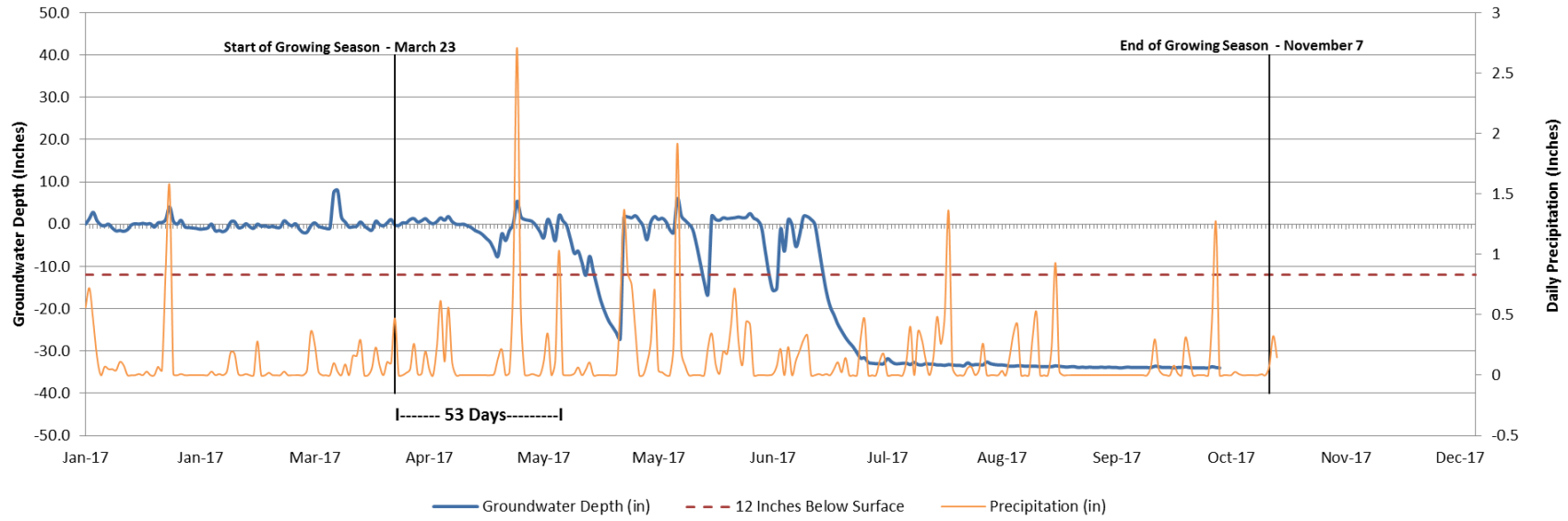


Figure 9.12 Suther (DBC) Groundwater Gauge 16 - MY6 (2017)

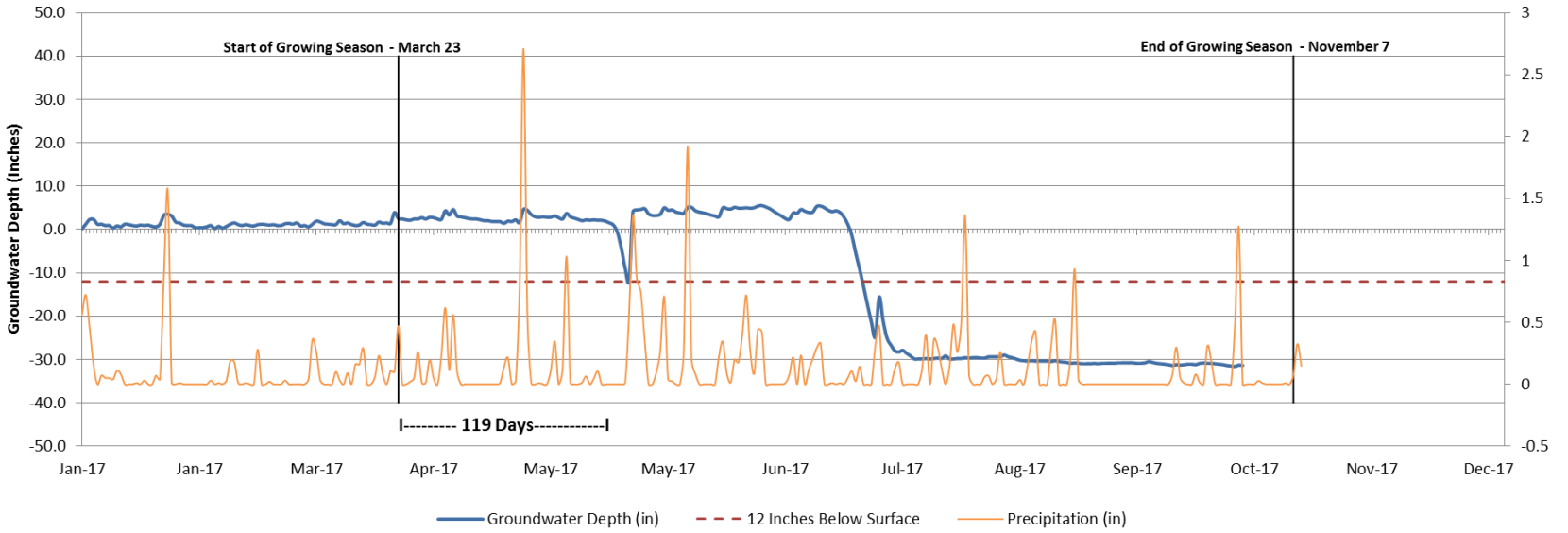


Figure 9.13 Suther (DBC) Groundwater Gauge 17 - MY6 (2017)

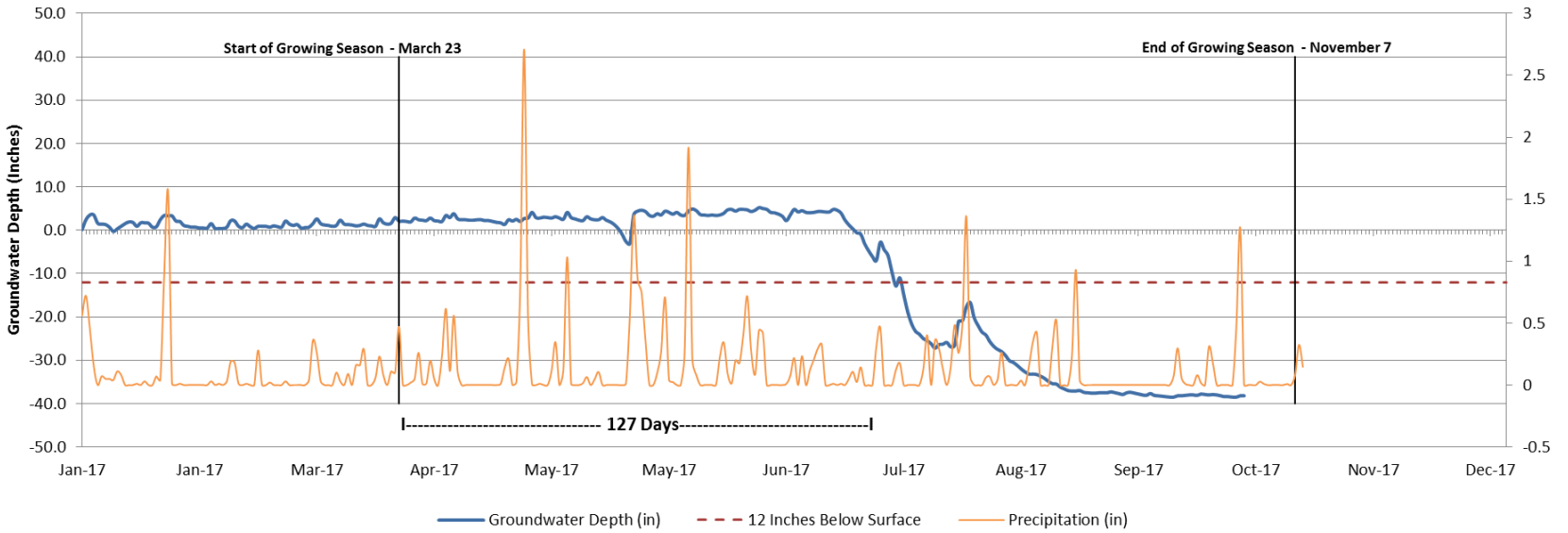


Figure 9.14 Suther (DBC) Groundwater Gauge 18 - MY6 (2017)

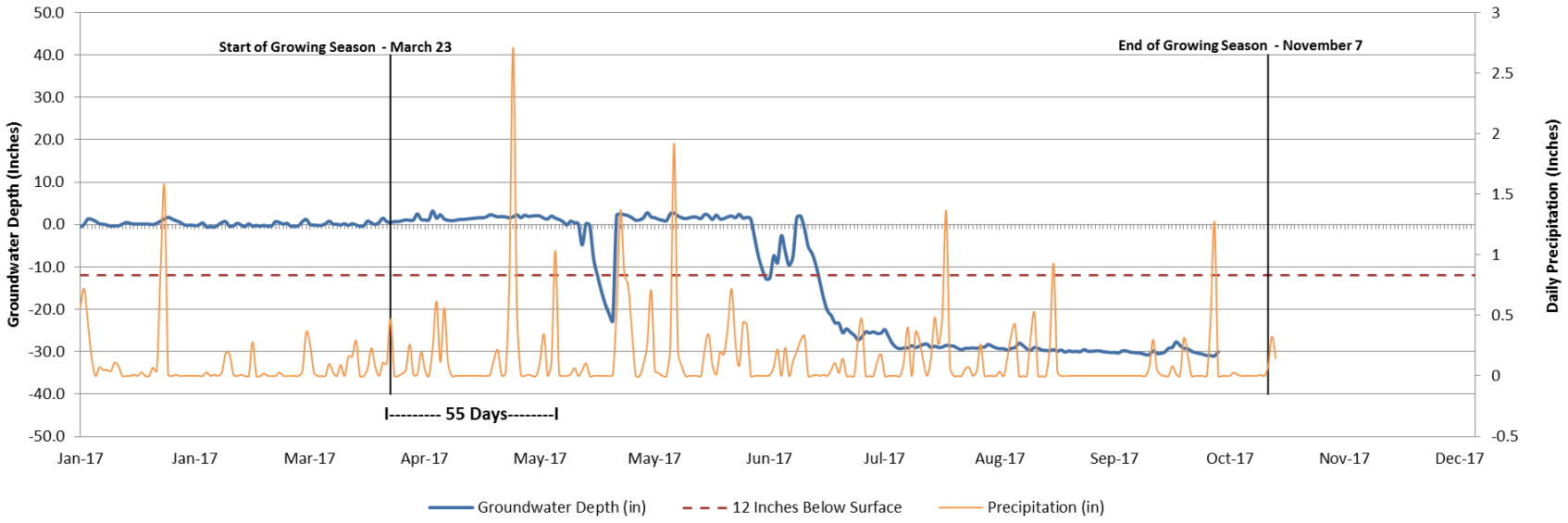


Table 13. Bankfull Flow Events (DBC and UT-1) and Continuous Baseflow Duration (UT-1)

Peak Stage Events Summary: Dutch Buffalo Cr -- 10 Apr 2014 to 07 Aug 2015					
stage > 0.5 ft above gage	Peak	ft above	ft above	stage	ft above
date range	Day	gauge	thalweg	real elev	BKF **
Apr 15-17, 2014	Apr 15	4.90	6.50	646.90	1.50
Apr 18-23, 2014	Apr 19	5.73	7.33	647.73	2.33
May 15-16, 2014	May 16	3.53	5.13	645.53	0.13
May 30-31, 2014	May 31	2.59	4.19	644.59	
Jul 21, 2014	Jul 21	2.16	3.76	644.16	
Aug 01, 2014	Aug 01	1.91	3.51	643.91	
Dec 24-25, 2014	Dec 24	1.16	2.76	643.16	
Jan 12, 2015	Jan 12	0.52	2.12	642.52	
Jan 23-25, 2015	Jan 24	2.04	3.64	644.04	
Feb 10, 2015	Feb 10	0.55	2.15	642.55	
Feb 27-Mar 3, 2015	Feb 28	1.16	2.76	643.16	
Mar 5-8, 2015	Mar 5	4.85	6.45	646.85	1.45
Mar 14-15, 2015	Mar 14	0.58	2.18	642.58	
Apr 15-16, 20145	Apr 16	0.84	2.44	642.84	
Apr 19-22, 2015	Apr 20	5.50	7.10	647.50	2.10

**** Hobo gauge in DBCr = 1.6 ft above THW; 6.0 ft below Top of Bank. Gauge location = Left bank, pool 200 ft upstream of DBCr confluence with UT-1 Trib. DBCr is incised and bankfull indicators are unlear; estimated BKF is 5.0 ft above THW, and 2.5 ft below TOB near Hobo gauge. THW elev @ gauge = 640.4**

Peak Stage Events Summary: UT-1 Tributary -- 07 Aug 2015 to 24 Mar 2016					
stage > 0.2 ft above gage	Peak	ft above	ft above	stage	ft above
date range	Day	gauge	thalweg	real elev	BKF
Aug 19, 2015	Aug 19	2.19	2.89	647.15	**0.65**
Oct 02-04, 2015	Oct 03	3.87	4.57	648.83	**2.33**
Oct 10-11, 2015	Oct 10	0.58	1.28	645.54	
Nov 02-03, 2015	Nov 02	3.41	4.11	648.37	**1.87**
Nov 07, 2015	Nov 07	1.01	1.71	645.97	
Nov 09-10, 2015	Nov 10	4.09	4.79	649.05	**2.55**
Nov 19, 2015	Nov 19	2.97	3.67	647.93	**1.43**
Dec 17-18, 2015	Dec 17	2.36	3.06	647.32	**0.82**
Dec 22, 2015	Dec 22	3.54	4.24	648.50	**2.00**
Dec 23-24, 2015	Dec 24	3.75	4.45	648.71	**2.21**
Dec 29, 2015	Dec 29	2.71	3.41	647.67	
Dec 30-31, 2015	Dec 30	5.13	5.83	650.09	**3.59**
Jan 01, 2016	Jan 01	0.11	0.81	645.07	
Jan 15-16, 2016	Jan 16	0.40	1.10	645.36	
Feb 16, 2016	Feb 16	2.20	2.90	647.16	**0.66**
Feb 23, 2016	Feb 23	1.42	2.12	646.38	
Feb 24-25, 2016	Feb 25	2.37	3.07	647.33	**0.83**

**** Hobo gauge in Trib UT-1 = 0.7 ft above THW; 1.5 ft below Top of Bank (BKF). THW**

Continuous Flow Events Summary: UT-1 Tributary -- 24 Mar 2016 to Nov 2017					
stage > 0.2 ft above gage	continuous				
date range	flow days				
Mar 24 - Jun 09, 2016	77 days				
Oct 08 - Oct 10, 2016	3 days				
Jan 11 - May 18, 2017	128 days				
May 21 - July 05, 2017	46 days				
July 06 - July 12, 2017	7 days				

Peak Stage Events Summary: UT-1 Tributary -- 24 Mar 2016 to Nov 2017					
stage > 2.1 ft above gage		ft above	ft above	stage	ft above
bankfull peak dates		gauge	thalweg	real elev	BKF
May 03, 2016		2.72	2.82	647.12	0.62
May 21, 2016		4.30	4.40	648.70	2.20
Oct 08, 2016		2.93	3.03	647.33	0.83
Jan 23, 2017		4.36	4.46	648.76	2.26
Apr 24, 2017		4.52	4.62	648.92	2.42
May 23, 2017		2.15	2.25	646.55	0.05
Jun 05, 2017		4.78	4.88	649.18	2.68
Jan 06, 2017		3.67	3.77	648.07	1.57
Jun 19, 2017		2.14	2.24	646.54	0.04
Jun 20, 2017		3.76	3.86	648.16	1.66

**** Hobo gauge in Trib UT-1 = 0.1 ft above THW; 2.1 ft below below Top of Bank (BKF). THW elev @ gauge = 644.3, BKF elev = 646.5**

Photo: Wrack material on floodplain, UT-1 near station 3+00, May 2017

Appendix E - Hydrologic Data: Suther Site DMS # 370

Table 14. Wetland GW Gauge Success Attainment, 2010-2017

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)			MY-06 (2017)			Multi-YR success	
			Days	% Gro	Crit	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	53	23	YES	Y	4 / 4
	PG-2	GW7	--	--	--	41	18	YES	39	17	YES	57	25	YES	59	26	YES	49	21	YES	55	24	YES	53	23	YES	Y	7 / 7
	PG-1	GW8	--	--	--	18	8	YES	3	1	NO	*MAL*	-	*Unk*	24	10	YES	12	5	NO	38	16	YES	20	9	YES	Y	4 / 6
B4		GW5-N	--	--	--	--	--	--	--	--	--	--	--	--	25	11	YES	*MAL*	-	*Unk*	25	11	YES	25	11	YES	Y	3 / 3
	PG-3	GW6	46	20	YES	64	28	YES	32	14	YES	56	24	YES	40	17	YES	43	19	YES	27	12	YES	26	11	YES	Y	8 / 8
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	3	1	NO	N	1 / 8
		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	121	53	YES	Y	6 / 6
	C-1	GW14													29	13	YES	49	21	YES	66	29	YES	53	23	YES	Y	4 / 4
		GW17													46	20	YES	57	25	YES	94	41	YES	127	55	YES	Y	4 / 4
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	54	24	YES	Y	8 / 8
	PG-6	GW3	19	8	YES	12	5	NO	17	7	NO	26	11	YES	38	17	YES	44	19	YES	26	11	YES	54	24	YES	Y	6 / 8
		GW12													11	5	NO	14	6	NO	12	5	NO	22	10	YES	N	1 / 4
		GW13													*MAL*	-	*Unk*	5	2	NO	4	2	NO	4	2	NO	N	0 / 4
		GW16													30	13	YES	51	22	YES	81	35	YES	119	52	YES	Y	4 / 4
		GW18													28	12	YES	46	20	YES	40	17	YES	55	24	YES	Y	4 / 4

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, April 2014
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 April 2014; not replaced.
Gages 11 to 18 – New well locations installed with reconditioned RDS GW gages.
Gauges 11 and 15 -- Cease monitoring after 2016, as per Mitigation Plan Addendum.

Appendix F. Addendum to Mitigation Plan, Nov 2016

PAT MCCRORY
Governor

DONALD R. VAN DER VAART
Secretary

MEMORANDUM

To: Interagency Review Team (IRT)
Todd Tugwell, USACE
Andrea Hughes, USACE
Steve Kichefski, USACE
Mac Haupt, NCDWR
Travis Wilson, NCWRC

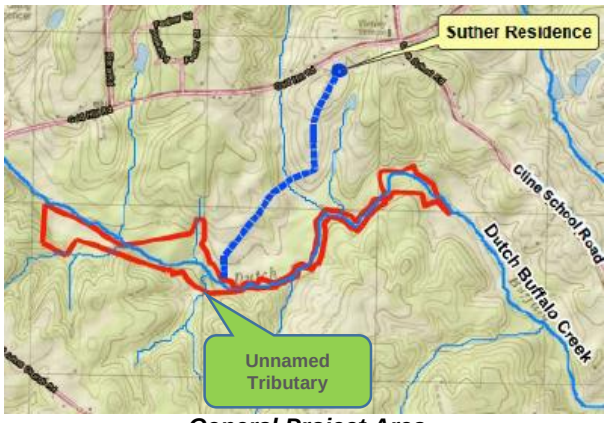
From: Harry Tsomides, NCDMS (Project Manager)
Greg Melia, NCDMS

Cc: Melonie Allen, NCDMS
Paul Wiesner, NCDMS
Tim Baumgartner, NCDMS

Subject: Addendum to Mitigation Plan - Assets and Monitoring Update
Suther Stream and Wetland Mitigation Site (DMS ID #370)
Cabarrus County, NC
Yadkin River Basin 03040105

Date: 11/21/2016

The Suther Stream and Wetland Mitigation Site is an NCDOT-acquired mitigation site that was transferred to DMS in March 2006. After careful review of project documents and history DMS would like to submit this addendum to the 2007 project mitigation (restoration) plan in order to clarify the project history, asset status, and remaining monitoring prior to planned close out in 2018.



General Project Area

DMS hopes to provide the most accurate and up to date project to the IRT at eventual close out, and establishing general agreement on close out expectations will hopefully facilitate the close out process. As the result of some changes to project monitoring approaches and asset expectations following

construction, a project meeting among the IRT and DMS was held at the Site to discuss the project. All project reaches and wetlands were field-observed and discussed. At the meeting (held on 6/9/2015) DMS expressed an intention to submit this memo of addendum in order to organize and clarify the historical project reporting components, and propose an asset scenario and remaining monitoring protocol that are accurate, realistic, and will be an appropriate reflection of mitigation yields if the project shows adequate success for planned site close out in the summer of 2018.

The following persons attended the June 9 field meeting:
Todd Tugwell, USACE
Andrea Hughes, USACE
Steve Kichefski, USACE
Virginia Baker, NCDWR
Travis Wilson, NCWRC
Harry Tsomides, NCDMS
Greg Melia, NCDMS

1. Project Setting, History and Timeline

The Site is located along Dutch Buffalo Creek and an Unnamed Tributary (Ut) in Cabarrus County. Dutch Buffalo Creek is a third order stream with an approximate drainage area of 23 square miles at the farthest downstream point of the project. The unnamed tributary (UT) to Dutch Buffalo Creek is a first order stream with an approximate drainage area of 0.3 square miles. Dutch Buffalo Creek drains into the Pee Dee River and is listed as WS-II class waters. Following are tabular summaries of the project setting and activity time line:

Project Setting & Classifications
XY Coordinates: 36 ° 27′ 05″ N, 80 ° 29′ 32″ W

County	Cabarrus
General Location	Northeast of Concord
Basin	Yadkin
Physiographic Region	Piedmont
Ecoregion Level IV	Southern Outer Piedmont
USGS Hydro Unit	03040105
NCDWQ Sub-basin	03-07-12
Wetland Classification	Riparian
Thermal Regime	Warm
Trout Water	No
Project Performers	
Source Agency	NCDOT
Provider	NCDMS
Designer	Jordan Jones Goulding
Monitoring Firm (through 2011)	Jordan Jones Goulding
Monitoring Firm (current)	RJ Goldstein / MMI
Vegetation Remediation	H.A.R.P.
Approved for transfer to Stewardship	TBD
Stewards	TBD (NCDOT)

Project Activities and Timeline

Milestone	Day/Month
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
Monitoring - Report Year 5	(Nov 2016)*
Monitoring - Report Year 6	(Nov 2017)*
Closeout Submission	(Jun 2018)*

*planned

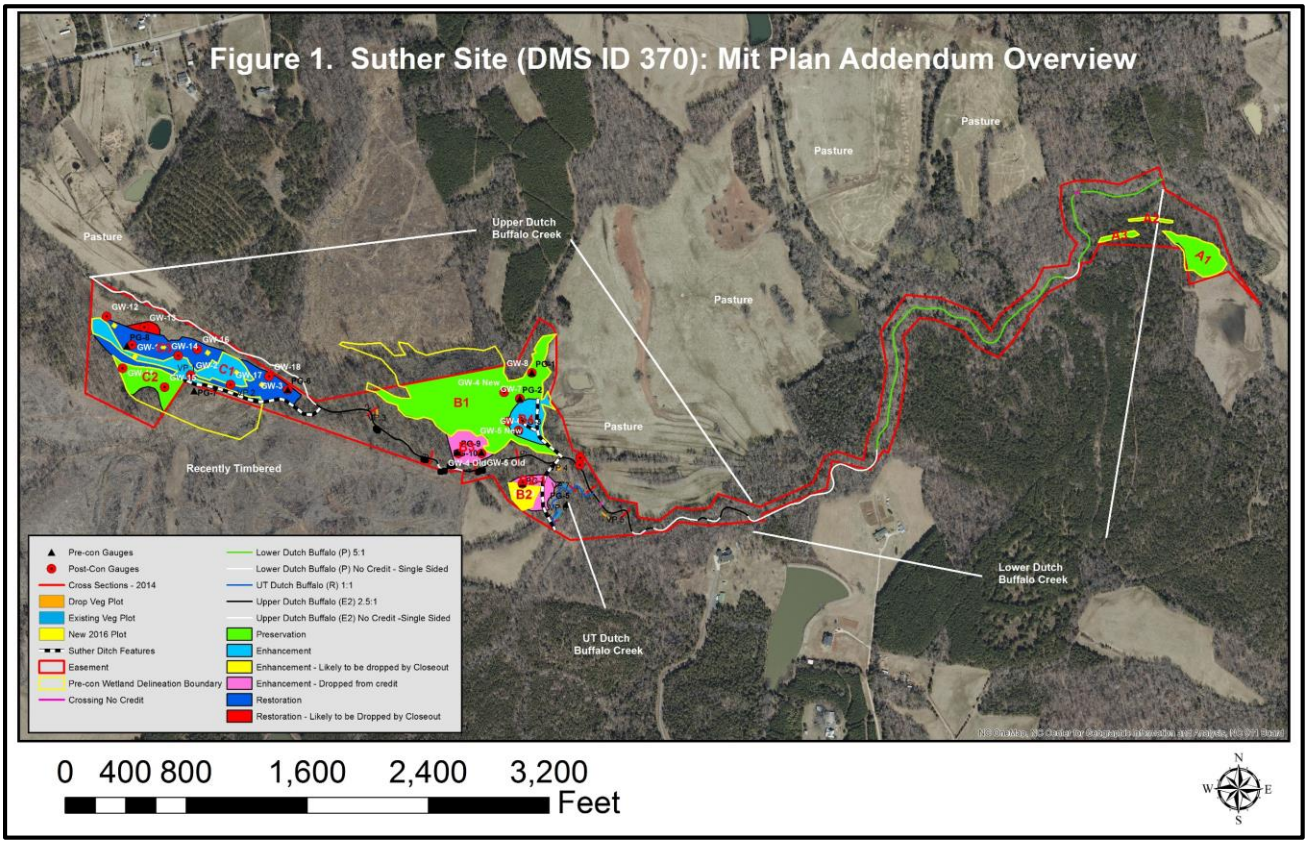


Figure 1 – Mitigation Plan Addendum Overview

2. Project Streams

To be candid, the original project Restoration Plan (2007) lacks clarity and internal consistency regarding project stream assets. The complete set of assets are distributed across both tables and maps but are not always consistent in both places. This was discussed some at the field meeting. A downgrading of assets was made during production of the MY0/baseline report, when it was determined that single sided streams (essentially one-sided easement sections along the main channel) and two 60-foot crossings had not been omitted from asset calculations. A recent (2016) detailed GIS analysis by DMS staff revealed a few additional segments affected by narrow or absent easement, and were subsequently removed from project assets (see Table 1 - Stream Asset History). Thus, the total length of the main channel spanning the upper and lower project boundaries is 10,700 feet, but there are multiple single sided easement segments that resulted in the reductions in the creditable footage over the projects history (see Table 1 below and white stream segments in Figures 1 through 4).

Suther Site - Stream Mitigation Quantity History (all units in linear feet)

Reach	Restoration Level	Restoration Plan (2007)	404 Permit (2008)	Baseline MY0 Report (2010)	Updated / Creditable[1] (2016)
Upper DBC	Enhancement II	3611	3611	3004	2763
Lower DBC	Preservation	4678	4678	3583	3413
Unnamed Tributary	Restoration	608	608	608	608

DBC = Dutch Buffalo Creek

[1]Reflects all subtractions of single sided stream features (white segments in Figure 1) and crossings

Upper Dutch Buffalo Creek (Enhancement Level II)

The NCDOT feasibility study for the site (EcoScience, 2002) indicated the potential for stream restoration (1:1 credit ratio) along most of Dutch Buffalo Creek. While this reach is enlarged and incised, there have been multiple occasions where the main flood feature has been accessed since 2007, and prior. There are areas of this reach where the channel is attempting to develop pattern and belt width.

After further evaluation by NCDMS and designer in the 2006-2007 design development time frame, it was determined that the size of the drainage area, established streamside canopy, and grading-related impacts that would be incurred during restoration attempts would be practically difficult and incur excessive ecological impact. Multiple approaches were considered; site elevations would not permit a Priority I restoration, and the only potential outcome would have been a Priority 2 with a moderate bench, which still would have resulted in the removal of many mature trees. These reasons, combined with the documented presence and impact from livestock along this reach, and the historical management of vegetation, led to the Enhancement II approach ultimately chosen.

After subtracting single sided stream segments and active crossings, the creditable Enhancement Level II length of Upper DBC is 2763 linear feet

Lower Dutch Buffalo Creek (Preservation)

This reach was also initially proposed by NCDOT to have restoration (1:1) potential. However, stream conditions improve substantially with a better floodplain connection and bank conditions relative to Upper DBC. Cattle pasture borders this reach as well. While documentation and landowner discussions indicate that livestock crossed in this area on occasion and may have had some access, livestock as a whole did not impact the stream to the same degree as the Upper DBC. Access was limited to the crossings, because there was a fence running near the top of bank, meaning there were livestock pressures along the reach, but to a lesser extent, and cattle had already been fenced out. The new easement and fence runs along the outer tree line on the northern side of the preservation reach and provides a much wider buffer exclusion zone with no fence breaks. For these reasons, and intervention concerns similar to those stated above for Upper DBC, this reach was designated as preservation during the design phase even though there was over 100 additional feet of cattle exclusion as a result of the new fencing.

After subtracting single sided stream segments and active crossings, the creditable Preservation length of Lower DBC is 3,413 linear feet.

Unnamed Tributary to DBC (Restoration)

Prior to restoration this tributary was deeply incised and appeared to have been modified or straightened. The majority of the substrate in the tributary was fine sand. The stream banks had high angles, with little to no vegetation and represented a Rosgen G-type sandy gully. Overall, the instability of the stream was contributing to stream bank loss, increased sedimentation, and poor aquatic habitat.

Unnamed Tributary prior to restoration

Unnamed Tributary immediately after restoration

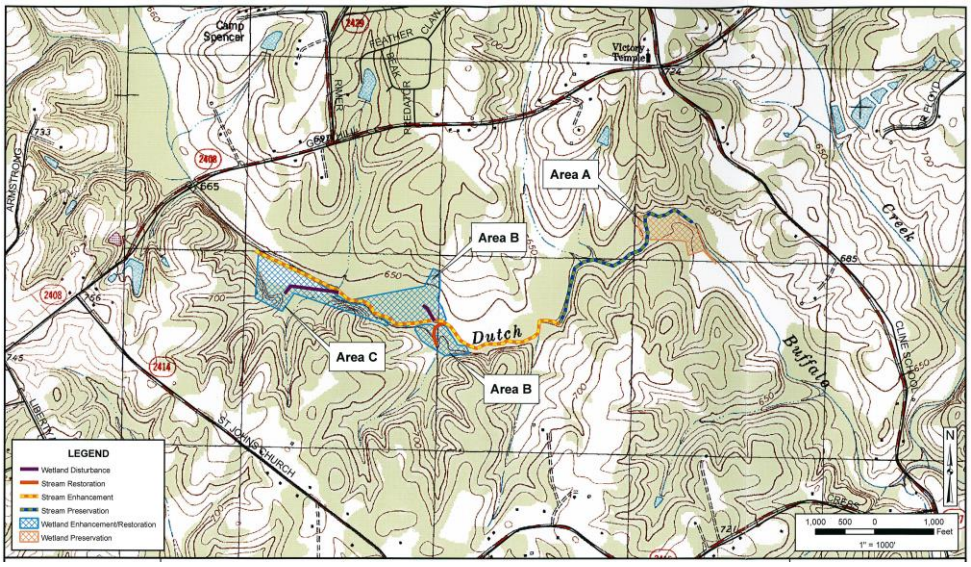
The UT was restored using a Priority Level 1 and 2 approach as a C/E channel. Stream dimension, pattern and profile were re-established to maintain stability and establish riffle/pool sequences. The channel was relocated onto the floodplain and transitioned to meet up with the main channel of Dutch Buffalo Creek. Adjacent stream banks and riparian zones were replanted using native species appropriate to the area. Brush mattresses of native plant material were installed on the outside meander bends to provide bank protection and habitat. A cross-vane was installed at the beginning of the project above the channel plug to provide grade control, habitat, and bank protection while vegetation is established. A series of log vane step-pools were installed to transition the UT from its elevation to the elevation of the main channel.

A farm pond about 2400 l.f. upstream from this project reach regulates flow to the UT and keeps stream flow somewhat constant during the wet season. During drier periods, the flow available for the stream is minimal because the pond stores much of the runoff until it reaches the outlet elevation. Therefore, the pond acts to moderate stream flow rate variations and appears seasonally dry especially during drier years. A continuous stage sensor is currently reporting flow data for the Unnamed Tributary and have indicated multiple bank full events since early 2015. From August 2015 to December 2015, the in-stream sensor recorded five apparent bankfull flow events in the UT (August 19, October 3, November 2, November 10, and November 19). Matted vegetation and wrack lines were observed in multiple locations along the tributary floodplain during the May, September, and December site visits in 2015.

The creditable Unnamed Tributary restoration footage has remained at 608 l.f. throughout the project design, permitting, and monitoring phase.

3. Project Wetlands

The project includes three areas/groups of wetlands (A, B, C) in the floodplain of the projects main stem (see following figure and table from the 2007 wetland delineation and request for jurisdictional determination).



Jurisdictional Area	USGS Stream Association	Classification	Flow regime / Community	Acreage GPS Located
Area A				
A-1	Dutch Buffalo Creek	PSS1B	Scrub-shrub	1.39
A-2	Dutch Buffalo Creek	PSS1E	Scrub-shrub	0.12
A-3	Dutch Buffalo Creek	PSS1B	Scrub-shrub	0.16
Area B				
B-1	Dutch Buffalo Creek	PFO1B/E	Forested	12.79*
B-2	Dutch Buffalo Creek	PFO1A	Forested	0.55
B-3	Dutch Buffalo Creek	PFO1A	Forested	0.27
Area C				
C-1	Dutch Buffalo Creek	PFO1B/E PEM1B/E	Forested-emergent	4.34
			Total Wetland Acreage	**19.62**

* This area includes 3.6 acre of wetland that is located outside the conservation easement

While ultimately DMS would like to focus on closing out the project with assets that reflect reasonable merging of prior documentation with project performance and function based on the implemented mitigation, the wetland assets in the historical documents are difficult to follow and warrant a detailed explanation. As an example, none of the acreage from wetland B1 was included in the asset table, although it was presented in the mitigation plan maps and in the map associated with the jurisdictional determinations. The following asset summary and figures reflect how assets have been documented as well as adjustments/reductions that have been made based on ground water gage performance to date.

Wetland Group A

Wetland group A consists of three preservation wetlands and are identified in the permits throughout the rest of the document history.

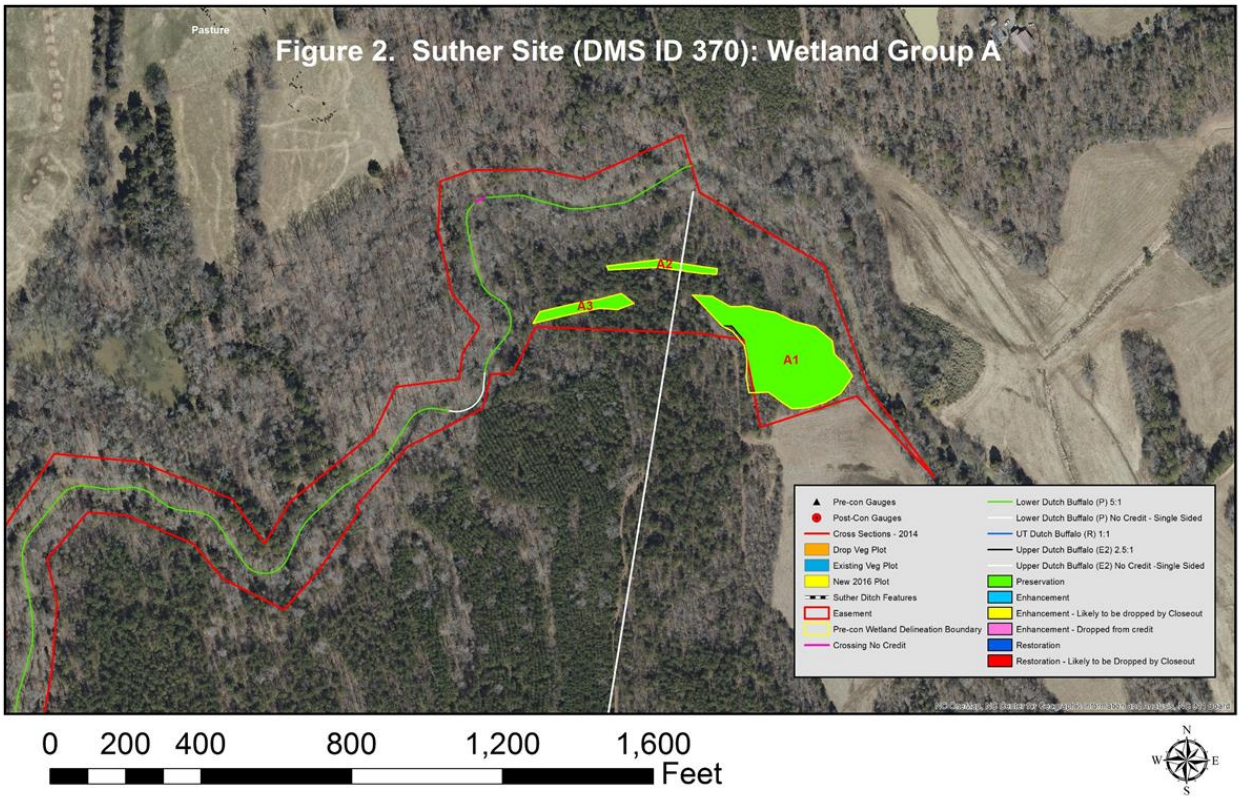


Figure 2 – Wetland Group A

The creditable preservation acreage has been adjusted slightly downward from 1.67 acres since 0.03 acres have been identified just beyond the conservation easement boundary abutting wetland A-1 (see Appendix Figure 2). The current creditable preservation acreage in this wetland group will be presented as 1.64 acres.

Wetland Group B

Wetland group B in the center of the project site consists preservation and enhancement wetlands, including a small wetland area originally identified along the Unnamed Tributary restoration.

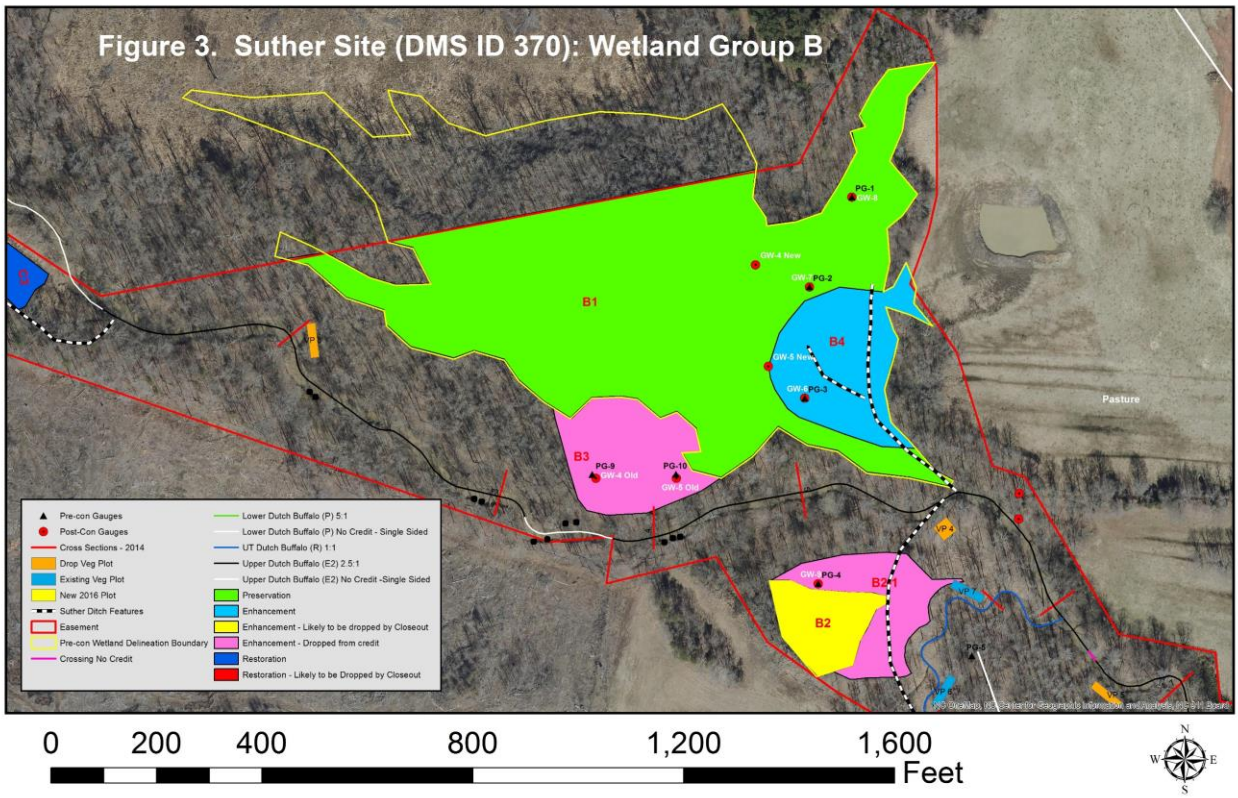
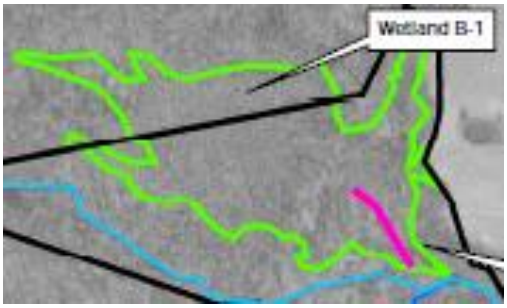


Figure 3 – Wetland Group B

Wetland B-1

This 9.19-acre wetland area is shown Fig 5.1a of the 2007 site restoration plan, and Figure 1.2 of the Baseline (MY0) Monitoring Report (however this was inadvertently omitted as a discreet entry from these report tables). The originally delineated wetland area of 12.79 acres was noted as having 3.6 acres outside the conservation easement, so the B-1 area total is 9.19 acres within the conservation easement.



Wetland B-1 Cutout from Fig 5.1a of the 2007 site restoration plan

Wetland B-1 has been reduced from 9.19 acres to 7.83 acres to reflect removal of the enhancement area from this wetland, which is now identified as Wetland B-4 (see above Figure 3). Wetland B-4 is being proposed as an enhanced wetland. The pink line shown is the disturbed acreage where ditch plugging occurred.
The creditable preservation acreage for Wetland B-1 is 7.83 acres.

Wetland B-4
The 1.36-acre area within the original preservation Wetland B-1 was mistakenly not presented as an Enhancement wetland in the design and as built documents. This area is shown in Appendix Figure 3 and is now being separated out to reflect the enhancement approach the plugging of ditch indicated and now appropriately reflected by gage data.

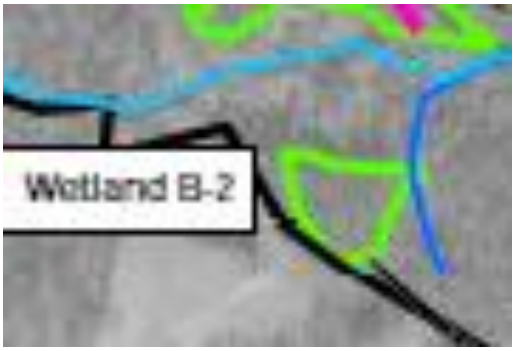
The 2007 Restoration Plan states the following regarding this enhancement acreage originally included in Wetland B-1, and now being called Wetland B-4:

"Similar to Wetland Restoration Area C, the area adjacent to Reference Wetland B-1 (referred to as Wetland Enhancement Area B) has been altered by an existing drainage ditch cut through the southeastern edge of Wetland B-1 and drains to Dutch Buffalo Creek. Similarly, there are also several side ditches off of this ditch. The drainage ditch was dug by the landowner's father (L. Suther, 2006.). Over time, the ditches have incised due to the elevation of Dutch Buffalo Creek and cattle activity. Cattle have been allowed to trample this area and graze on vegetation, which has resulted in reduced vegetation and increased runoff. These stresses have likely exacerbated the incision of the streams. Representative photographs of this channel are shown in Appendix 1. These channelized ditches effectively drain surface water and shallow groundwater from the surrounding area by providing a drainage way at an elevation lower than potential groundwater levels. Two approaches will be used in these areas. The more incised portions of these channels will be partially filled and then restored with shallow log vane step-pools."

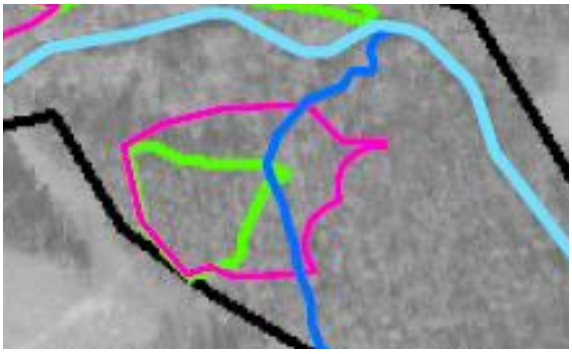
The ditch plugging activities during construction along with livestock exclusion and elimination of cattle impacts are the basis for enhancement assets. The performance of gage 6 compared to pre-gage (mean hydroperiod of 20.3 days from 2010 through 2015 compared to pre-construction hydroperiod of 3.4 days in PG-3, see GW gage performance table below) suggests that the ditch plugging has been successful in raising the water table up towards pre-disturbed conditions. The fencing installed as part of the project is intact and continues to exclude livestock from this area as another enhancement measure taken.

Based on the level of intervention (ditch plugging and livestock exclusion) and success criteria achieved, the 1.36-acre area of Wetland B-4 is identified as wetland enhancement.

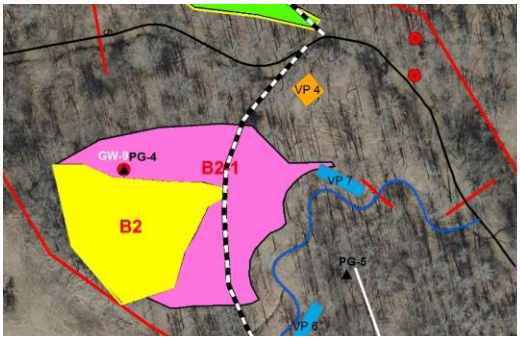
Wetland B-2
B-2: Due to gage performance to date it is unlikely that this polygon will be creditable at closeout. Its original conception as enhancement was based on the partial filling of the relic channel depicted in fig 3 along its border that would no longer drain seepage from the southwest of wetland B2.
B-2-1: Both the soil characteristics of this polygon and gage performance has led DMS to eliminate this as a creditable asset. See footnotes 7 and 12. Its original conception as enhancement was based the partial filling of the relic channel depicted in fig 3 along its border that would no longer drain seepage from the southwest of wetland B2.



Wetland B-2 Cutout from Fig 5.1a of the 2007 site restoration plan



Wetland B-2/B-2-1 Cutout from Fig 1.2 of the 2010 MY0 Baseline Report



Current status of Wetland B-2 Area

Both areas in Wetland B2 (B2 and B2-1) are being removed from crediting due to inadequate attainment of hydrology criteria.

Wetland B-3

Both wells in this area failed to meet hydrology success criteria across four consecutive years of data collection between 2010 and 2013. This area, despite not being included in the original 2007 delineation, appeared as an understory-planted enhancement area in the planting plan of the 2007 restoration plan, and erroneously got carried over to the MY0/baseline report.

Enhancement Wetland B3, having no documented validity as a site wetland, has been dropped from crediting.

Wetland Group C

Wetland group C in the eastern end of the project site consists varying levels of wetland mitigation based on the original delineation and subsequent project objectives. The activities included ditch plugging in order to improve ground water hydrology, preserving existing wetlands, and wetland planting in enhancement and restoration areas.

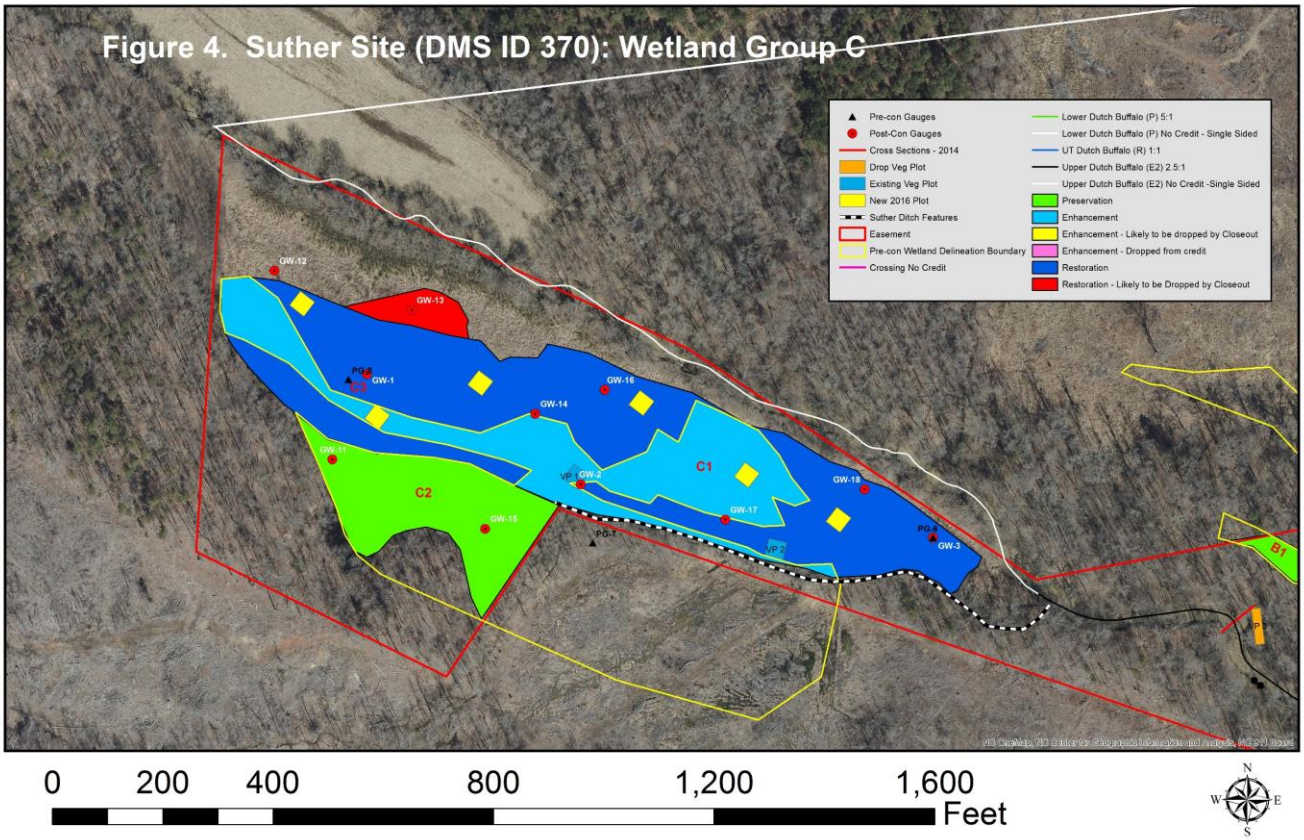


Figure 4 – Wetland Group C

Wetlands C-1(enhancement) and C-3 (restoration)

Wetland C-1 includes the enhancement area shown in Figure 4 (above) that was improved via hydrological means (ditch plugging) and native woody plantings. The surrounding area shown as Wetland C-3 was not captured in the 2007 jurisdictional determination but was targeted as a potential restoration area where hydrology and wetland status could be restored as part of the same activities aimed at enhancing Wetland C-1. This entire meadow had been historically managed as a livestock pasture planted in switch grass. A drainage ditch and some side ditches were cut by the landowner's father through the southern edge of the switch grass field and drained to Dutch Buffalo Creek. The following are representative photographs of this channel taken April 2007:

Wetland C ditch draining wetland

Wetland C area switchgrass field

The ditches acted to drain surface water and shallow groundwater from the switch grass area by providing a drainage route at an elevation lower than potential groundwater levels. The first 100 feet of this channel (from convergence with Dutch Buffalo Creek moving upgradient) were partially filled and then restored with shallow log steps to retain more water in the wetland while allowing a gradual outlet. The remainder of these channelized ditches were plugged with a combination of clay plug material and native fill material to restore the ditches to current grade and try to restore groundwater to its pre-impacted levels. Although volunteer native vegetation has been strong in some sections, parts of Wetland C-1 required supplemental planting in winter 2015/2016 to establish a denser and more diverse natural community.

In enhancement Wetland C-1, all three gages have exceeded success criteria. GW-2 well data from 2010 through 2016 indicate success criteria were met for 5 out of 5 years (there were 2 years where the well malfunctioned). The other two wells, GW-14 and GW-17, were installed in early 2014 in an effort to provide greater well coverage across this wetland. Both these wells have met criteria for all three years from 2014 through 2016 and will be monitored again (along with GW-2) in 2017.

In restoration Wetland C-3, GW-1 and GW-3 have both shown a growing season hydroperiod of 11% or greater (success criteria was established at 8%) for each of the last 3 years of monitoring from 2014 through 2016. These will be monitored again in 2017. Additionally, GW-16 and GW-18, along the northern perimeter of Wetland C-3, have each shown a growing season hydroperiod of 12% or greater for each of the last 3 years of monitoring; these will also be monitored again in 2017. Conversely, GW-12 and GW-13, towards the northwest corner of the meadow, failed to show hydroperiods greater than 2 to 6 percent over the past three monitoring years and have thus been excluded from crediting.

Based on levels of restoration and enhancement activity and post-construction performance monitoring to date, Wetland C-1 is being proposed as a 2.31-acre enhancement area and wetland C-3 as 4.84 acres of restored wetlands, after eliminating the GW-12 and GW13 non-attainment areas. Additional data between now and close out will be evaluated and their status updated accordingly.

Wetland C-2 (preservation)

This forested preservation area was originally part of the 4.34 acres of the Area C jurisdictional determination which had it coupled with the current C-2 enhancement area. To confirm the wetland status, both recently installed wells in this area, GW-11 and GW-15, have shown growing season hydroperiods of 31% or longer for each of the past three years of data collection (2014 through 2016).

This existing forested wetland is classified as preservation and the total area within the easement is 1.52 acres.

4. Credit Summary

Reach ID	Existing Footage/ Acreage	As-Built Stationing/ Location	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 acres to yield 7.83 acres
		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	2.5:1	0.54	Ditches plugged, livestock excluded, and and hydrology improved
Wetland Group C	4.34*	C-1	Enhancement	2.31	2.31	2:1	1.15	Planting and ditch plugging
		C-2	Preservation	1.52	1.52	5:1	0.3	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.

Component Summation

Restoration Level	Stream (lf)	Riparian Wetland (acres)
Restoration	608	4.8
Enhancement	N/A	3.7
Enhancement I	0	N/A
Enhancement II	2,763	N/A
Preservation	3,413	9.35

Overall Credits

Asset Category	Overall Credits
Stream	2,395.8
Riparian Wetland	8.73

5. Conclusion

DMS appreciates the attention and review of this information in advance of close out. If there are any major concerns or questions with the approaches, need for another field meeting, or other feedback we would welcome any comments or questions we might be able to address at close out.

APPENDIX

Wetland gage data summary

Wetland GW Gage Performance, 2010-2016

Pre-Constr. Gage ID(HP%)	Wetland	Gage Site #	MY-01 (2010)			MY-02 (2011)			MY-xx (2012)			MY-xx (2013)			MY-03 (2014)			MY-04 (2015)			MY-05 (2016)			Success	
			Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Meets	#/Total
PG-2(23.7)	B-1	7	--	--	--	41	18	YES	39	17	YES	57	25	YES	59	26	YES	49	21	YES	55	24	YES	Y	6 / 6
	B-1	4-N	--	--	--	--	--	--	--	--	--	--	--	--	28	12	YES	44	19	YES	70	31	YES	Y	3 / 3
PG-1(30.2)	B-1	8	--	--	--	18	8	YES	3	1	NO	*MAL*	-	*Unk*	24	10	YES	12	5	NO	38	16	YES	N	3/ 5
PG-4(1.3)	B-2	9	10	4	NO	3	1	NO	6	3	NO	13	6	NO	23	10	YES	6	3	NO	5	2	NO	N	1 / 7
	B-2	10	20	9	YES	9	4	NO	9	4	NO	*MAL*	--	*Unk*	--	--	--	--	--	--	--	--	--	N	1 / 4
PG-5(3.0)	B-2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PG-9(1.7)	B-3	4-O	4	2	NO	0	0	NO	3	1	NO	9	4	NO	--	--	--	--	--	--	--	--	--	N	0 / 4
PG-10(3.9)	B-3	5-O	0	0	NO	3	1	NO	7	3	NO	15	7	NO	--	--	--	--	--	--	--	--	--	N	0 / 4
PG-3(3.4)	B-4	6	46	20	YES	64	28	YES	32	14	YES	56	24	YES	40	17	YES	43	19	YES	27	12	YES	Y	7 / 7
	B-4	5-N	--	--	--	--	--	--	--	--	--	--	--	--	25	11	YES	*MAL*	-	*Unk*	25	11	YES	Y	2 / 2
	C-1	2	52	23	YES	71	31	YES	44	19	YES	*MAL*	-	*Unk*	*MAL*	-	*Unk*	62	27	YES	93	41	YES	Y	5 / 5
	C-1	14													29	13	YES	49	21	YES	66	29	YES	Y	3 / 3
	C-1	17													46	20	YES	57	25	YES	94	41	YES	Y	3 / 3
PG-7(24.6)	C2	ref.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	C-2	11													78	34	YES	87	38	YES	129	56	YES	Y	3 / 3
	C-2	15													71	31	YES	84	37	YES	126	55	YES	Y	3 / 3
PG-8(12.9)	C-3	1	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(3.4)	C-3	3	19	8	YES	12	5	NO	17	7	NO	26	11	YES	38	17	YES	44	19	YES	26	11	YES	Y	5 / 7
	C-3	12													11	5	NO	14	6	NO	12	5	NO	N	0 / 3
	C-3	13													*MAL*	-	*Unk*	5	2	NO	4	2	NO	N	0 / 3
	C-3	16													30	13	YES	51	22	YES	81	35	YES	Y	3 / 3
	C-3	18													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) HP = Hydroperiod

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; some wells stopped recording during this period.

10 Apr 2014: MMI-RJGA replaced 9 old wells and installed 8 new well 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

Remaining monitoring

The following table highlights the remainder of monitoring activities carrying through 2017 into expected close in 2018.

Asset	Morph Stability	Number Years by Closeout	Vegetation	Number Years by Closeout	Hydrology	Number Years by Closeout	Visual	Number Years by Closeout
Upper DBC	2014-2016	3	NA	NA	2010-11; 14-17	6	2010-11; 14-17	6
Lower DBC	NA	NA	NA	NA	NA	NA	2010-11; 14-17	6
Unnamed Tributary	2010-11; 14-17	5	2010-11; 16-17	4	2010-11; 14-17[1]	6	2010-11; 14-17	6
Wetland A	NA		NA		NA		2010-11; 14-17	6
Wetland B1	NA		NA		2010 - 2017	8	2010 - 2017	8
Wetland B2	NA		NA		2010 - 2017	8	NA	
Wetland B2-1	NA		NA		2010 - 2013	4	NA	
Wetland B3	NA		NA		2010 - 2013	4	NA	
Wetland B4	NA		NA		2010 - 2017	8	NA	
Wetland C1	NA		2010-11; 16-17[3]	2-4[3]	2010 - 2017	4-6	2010 - 2017	6
Wetland C2	NA		NA		2014 – 2016	3[2]	NA	
Wetland C3	NA		2010-11; 16-17[3]	2-4[3]	2010 - 2017	4-8	2010 - 2017	6

Indicates assets are deemed non-creditable

1 – In 2015 hydrology monitoring included baseflow monitoring for 2015-2017
2 – Assignment of wetland C2 to preservation means hydro monitoring will cease
3 – 1 veg plot was measured in in C1 and C3 in 2010 to 2011. There was a substantial section of these wetlands that required replant. This occurred in winter 2015 and these plants will be monitored in 2016 and 2017 with the new plots depicted figure 4.