YEAR 3 MONITORING REPORT

UT MILLERS CREEK
Duplin County, North Carolina
DMS Project ID No. 95719, Contract No. 5000, USACE Action ID No. SAW-2013-00386
DWR Project No. 13-0187

Prepared for:

NCDEQ Division of Mitigation Services (DMS)
217 West Jones St., Suite 3000A
Raleigh, North Carolina 27603

Construction Completed: February 2015
Morphology Data Collected: January 17, 2017
Vegetation Data Collected: October 25, 2017
Hydrology Data Collected: November 7, 2017
Submitted: January 2018

Prepared by:

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I HEREBY CERTIFY THAT THE DOCUMENT CONTAINED HEREIN, UT MILLERS CREEK YEAR 3 MONITORING REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION.

SIGNED SEALED, AND DATED THIS 19TH DAY OF JANUARY 2018.

Chris L. Smith, PE

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1.0 PROJECT SUMMARY

The following report summarizes the vegetation establishment, stream stability, and wetland hydrology for Year 3 monitoring for the UT Millers Creek Site (hereafter referred to as the "Site") in Duplin County, North Carolina.

1.1 Goals and Objectives

The primary goals of the UT Millers Creek stream and wetland mitigation project focus on:

- Reducing stressors to water quality
- Providing and enhancing flood attenuation
- Restoring and enhancing aquatic, semi-aquatic and riparian habitat, and
- Restoring and enhancing habitat connectivity with adjacent natural habitats.

The following objectives accomplish the goals listed above:

1. Removing stressors to water quality and increasing attenuation is directly tied to:
    a. Restoration of the formerly deeply incised and entrenched UT as a Priority I (PI) restoration where bankfull and larger flows access the historic floodplain allowing nutrients, sedimentation, trash and debris from upstream urban runoff to settle from floodwaters.
    b. Restoration of the UT as PI restoration allows the Site to mitigate flood flows by reconnecting bankfull and higher flows to its historic floodplain.
    c. Restoration of the riparian buffers and wetlands adjacent to the UT (i.e. restoration of an existing pond and ditch back to riparian wetlands) allows floodwaters to attenuate, in turn reducing stressors from upstream impacts.
    d. Restoration of wetland hydrology within the riparian buffer supports hydrophytic vegetation, which assists in the uptake, storage and fixation of nutrients and sedimentation from overbank flows. Adjacent low quality pine plantations were removed and planted with native hydrophytic vegetation.
2. Restoring and enhancing aquatic, semi-aquatic and terrestrial habitat is directly tied to:
    a. Introduction of woody materials such as planted vegetation, log sills, soil lifts and toe wood to the restored channel. Woody materials will promote shading, bed form diversity and foraging opportunities for aquatic organisms, benthic macroinvertebrates, and fish.
    b. Restoration of native vegetation to the stream channel banks and the adjacent riparian corridor has diversified flora and provides an abundance of available foraging and cover habitat for amphibians, reptiles, mammals and birds.
    c. Restoration of wetland hydrology and introducing floodwaters back to the historic floodplain provides a diversity of habitats for semi-aquatic flora and fauna that may have not been seen on the Site since before anthropogenic disturbances.
3. Habitat restoration and connectivity can be directly tied to:
    a. The removal of existing pine plantations and replanting of native vegetation.
    b. The restored community ensures a protected habitat corridor between the Site and the downstream mature riparian buffers and upland habitats.

1.2 Success Criteria

Monitoring of restoration efforts will be performed until success criteria are fulfilled. Monitoring includes stream channel/hydraulics, wetland hydrology, and vegetation. In general, the

restoration success criteria, and required remediation actions, are based on the Stream Mitigation Guidelines (USACE et al. 2003) and the Ecosystem Enhancement Program Monitoring Requirements and Performance Standards for stream and/or Wetland Mitigation (NCEEP 2011). Project success criteria are further detailed in the Baseline Monitoring Document & As-Built Baseline Report (ICA 2015).

1.3 Background Summary

The North Carolina Department of Environmental Quality Department of Mitigation Services (DMS) contracted ICA Engineering, Inc. (ICA) to restore 2,625 linear feet of the Unnamed Tributary to Millers Creek (UT) and 4.5 acres of riparian wetlands within the Site to assist in fulfilling stream mitigation goals in the watershed (Table 1 and Table 4). The Site is located approximately one-half (0.5) mile west of Magnolia in Duplin County, North Carolina and contains an unnamed tributary to Millers Creek and associated restored riparian wetlands (Figure 1). The Site is located within DMS Targeted Local Watershed Catalogue Unit (CU) 03030006. The Site is comprised of one property owned by William Jeffrey Hatcher and wife Susan King Hatcher (PIN # 247100987405). Additional information concerning project history is presented in Table 2.

1.4 Vegetation

Vegetation is meeting success criteria across the site following the third year of monitoring. Overall, the site is averaging 715 planted stems per acre; exceeding the success criteria of 320 stems per acre after Year 3 Monitoring. Additionally, all plots are individually exceeding success criteria by over 50%.

Insect damage and deer browse was noted within Plot 2, however all but one of the damaged plants have a vigor of 3 or higher. It is not expected that the insects and deer will contribute to reduced survival rates on-site; however, HDR|ICA will continue to monitor the status of the damage.

In Plot 3, the majority of stems have a vigor of 2 and have shown little to no growth over the past monitoring year. Monitoring Well 4 indicates that the area immediately upstream of Plot 3 was covered by 10 inches of surface water for over half of the growing season. HDR | ICA will closely monitor vegetation in this area and may take corrective action if necessary.

Two bare areas and two areas of thin grass remain present on-site. The thin grass areas noted near station 25+00 in Year 2 report appear to have filled in after supplemental seeding. In the two thin grass areas that remain near station 35+00, vegetation is beginning to establish. The total acreage of bare areas is 0.23 (1.9% of planted acreage) and the total acreage of thin grass is 0.14 (1% of planted acreage). Problem areas were reseeded in January and April of 2017. Following seeding, the thin grass area was reduced by 50% but bare areas have not improved.

1.5 Stream Stability

The UT Millers Creek reach is stable and functioning as designed. Cross section geometry has remained stable over the course of Monitoring Year 3.

HDR|ICA repaired the areas of surficial erosion at station 33+00 in January of 2017 by transplanting clusters of *Juncus effuses*, spreading temporary seed and laying out excelsior matting. These areas appeared stable during follow up visits during April of 2017.

Channel bank stability continues to benefit from the maturation of vegetation along the channel toes and bank. Two areas of minor erosion have developed around soil lifts due to the sandy soil composition on-site. All instances of erosion noted during Year 3 monitoring were minor and will likely fill in with vegetation over time.

The site has experienced several bankfull flows throughout the monitoring period. Bankfull event documentation can be found in Appendix E.

Bank pin locations were inspected and pins were not visible. Banks showed no signs of erosion over the course of the monitoring period.

1.6 Wetlands

Based upon the Final Mitigation Plan, the hydrologic criteria for restored wetlands at the Site are as follows (based upon the corresponding landscape position and wetland community type):

a. For the **riparian bottomland hardwood forest community**, the hydrologic criterion will be the establishment of a static water table at, or within, 12 inches of the soil surface for a minimum of 12.5 percent of the growing season, equivalent to 38 days based upon hydrologic monitoring undertaken from Feb 1st through Nov 30th of each monitoring year.
b. For the **headwater riparian community (zero-order geomorphic position)**, the hydrologic criterion will be the establishment of a static water table at, or within, 12 inches of the soil surface for a minimum of 10 percent of the growing season, equivalent to 30 days based upon hydrologic monitoring undertaken from Feb 1st through Nov 30th of each monitoring year.

The UT Millers site exhibits a range of hydrologic conditions characteristic of small stream swamp wetland community types of the inner Coastal Plain of North Carolina. Several of the groundwater gauges documented elevated groundwater levels at or near the soil surface for extended periods of time during the growing season. In addition, portions of the site exhibited intermittent to prolonged periods of surface inundation. Refer to the attached gauge hydrographs depicting recorded groundwater and surface water levels from February 1 through November 30.

Regional drought index maps are useful tools to evaluate specific gauge data relative to ambient precipitation and sub-surface water storage conditions. For instance, the NC Drought Status Monitoring Program compares existing data to long-term (1965-2016) climatic conditions for well data, stream baseflow data, and combined well and baseflow data. Contoured percentile data (30th/70th percentiles) are graphically displayed on monthly drought images. Based upon these maps, subsurface storage (i.e. groundwater) conditions were considered abnormally dry during February and March with relatively normal rainfall conditions for much of the summer. The NC DWR Drought Status Maps are included for reference in Appendix E. Cumulatively, total on-site rainfall for 2017 through November 30 was 36.12 inches, which is 16.68 inches below normal (based upon long-term climatic data available through AgACIS, Wallace Station).

All of the groundwater gauges located on the mitigation site exhibit hydrology indicative of jurisdictional wetlands (i.e. hydroperiods greater than 5% of the growing season), and four of the six gauges exceeded the minimum success criteria as outlined above. While the specific durations of wetland hydrology at each gauge varied across the site, each gauge also displayed prolonged wetland hydroperiods during normal rainfall conditions. The site experienced drought conditions during the early portion of the growing season (which is typically the period of the year for hydrologic recharge of wetlands). As a result, Gauge 1 and Gauge 3 exhibited brief periods of water levels below 12 inches of the soil surface at the outset of the growing season. Cumulatively, Gauge 1 exhibited groundwater levels within 12 inches of the soil surface for 106 days (equivalent to 32%) of the monitoring period through November 30. Similarly, Gauge 3 exhibited groundwater levels within 12 inches of the soil surface for 118 days (equivalent to 36%) of the monitoring period through November 30. Based upon the hydrograph, it is evident that Gauge 3 has a more pronounced groundwater discharge largely as a result of its proximity to the adjacent restored stream channel. During periods of low flow or no flow in the channel, groundwater of the adjacent floodplain is discharged to the channel more rapidly.

The summary of hydroperiods for each gauge is presented in Table 12 and gauge locations are depicted in Figures 3.0 – 3.6.

2.0 METHODOLOGY

Year 3 monitoring surveys were completed using a Total Station. Each cross section was marked with a rebar monument at their beginning and ending points. The rebar has been located vertically and horizontally in NAD 83-State Plane. Surveying these monuments throughout the Site ensured proper orientation. The survey data was imported into MicroStation for verification. RIVERMorph was used to analyze cross section data. Tables and figures were created using Microsoft Excel, ArcGIS, and MicroStation. The channel is entirely a sand bed system; therefore, a pebble count was not conducted. Bank pin locations were inspected but pins were not observable, and therefore were not surveyed.

Vegetation monitoring was completed using CVS level II methods, for nine, 100 square meter vegetation plots (Lee et al. 2006). The taxonomic standard for vegetation used for this document was Flora of the Southern and Mid-Atlantic States (Weakley 2011).

Groundwater hydrology was monitored using six automated gauges (RDS, Inc. WM-20s) located within the riparian wetland restoration areas. Two reference gauges were installed; one in a Headwater Riparian Wetland and one in a Bottomland Hardwood Wetland. Gauges were installed in accordance with installation methods outlined in the Wetlands Regulatory Assistance Program (WRAP) Technical Note 00-02 (Sprecher, 2000). Water levels were recorded once daily and the data was downloaded every two months.

3.0 REFERENCES

ICA Engineering, Inc. As-Built Monitoring Document & As-Built Baseline Report for UT Millers Creek Full Delivery Site. 2015.

Lee, Michael T., R. K. Peet, S. D. Roberts, and T. R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0 (http://cvs.bio.unc.edu/methods.htm).

NCEEP. Ecosystem Enhancement Program Monitoring Requirements and Performance Standards for stream and/or Wetland Mitigation. 2011.

Sprecher, S. W. (2000). "Installing Monitoring Wells/Piezometers in Wetlands," ERDC TN-WRAP-00-02, U.S. Army Research and Development Center, Vicksburg, MS.

US Army Corps of Engineers Wilmington District. Stream Mitigation Guidelines. 2003

Weakley, Alan S. 2011. Flora of the Southern and Mid-Atlantic States (online). Available: http://www.herbarium.unc.edu/FloraArchives/WeakleyFlora_2011-May-nav.pdf [May 15, 2011]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.

APPENDICES

Appendix A. Project Vicinity Map and Background Tables

Vicinity Map

UT to Millers Creek Mitigation Site, Duplin County, NC

0 750 1,500 3,000 4,500 6,000 Feet

1 inch = 2,000 feet

Figure 1

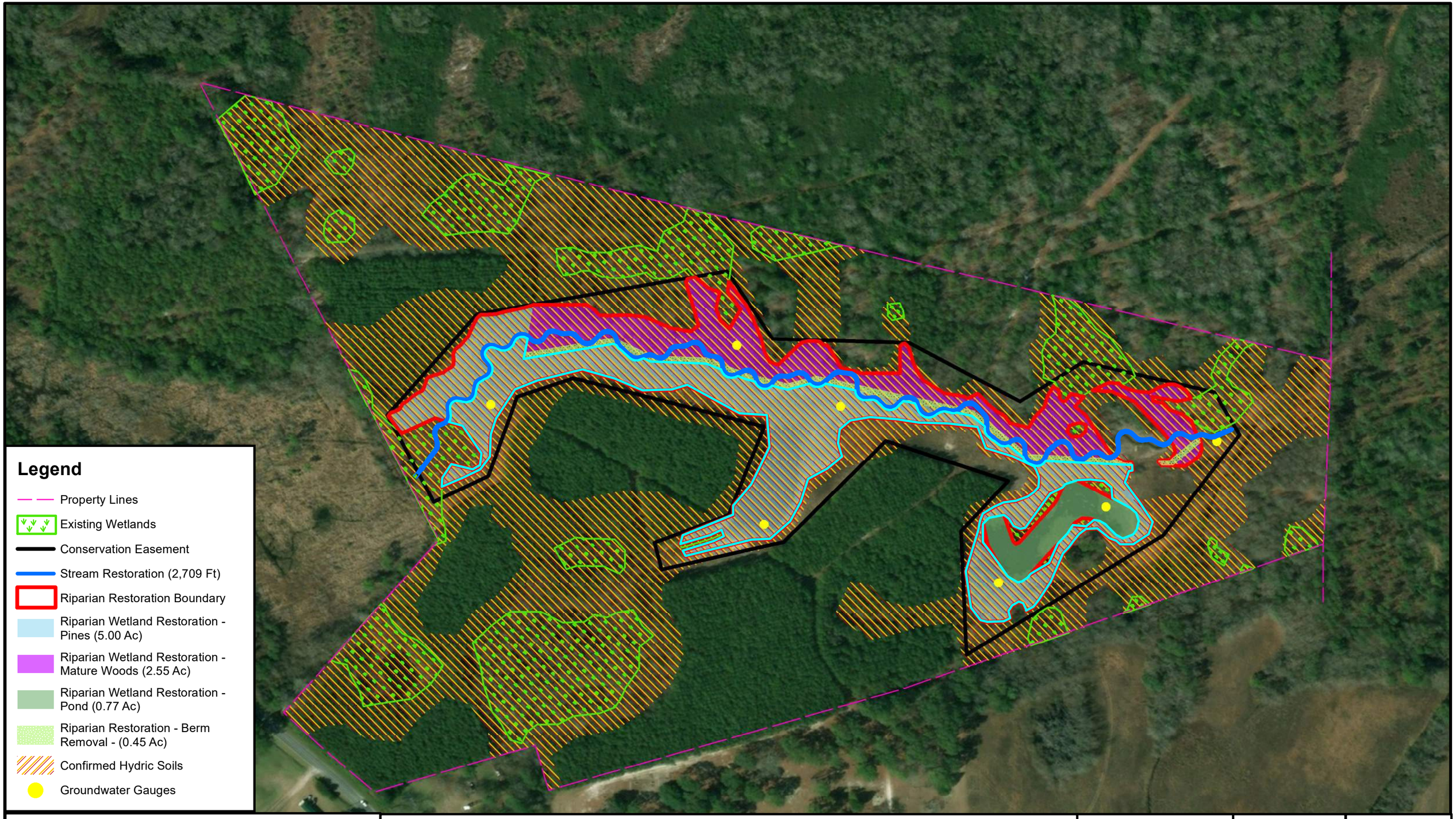
Table 1. Project Components and Mitigation Credits
UT to the Millers Creek, Duplin County
DMS Project ID No. 95719

Mitigation Credits									
	Stream (SMU)		Riparian Wetland (WMU)		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE	--	--	--
Totals	2,709		8.00						

Project Components							
Project Component or Reach ID	Stationing/ Location	Existing Footage/ Acreage	Approach (PI, PII, etc.)	Restoration or Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio	SMU or WMU
UT Millers Creek	10+13 – 37+22	2,100	PI	Restoration	2,709	1:1	2,709
Drained Wetland (Pines)	NA	5.00	NA	Restoration	5.00	1:1	5.00
Drained Wetland (Mature Woods)	NA	2.55	NA	Restoration	2.55	1.25:1	2.04
Drained Wetland (Berm/Spoil Along UT)	NA	0.45	NA	Restoration	0.45	1:1	0.45
Pond	NA	0.77	NA	Restoration	0.77	1.5:1	0.51
TOTAL	NA	2,100/8.77	PI/NA	Restoration	2,709/8.77	1 – 1.5:1	2,709/8.00

Component Summation						
Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	2,709	8.77				

BMP Elements			
Element	Location	Purpose/Function	Notes
Forested Buffer	UT Millers buffer	Buffer to protect stream	Filter nutrients and provide cover, foraging areas, habitat, woody debris, and wildlife



HDR | ICA

Asset Overview Map

UT Millers Creek, Duplin County, North Carolina

0 130 260 520 780 1,040 Feet

NC Environmental Quality

W N S E

Figure 2

Table 2. Project Activity and Reporting History UT to Millers Creek (DMS Project ID No. 95719)		
Activity or Report	**Data Collection Complete**	**Completion or Delivery**
Restoration Plan	Aug-13	Sep-14
Final Design – Construction Plans	Sep-14	Sep-14
Construction	3-Nov-14	23-Jan-15
Temporary S&E Mix Applied to Entire Project Area	---	23-Jan-15
Permanent Seed Mix Applied to Entire Project Area	---	23-Jan-15
Bare Root, Containerized, and B&B plantings for Entire Project Area	---	10-Mar-15
Mitigation Plan/As-built (Year 0 Monitoring-Baseline)	Mar-15	Apr-15
Year 1 Monitoring	Oct-15	Dec-15
Year 2 Monitoring	Nov-16	Feb-17
Year 3 Monitoring	Nov-17	Jan-18
Year 4 Monitoring		
Year 5 Monitoring		
Year 6 Monitoring		
Year 7 Monitoring		

Table 3. Project Contacts Table UT to Millers Creek (DMS Project ID No. 95719)	
Designer Primary project design POC	HDR | ICA Engineering 555 Fayetteville Street, Suite 900 Raleigh, North Carolina 27601 Kevin Williams (919) 851-6066
Construction Contractor Construction Contractor POC	Land Mechanic Designs, Inc. 126 Circle G Lane Willow Spring, NC 27592 Lloyd Glover (919) 639-6132
Planting Contractor Planting Contractor POC	River Works, Inc. 6105 Chapel Hill Road Raleigh, NC 27607 Phillip Todd (919) 582-3574
Seeding Contractor Seeding Contractor POC	Land Mechanic Designs, Inc. 126 Circle G Lane Willow Spring, NC 27592 Lloyd Glover (919) 639-6132
Seed Mix Sources	Green Resources – Triangle Office
Nursery Stock Suppliers	1) ArborGen 2) Mellow Marsh Farm, Inc. 3) Foggy Mountain Nursery (live stakes)
Monitoring Performers	HDR | ICA Engineering 555 Fayetteville Street, Suite 900 Raleigh, North Carolina 27601 Alex DiGeronimo (919) 900-1645
Stream Monitoring POC	HDR | ICA Engineering 555 Fayetteville Street, Suite 900 Raleigh, North Carolina 27601 Alex DiGeronimo (919) 900-1645
Vegetation Monitoring POC	Land Management Group, Inc 3805 Wrightsville Avenue, Suite 15 Wilmington, NC 28403 Kim Williams (910) 452-0001 x 1908

Table 4. Project Information UT to Millers Creek (DMS Project ID No. 95719)	
Project Information	
Project Name	UT to Millers Creek Stream and Wetland Mitigation Site
Project County	Duplin
Project Area (acres)	15.944 AC
Project Coordinates	34.894467,-78.067625
Project Watershed Summary Information	
Physiographic Region	Coastal Plain
Ecoregion	Southeastern Plains
Project River Basin	Cape Fear
USGS 8-digit HUC	3030006
USGS 14-digit HUC	3030006110040
NCDWQ Subbasin	03-06-19
Project Drainage Area	250 AC
Watershed Land Use	Cultivated, Southern Yellow Pine, Bottomland Forest / Hardwood Swamps

Reach Summary Information	
Parameters	**UT to Millers Creek**
Restored length	2,709 linear feet
Drainage Area	250 AC.
NCDWQ Index Number	36
NCDWQ Classification	C, Sw
Valley Type/Morphological Description	X/Existing G/5/Restored E5
Dominant Soil Series	Bibb sandy loam and Torhunta fine sandy loam (USDA/NRCS records). Cape Fear, Rains, Plummer, Rutlege and Lynn Haven Soil series (additional series mapped by LMG)
Drainage Class	Poorly and very poorly
Soil Hydric Status	Bibb sandy loam (hydric) Torhunta mucky fine sandy loam (hydric)
Slope	0.0016
FEMA Classification	Zone X
Native Vegetation Community	Mixed stand of hardwoods and pine
Percent Composition of Exotic Invasives	<5%

Wetland Summary Information			
Parameters	**Wetland 1**	**Wetland 2**	**Wetland 3**
Size of Wetland (acres)	0.21	0.12	0.59
Wetland Type (non-riparian riverine or riparian non-riverine	Riparian Non-Riverine	Riparian Non-Riverine	Riparian Non-Riverine
Mapped Soil Series	BbA	ToA	BnB
Drainage class	Poorly Drained	Very Poorly Drained	Moderately Well Drained
Soil Hydric Status	Hydric	Hydric	Partially Hydric
Source of Hydrology	Groundwater	Groundwater	Groundwater
Hydrologic Impairment	Stream Incision	Stream Incision	Stream Incision/Beavers
Native vegetation community	Forested	Forested	Emergent
Percent composition of exotic invasion vegetation	0	0	0

Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the U.S. –Sections 404 and 401	Yes	Yes	Restoration Plan/NW 27
Endangered Species Act	No	Yes	NCNHP/USFWS
Historic Preservation Act	No	Yes	NCSHPO
CZMA/CAMA	No	Yes	--
FEMA Floodplain Compliance	Yes	Yes	HECRAS
Essential Fisheries Habitat	No	N/A	--

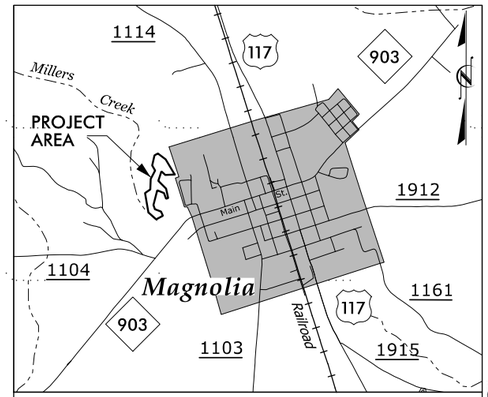
Appendix B. Visual Assessment Data

CURRENT CONDITIONS PLAN VIEW (CCPV)
UT MILLERS CREEK

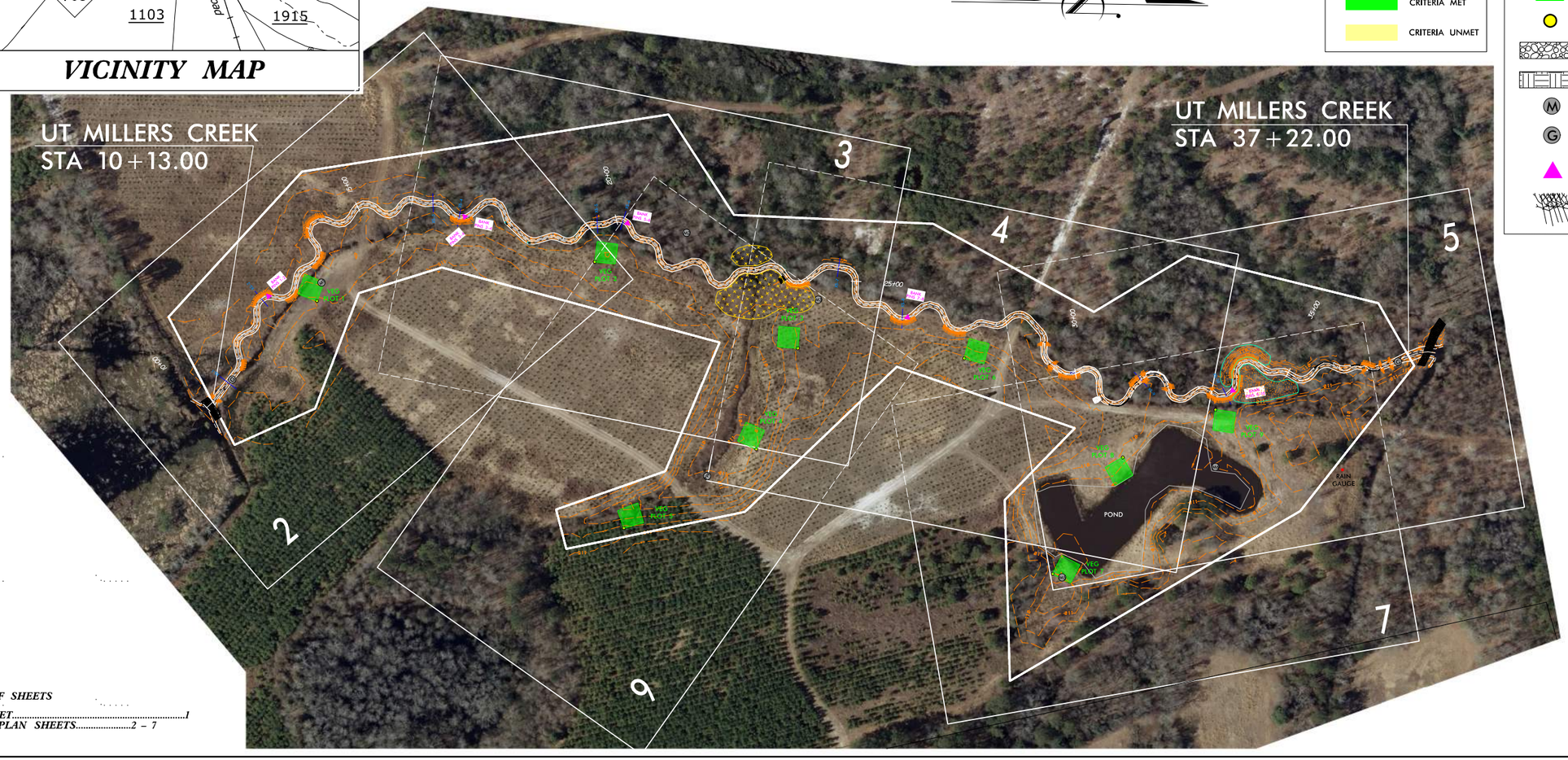
STATE		SHEET NO.	TOTAL SHEETS
N.C.	UT MILLERS CREEK	1	7

LOCATION: DUPLIN COUNTY, NORTH CAROLINA
LAT: 34°53'48" N LONG: 78°04'04" W
TYPE OF WORK: CCPV PLANS – YEAR 3

CONTRACT: UT MILLERS CREEK DMS PROJECT # 95719
NCDEQ CONTRACT # 5000



VICINITY MAP



INDEX OF SHEETS

TITLE SHEET.....1
CCPV YR1 PLAN SHEETS.....2 – 7

YEAR 3 CONDITIONS

BANK/BED CONDITION
- MINOR EROSION

VEGETATION PROBLEM AREAS
- THIN GRASS
- NO GRASS (BARE)

VEGETATION PLOT CONDITIONS
- CRITERIA MET
- CRITERIA UNMET

LEGEND
- CONSERVATION EASEMENT LINE
- THALWEG
- BANKFULL
- ASBUILT TOP OF TRAY
- ASBUILT TOE OF TRAY
- CROSS-SECTION LOCATIONS
- LOG SILL
- 10M x 10M VEG PLOT
- VEG PLOT ORIGIN
- FLOODPLAIN INTERCEPTOR
- SOIL LIFT
- MONITORING WELL
- CREST GAUGE
- BANK PIN
- BRUSH TOE

GRAPHIC SCALES

50 25 0 50 100
PLANS

10 5 0 10 20
PROFILE (HORIZONTAL)

20 10 0 20 40
PROFILE (VERTICAL)

DESIGN DATA

DESIGN STREAM TYPE	=	E5
BANKFULL AREA (FT^2) CROSS-SECTIONED	=	8.06
BANKFULL WIDTH (FT)	=	8.8
MAX DEPTH (FT)	=	1.40
WIDTH /DEPTH RATIO	=	9.5
DRAINAGE AREA (MI^2)	=	0.39
BANKFULL SLOPE(FT/FT)	=	0.0005

PROJECT LENGTH

EXISTING STREAM LENGTH	=	2,095 FT
PROPOSED DESIGN STREAM LENGTH	=	2,696 FT
ASBUILT STREAM LENGTH	=	2,709 FT

R. KEVIN WILLIAMS
PROJECT ENGINEER

KATHLEEN M. McKEITHIAN
PROJECT DESIGNER

RYAN V. SMITH
PROJECT MANAGER

INCOMPLETE PLANS
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

SURVEY PREPARED BY:
STEWART – PROCTOR, PLLC
319 CHAPANOKE ROAD
RALEIGH NC 27603
HERBERT H. PROCCTOR, JR. L–3621

Prepared In the Office of:

ICA Engineering, Inc.
555 Fayetteville Street,
Suite 900
Raleigh, NC 27601
NC License No: F–0258

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 3

LEGEND

- E — CONSERVATION EASEMENT LINE
- THALWEG
- BANKFULL
- ASBUILT TOP OF TRAY
- ASBUILT TOE OF TRAY
- CROSS–SECTION LOCATIONS
- LOG SILL
- 10M x 10M VEG PLOT
- VEG PLOT ORIGIN
- FLOODPLAIN INTERCEPTOR
- SOIL LIFT
- M — MONITORING WELL
- G — CREST GAUGE
- BANK PIN
- BRUSH TOE

UT MILLERS CREEK
STA 10+13.00

10+00

15+00

XS-1

XS-2

XS-3

XS-4

G

M1

VEG PLOT 1

BANK PINS 1–2

BANK PINS 3–4

Flow Direction

PERMANENT FORD CROSSING

CONSERVATION EASEMENT

CONSERVATION EASEMENT

-MATCHLINE- STATION 17+00 SEE SHEET 3

N

YEAR 3 CONDITIONS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

HDR | ICA

UT MILLERS CREEK
STREAM RESTORATION PROJECT
DUPLIN COUNTY, NORTH CAROLINA
STA 10+13 – STA 17+00

GRAPHIC SCALE
50 25 0 25
PLANS

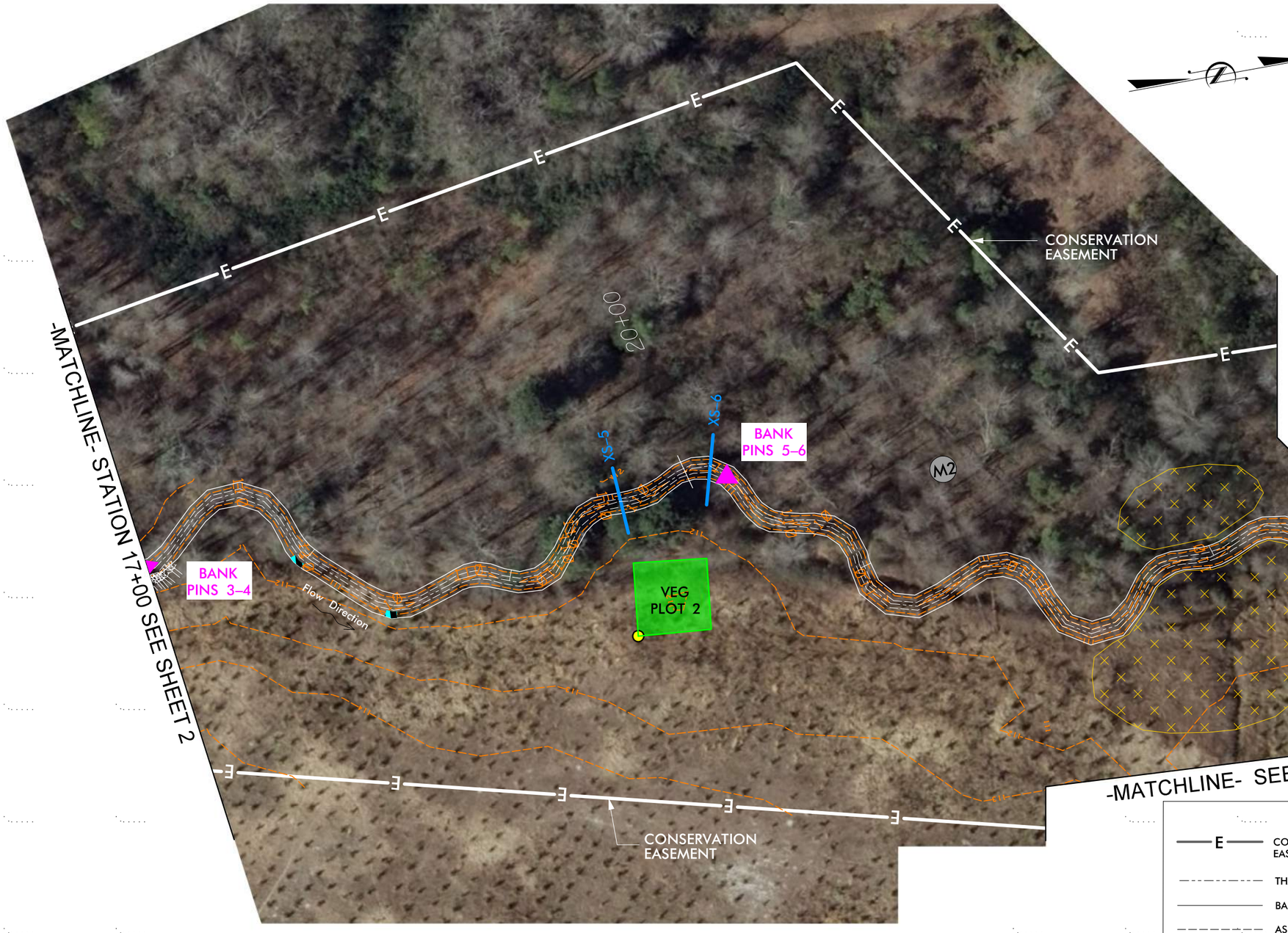
DATE: 12–19–16

CCVP YR3 PLAN

SHEET 2 OF 7

$$$$$$$SYSTIME$$$$$$
Z:\AUT_Millers_Creek\6.0_CAD_BIM\6.2_Work_In_Progress\stream\Proj\Monitoring Plans\Year 3\UTMillersCrk_psh_Mon_YR3_02.dgn
(C) ICA ENGINEERING INC

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 3



YEAR 3 CONDITIONS

BANK/BED CONDITION

- MINOR EROSION

VEGETATION PROBLEM AREAS

- NO GRASS (BARE)

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

LEGEND

- E — CONSERVATION EASEMENT LINE
- THALWEG
- BANKFULL
- ASBUILT TOP OF TRAY
- ASBUILT TOE OF TRAY
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- SOIL LIFT
- M — MONITORING WELL
- BANK PIN
- BRUSH TOE

HDR | ICA

UT MILLERS CREEK
STREAM RESTORATION PROJECT
DUPLIN COUNTY, NORTH CAROLINA
STA 17+00 - STA 24+00

GRAPHIC SCALE
50 0 25 25
PLANS

DATE: 12-19-16

CCVP YR3 PLAN

SHEET 3 OF 7

$$$$$$$SYSTIME$$$$$
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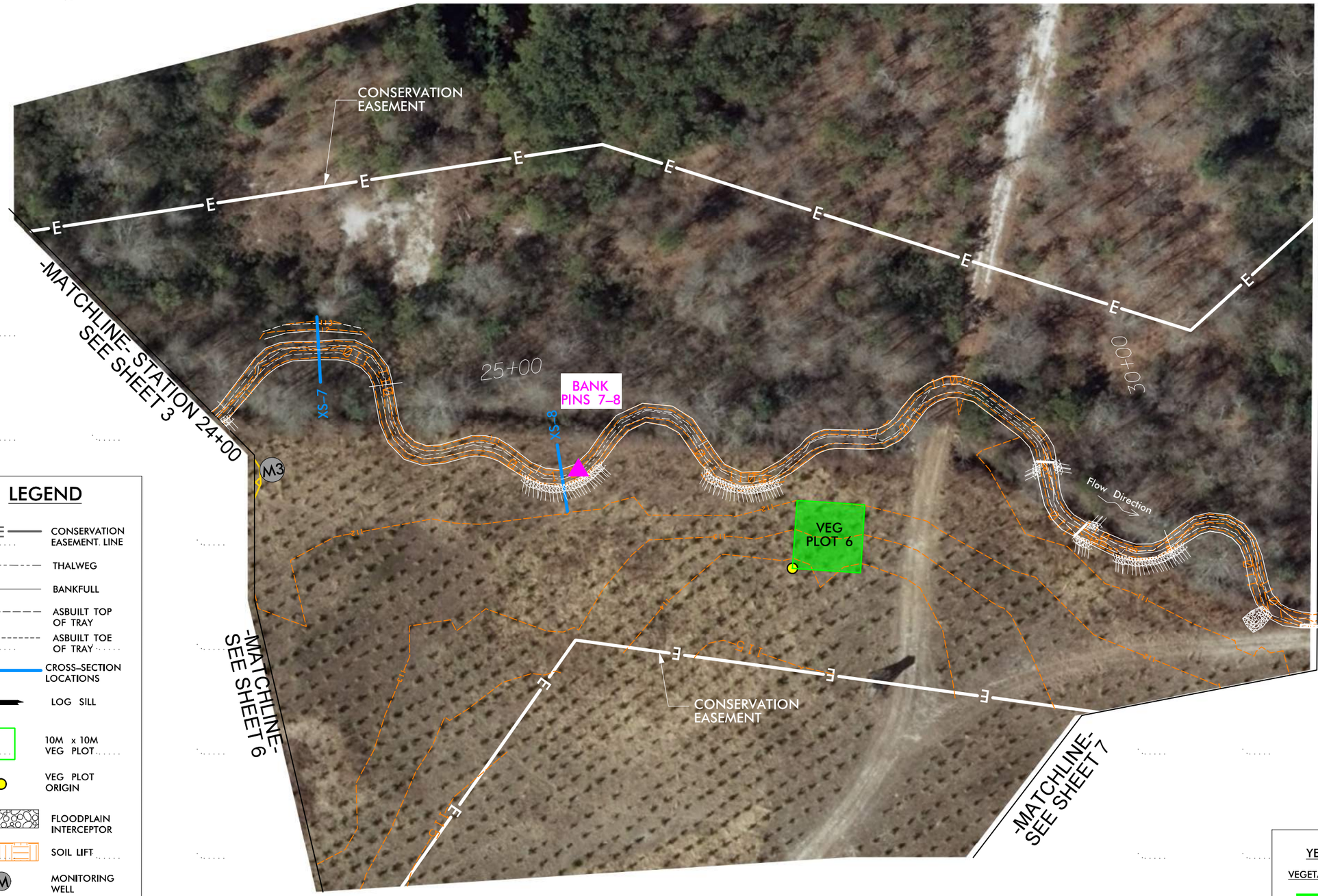
$$$$$$$USERNAME$$$$$
FA ENGINEERING INC

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 3



LEGEND

- E — CONSERVATION EASEMENT LINE
- THALWEG
- BANKFULL
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- ASBUILT TOE OF TRAY
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- FLOODPLAIN INTERCEPTOR
- SOIL LIFT
- M — MONITORING WELL
- BANK PIN
- BRUSH TOE

YEAR 3 CONDITIONS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

HDR | ICA

UT MILLERS CREEK
STREAM RESTORATION PROJECT
DUPLIN COUNTY, NORTH CAROLINA
STA 24+00 – STA 31+00

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12–19–16

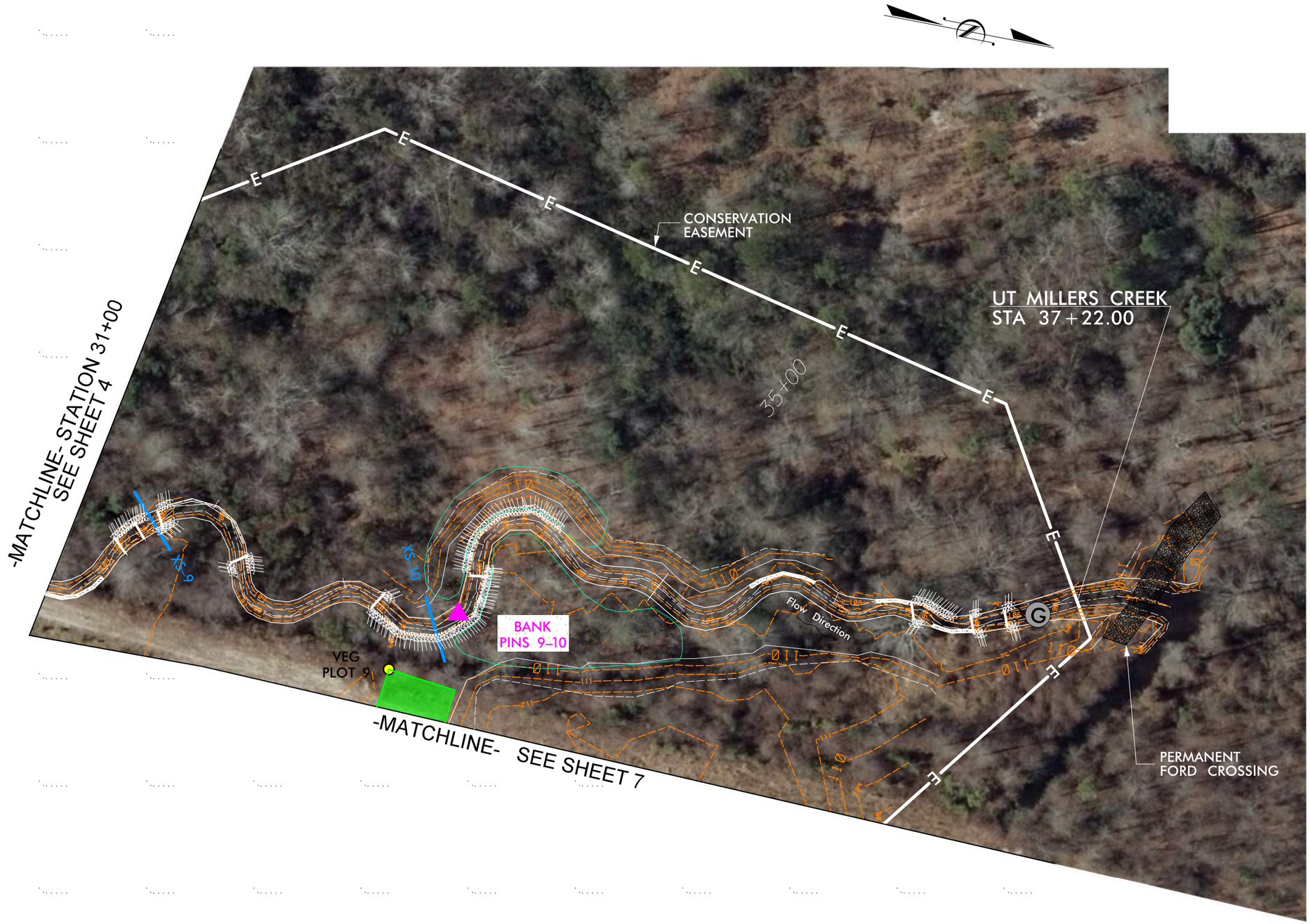
CCVP YR3 PLAN

SHEET 4 OF 7

$$$$$$$SYSTIME$$$$$$
Z:\UT_Millers_Creek\6.0_CAD_BIM\6.2_Work_In_Progress\stream\Proj\Monitoring Plans\Year 3\UTMillersCrk_psh_Mon_YR3_04.dgn
FTA ENGINEERING INC

LEGEND

- E — CONSERVATION EASEMENT LINE
- THALWEG
- BANKFULL
- ASBUILT TOP OF TRAY
- ASBUILT TOE OF TRAY
- CROSS-SECTION LOCATIONS
- LOG SILL
- 10M x 10M VEG PLOT
- VEG PLOT ORIGIN
- FLOODPLAIN INERCEPTOR
- SOIL LIFT
- G — CREST GAUGE
- BANK PIN
- BRUSH TOE



YEAR 3 CONDITIONS

VEGETATION PROBLEM AREAS

- THIN GRASS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

HDR | ICA

UT MILLERS CREEK
STREAM RESTORATION PROJECT
DUPLIN COUNTY, NORTH CAROLINA
STA 31+00 - STA 37+22

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12-19-16

CCVP YR3 PLAN

SHEET 5 OF 7

$$$$$$$$YSTIME$$$$$
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FOR ENGINEERING USE

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 3

YEAR 2 CONDITIONS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

LEGEND

- E — CONSERVATION EASEMENT LINE
- 10M x 10M VEG PLOT
- VEG PLOT ORIGIN
- M — MONITORING WELL

GRAPHIC SCALE
50 25 0 25
PLANS

UT MILLERS CREEK
STREAM RESTORATION PROJECT
DUPLIN COUNTY, NORTH CAROLINA

DATE: 12-19-16

CCVP YR3 PLAN

SHEET 6 OF 7

HDR ICA

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 3

YEAR 3 CONDITIONS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

LEGEND

- CONSERVATION EASEMENT LINE
- 10M x 10M VEG PLOT
- VEG PLOT ORIGIN
- MONITORING WELL

UT MILLERS CREEK
STREAM RESTORATION PROJECT
DUPLIN COUNTY, NORTH CAROLINA
POND

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12-19-16

CCVP YR3 PLAN

SHEET 7 OF 7

Table 5: Visual Stream Morphology Stability Assessment
Reach ID: UT Millers Creek
Assessed Length: 2,709 FT

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	N/A	N/A			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	5	5			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	61	61			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	57	57			100%			
		2. Thalweg centering at downstream of meander (Glide)	57	57			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			2	8	99.6%	N/A	N/A	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.			0	0	100%	N/A	N/A	N/A
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	N/A	N/A	N/A
				Totals	2	8	99.6%	N/A	N/A	N/A
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	12	12			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	12	12			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	12	12			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	12	12			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	12	12			100%			

Table 6 Vegetation Condition Assessment

Planted Acreage **12.35**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.05 acres	polygons filled with orange dots and x's	4	0.37	2.9%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	N/A	N/A	N/A	N/A	N/A
			Total			
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	N/A	Pattern and Color	N/A	N/A	N/A
			Cumulative Total			

Easement Acreage **15.94**

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

Figure 4.1 - 4.13 Vegetation Plot Photos and Problem Areas

4.1 Vegetation Plot 1

4.2 Vegetation Plot 2

4.3 Vegetation Plot 3

4.4 Vegetation Plot 4

4.5 Vegetation Plot 5

4.6 Vegetation Plot 6

4.7 Vegetation Plot 7

4.8 Vegetation Plot 8

4.9 Vegetation Plot 9

4.10 Bare area near STA 24+00

4.11 Thin grass adjacent to XS-10

4.12 Minor erosion on right bank at STA 18+0

4.13 Minor erosion on right bank at STA 18+50

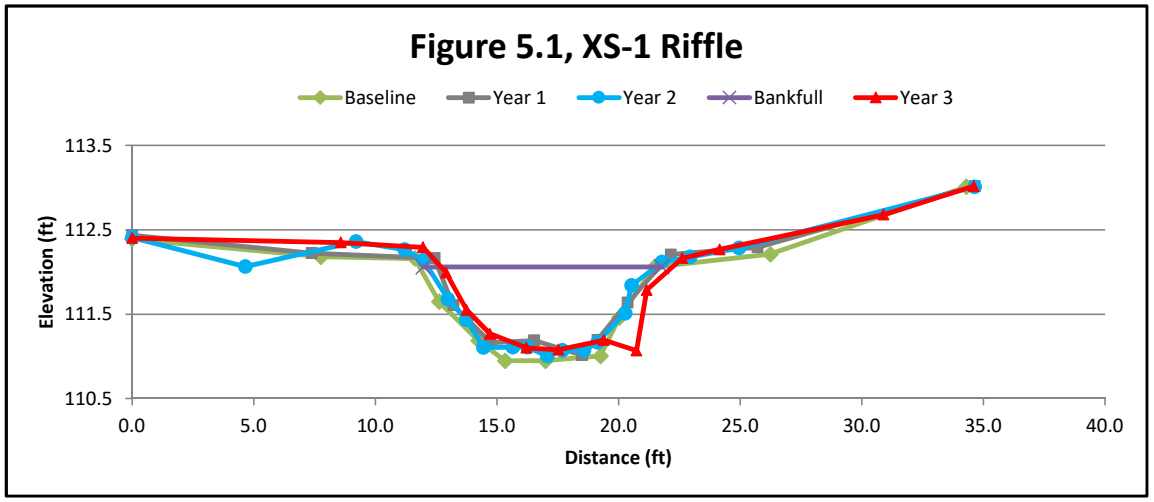
Appendix C. Vegetation Plot Data

Table 7.

EEP Project Code 95719. Project Name: UT Millers Creek

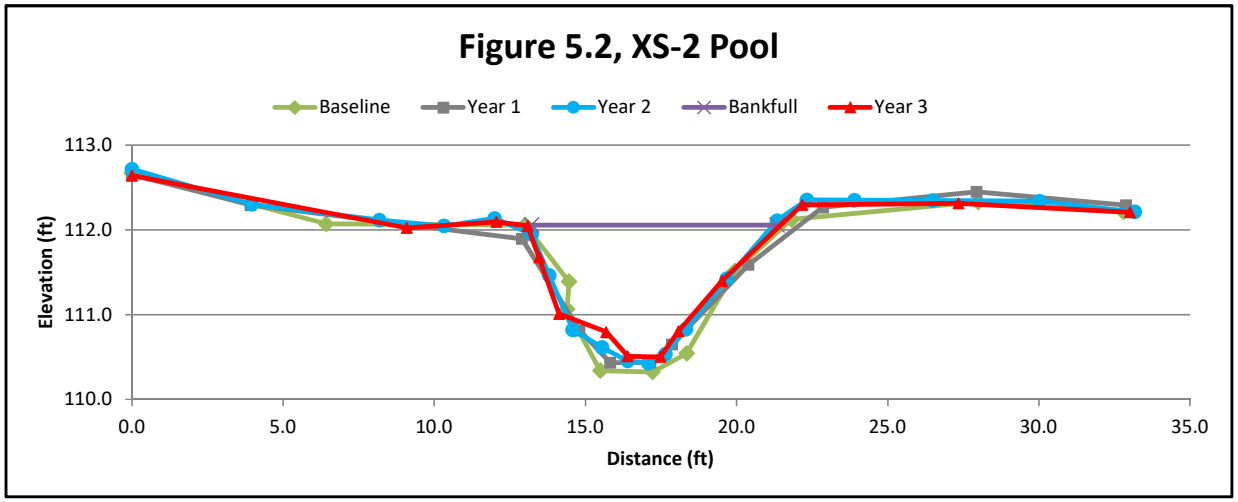
			Current Plot Data (MY3 2017)																									Annual Means								
			95719-01-0001			95719-01-0002			95719-01-0003			95719-01-0004			95719-01-0005			95719-01-0006			95719-01-0007			95719-01-0008			95719-01-0009			MY3 (2017)			MY2 (2016)			MY1 (2015)			MY0 (2015)		
Scientific Name	Common Name	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	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree															2									1						3								
Betula nigra	river birch	Tree				2	2	2										1	1	1							1	1	1	4	4	4	3	3	4	8	8	8	13	13	13
Fraxinus pennsylvanica	green ash	Tree				1	1	1	3	3	3							4	4	4	10	10	10	5	5	5	4	4	4	27	27	27	27	27	27	27	27	27	28	28	28
Liquidambar styraciflua	sweetgum	Tree			3			13												14						2			3			35			23			5			
Liriodendron tulipifera	tuliptree	Tree				2	2	2	4	4	4							2	2	2				2	2	2	4	4	4	14	14	14	13	13	13	15	15	15	19	19	19
Magnolia virginiana	sweetbay	Tree				1	1	1																						1	1	1	1	1	1	1	1	1	1	1	1
Morella cerifera	wax myrtle	shrub									1				2	2	2						1							2	2	4	2	2	2	2	2	2	3	3	3
Nyssa sylvatica	blackgum	Tree						1									1			1												3								
Persea borbonia	redbay	tree						1																								1								
Pinus	pine	Tree																																	3						
Pinus taeda	loblolly pine	Tree						2			2						4			3			1									12								
Platanus occidentalis	American sycamore	Tree													8	8	8												8	8	8	8	8	8	8	8	8	8	8	8
Prunus serotina	black cherry	Tree																																	1						
Quercus	oak	Tree																																	2						
Quercus michauxii	swamp chestnut oak	Tree	3	3	3	3	3	3	2	2	2							5	5	5				2	2	2	4	4	4	19	19	19	20	20	20	21	21	21	22	22	22
Quercus phellos	willow oak	Tree				2	2	2	4	4	4							9	9	9				1	1	1	3	3	3	19	19	19	21	21	21	25	25	25	28	28	28
Salix nigra	black willow	Tree															6															6			1					
Taxodium distichum	bald cypress	Tree	9	9	9	5	5	5	4	4	4	12	12	12	8	8	8	2	2	2	10	10	10	10	10	10	5	5	5	65	65	65	64	64	64	64	64	64	67	67	67
		Stem count	12	12	15	16	16	33	17	17	20	12	12	12	18	18	31	23	23	41	20	20	22	20	20	23	21	21	24	159	159	221	159	159	190	171	171	176	189	189	189
		size (ares)	1			1			1			1			1			1			1			1			1			9			9			9			9		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.22			0.22			0.22			0.22		
		Species count	2	2	3	7	7	11	5	5	7	1	1	1	3	3	7	6	6	9	2	2	4	5	5	7	6	6	7	9	9	15	9	9	14	9	9	10	9	9	9
		Stems per ACRE	485.6	485.6	607	647.5	647.5	1335	688	688	809.4	485.6	485.6	485.6	728.4	728.4	1255	930.8	930.8	1659	809.4	809.4	890.3	809.4	809.4	930.8	849.8	849.8	971.2	714.9	714.9	993.7	714.9	714.9	854.3	768.9	768.9	791.4	849.8	849.8	849.8

Appendix D. Stream Survey Data

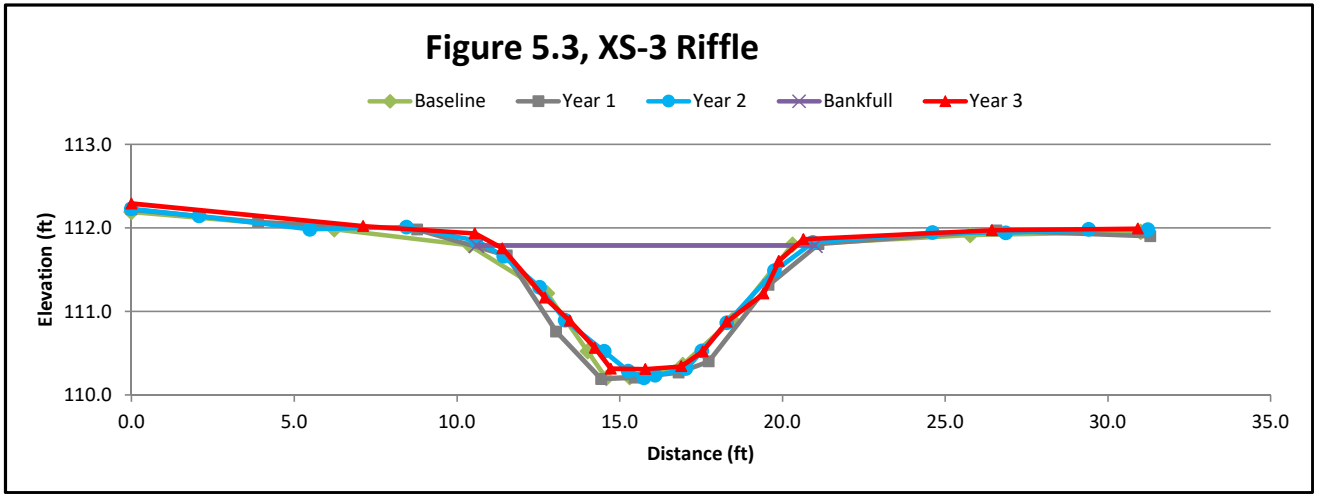


	Cross Section 1 (Riffle)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	9.7	9.1	9.4	9.5		
Floodprone Width (ft)	195.2	195.2	195.2	195.2		
Bankfull Mean Depth (ft)	0.8	0.7	0.7	0.7		
Bankfull Max Depth (ft)	1.1	1.0	1.1	1.0		
Bankfull Cross Sectional Area (ft^2)	7.7	6.3	6.7	6.8		
Bankfull Width/Depth Ratio	12.2	13.2	13.2	13.2		
Bankfull Entrenchment Ratio	20.2	21.4	20.8	20.5		
Bankfull Bank Height Ratio*	1.0	1.1	1.1	1.1		

*Bankfull Bank Height Ratio =((Current Monitoring Year Top of Bank Elevation - Baseline Bankfull Elevation) + Baseline Max Depth) / Baseline Bankfull Max Depth

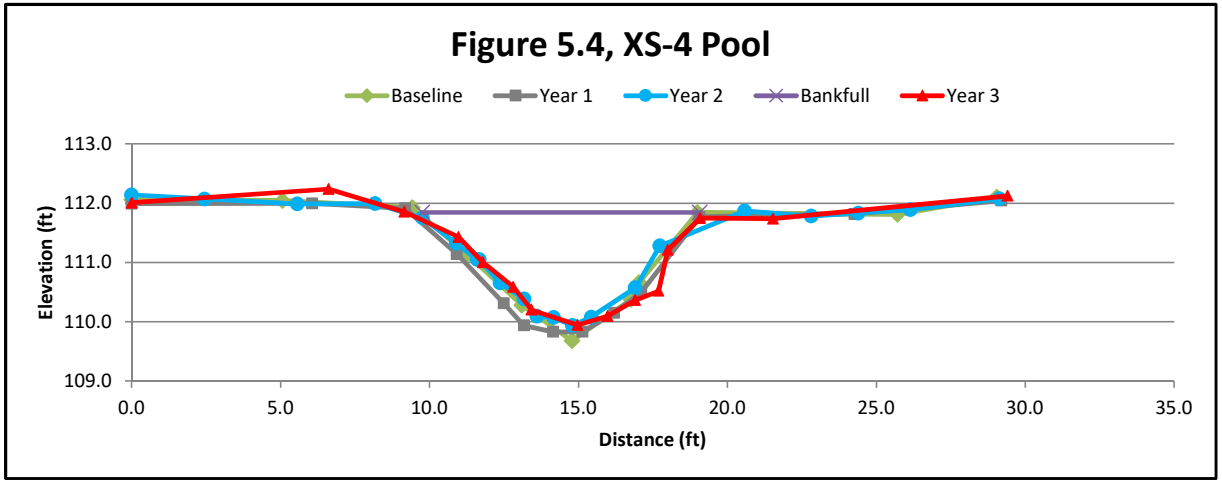


	Cross Section 2 (Pool)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	8.6	8.6	7.8	8.0		
Floodprone Width (ft)						
Bankfull Mean Depth (ft)	1.0	0.9	1.0	0.9		
Bankfull Max Depth (ft)	1.7	1.5	1.5	1.5		
Bankfull Cross Sectional Area (ft^2)	8.8	7.3	7.3	7.0		
Bankfull Width/Depth Ratio						
Bankfull Entrenchment Ratio						
Bankfull Bank Height Ratio						

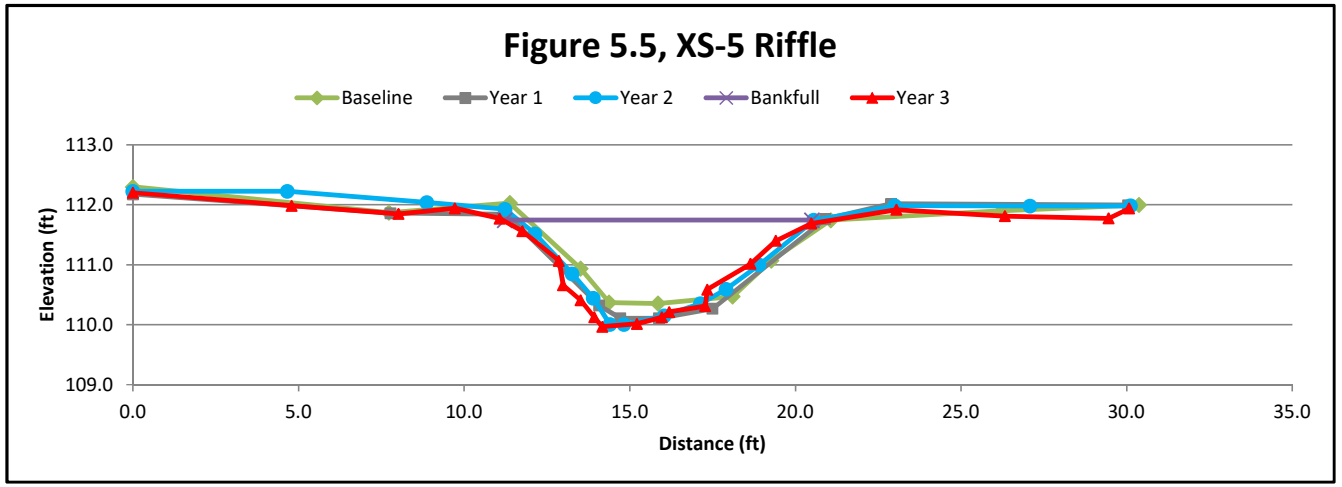


	Cross Section 3 (Riffle)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	9.9	10.6	10.0	9.2		
Floodprone Width (ft)	126.3	126.3	126.3	126.3		
Bankfull Mean Depth (ft)	0.9	0.9	0.9	0.9		
Bankfull Max Depth (ft)	1.6	1.6	1.6	1.5		
Bankfull Cross Sectional Area (ft^2)	8.8	9.9	8.5	8.5		
Bankfull Width/Depth Ratio	11.1	11.4	11.6	10.0		
Bankfull Entrenchment Ratio	12.8	11.9	12.7	13.8		
Bankfull Bank Height Ratio*	1.0	1.0	1.0	1.1		

*Bankfull Bank Height Ratio =((Current Monitoring Year Top of Bank Elevation - Baseline Bankfull Elevation) + Baseline Max Depth) / Baseline Bankfull Max Depth

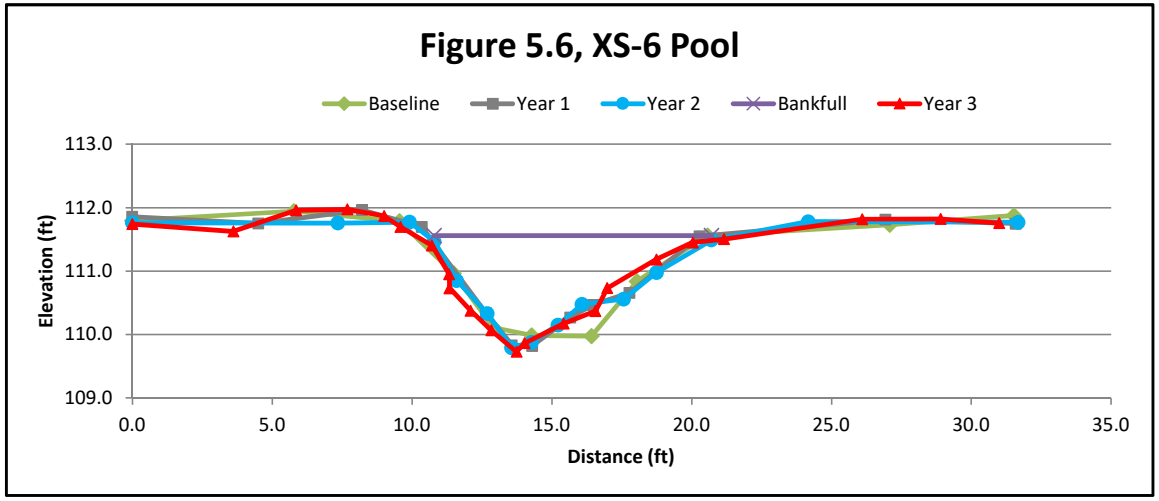


	Cross Section 4 (Pool)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	9.4	9.8	10.2	12.2		
Floodprone Width (ft)						
Bankfull Mean Depth (ft)	1.2	1.2	0.9	0.8		
Bankfull Max Depth (ft)	2.2	1.9	1.8	1.8		
Bankfull Cross Sectional Area (ft^2)	10.9	11.4	9.4	9.8		
Bankfull Width/Depth Ratio						
Bankfull Entrenchment Ratio						
Bankfull Bank Height Ratio						

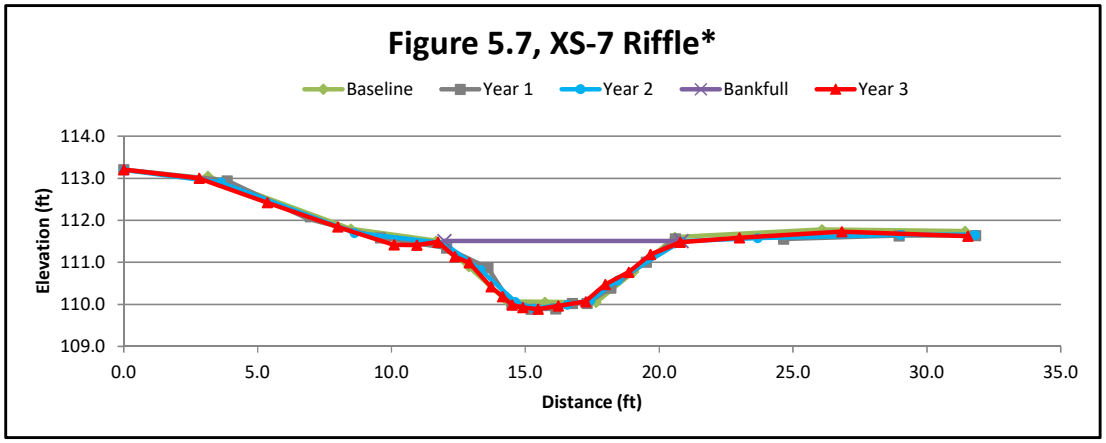


	Cross Section 5 (Riffle)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	9.1	9.4	8.9	9.9		
Floodprone Width (ft)	182.9	182.9	182.9	182.9		
Bankfull Mean Depth (ft)	0.9	1.0	1.0	0.9		
Bankfull Max Depth (ft)	1.4	1.6	1.7	1.8		
Bankfull Cross Sectional Area (ft^2)	8.4	9.7	9.1	9.3		
Bankfull Width/Depth Ratio	10.0	9.1	8.7	10.5		
Bankfull Entrenchment Ratio	20.0	19.5	20.5	18.5		
Bankfull Bank Height Ratio*	1.0	1.1	1.0	1.0		

*Bankfull Bank Height Ratio =((Current Monitoring Year Top of Bank Elevation - Baseline Bankfull Elevation) + Baseline Max Depth) / Baseline Bankfull Max Depth



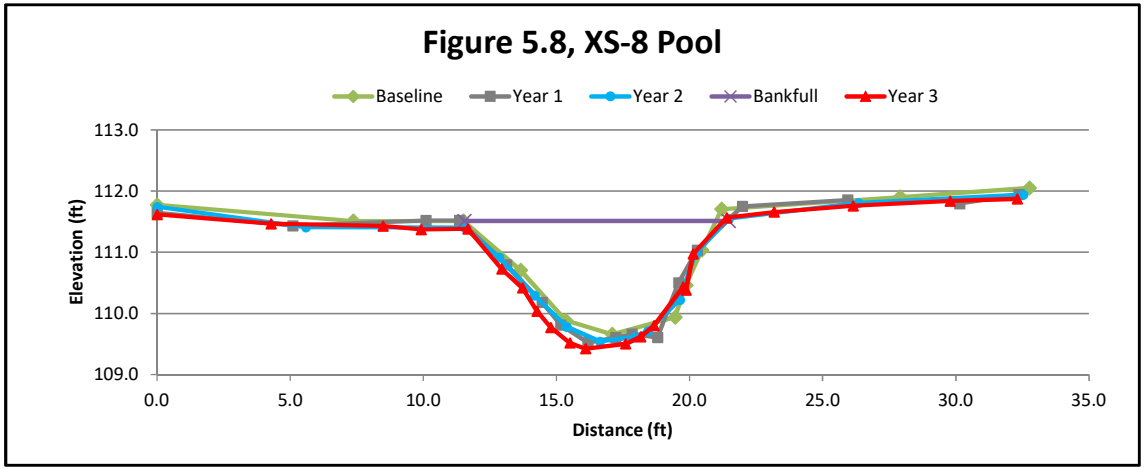
	Cross Section 6 (Pool)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	10.5	9.7	9.8	9.5		
Floodprone Width (ft)						
Bankfull Mean Depth (ft)	1.0	1.0	0.9	0.9		
Bankfull Max Depth (ft)	1.6	1.7	1.7	1.7		
Bankfull Cross Sectional Area (ft^2)	10.1	9.3	8.7	8.4		
Bankfull Width/Depth Ratio						
Bankfull Entrenchment Ratio						



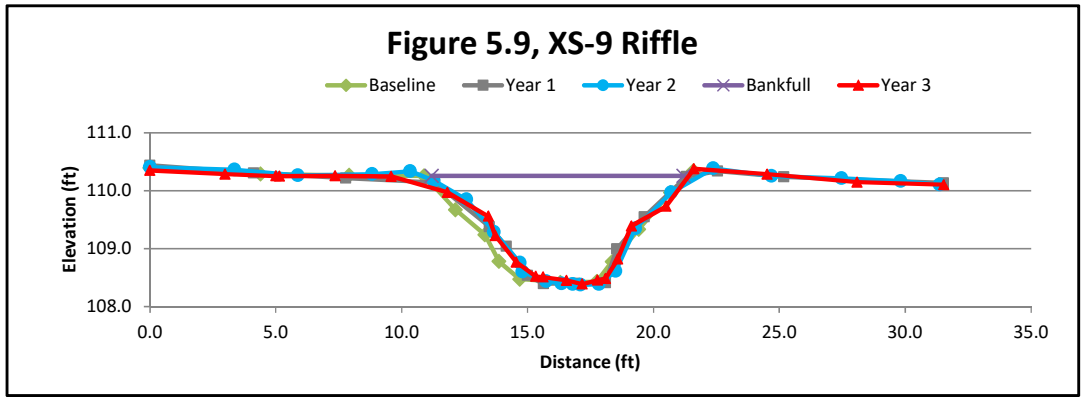
*Baseline cross-section was not started on left pin

	Cross Section 7 (Riffle)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	8.8	10.2	9.6	9.7		
Floodprone Width (ft)	162.2	162.2	162.2	162.2		
Bankfull Mean Depth (ft)	1.0	0.9	0.9	0.9		
Bankfull Max Depth (ft)	1.5	1.6	1.6	1.6		
Bankfull Cross Sectional Area (ft^2)	8.7	8.6	8.5	8.7		
Bankfull Width/Depth Ratio	8.8	12.0	10.9	10.9		
Bankfull Entrenchment Ratio	18.5	16.0	16.8	16.7		
Bankfull Bank Height Ratio**	1.0	1.0	1.0	1.0		

**Bankfull Bank Height Ratio =((Current Monitoring Year Top of Bank Elevation - Baseline Bankfull Elevation) + Baseline Max Depth) / Baseline Bankfull Max Depth

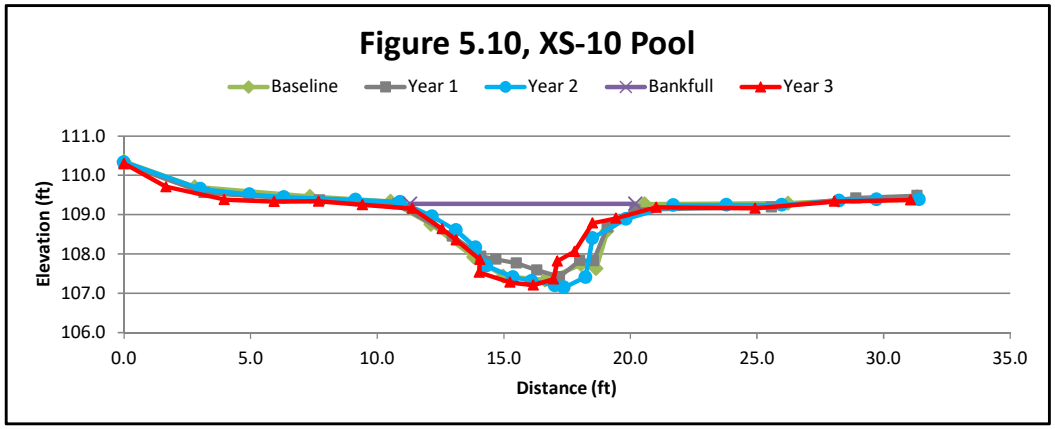


	Cross Section 8 (Pool)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	9.5	10.0	9.6	9.3		
Floodprone Width (ft)						
Bankfull Mean Depth (ft)	1.2	1.2	1.1	1.2		
Bankfull Max Depth (ft)	1.9	2.0	1.9	2.0		
Bankfull Cross Sectional Area (ft^2)	11.1	11.9	10.8	11.4		
Bankfull Width/Depth Ratio						
Bankfull Entrenchment Ratio						
Bankfull Bank Height Ratio						



	Cross Section 9 (Riffle)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	10.5	10.2	11.1	11.7		
Floodprone Width (ft)	219.0	219.0	219.0	219.0		
Bankfull Mean Depth (ft)	1.1	1.1	1.0	1.0		
Bankfull Max Depth (ft)	1.8	1.9	1.9	1.9		
Bankfull Cross Sectional Area (ft^2)	12.0	11.1	11.3	11.2		
Bankfull Width/Depth Ratio	9.1	9.4	10.9	12.2		
Bankfull Entrenchment Ratio	20.9	21.5	19.8	18.8		
Bankfull Bank Height Ratio*	1.0	0.9	1.0	1.1		

*Bankfull Bank Height Ratio =((Current Monitoring Year Top of Bank Elevation - Baseline Bankfull Elevation) + Baseline Max Depth) / Baseline Bankfull Max Depth



	Cross Section 10 (Pool)					
Dimension	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation						
Bankfull Width (ft)	9.8	9.2	10.5	9.6		
Floodprone Width (ft)						
Bankfull Mean Depth (ft)	1.2	1.0	1.0	1.0		
Bankfull Max Depth (ft)	1.9	1.7	2.1	2.1		
Bankfull Cross Sectional Area (ft^2)	11.4	8.7	10.7	10.2		
Bankfull Width/Depth Ratio						
Bankfull Entrenchment Ratio						
Bankfull Bank Height Ratio						

Table 8. Baseline Stream Data Summary
UT to Millers Creek, DMS Project ID No. 95719
UT to Millers Creek: 2,709 LF

Parameter	Regional Curve			Pre-Existing Condition	Reference - Wildcat Branch	Referece - UT Brick Bound Swamp	Design	As-built/Baseline					
Dimension and Substrate - Riffle	Eq.			Mean	Mean	Mean	Mean	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)				9.7	8.2	6.1	8.8	8.8	9.6	9.7	10.5	0.7	5
Floodprone Width (ft)				12.3	130.0	24.5	125.0	126.3	177.1	182.9	219.0	35.1	5
Bankfull Mean Depth (ft)				0.75	1.03	0.50	0.92	0.8	0.9	0.9	1.1	0.1	5
Bankfull Max Depth (ft)				1.1	1.6	1.0	1.4	1.1	1.5	1.5	1.8	0.3	5
Bankfull Cross Sectional Area (ft^2)				7.2	8.5	3.1	8.3	7.7	9.1	8.7	12.0	1.7	5
Width/Depth Ratio				12.9	8.0	12.2	9.5	8.8	10.2	10.0	12.2	1.4	5
Entrenchment Ratio				1.3	15.9	4.0	14.3	11.9	13.1	12.9	14.3	0.9	5
Bank Height Ratio				4.83	1.09	1.00	1.00	1.0	1.0	1.0	1.0	0.0	5
d50 (mm)				sand	sand	sand	sand						
Profile													
Riffle Length (ft)								8.6	21.9	22.8	33.6	9.0	7
Riffle Slope (ft/ft)				Channelized	0.0022	0.0012	0.0007	0.0039	0.0069	0.0075	0.0096	0.0019	7
Pool Length (ft)								9.1	27.0	25.7	53.9	11.6	61
Pool Max depth (ft)				Channelized	1.75	1.25	1.75	1.60	1.86	1.90	2.20	0.23	5
Pool Spacing (ft)				Channelized	14.0 - 16.6	15.29 - 27.81	20.1 - 84.9	12.5	41.8	40.3	96.3	18.4	63
Pool Cross Sectional Area (ft^2)								8.80	10.46	10.90	11.40	1.05	5
Pattern													
Channel Beltwidth (ft)				Channelized	13.8 - 19.4	13.8 - 19.4	17.5 - 52.5						
Radius of Curvature (ft)				Channelized	10.9 - 15.3	5.0 - 9.0	20.1 - 22.8						
Rc: Bankfull Width (ft/ft)				Channelized	1.3 - 1.9	0.9 - 1.5	2.3 - 2.6						
Meander Wavelength (ft)				Channelized	22.5 - 29.0	23.0 - 29.0	14.0 - 56.0						
Meander Width Ratio				Channelized	1.7 - 2.4	2.3 - 3.2	2.0 - 6.0						
Substrate, bed and transport parameters													
Ri% / P%								33/67					
SC% / Sa% / G% / C% / B% / Be%													
d16 / d35 / d50 / d84 / d95/ di^p / di^{sp} (mm)													
Reach Shear Stress (competency) lb/ft^2													
Max part size (mm) mobilized at bankfull													
Unit Stream Power (transport capacity) lbs/ft.s				0.01			0.01	0.02					
Additional Reach Parameters													
Drainage Area (SM)				0.37	0.44	0.11	0.37						
Impervious cover estimate (%)													
Rosgen Classification				G-F/5	E5	E5	E5	E5					
Bankfull Velocity (fps)					1.00	0.97	0.80						
Bankfull Discharge (cfs)				8.4	8.5	3.0	8.4						
Valley length (ft)				2126			2126	2126					
Channel Thalweg length (ft)				2339			2679	2709					
Sinuosity (ft)				1.10	1.15	1.35	1.26	1.27					
Water Surface Slope (Channel) (ft/ft)				0.0011	0.0024	0.0016	0.0005	0.0005					
BF slope (ft/ft)							0.0005	0.0005					
Bankfull Floodplain Area (acres)													
Proportion over wide (%)													
Entrenchment Class (ER Range)													
Incision Class (BHR Range)													
BEHI VL% / L% / M% / H% / VH% / E%													
Channel Stability or Habitat Metric													
Biological or Other													

Table 9. Morphology and Hydraulic Monitoring Summary (Dimensional Parameters - Cross Section)
UT to Millers Creek (DMS Project No. 95719)
UT to Millers Creek: 2,709 LF

	Cross Section 1 (Riffle)							Cross Section 2 (Pool)						
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation														
Bankfull Width (ft)	9.7	9.1	9.4	9.5				8.6	8.6	7.8	8.0			
Floodprone Width (ft)	195.2	195.2	195.2	195.2										
Bankfull Mean Depth (ft)	0.8	0.7	0.7	0.7				1.0	0.9	1.0	0.9			
Bankfull Max Depth (ft)	1.1	1.0	1.1	1.0				1.7	1.5	1.5	1.5			
Bankfull Cross Sectional Area (ft^2)	7.7	6.3	6.7	6.8				8.8	7.3	7.3	7.0			
Bankfull Width/Depth Ratio	12.2	13.2	13.2	13.2										
Bankfull Entrenchment Ratio	20.2	21.4	20.8	20.5										
Bankfull Bank Height Ratio*	1.0	1.1	1.1	1.1										
	Cross Section 3 (Riffle)							**Cross Section 4 (Pool)**						
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation														
Bankfull Width (ft)	9.9	10.6	10.0	9.2				9.4	9.8	10.2	12.2			
Floodprone Width (ft)	126.3	126.3	126.3	126.3										
Bankfull Mean Depth (ft)	0.9	0.9	0.9	0.9				1.2	1.2	0.9	0.8			
Bankfull Max Depth (ft)	1.6	1.6	1.6	1.5				2.2	1.9	1.8	1.8			
Bankfull Cross Sectional Area (ft^2)	8.8	9.9	8.5	8.5				10.9	11.4	9.4	9.8			
Bankfull Width/Depth Ratio	11.1	11.4	11.6	10.0										
Bankfull Entrenchment Ratio	12.8	11.9	12.7	13.8										
Bankfull Bank Height Ratio*	1.0	1.0	1.0	1.1										
	Cross Section 5 (Riffle)							**Cross Section 6 (Pool)**						
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation[1]														
Bankfull Width (ft)	9.1	9.4	8.9	9.9				10.5	9.7	9.8	9.5			
Floodprone Width (ft)	182.9	182.9	182.9	182.9										
Bankfull Mean Depth (ft)	0.9	1.0	1.0	0.9				1.0	1.0	0.9	0.9			
Bankfull Max Depth (ft)	1.4	1.6	1.7	1.8				1.6	1.7	1.7	1.7			
Bankfull Cross Sectional Area (ft^2)	8.4	9.7	9.1	9.3				10.1	9.3	8.7	8.4			
Bankfull Width/Depth Ratio	10.0	9.1	8.7	10.5										
Bankfull Entrenchment Ratio	20.0	19.5	20.5	18.5										
Bankfull Bank Height Ratio*	1.0	1.1	1.0	1.0										
	Cross Section 7 (Riffle)							**Cross Section 8 (Pool)**						
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation														
Bankfull Width (ft)	8.8	10.2	9.6	9.7				9.5	10.0	9.6	9.3			
Floodprone Width (ft)	162.2	162.2	162.2	162.2										
Bankfull Mean Depth (ft)	1.0	0.9	0.9	0.9				1.2	1.2	1.1	1.2			
Bankfull Max Depth (ft)	1.5	1.6	1.6	1.6				1.9	2.0	1.9	2.0			
Bankfull Cross Sectional Area (ft^2)	8.7	8.6	8.5	8.7				11.1	11.9	10.8	11.4			
Bankfull Width/Depth Ratio	8.8	12.0	10.9	10.9										
Bankfull Entrenchment Ratio	18.5	16.0	16.8	16.7										
Bankfull Bank Height Ratio*	1.0	1.0	1.0	1.0										
	Cross Section 9 (Riffle)							**Cross Section 10 (Pool)**						
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation														
Bankfull Width (ft)	10.5	10.2	11.1	11.7				9.8	9.2	10.5	9.6			
Floodprone Width (ft)	219.0	219.0	219.0	219.0										
Bankfull Mean Depth (ft)	1.1	1.1	1.0	1.0				1.2	1.0	1.0	1.0			
Bankfull Max Depth (ft)	1.8	1.9	1.9	1.9				1.9	1.7	2.1	2.1			
Bankfull Cross Sectional Area (ft^2)	12.0	11.1	11.3	11.2				11.4	8.7	10.7	10.2			
Bankfull Width/Depth Ratio	9.1	9.4	10.9	12.2										
Bankfull Entrenchment Ratio	20.9	21.5	19.8	18.8										
Bankfull Bank Height Ratio*	1.0	0.9	1.0	1.1										

*Bankfull Bank Height Ratio = ((Current Monitoring Year Top of Bank Elevation - Baseline Bankfull Elevation) + Baseline Bankfull Max Depth) / Baseline Bankfull Max Depth

Table 10. Monitoring Data - Stream Reach Data Summary
UT to Millers Creek (DMS Project No. 95719)

Parameter	Baseline						MY-1						MY-2						MY- 3						MY- 4						MY- 5					
Dimension and Substrate	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n	Min	Mean	Med	Max	SD[4]	n
Bankfull Width (ft)	8.8	9.6	9.7	10.5	0.7	5	9.1	9.9	10.2	10.6	0.6	5	8.9	9.8	9.6	11.1	0.8	5	9.2	10.0	9.7	11.7	1.0	5												
Floodprone Width (ft)	126.3	177.1	182.9	219.0	35.1	5	126.3	177.1	182.9	219.0	35.1	5	126.3	177.1	182.9	219.0	35.1	5	126.3	177.1	182.9	219.0	35.1	5												
Bankfull Mean Depth (ft)	0.8	0.9	0.9	1.1	0.1	5	0.7	0.9	0.9	1.1	0.2	5	0.7	0.9	0.9	1.0	0.1	5	0.7	0.9	0.9	1.0	0.1	5												
[1]Bankfull Max Depth (ft)	1.1	1.5	1.5	1.8	0.3	5	1.0	1.6	1.6	1.9	0.3	5	1.1	1.6	1.6	1.9	0.3	5	1.0	1.5	1.6	1.9	0.3	5												
Bankfull Cross Sectional Area (ft^2)	7.7	9.1	8.7	12.0	1.7	5	6.3	9.1	9.7	11.1	1.8	5	6.7	8.8	8.5	11.3	1.6	5	6.8	8.9	8.7	11.2	1.6	5												
Width/Depth Ratio	8.8	10.2	10.0	12.2	1.4	5	9.1	11.0	11.4	13.2	1.7	5	8.7	11.1	10.9	13.2	1.6	5	10.0	11.4	10.9	13.2	1.3	5												
Entrenchment Ratio	11.9	13.1	12.9	14.3	0.9	5	11.9	18.1	19.5	21.5	4.1	5	12.7	18.1	19.8	20.8	3.4	5	13.8	17.6	18.5	20.5	2.6	5												
[1]Bank Height Ratio	1.0	1.0	1.0	1.0	0.0	5	0.9	1.0	1.0	1.1	0.1	5	1.0	1.0	1.0	1.0	0.0	5	1.0	1.0	1.1	1.1	0.1	5												
Profile																																				
Riffle Length (ft)	8.6	21.9	22.8	33.6	9.0	7																														
Riffle Slope (ft/ft)	0.0039	0.0069	0.0075	0.0096	0.0019	7																														
Pool Length (ft)	9.1	27.0	25.7	53.9	11.6	61																														
Pool Max depth (ft)	1.60	1.86	1.90	2.20	0.23	5																														
Pool Spacing (ft)	12.5	41.8	40.3	96.3	18.4	63																														
Pattern*																																				
Channel Beltwidth (ft)		17.5 - 52.5																																		
Radius of Curvature (ft)		20.1 - 22.8																																		
Rc:Bankfull width (ft/ft)		2.3 - 2.6																																		
Meander Wavelength (ft)		14.0 - 56.0																																		
Meander Width Ratio		2.0 - 6.0																																		
Additional Reach Parameters																																				
Rosgen Classification			E5																																	
Channel Thalweg length (ft)			2709																																	
Sinuosity (ft)			1.27																																	
Water Surface Slope (Channel) (ft/ft)			0.0011																																	
BF slope (ft/ft)			0.0005																																	
[3]Ri% / Ru% / P% / G% / S%	33		67																																	
[3]SC% / Sa% / G% / C% / B% / Be%																																				
[3]d16 / d35 / d50 / d84 / d95 /																																				
[2]% of Reach with Eroding Banks																																				
Channel Stability or Habitat Metric																																				
Biological or Other																																				

Shaded cells indicate that these will typically not be filled in.
1 = The distributions for these parameters can include information from both the cross-section measurements and the longitudinal profile.
2 = Proportion of reach exhibiting banks that are eroding based on the visual survey from visual assessment table
3 = Riffle, Run, Pool, Glide, Step; Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock; dip = max pave, disp = max subpave
4. = Of value/needed only if the n exceeds 3
*Pattern data taken from design calculations as stream was built according to design plans per As-Built drawings

Appendix E. Hydrologic Data

Table 11. Verification of Bankfull Events

Date	Crest Gauge Info		Gauge Reading (ft)	Gauge Elevation (ft)	Crest Elevation (ft)	Bankfull Elevation (ft)	Height above Bankfull (ft)
	Site	Sta.					
7/14/2015	2	37+03	2.29	107.16	109.45	107.71	1.74
10/19/2015	1	10+62	1.50	111.46	112.96	112.07	0.89
4/27/2016	1	10+62	1.88	111.46	113.34	112.07	1.26
4/27/2016	2	37+03	3.70	107.16	110.87	107.71	3.15
10/10/2016	1	10+62	2.79	111.46	114.25	112.07	2.18
10/10/2016	2	37+03	3.43	107.16	110.59	107.71	2.88
10/10/2016	N/A	Approx. 20+00	Visual	Visual	Visual	Visual	Visual
1/17/2017	1	10+62	2.29	111.46	113.75	112.07	1.68
1/17/2017	2	37+03	3.13	107.16	110.29	107.71	2.58
4/26/2017	1	10+62	2.00	111.46	113.46	112.07	1.39
4/26/2017	2	37+03	4.06	107.16	111.22	107.71	3.51

Figure 6.1 - 6.4 Crest Gauge Photos

6.1 Crest Gauge 1 (1/17/2017)

6.2 Crest Gauge 2 (1/17/2017)

6.3 Crest Gauge 1 (4/26/2017)

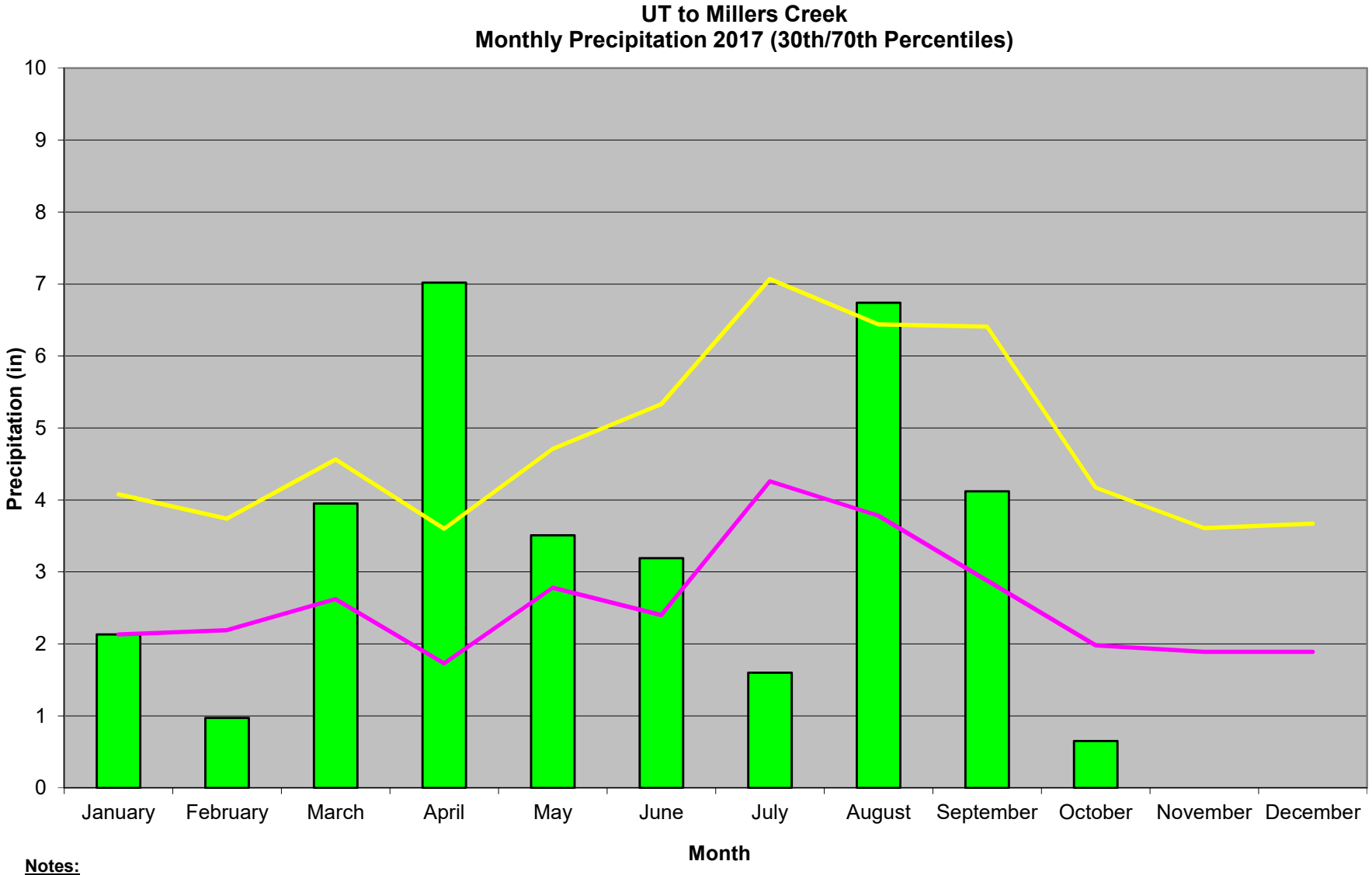
6.4 Crest Gauge 2 (4/26/2017)

Table 12. Summary of Gauge Hydrologic Data

Gauge Number*	Wetland Community Type	Target Hydroperiod	Percentage of Growing Season Year 1	Longest Number Of Consecutive Days Meeting Wetland Hydrology Criteria During Year 1 Growing Season	Percentage of Growing Season Year 2	Longest Number Of Consecutive Days Meeting Wetland Hydrology Criteria During Year 2 Growing Season	Percentage of Growing Season Year 3	Longest Number Of Consecutive Days Meeting Wetland Hydrology Criteria During Year 3 Growing Season
1	Riparian Bottomland Hardwood	12.5%	43	130	23	69	7.6	23
2	Riparian Bottomland Hardwood	12.5%	53	161	49	149	43.6	132
3	Riparian Bottomland Hardwood	12.5%	10	30	21	65	5.6	17
4	Headwater Riparian (Zero Order)	10%	70	212	100	304	52.5	159
5	Riparian Bottomland Hardwood	12.5%	32	97	49	149	49.2	149
6	Riparian Bottomland Hardwood	12.5%	52	158	48	146	51.5	156
Reference	Headwater Riparian (Zero Order)	10%	39	118	46	141	17.8	54
Reference	Riparian Bottomland Hardwood	12.5%	36	108	26	79	26.1	79

*Green shading indicates that gauge has met target hydroperiod for monitoring year
Red shading indicates that gauge has not met target hydroperiod for monitoring year

Figure 7. Zero Order Reference Wetland Gauge



Notes:

1. Precipitation data obtained from on-site rain gauge (collected through December 31).

2. 30th and 70th percentiles calculated from long-term climatic data 1984-2013 (www.wcc.nrcs.usda.gov)

Figure 8.0. Zero Order Reference Wetland Gauge

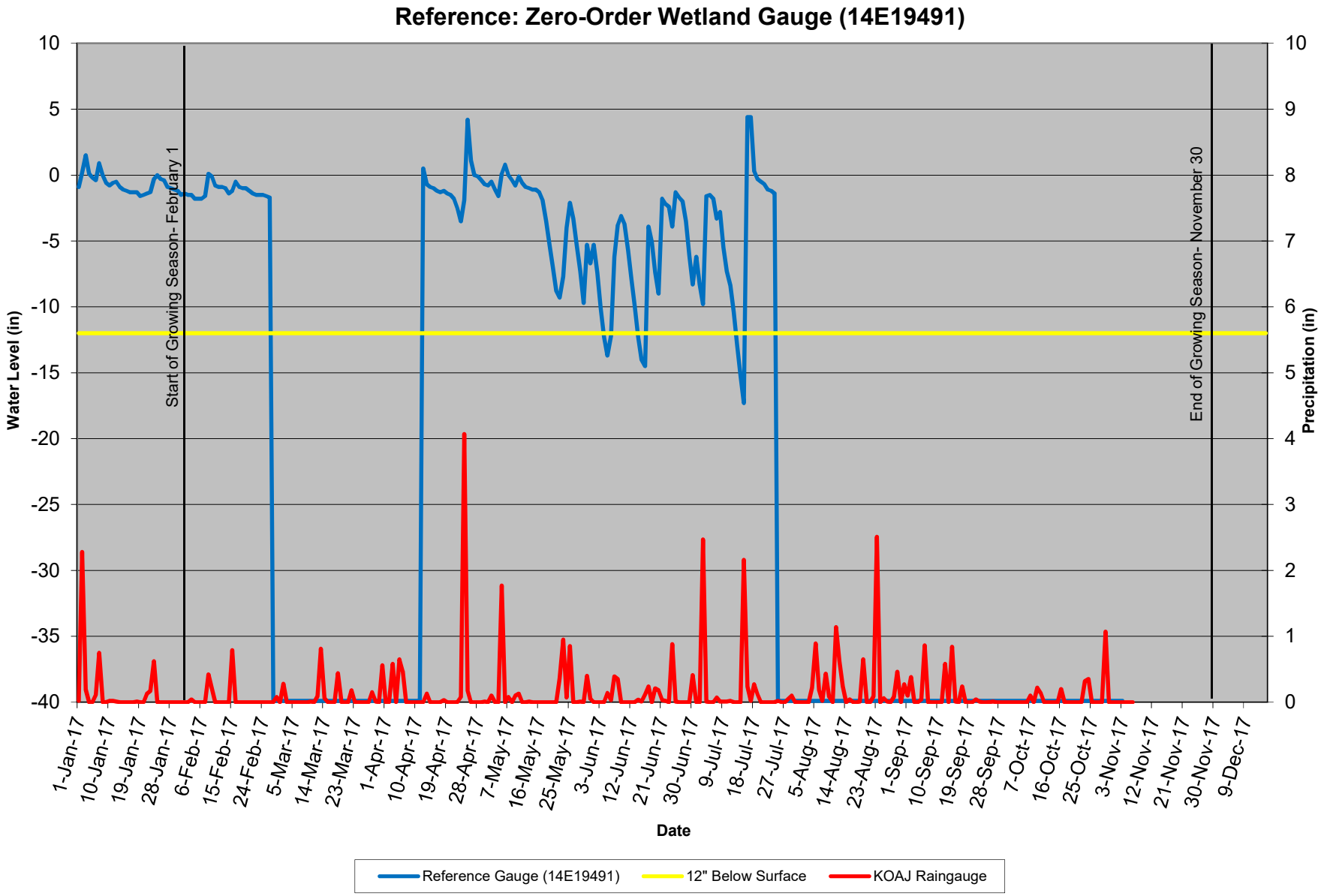


Figure 8.1. Second Order Reference Wetland Gauge

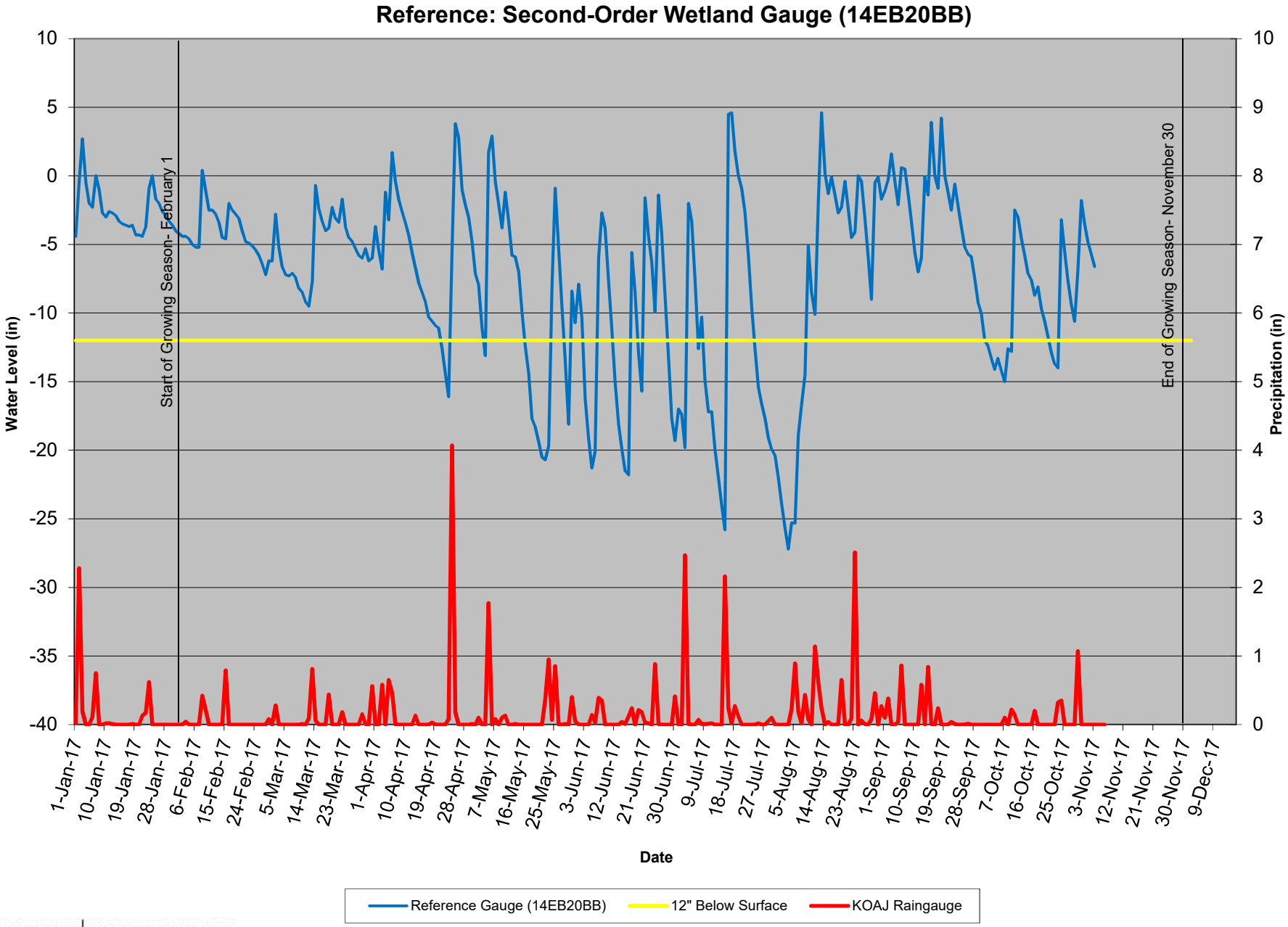


Figure 8.2. Wetland Gauge 1

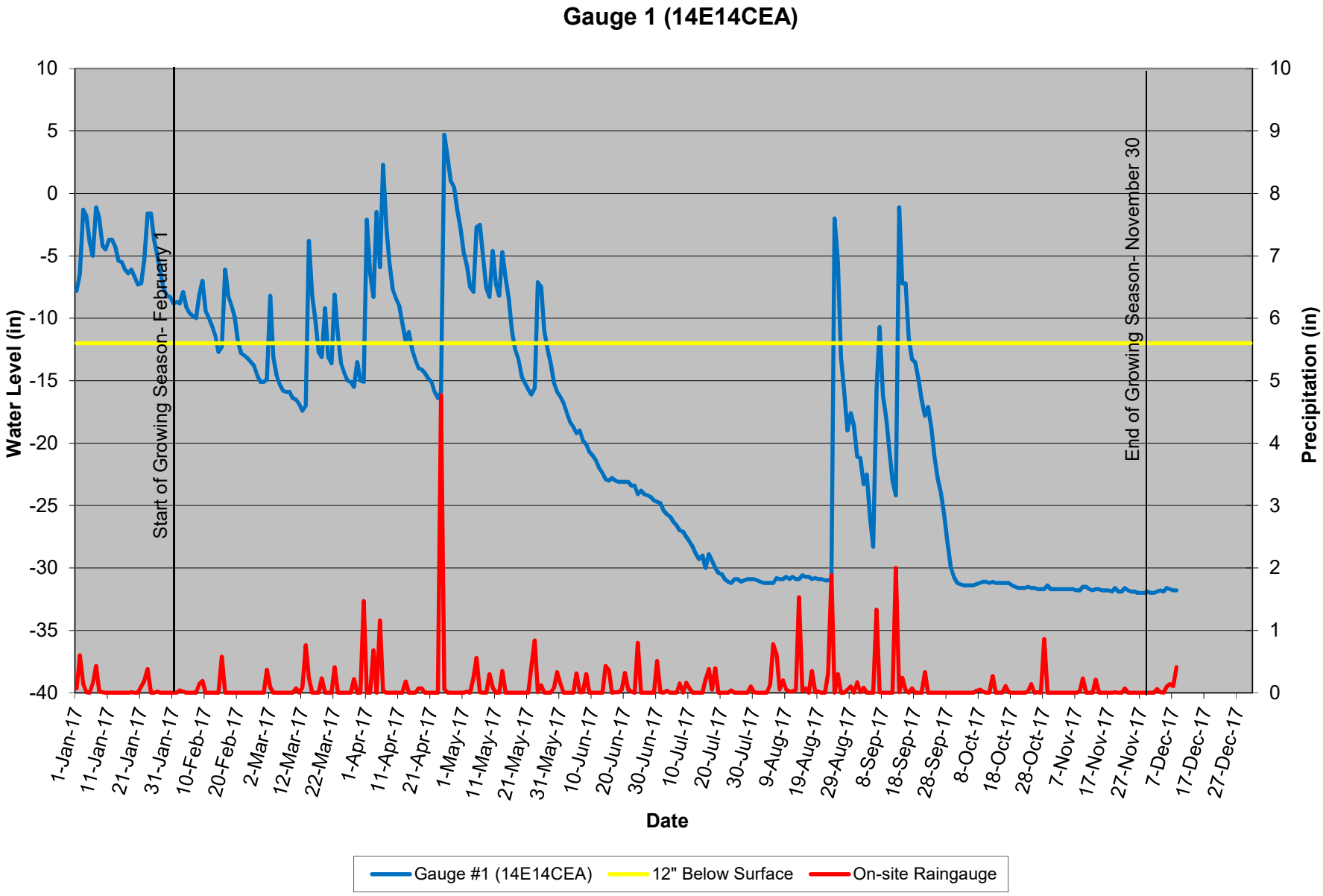


Figure 8.3. Wetland Gauge 2

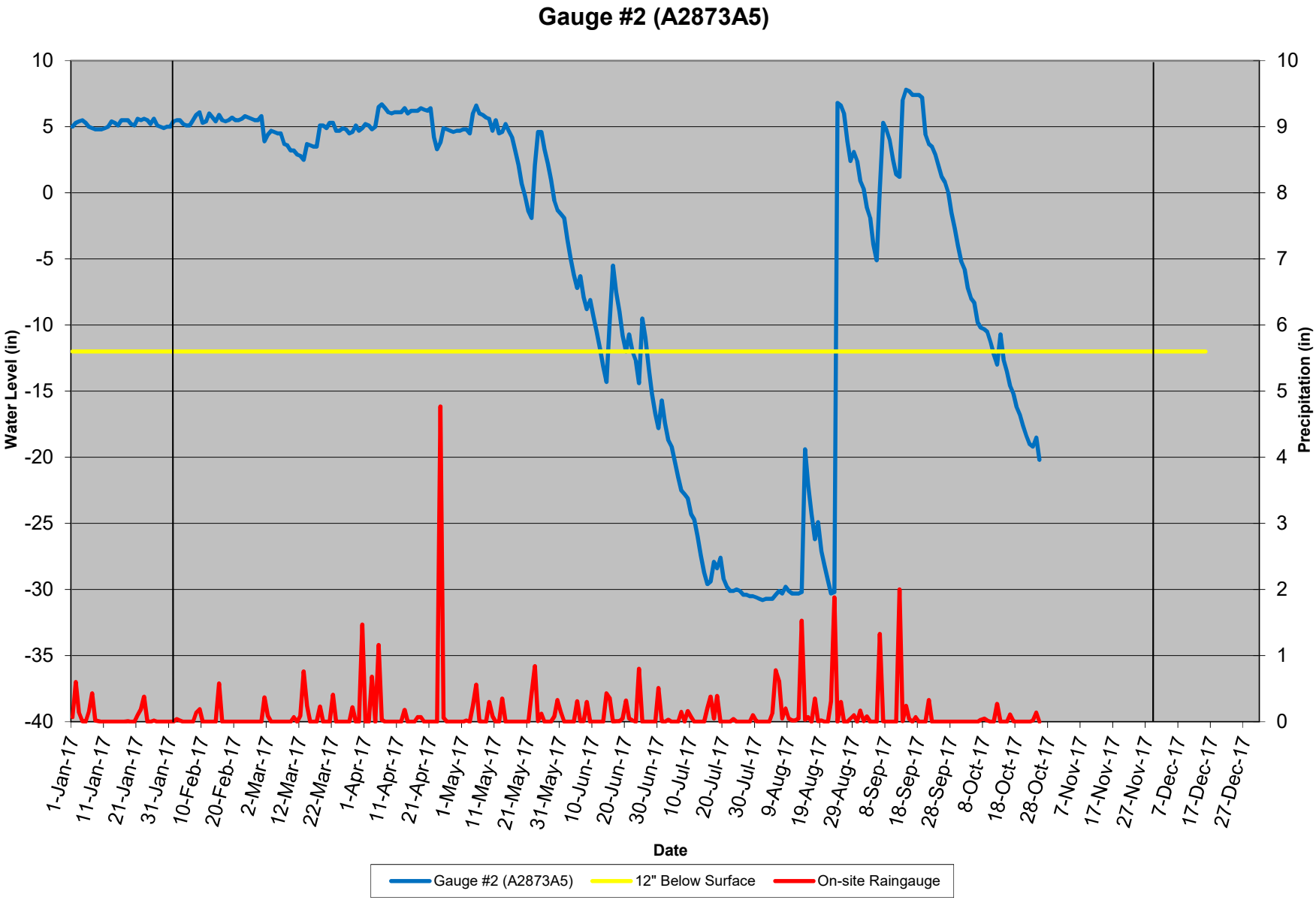


Figure 8.4. Wetland Gauge 3

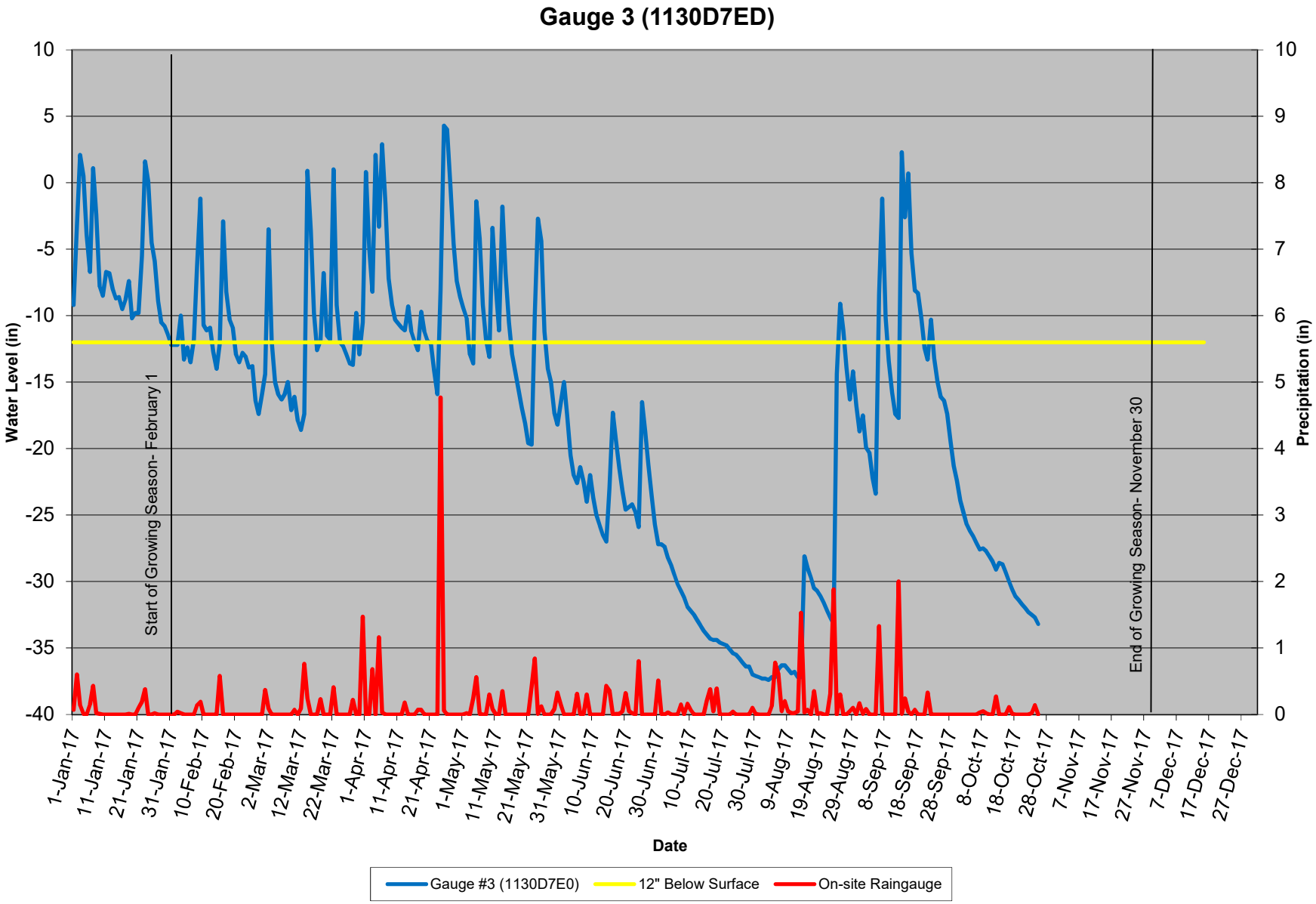


Figure 8.5. Wetland Gauge 4

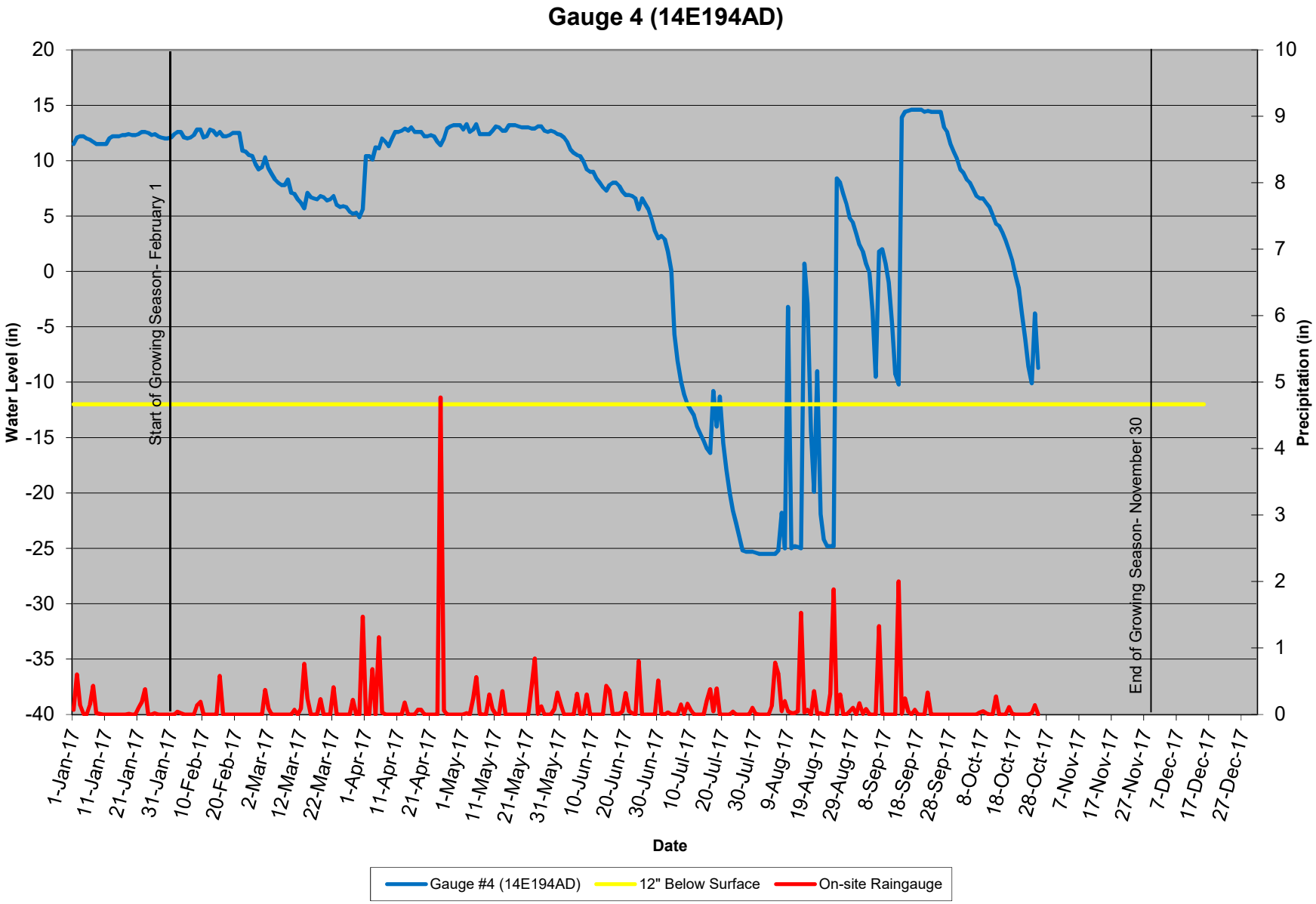


Figure 8.6. Wetland Gauge 5

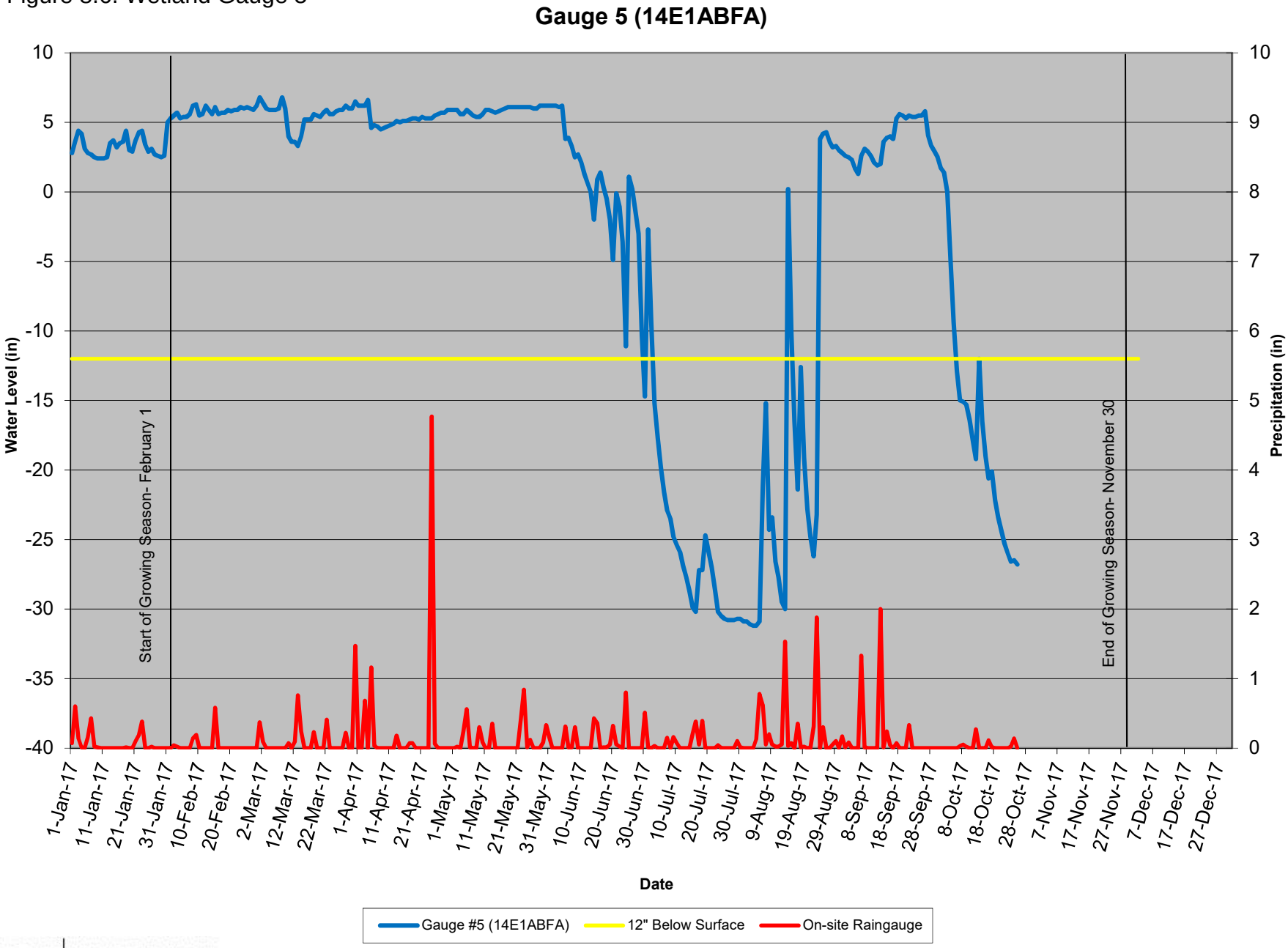


Figure 8.7. Wetland Gauge 6

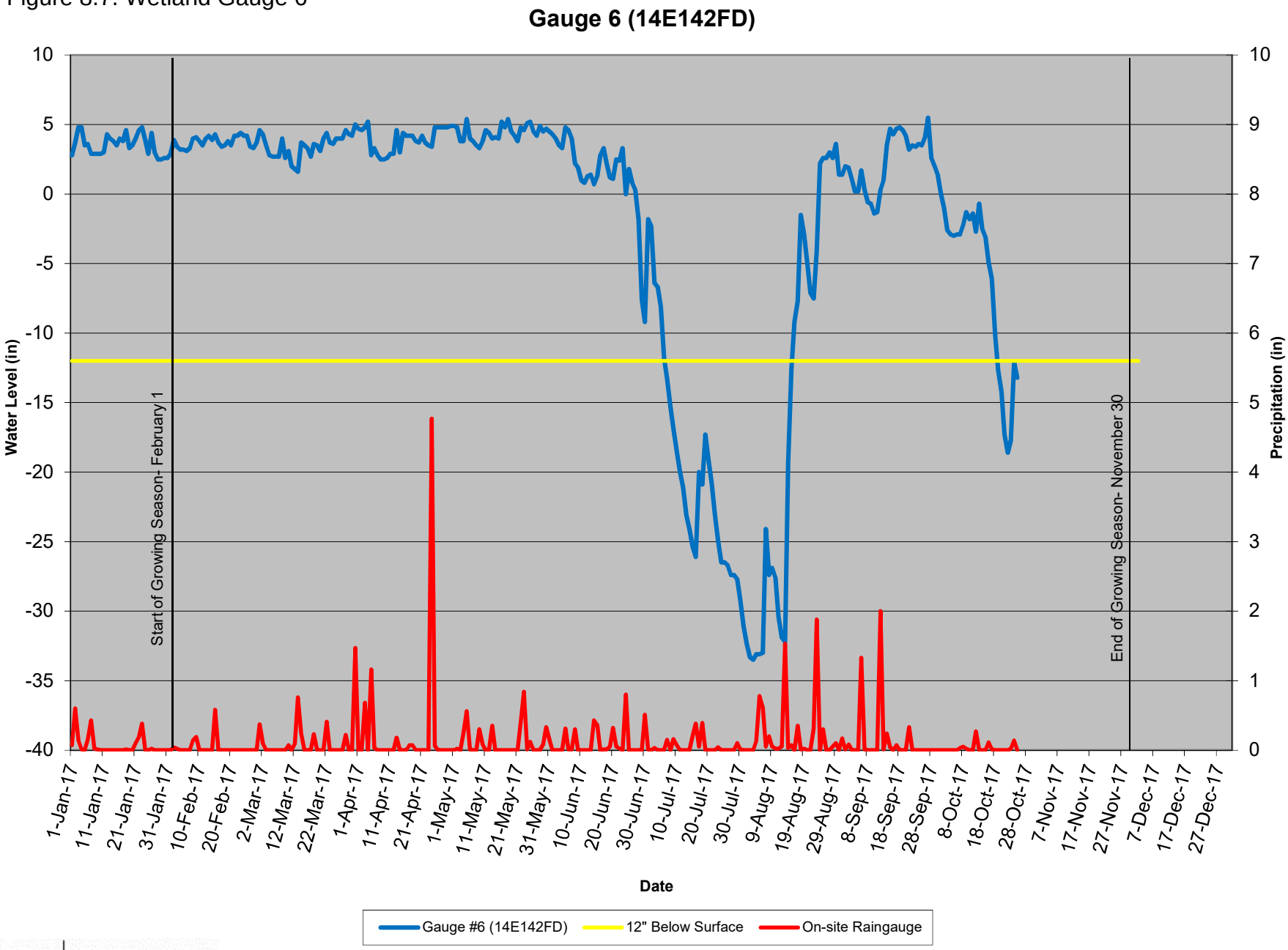


Figure 9.0. NCDWR Drought Status Map January

North Carolina Division of Water Resources January 31, 2017
DWR Drought Image

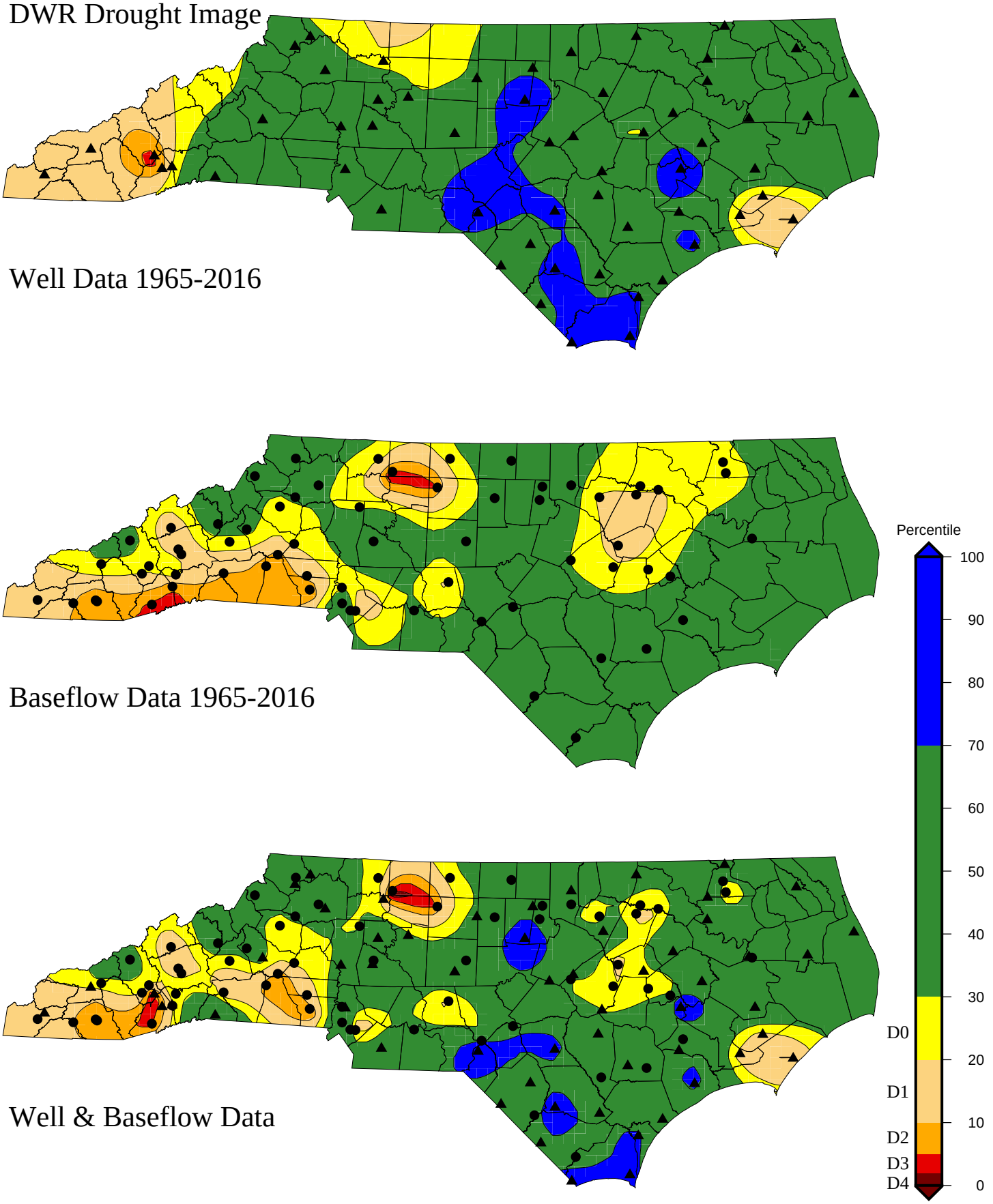
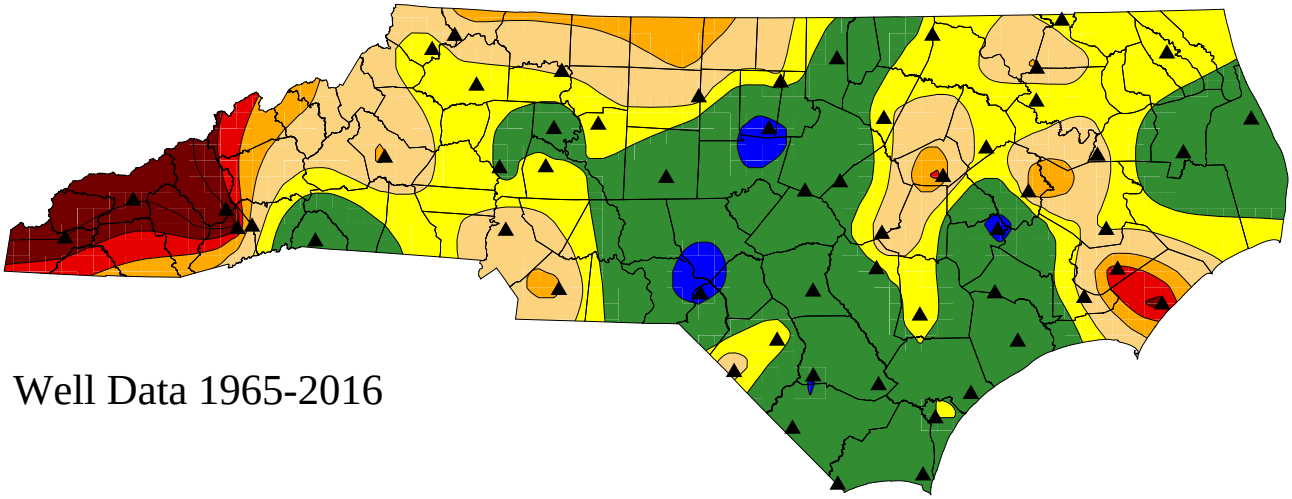


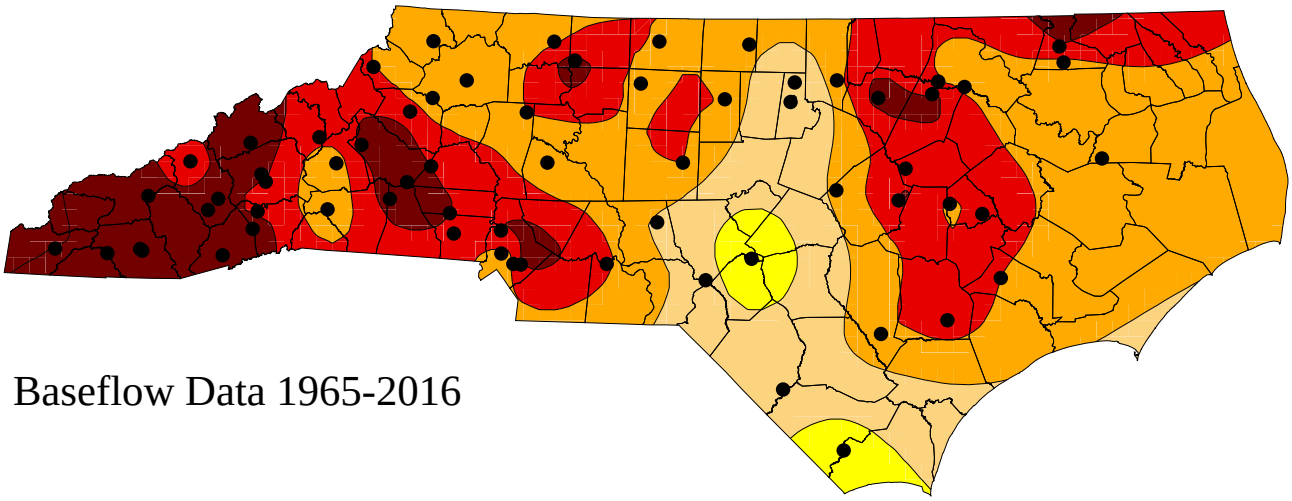
Figure 9.1. NCDWR Drought Status Map February

North Carolina Division of Water Resources February 28, 2017

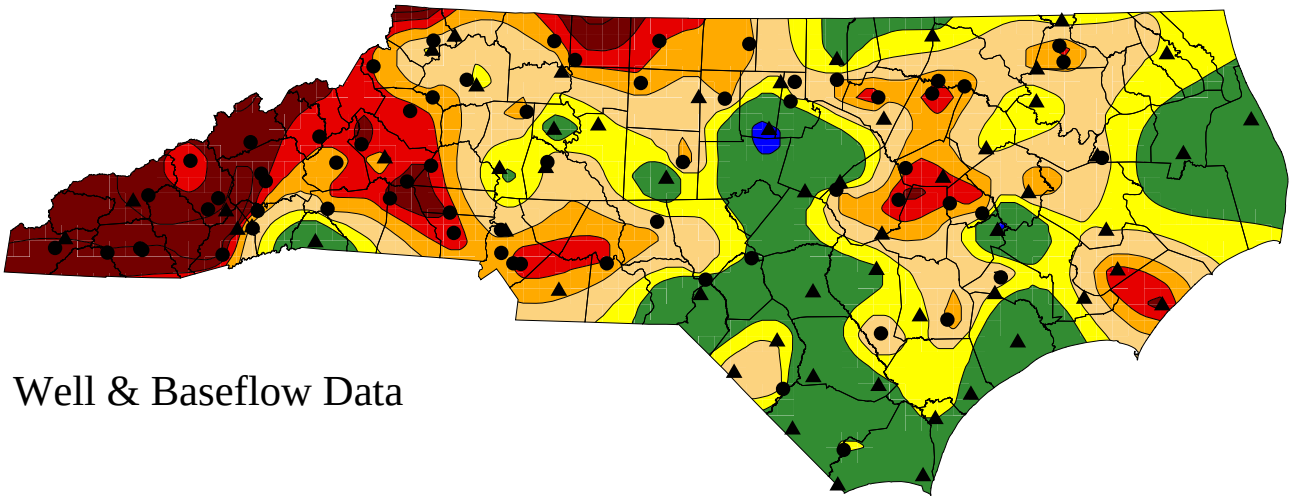
DWR Drought Image



Well Data 1965-2016



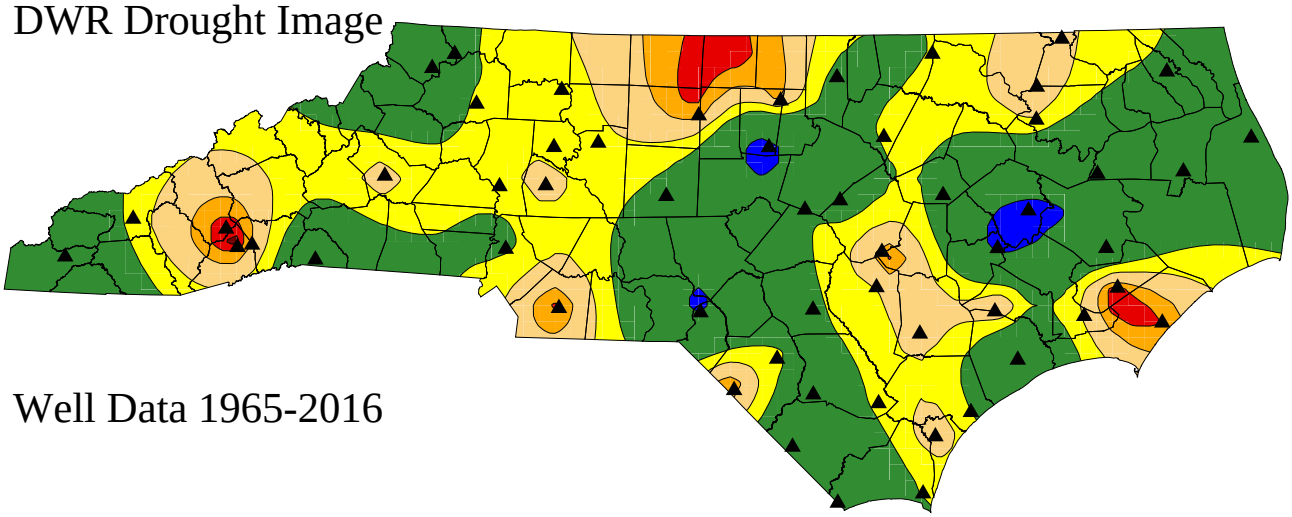
Baseflow Data 1965-2016



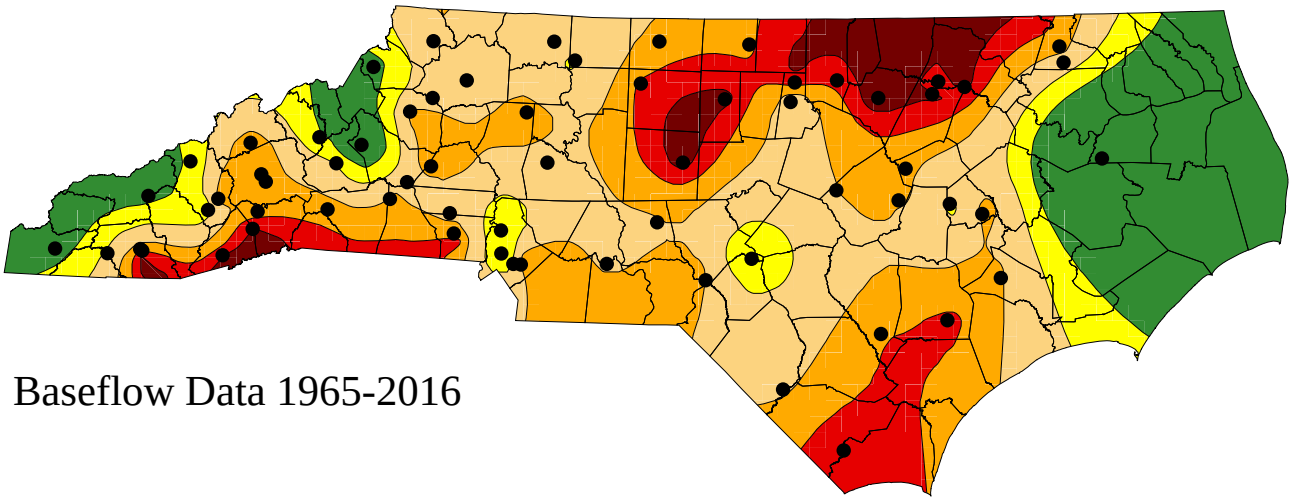
Well & Baseflow Data

Figure 9.2. NCDWR Drought Status Map March

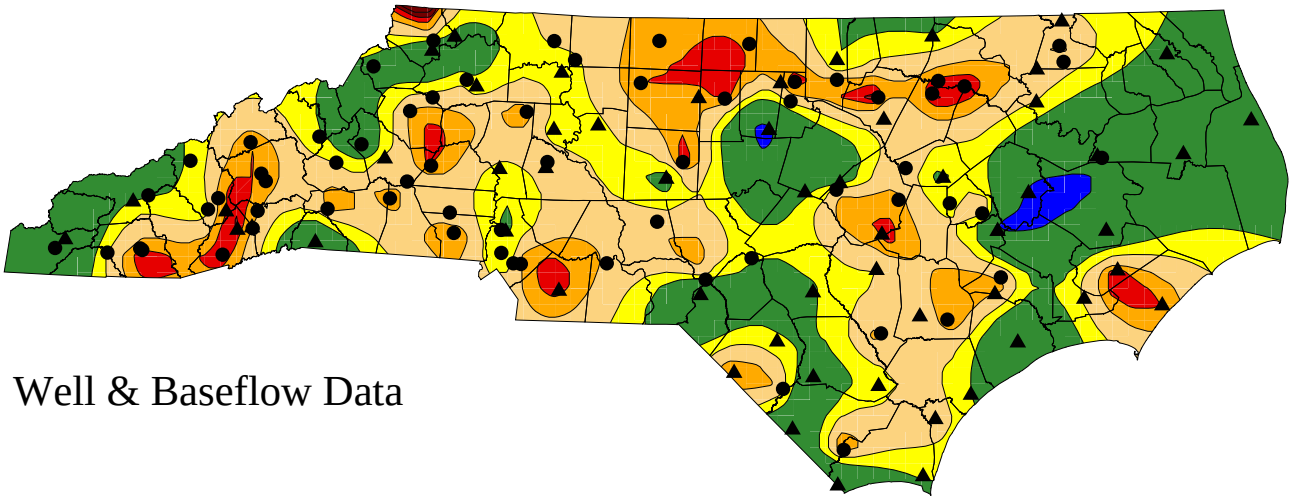
North Carolina Division of Water Resources March 31, 2017
DWR Drought Image



Well Data 1965-2016



Baseflow Data 1965-2016



Well & Baseflow Data