


MONITORING YEAR 7 ANNUAL/CLOSEOUT REPORT

FINAL

CROOKED CREEK #2 RESTORATION PROJECT

Union County, NC
DEQ Contract 6617
DMS Project Number 94687
USACE Permit No. SAW-2011-02201

Data Collection Period: April – November 2022
Submission Date: February 27, 2023

PREPARED FOR:

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EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) completed a design-bid-build project at the Crooked Creek #2 Mitigation Site (Site) for the North Carolina Division of Mitigation Services (DMS) to restore and enhance 5,599 linear feet (LF) of perennial streams, enhance 1.0 acre of existing wetlands, restore and create 10.5 acres of wetlands, and restore and enhance 70,936 square feet (SF) of riparian buffer in Union County, NC. Per the Mitigation Plan (2013), the Site was proposed to generate 3,242.600 stream mitigation units (SMUs), 8.4 wetland mitigation units (WMUs), and 1.24 buffer mitigation units (BMU) for the Goose Creek watershed (Table 1). Due to the presence of "at-risk" wetland areas observed during the seven years of post-construction monitoring, DMS is proposing a revised wetland boundary for closeout assets. The proposed closeout credit adjustment includes a reduction of WMUs from 8.400 WMUs to 6.950 WMUs. The revised asset table and figures are located in Appendix 1 and 2. Supplemental wetland data is included in Appendix 6.

The Site is located off NC Highway 218 in the northern portion of Union County, NC in the Yadkin Pee-Dee River Basin; eight-digit Cataloging Unit (CU) 03040105 and the 14-digit Hydrologic Unit Code (HUC) 03040105040010 (Figure 1). The project streams consist of two unnamed tributaries (UT) to Crooked Creek, UT1 and UT2, and two reaches of the Crooked Creek mainstem (Reach A and Reach B) (Figure 2). Crooked Creek flows into the Rocky River 4 miles northeast of the Site near Love Mill Road at the Stanly County line. The adjacent land to the streams and wetlands is primarily maintained for agricultural and residential uses.

The Site is within a Targeted Local Watershed (TLW) in the Lower Yadkin Pee-Dee River Basin Restoration Priority Plan (RBRP) (NCEEP, 2009). The Site is also located within the Goose Creek and Crooked Creek Local Watershed Plan (LWP). The final watershed management plan (WMP) for Goose Creek and Crooked Creek was completed in July 2012 (NCEEP, 2012). The stressors to watershed function identified in the WMP were sediment pollution and increases in peak stream flows resulting in impairments to aquatic habitat and aquatic life. Stream enhancement and restoration were identified as the best management opportunities to offset these impacts. Other stressors identified included nonpoint source runoff, degraded terrestrial habitat, and disconnected floodplains. Wetland enhancement and restoration was also identified as a best management opportunity to offset impacts related to these stressors. The wetland portion of the project was identified as a specific priority in the Project Atlas that accompanies the 2012 WMP.

The project goals established in the mitigation plan (Wildlands, 2013) were created with careful consideration of the goals and objectives described in the RBRP and address stressors identified in the LWP. The following project goals established include:

- Improve wetland hydrologic connectivity;
- Decrease sediment input into stream;
- Create appropriate terrestrial habitat;
- Decrease water temperature and increase dissolved oxygen concentrations; and
- Decrease nutrient and adverse chemical levels.

The data presented in this report serves as the seventh and final monitoring year (MY7) and the closeout report for the Site. Overall, the Site has met the required stream geomorphology, stream hydrology, and riparian vegetation success criteria for MY7. All restored and enhanced streams are stable and functioning as designed with cross-section dimensions exhibiting minimal adjustments compared to as-built. The Site met the final bankfull performance criteria in MY4, and all project streams recorded at least one bankfull event in MY7. UT1 met the intermittent stream requirement 30 consecutive day flow requirement in MY7 and has consistently done so for the past four monitoring years (MY3 – MY7). The average planted stem density for the Site is 492 stems per acre with all

vegetation plots exceeding the final density criteria of 210 stems per acre by greater than 10%. The average stem height for the Site is 21 feet and exceeds the final height requirement of 10 feet in the closeout year. The MY7 visual assessments revealed minor areas of concern which included a headcut at the wetland outlet, a small area of encroachment at the easement boundary and a few pockets invasive plant species.

Four of the eleven groundwater monitoring gages (GWG) installed on the Site met or exceeded the hydrologic success criteria for MY7 as well as throughout the post-construction monitoring period. Therefore, DMS has modified the wetland boundary proposed for credit on Site to no longer included high areas with weak hydrology represented near GWGs 4, 10 and 11. Please refer to Appendix 1 for the original (Table 1) and the revised (Table 1.2) project component and mitigation credit tables and Appendix 2 for the revised Current Condition Plan View (CCPV) maps.

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APPENDICES

Section 1: PROJECT OVERVIEW

The Crooked Creek #2 Mitigation Site (Site) is located in the Yadkin Pee-Dee River Basin; eight-digit Cataloging Unit (CU) 03040105 and the 14-digit Hydrologic Unit Code (HUC) 03040105040010 (Figure 1). The Site is located off NC Highway 218 in the northern portion of Union County, NC (Figure 1). Located in the Carolina Slate Belt of the Piedmont Physiographic Province (USGS, 1998), the project watershed includes primarily agricultural forested and developed land. The drainage area for the project Site is 24,619 acres. The project streams consist of two streams (Crooked Creek and UT2) that underwent Stream Enhancement as well as one stream (UT1) which underwent Stream Restoration.

The Site is located within a Targeted Local Watershed (TLW) in the Lower Yadkin Pee-Dee River Basin Restoration Priority Plan (RBRP) (NCEEP, 2009). The Site is also located within the Goose Creek and Crooked Creek Local Watershed Plan (LWP). The final watershed management plan (WMP) for Goose Creek and Crooked Creek was completed in July 2012 (NCEEP, 2012). The stressors to watershed function identified in the WMP were sediment pollution and increased peak stream flows resulting in impairments to aquatic habitat and aquatic life. Stream enhancement and restoration were identified as the best management opportunities to offset these impacts. Other stressors identified included nonpoint source runoff, degraded terrestrial habitat, and disconnected floodplains. Wetland enhancement and restoration was also identified as a best management opportunity to offset impacts related to these stressors. The wetland portion of the project was identified as a specific priority in the Project Atlas that accompanies the 2012 WMP.

Prior to construction activities, the streams on the Site had been channelized and the adjacent floodplain wetland areas had been cleared and ditched to provide drainage for surrounding pasture. These land use activities resulted in bank instability due to erosion and livestock access, lack of riparian buffer, and altered hydrology. Stream Incision, lateral erosion, and widening also resulted in degraded aquatic and benthic habitat, reduction in quality and acreage of riparian wetlands, and lowered dissolved oxygen levels in the stream. Table 4 in Appendix 1 and Table 11 in Appendix 4 present the post-restoration conditions in more detail.

1.1 Project Goals and Objectives

This mitigation Site is intended to provide numerous ecological benefits within the Yadkin Pee-Dee River Basin. While many of these benefits are limited to the Crooked Creek project area, others, such as pollutant removal, reduced sediment loading, and improved aquatic and terrestrial habitat, have farther-reaching effects. Expected improvements to water quality and ecological processes are outlined below as project goals and objectives.

The project goals established in the mitigation plan (Wildlands, 2013) were created with careful consideration of the goals and objectives described in the RBRP and address stressors identified in the LWP. The following project goals established include:

- Improve wetland hydrologic connectivity;
- Decrease sediment input into stream;
- Create appropriate terrestrial habitat;
- Decrease water temperature and increase dissolved oxygen concentrations; and
- Decrease nutrient and adverse chemical levels.

The project objectives have been defined as follows:

- Construct stream channels that will remain relatively stable over time and adequately transport their sediment loads without significant erosion or aggradation;
- Construct stream channels that maintain riffles with coarse bed material and pools with finer bed material;
- Provide aquatic and benthic habitat diversity in the form of pools, riffles, woody debris, and in-stream structures;
- Add riffle features and structures and riparian vegetation to decrease water temperatures and increased dissolved oxygen to improve water quality;
- Construct stream reaches so that floodplains and wetlands are frequently flooded to provide energy dissipation, detain and treat flood flows, and create a more natural hydrologic regime;
- Construct fencing to keep livestock out of the streams;
- Raise local groundwater table through raising stream beds and plugging agricultural drainage features;
- Perform minor grading in wetland areas as necessary to promote wetland hydrology; and Plant native tree species to establish appropriate wetland and floodplain communities and retain existing, native trees where possible.

1.2 Monitoring Year 7 Data Assessment

The following sections present the MY7 data collected between April 2022 and January 2023 to assess the condition of the project. The success criteria for the Site follows the approved success criteria presented in the Crooked Creek #2 Project Mitigation Plan (Wildlands, 2013).

1.2.1 Vegetation Assessment

A total of 12 standard 10-meter by 10-meter permanent vegetation plots were established during the baseline monitoring within the project easement area. The final vegetative success criteria are the survival of 210 planted stems per acre with an average height of 10 feet in each plot in the riparian corridor along restored and enhanced reaches at the end of the seven-year monitoring period (MY7).

The MY7 vegetation survey was completed in September 2022 resulting in an average stem density of 492 stems per acre. All 12 vegetation plots individually met the year seven requirement of 210 stems/acre, with an average of 12 stems per plot. All plots except 12 individually meet the 10-foot requirement. Plots 12 has an average stem height of 6 feet and is located within the mature canopy of the Crooked Creek riparian corridor, slowing growth in the plot. The MY7 average stem height for the Site is 21 feet, exceeding the final height requirement and plots exceed the MY7 stem density requirement. Please refer to Appendix 2 for vegetation plot photographs and the overall vegetation condition assessment table. The vegetation data tables are located in Appendix 3. Please refer to Appendix 6 for the Invasive Species Treatment Logs.

1.2.2 Vegetation Areas of Concern

Generally, the vegetation within the Site is healthy. The native invasive species, cattail (*Typha latifolia*) continues to surround vegetation plot 5, but it is not adversely affecting tree growth in the plot. The colony is established but has not expanded beyond the area adjacent to vegetation plot 5.

The percent of easement area covered in invasive species is at 0.26% of the easement area in MY7. Since the September 2021 invasive treatments in MY6 there have been very few privet, tree of heaven, or honeysuckle resprouts observed. These populations are no longer a concern and have been removed from the CCPV maps. The only invasive population observed on site in MY7 was balloon vine in two isolated populations present in the late Fall growing season. DMS will continue to treat these invasive species as needed through closeout.

Previous mowing within the easement during MY5 and MY6 has been resolved with additional easement signs and a clear marker line connecting the easement signs with white tape. However, a new area of encroachment involving clearing into the easement from an adjacent landowner occurred during MY7 and DMS is actively corresponding with the landowner to rectify the encroachment and the area is circled on the MY7 CCPV maps. Refer to Appendix 2 for the vegetation condition assessment table, Area of concern photographs and the CCPV maps for MY7 areas of concern.

1.2.3 Stream Assessment

The MY7 morphological survey and substrate assessments conducted in April 2022 indicated that UT1 channel dimensions appear stable and functioning as designed. In general, the cross-sections show only minor changes in the bankfull area, maximum depth ratio, or width-to-depth ratio compared to the baseline survey. Surveyed riffle cross-sections and riffle pebble counts continue to fall within the parameters defined for channels of the appropriate Rosgen stream type (Rosgen, 1996). Refer to Appendix 2 for the visual stability assessment table, CCPV map, and stream photographs. Refer to Appendix 4 for the morphological summary data and plots.

1.2.4 Stream Areas of Concern

There were no stream areas of concern for UT1 or UT2 in MY7.

1.2.5 Hydrology Assessment

The stream hydrology success criteria require two bankfull events must occur in separate years within the seven-year monitoring period. Although, the stream hydrology success criteria were met in MY2, bankfull events continue to be recorded on Crooked Creek, UT1, and UT2. Events were verified with stream gages or visual indicators, such as wrack lines. During MY7 there were 6 bankfull events recorded on UT1. Wracklines were documented on all stream channels during the Site walk on 4/21/22. In addition, stream baseflow is being monitored on UT1 and 30 days of consecutive baseflow were recorded in MY7. Refer to Appendix 5 for hydrologic plots and photographs of documented bankfull events.

1.2.6 Wetland Assessment

At total of 11 groundwater gages (GWG) have been installed throughout the wetland areas to provide groundwater level data and one soil temperature probe was installed near GWG2. The target success criteria for wetland hydrology success consists of a groundwater surface within 12 inches of the ground surface for 17 consecutive days (7.5 %) of the defined 226 day growing season for Union County (March 23 through November 4) under typical precipitation conditions.

Four of eleven gages meet success criteria in MY7. Generally, the gages that met were located in Wetland Restoration Zone A away from the left floodplain of UT1: GWG3 (36 days,15.9%), GWG6 (44 days, 19.4%), GWG7 (39 days, 17.2%), and GWG8 (26 days, 11. 5%). GWGs 6, 7, and 8 have consistently met the success criteria each monitoring year and GWG3 has met success criteria each monitoring year after MY2.

DMS contracted Wildlands to conduct a soils investigation in Winter 2022. Based on the field investigation, GWG10 has neither hydric soils present at the gage nor does the gage data support a high water table in this area. Therefore, DMS is no longer seeking credit for the high area surrounding GWG10. The soils investigation did indicate that in the floodplain to the west of UT1 represented by GWGs 4 and 11 had hydric soil development using the F19 hydric indicator. However, neither of the gages have met the required hydrology success criteria throughout the monitoring period. Because hydrology would not meet a primary hydrology indicator on the USACE delineation determination form

nor is supported by GWG gage hydrology based on the monitoring data, DMS is no longer requesting credit for the proposed wetland area to the west of UT1. Please see Appendix 1 for the adjusted credit request (Table 1.2) and the CCPV figures in Appendix 2. All supplemental data collected during the Winter 2022 field assessment (soil, vegetation, and delineation forms) is included in Appendix 6.

GWGs 1, 2, 5, and 9 did not meet hydrology criteria using gage data in the majority of the monitoring years. These gages represent the right floodplain in wetland restoration zone A and wetland creation zone B and contain F19 hydric soils. In addition to hydric soils, a high water table was present at the gages during the soils investigation in Winter 2022. Based on the soils, hydrology, and type of vegetation present during the investigation, Wildlands determined that GWGs 1, 2, 5, and 9 would delineate as a wetland using the USACE wetland delineation determination form. Although these wetland areas are marginal, they show continued development of hydrology and wetland soils and DMS determined this area should remain as part of the wetland credits proposed for closeout subject to further field discussion. For soil, vegetation, and delineation forms please refer to Appendix 6. Please refer to Appendix 5 for the groundwater hydrology data, plots, and rainfall data.

1.2.7 Hydrology Data with Adjusted Growing Season Data and Soil Temperature Data

In addition to the modified wetland boundary, DMS has included supplemental data to consider in the closeout assessment for the Site. Multiple indicators at Crooked Creek collected over the past few years suggest the growing season beings as early as March 1st. Soil temperature data has indicated that the ground temperature starts to rise in early March and remains above the 41-degree Fahrenheit threshold throughout the growing season. Supplemental soil temperature data has been collected on site since 2019. Additionally, Wildlands has included March 1st bud burst documentation from the Deep Meadow Mitigation Site, located 9 miles from the Site.

Data gathered to support an adjusted growing season is included in Appendix 7. A revised groundwater attainment table is also included to illustrate the wetland gage attainment with an adjusted growing season. For this assessment, the gage data was assessed with an equal number of days added to the beginning and end of the growing season for adjusted dates of 3/1- 11/26 and 20 days needed to meet the 7.5% success criteria requirements. The adjusted gage data supports the developing hydrology and soil observations recorded during the soils investigation during winter 2022 and supports that the UT1 floodplain overall is functioning as a wetland.

1.2.8 Wetland Areas of Concern

Currently, the only area of concern in the wetland areas is the headcut within Wetland Creation Zone B. The area was stabilized by coir matting and live stake in Spring 2022. There is some evidence that water has continued to move through this area where vegetation has not fully established. The headcut area will continue to be monitored through closeout. Refer to Appendix 2 for wetland photographs and area of concern photographs.

1.3 Monitoring Year 7 & Closeout Summary

Assessments completed over the past seven years illustrate that the Site has met success criteria as defined in the mitigation plan (Wildlands, 2013) for vegetation and stream morphology and hydrology. However, the site has not met the wetland hydrology success criteria for all wetland areas of the site. To address the at-risk wetland areas DMS has revised the wetland credit request in MY7 to include 0.350 AC wetland enhancement, 5.600 AC for wetland restoration and 1.000 AC for wetland creation to total 9.365 AC of wetlands on the site. The credit request is being revised from the proposed 8.400 WMUs to 6.950 WMUs at closeout. The updated credit request is located in Appendix 1, summarized in table 1.2.

Stream morphology surveys throughout MY0-MY7 demonstrate the dimensions and profiles of the restored and enhanced stream channels are stable and are functioning as designed. The Site has withstood several bankfull events throughout the monitoring period and has met success criteria for the project. The average planted stem density of 492 stems per acre and the average planted stem height of 21 feet both exceed the MY7 success criteria. The Site has responded well to previous supplemental plantings and invasive species treatments. The MY7 visual assessments revealed minor areas of concern which included a headcut at the wetland outlet, a small area of encroachment at the easement boundary which is actively being addressed with the adjacent landowner, and a few pockets invasive plant species.

Summary information and data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Mitigation Plan documents available on DMS's website. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

Section 2: METHODOLOGY

Geomorphic data were collected following the standards outlined in The Stream Channel Reference Site: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003). All Integrated Current Condition Mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using Pathfinder and ArcGIS. Crest gages and pressure transducers were installed in surveyed riffle cross-sections during annual Site visits. Hydrologic monitoring instrument installation and monitoring methods are in accordance with the United States Army Corps of Engineers (USACE, 2003) standards. Vegetation monitoring protocols followed the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008).

Section 3: REFERENCES

Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E. 2003. Stream Restoration A Natural Channel Design Handbook.

Harrelson, Cheryl C; Rawlins, C.L.; Potyondy, John P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique.* Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Lee, Michael T., Peet, Robert K., Steven D., Wentworth, Thomas R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. Retrieved from: http://cvs.bio.unc.edu/protocol/cvs-eep-protocol-v4.2-lev1-2.pdf

North Carolina Ecosystem Enhancement Program (NCEEP), 2009. Lower Yadkin Pee-Dee River Basin Restoration Priorities. Retrieved from: http://deq.nc.gov/document/yadkin-pee-dee-rbrp-2009-final

North Carolina Ecosystem Enhancement Program (NCEEP), Tetra Tech, CCoG, 2012. Goose Creek and Crooked Creek Local Watershed Plan. Retrieved from: http://www.gooseandcrooked.org/documents/GooseandCrookedLWP-WMP_Final_7-2012.pdf

North Carolina Division of Mitigation Services and Interagency Review Team Technical Workgroup. 2018. Standard Measurement of the BHR Monitoring Parameter. Raleigh, NC.

Rosgen, D.L. 1996. Applied River Morphology. Pagosa Springs, CO: Wildland Hydrology Books.

United States Army Corps of Engineers (USACE), 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.

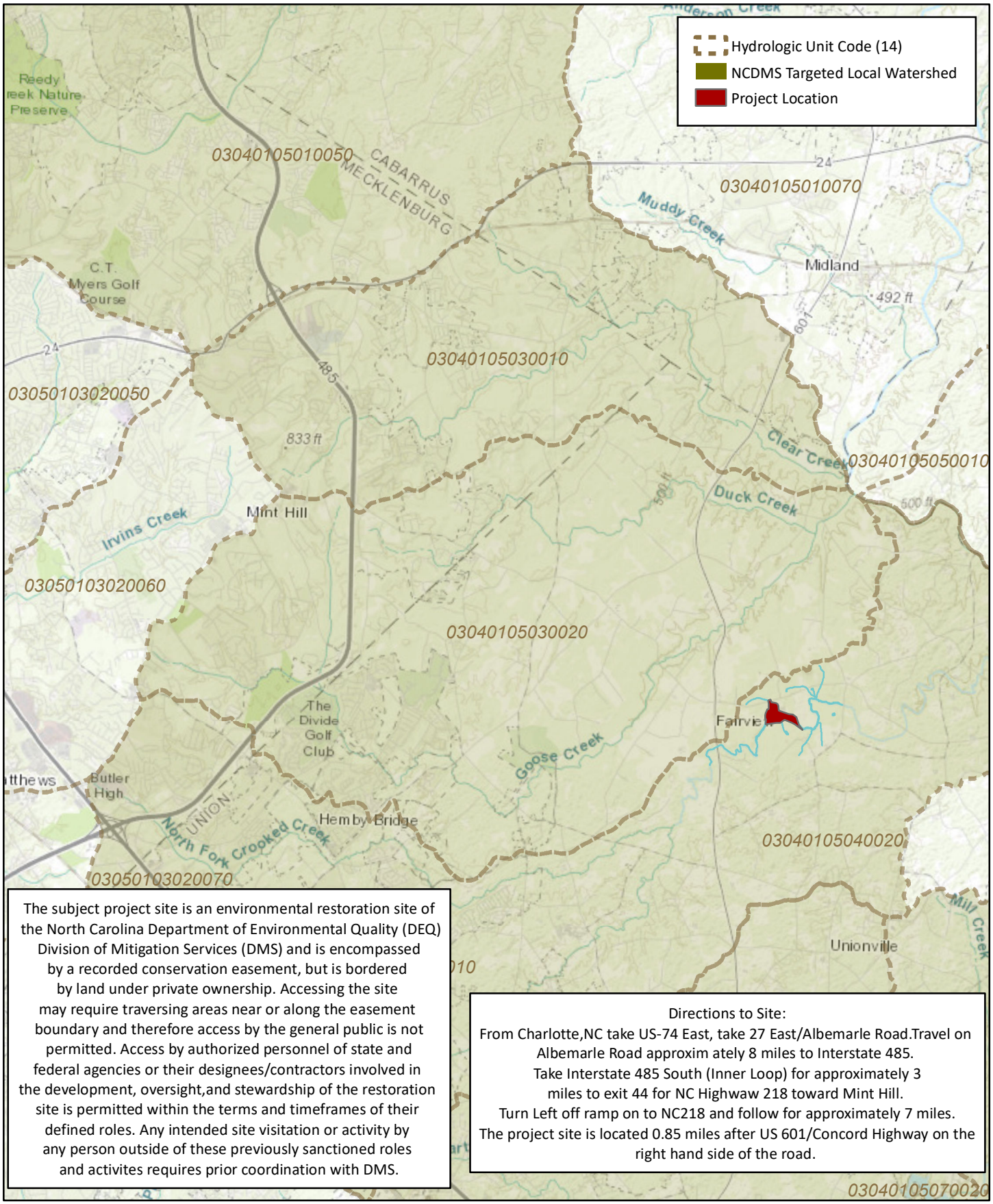
United States Department of Agriculture (USDA), 2016. USDA Field Office Climate Data, WETS Table: Monroe, NC5771 (1971-2000).

United States Geological Survey (USGS), 1998. North Carolina Geology. Retrieved from: http://www.geology.enr.state.nc.us/usgs/coastalp.htm

United States Geological Survey (USGS), 2016. Real Time Water Data for North Carolina. Retrieved from: http://nc.water.usgs.gov/realtime/real_time_yadkin_peedee.html

Wildlands Engineering, Inc. (2013). Crooked Creek #2 Restoration Project Final Mitigation Plan. NCEEP, Raleigh, NC.

APPENDIX 1. General Figures and Tables



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

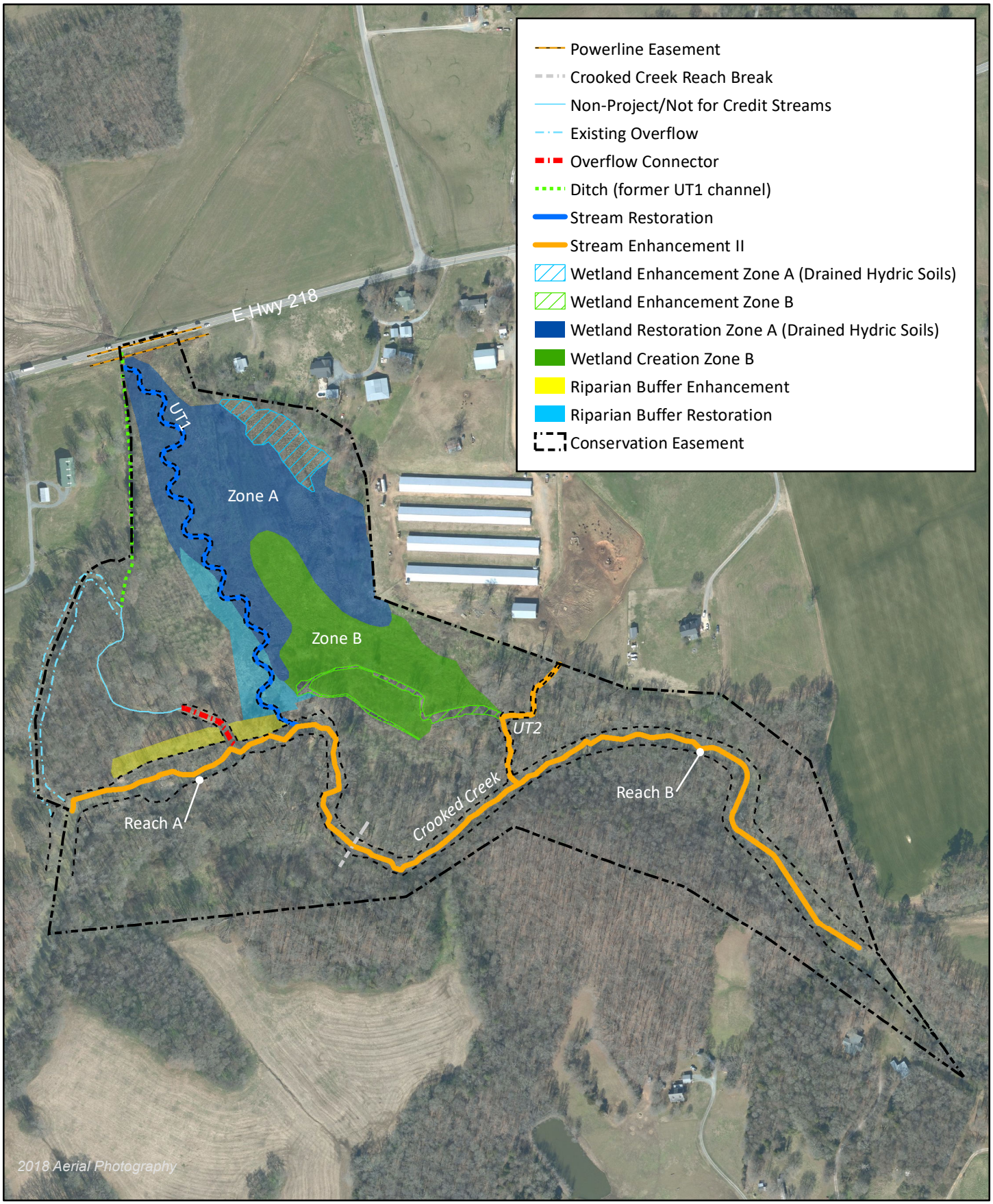
Directions to Site:
From Charlotte,NC take US-74 East, take 27 East/Albemarle Road.Travel on Albemarle Road approxim ately 8 miles to Interstate 485.
Take Interstate 485 South (Inner Loop) for approximately 3 miles to exit 44 for NC Highwaw 218 toward Mint Hill.
Turn Left off ramp on to NC218 and follow for approximately 7 miles.
The project site is located 0.85 miles after US 601/Concord Highway on the right hand side of the road.

WILDLANDS ENGINEERING

0 0.5 1 Mile

N

Figure 1 Project Vicinity Map
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022
Union County, NC



WILDLANDS ENGINEERING

0 400 Feet

N

Figure 2 Project Component/Asset Map
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7- 2022
Union County, NC

Table 1. Project Components and Mitigation Credits

Crooked Creek #2 Restoration Project Site

DMS Project No. 94687

Monitoring Year 7 - 2022

Mitigation Credits									
	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer (sqft)	Nitrogen Nutrient	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	3,242.2	N/A	7.900	0.500	N/A	N/A	54,135.33	N/A	

Project Components							
Reach ID	As-Built Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration or Restoration Equivalent	Restoration Footage/ Acreage	Mitigation Ratio	Credits[1] (SMU/ WMU)
STREAMS							
Crooked Creek Reach A	202+20-215+55	1,555 LF	N/A	Enhancement II	1,335	2.5:1	534.000
Crooked Creek Reach B	215+55-236+78	2,404 LF	N/A	Enhancement II	2,123	2.5:1	849.200
UT1	100+47-117+18	1,762 LF	P1	Restoration	1,671	1:1	1,671.000
UT2	300+00-305+60	470 LF	N/A	Enhancement II	470	2.5:1	188.000
WETLANDS							
Zone A (Drained Hydric Soils)	N/A	0.7 AC		Enhancement	0.7	2:1	0.350
Zone A (Drained Hydric Soils)	N/A	N/A		Restoration	6.6	1:1	6.600
Zone B	N/A	0.3 AC		Enhancement	0.3	2:1	0.150
Zone B	N/A	N/A		Creation	3.9	3:1	1.300
BUFFER							
Goose Creek Buffer	N/A	25,201 sqft		Enhancement	25,201 sqft	3:1	8,400.33 sqft
Goose Creek Buffer	N/A	N/A		Restoration	45,735 sqft	1:1	45,735 sqft

Component Summation						
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	1,671	6.6			45,735	
Enhancement		1.0			25,201	
Enhancement I						
Enhancement II	3,928					
Creation		3.9				

1 No credit generated where only one side of stream is buffered per email from Harry Tsomides dated October 15, 2018

2 UT1 crediting starts at the outer edge of the powerline right-of-way along Hwy 218; Crooked Creek assets have been reduced to account for one-side easement sections at upstream and downstream ends.

Table 1.2 Project Components and Mitigation Credits Udpated Credit Request Based on Wetland Performance Standards
Crooked Creek #2 Restoration Project Site
DMS Project No. 94687
Monitoring Year 7 - 2022

Mitigation Credits									
	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer (sqft)	Nitrogen Nutrient	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	3,242.2	N/A	6.600	0.350	N/A	N/A	54,135.33	N/A	

Project Components							
Reach ID	As-Built Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration or Restoration Equivalent	Restoration Footage/ Acreage	Mitigation Ratio	Credits[1] (SMU/ WMU)
STREAMS							
Crooked Creek Reach A	202+20-215+55	1,555 LF	N/A	Enhancement II	1,335	2.5:1	534.000
Crooked Creek Reach B	215+55-236+78	2,404 LF	N/A	Enhancement II	2,123	2.5:1	849.200
UT1	100+47-117+18	1,762 LF	P1	Restoration	1,671	1:1	1,671.000
UT2	300+00-305+60	470 LF	N/A	Enhancement II	470	2.5:1	188.000
WETLANDS							
Zone A (Drained Hydric Soils)	N/A	0.7 AC		Enhancement	0.7	2:1	0.350
Zone A (Drained Hydric Soils)	N/A	N/A		Restoration	5.6	1:1	5.600
Zone B	N/A	0.3 AC		Enhancement	0.0	2:1	0.000
Zone B	N/A	N/A		Creation	3.0	3:1	1.000
BUFFER							
Goose Creek Buffer	N/A	25,201 sqft		Enhancement	25,201 sqft	3:1	8,400.33 sqft
Goose Creek Buffer	N/A	N/A		Restoration	45,735 sqft	1:1	45,735 sqft

Component Summation						
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	1,671	5.6			45,735	
Enhancement		0.7			25,201	
Enhancement I						
Enhancement II	3,928					
Creation		3.0				

1 No credit generated where only one side of stream is buffered per email from Harry Tsomides dated October 15, 2018.
2 UT1 crediting starts at the outer edge of the powerline right-of-way along Hwy 218; Crooked Creek assets have been reduced to account for one-side easement sections at upstream and downstream ends.
3 The Goose Creek buffer credits approved and closed out by DWR on 9/15/2021. The approval letter is included in Appendix 8.
Highlighted cells have been updated from original credit request based on at-risk hydrology indicators during MY7

Table 2. Project Activity and Reporting History
Crooked Creek #2 Restoration Project Site
DMS Project No. 94687
Monitoring Year 7 - 2022

Activity or Report		Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan		June 2011	August 2013
Final Design - Construction Plans		August 2011	April 2014
Construction		January 2015 - April 2015	January 2015 - April 2015
Temporary S&E mix applied to entire project area[1]		January 2015 - March 2015	January 2015 - March 2015
Permanent seed mix applied to reach/segments		January 2015 - March 2015	January 2015 - March 2015
Bare root and live stake plantings for reach/segments		January 2016	January 2016
Baseline Monitoring Document (Year 0)		January - February 2016	May 2016
Year 1 Monitoring	Stream Survey	August 2016	November 2016
	Vegetation Survey	September 2016	
Year 2 Monitoring	Stream Survey	April 2017	November 2017
	Vegetation Survey	August 2017	
Year 3 Monitoring	Invasive Treatment	January 2018	November 2018
	Supplemental Planting		
	Stream Survey	April 2018	
	Invasive Treatment	May 2018	
		June 2018	
	Vegetation Survey	August 2019	
	Invasive Treatment	August 2018	
		October 2018	
Year 4 Monitoring	Stream Survey	April 2019	November 2019
	Vegetation Survey	August 2019	
Year 5 Monitoring	Stream Survey	March 2020	November 2020
	Vegetation Survey	September 2020	
	Invasive Treatment	October 2020	
Year 6 Monitoring	Stream Survey	April 2021	November 2021
	Vegetation Survey	September 2021	
	Invasive Treatment	March 2021	
		Septmber 2021	
Year 7 Monitoring	Stream Survey	April 2022	January 2022
	Vegetation Survey	September 2022	

[1]Seed and mulch is added as each section of construction is completed.

Table 3. Project Contact Table
Crooked Creek #2 Restoration Project Site
DMS Project No. 94687
Monitoring Year 7 - 2022

Designer Aaron Earley, PE, CFM	**Wildlands Engineering, Inc.** 1430 South Mint Street, Suite 104 Charlotte, NC 28203 704.332.7754
Construction Contractor	**North State Environmental, Inc.** 2889 Lowery Street Winston Salem, NC 27101
Planting Contractor	**Keller Environmental** 7921 Haymarket Lane Raleigh, NC 27615
Supplemental Planting Contractor & Invasive Species Maintenance	**Carolina Silvics** 908 Indian Trail Road Edenton, NC 27932
Seeding Contractor	**North State Environmental, Inc.** 2889 Lowery Street Winston Salem, NC 27101
Seed Mix Sources	**Green Resource, LLC**
Nursery Stock Suppliers **Bare Roots** **Live Stakes**	**Dykes & Son Nursery** 825 Maude Etter Rd. McMinnville, TN 37110
Monitoring Performers	**Wildlands Engineering, Inc.**
Monitoring, POC	Kirsten Gimbert 704.941.9093

Table 4. Project Information and Attributes
Crooked Creek #2 Restoration Project Site
DMS Project No. 94687
Monitoring Year 7 - 2022

Project Information	
Project Name	Crooked Creek #2 Restoration Project
County	Union County
Project Area (acres)	54.94
Project Coordinates (latitude and longitude)	34° 58' 54.78"N, 080° 31' 25.79"W

Project Watershed Summary Information	
Physiographic Province	Carolina Slate Belt of the Piedmont Physiographic Province
River Basin	Yadkin
USGS Hydrologic Unit 8-digit	03040105
USGS Hydrologic Unit 14-digit	03040105040010
DWR Sub-basin	03-07-12
Project Drainiage Area (acres)	24,619
Project Drainage Area Percentage of Impervious Area	28%
CGIA Land Use Classification	Agriculture 38%, Forested 29%, Developed 28%, Wetlands 3%, and Herbaceous Upland 2%

Reach Summary Information

Parameters	Crooked Creek Reach A	Crooked Creek Reach B	UT1	UT2	
Length of reach (linear feet) - Post-Restoration	1,555	2,404	1,671	195	275
Drainage area (acres)	24,619		153	51	
NCDWR stream identification score	52		34.5	24.5	38
NCDWR Water Quality Classification	C				
Morphological Desription (stream type)	P	P	P	I	P
Evolutionary trend (Simon's Model) - Pre- Restoration	N/A	N/A	Stage III	Stage IV	
Underlying mapped soils	Chewacala silt loam 0-2% slopes (ChA)	Chewacala silt loam 0-2% slopes (ChA)	Chewacala silt loam 0-2% slopes (ChA)	Badin channery silt loam 8-15% slopes (BaC)	
Drainage class	Somewhat poorly drained	Somewhat poorly drained	Somewhat poorly drained	Well drained	
Soil hydric status	Type B (inclusions)	Type B (inclusions)	Type B (inclusions)	N/A	
Slope	0.0022		0.0047	0.0050	
FEMA classification	Zone AE	Zone AE	no regulated floodplain	no regulated floodplain	
Native vegetation community	Piedmont Bottomland forest				
Percent composition exotic invasive vegetation -Post-Restoration	5%	5%	60%	5%	

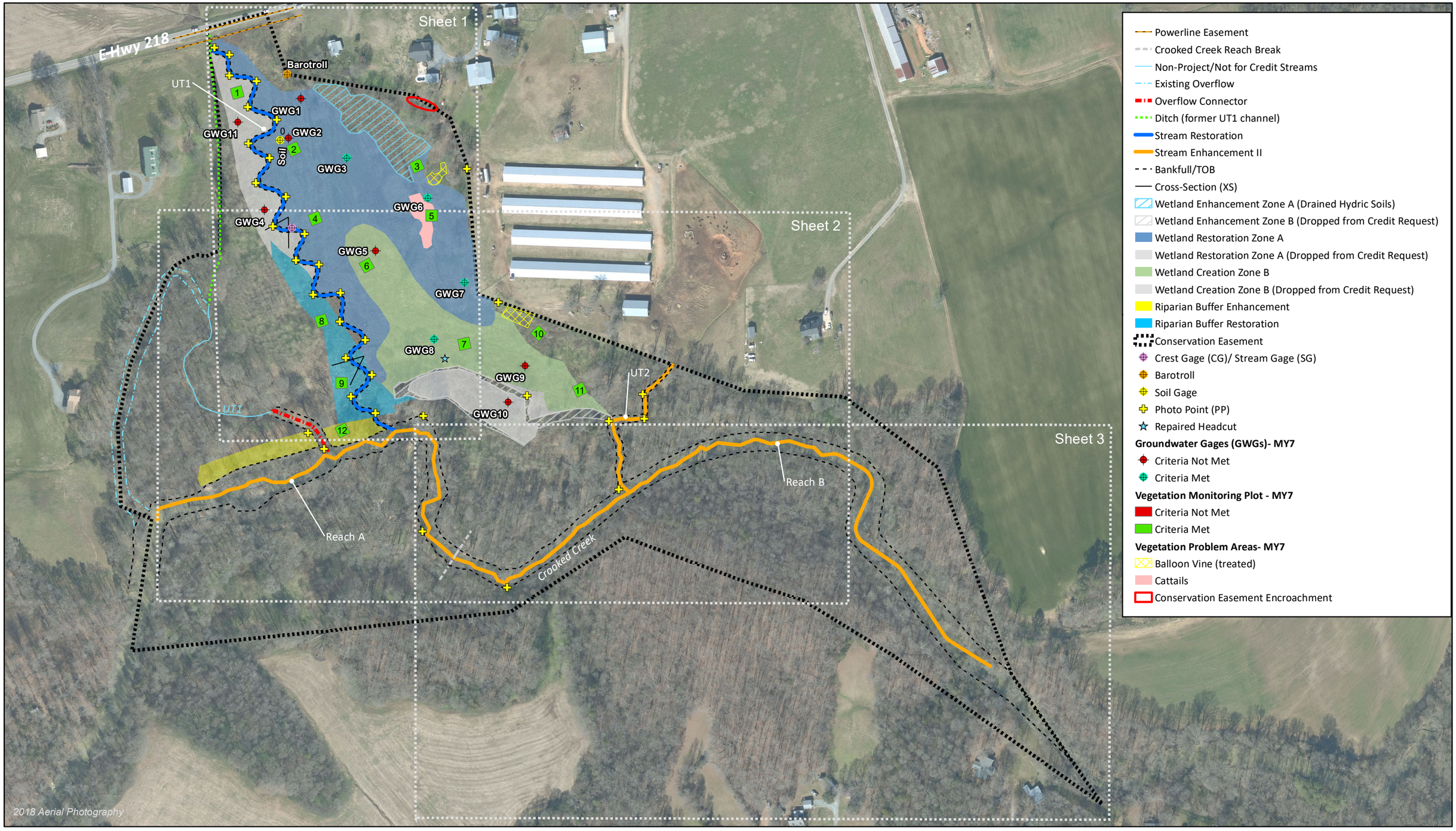
Regulatory Considerations

Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States - Section 404	X	X	USACE Nationwide Permit No.27 and DWQ 401 Water Quality Certification No. 3885. Action ID # 2011-02201
Waters of the United States - Section 401	X	X	
Division of Land Quality (Erosion and Sediment Control)	X	X	NPDES Construction Stormwater General Permit NCG010000
Endangered Species Act	X	X	Crooked Creek #2 Mitigation Plan; Wildlands determined "no effect" on Union County listed endangered species. June 21, 2011 email correspondence from USFWS indicating no listed species occur on site.
Historic Preservation Act	X	X	No historic resources were found to be impacted (letter from SHPO dated 6/23/2011).
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	X	X	Crooked Creek is a mapped Zone AE floodplain with defined base flood elevations. Base flood elevations have been defined and the floodway has been delineated; (FEMA Zone AE, FIRM panel 5540).
Essential Fisheries Habitat	N/A	N/A	N/A

Table 5. Monitoring Component Summary
Crooked Creek #2 Restoration Project Site
DMS Project No. 94687
Monitoring Year 7 - 2022

Parameter	Monitoring Feature	Quantity / Length by Reach					Frequency
		Crooked Creek Reach A	Crooked Creek Reach B	UT1	UT2	Wetlands	
Dimension	Riffle Cross-Section	N/A	N/A	2	N/A	N/A	Annual
	Pool Cross-Section	N/A	N/A	2	N/A	N/A	
Pattern	Pattern	N/A	N/A	N/A	N/A	N/A	N/A
Profile	Longitudinal Profile	N/A	N/A	N/A	N/A	N/A	Year 0
Substrate	Reach Wide (RW)/ Riffle 100 Pebble Count (RF)	N/A	N/A	1 RW / 2 RF	N/A	N/A	Annual
Hydrology	Crest Gage	N/A		1	N/A	N/A	Quarterly
Hydrology	Groundwater Gages	N/A	N/A	N/A	N/A	11	Quarterly
Vegetation	Vegetation Plots	12					Annual
Visual Assessment	All Streams	Y	Y	Y	Y	Y	Semi-Annual
Exotic and nuisance vegetation		Y	Y	Y	Y	Y	Semi-Annual
Project Boundary		Y	Y	Y	Y	Y	Semi-Annual
Reference Photos	Photo Points	34					Annual

APPENDIX 2. Visual Assessment Data



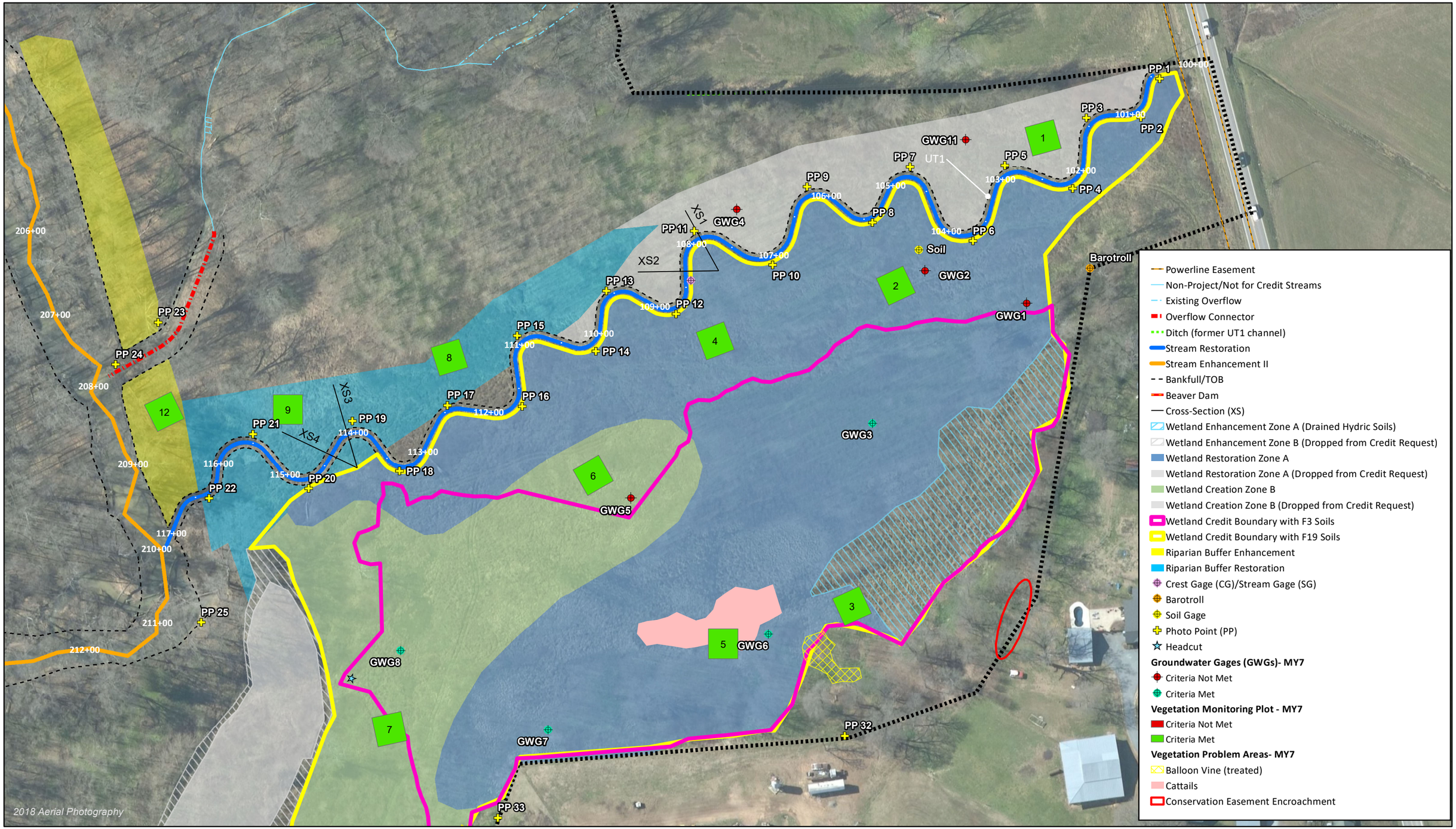
WILDLANDS ENGINEERING

0 130 260 520 Feet

N

Figure 3.0 Inegrated Current Condition Plan View (Key)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7- 2022

Union County, NC

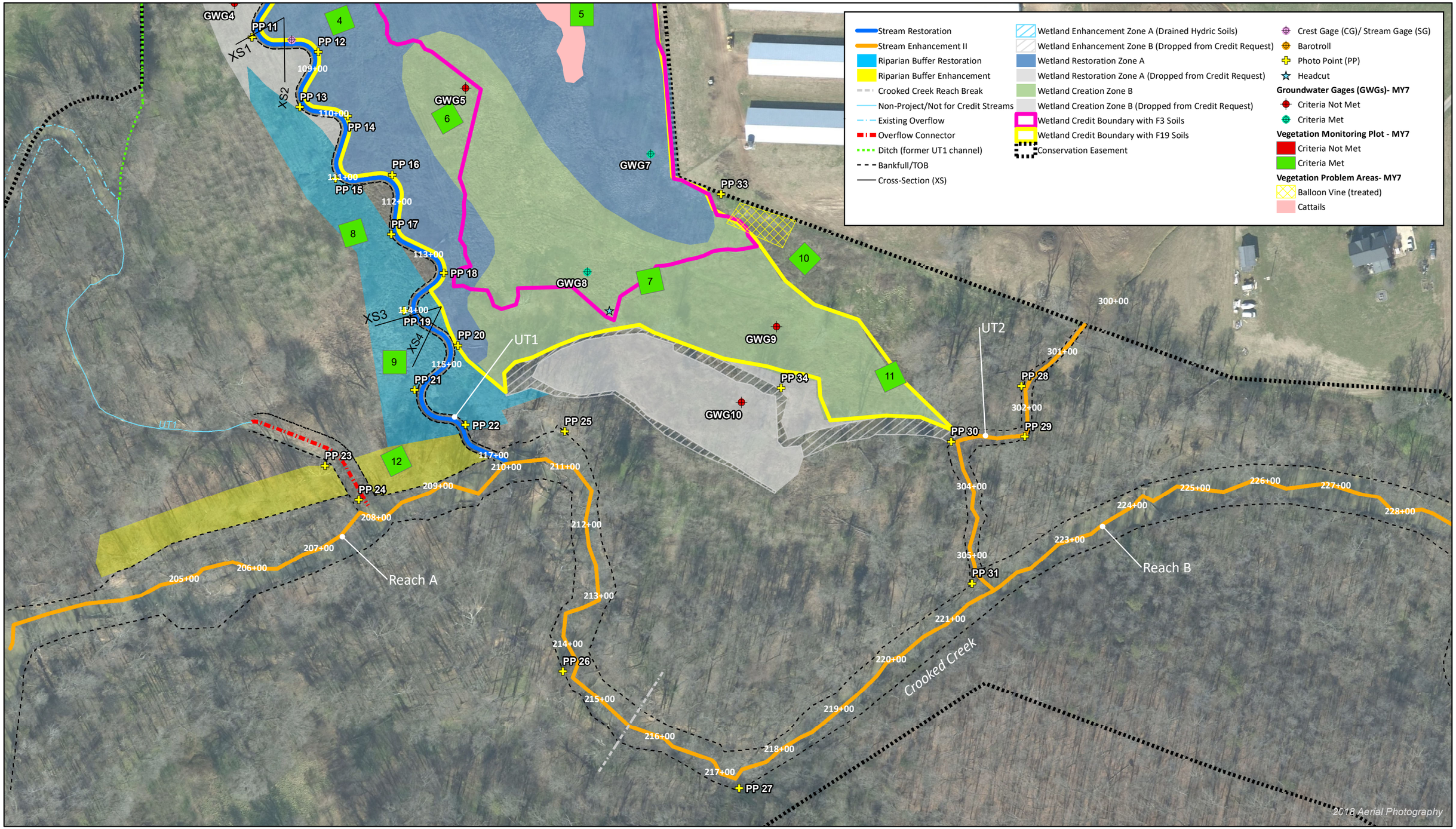


WILDLANDS ENGINEERING

0 50 100 200 Feet

Figure 3.1 Integrated Current Condition Plan View (Sheet 1)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022

Union County, NC



WILDLANDS ENGINEERING

0 62.5 125 250 Feet

Figure 3.2 Integrated Current Condition Plan View (Sheet 2)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022

Union County, NC

WILDLANDS ENGINEERING

0 62.5 125 250 Feet

N

Figure 3.3 Integrated Current Condition Plan View (Sheet 3)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022

Union County, NC

Table 6. Visual Stream Morphology Stability Assessment Table
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7- 2022

UT1 (1,671 LF)

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	16	16			100%			
	3. Meander Pool Condition	Depth Sufficient	20	20			100%			
		Length Appropriate	20	20			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	20	20			100%			
		Thalweg centering at downstream of meander bend (Glide)	20	20			100%			
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	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	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	9	9			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	4	4			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	4	4			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	9	9			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	20	20			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 7. Vegetation Condition Assessment Table
Crooked Creek #2 Restoration Site
DMS Project No. 94687
Monitoring Year 7- 2022

Planted Acreage **15.0**

Vegetation Category	Definitions	Mapping Threshold	Number of Polygons	Combined Acreage[1]	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1 ac	0	0.0	0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, 5, or 7 stem count criteria.	0.1 ac	0	0.00	0.0%
		Total	**0.00**	**0.00**	**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	0	0.00	0.0%
		Cumulative Total	**0**	**0.00**	**0.00**

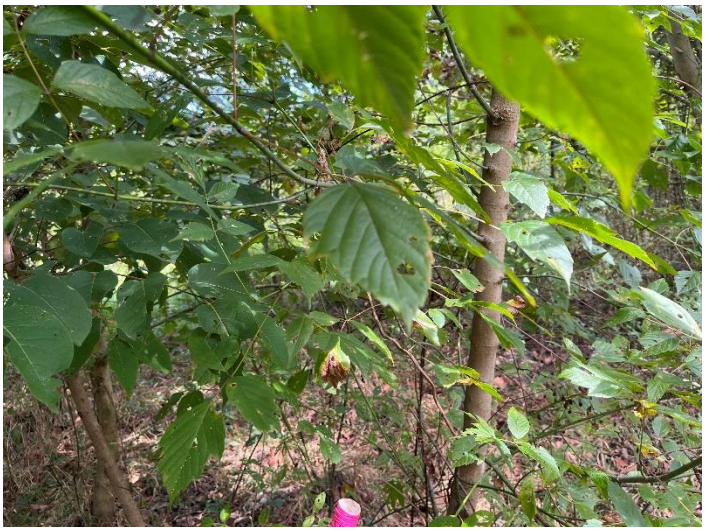
Easement Acreage **54.9**

Vegetation Category	Definitions	Mapping Threshold	Number of Polygons	Combined Acreage[2]	% of Easement Acreage
Invasive Areas of Concern[1]	Areas or points (if too small to render as polygons at map scale).	1000 SF	3	0.26	0.5%
Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	none	1	0.04	0.1%

1. Treated October 2020, November 2020, March 2021, and September 2021.

Vegetation Photographs
Monitoring Year 7

	
Vegetation Plot 1 – (9/8/2022)	**Vegetation Plot 2** – (9/8/2022)
	
Vegetation Plot 3 – (9/8/2022)	**Vegetation Plot 4** – (9/8/2022)
	
Vegetation Plot 5 – (9/8/2022)	**Vegetation Plot 6** – (9/8/2022)

	
Vegetation Plot 7 – (9/8/2022)	**Vegetation Plot 8** – (9/8/2022)
	
Vegetation Plot 9 – (9/8/2022)	**Vegetation Plot 10** – (9/8/2022)
	
Vegetation Plot 11 – (9/8/2022)	**Vegetation Plot 12** – (9/8/2022)

Stream Photographs

	
Photo Point 1 – UT1 looking upstream (4/21/2022)	**Photo Point 1** – UT1 looking downstream (4/21/2022)
	
Photo Point 2 – UT1 looking upstream (4/21/2022)	**Photo Point 2** – UT1 looking downstream (4/21/2022)
	
Photo Point 3 – UT1 looking upstream (4/21/2022)	**Photo Point 3** – UT1 looking downstream (4/21/2022)

	
Photo Point 4 – UT1 looking upstream (4/21/2022)	**Photo Point 4** – UT1 looking downstream (4/21/2022)
	
Photo Point 5 – UT1 looking upstream (4/21/2022)	**Photo Point 5** – UT1 looking downstream (4/21/2022)
	
Photo Point 6 – UT1 looking upstream (4/21/2022)	**Photo Point 6** – UT1 looking downstream (4/21/2022)

	
Photo Point 7 – UT1 looking upstream (4/21/2022)	**Photo Point 7** – UT1 looking downstream (4/21/2022)
	
Photo Point 8 – UT1 looking upstream (4/21/2022)	**Photo Point 8** – UT1 looking downstream (4/21/2022)
	
Photo Point 9 – UT1 looking upstream (4/21/2022)	**Photo Point 9** – UT1 looking downstream (4/21/2022)

	
Photo Point 10 – UT1 looking upstream (4/21/2022)	**Photo Point 10** – UT1 looking downstream (4/21/2022)
	
Photo Point 11 – UT1 looking upstream (4/21/2022)	**Photo Point 11** – UT1 looking downstream (4/21/2022)
	
Photo Point 12 – UT1 looking upstream (4/21/2022)	**Photo Point 12** – UT1 looking downstream (4/21/2022)

	
Photo Point 13 – UT1 looking upstream (4/21/2022)	**Photo Point 13** – UT1 looking downstream (4/21/2022)
	
Photo Point 14 – UT1 looking upstream (4/21/2022)	**Photo Point 14** – UT1 looking downstream (4/21/2022)
	
Photo Point 15 – UT1 looking upstream (4/21/2022)	**Photo Point 15** – UT1 looking downstream (4/21/2022)

	
Photo Point 16 – UT1 looking upstream (4/21/2022)	**Photo Point 16** – UT1 looking downstream (4/21/2022)
	
Photo Point 17 – UT1 looking upstream (4/21/2022)	**Photo Point 17** – UT1 looking downstream (4/21/2022)
	
Photo Point 18 – UT1 looking upstream (4/21/2022)	**Photo Point 18** – UT1 looking downstream (4/21/2022)

	
Photo Point 19 – UT1 looking upstream (4/21/2022)	**Photo Point 19** – UT1 looking downstream (4/21/2022)
	
Photo Point 20 – UT1 looking upstream (4/21/2022)	**Photo Point 20** – UT1 looking downstream (4/21/2022)
	
Photo Point 21 – UT1 looking upstream (4/21/2022)	**Photo Point 21** – UT1 looking downstream (4/21/2022)

	
Photo Point 22 – UT1 looking upstream (4/21/2022)	**Photo Point 22** – UT1 looking downstream (4/21/2022)
	
Photo Point 23 – UT1 looking upstream (4/21/2022)	**Photo Point 23** – UT1 looking downstream (4/21/2022)
	
Photo Point 24 – Crooked Creek looking upstream (4/21/2022)	**Photo Point 24** – Crooked Creek looking downstream (4/21/2022)

	
Photo Point 25 – Crooked Creek looking upstream (4/21/2022)	**Photo Point 25** – Crooked Creek looking downstream (4/21/2022)
	
Photo Point 26 – Crooked Creek looking upstream (4/21/2022)	**Photo Point 26** – Crooked Creek looking downstream (4/21/2022)
	
Photo Point 27 – Crooked Creek looking upstream (4/21/2022)	**Photo Point 27** – Crooked Creek looking downstream (4/21/2022)

Photo Point 28 – UT2 looking upstream (4/21/2022)

Photo Point 28 – UT2 looking downstream (4/21/2022)

Photo Point 29 – UT2 looking upstream (4/21/2022)

Photo Point 29 – UT2 looking downstream (4/21/2022)

Photo Point 30 – UT2 looking downstream to UT2 (4/21/2022)

Photo Point 31 – UT2 looking upstream Crooked Creek (9/7/2022)

Photo Point 31 – UT2 looking downstream Crooked Creek (9/7/2022)

Photo Point 31 – UT2 looking upstream UT2 (9/7/2022)

Wetland Photographs

	
Photo Point 30 –Wetland CC outlet facing West (4/21/2022)	**Photo Point 30** –Wetland CC outlet facing East (4/21/2022)
	
Photo Point 32 –Wetland AA facing West (4/21/2022)	**Photo Point 32** – Wetland Zone A facing South (4/21/2022)
	
Photo Point 33 – Wetland Zone A & B facing West (4/21/2022)	**Photo Point 33** - Wetland B facing South (4/21/2022)

	
Photo Point 34 –Wetland CC facing Northwest (4/21/2022)	**Photo Point 34** –Wetland CC facing South (4/21/2022)

Area of Concern Photographs
Monitoring Year 7

	
Repaired Wetland Headcut (11/10/2022)	Repaired Wetland Headcut (11/10/2022)
	
Honeysuckle area treated with no re-sprouts (9/07/2022)	Balloon Vine (9/07/2022)
	
Easement Mowing Resolved MY7 (4/22/2022)	Easement Encroachment (12/21/2022)

APPENDIX 3. Vegetation Plot Data

Table 8. Vegetation Plot Criteria Attainment

Crooked Creek #2 Restoration Project Site
DMS Project No. 94687
Monitoring Year 7 - 2022

Plot	MY2 Success Criteria Met (Y/N)	Tract Mean
1	Y	100%
2	Y	
3	Y	
4	Y	
5	Y	
6	Y	
7	Y	
8	Y	
9	Y	
10	Y	
11	Y	
12	Y	

Table 9. CVS Vegetation Plot Metadata
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022

Report Prepared By	Ella Wickliff
Date Prepared	10/2/2022 14:01
Database Name	cvs-eep-entrytool-v2.3.0_Crooked Creek_MY6.mdb
Database Location	Q:\ActiveProjects\005-02156 Crooked Creek Monitoring\Monitoring\Monitoring Year 7 (2022)\Vegetation Assessment
Computer Name	ELLA-PC
File Size	46927872
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Project planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Project Total Stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	94687
Project Name	Crooked Creek #2 Restoration Project
Description	Crooked Creek #2 Restoration Project
Required Plots (calculated)	12
Sampled Plots	12

Table 10a. Planted and Total Stem Counts

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Current Plot Data (MY7 2022)																																						
			VP1			VP2			VP3			VP4			VP5			VP6			VP7			VP8			VP9			VP10			VP11			VP12		
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
Acer negundo	Box Elder	Tree																																				
Acer rubrum	Red Maple	Tree										2	2	2										3	3	3	5	5	5									
Betula nigra	River Birch	Tree							1	1	1	1	1	1	1	1	1	5	5	5	1	1	1	1	1	1	3	3	3	2	2	2	4	4	4	4	4	4
Carpinus caroliniana	Ironwood	Shrub Tree																1	1	1																		
Celtis laevigata	Sugarberry	Shrub Tree	2	2	2				1	1	1																			2	2	2						
Cornus florida	Flowering Dogwood	Shrub Tree																																				
Diospyros virginiana	American Persimmon	Tree	2	2	2	1	1	1	1	1	1													5	5	5	2	2	2							1	1	1
Fraxinus pennsylvanica	Green Ash	Tree																																				
Juglans nigra	Black Walnut	Tree																																				
Liquidambar styraciflua	Sweet Gum	Tree																																				
Liriodendron tulipifera	Tulip Poplar	Tree																																				
Nyssa sylvatica	Black Gum	Tree																												1	1	1						
Platanus occidentalis	Sycamore	Tree	6	6	6	6	6	6	1	1	1	2	2	2	1	1	1	4	4	4	2	2	2	3	3	3										1	1	1
Quercus	Oak sp.	Shrub Tree																																				
Quercus lyrata	Overcup Oak	Tree																1	1	1				1	1	1				1	1	1	3	3	3	2	2	2
Quercus nigra	Water Oak	Tree																			3	3	3	1	1	1				1	1	1	6	6	6	1	1	1
Quercus phellos	Willow Oak	Tree	1	1	1	1	1	1				1	1	1				1	1	1	3	3	3							1	1	1						
Salix nigra	Black Willow	Tree																																				
Salix sericea	Silky Willow	Shrub Tree																																				
Taxodium distichum	Bald-cypress	Tree	2	2	2	4	4	4	7	7	7	4	4	4	9	9	9	2	2	2				1	1	1	1	1	1	2	2	2				4	4	4
Ulmus alata	Winged Elm	Tree																1	1	1	3	3	3															
Ulmus americana	American Elm	Tree																																				
Stem count			13	13	13	12	12	12	11	11	11	10	10	10	11	11	11	15	15	15	12	12	12	15	15	15	11	11	11	10	10	10	13	13	13	13	13	13
size (ares)			1			1			1			1			1			1			1			1			1			1			1			1		
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
Species count			5	5	5	4	4	4	5	5	5	5	5	5	3	3	3	7	7	7	5	5	5	7	7	7	4	4	4	7	7	7	3	3	3	6	6	6
Stems per ACRE			526	526	526	486	486	486	445	445	445	405	405	405	445	445	445	607	607	607	486	486	486	607	607	607	445	445	445	405	405	405	526	526	526	526	526	526

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%

Volunteers included in total

PnoLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

Table 10b. Planted and Total Stem Annual Means

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Annual Means																										
			MY7 (9/2022)			MY6 (9/2021)			MY5 (9/2020)			MY4 (8/2019)			MY3 (8/2018)			MY2 (8/2017)			MY1 (9/2016)			MY0 (2/2016)		
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
Acer negundo	Box Elder	Tree						51			11			23			49			43			18			17
Acer rubrum	Red Maple	Tree	10	10	10	12	12	12	12	12	12	12	12	15	13	13	14	11	11	11	13	13	13	14	14	14
Betula nigra	River Birch	Tree	23	23	23	23	23	23	22	22	24	27	27	28	26	26	26	12	12	14	14	14	15	18	18	18
Carpinus caroliniana	Ironwood	Shrub Tree	1	1	1	1	1	1	2	2	2	2	2	2												2
Celtis laevigata	Sugarberry	Shrub Tree	5	5	5	5	5	5	6	6	6	6	6	6	9	9	14			4			1			
Cornus florida	Flowering Dogwood	Shrub Tree				1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	6	6	6
Diospyros virginiana	American Persimmon	Tree	12	12	12	12	12	14	12	12	13	12	12	12	13	13	16	7	7	7	10	10	13	27	27	27
Fraxinus pennsylvanica	Green Ash	Tree						42			55			127			41			25			26			45
Juglans nigra	Black Walnut	Tree															3			4						1
Liquidambar styraciflua	Sweet Gum	Tree						29			22			39			6			7			7			4
Liriodendron tulipifera	Tulip Poplar	Tree												1						1			1			2
Nyssa sylvatica	Black Gum	Tree	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	2	2	2	3	3	3	7	7	7
Platanus occidentalis	Sycamore	Tree	26	26	26	26	26	41	27	27	54	27	27	41	28	28	50	12	12	44	13	13	26	15	15	16
Quercus	Oak sp.	Shrub Tree													2	2	2	1	1	1	13	13	13	53	53	53
Quercus lyrata	Overcup Oak	Tree	8	8	8	8	8	8	8	8	8	6	6	6	8	8	8	8	8	8	7	7	7			
Quercus nigra	Water Oak	Tree	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	11	11	4	4	4			
Quercus phellos	Willow Oak	Tree	8	8	8	8	8	8	8	8	8	9	9	10	6	6	6	6	6	6	3	3	3			
Salix nigra	Black Willow	Tree															2									
Salix sericea	Silky Willow	Shrub Tree						1																		
Taxodium distichum	Bald-cypress	Tree	36	36	36	38	38	40	39	39	45	40	40	41	41	41	41	12	12	12	13	13	13	16	16	16
Ulmus alata	Winged Elm	Tree	4	4	4	5	5	16	5	5	5	6	6	10	6	6	12			5						1
Ulmus americana	American Elm	Tree									14												7			
Stem count			146	146	146	152	152	305	156	156	294	163	163	377	168	168	307	84	84	207	95	95	172	156	156	229
size (ares)			12			12			12			12			12			12			12			12		
size (ACRES)			0.30			0.30			0.30			0.30			0.30			0.30			0.30			0.30		
Species count			12	12	12	13	13	17	13	13	17	13	13	17	13	13	18	11	11	18	11	11	17	8	8	15
Stems per ACRE			492	492	492	513	513	1029	526	526	991	550	550	1271	567	567	1035	283	283	698	320	320	580	526	526	772

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%

Volunteers included in total

PnoLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

APPENDIX 4. Morphological Summary Data and Plots

Table 11. Baseline Stream Data Summary
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022

UT1

		Pre-Restoration Condition				Reference Reach Data				Design		As-Built/Baseline	
Parameter	**Gage**	**UT1 Reach 1**		**UT1 Reach 2**		**UT to Lyle Creek**		**Spencer Creek 1**		**UT1**		**UT1**	
		Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Dimension and Substrate - Shallow													
Bankfull Width (ft)	N/A	17.7		10.9		7.0	8.6	8.7		12.0		11.7	12.6
Floodprone Width (ft)		500		539		45	49	229		44+		200+	
Bankfull Mean Depth		0.5		0.7		0.5		1.2		0.7		0.6	
Bankfull Max Depth		1.3		1.0		1.0	1.1	1.9		1.0		1.1	
Bankfull Cross-sectional Area (ft^2)		8.6		7.8		3.5	4.1	10.6		8.7		7.3	7.5
Width/Depth Ratio		36.4		15.3		14.9	18.3	7.3		16.6		18.9	21.1
Entrenchment Ratio		28.2		49.3		5.7	6.4	26.3		2.2+		2.2+	
Bank Height Ratio		1.4		2.9		0.6	0.9	1.0		1.0		1.0	
D50 (mm)		3.1		---								0.3	35.9
Riffle Length (ft)	N/A					---		---		---		12	50
Riffle Slope (ft/ft)		*		*		0.0055	0.0597	0.0100	0.0670	0.0045	0.0080	0.0004	0.0193
Pool Length (ft)						---		---		---		17.8	65.4
Pool Max Depth (ft)		0.76	1.27	0.76	1.27	1.3		2.5		1.5	2.1	1.1	3.0
Pool Spacing (ft)		20	74	20	74	15	28	13	47	42	84	36	99
Pool Volume (ft^3)													
Pattern													
Channel Beltwidth (ft)	N/A	---		115	543	21		24	52	30	72	30	72
Radius of Curvature (ft)		61.2	170.6	61.2	170.6	19	32	5	22	22	48	22	48
Rc:Bankfull Width (ft/ft)		3.5	9.6	3.5	9.6	2.7	3.7	0.6	2.5	1.8	4.0	1.8	4.0
Meander Length (ft)		---		163	400	39	44	54	196	72	132	102	135
Meander Width Ratio		---		10.5	49.7	2.4	3	2.8	6.0	2.5	6.0	2.5	6.0
Substrate, Bed and Transport Parameters													
Ri%/Ru%/P%/G%/S%	N/A												
SC%/Sa%/G%/C%/B%/Be%													
d16/d35/d50/d84/d95/d100		-/-/3.1/8.6/11.0/16.0		---		-/0.1/0.2/0.5/4.0/8.0		0.1/3.0/8.8/77/180/-				SC/SC/0.1/19/90/256	
Reach Shear Stress (Competency) lb/ft^2		---		---						0.012		0.11	0.12
Max part size (mm) mobilized at bankfull													
Stream Power (Capacity) W/m^2													
Additional Reach Parameters													
Drainage Area (SM)	N/A	0.24		N/A		0.25		0.50		0.24		0.24	
Watershed Impervious Cover Estimate (%)		<1%		<1%		---		---		<1%		<1%	
Rosgen Classification		N/A[1]		N/A[1]		C5/6		E4/C4		C4		C4	
Bankfull Velocity (fps)		3.5		4.1		4.7		---		3.4		2.2	
Bankfull Discharge (cfs)		30		N/A[2]		18		---		30		16	
Q-NFF regression (2-yr)		50		N/A[2]									
Q-USGS extrapolation (1.2-yr)		17	40	N/A[2]									
Q-Mannings		24		N/A[2]									
Valley Length (ft)		---		---		---		---		1,353		1,353	
Channel Thalweg Length (ft)		1,789				---		---		1,718		1,718	
Sinuosity		1.0		1.5		1.1		1.1		1.3		1.3	
Water Surface Slope ($ft/ft)^2$		0.0071		0.0034		0.004		0.0132		0.0032		0.0034	
Bankfull Slope (ft/ft)		0.0066		0.0058		0.009		0.0139		0.0041		0.0036	

SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable
N/A[1]: The rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore the Rosgen classification system is not applicable
N/A[2]: Donstream of the confluence with overflow channel, hydraulic regime not applied
*: Channel was dry during survey, slope was calculated using channel thalweg

Table 12. Morphology and Hydrauloc Summary (Dimensional Parameters- Cross-Section)

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

	Cross-Section 1, UT1 (Pool)								Cross-Section 2, UT1 (Riffle)							
Dimension and Substrate[1]	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull elevation	541.8	541.9	541.8	541.8	541.8	541.8	541.9	542.0	542.1	542.0	542.1	542.1	542.0	542.1	542.2	542.2
Low Bank Elevation	541.8	541.9	541.8	541.8	541.8	541.8	541.9	542.0	542.1	542.0	542.1	542.1	542.0	542.1	542.1	542.1
Bankfull Width (ft)	13.3	12.7	13.6	13.3	10.2	12.1	12.2	11.4	11.7	11.1	11.4	15.6	10.9	11.2	10.7	11.3
Floodprone Width (ft)	---	---	---	---	---	---	---	---	200+	200+	200+	89.0	89.0	89.0	89.3	89.3
Bankfull Mean Depth (ft)	0.7	0.7	0.6	0.7	0.8	0.7	0.7	0.8	0.6	0.5	0.6	0.5	0.6	0.6	0.5	0.5
Bankfull Max Depth (ft)	1.5	1.4	1.4	1.5	1.5	1.4	1.4	1.4	1.1	0.9	1.0	1.1	1.0	1.0	1.0	0.9
Bankfull Cross-Sectional Area (ft^2)	8.7	8.5	8.3	8.7	8.4	8.3	8.5	8.8	7.3	5.9	6.5	7.9	6.3	6.4	5.9	5.6
Bankfull Width/Depth Ratio	20.4	18.9	22.4	20.4	12.5	17.5	17.6	14.6	18.9	20.8	20.1	30.7	18.8	19.8	19.4	22.6
Bankfull Entrenchment Ratio	---	---	---	---	---	---	---	---	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+
Bankfull Bank Height Ratio	---	---	---	---	---	---	---	---	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9
	Cross-Section 3, UT1 (Pool)								**Cross-Section 4, UT1 (Riffle)**							
Dimension and Substrate[1]	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull elevation	539.7	539.7	539.7	539.6	539.7	539.7	539.7	539.7	539.8	539.8	539.8	539.7	539.9	539.8	539.8	539.8
Low Bank Elevation	539.7	539.7	539.7	539.6	539.7	539.7	539.7	539.7	539.8	539.8	539.8	539.7	539.9	539.8	539.8	539.8
Bankfull Width (ft)	12.6	12.3	12.2	15.4	13.6	14.2	12.8	11.5	12.6	11.9	12.0	13.1	13.1	12.3	11.8	12.1
Floodprone Width (ft)	---	---	---	---	---	---	---	---	200+	200+	200+	83.0	83.0	83.0	83.0	83.0
Bankfull Mean Depth (ft)	1.0	0.9	1.0	0.8	1.0	1.0	1.1	1.0	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6
Bankfull Max Depth (ft)	2.4	2.2	2.1	2.2	2.2	2.1	2.2	2.0	1.1	1.0	1.2	1.1	1.1	1.0	1.4	1.2
Bankfull Cross-Sectional Area (ft^2)	12.6	11.4	12.3	12.6	13.3	13.9	14.6	11.5	7.5	7.8	7.6	7.6	7.4	7.1	7.6	7.6
Bankfull Width/Depth Ratio	12.7	13.4	12.1	18.9	13.8	14.6	11.2	11.4	21.1	18.0	18.9	22.7	23.2	21.2	18.3	19.3
Bankfull Entrenchment Ratio	---	---	---	---	---	---	---	---	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+
Bankfull Bank Height Ratio	---	---	---	---	---	---	---	---	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

[1] In MY3- MY5 Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document provided by the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current year's low bank height.

Table 13. Monitoring Data - Stream Reach Data Summary

Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022

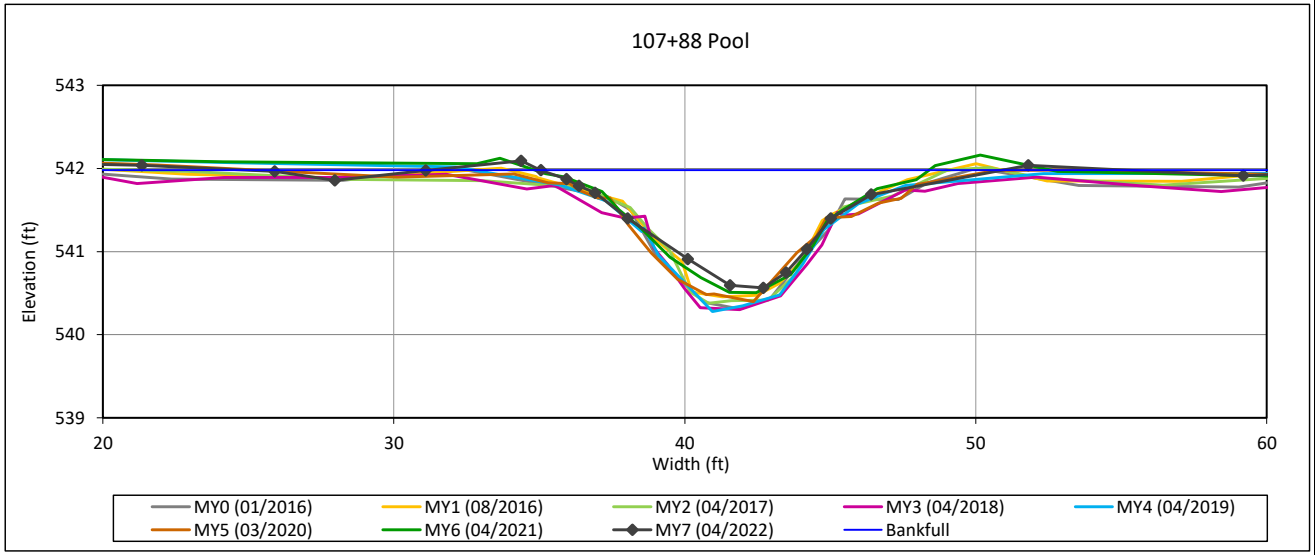
Parameter	As-Built/Baseline		MY-1		MY-2		MY-3		MY-4		MY-5		MY-6		MY-7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle[1]																
Bankfull Width (ft)	11.7	12.6	11.1	11.9	11.4	12.0	13.0	15.6	10.9	19.5	11.2	12.3	10.7	11.8	11.3	12.1
Floodprone Width (ft)	200+		200+		200+		89+		89+		83	89	83	89	83	89
Bankfull Mean Depth	0.6		0.5	0.7	0.6		0.5	0.6	0.6		0.6		0.5	0.6	0.5	0.6
Bankfull Max Depth	1.1		0.9	1.0	1.0	1.2	1.1		1.0	1.1	1.0		1.0	1.4	0.9	1.2
Bankfull Cross-sectional Area (ft^2)	7.3	7.5	5.9	7.8	6.5	7.6	7.6	7.9	6.3	7.4	6.4	7.1	5.9	7.6	5.6	7.6
Width/Depth Ratio	18.9	21.1	18.0	20.8	18.9	20.1	22.7	30.7	18.8	23.2	19.8	21.2	18.3	19.4	19.3	22.6
Entrenchment Ratio	2.2+		2.2+		2.2+		2.2+		2.2+		2.2+		2.2+		2.2+	
Bank Height Ratio	1.0		1.0		1.0		1.0		0.9	1.0	0.9	1.0	0.9	1.0	0.9	1.0
D50 (mm)	0.3	35.9	SC	65.6	SC	66.2	SC	52.8	SC	46.0	0.3	16.0	SC	46.7	16.0	55.0
Profile																
Riffle Length (ft)	12	50														
Riffle Slope (ft/ft)	0.0004	0.0193														
Pool Length (ft)	18	65														
Pool Max Depth (ft)	1.1	3.0														
Pool Spacing (ft)	36	99														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	30	72														
Radius of Curvature (ft)	22	48														
Rc:Bankfull Width (ft/ft)	1.8	4.0														
Meander Wave Length (ft)	102	135														
Meander Width Ratio	2.5	6.0														
Additional Reach Parameters																
Rosgen Classification	C4															
Channel Thalweg Length (ft)	1,718															
Sinuosity (ft)	1.3															
Water Surface Slope (ft/ft)	0.0034															
Bankfull Slope (ft/ft)	0.004															
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
d16/d35/d50/d84/d95/d100	SC/SC/0.1/19/90/25(															
% of Reach with Eroding Banks																

[1] In MY3- MY5 Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document provided by the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current year's low bank height.

Cross-Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 7 -2022

Cross Section 1-UT1



Bankfull Dimensions	
8.8	x-section area (ft.sq.)
11.4	width (ft)
0.8	mean depth (ft)
1.4	max depth (ft)
11.7	wetted perimeter (ft)
0.8	hydraulic radius (ft)
14.6	width-depth ratio

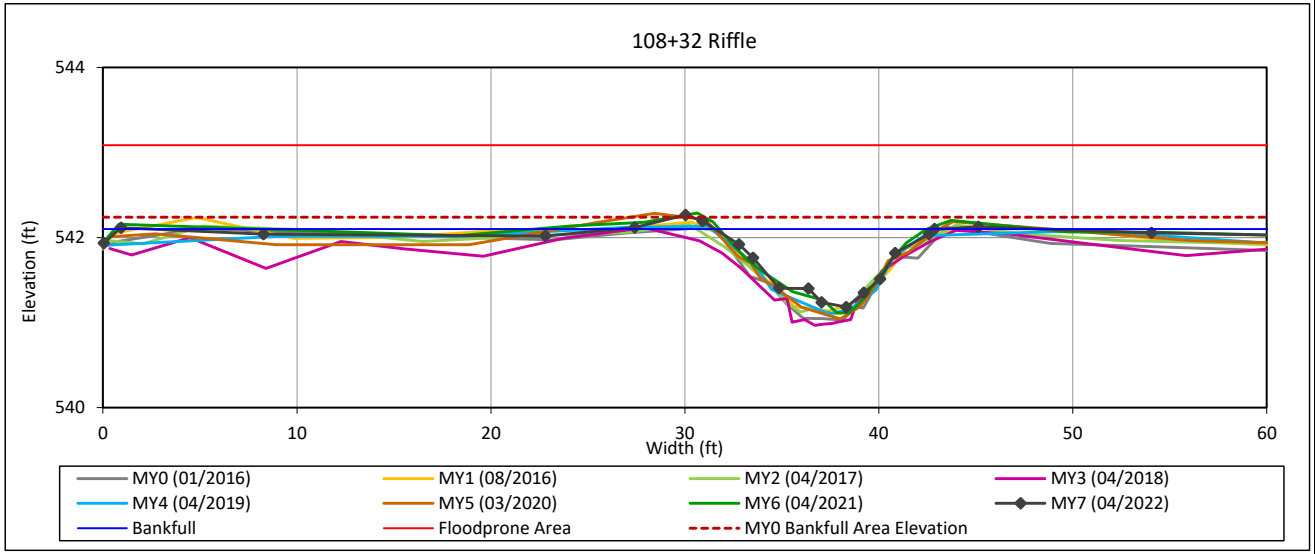
Survey Date: 04/2022
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 7 - 2022

Cross Section 2-UT1



Bankfull Dimensions	
5.6	x-section area (ft.sq.)
11.3	width (ft)
0.5	mean depth (ft)
0.9	max depth (ft)
11.5	wetted perimeter (ft)
0.5	hydraulic radius (ft)
22.6	width-depth ratio
89.3	W flood prone area (ft)
7.9	entrenchment ratio
0.9	low bank height ratio

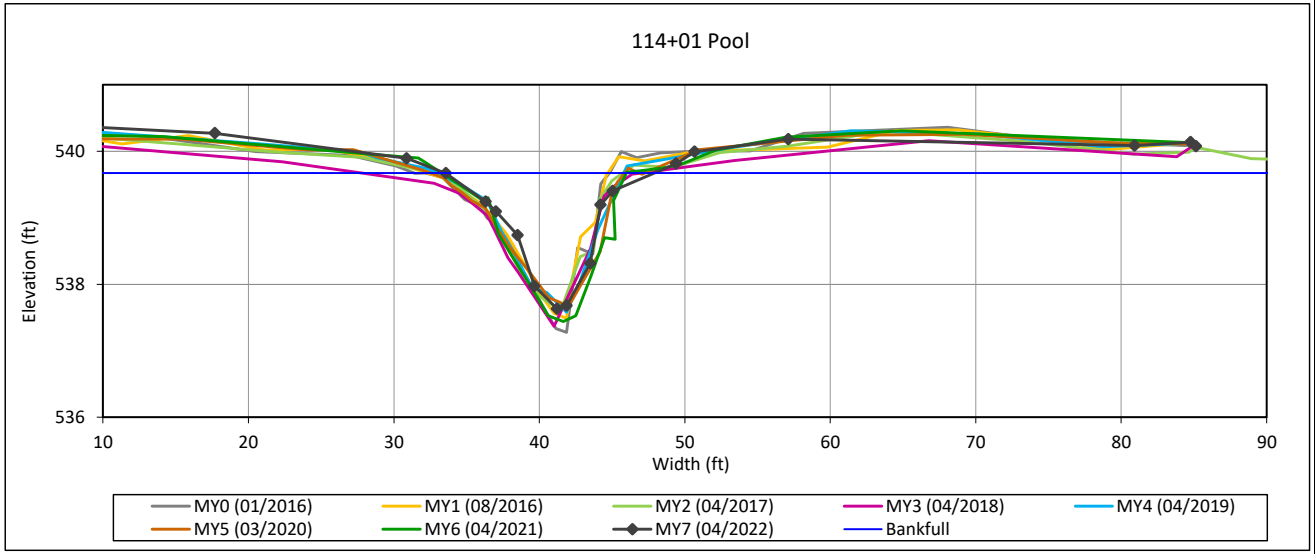
Survey Date: 04/2022
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 7 -2022

Cross Section 3-UT1



Bankfull Dimensions	
11.5	x-section area (ft.sq.)
11.5	width (ft)
1.0	mean depth (ft)
2.0	max depth (ft)
12.4	wetted perimeter (ft)
0.9	hydraulic radius (ft)
11.4	width-depth ratio

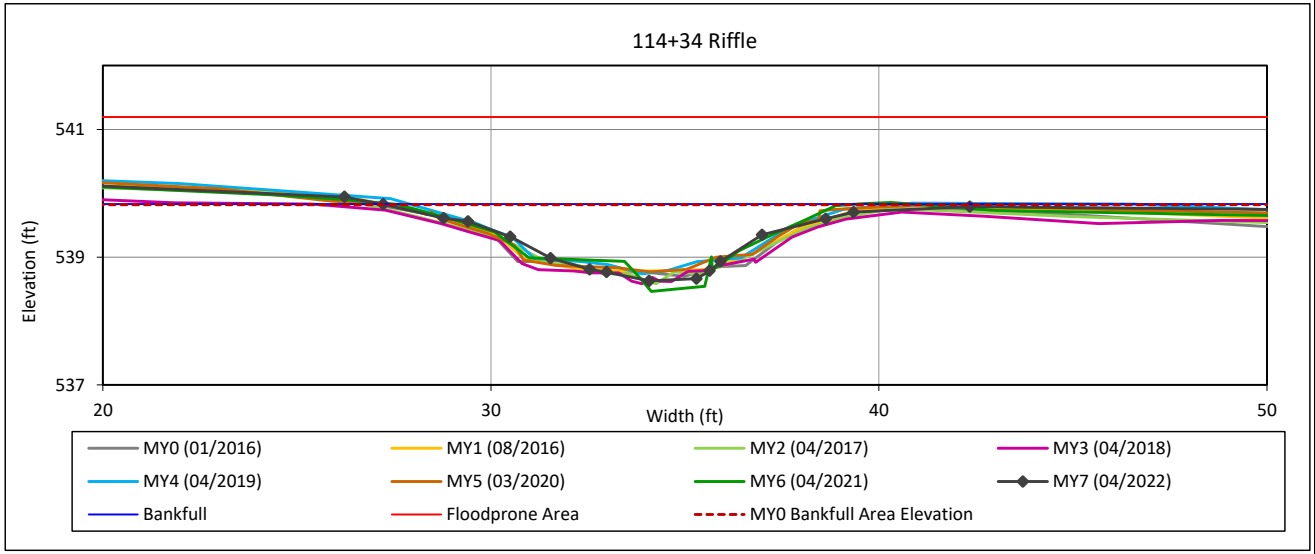
Survey Date: 04/2022
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 7 -2022

Cross Section 4-UT1



Bankfull Dimensions	
7.6	x-section area (ft.sq.)
12.1	width (ft)
0.6	mean depth (ft)
1.2	max depth (ft)
12.4	wetted perimeter (ft)
0.6	hydraulic radius (ft)
19.3	width-depth ratio
82.9	W flood prone area (ft)
6.8	entrenchment ratio
1.0	low bank height ratio

Survey Date: 04/2022
Field Crew: Wildlands Engineering

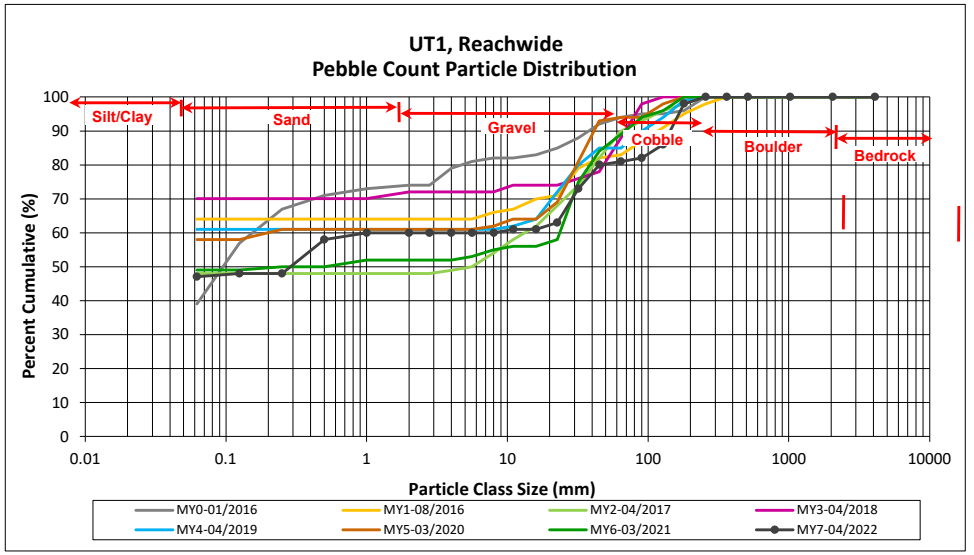
View Downstream

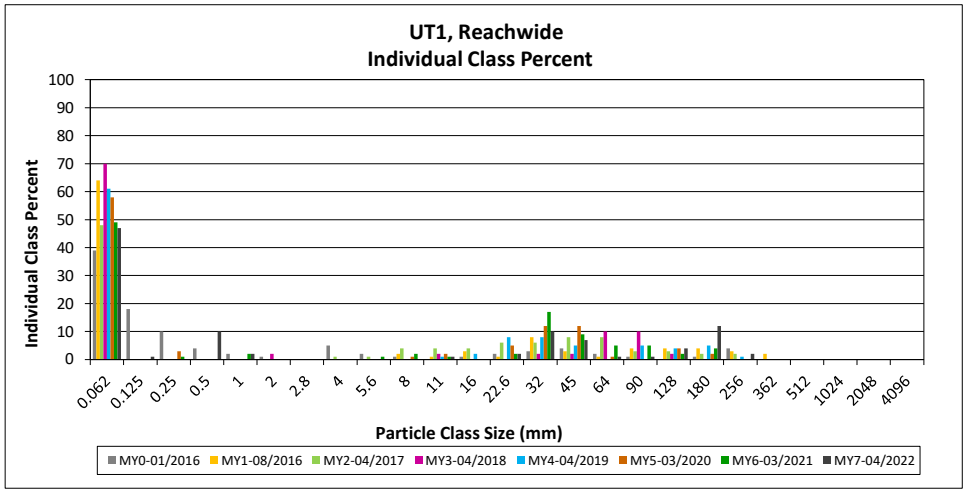
Reachwide and Cross-Section Pebble Count Plots

Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 7 - 2022
UT1, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	8	39	47	47	47
SAND	Very fine	0.062	0.125		1	1	1	48
	Fine	0.125	0.250					48
	Medium	0.25	0.50	2	8	10	10	58
	Coarse	0.5	1.0	1	1	2	2	60
	Very Coarse	1.0	2.0					60
GRAVEL	Very Fine	2.0	2.8					60
	Very Fine	2.8	4.0					60
	Fine	4.0	5.6					60
	Fine	5.6	8.0					60
	Medium	8.0	11.0		1	1	1	61
	Medium	11.0	16.0					61
	Coarse	16.0	22.6	2		2	2	63
	Coarse	22.6	32	10		10	10	73
	Very Coarse	32	45	7		7	7	80
	Very Coarse	45	64	1		1	1	81
COBBLE	Small	64	90	1		1	1	82
	Small	90	128	4		4	4	86
	Large	128	180	12		12	12	98
	Large	180	256	2		2	2	100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	Silt/Clay
D_{50} =	0.3
D_{84} =	107.3
D_{95} =	165.3
D_{100} =	256.0



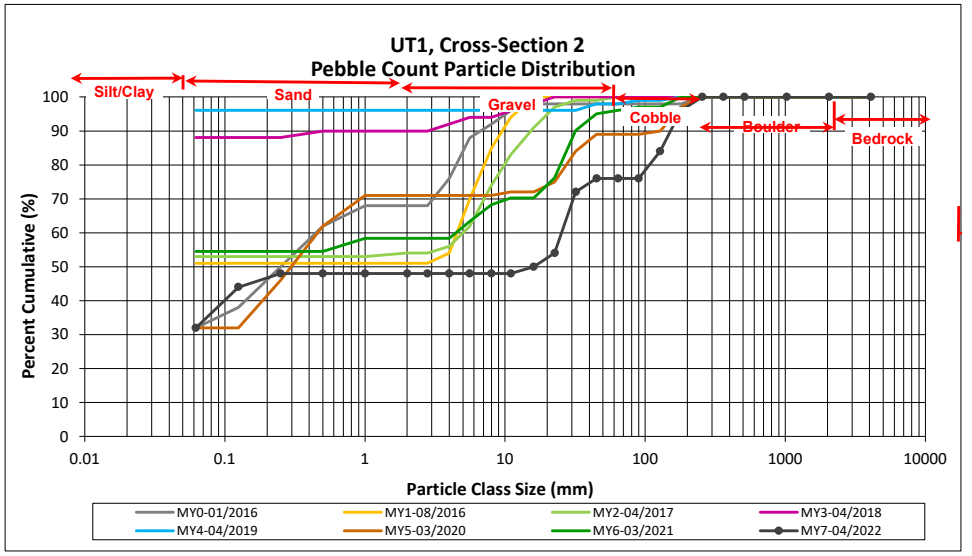


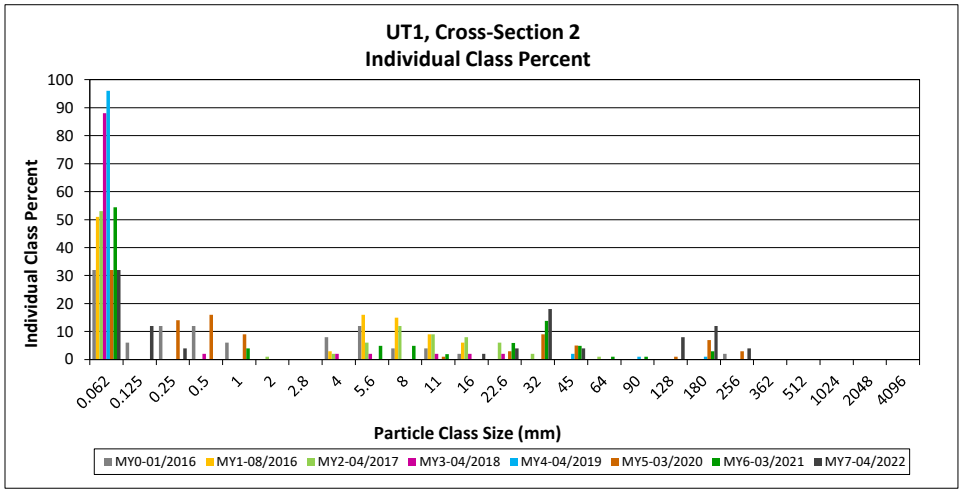
Reachwide and Cross-Section Pebble Count Plots

Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 7 - 2022
UT1, Cross-Section 2

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	32	32	32
SAND	Very fine	0.062	0.125	12	12	44
	Fine	0.125	0.250	4	4	48
	Medium	0.25	0.50			48
	Coarse	0.5	1.0			48
	Very Coarse	1.0	2.0			48
GRAVEL	Very Fine	2.0	2.8			48
	Very Fine	2.8	4.0			48
	Fine	4.0	5.6			48
	Fine	5.6	8.0			48
	Medium	8.0	11.0			48
	Medium	11.0	16.0	2	2	50
	Coarse	16.0	22.6	4	4	54
	Coarse	22.6	32	18	18	72
	Very Coarse	32	45	4	4	76
	Very Coarse	45	64			76
COBBLE	Small	64	90			76
	Small	90	128	8	8	84
	Large	128	180	12	12	96
	Large	180	256	4	4	100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 2	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	0.07
D_{50} =	16.0
D_{84} =	128.0
D_{95} =	175.0
D_{100} =	256.0



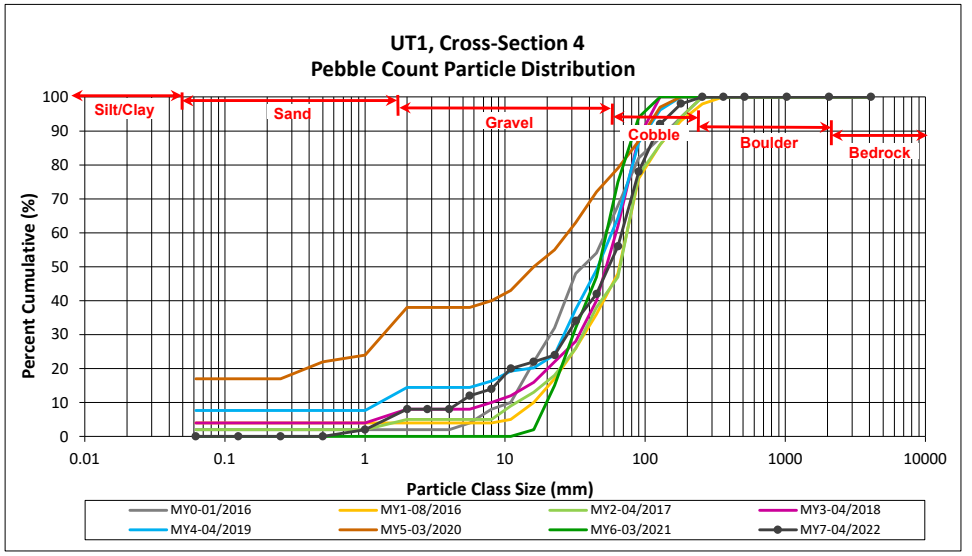


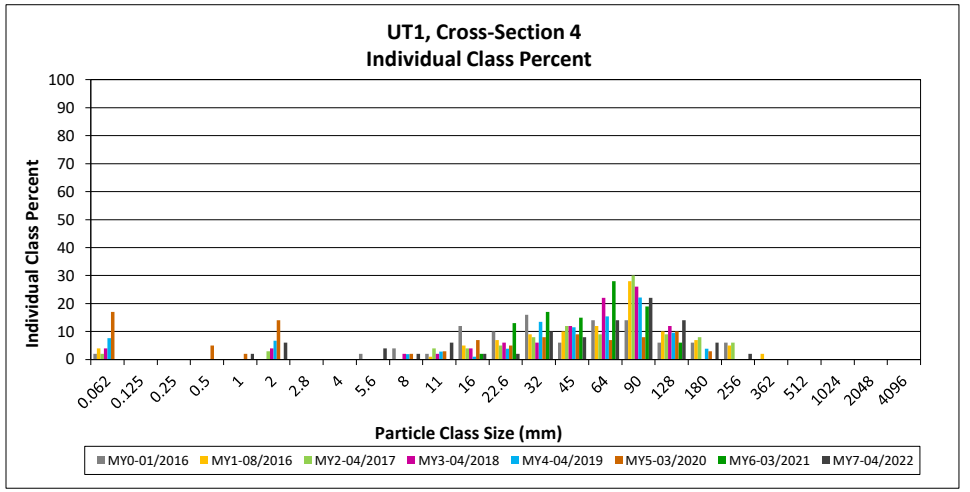
Reachwide and Cross-Section Pebble Count Plots

Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 7 - 2022
UT1, Cross-Section 4

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50			0
	Coarse	0.5	1.0	2	2	2
	Very Coarse	1.0	2.0	6	6	8
GRAVEL	Very Fine	2.0	2.8			8
	Very Fine	2.8	4.0			8
	Fine	4.0	5.6	4	4	12
	Fine	5.6	8.0	2	2	14
	Medium	8.0	11.0	6	6	20
	Medium	11.0	16.0	2	2	22
	Coarse	16.0	22.6	2	2	24
	Coarse	22.6	32	10	10	34
	Very Coarse	32	45	8	8	42
	Very Coarse	45	64	14	14	56
COBBLE	Small	64	90	22	22	78
	Small	90	128	14	14	92
	Large	128	180	6	6	98
	Large	180	256	2	2	100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 4	
Channel materials (mm)	
D_{16} =	8.90
D_{35} =	33.39
D_{50} =	55.0
D_{84} =	104.7
D_{95} =	151.8
D_{100} =	256.0





APPENDIX 5. Hydrology Summary Data and Plots

Table 14. Verification of Bankfull Events
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022

Reach	MY of Occurrence	Date of Occurrence (Approximate)	Method
UT1	MY1	7/11/2016	Stream Gage
	MY2	6/20/2017	Stream Gage
	MY3	9/17/2018	Stream Gage
		10/12/2018	
		10/27/2018	
		11/5/2018	
	MY4	4/5/2019	Stream Gage
	MY5	2/7/2020	Stream Gage, Photos
		3/25/2020	
		4/30/2020	
		5/21/2020	
		5/28/2020	
		8/10/2020	
		8/15/2020	
		9/25/2020	
		10/11/2020	
		11/1/2020	
	MY6	1/1/2021	Stream Gage, Photos
		1/28/2021	
		2/15/2021	
		3/16/2021	
		3/25/2021	
		6/20/2021	
	MY7	1/3/2022	Stream Gage, Photos
		1/17/2022	
		2/4/2022	
		3/9/2022	
		4/18/2022	
		7/20/2022	

Reach	MY of Occurrence	Date of Occurrence (Approximate)	Method
UT2	MY1	7/11/2016	Crest Gage
		10/8/2016	
	MY2	6/20/2017	
	MY3	11/5/2018	Wrack Line
	MY4	4/5/2019	Bankfull Flow Photo
	MY5	3/25/2020	Wrack Line
		11/1/2020	Wrack Line
	MY7	4/21/2022	Wrack Line
Crooked Creek	MY6	4/5/2021	Wrack Line
	MY1	7/11/2016	Crest Gage
		10/8/2016	
	MY2	6/20/2017	Crest Gage
	MY3	11/5/2018	Wrack Line
	MY4	4/5/2019	Bankfull Flow Photo
		Unknown	Wrack Line
	MY5	3/25/2020	Bankfull Flow Photo
	MY6	4/5/2021	Wrack Line
	MY7	4/21/2022	Wrack Line

Recorded In-stream Flow Events

Crooked Creek #2 Restoration Project

DMS Project No. 94687

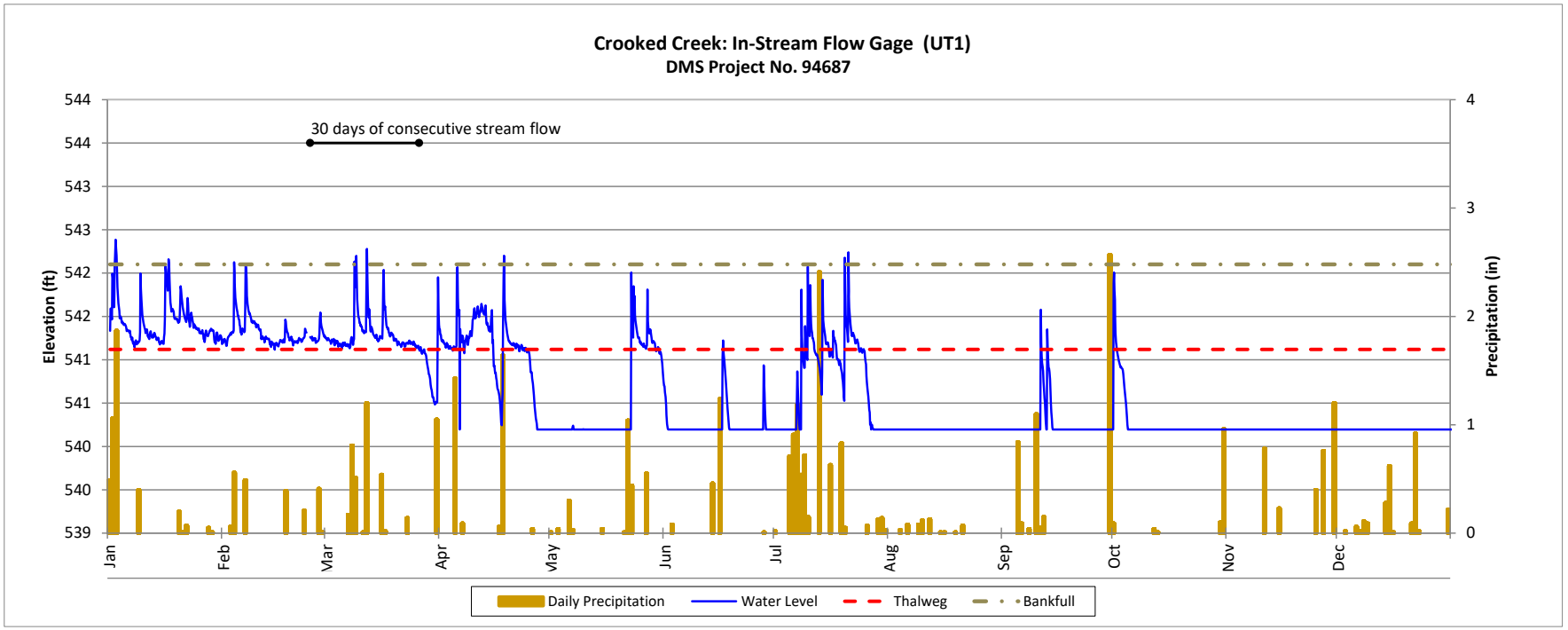


Table 15. Wetland Gage Attainment Summary Growing Season 3/23- 11/4

Crooked Creek #2 Restoration Project

DMS Project No. 964687

Monitoring Year 7 - 2022

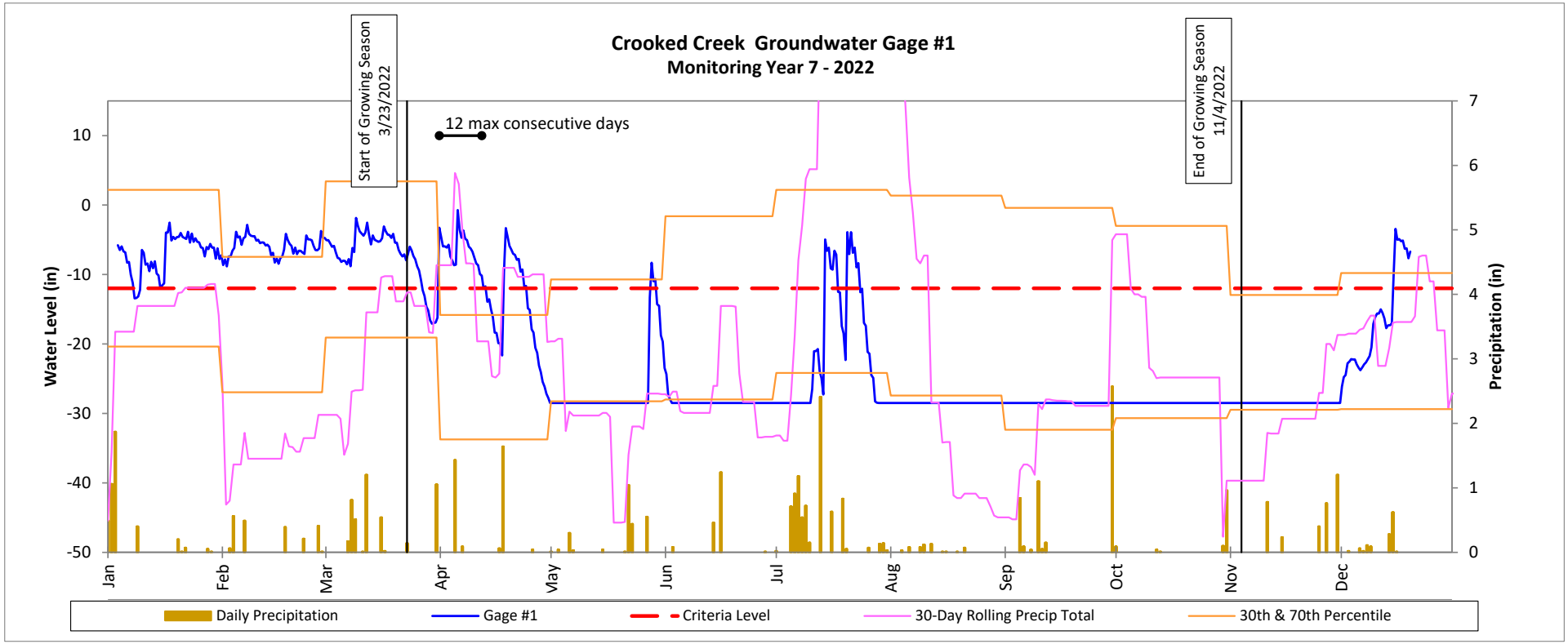
Summary of Groundwater Gage Results for Monitoring Years 1 through 7							
Gage	**Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)**						
	MY1 (2016)	**MY2 (2017)**	**MY3 (2018)**	**MY4 (2019)**	**MY5 (2020)**	**MY6 (2021)**	**MY7 (2022)**
1	No/0 Days (0%)	No/7 Days (3%)	No/12 Days (5%)	Yes/22 Days (9.7%)	No/ 15 Days (6.6%)	No/ 14 Days (6.2%)	No/ 12 Days (5.3%)
2	No/2 Days (0.9%)	No/8 Days (4%)	No/13 Days (6%)	Yes/21 Days (9.3%)	Yes/ 25 Days (11%)	No/ 14 Days (6.2%)	No/ 14 Days (6.2%)
3	No/1 Days (0.4%)	No/9 Days (4%)	Yes/29 Days (13%)	Yes/34 Days (15%)	Yes/ 25 Days (11%)	Yes/ 18 Days (7.9%)	Yes/ 36 Days (15.9%)
4	No/0 Days (0%)	No/6 Days (3%)	No/10 Days (4%)	No/16 Days (7.1%)	No/ 14 Days (6.2%)	No/ 10 Days (4.4%)	No/ 6 Days (2.6%)
5	No/1 Days (0.4%)	No/7 Days (3%)	No/12 Days (5%)	Yes/22 Days (9.7%)	Yes/ 25 Days (11%)	No/ 14 Days (6.2%)	No/ 12 Days (5.3%)
6	Yes/26 Days (11.5%)	Yes/75 Days (33%)	Yes/88 Days (39%)	Yes/67 Days (29.6%)	Yes/116 Days (51.1%)	Yes/ 25 Days (11.0%)	Yes/ 44 Days (19.4%)
7	Yes/18 Days (8%)	Yes/47 Days (21%)	Yes/45 Days (20%)	Yes/56 Days (24.8%)	Yes/ 54 Days (23.8%)	Yes/ 30 Days (13.2%)	Yes/ 39 Days (17.2%)
8	No/14 Days (6.2%)	Yes/31 Days (14%)	Yes/45 Days (20%)	Yes/35 Days (15.5%)	Yes/ 51 Days (22.5%)	Yes/ 26 Days (11.5%)	Yes/ 26 Days (11.5%)
9	No/1 Days (0.4%)	No/7 Days (3%)	No/13 Days (6%)	Yes/23 Days (10.2%)	No/ 16 Days (7%)	No/ 14 Days (6.2%)	No/ 12 Days (5.3%)
10	No/2 Days (0.9%)	No/11 Days (5%)	No/10 Days (4%)	Yes/23 Days (10.2%)	No/ 15 Days (6.6%)	No/ 12 Days (5.3%)	No/ 5 Days (2.2%)
11*					No/ 14 Days (6.2%)	No/ 8 Days (3.5%)	No/ 4 Days (1.8%)

Growing season 3/23/2022- 11/4/2022, success criteria is 17 days.

* GWG11 installed 3/27/2020

Groundwater Gage Plots

Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022
Wetland Wetland Restoration



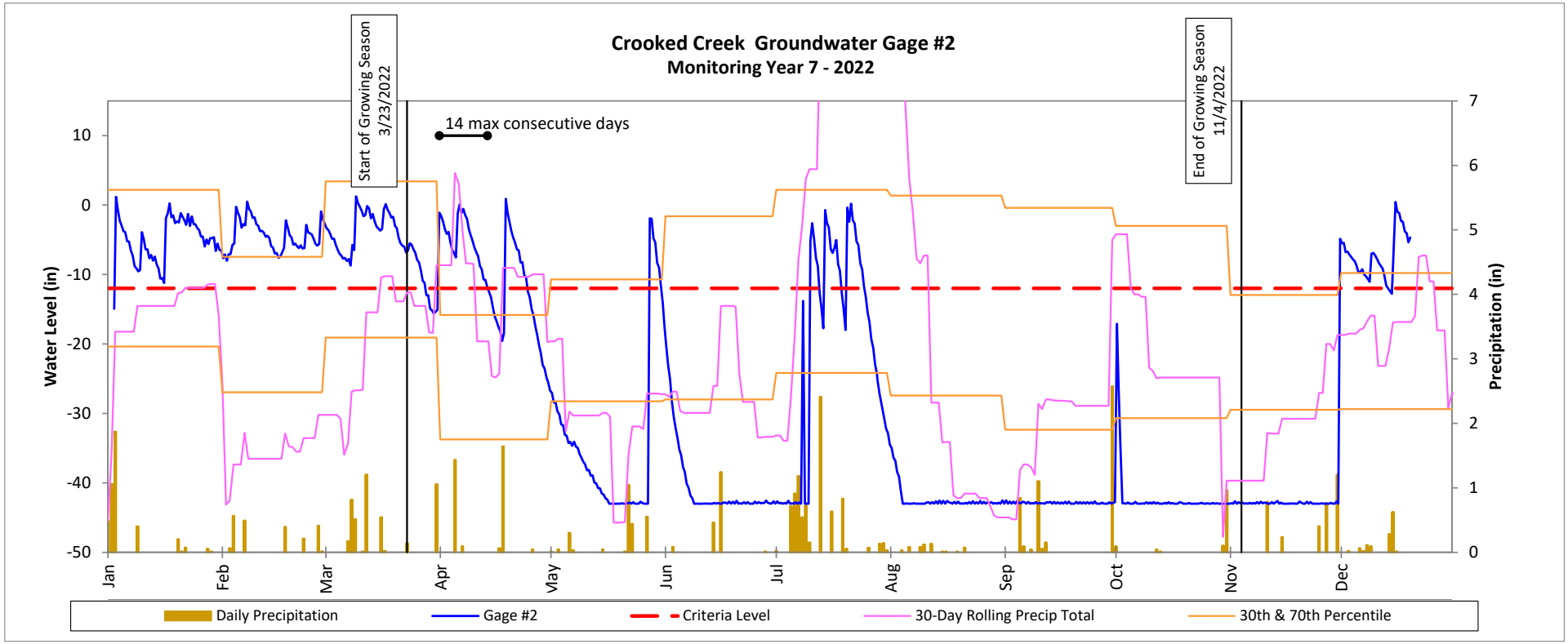
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Restoration



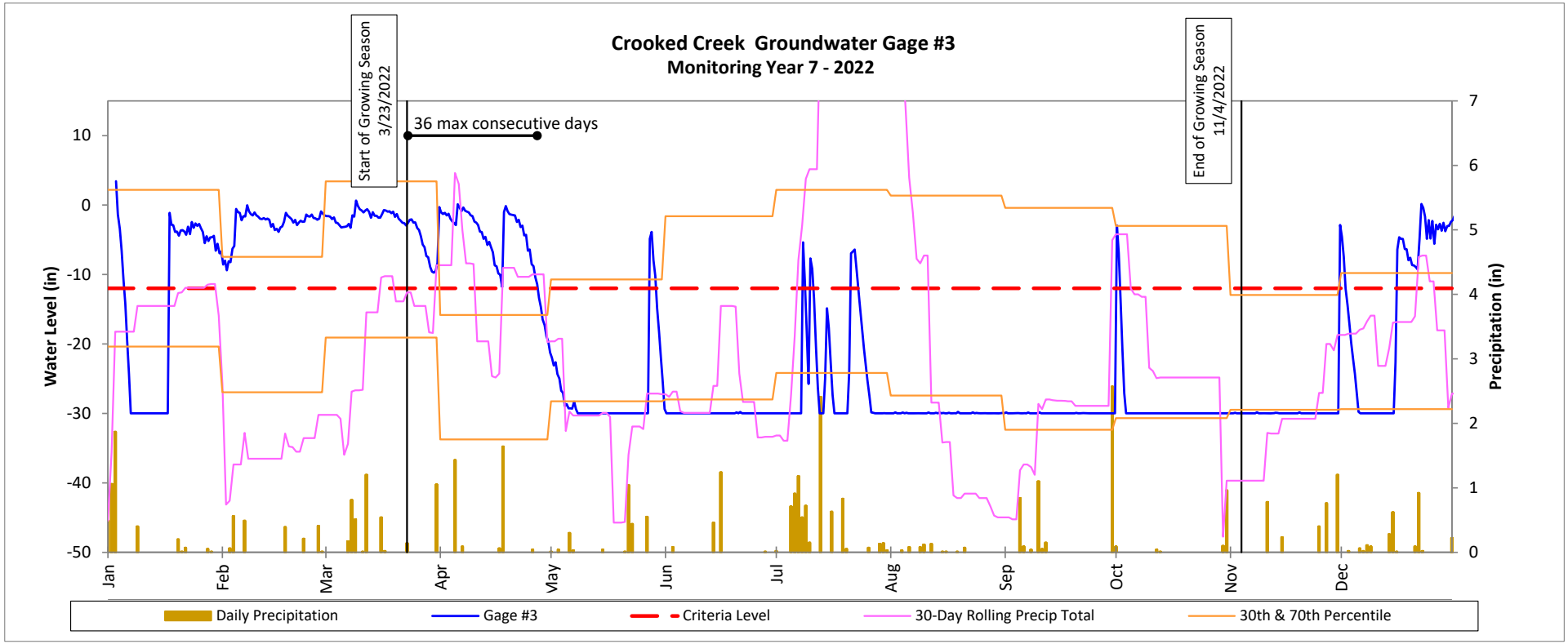
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

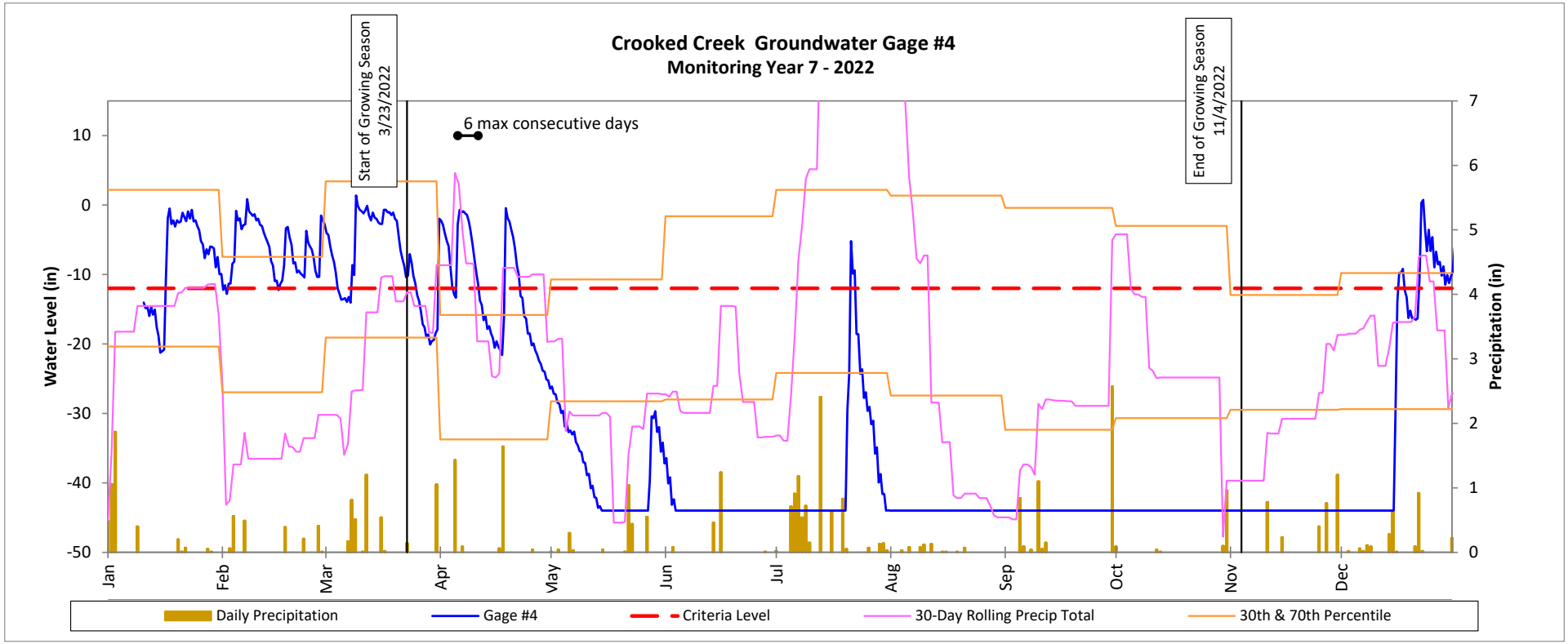
Monitoring Year 7 - 2022

Wetland Wetland Restoration



Groundwater Gage Plots

Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022
Wetland Wetland Restoration



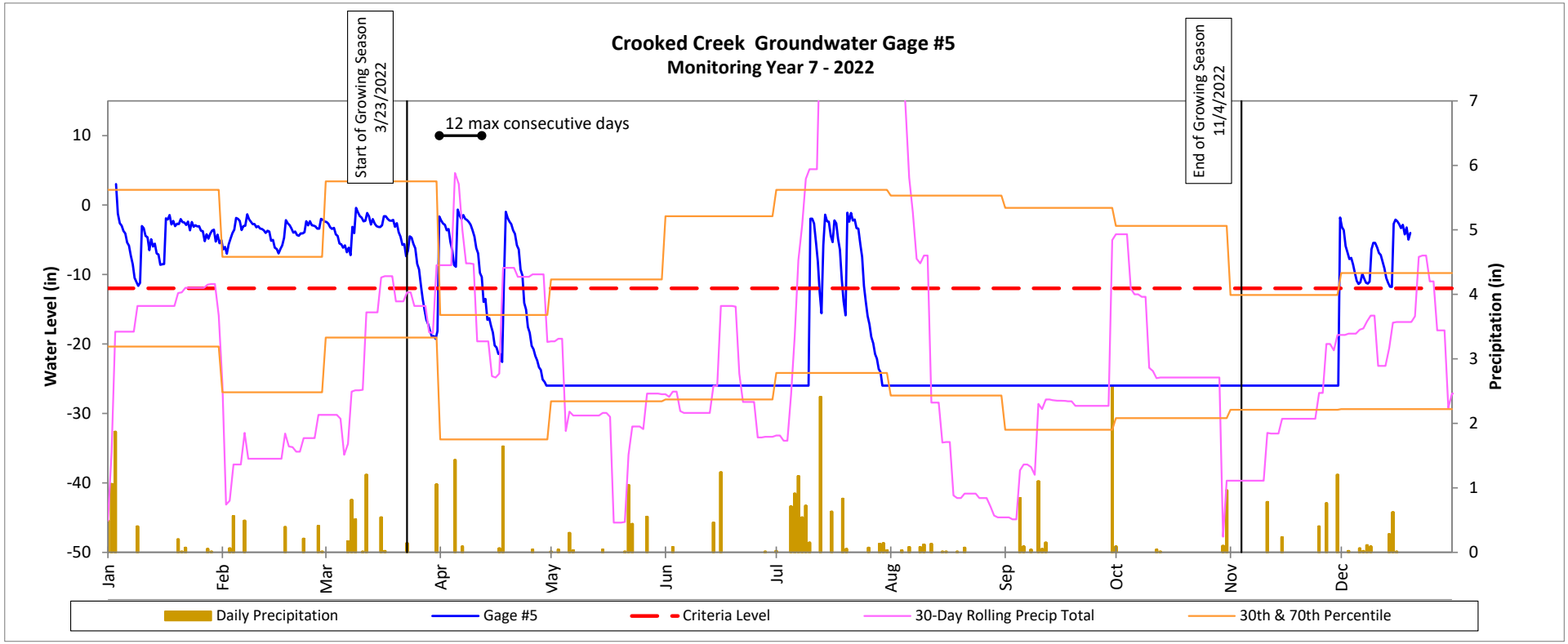
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Creation



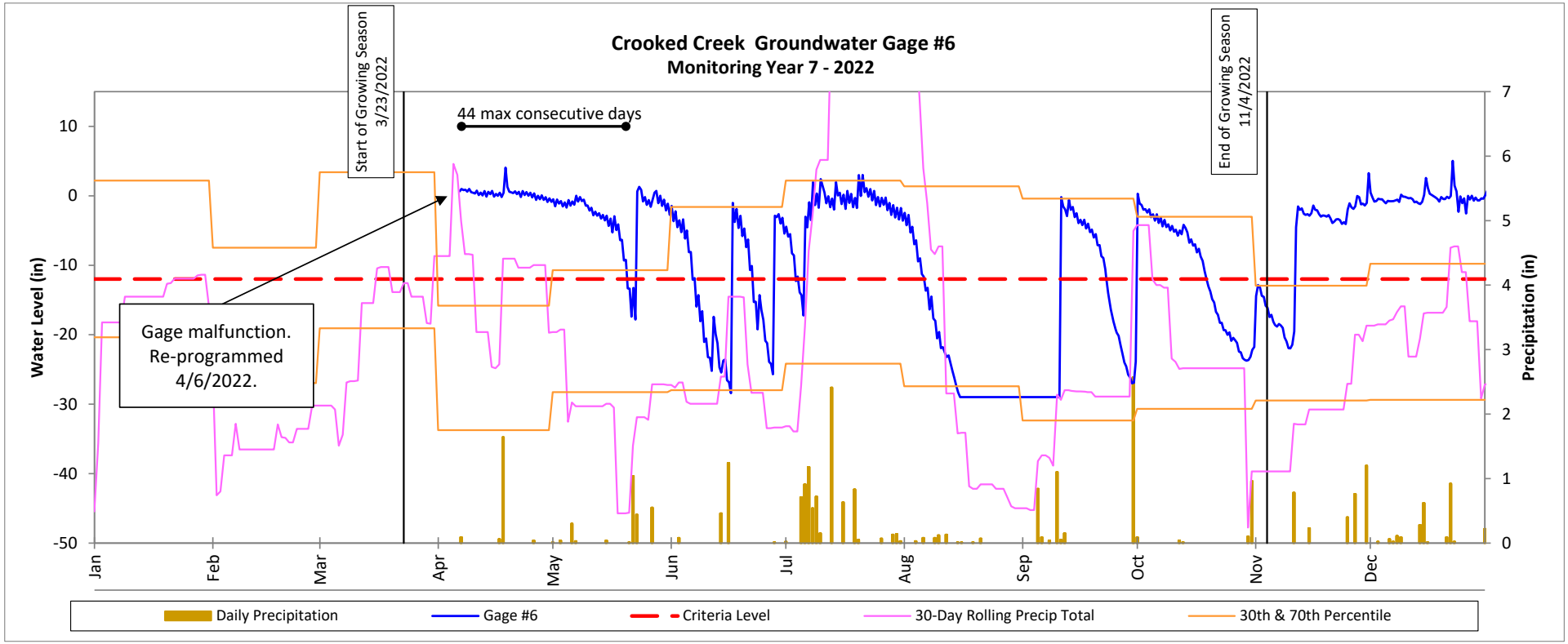
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Restoration



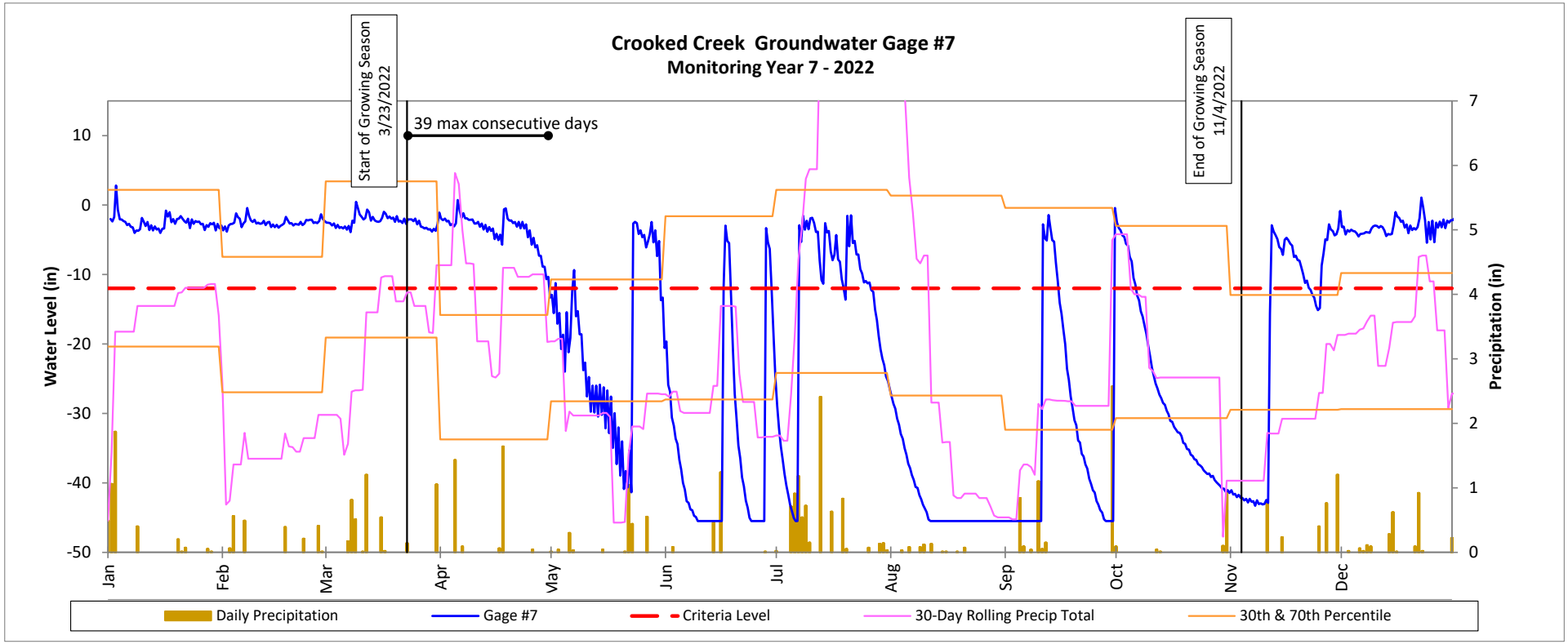
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Restoration



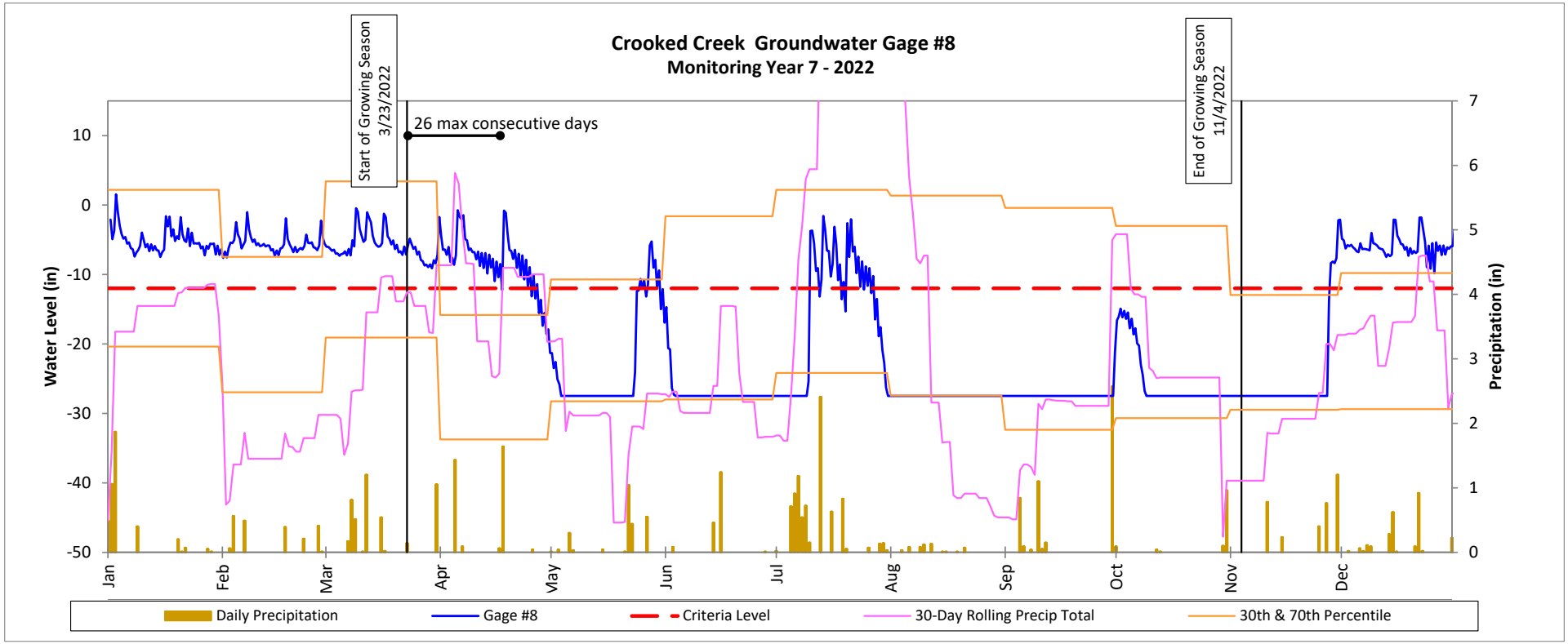
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

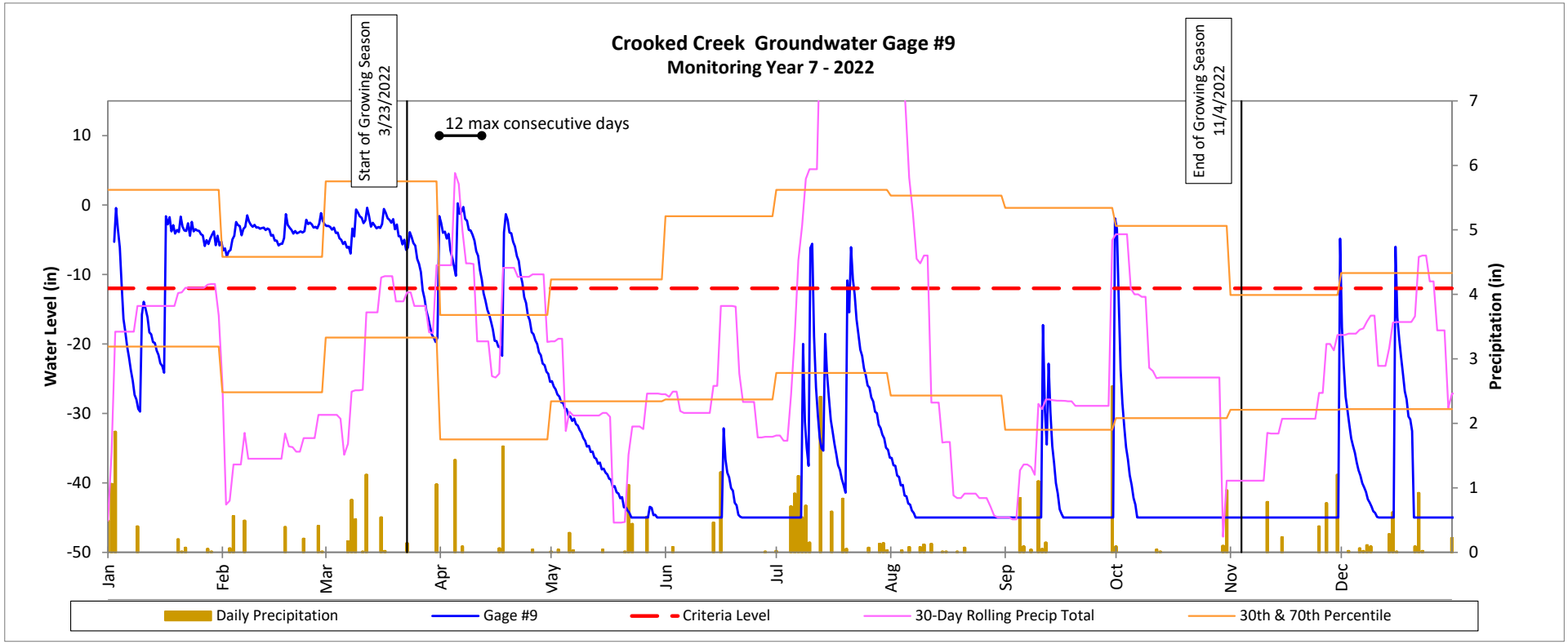
Monitoring Year 7 - 2022

Wetland Wetland Creation



Groundwater Gage Plots

Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022
Wetland Wetland Creation



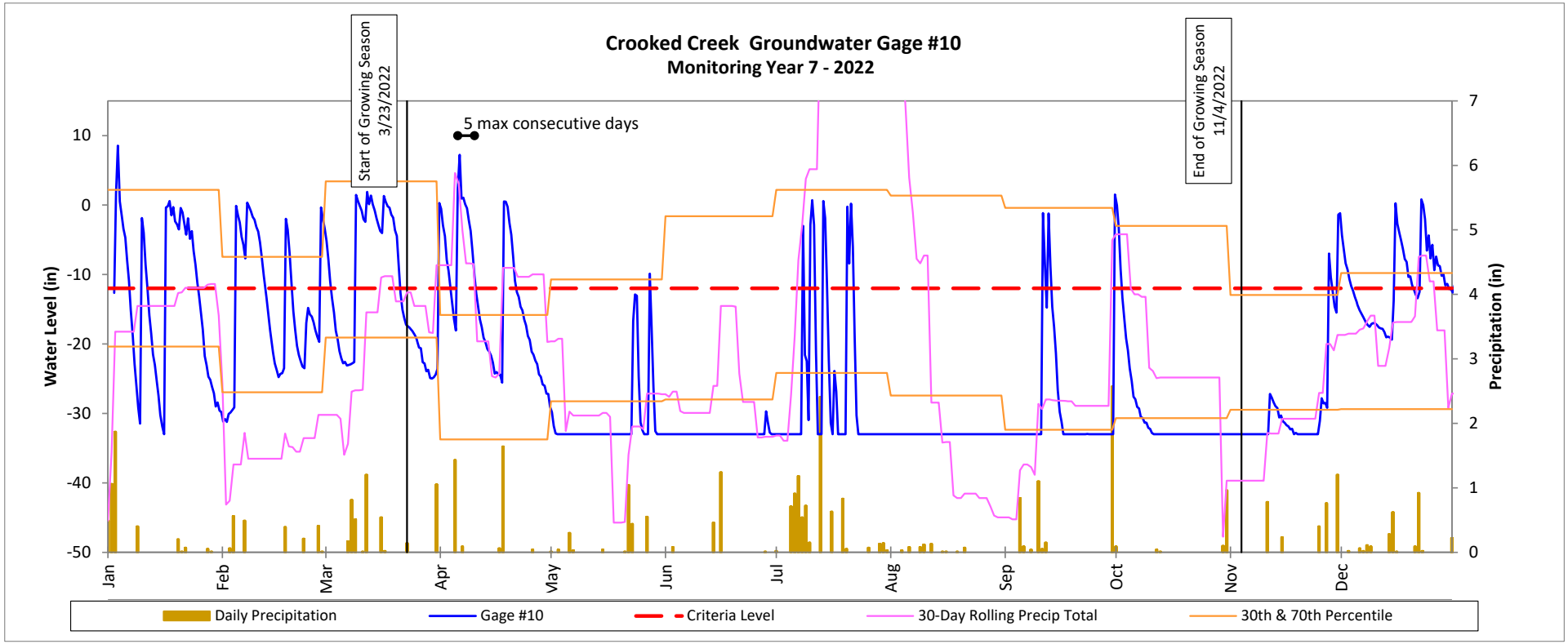
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Creation



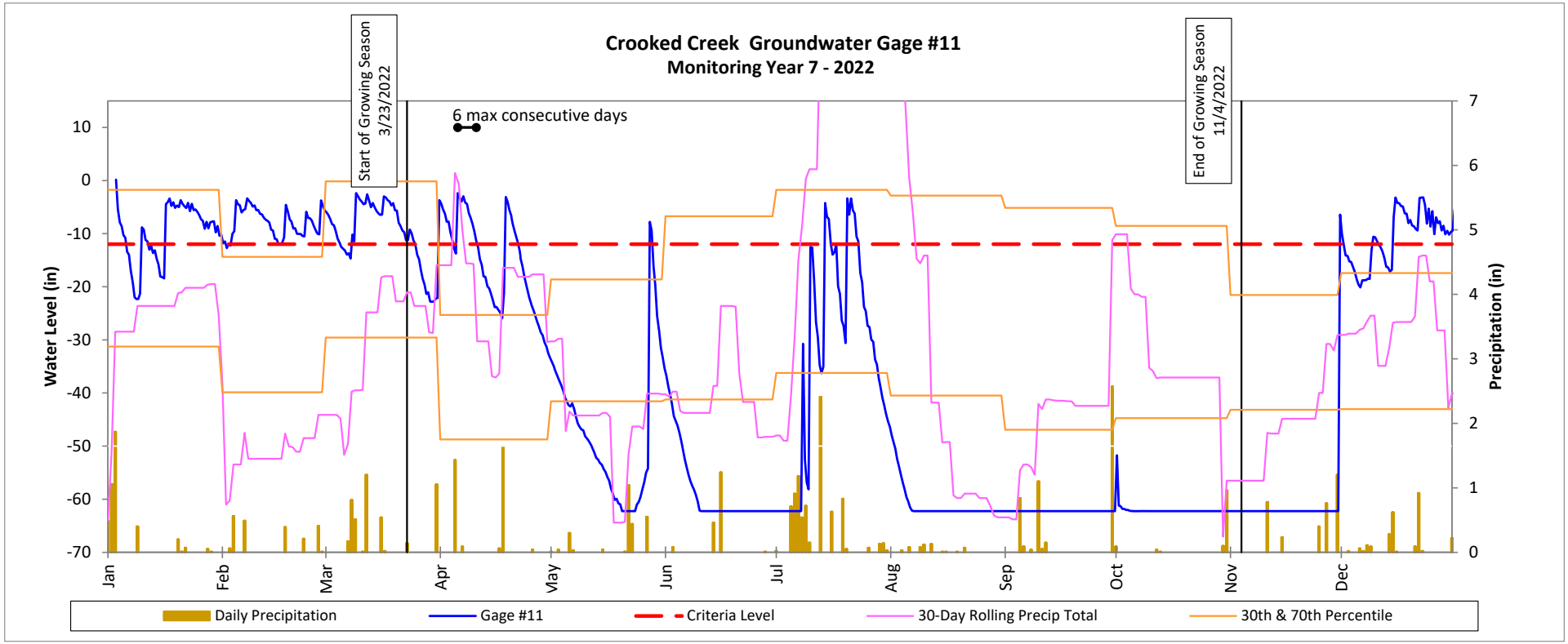
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

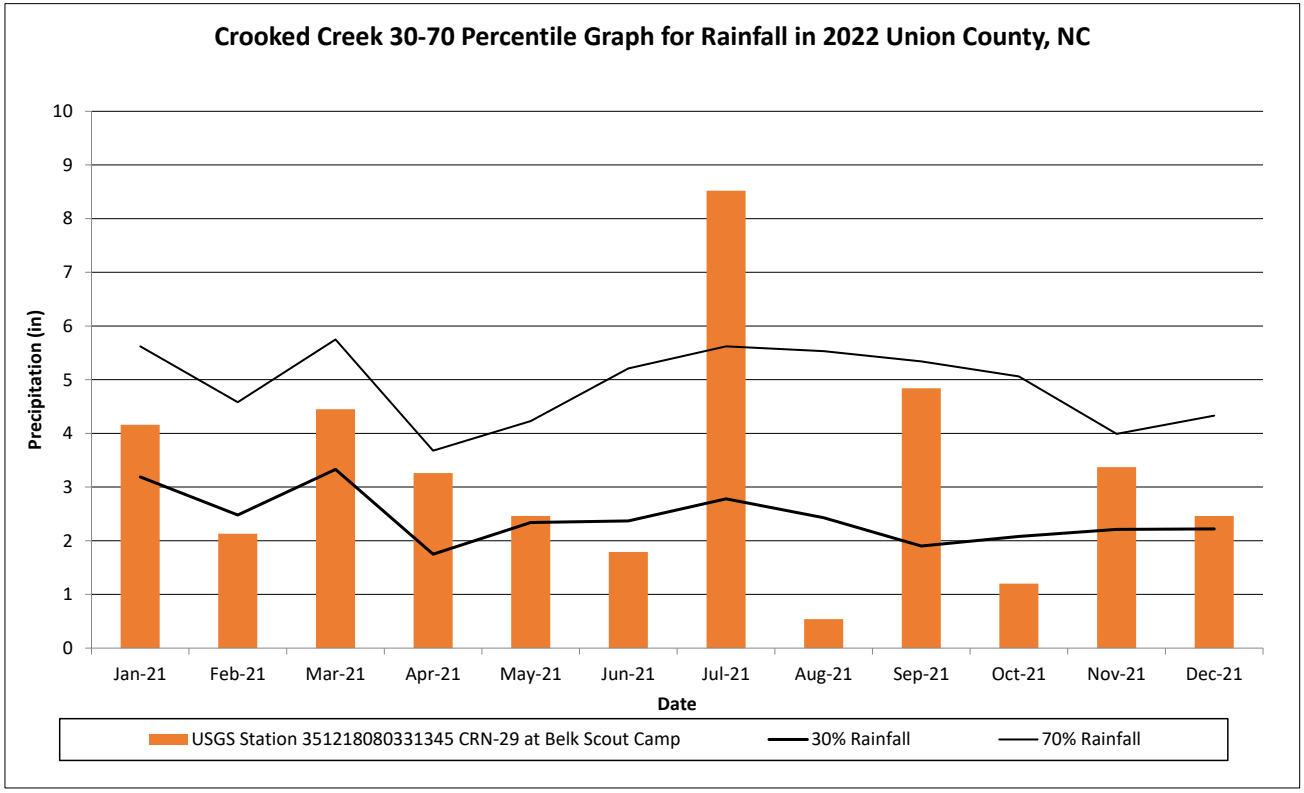
Monitoring Year 7 - 2022

Wetland Wetland Creation



Monthly Rainfall Data

Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 7 - 2022



[1] 30th and 70th percentile rainfall data generated from WETS Table: Monroe, NC5771 (1971-2000). (USDA Field Office Climate Data, 2016)

Bankfull Wrackline and Hydrology Photographs
Monitoring Year 7

	
UT2 water in channel – UT2 (4/21/2022)	**Wrack Lines –** UT2 (4/18/2022)
	
Wrack Lines – Crooked Creek (4/18/2022)	**Wrack Lines –** UT1 (4/18/2022)

APPENDIX 6. Supplemental Wetland Soil Documentation and USACE Determination Forms

Representative Wetland Groundwater Gage Photos

	
GWG1 – Surrounding wetland area Spring (4/5/2022)	**GWG1** – Surrounding wetland area Fall (11/10/2022)
	
GWG2 – Surrounding wetland area Spring (4/5/2022)	**GWG2** – Surrounding wetland area Fall (11/10/2022)
	
GWG3 – Surrounding wetland area Spring (4/5/2022)	**GWG3** – Surrounding wetland area Fall (11/10/2022)

	
GWG4 – Surrounding wetland area Spring (4/5/2022)	**GWG4** – Surrounding wetland area Fall (11/10/2022)
	
GWG5 – Surrounding wetland area Spring (4/5/2022)	**GWG5** – Surrounding wetland area Fall (11/10/2022)
	
GWG6 – Surrounding wetland area Spring (4/5/2022)	**GWG6** – Surrounding wetland area Fall (11/10/2022)

	
GWG7 – Surrounding wetland area Spring (4/5/2022)	**GWG7** – Surrounding wetland area Fall (11/10/2022)
	
GWG8 – Surrounding wetland area Spring (4/5/2022)	**GWG8** – Surrounding wetland area Fall (11/10/2022)
	
GWG9 – Surrounding wetland area Spring (4/5/2022)	**GWG9** – Surrounding wetland area Fall (11/10/2022)

	
GWG10 – Surrounding wetland area Spring (4/5/2022)	**GWG10** – Surrounding wetland area Fall (11/10/2022)
	
GWG11 – Surrounding wetland area Spring (4/5/2022)	**GWG11** – Surrounding wetland area Fall (11/10/2022)

Wetland Soil Investigation Borings

GWG1 Soil Boring – F19 Hydric Soils (12/21/2022)

GWG2 Soil Boring – F19 Hydric Soils (12/21/2022)

GWG3 Soil Boring – F3 Hydric Soils (1/3/2023)

GWG4 Soil Boring –F19 Hydric Soils (12/21/2022)

GWG5 Soil Boring – F19 Hydric Soils (12/21/2022)

GWG7 Soil Boring – F3 Hydric Soils (1/3/2023)

	
GWG8 Soil Boring – F3 Hydric Soils (1/3/2023)	**GWG9 Soil Boring** – F19 Hydric Soils (12/21/2022)
	
GWG10 Soil Boring – Not Hydric Soil Indicators (12/21/2022)	**GWG11 Soil Boring** – F19 Hydric Soils (1/3/2023)

USACE Wetland Determination Forms

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 12/20/22
Applicant/Owner: Wildlands Engineering State: NC Sampling Point: GWG1
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0-2
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?** **Yes** X **No**
Hydric Soil Present?	Yes X	No	
Wetland Hydrology Present?	Yes X	No	

Remarks:
Data point taken at Groundwater Gage 1.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- X High Water Table (A2)
- X Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- True Aquatic Plants (B14)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes X	No	Depth (inches): 9
Saturation Present? (includes capillary fringe)	Yes X	No	Depth (inches): 8

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Standing water in the bore hole at 9 inches below the surface and saturated soils starting at 8 inches.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: GWG1

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
50% of total cover:	20% of total cover:		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Celtis laevigata*	15	Yes	FACW
2. *Fraxinus pennsylvanica*	10	Yes	FACW
3. *Taxodium distichum*	10	Yes	OBL
4. *Platanus occidentalis*	5	No	FACW
5.			
6.			
7.			
8.			
9.			
	40 =Total Cover		
50% of total cover: 20	20% of total cover: 8		
Herb Stratum (Plot size: 5)			
1. *Lamium purpureum*	60	Yes	UPL
2. Unknown grass sp.	25	Yes	
3. *Solidago altissima*	5	No	FACU
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	90 =Total Cover		
50% of total cover: 45	20% of total cover: 18		
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 60.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	10	x 1 =	10
FACW species	30	x 2 =	60
FAC species	0	x 3 =	0
FACU species	5	x 4 =	20
UPL species	60	x 5 =	300
Column Totals:	105 (A)		390 (B)

Prevalence Index = B/A = 3.71

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	2.5Y 4/4	100					Loamy/Clayey	
3-14	2.5Y 5/3	80	7.5YR 4/6	20	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- X Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 12/20/22
Applicant/Owner: Widlands Engineering State: NC Sampling Point: GWG2
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 1-2
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?** **Yes** X **No**
Hydric Soil Present?	Yes X	No	
Wetland Hydrology Present?	Yes X	No	

Remarks:
Data point taken at Groundwater Gage 2.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes X	No	Depth (inches): 5
Saturation Present? (includes capillary fringe)	Yes X	No	Depth (inches): 5

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Saturation and water table present in hole at 5 inches below ground surface.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: GWG2

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Platanus occidentalis*	25	Yes	FACW
2. *Betula nigra*	15	Yes	FACW
3.			
4.			
5.			
6.			
7.			
	40	=Total Cover	
50% of total cover: 20		20% of total cover: 8	
Sapling/Shrub Stratum (Plot size: 15)			
1. *Taxodium distichum*	5	Yes	OBL
2. *Betula nigra*	5	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	10	=Total Cover	
50% of total cover: 5		20% of total cover: 2	
Herb Stratum (Plot size: 5)			
1. *Lamium purpureum*	40	Yes	UPL
2. Unknown grass sp.	30	Yes	
3. *Solidago altissima*	10	No	FACU
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	80	=Total Cover	
50% of total cover: 40		20% of total cover: 16	
Woody Vine Stratum (Plot size: 15)			
1.			
2.			
3.			
4.			
5.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66.7% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	5	x 1 =	5
FACW species	45	x 2 =	90
FAC species	0	x 3 =	0
FACU species	10	x 4 =	40
UPL species	40	x 5 =	200
Column Totals:	100 (A)		335 (B)

Prevalence Index = B/A = 3.35

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 3/3	100					Loamy/Clayey	
4-10	2.5Y 5/4	90	7.5YR 5/6	10	C	M	Loamy/Clayey	Prominent redox concentrations
10-16	10YR 5/3	85	7.5YR 4/6	20	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- X Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 1/3/2023
Applicant/Owner: Wildlands Engineering State: NC Sampling Point: GWG3
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0-2
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?** **Yes** X **No**
Hydric Soil Present?	Yes X	No	
Wetland Hydrology Present?	Yes X	No	

Remarks:
Data point taken at Groundwater Gage 3.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- True Aquatic Plants (B14)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes X	No	Depth (inches): 11
Saturation Present? (includes capillary fringe)	Yes X	No	Depth (inches): 8

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Saturation present in hold at 8 inches and water table present at 11 inches below ground surface.

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: GWG3

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
50% of total cover:	20% of total cover:		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Fraxinus pennsylvanica*	100	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	100 =Total Cover		
50% of total cover: 50	20% of total cover: 20		
Herb Stratum (Plot size: 5)			
1. Unknown grass sp.	70	Yes	
2. *Ranunculus repens*	10	No	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	80 =Total Cover		
50% of total cover: 40	20% of total cover: 16		
Woody Vine Stratum (Plot size: 5)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	100	x 2 =	200
FAC species	10	x 3 =	30
FACU species	0	x 4 =	0
UPL species	0	x 5 =	0
Column Totals:	110 (A)		230 (B)

Prevalence Index = B/A = 2.09

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

X 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 5/2	100	10YR 4/6	5	C	M	Loamy/Clayey	Prominent redox concentrations
2-8	2.5Y 5/2	100	7.5YR 4/6	10	C	M	Loamy/Clayey	Prominent redox concentrations
8-16	2.5Y 6/2	100	2.5Y 6/6	25	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 12/20/22
Applicant/Owner: Widlands Engineering State: NC Sampling Point: GWG4
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): Local relief (concave, convex, none): floodplain Slope (%): 1%<
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes	No X	**Is the Sampled Area within a Wetland?** **Yes** **No** X
Hydric Soil Present?	Yes X	No	
Wetland Hydrology Present?	Yes	No X	

Remarks:
Data point taken at Groundwater Gage 4. F19 soils present but weak hydrology indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- Surface Water (A1)
- High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- True Aquatic Plants (B14)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes	No X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	No X	Depth (inches):

Wetland Hydrology Present? **Yes** **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: GWG4

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
50% of total cover:	20% of total cover:		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Fraxinus pennsylvanica*	75	Yes	FACW
2. *Acer negundo*	10	No	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	85 =Total Cover		
50% of total cover: 43	20% of total cover: 17		
Herb Stratum (Plot size: 5)			
1. Unknown grass sp.	75	Yes	
2. *Ranunculus repens*	10	No	FAC
3. *Lamium purpureum*	5	No	UPL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	90 =Total Cover		
50% of total cover: 45	20% of total cover: 18		
Woody Vine Stratum (Plot size: 15)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	75	x 2 =	150
FAC species	20	x 3 =	60
FACU species	0	x 4 =	0
UPL species	5	x 5 =	25
Column Totals:	100 (A)		235 (B)

Prevalence Index = B/A = 2.35

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** ___ **No** X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-1	2.5Y 4/3	100					Loamy/Clayey	
1-8	2.5Y 5/3	80	7.5YR 5/6	20	C	M	Loamy/Clayey	Prominent redox concentrations
8-13	2.5Y 5/4	70	10YR 6/6	30	C	M	Loamy/Clayey	Distinct redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- X Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 12/20/22
Applicant/Owner: Widlands Engineering State: NC Sampling Point: GWG5
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): Local relief (concave, convex, none): floodplain Slope (%): 1-2
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?** **Yes** X **No**
Hydric Soil Present?	Yes X	No	
Wetland Hydrology Present?	Yes X	No	

Remarks:
Data point taken at Groundwater Gage 5.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- Surface Water (A1)
- X High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- True Aquatic Plants (B14)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes X	No	Depth (inches): 12
Saturation Present? (includes capillary fringe)	Yes X	No	Depth (inches): 12

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Water table and saturation present at the hole beginning at 12 inches below ground surface.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: GWG5

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
50% of total cover:	20% of total cover:		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Fraxinus pennsylvanica*	10	Yes	FACW
2. *Platanus occidentalis*	5	Yes	FACW
3. *Nyssa sylvatica*	5	Yes	FAC
4.			
5.			
6.			
7.			
8.			
9.			
	20 =Total Cover		
50% of total cover: 10	20% of total cover: 4		
Herb Stratum (Plot size: 5)			
1. Unknown gass sp.	25	Yes	
2. *Rubus argutus*	25	Yes	FACU
3. *Ranunculus repens*	5	No	FAC
4. *Solidago altissima*	5	No	FACU
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	60 =Total Cover		
50% of total cover: 30	20% of total cover: 12		
Woody Vine Stratum (Plot size: 15)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 60.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	15	x 2 =	30
FAC species	10	x 3 =	30
FACU species	30	x 4 =	120
UPL species	0	x 5 =	0
Column Totals:	55 (A)		180 (B)

Prevalence Index = B/A = 3.27

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-7	2.5Y 5/3	75	10YR 4/4	20	C	PL/M	Loamy/Clayey	Manganese Knodules (5%)
7-14	2.5Y 6/4	85	2.5Y 5/1	10	D	M	Loamy/Clayey	Manganese Knodules (5%)
			7.5YR 5/6	10	C	M		Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- X Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 1/3/2023
Applicant/Owner: Wildlands Engineering State: NC Sampling Point: GWG7
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0-2
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?** **Yes** X **No**
Hydric Soil Present?	Yes X	No	
Wetland Hydrology Present?	Yes X	No	

Remarks:
Data point taken at Groundwater Gage 7. Stromg hydrology, vegetation and soil indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- Surface Water (A1)
- X High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- True Aquatic Plants (B14)
- Hydrogen Sulfide Odor (C1)
- X Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- X Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes X	No	Depth (inches): 6
Saturation Present? (includes capillary fringe)	Yes X	No	Depth (inches): 6

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Water table and saturation present at 6 inches below ground surface.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: GWG7

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
50% of total cover:	20% of total cover:		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Fraxinus pennsylvanica*	50	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	50 =Total Cover		
50% of total cover: 25	20% of total cover: 10		
Herb Stratum (Plot size: 5)			
1. *Juncus effusus*	25	Yes	FACW
2. *Ranunculus repens*	20	Yes	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	45 =Total Cover		
50% of total cover: 23	20% of total cover: 9		
Woody Vine Stratum (Plot size: 15)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	75	x 2 =	150
FAC species	20	x 3 =	60
FACU species	0	x 4 =	0
UPL species	0	x 5 =	0
Column Totals:	95 (A)		210 (B)

Prevalence Index = B/A = 2.21

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- X 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 5/2	95	10YR 4/6	5	C	M	Loamy/Clayey	Prominent redox concentrations
2-7	10YR 4/1	85	7.5YR 4/6	15	C	M	Loamy/Clayey	Prominent redox concentrations
7-14	N 4/	85	10YR 4/4	15	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- X Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 1/3/2023
Applicant/Owner: State: NC Sampling Point: GWG8
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0-2
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?** **Yes** X **No**
Hydric Soil Present?	Yes X	No	
Wetland Hydrology Present?	Yes X	No	

Remarks:
Data point taken at Groundwater Gage 8.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- Surface Water (A1)
- High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- True Aquatic Plants (B14)
- Hydrogen Sulfide Odor (C1)
- X Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes	No X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	No X	Depth (inches):

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: GWG8

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
50% of total cover:	20% of total cover:		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Acer negundo*	10	Yes	FAC
2. *Fraxinus pennsylvanica*	5	Yes	FACW
3. *Taxodium distichum*	5	Yes	OBL
4.			
5.			
6.			
7.			
8.			
9.			
	20 =Total Cover		
50% of total cover: 10	20% of total cover: 4		
Herb Stratum (Plot size: 5)			
1. Unknown grass sp.	10	Yes	
2. *Rubus allegheniensis*	10	Yes	FACU
3. *Juncus effusus*	5	Yes	FACW
4. *Ranunculus repens*	5	Yes	FAC
5. *Dulichium arundinaceum*	5	Yes	OBL
6. *Solidago altissima*	5	Yes	FACU
7.			
8.			
9.			
10.			
11.			
	40 =Total Cover		
50% of total cover: 20	20% of total cover: 8		
Woody Vine Stratum (Plot size: 15)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 6 (A)

Total Number of Dominant Species Across All Strata: 9 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66.7% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	10	x 1 =	10
FACW species	10	x 2 =	20
FAC species	15	x 3 =	45
FACU species	15	x 4 =	60
UPL species	0	x 5 =	0
Column Totals:	50 (A)		135 (B)

Prevalence Index = B/A = 2.70

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- X 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG8

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 5/2	95	10YR 4/6	5	C	M	Loamy/Clayey	Prominent redox concentrations
3-10	10YR 5/2	90	10YR 4/4	10	C	M	Loamy/Clayey	Distinct redox concentrations
10-16	10YR 5/2	80	7.5YR 4/6	20	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 12/20/22
Applicant/Owner: Widlands Engineering State: NC Sampling Point: GWG9
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 1-2
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?** **Yes** X **No**
Hydric Soil Present?	Yes X	No	
Wetland Hydrology Present?	Yes X	No	

Remarks:
Data point taken at Groundwater Gage 9.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- X High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- True Aquatic Plants (B14)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes X	No	Depth (inches): 11
Saturation Present? (includes capillary fringe)	Yes X	No	Depth (inches): 11

Wetland Hydrology Present? **Yes** X **No**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
No hydrology present at well.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: GWG9

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
50% of total cover:	20% of total cover:		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Fraxinus pennsylvanica*	5	Yes	FACW
2. *Acer negundo*	5	Yes	FAC
3. *Nyssa sylvatica*	5	Yes	FAC
4.			
5.			
6.			
7.			
8.			
9.			
	15 =Total Cover		
50% of total cover: 8	20% of total cover: 3		
Herb Stratum (Plot size: 5)			
1. Unknown grass sp.	35	Yes	
2. *Solidago altissima*	25	Yes	FACU
3. *Ranunculus repens*	10	No	FAC
4. *Solidago altissima*	5	No	FACU
5. *Rubus argutus*	5	No	FACU
6.			
7.			
8.			
9.			
10.			
11.			
	80 =Total Cover		
50% of total cover: 40	20% of total cover: 16		
Woody Vine Stratum (Plot size: 15)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 60.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	5	x 2 =	10
FAC species	20	x 3 =	60
FACU species	35	x 4 =	140
UPL species	0	x 5 =	0
Column Totals:	60 (A)		210 (B)

Prevalence Index = B/A = 3.50

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG9

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	2.5Y 4/3	100					Loamy/Clayey	
4-13	2.5Y 6/3	75	7.5YR 5/6	25	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- X Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 12/20/22
Applicant/Owner: Widlands Engineering State: NC Sampling Point: GWG10
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): Local relief (concave, convex, none): floodplain Slope (%): 1%<
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?** **Yes** **No** X
Hydric Soil Present?	Yes	No X	
Wetland Hydrology Present?	Yes	No X	

Remarks:
Data point at Groundwater Gage 10. Located in Crooked Creek floodplain. No hydrology or hydric soil indicators present.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- Surface Water (A1)
- High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- True Aquatic Plants (B14)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes	No X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	No X	Depth (inches):

Wetland Hydrology Present? **Yes** **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
No hydrology indicators.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: GWG10

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
50% of total cover:	20% of total cover:		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Acer negundo*	25	Yes	FAC
2. *Celtis laevigata*	15	Yes	FACW
3. *Fraxinus pennsylvanica*	10	Yes	FACW
4.			
5.			
6.			
7.			
8.			
9.			
	50 =Total Cover		
50% of total cover: 25	20% of total cover: 10		
Herb Stratum (Plot size: 5)			
1. *Solidago altissima*	30	Yes	FACU
2. Unknown grass sp.	10	Yes	
3. *Lamium purpureum*	5	No	UPL
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	45 =Total Cover		
50% of total cover: 23	20% of total cover: 9		
Woody Vine Stratum (Plot size: 15)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 60.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	25	x 2 =	50
FAC species	25	x 3 =	75
FACU species	30	x 4 =	120
UPL species	5	x 5 =	25
Column Totals:	85 (A)		270 (B)

Prevalence Index = B/A = 3.18

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG10

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-3	7.5YR 4/3	100					Loamy/Clayey	
3-7	2.5Y 5/4	85	7.5YR 5/6	15	C	M	Loamy/Clayey	Prominent redox concentrations
7-13	2.5Y 6/4	55	7.5YR 5/8	40	C	M	Loamy/Clayey	Prominent redox concentrations
			2.5Y 6/1	15	D	M		

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region
See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R

OMB Control #: 0710-xxxx, Exp: Pending
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Crooked Creek Mitigation Site City/County: Union Sampling Date: 12/20/22
Applicant/Owner: Widlands Engineering State: NC Sampling Point: GWG11
Investigator(s): Ian Eckardt & Ella Wickliff Section, Township, Range:
Landform (hillside, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 1-2
Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: Long: Datum: NAD83
Soil Map Unit Name: NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes X No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?** **Yes** **No** X
Hydric Soil Present?	Yes X	No	
Wetland Hydrology Present?	Yes	No X	

Remarks:
Data point at Groundwater Gage 11. F19 soils present but weak hydrology.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- Surface Water (A1)
- High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- True Aquatic Plants (B14)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes	No X	Depth (inches):
Water Table Present?	Yes	No X	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	No X	Depth (inches):

Wetland Hydrology Present? **Yes** **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: GWG11

Tree Stratum (Plot size: 30)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	=Total Cover		
50% of total cover:	20% of total cover:		
Sapling/Shrub Stratum (Plot size: 15)			
1. *Platanus occidentalis*	30	Yes	FACW
2. *Acer negundo*	20	Yes	FAC
3. *Betula nigra*	10	No	FACW
4. *Taxodium distichum*	5	No	OBL
5.			
6.			
7.			
8.			
9.			
	65 =Total Cover		
50% of total cover: 33	20% of total cover: 13		
Herb Stratum (Plot size: 5)			
1. Unknown grass so.	60	Yes	
2. *Ranunculus repens*	15	No	FAC
3. *Solidago altissima*	5	No	FACU
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	80 =Total Cover		
50% of total cover: 40	20% of total cover: 16		
Woody Vine Stratum (Plot size: 15)			
1.			
2.			
3.			
4.			
5.			
	=Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66.7% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	5	x 1 =	5
FACW species	40	x 2 =	80
FAC species	35	x 3 =	105
FACU species	5	x 4 =	20
UPL species	0	x 5 =	0
Column Totals:	85 (A)		210 (B)

Prevalence Index = B/A = 2.47

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: GWG11

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	2.5Y 4/3	100					Loamy/Clayey	
4-8	2.5Y 4/3	90	7.5YR 4/6	10	C	M	Loamy/Clayey	Prominent redox concentrations
8-15	2.5Y 6/3	80	10YR 4/6	20	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Mucky Mineral (F1) **(MLRA 136)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 122, 136)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- X Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
- ___ Very Shallow Dark Surface (F22)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

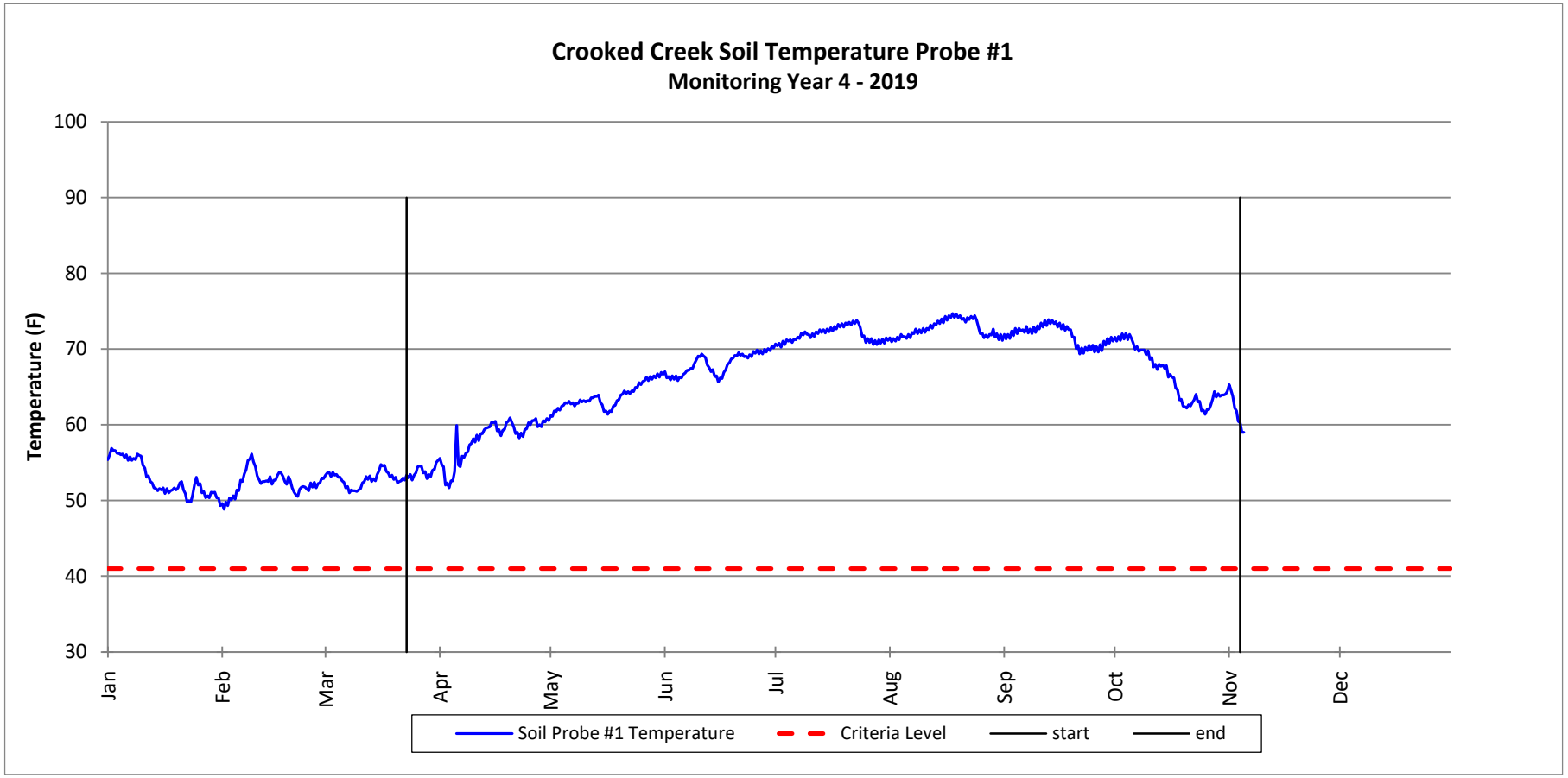
Hydric Soil Present? **Yes** X **No** ___

Remarks:

APPENDIX 7. Hydrology Data with Adjusted Growing Season and Soil Temperature Data

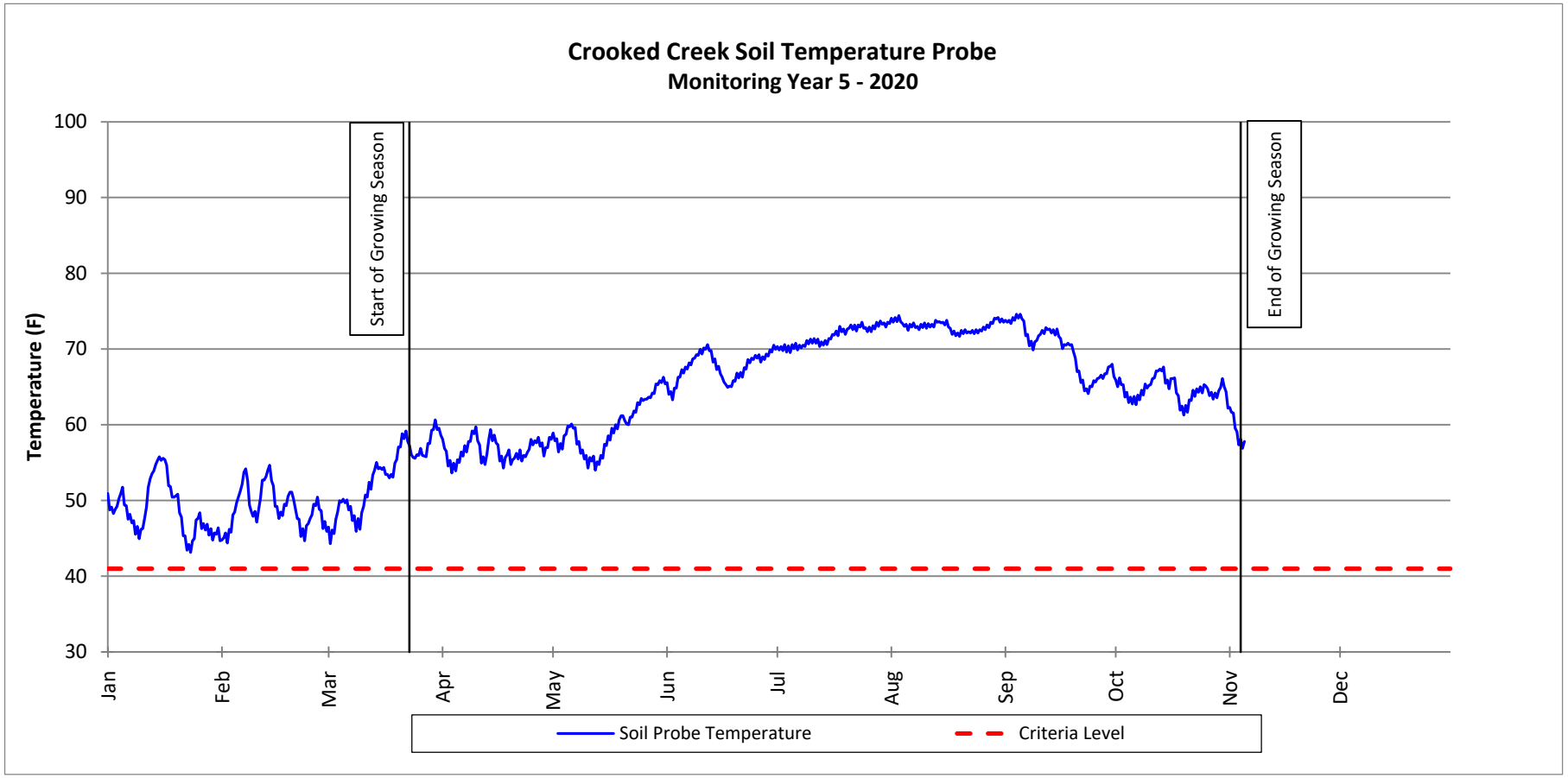
Soil Temperature Probe Plots

Crooked Creek #2 Restoration Project
(DMS Project No. 94687)
Wetland Restoration Zone A
Monitoring Year 4 - 2019



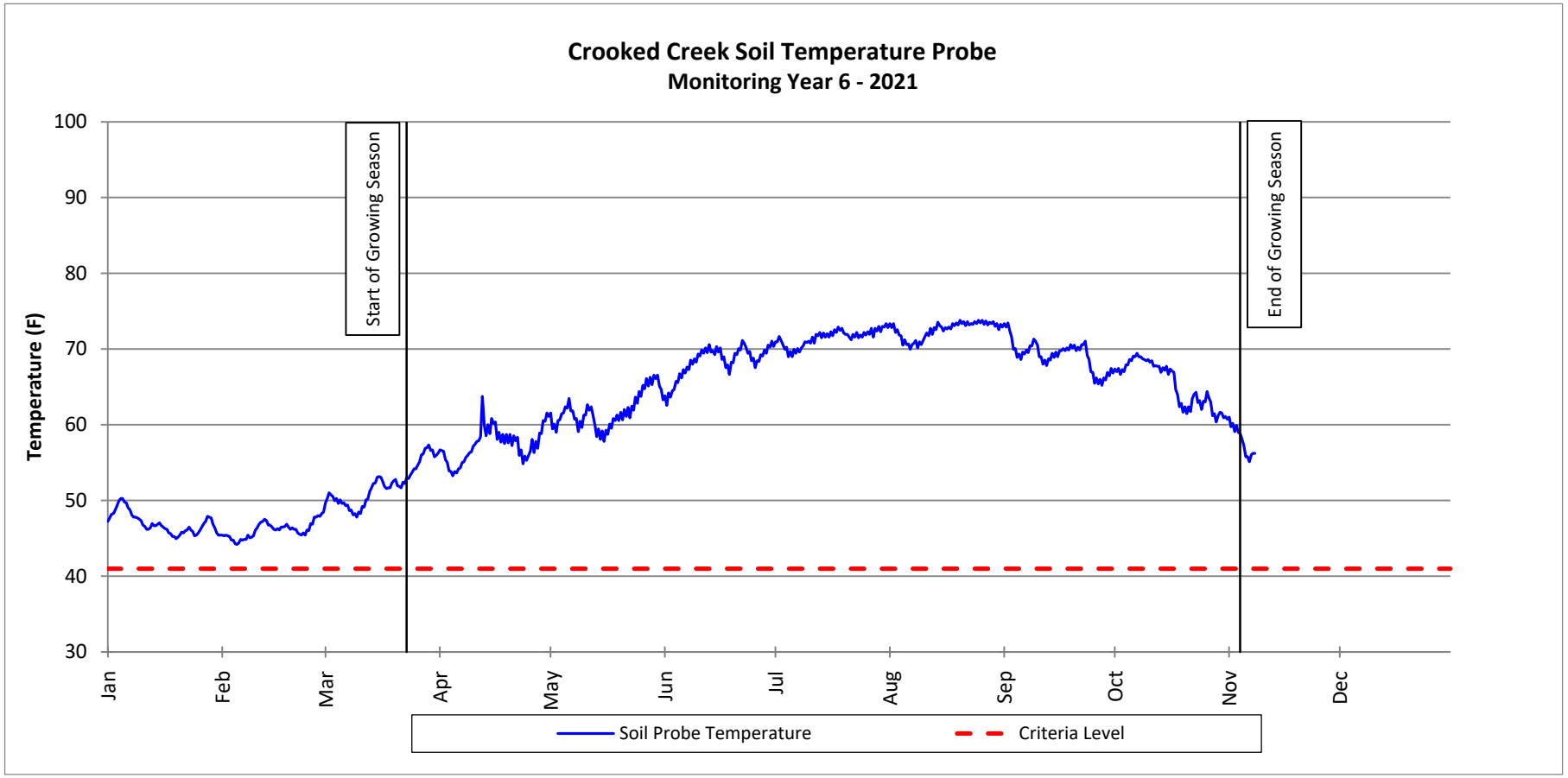
Soil Temperature Probe Plots

Crooked Creek #2 Restoration Project
(DMS Project No. 94687)
Wetland Restoration Zone A
Monitoring Year 5 - 2020



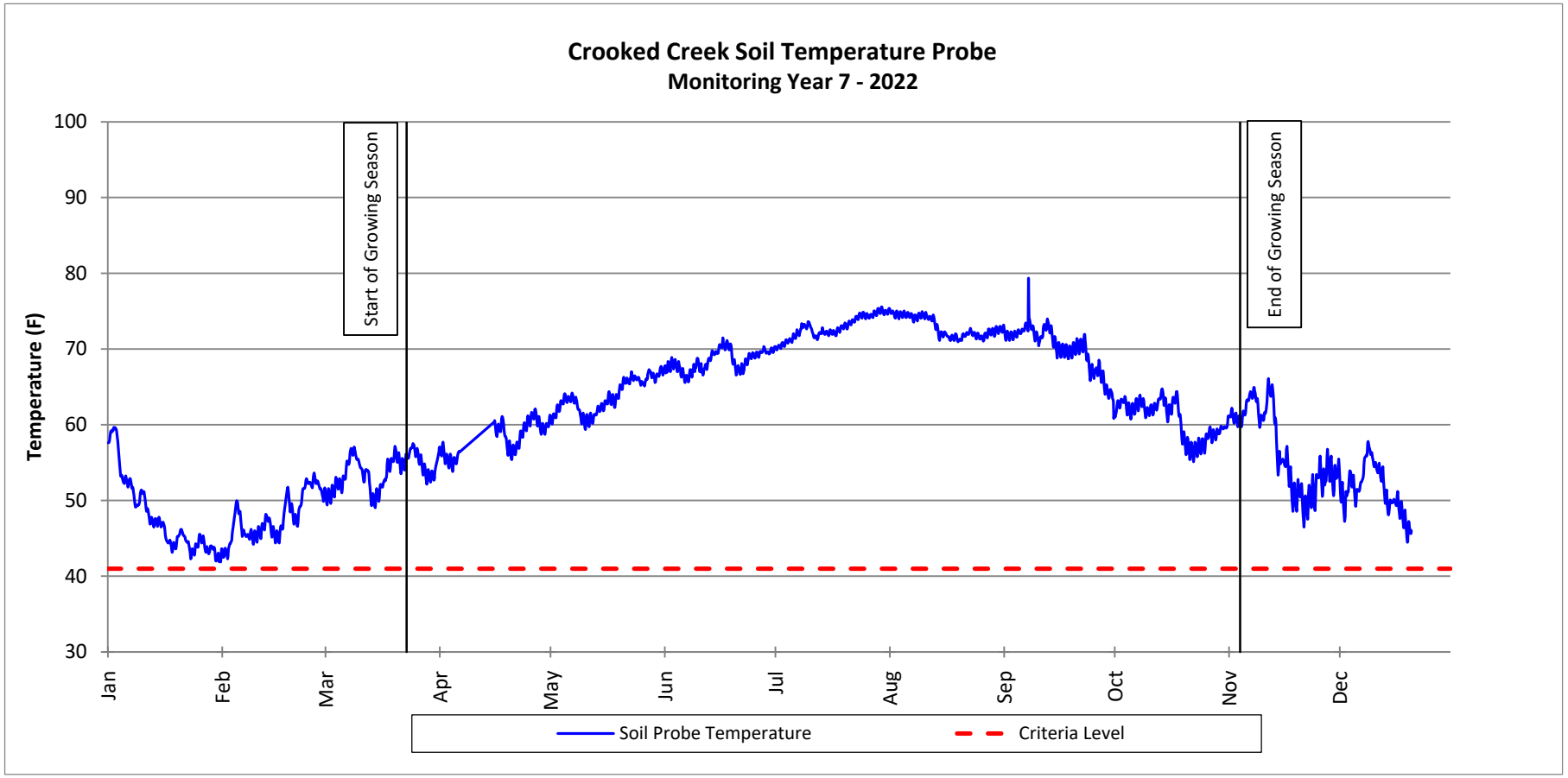
Soil Temperature Probe Plots

Crooked Creek #2 Restoration Project
(DMS Project No. 94687)
Wetland Restoration Zone A
Monitoring Year 6 - 2021



Soil Temperature Probe Plots

Crooked Creek #2 Restoration Project
(DMS Project No. 94687)
Wetland Restoration Zone A
Monitoring Year 7 - 2022



Growing Season Start Bud Burst Documentation

Bud burst documentation (3/1/2022)- photo taken at Deep Meadow Mitigation Site approximately 9 miles away from Crooked Creek Mitigation Site

Wetland Gage Attainment Summary Extended Growing Season 3/1- 11/26

Crooked Creek #2 Restoration Project

DMS Project No. 964687

Monitoring Year 7 - 2022

Summary of Groundwater Gage Results for Monitoring Years 1 through 7							
Gage	**Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)**						
	MY1 (2016)	**MY2 (2017)**	**MY3 (2018)**	**MY4 (2019)**	**MY5 (2020)**	**MY6 (2021)**	**MY7 (2022)**
1	No/6 Days (2.2%)	No/9 Days (3.3%)	Yes/34 Days (12.6%)	Yes/23 Days (8.5%)	Yes/ 33 Days (12.2%)	Yes/ 20 Days (7.5%)	Yes/ 27 Days (10%)
2	No/4 Days (1.5%)	No/9 Days (3.3%)	Yes/35 Days (13.0%)	Yes/23 Days (8.5%)	Yes/ 33 Days (12.2%)	Yes/ 21 Days (7.7%)	Yes/ 28 Days (10%)
3	No/10 Days (3.7%)	No/13 Days (4.8%)	Yes/51 Days (18.9%)	Yes/56 Days (20.7%)	Yes/ 36 Days (13.3%)	Yes/ 41 Days (15.1%)	Yes/ 58 Days (21.4%)
4	No/2 Days (0.7%)	No/6 Days (2.2%)	Yes/51 Days (18.9%)	No/18 Days (6.7%)	No/ 14 Days (5.2%)	No/ 17 Days (6.3%)	No/ 18 Days (6.6%)
5	No/2 Days (0.7%)	No/7 Days (2.6%)	Yes/32 Days (11.9%)	Yes/23 Days (8.5%)	Yes/ 34 Days (12.5%)	Yes/ 36 Days (13.3%)	Yes/ 27 Days (10%)
6	Yes/48 Days (17.8%)	Yes/75 Days (27.8%)	Yes/110 Days (40.7%)	Yes/89 Days (33.0%)	Yes/139 Days (51.3%)	Yes/ 36 Days (13.3%)	Yes/ 44 Days (16.2%)
7	Yes/40 Days (14.8%)	Yes/47 Days (17.4%)	Yes/67 Days (24.8%)	Yes/78 Days (28.9%)	Yes/ 77 Days (28.4%)	Yes/ 52 Days (19.2%)	Yes/ 61 Days (22.5%)
8	Yes/36 Days (13.3%)	Yes/31 Days (11.5%)	Yes/67 Days (24.8%)	Yes/57 Days (21.1%)	Yes/ 74 Days (27.3%)	Yes/ 48 Days (17.7%)	Yes/ 48 Days (17.7%)
9	No/4 Days (1.5%)	No/7 Days (2.6%)	Yes/35 Days (13.0%)	Yes/31 Days (11.5%)	Yes/ 34 Days (12.5%)	No/ 21 Days (7.7%)	No/ 27 Days (10%)
10	No/2 Days (0.7%)	No/11 Days (4.1%)	Yes/31 Days (11.5%)	Yes/23 Days (8.5%)	No/ 15 Days (5.5%)	No/ 18 Days (6.6%)	No/ 13 Days (4.8%)
11*					No/ 14 Days (5.2%)	No/ 8 Days (3.0%)	No/ 18 Days (6.6%)

Growing season 3/1/2022- 11/26/2022, success criteria is 20 days.

* GWG11 installed 3/27/2020

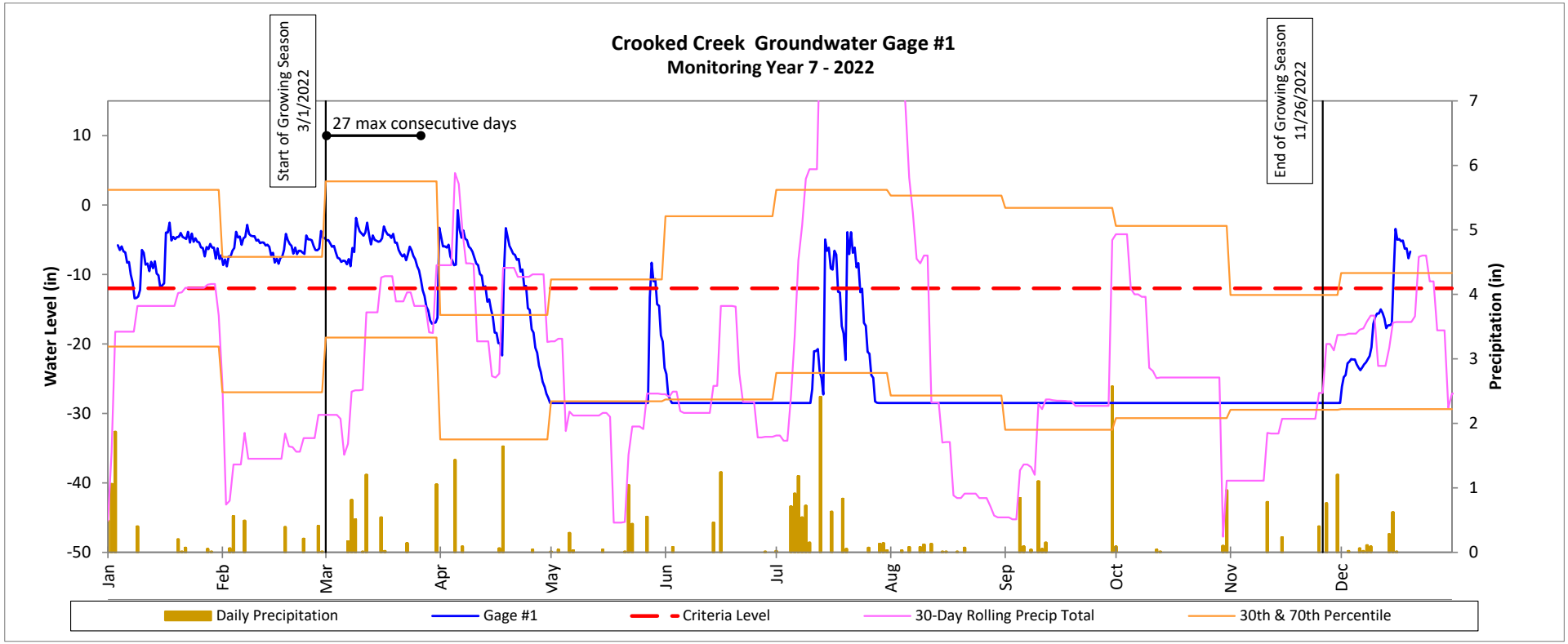
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Restoration



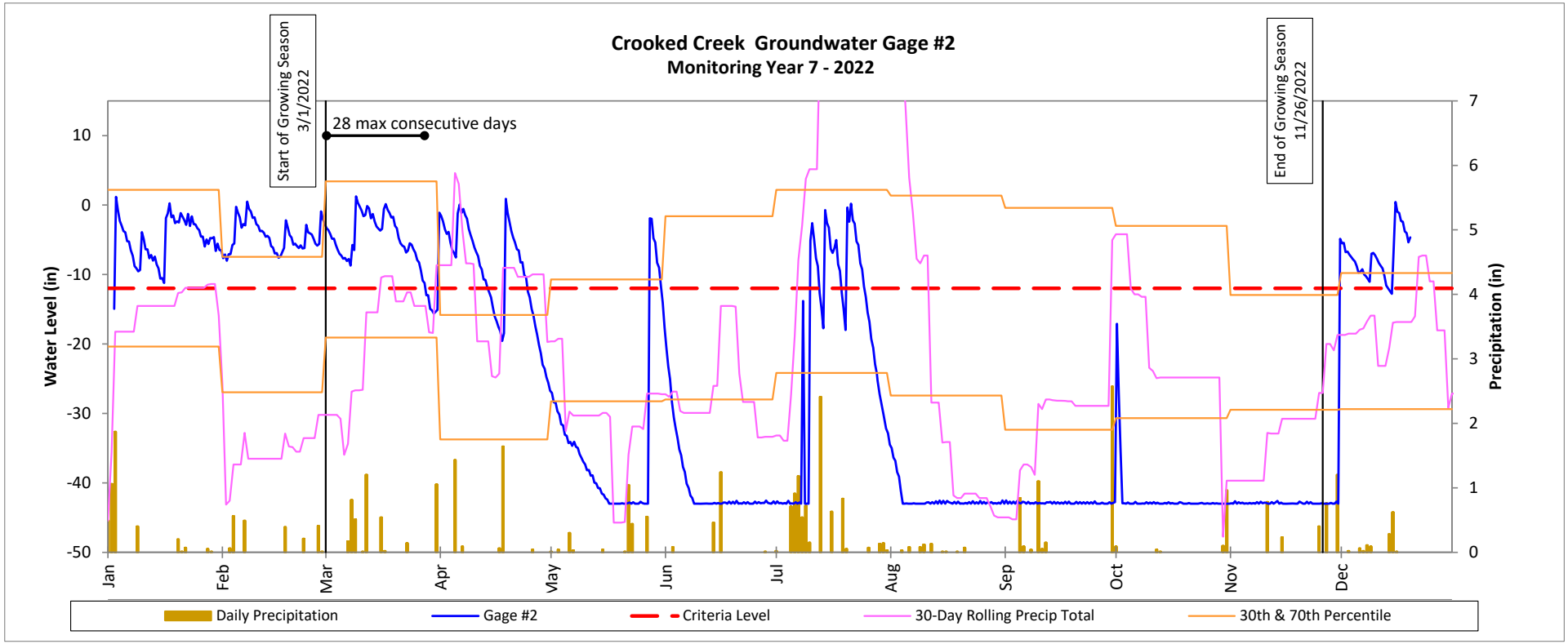
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Restoration



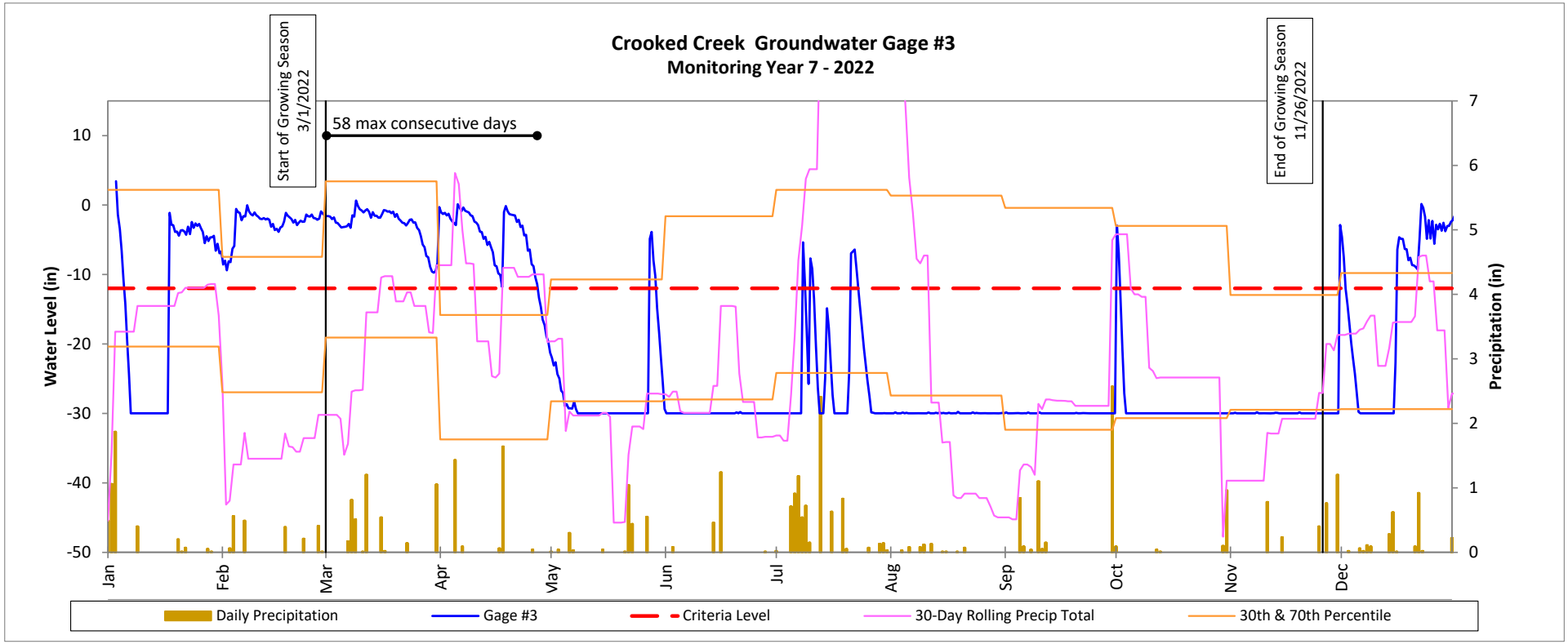
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Restoration



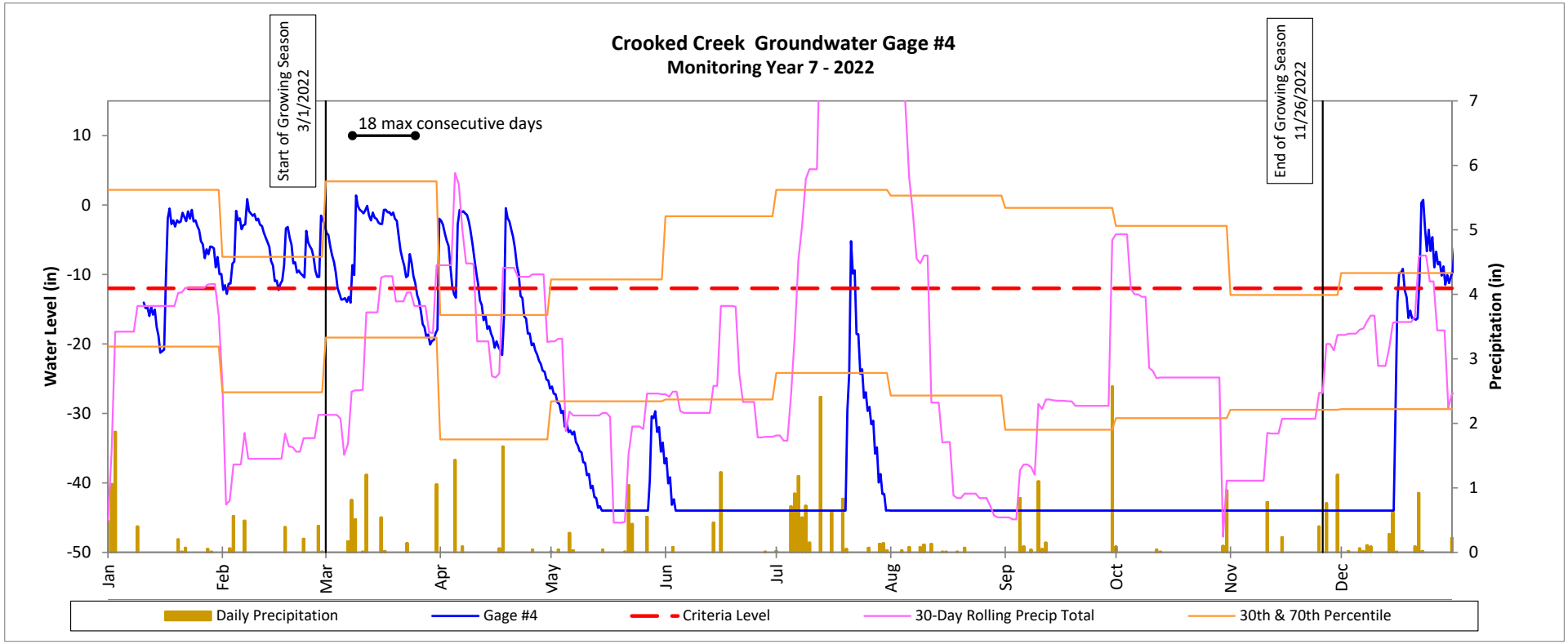
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Restoration



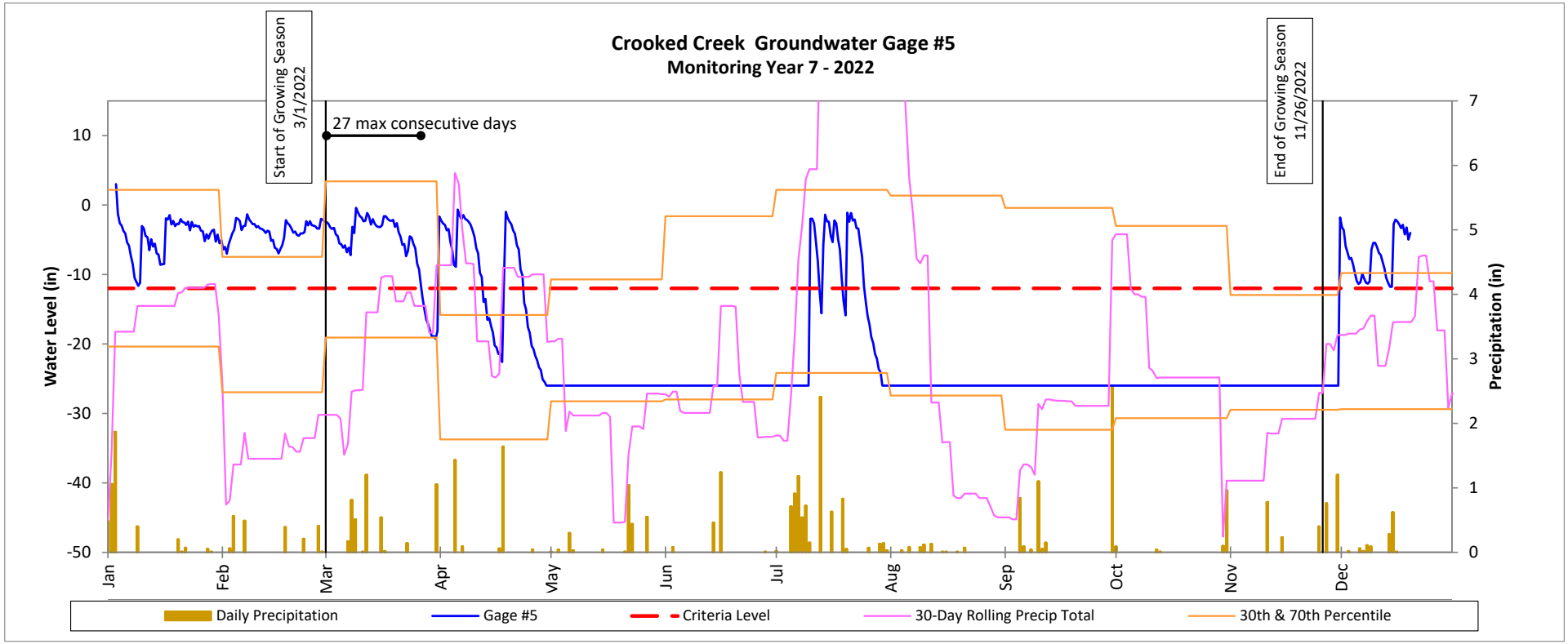
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Creation



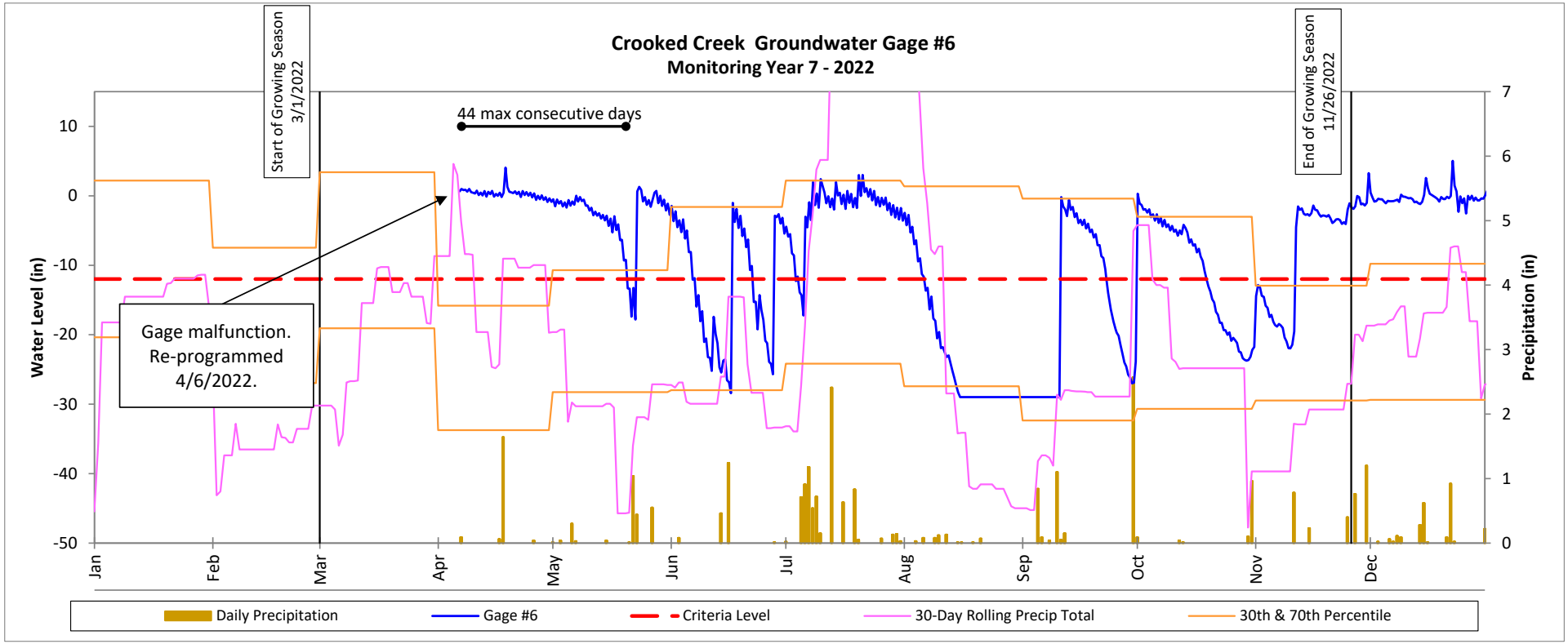
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Restoration



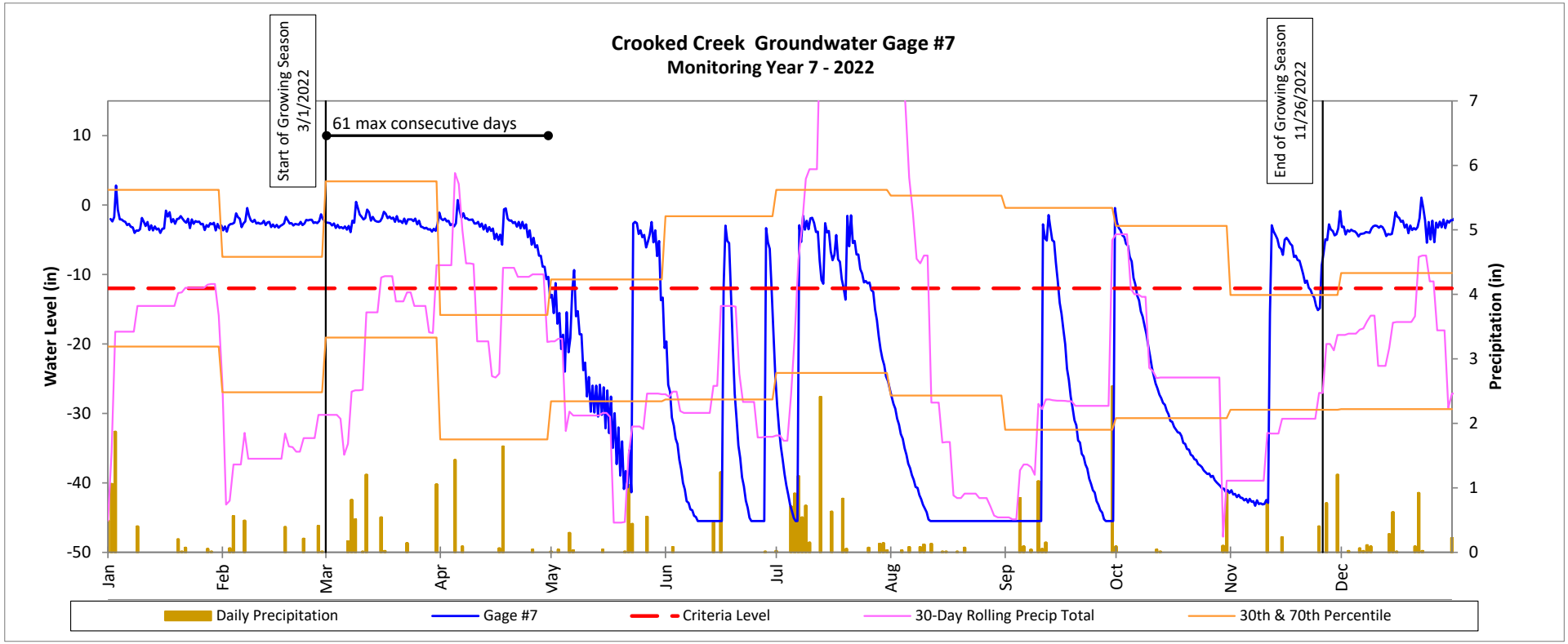
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Restoration



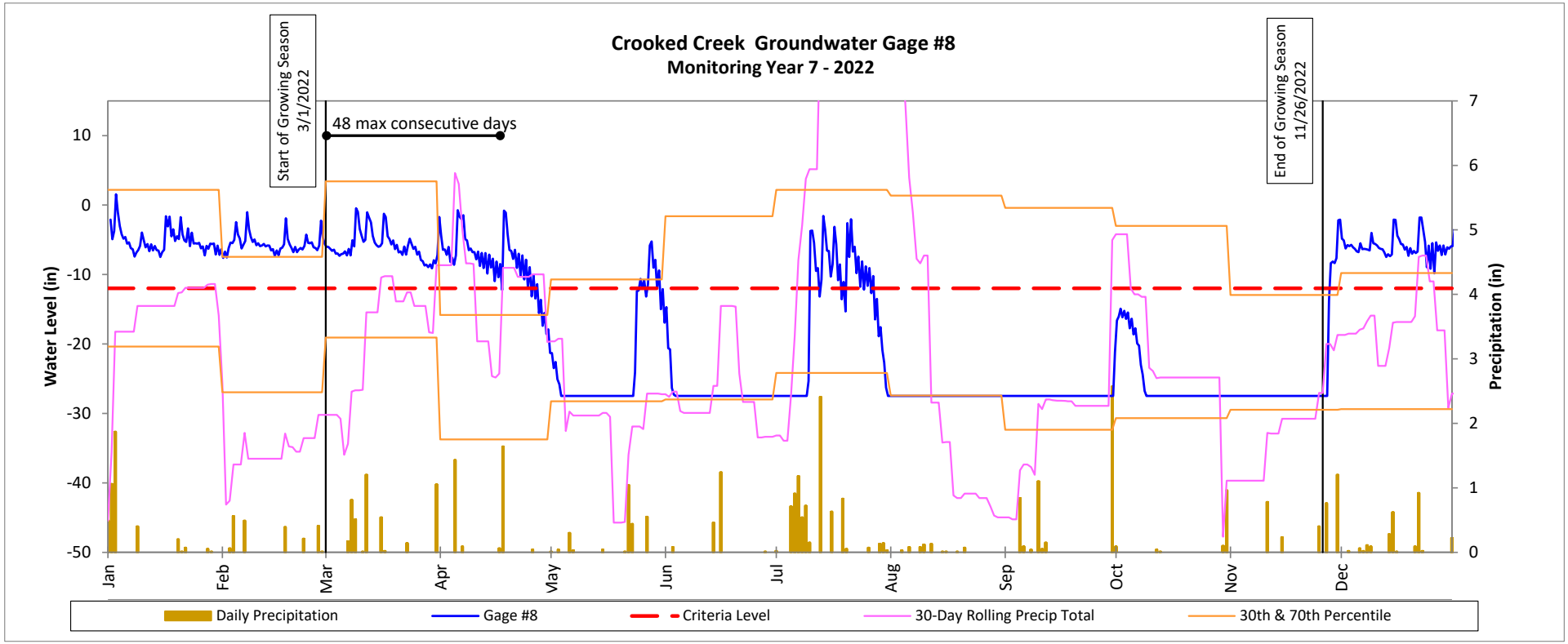
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Creation



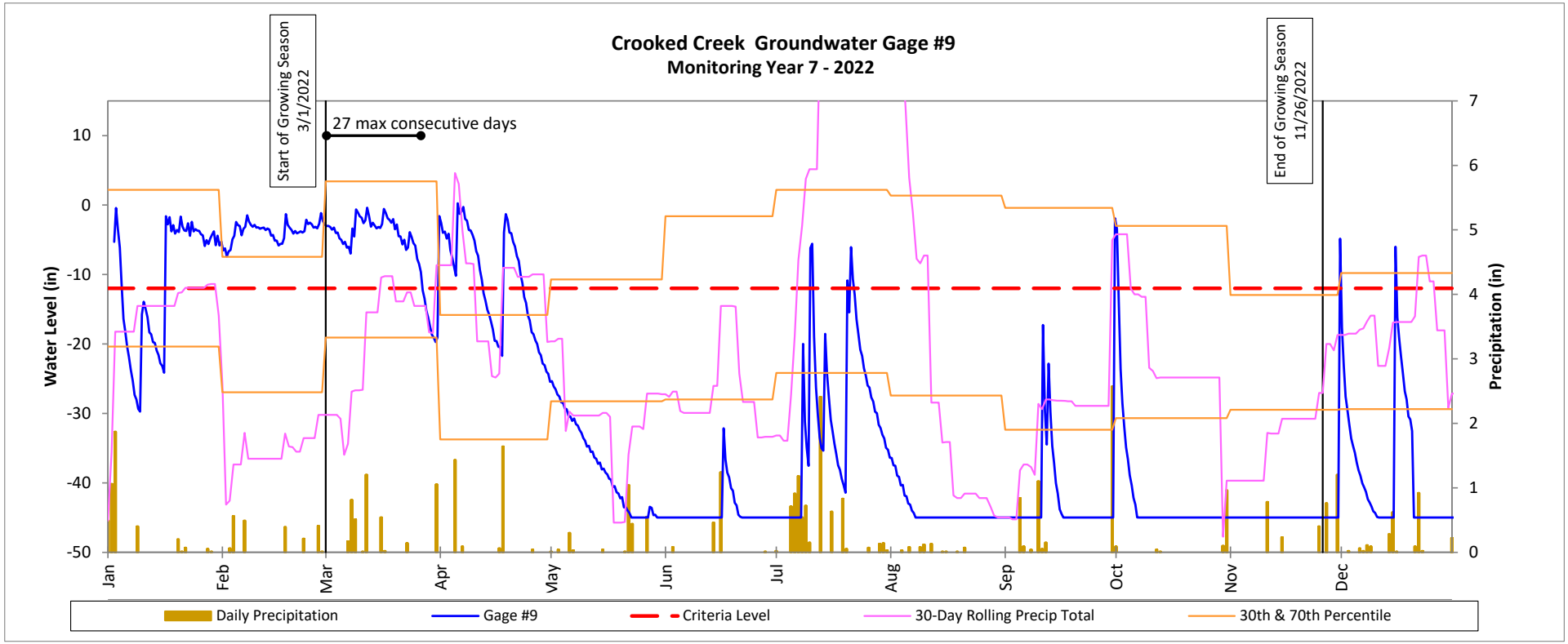
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Creation



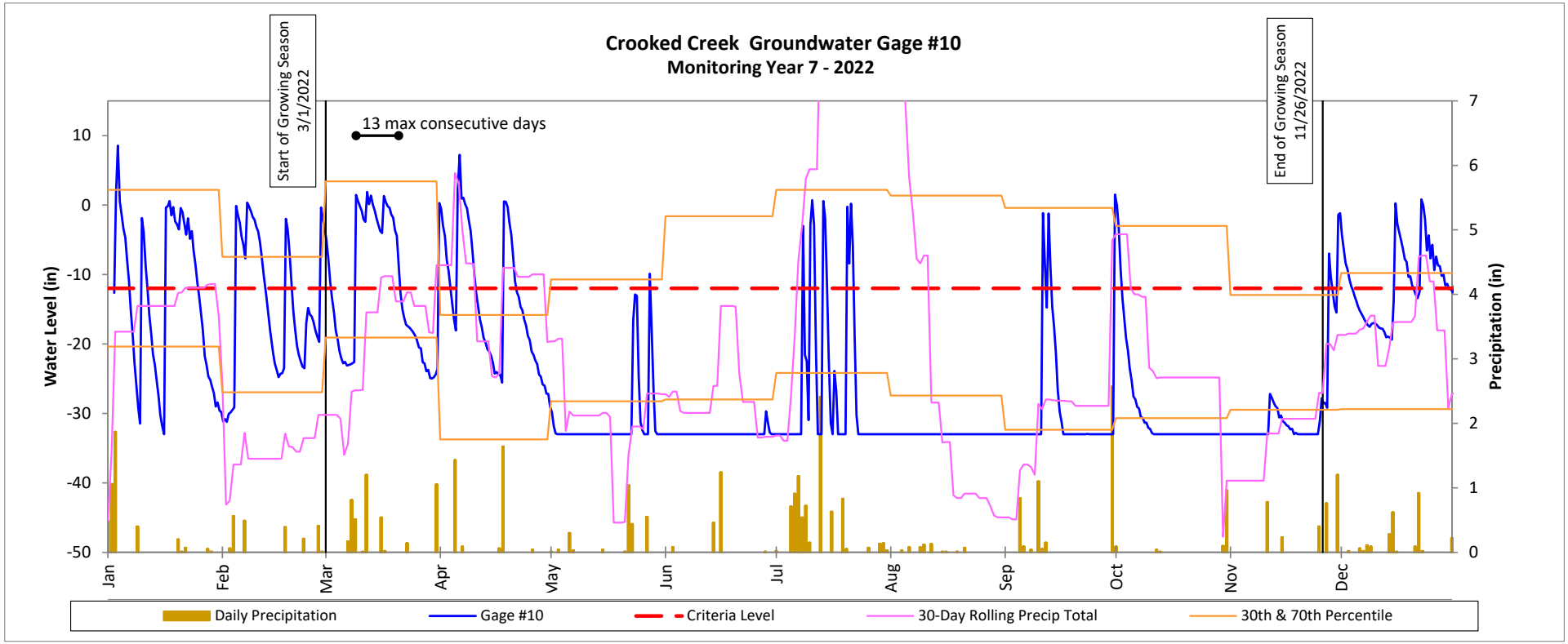
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Creation



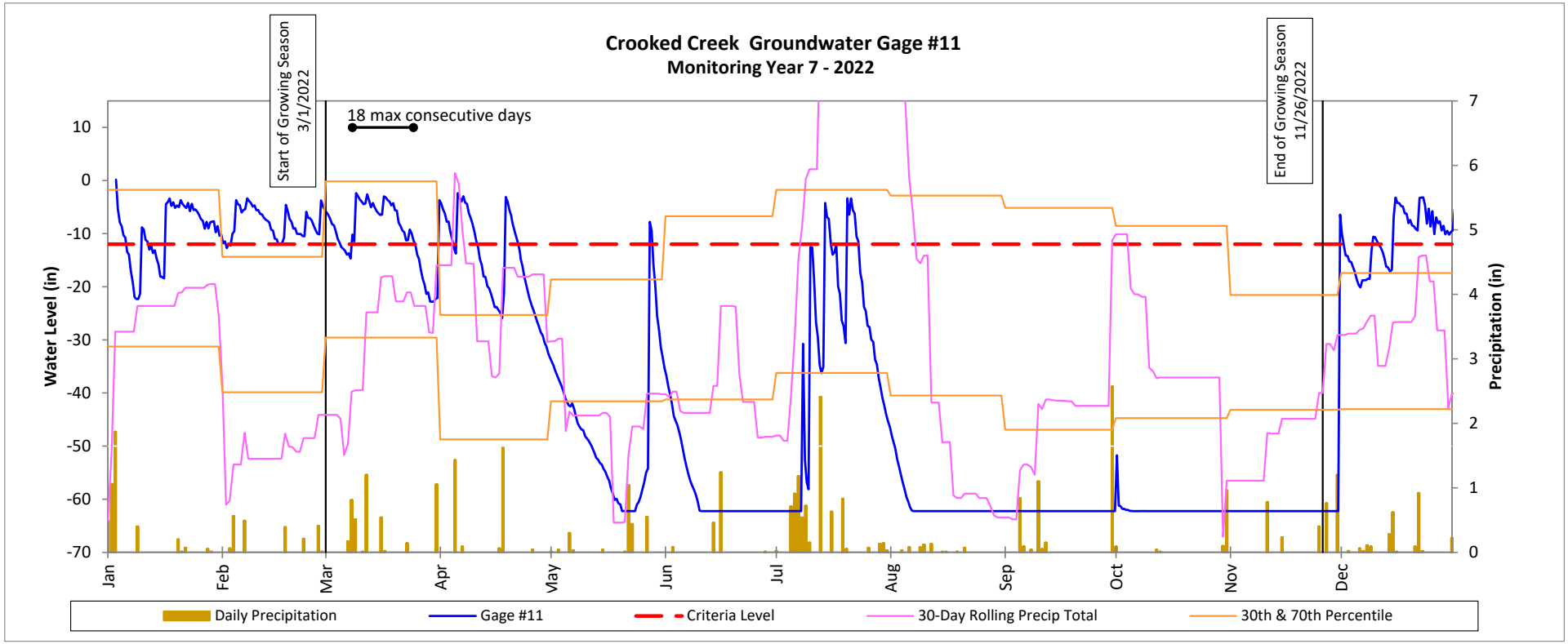
Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 7 - 2022

Wetland Wetland Creation



APPENDIX 8. Crooked Creek II Buffer Closeout Letter

ROY COOPER
Governor
ELIZABETH S. BISER
Secretary
S. DANIEL SMITH
Director

NORTH CAROLINA
Environmental Quality

September 15, 2021

Division of Mitigation Services
Attn: Melonie Allen
(via electronic mail: melonie.allen@ncdenr.gov)

DWR Project # 2012-0064v1
Union County

Re: **Crooked Creek II Site**
DMS ID #94687 –CLOSEOUT ACCEPTANCE LETTER

Dear Ms. Allen,

On August 30, 2021, the Division of Water Resources (DWR) received a close-out packet from you on behalf of the Division of Mitigation Services (DMS) requesting approval to close-out the subject site for monitoring and maintenance of the riparian areas where riparian buffer credit is generated. On September 15, 2021, Katie Merritt with DWR reviewed site documents with you and determined that a site visit would not be necessary to close out the site. The asset map and asset table, both initialed by Ms. Merritt on September 15, 2021, are attached.

DWR has reviewed the close-out request and the following is approved:

River Basin/Service Area	Mitigation Type	Credit Type	Mitigation Ratio	*Mitigation Units/Credit	Distance from stream
Goose Creek Watershed	Riparian Enhancement	Buffer	3:1	8,400.33 ft^2	unknown
Goose Creek Watershed	Riparian Restoration	Buffer	1:1	45,735 ft^2	unknown
TOTAL				**54,135.33 ft^2**	

Please feel free to contact Ms. Merritt at (919) 707-3637 if you have any questions regarding this correspondence.

Sincerely,

DocuSigned by:
Paul Wojoski
949D91BA53EF4E0...

Paul Wojoski, Supervisor
401 & Buffer Permitting Branch

ATTACHMENTS: Project Components Table, Project Component Map

cc: File Copy –Katie Merritt (DWR)

KPM 9-15-21

Project Components and Mitigation/Buffer Credits

Table 1. Project Components and Mitigation Credits

Crooked Creek #2 Restoration Project Site
DMS Project No. 94687
Monitoring Year 5 - 2020

Mitigation Credits

	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer (sqft)	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	3,242.2	N/A	7.900	0.500	N/A	N/A	54,135.33	N/A	

Project Components

Reach ID	As-Built Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration or Restoration Equivalent	Restoration Footage/ Acreage	Mitigation Ratio	Credits[1] (SMU/ WMU)
STREAMS							
Crooked Creek Reach A	202+20-215+55	1,555 LF	N/A	Enhancement II	1,335	2.5:1	534.000
Crooked Creek Reach B	215+55-236+78	2,404 LF	N/A	Enhancement II	2,123	2.5:1	849.200
UT1	100+47-117+18	1,762 LF	P1	Restoration	1,671	1:1	1,671.000
UT2	300+00-305+60	470 LF	N/A	Enhancement II	470	2.5:1	188.000
WETLANDS							
Zone A (Drained Hydric Soils)	N/A	0.7 AC		Enhancement	0.7	2:1	0.350
Zone A (Drained Hydric Soils)	N/A	N/A		Restoration	6.6	1:1	6.600
Zone B	N/A	0.3 AC		Enhancement	0.3	2:1	0.150
Zone B	N/A	N/A		Creation	3.9	3:1	1.300
BUFFER							
Goose Creek Buffer	N/A	25,201 sqft		Enhancement	25,201 sqft	3:1	8,400.33 sqft
Goose Creek Buffer	N/A	N/A		Restoration	45,735 sqft	1:1	45,735 sqft

Component Summation

Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	1,671	6.6			45,735	
Enhancement		1.0			25,201	
Enhancement I						
Enhancement II	3,928					
Creation		3.9				

1 No credit generated where only one side of stream is buffered per email from Harry Tsomides dated October 15, 2018.

2 UT1 rediting starts at the outer edge of the powerline right-of-way along Hwy 218; Crooked Creek assets have been reduced to account for one-side easement sections at upstream and downstream ends.

Kym 9-15-21

Project Asset Map

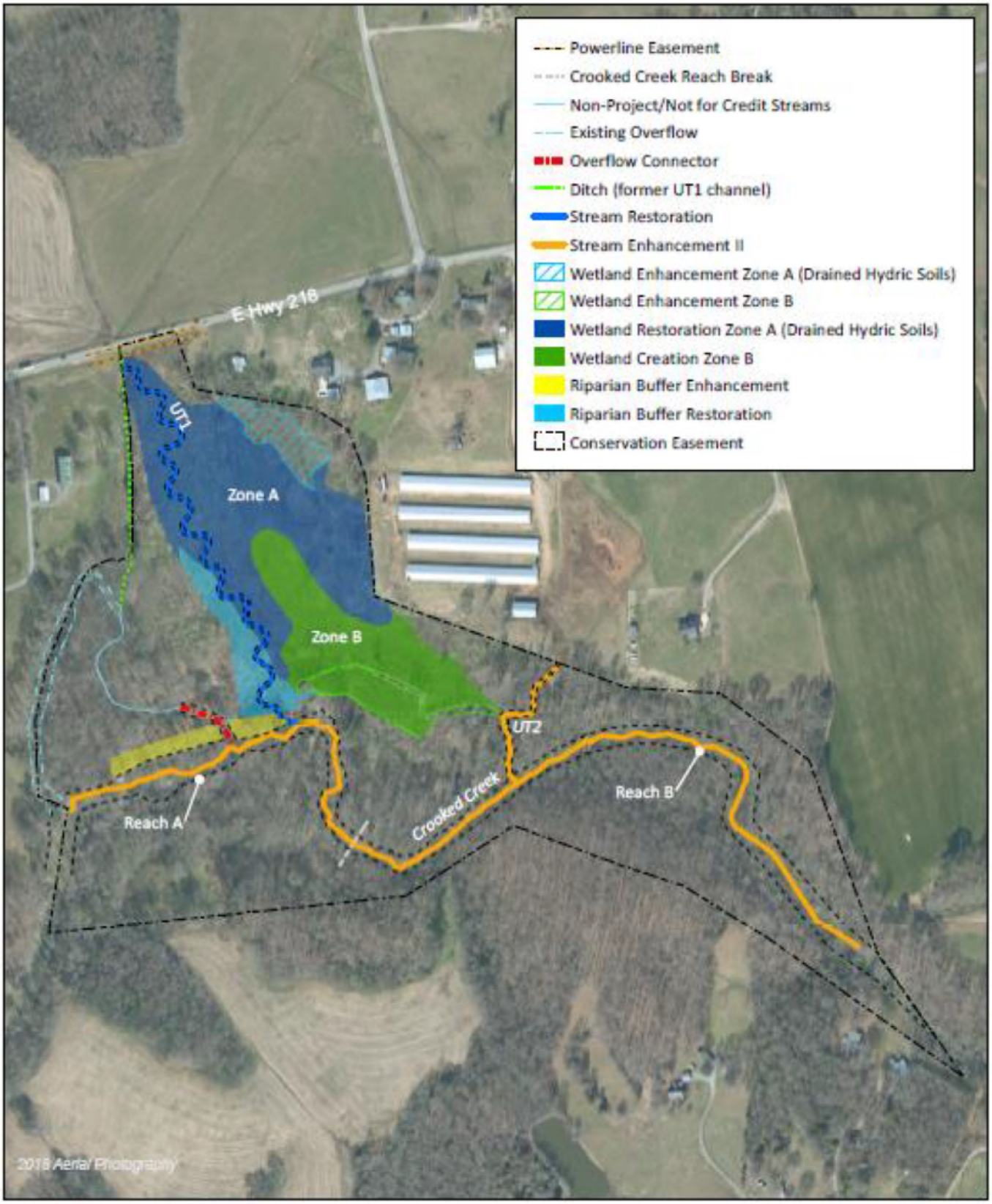


Figure 2 Project Component/Asset Map
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 5 - 2020
Union County, NC