MONITORING YEAR 6 ANNUAL/CLOSEOUT REPORT

Final

GLADE CREEK II RESTORATION PROJECT

Alleghany County, NC
DWR No. 20090049 v.2
DMS Project Number 92343
USACE Action ID 2009-00589

Data Collection Period: June - October 2021
Draft Submission Date: November 23, 2021
Final Submission Date: December 10, 2021

PREPARED FOR:

NC Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

PREPARED BY:

Wildlands Engineering, Inc.
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Phone: 704.332.7754
Fax: 704.332.3306

December 10, 2021

Mr. Harry Tsomides
NC Department of Environmental Quality
Division of Mitigation Services
5 Ravenscroft Dr., Suite 102
Asheville, NC 28801

RE: Monitoring Year 6 (MY6) Report – Draft Submittal
Glade Creek II Mitigation Project
DMS Project # 92343
Contract Number 6843
New River Basin - CU# 05050001 - Alleghany County, North Carolina

Dear Mr. Tsomides:

Wildlands Engineering, Inc. (Wildlands) has reviewed the Division of Mitigation Services (DMS) comments from the Draft Monitoring Year 6 report for the Glade Creek II Mitigation Project. DMS's comments are noted below in **bold**. Wildlands' responses to those comments are noted in *italics*.

DMS comment: In the close out summary, please note that DMS and DEQ-Stewardship have recently assessed the easement and boundary conditions, made minor upgrades to markings and posting, and DEQ stewardship has unofficially accepted the site for transfer.

Wildlands response: The above text has been added to the close out summary in the executive summary and section 1.3.

DMS comment: Executive summary indicates adjacent land being used for white pine production. This is no longer the case.

Wildlands response: This sentence has been omitted from the executive summary.

DMS comment: Aerial photos appear washed out/yellow on the hard copies. If possible, please remove any opaque filtering and/or improve the print quality

Wildlands response: The transparency for the aerial imagery has been reduced to 0% to create a darker background in Figures 2 and 3.

DMS comment: DMS hopes to close out this project in 2022; that said, DMS would like to thank Wildlands for an outstanding job in their assessment, reporting, communicating with DMS, being proactive and prompt, and helping capture all the project activities and details over the years on this DBB project. DMS sincerely appreciates all of Wildlands efforts.

Wildlands response: Thank you for your feedback and kind words. Wildlands has enjoyed working with DMS as well and appreciated the opportunity to work on this monitoring project.

Enclosed please find two (2) hard copies and one (1) electronic copy on CD of the Final Monitoring Report and all digital support files. Please contact me at 704-941-9093 if you have any questions.

Sincerely,

Kirsten Y. Gimbert
Project Manager
kgimbert@wildlandseng.com

EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) completed design and construction management on a design-bid-build project at the Glade Creek II Restoration Site (Site) for the North Carolina Division of Mitigation Services (DMS) in Alleghany County, NC. The project components included restoring and enhancing 2,579 linear feet (LF) and preserving 129 LF of perennial stream, restoring 0.16 acre of wetlands, and preserving 0.84 acre of existing wetland. Riparian buffers were also established by removing exotic invasive plants and installing a variety of native vegetation. The Site is expected to generate 2,166.467 stream mitigation units (SMUs) and 0.328 wetland mitigation units (WMUs) for the Glade Creek watershed (Table 1). The Site is located off US Highway 21 in the northern portion of Alleghany County, NC in the New River Basin, eight-digit Hydrologic Unit Code (HUC) 05050001 and the 14-digit HUC 05050001030020 (Figure 1). The project streams consist of one unnamed tributary, UT to Glade Creek, and two reaches along Glade Creek mainstem (Reach 1 and Reach 2) (Figure 2). Glade Creek flows into the Little River four miles northeast of the Site near Fox Trot Lane in the Town of Hooker, North Carolina.

The Glade Creek II Restoration Project is located within a DMS Targeted Local Watershed (TLW) (Brush Creek, HUC 05050001030020), as documented within the 2009 River Basin Restoration Priorities (RBRP) for the New River Basin. Furthermore, the project site is located within Middle Glade Creek, a priority subwatershed for stream and wetland restoration (and habitat protection), as identified within 2006 Local Watershed Plan and Preliminary Project Atlas for Little River and Brush Creek. Primary stressors within the Brush Creek TLW and the Middle Glade Creek subwatershed include stream channelization, livestock access, degraded riparian buffers, and Christmas tree farming. Glade Creek is also classified as a trout water and the project will help improve trout habitat in the watershed.

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

- Improve water quality by repairing eroding stream banks and establishing riparian buffers;
- Improve the community structure of the buffers;
- Improve stream function and habitat by re-establishing stream-to-floodplain connections;
- Restore long-term stability through the restoration of channel dimension, pattern and profile;
- Improve in-stream habitat using in-stream structures; and
- Remove exotic invasive plant species.

The Site construction was completed between December 2015 and April 2016. Planting was completed in February 2016. The as-built survey was completed in January 2016 with Monitoring Year (MY) 0 beginning in May 2016. Annual monitoring has been completed for six years since as-built/construction. This report presents the Site's MY6 assessment and data as well as a closeout summary/analysis.

Assessments completed over the past six monitoring years illustrate that the Site has met the success criteria as defined in the mitigation plan (Confluence, 2013) for vegetation, stream morphology, and stream and wetland hydrology, with the exception of a portion of UT to Glade where sediment deposition has resulted in a loss of stream function. The MY6 visual assessment revealed that invasive treatments have nearly eradicated many invasive species on the Site. In addition, wetland adaptive management activities and stream repairs that occurred in the Spring 2020 to alleviate previously identified areas of concern are performing well and have benefited the long-term ecological function of the Site.

The as-built planted stem density averaged 742 stems per acre with the MY6 vegetation assessment resulting in an average planted stem density of 398 stems per acre. This exceeds the final success

criteria of 260 stems per acre and demonstrates that the Site has established a healthy riparian buffer. Stream morphology surveys along Glade Creek throughout the six years of monitoring demonstrate that the channel is functioning as designed and dimensions are indicative of stability. The extent of sediment deposition along UT to Glade Creek has been documented with the annual pebble counts, longitudinal and cross-section surveys. Bankfull events on all reaches have been documented in each post-construction monitoring year. Therefore, the success criteria of two bankfull flow events documented on restoration reaches and occurring in separate monitoring years was met for the project in MY2. The wetland groundwater gage has consistently met the success criteria for all six monitoring years, which demonstrates that the wetland hydrology has been restored on the Site. Included in Appendix 2 are photos from MY0 and MY6 to illustrate bank stability and vegetation establishment over the course of six years of monitoring. DMS and DEQ-Stewardship have recently assessed the easement and boundary conditions, made minor upgrades to markings and posting, and DEQ stewardship has unofficially accepted the site for transfer.

GLADE CREEK II RESTORATION PROJECT

Monitoring Year 6 Annual/Closeout Report

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APPENDICES

Section 1: PROJECT OVERVIEW

The Site is a design-bid-build contract with DMS in Alleghany County, NC. The Site is located in the New River Basin, eight-digit Hydrologic Unit Code (HUC) 05050001 and the 14-digit HUC 05050001030020 (Figure 1). Located in the Blue Ridge Belt (USGS,2016), Blue Ridge physiographic province, the project watershed includes primarily agricultural and forest land uses, with a drainage area of 8.0 square miles.

The project stream reaches consist of Glade Creek and UT to Glade Creek (stream restoration). The project wetland areas consist of restoration and preservation (Wetlands A-D). Mitigation work within the Site included restoring and enhancing 2,579 LF and preserving 129 LF of perennial stream, restoring 0.16 acre of wetlands, and preserving 0.84 acre of existing wetland and proposes the generation of 2,166.467 SMUs and 0.328 WMUs. The stream and wetland areas were planted with native vegetation to improve habitat and protect water quality. Construction activities were completed by Carolina Environmental, Inc. in December 2015. Turner Land Surveying completed the as-built survey in January 2016. Storm repairs prior to end of the construction phase were completed in April 2016 and the repairs were judged to have not resulted in changes that would warrant a revised as-built survey. A 12.8-acre conservation easement was purchased in 2008 by the State of North Carolina and was recorded with Alleghany County Register of Deeds which will protect the project area in perpetuity.

Appendix 1 includes detailed project activity, history, contact information, and watershed/site background information. Directions and a map of the Site are provided in Figure 1. Project components are illustrated in Figure 2 while Table 1 outlines the project component and mitigation credit information for the Site.

1.1 Project Goals and Objectives

Prior to construction, the streams had been impacted by historic agricultural practices, silviculture and valley filling. In addition, there was widespread bank erosion, especially along the outside meander bends, and mid-channel deposition. The wetlands had been impacted by vegetation clearing, the establishment of exotic invasive plant species, and the burial of the hydric soils layer from historic valley fill. Table 4 in Appendix 1 and Tables 6a and 6b in Appendix 2 present the pre- and post-restoration conditions in detail.

This mitigation site is intended to provide numerous ecological benefits within the New River Basin and addresses habitat degradation, which is the primary water quality stressor described in the New River RBRP (2009). While many of the benefits are limited to the immediate 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. These project goals were met by giving careful consideration to the goals and objectives described in the RBRP.
The project specific goals of the Glade Creek II Restoration Site included the following:

- Improve water quality by repairing eroding stream banks and establishing riparian buffers;
- Improve the community structure of the buffers;
- Improve stream function and habitat by re-establishing stream-to-floodplain connections;
- Restore long-term stability through the restoration of channel dimension, pattern and profile;
- Improve in-stream habitat using in-stream structures; and
- Remove exotic invasive plant species.

The project objectives have been defined as follows:

- Restoration and enhancement of approximately 2,260 LF of Glade Creek;
- Restoration of 319 LF of the UT to Glade Creek;
- Preservation of 129 LF of UT to Glade Creek;
- Restoration of 0.16 acre of wetland by improving hydrologic connections;
- Preservation of 0.84 acre of existing jurisdictional wetland; and
- Establishment of riparian buffers by removing exotic invasive plants and installing a variety of native vegetation.

The stream and wetland performance criteria for the Site follow approved performance standards presented in the Glade Creek II Restoration Plan (Ward, 2008). Annual monitoring and semi-annual site visits were conducted to assess the condition of the finished project. The stream restoration and enhancement reaches (Glade Creek and UT to Glade Creek) of the project were assigned specific performance standards for stream morphology, hydrology, and vegetation. Wetland restoration areas were assigned specific performance standards for wetland hydrology and vegetation. The Glade Creek Stream Restoration Project was instituted prior to 7/28/2010; therefore, the Site was grandfathered in to be monitored for a minimum of five years post-construction. An additional year of monitoring (MY6) occured in 2021 to further assess repairs, with the Site anticipated to be presented for closeout in 2022. This report presents the Site's MY6 assessment and data as well as a closeout summary/analysis.

1.2 Monitoring Year 6 Data Assessment

Annual monitoring was conducted between June and October 2021 to assess the condition of the project. The stream restoration success criteria for the Site follows the approved monitoring plan presented in the Glade Creek II Restoration Plan (Ward, 2008).

1.2.1 Vegetation Assessment

A total of six vegetation monitoring plots were established during baseline monitoring within the project easement areas using a standard 10 by 10 meter or 5 by 20 meter plots. Please refer to the Current Condition Plan View (CCPV) Figure 3 in Appendix 2 for the vegetation monitoring plot locations. The final vegetation success criterion is the survival of 260 planted stems per acre in the riparian corridor along restored and enhanced reaches at the end of year five of the monitoring period.

The MY6 vegetation survey was completed in September 2021, resulting in an average planted stem density of 398 stems per acre. The Site is exceeding the final density requirement of 260 planted stems, with all six plots (100%) individually exceeding this requirement. In addition, the number of volunteer woody stems have steadily increased each year with desired species including tag alder (*Alnus serrulata*), nine bark (*Physocarpus opulifolius*), red maple (*Acer rubrum*), and black willow (*Salix nigra*). Approximately 46% of the monitored stems have a health score (vigor) of 3 or greater, indicating that they are very likely to survive. Moreover, about 30% of the monitored stems have a vigor of 2 indicating that they have fair plant health with some damage present. Stems with a vigor of 1 that are unlikely to survive next year accounted for roughly 4% of the monitored stems. These lower vigor ratings were due to damage from deer and beaver herbivory, storm events, insects, suffocation from dense herbaceous cover, and other unknown factors. Tag alders that were planted from bare root at as-built accounted for 83% of the monitored stems found to be dead this year. However, the volunteer and transplant tag alders are numerous and thriving throughout the Site. Please refer to Appendix 2 for vegetation plot photographs and Appendix 3 for vegetation data tables.

1.2.2 Vegetation Areas of Concern and Adaptive Management Activity

The MY6 vegetation monitoring and visual assessments revealed that very few areas of concern persist on the Site. DMS contracted with a provider for invasive species treatment beginning in October 2019

and continuing throughout October 2021. Previously noted areas of invasive species were treated and observed to have very few resprouts with less than 0.1% of the easement acreage currently affected by invasive species. To increase woody stem densities in the wetland preservation area, supplemental planting occurred in April 2020. Visual assessments in MY6 revealed that planted woody stems in Wetland B appear healthy. Please refer to the CCPV Figure 3 in Appendix 2 for vegetation areas of concern.

1.2.3 Stream Assessment

Morphological surveys for MY6 were conducted in June 2021; however, longitudinal profiles were only required for UT to Glade Creek. The longitudinal profile plot for UT to Glade Creek demonstrates the extent of aggradation and little change compared to MY5, which is further discussed below in Section 1.2.4.

Cross-section survey results indicate that channel dimensions are stable and continuing to function on Glade Creek with minimal adjustments. As woody vegetation has become well established along the banks, floodplain deposition from recent bankfull events is evident in the riffle cross-sections along Glade Creek. As observed in previous MYs, cross-sections along UT to Glade Creek are representative of the significant sediment deposition and decreasing pool depths occurring throughout the reach. However, the surveyed riffle cross-section along UT to Glade (XS5) has maintained bed and bank elevations compared to MY5 with dimensions similar to MY0.

Along Glade Creek, the reachwide pebble counts show coarser materials in the riffles and fines in the pools. The UT to Glade Creek reachwide channel materials resulted in a D_{50} of 0.3 mm (sand) during MY6. This fining of sediment materials observed in MY3 has continued through MY6 for UT to Glade Creek. Please refer to Appendix 4 for morphological tables and plots with annual overlays.

1.2.4 Stream Areas of Concern and Adaptive Management Activity

As noted in previous MYs, UT to Glade Creek has experienced an increase in fine sediment each year after as-built. Large bankfull events along Glade Creek are depositing sediment along the floodplain and within the channel of UT to Glade Creek. In addition, land management activities upstream of the project are contributing excessive sedimentation on UT to Glade Creek. At the start of UT to Glade Creek Reach 2, the channel is actively braiding through Wetland D in the right floodplain of the original alignment. However downstream of Wetland D, willows and alders have become more established along the banks and have helped maintain channel form and function.

DMS contracted with a provider to completed repairs along Glade Creek in April 2020. These repairs included installing a brush toe geolift and point bar regrading between stations 22+95 and 23+50, and stabilization of the hillslope between stations 24+25 and 24+75. Visual assessments in MY6 revealed that repairs appear to be stable and functioning as designed with livestakes and transplants becoming well established. ***A memo with as-built repair plans can be found in Appendix 6.*** Other small areas of scour that were not addressed by the repair remain along Glade Creek. However, woody vegetation is present along the banks in these areas causing them to be of relatively minor concern to the ecological integrity of the project. DMS also contracted with a provider to remove a beaver dam located on Glade Creek (near station 18+70) in October 2021.

1.2.5 Hydrology Assessment

A bankfull event was documented for Glade Creek and UT to Glade Creek on June 7, 2021 based on crest gage measurements and recent wracklines found throughout the floodplain. In MY1 through MY6, there has been at least six bankfull events for each reach documented in separate years. The performance standard was met in MY2 with two bankfull flow events documented on restoration reaches and

occurring in separate years during the five-year monitoring period. Refer to Appendix 5 for hydrologic data and graphs.

1.2.6 Wetland Assessment

One groundwater monitoring gage (GWG 1) was established during baseline monitoring within the wetland restoration area using a logging hydrology pressure transducer. The gage was installed at an appropriate location so that the data collected will provide an indication of groundwater levels throughout the wetland restoration area. The target performance standard for wetland hydrology success consists of the presence of groundwater within 12 inches of the ground's surface for 21 consecutive days (12.5%) of the defined growing season for Alleghany County (April 26th to October 11th) under typical precipitation conditions. The Site does not contain a rainfall gage; therefore, the daily precipitation data was collected from closest NC CRONOS Station, Sparta 3.5 SSW.

The GWG 1 recorded 169 consecutive days or 100% of the growing season; thereby exceeding the performance standard for MY6. Each time that the groundwater gage was downloaded in MY6, standing water was observed in the area surrounding the gage in Wetland D. This is corroborated by the groundwater gage data which plots water levels above the ground's surface for a majority of the growing season. Monthly rainfall data in 2021 indicated higher than normal rainfall amounts occurred during the month of August and lower than normal rainfall amounts occurred during the months of January and February. Please refer Figure 3 in Appendix 2 for the groundwater gage location, and Appendix 5 for hydrology data and plots.

1.2.7 Wetland Areas of Concern and Adaptive Management Activity

In April 2020, DMS contracted with a provider to repair a headcut that had formed at the outflow of Wetland B where it meets Glade Creek Reach 2 (near station 22+75). The repairs included the installation of log sills for grade control at the wetland outflow. MY6 visual assessments reveal that the repair appears stable and has prevented the headcut from migrating into the wetland. As discussed in section 1.2.2, Wetland B had previously been noted to have poor woody stem growth and therefore supplemental planting occurred in April 2020 with appropriate wetland tree and shrub species.

1.3 Monitoring Year 6/Closeout Summary

Assessments completed over the past six monitoring years illustrate that the Site has met the success criteria as defined in the mitigation plan (Confluence, 2013) for vegetation, stream morphology, and stream and wetland hydrology, with the exception of UT to Glade where sediment deposition has resulted in a loss of stream function. The MY6 visual assessment revealed that invasive treatments have nearly eradicated many invasive species on the Site. In addition, wetland adaptive management activities and stream repairs that occurred in the Spring 2020 to alleviate previously identified areas of concern are performing well and have benefited the long-term ecological function of the Site.

The as-built planted stem density averaged 742 stems per acre with the MY6 vegetation assessment resulting in an average planted stem density of 398 stems per acre. This exceeds the final success criteria of 260 stems per acre and demonstrates that the Site has established a healthy riparian buffer. Stream morphology surveys along Glade Creek throughout the six years of monitoring demonstrate that the channel is functioning as designed and dimensions are indicative of stability. The extent of sediment deposition along UT to Glade Creek has been documented with the annual pebble counts, longitudinal and cross-section surveys. Bankfull events on all reaches have been documented in each post-construction monitoring year. Therefore, the success criteria of two bankfull flow events documented on restoration reaches and occurring in separate monitoring years was met for the project in MY2. The wetland groundwater gage has consistently met the success criteria for all six monitoring years, which demonstrates that the wetland hydrology has been restored on the Site. Included in Appendix 2 are

photos from MY0 and MY6 to illustrate bank stability and vegetation establishment over the course of six years of monitoring. DMS and DEQ-Stewardship have recently assessed the easement and boundary conditions, made minor upgrades to markings and posting, and DEQ stewardship has unofficially accepted the site for transfer. Repair area and site-wide comparative close out photos can be found in Appendix 7.

Section 2: METHODOLOGY

Geomorphic data was 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). Longitudinal and cross-sectional data were collected using a total station and were georeferenced. All Integrated Current Condition Plan View mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using was Pathfinder and ArcView. Crest gages were installed in surveyed riffle cross-sections and monitored semi-annually. Hydrology attainment installation and monitoring methods are in accordance with the USACE (2003) standards. Vegetation monitoring protocols followed the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2008).

Section 3: REFERENCES

Confluence Engineering, P.C. (2013). Glade Creek II Restoration Project Final Mitigation Plan Addendum. NCEEP, Raleigh, NC.

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 Climate Retrieval and Observations Network of the Southeast Database (NCCRONOS). 2021. State Climate Office of North Carolina. Version 2.7.2. Station ID Sparta 3.5 SSW. Accessed October 2021.

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

North Carolina Ecosystem Enhancement Program (NCEEP), 2009. New River Basin Restoration Priorities. Accessed from: https://ncdenr.s3.amazonaws.com/s3fs-public/Mitigation%20Services/PublicFolder/Work%20With/Watershed%20Planners/New_RBRP_2009.pdf

North Carolina Ecosystem Enhancement Program (NCEEP). Little River and Brush Creek Local Watershed Plan. Accessed from: https://ncdenr.s3.amazonaws.com/s3fs-public/documents/files/LittleRiver-BrushCrk%20LWP%20FactSheet.pdf

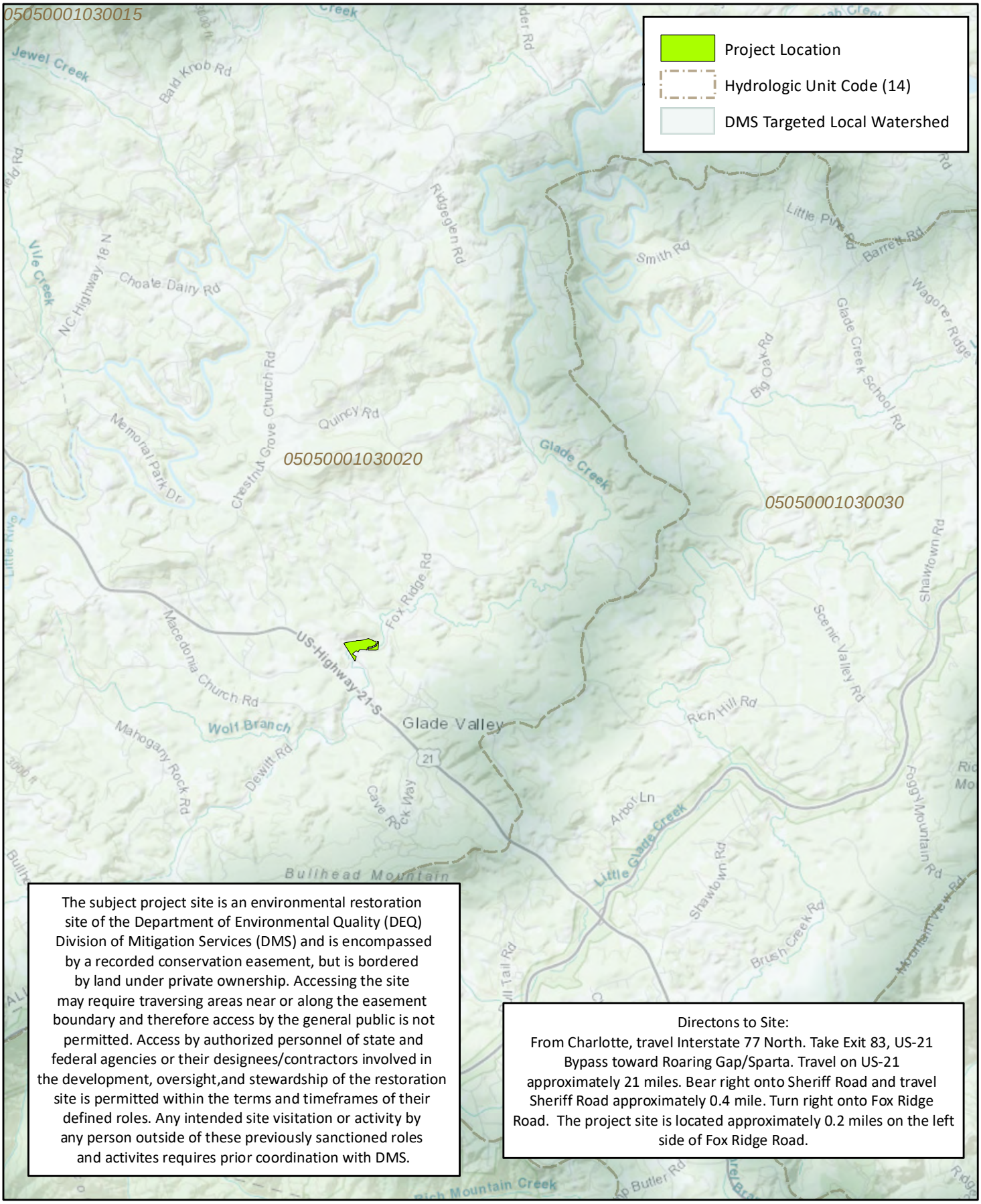
Rosgen, D.L. 1996. Applied River Morphology. Pagosa Springs, CO: Wildland Hydrology Books.

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

United States Geological Survey (USGS), 2016. North Carolina Geology. Accessed from: http://ngmdb.usgs.gov/maps/mapview/

Ward Consulting Engineers, P.C. (2008). Glade Creek II Restoration Project Restoration Plan. NCEEP, Raleigh, NC.

APPENDIX 1. General Tables and Figures



The subject project site is an environmental restoration site of the 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.

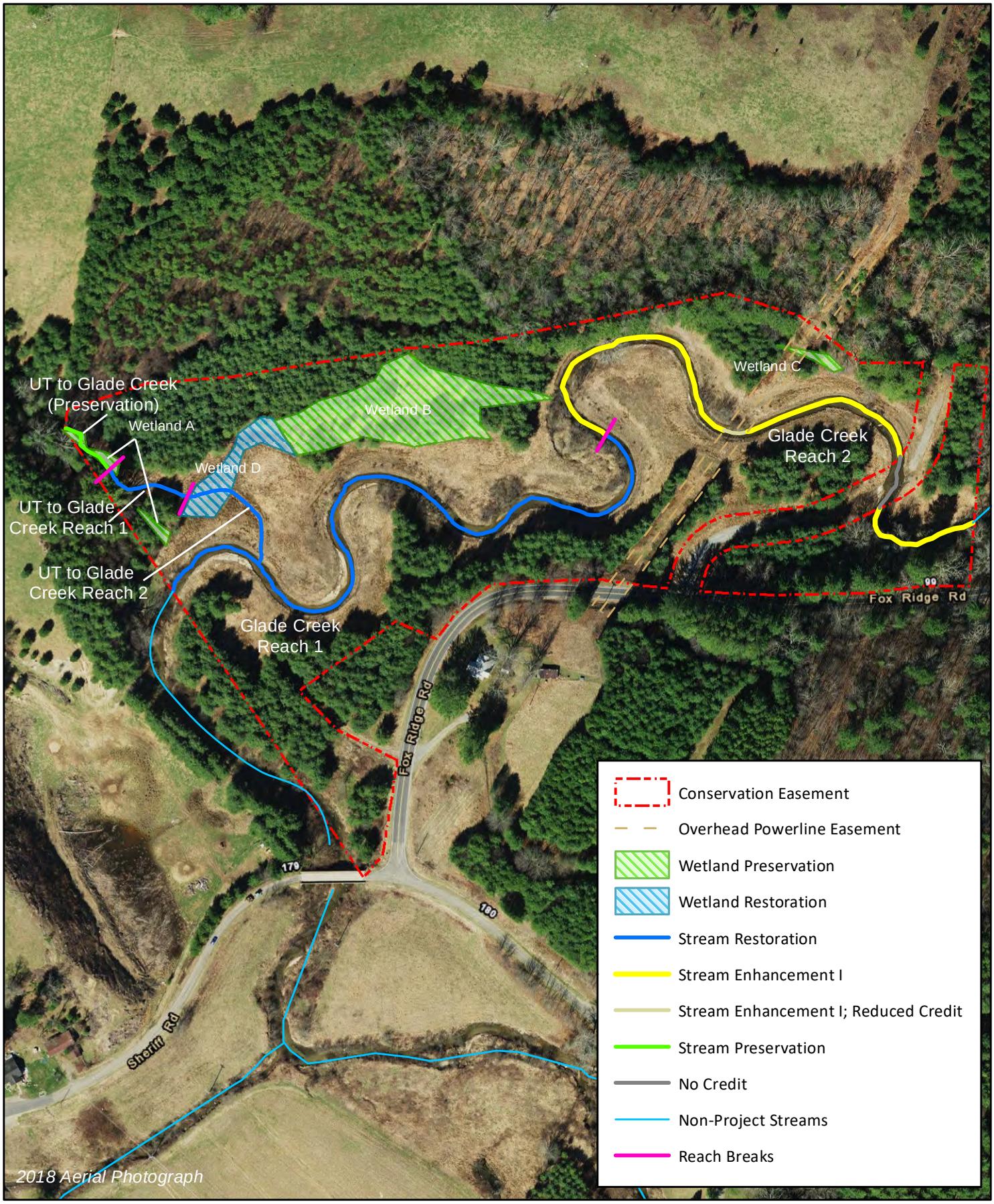
Directons to Site:
From Charlotte, travel Interstate 77 North. Take Exit 83, US-21 Bypass toward Roaring Gap/Sparta. Travel on US-21 approximately 21 miles. Bear right onto Sheriff Road and travel Sheriff Road approximately 0.4 mile. Turn right onto Fox Ridge Road. The project site is located approximately 0.2 miles on the left side of Fox Ridge Road.

WILDLANDS ENGINEERING

0 0.5 1 Miles

N

Figure 1 Project Vicinity Map
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021
Alleghany County, NC



WILDLANDS ENGINEERING

0 100 200 Feet

N

Figure 2 Project Component/Asset Map
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Alleghany County, NC

Table 1. Project Components and Mitigation Credits
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Mitigation Credits								
	Stream		Riparian Wetland	Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	R	RE			
Totals	2,140.667	25.800	0.328	N/A	N/A	N/A	N/A	

Project Components							
Reach ID	Existing Footage/ Acreage	Approach	Restoration (R) or Restoration Equivalent (RE)	As-Built Stationing/ Location	Restoration Footage/Acreage	Mitigation Ratio	Credits (SMU/WMU)
STREAMS							
Glade Creek Reach 1	1200 LF	P2	Restoration (R)	10+00 - 21+70	1,170	1:1	1170.000
Glade Creek Reach 2*	1074 LF	P2	Enhancement I (R)	21+70-26+41; 26+86-29+69; 30+59-32+60	1,090	1.5:1	651.667
UT to Glade Creek Preservation	129 LF	N/A	Preservation (RE)	10+00 - 11+29	129	5:1	25.800
UT to Glade Creek Reaches 1 and 2	197 LF	P1	Restoration (R)	11+29 - 14+48	319	1:1	319.000
WETLANDS							
Wetland A, B, C	0.84 AC	N/A	Preservation (RE)	N/A	0.84	5:1	0.168
Wetland D	0.16 AC	N/A	Restoration (R)	N/A	0.16	1:1	0.160

Component Summation						
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	1,489		0.16			
Preservation	129		0.84			
Enhancement I	1,090					
Enhancement II						
Creation						

* Stream Enhancement I credit reduced; 90 LF removed at break in conservation easement and 45 LF reduced by 50% at overhead power easement.

Table 2. Project Activity and Reporting History
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Activity or Report		Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan		December 2008	December 2008
Mitigation Plan Addendum		January 2013	January 2013
Final Design - Construction Plans		January 2015	January 2015
Construction		December 2015 - April 2016	April 2016
Temporary S&E mix applied to entire project area[1]		December 2015 - April 2016	April 2016
Permanent seed mix applied to reach/segments[1]		December 2015 - April 2016	April 2016
Bare root and live stake plantings for reach/segments		February 2016	February 2016
Baseline Monitoring Document (Year 0)		January - May 2016	June 2016
Year 1 Monitoring	Stream Survey	October 2016	December 2016
	Vegetation Survey	October 2016	
Year 2 Monitoring	Stream Survey	May 2017	December 2017
	Vegetation Survey	September 2017	
Year 3 Monitoring	Stream Survey	June 2018	November 2018
	Vegetation Survey	September 2018	
Live staking for small eroded sections along Glade Creek		April 2019	April 2019
Invasive species treatment		October 2019	October 2019
Year 4 Monitoring	Stream Survey	May 2019	November 2019
	Vegetation Survey	September 2019	
Stream repairs and wetland supplemental planting		April 2020	May 2020
Invasive species treatment		October 2020	October 2020
Year 5 Monitoring	Stream Survey	June 2020	November 2020
	Vegetation Survey	August 2020	
Livestock Fence Repair		January 2021	January 2021
Beaver Treatment		October 2021	October 2021
Invasive species treatment		October 2021	October 2021
Year 6 Monitoring	Stream Survey	June 2021	November 2021
	Vegetation Survey	September 2021	

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

Table 3. Project Contact Table
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Designer Andrew Bick, PE, CFM	**Confluence Engineering, PC** 16 Broad Street Asheville, NC 28806
Construction Contractor	**Carolina Environmental Contracting, Inc.** PO Box 1905 Mt. Airy NC 27030
Planting Contractor	**Keller Environmental** 7921 Haymarket Lane Raleigh, NC 27615
Seeding Contractor	**Carolina Environmental Contracting, Inc.** PO Box 1905 Mt. Airy NC 27030
Seed Mix Sources	**Carolina Environmental Contracting, Inc.**
Monitoring Performers	**Wildlands Engineering, Inc.**
Monitoring, POC	Kirsten Gimbert 704.941.9093

Table 4. Project Information and Attributes
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Project Information	
Project Name	Glade Creek II Restoration Project
County	Alleghany
Project Area (acres)	44.50
Project Coordinates (latitude and longitude)	36° 28' 37.0878"N, -81° 3' 42.7896"W

Project Watershed Summary Information	
Physiographic Province	Blue Ridge Mountains
River Basin	New River
USGS Hydrologic Unit 8-digit	05050001
USGS Hydrologic Unit 14-digit	05050001030020
DWR Sub-basin	05-07-03
Project Drainiage Area (acres)	5,120
Project Drainage Area Percentage of Impervious Area	<1%
CGIA Land Use Classification	61% Forested, 35% Agriculture/Livestock, 3% Residential/Commercial

Reach Summary Information				
Parameters	**Glade Creek Reach 1**	**Glade Creek Reach 2**	**UT to Glade Creek Reach 1**	**UT to Glade Creek Reach 2**
Length of reach (linear feet) - Post-Restoration	1,170	1,090	129	319
Drainage area (acres)	5,120		13	
NCDWR stream identification score	47		31	
NCDWR Water Quality Classification	C; Tr		-	-
Morphological Desription (stream type)	C4		B4	
Underlying mapped soils	Suncook			
FEMA classification	no regulated floodplain		no regulated floodplain	
Native vegetation community	White Pine Plantation			
Percent composition exotic invasive vegetation -Post-Restoration	0%		0%	
Parameters	**Wetlands A, B & C**		**Wetland D**	
Size of Wetland (acres)	0.84		0.16	
Wetland Type	Riparian-Non Riverine			
Underlying mapped soils	Suncook			
Drainage class	frequently flooded, excessively drained			
Soil hydric status	N/A			
Source of Hydrology	hillside seep			
Restoration or Enhancement Method (hydrologic, vegetative, etc.)	Preservation		hydrologic/ vegetative	

Regulatory Considerations			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States - Section 404	Yes	Yes	USACE Nationwide Permit No.27 and DWQ 401 Water Quality Certification No. 3885. Action ID # 2009-00589
Waters of the United States - Section 401	Yes	Yes	
Division of Land Quality (Erosion and Sediment Control)	Yes	Yes	NPDES Construction Stormwater General Permit NCG010000
Endangered Species Act	Yes	Yes	Glade Creek II Restoration Project; Ward Consulting determined "no affect" on Alleghany County listed endangered species
Historic Preservation Act	Yes	Yes	No recommendations received.
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	N/A	N/A	The upper portion of Glade Creek is not currenlty mapped as a regulated flood zone
Essential Fisheries Habitat	N/A	N/A	N/A

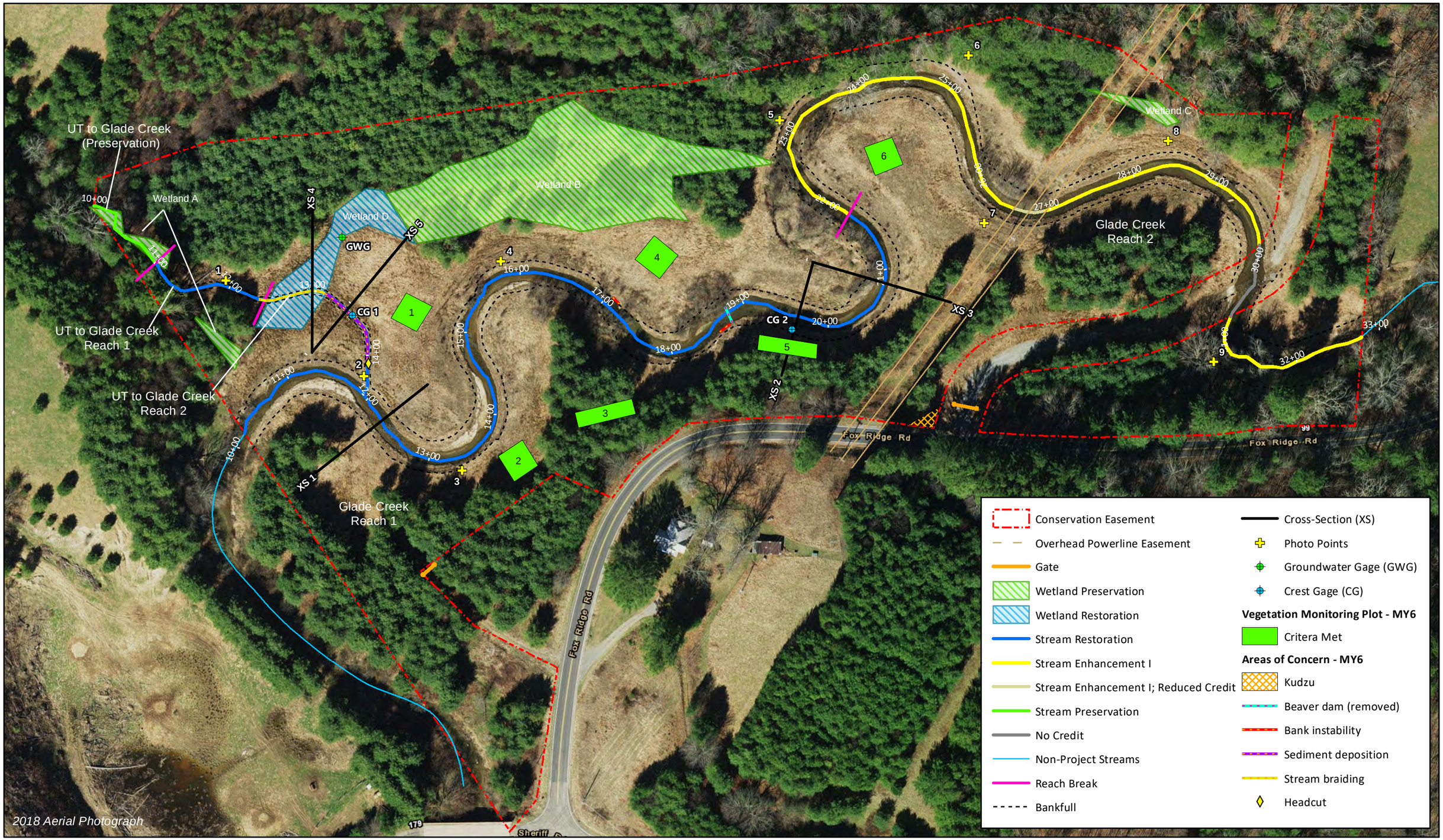
--- Data not provided

Table 5. Monitoring Component Summary
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Parameter	Monitoring Feature	Quantity/ Length by Reach			Frequency
		Glade Creek	UT to Glade Creek	Wetlands	
Dimension	Riffle Cross Section	2	1	N/A	Annual
	Pool Cross Section	1	1	N/A	
Pattern	Pattern	Yes	Yes	N/A	See Footnote[1]
Profile	Longitudinal Profile	Yes	Yes	N/A	Annual
Substrate	Reach Wide (RW) / Riffle 100 Pebble Count (RF)	RW-1, RF 1	RW-1, RF-1	N/A	Annual
Stream Hydrology	Crest Gage	1	1	N/A	Semi-Annual
Wetland Hydrology	Groundwater Gages	N/A	N/A	Enhancement I (R)	Semi-Annual
Vegetation	CVS Level 2	6			Annual
Visual Assessment	All Streams	Y	Y	Y	Semi-Annual
Exotic and nuisance vegetation					Semi-Annual
Project Boundary					Semi-Annual
Reference Photos	Photographs	9			Annual

[1]Pattern measurements will include sinuosity and meander width ratio and will be performed yearly. Measurements of radius of curvature will be monitored on newly constructed meanders for the first year only.

APPENDIX 2. Visual Assessment Data



WILDLANDS ENGINEERING

0 100 200 Feet

N

Figure 3 Current Condition Plan View Map
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021
Alleghany County, NC

Table 6a. Visual Stream Morphology Stability Assessment Table Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Glade Creek (2,260 LF) **Assessment Date: 6/7-6/8 2021**

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	9	9			100%			
	3. Meander Pool Condition	Depth Sufficient	6	6			100%			
		Length Appropriate	6	6			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	6	6			100%			
		Thalweg centering at downstream of meander bend (Glide)	6	6			100%			
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			2	25	99%	2	25	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	2	25	99%	2	25	100%
3. Engineered Structures[1]	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	7	7			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	7	7			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	7	7			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	7	7			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	7	7			100%			

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

Table 6b. Visual Stream Morphology Stability Assessment Table Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

UT to Glade Creek (448 LF) **Assessment Date: 6/7-6/8 2021**

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			1	172	62%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	2	5			40%			
	3. Meander Pool Condition	Depth Sufficient	2	4			50%			
		Length Appropriate	2	4			50%			
	4. Thalweg Position[2]	Thalweg centering at upstream of meander bend (Run)	2	2			100%			
		Thalweg centering at downstream of meander bend (Glide)	2	2			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.	7	7			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	7	7			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	7	7			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	7	7			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	4	7			57%			

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

[2]Applicable to only 2 meander bends because the other 2 meander bends are being impacted by sedimentation and the stream has braided.

Table 7. Vegetation Condition Assessment Table Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021 **Assessment Date: 9/13/2021**

Planted Acreage **6.4**

Vegetation Category	Definitions	Mapping Threshold (acres)	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1	0	0.0	0.0%
Low Stem Density Areas[1]	Woody stem densities clearly below target levels based on MY3, 4, 5, or 7 stem count criteria.	0.1	0	0.0	0.0%
		Total	**0**	**0.0**	**0.0%**
Areas of Poor Growth Rates or Vigor[1]	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25	0	0.0	0%
		Cumulative Total	**0**	**0.0**	**0.0%**

Easement Acreage **12.8**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale).	1000	1	0.01	0.1%
Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	none	0	0	0%

[1]Acreage calculated from vegetation plots monitored for site.

Stream Photographs

	
Photo Point 1 – view upstream UT Glade Creek MY0 *(05/06/2016)*	**Photo Point 1** – view upstream UT Glade Creek MY6 *(06/07/2021)*
	
Photo Point 1 – view downstream UT Glade Creek MY0 (*05/06/2016*)	**Photo Point 1** – view downstream UT Glade Creek MY6 (*06/07/2021*)
	
Photo Point 2 – view upstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 2** – view upstream Glade Creek MY6 *(06/07/2021)*

	
Photo Point 2 – view downstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 2** – view downstream Glade Creek MY6 *(06/07/2021)*
	
Photo Point 2 – view upstream UT Glade Creek MY0 *(05/06/2016)*	**Photo Point 2** – view upstream UT Glade Creek MY6 *(06/07/2021)*
	
Photo Point 3 – view upstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 3** – view upstream Glade Creek MY6 *(06/07/2021)*

	
Photo Point 3 – view downstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 3** – view downstream Glade Creek MY6 *(06/07/2021)*
	
Photo Point 4 – view upstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 4** – view upstream Glade Creek MY6 *(06/07/2021)*
	
Photo Point 4 – view downstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 4** – view downstream Glade Creek MY6 *(06/07/2021)*

Photo Point 5 – view upstream Glade Creek MY0 *(05/06/2016)*

Photo Point 5 – view upstream Glade Creek MY6 *(06/07/2021)*

Photo Point 5 – view downstream Glade Creek MY0 *(05/06/2016)*

Photo Point 5 – view downstream Glade Creek MY6 *(06/07/2021)*

Photo Point 6 – view upstream Glade Creek MY0 *(05/06/2016)*

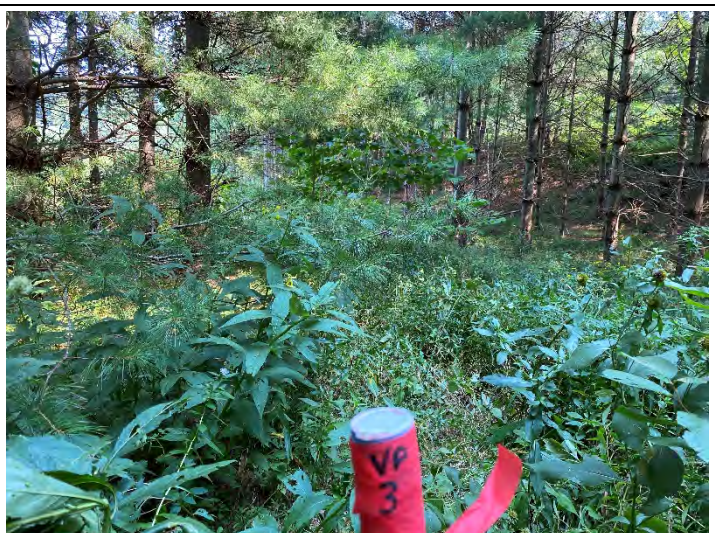
Photo Point 6 – view upstream Glade Creek MY6 *(06/07/2021)*

	
Photo Point 6 – view downstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 6** – view downstream Glade Creek MY6 *(06/07/2021)*
	
Photo Point 7 – view upstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 7** – view upstream Glade Creek MY6 *(06/07/2021)*
	
Photo Point 7 – view downstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 7** – view downstream Glade Creek MY6 *(06/07/2021)*

	
Photo Point 8 – view upstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 8** – view upstream Glade Creek MY6 *(06/07/2021)*
	
Photo Point 8 – view downstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 8** – view downstream Glade Creek MY6 *(06/07/2021)*
	
Photo Point 9 – view upstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 9** – view upstream Glade Creek MY6 *(06/07/2021)*

	
Photo Point 9 – view downstream Glade Creek MY0 *(05/06/2016)*	**Photo Point 9** – view downstream Glade Creek MY6 *(06/07/2021)*

Vegetation Photographs

	
Vegetation Plot 1 – MY0 *(05/02/2016)*	**Vegetation Plot 1** – MY6 *(09/13/2021)*
	
Vegetation Plot 2 – MY0 *(05/02/2016)*	**Vegetation Plot 2** – MY6 *(09/13/2021)*
	
Vegetation Plot 3 – MY0 *(05/02/2016)*	**Vegetation Plot 3** – MY6 *(09/13/2021)*

	
Vegetation Plot 4 – MY0 *(05/02/2016)*	**Vegetation Plot 4** – MY6 *(09/13/2021)*
	
Vegetation Plot 5 – MY0 *(05/02/2016)*	**Vegetation Plot 5** – MY6 *(09/13/2021)*
	
Vegetation Plot 6 – MY0 *(05/02/2016)*	**Vegetation Plot 6** – MY6 *(09/13/2021)*

APPENDIX 3. Vegetation Plot Data

Table 8. Vegetation Plot Criteria Attainment

Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Plot	MY5 Success Criteria Met (Y/N)	Tract Mean
1	Y	100%
2	Y	
3	Y	
4	Y	
5	Y	
6	Y	

Table 9. CVS Vegetation Plot Metadata

Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Report Prepared By	Mimi Caddell
Date Prepared	10/12/2021 10:00
Database Name	cvs-eep-entrytool-v2.5.0 Glade MY6.mdb
Database Location	L:\ActiveProjects\005-02161 Glade Creek II Monitoring\Monitoring\Monitoring Year 6\Vegetation Assessment
Computer Name	MIMI-PC
File Size	52371456
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, 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	92343
project Name	Glade Creek II Restoration Project
Description	Glade Creek II Restoration Project
Required Plots (calculated)	6
Sampled Plots	6

Table 10a. Planted and Total Stem Counts
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Current Plot Data (MY6 2021)																				
			92343-WEI-0001			92343-WEI-0002			92343-WEI-0003			92343-WEI-0004			92343-WEI-0005			92343-WEI-0006		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer rubrum	Red Maple	Tree	3	3	3						5						25			
Alnus serrulata	Tag Alder	Shrub Tree	2	2	2	1	1	16			5			3			50	5	5	65
Carpinus caroliniana	American Hornbeam	Shrub Tree				1	1	1	1	1	1	1	1	1				1	1	1
Cercis canadensis	Eastern Redbud	Shrub Tree																		
Cornus amomum	Silky Dogwood	Shrub Tree																		
Diospyros virginiana	American Persimmon	Tree				1	1	1				3	3	3	1	1	1	1	1	1
Fraxinus pennsylvanica	Green Ash	Tree	2	2	2															
Hamamelis virginiana	Witch-hazel	Shrub Tree				1	1	1	1	1	1	1	1	1	2	2	2			
Liriodendron tulipifera	Tulip Poplar	Tree				3	3	3	6	6	6	1	1	1	2	2	2	2	2	2
Nyssa sylvatica	Black Gum	Tree				1	1	1				2	2	2						
Physocarpus opulifolius	Nine bark	Shrub Tree			40			45						50			50			175
Platanus occidentalis	Sycamore	Tree	1	1	1	3	3	3	5	5	5	2	2	2	3	3	3			
Quercus rubra	Red Oak	Tree																		
Salix	Willow	Tree																		
Salix nigra	Black Willow	Tree						5									2			
Salix sericea	Silky Willow	Shrub Tree																		
Sambucus canadensis	Common Elderberry	Shrub Tree																		
		Stem count	8	8	48	11	11	76	13	13	23	10	10	63	8	8	135	9	9	244
		size (ares)	1			1			1			1			1			1		
		size (ACRES)	0.02471			0.02471			0.02471			0.02471			0.02471			0.02471		
		Species count	4	4	5	7	7	9	4	4	6	6	6	8	4	4	8	4	4	5
		Stems per ACRE	324	324	1942	445	445	3076	526	526	931	405	405	2550	324	324	5463	364	364	9874

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%
Volunteer species 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 Counts
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Annual Summary																							
			MY6 (2021)			MY5 (2020)			MY4 (2019)			MY3 (2018)			MY2 (2017)			MY1 (2016)			MY0 (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**
Acer rubrum	Red Maple	Tree	3	3	33	3	3	18	3	3	8	3	3	23	3	3	4	3	3	3	6	6	6
Alnus serrulata	Tag Alder	Shrub Tree	8	8	141	12	12	79	12	12	55	12	12	74	12	12	57	13	13	20	14	14	14
Carpinus caroliniana	American Hornbeam	Shrub Tree	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Cercis canadensis	Eastern Redbud	Shrub Tree																		1			
Cornus amomum	Silky Dogwood	Shrub Tree												3									
Diospyros virginiana	American Persimmon	Tree	6	6	6	7	7	7	8	8	8	8	8	8	9	9	9	10	10	10	11	11	11
Fraxinus pennsylvanica	Green Ash	Tree	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
Hamamelis virginiana	Witch-hazel	Shrub Tree	5	5	5	8	8	8	9	9	9	10	10	10	10	10	10	10	10	10	10	10	10
Liriodendron tulipifera	Tulip Poplar	Tree	14	14	14	16	16	16	18	18	19	21	21	22	23	23	23	24	24	24	28	28	28
Nyssa sylvatica	Black Gum	Tree	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	6	6	6	7	7	7
Physocarpus opulifolius	Nine bark	Shrub Tree			360			89			73												
Platanus occidentalis	Sycamore	Tree	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	22	22	22
Quercus rubra	Red Oak	Tree						1			1												
Salix	Willow	Tree									5												
Salix nigra	Black Willow	Tree			7																		
Salix sericea	Silky Willow	Shrub Tree						7															
Sambucus canadensis	Common Elderberry	Shrub Tree							3	3	4	3	3	3	5	5	5	5	5	5	5	5	5
		Stem count	59	59	589	69	69	248	77	77	206	81	81	167	86	86	132	91	91	99	110	110	110
		size (ares)		6			6			6			6			6			6			6	
		size (ACRES)		0.1483			0.1483			0.1483			0.1483			0.1483			0.1483			0.1483	
		Species count	9	9	11	9	9	12	10	10	13	10	10	11	10	10	10	10	10	11	10	10	10
		Stems per ACRE	398	398	3973	465	465	1673	519	519	1389	546	546	1126	580	580	890	614	614	668	742	742	742

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%
Volunteer species included in total

PnoLS: Number of planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total stems

Table 11. Stems Per Plot Across All Years
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Plot	MY6 (2021)			MY5 (2020)			MY4 (2019)			MY3 (2018)			MY2 (2017)			MY1 (2016)			MY0 (2016)		
	Planted Stems	Total Stems	Total Stems/Ac	Planted Stems	Total Stems	Total Stems/Ac	Planted Stems	Total Stems	Total Stems/Ac	Planted Stems	Total Stems	Total Stems/Ac	Planted Stems	Total Stems	Total Stems/Ac	Planted Stems	Total Stems	Total Stems/Ac	Planted Stems	Total Stems	Total Stems/Ac
1	8	48	1942	8	17	688	6	18	728	6	6	243	6	7	283	6	6	243	15	15	607
2	11	76	3076	13	24	971	14	35	1416	15	30	1214	16	28	1133	17	18	728	20	20	809
3	13	23	931	14	24	971	16	22	890	18	21	850	20	21	850	22	22	890	25	25	1012
4	10	63	2550	13	42	1700	15	36	1457	15	17	688	16	18	728	17	17	688	17	17	688
5	8	135	5463	11	71	2873	15	66	2671	16	56	2266	17	32	1295	17	17	688	18	18	728
6	9	244	9874	10	70	2833	11	29	1174	11	37	1497	11	26	1052	12	19	769	15	15	607

APPENDIX 4. Morphological Summary Data and Plots

Table 12. Baseline Stream Data Summary
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Parameter	Gage	Pre-Restoration Condition				Reference Reach Data				Design				As-Built/Baseline			
		Glade Creek		UT to Glade Creek		Glade Creek Restoration		UT to Little Pine Trib 1		Glade Creek		UT to Glade Creek		Glade Creek		UT to Glade Creek	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Shallow																	
Bankfull Width (ft)	N/A	17.7	38.5	5.2	9.9	36.3	48.8	6.2	11.1	33.0		5.4		34.6	37.4	5.3	
Floodprone Width (ft)		47	115	7	12	69	118	14	46	99	165	22	33	106	111	61	
Bankfull Mean Depth		2.6	2.1	0.3	0.5	0.9	1.3	0.9	0.5	2.3		0.3		1.9	2.2	0.5	
Bankfull Max Depth		2.9	4.1	0.5	0.8	1.9	1.9	0.8	1.6	3.0		0.4		2.9	3.2	0.9	
Bankfull Cross-sectional Area (ft^2)		46.9	79.0	2.1	5.1	45.6	64.1	3.8	5.1	76.5		1.7		70.2	77.1	2.4	
Width/Depth Ratio		6.7	18.8	17.3	26.8	40.3	37.2	6.9	24.2	14.2		17.4		15.5	19.9	11.8	
Entrenchment Ratio		2.7	3.1	1.2	1.5	1.9	2.4	2.3	4.1	3.0	5.0	4.0	6.0	2.8	3.2	11.4	
Bank Height Ratio		1.1	1.7	0.0	0.0	1.0	1.0	1.0	2.1	1.0		1.0		1.0		1.0	
D50 (mm)		28.0	31.0	7.0	7.0	44.0	47.0	7.0	7.0	28.0	31.0	7.0		90.0		32.0	
Riffle Length (ft)	N/A					---		---		---		---		33	57	6.8	32.6
Riffle Slope (ft/ft)						---		---		---		---		0.0087	0.0271	0.0193	0.0964
Pool Length (ft)						---		---		5		---		64.0	197.8	8.8	32.9
Pool Max Depth (ft)		4.4	6.6	0.8		5.0		0.7	1.5	3.3	4.1	0.8	1.0	3.8	5.9	1.5	
Pool Spacing (ft)						---		---		---		---		107	353	33.0	70.0
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)	N/A	60	240	7	16	---	---	19	26	112	205	17		155	282	75.0	
Radius of Curvature (ft)		21	114	---	---	---	---	30		59.0	99.0	30		59.0	99.0	30	
Rc:Bankfull Width (ft/ft)		1.2	3.0	---	---	---	---	3.2	5.9	1.8	3.0	5.5-6.0		1.8	3.0	5.5-6.0	
Meander Length (ft)[1]				---	---	---	---	---	---	---	---	---	---	230	425	150	
Meander Width Ratio		3.4	6.2	1.3	1.6	---	---	2.5	3.5	3.4	6.2	3.1	7.0	4.5	7.5	3.1	7.0
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/-						1/26.47/42.3/128/180/>2048		0.11/0.63/13.3/176/241.4/>2048	
Reach Shear Stress (Competency) lb/ft^2		---		---						0.48		0.52	0.82	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	8.00		0.02		4.60		0.05		8.00		0.02		8.00		0.02	
Watershed Impervious Cover Estimate (%)		---		---		---		---		---		---		---		---	
Rosgen Classification		E4/C4		F4/B4		C4		C4/B4		C4		B4		C4		B4	
Bankfull Velocity (fps)		3.8	5.3	3.8	4.9	3.1	4.4	4.5	6.1	3.9		4.7		---		---	
Bankfull Discharge (cfs)		250	300	8	25	200		23		300		8		---		---	
Q-NFF regression (2-yr)		493		5		352											
Q-USGS extrapolation (1.2-yr)		561		4		335											
Q-Mannings		213	320	8		153	228										
Valley Length (ft)		---		---		---		---		1,322		280		1,322		280	
Channel Thalweg Length (ft)		1200		197		---		---		2,120		197		2,120		326	
Sinuosity		1.68		1.04		1.18		1.09		1.68		1.14		1.60		1.16	
Water Surface Slope $(ft/ft)^2$		0.0038		0.048		0.0049		0.0473		0.0038		0.0440		0.0031		0.0397	
Bankfull Slope (ft/ft)		---		---		---		---		---		---		0.0031		0.0326	

SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable
[1]Meander Wave Length was adjusted in the MY2 report.
[2] Channel was dry during survey, slope was calculated using channel thalweg

Table 13. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021

	Cross-Section 1, Glade Creek (Riffle)							Cross-Section 2, Glade Creek (Riffle)							Cross-Section 3, Glade Creek (Pool)						
Dimension and Substrate	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**
bankfull elevation (ft)	2571.8	2571.8	2571.8	2572.0	2572.3	2572.5	2572.5	2569.7	2569.7	2569.7	2570.0	2570.1	2570.2	2570.2	2569.8	2569.8	2569.8	2569.9	2570.2	2569.9	2570.1
low bank elevation (ft)	2571.8	2571.8	2571.3	2571.9	2572.1	2572.5	2572.2	2569.7	2569.7	2569.8	2570.1	2570.6	2570.9	2570.8	2569.8	2569.8	2569.6	2569.9	2570.2	2569.9	2570.1
Bankfull Width (ft)	37.4	34.4	38.7	34.4	32.2	32.6	30.8	34.6	35.0	36.2	36.2	38.4	37.0	35.9	31.9	30.0	32.5	32.2	35.2	31.0	30.4
Floodprone Width (ft)	106	106	102	101	102	107	102	111	110	93	104	104	96	97	---	---	---	---	---	---	---
Bankfull Mean Depth (ft)	1.9	1.9	1.8	1.9	2.0	2.1	2.0	2.2	2.2	2.1	2.2	2.5	2.7	2.7	2.8	2.9	2.8	2.7	2.8	2.8	2.7
Bankfull Max Depth (ft)	2.9	2.9	2.8	2.9	3.0	3.3	3.0	3.2	3.2	3.2	3.5	3.9	4.1	4.5	4.2	4.2	4.7	4.6	4.6	4.3	4.5
Bankfull Cross Sectional Area (ft^2)	70.2	66.9	70.2	64.0	63.1	69.4	61.2	77.1	78.0	77.6	79.2	95.9	101.6	95.9	89.0	88.4	91.5	87.9	99.7	88.0	83.3
Bankfull Width/Depth Ratio	19.9	17.7	21.3	18.4	16.4	15.4	15.5	15.5	15.7	16.9	16.5	15.4	13.5	13.4	11.5	10.2	11.6	11.7	12.4	10.9	11.1
Bankfull Entrenchment Ratio	2.8	3.1	2.6	2.9	3.2	3.3	3.3	3.2	3.2	2.6	2.9	2.7	2.6	2.7	---	---	---	---	---	---	---
Bankfull Bank Height Ratio[1,2,3]	1.0	1.0	<1.0	<1.0	<1.0	1.0	<1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.1	---	---	---	---	---	---	---

	Cross-Section 4, UT to Glade Creek (Pool)							Cross-Section 5, UT to Glade Creek (Riffle)						
Dimension and Substrate	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**
bankfull elevation (ft)	2574.0	2574.0	2574.0	2574.3	2574.4	2574.5	2574.5	2573.6	2573.6	2573.6	2573.7	2574.0	2574.0	2574.1
low bank elevation (ft)	2574.3	2574.3	2574.1	2574.3	2574.4	2574.5	2574.5	2573.6	2573.5	2573.5	2573.7	2574.1	2574.1	2574.1
Bankfull Width (ft)	5.3	7.1	7.0	6.8	7.9	5.1	7.0	5.3	6.1	5.9	6.2	6.1	6.5	5.7
Floodprone Width (ft)	---	---	---	---	---	---	---	61	61	61	36	37	35	29
Bankfull Mean Depth (ft)	0.9	0.8	0.7	0.4	0.3	0.2	0.4	0.5	0.4	0.5	0.3	0.5	0.4	0.4
Bankfull Max Depth (ft)	1.5	1.3	1.5	0.7	0.6	0.3	0.8	0.9	0.8	1.0	0.8	0.9	0.8	0.8
Bankfull Cross Sectional Area (ft^2)	4.7	5.5	4.9	2.6	2.1	1.1	2.8	2.4	2.7	3.1	2.2	2.8	2.8	2.4
Bankfull Width/Depth Ratio	6.0	9.6	10.1	18.0	29.8	24.5	17.5	11.8	13.5	11.4	17.8	13.5	15.3	13.7
Bankfull Entrenchment Ratio	---	---	---	---	---	---	---	11.4	10.0	10.3	5.8	6.0	5.3	5.2
Bankfull Bank Height Ratio[1,2,3]	---	---	---	---	---	---	---	1.0	1.0	1.0	1.0	1.1	1.1	1.0

---: not applicable

[1]Prior to MY3, bankfull dimensions were calculated using a fixed bankfull elevation.

[2]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 NCIRT and NCDMS (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height. MY3 dimensions were updated in MY4.

[3]BHRs that increased in MY4 were primarily due to additional floodplain deposition and not enlargement of the original baseline cross-section.

Table 14a. Monitoring Data - Stream Reach Data Summary

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021

Glade Creek

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle														
Bankfull Width (ft)	34.6	37.4	34.4	35.0	36.2	38.7	34.4	36.2	32.2	38.4	32.6	37.0	30.8	35.9
Floodprone Width (ft)	106	111	97	106	93	102	101	104	102	104	96	107	97	102
Bankfull Mean Depth	1.9	2.2	1.9	2.2	1.8	2.1	1.9	2.2	2.0	2.5	2.1	2.7	2.0	2.7
Bankfull Max Depth	2.9	3.2	2.9	3.2	2.8	3.2	2.9	3.5	3.0	3.9	3.3	4.1	3.0	4.5
Bankfull Cross-sectional Area (ft^2)	70.2	77.1	66.9	78.0	70.2	77.6	64	79.2	63.1	95.9	69.4	101.6	61.2	95.9
Width/Depth Ratio	15.5	19.9	15.7	17.7	16.9	21.3	16.5	18.4	15.4	16.4	13.5	15.4	13.4	15.5
Entrenchment Ratio	2.8	3.2	2.8	3.1	2.6		2.9	2.9	2.7	3.2	2.6	3.3	2.7	3.3
Bank Height Ratio [2,3]	1.0		1.0		1.0		<1.0	1.0	<1.0	1.2	1.0	1.2	<1.0	1.1
D50 (mm)	90.0		34.3		39.8	47.7	46.5	52.5	44.0	52.8	52.0	53.7	25.7	57.9
Profile														
Riffle Length (ft)	33	57	20	57	20	85	19	80	21	105	36	98	N/A	
Riffle Slope (ft/ft)	0.0087	0.0271	0.0065	0.0235	0.0011	0.0181	0.0012	0.0162	0.0014	0.0189	0.0031	0.0215	N/A	
Pool Length (ft)	64	198	66	190	62	222	56	240	65	229	55	224	N/A	
Pool Max Depth (ft)	3.8	5.9	4.2		4.4	5.4	3.7	5.8	4.1	6.4	4.2	5.8	N/A	
Pool Spacing (ft)	107	353	91	384	90	337	86	391	88	304	108	327	N/A	
Pool Volume (ft^3)														
Pattern[1]														
Channel Beltwidth (ft)	155	282	155	280	155	283	155	283	155	283	155	283	N/A	
Radius of Curvature (ft)	59.0	99.0	59.0	99.0	59.0	99.0	59.0	99.0	59.0	99.0	59.0	99.0	N/A	
Rc:Bankfull Width (ft/ft)	1.8	3.0	1.7	2.8	1.5	2.7	1.6	2.9	1.5	3.1	1.6	3.0	N/A	
Meander Wave Length (ft)	230	425	227	435	216	445	216	445	216	445	216	445	N/A	
Meander Width Ratio	4.5	7.5	4.5	8.0	4.2	7.3	4.2	7.3	4.2	7.3	4.2	7.3	N/A	
Additional Reach Parameters														
Rosgen Classification	C4		C4		C4		C4		C4		C4		C4	
Channel Thalweg Length (ft)	2,120		2,120		2,120		2,120		2,120		2,120		2,120	
Sinuosity (ft)	1.60		1.60		1.60		1.60		1.60		1.60		1.60	
Water Surface Slope (ft/ft)	0.0031		0.0030		0.0027		0.0027		0.0031		0.0029		N/A	
Bankfull Slope (ft/ft)	0.0031		0.0031		0.0030		0.0025		0.0032		0.0030		N/A	
Ri%/Ru%/P%/G%/S%														
SC%/Sa%/G%/C%/B%/Be%														
d16/d35/d50/d84/d95/d100	/26.47/42.3/128/180/>204		5/19.49/30.4/97.6/137/254		1/12.5/29.6/75.6/115.5/362		/11.0/27.6/109.5/172.5/512		2/0.6/11.0/64.0/113.8/256		6.1/19/33/85/155.5/256		.4/12.8/30.4/92.5/124.6/25	
% of Reach with Eroding Banks	0%		0%		2%		6%		8%		2%		1%	

[1]Meander Wave Length was adjusted for MY0 and MY1 in the MY2 report.

[2]Prior to MY3, bankfull dimensions were calculated using a fixed bankfull elevation.

[3]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 NCIRT and NCDMS (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height. MY3 dimensions were updated in MY4.

Table 14b. Monitoring Data - Stream Reach Data Summary

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021

UT to Glade Creek

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle														
Bankfull Width (ft)	5.3		6.1		5.9		6.2		6.1		6.5		5.7	
Floodprone Width (ft)	61		32		61		36		37		35		29	
Bankfull Mean Depth	0.5		0.4		0.5		0.3		0.5		0.4		0.4	
Bankfull Max Depth	0.9		0.8		1.0		0.8		0.9		0.8		0.8	
Bankfull Cross-sectional Area (ft^2)	2.4		2.7		3.1		2.2		2.8		2.8		2.4	
Width/Depth Ratio	11.8		13.5		11.4		17.8		13.5		15.3		13.7	
Entrenchment Ratio	11.4		5.3		10.3		5.8		6.0		5.3		5.2	
Bank Height Ratio [1,2]	1.0		1.0		1.0		1.0		1.1		1.1		1.0	
D50 (mm)	32.0		22.6		0.7		Silt/Clay		0.1		0.1		0.1	
Profile														
Riffle Length (ft)	6.8	32.6	17.3	51.4	5.0	42.0	3.0	24.8	7.1	29.6	3.7	18.9	7.4	35.2
Riffle Slope (ft/ft)	0.0193	0.0964	0.0118	0.0866	0.0148	0.1416	0.0170	0.1410	0.0351	0.0646	0.0076	0.1027	0.0099	0.1830
Pool Length (ft)	8.8	32.9	15.6	32.6	3.0	5.0	5.0	14.7	4.6	10.0	3.6	21.0	4.9	24.5
Pool Max Depth (ft)	1.5		1.3		1.1	2.4	1.0	2.5	0.7	1.8	0.8	1.7	0.8	1.4
Pool Spacing (ft)	33	70	39	84	16	99	13	68	13	229	10	82	53	103
Pool Volume (ft^3)														
Pattern														
Channel Beltwidth (ft)	75.0		75.0		75.0		75.0		75.0		75.0		75.0	
Radius of Curvature (ft)	30		30		30		30		30		30		30	
Rc:Bankfull Width (ft/ft)	5.5-6.0		5.5-6.0		5.5-6.0		5.5-6.0		5.5-6.0		5.5-6.0		5.5-6.0	
Meander Wave Length (ft)	150		150		150		150		150		150		150	
Meander Width Ratio	3.1	7.0	3.1	7.0	3.1	7.0	3.1	7.0	3.1	7.0	3.1	7.0	3.1	7.0
Additional Reach Parameters														
Rosgen Classification	B4		B4		B4		B4		B4		B4		B4	
Channel Thalweg Length (ft)	326		326		326		326		326		326		326	
Sinuosity (ft)	1.16		1.16		1.16		1.16		1.16		1.16		1.16	
Water Surface Slope (ft/ft)	0.0397		0.0372		0.0323		0.0342		0.0261		0.0348		0.0365	
Bankfull Slope (ft/ft)	0.0326		0.0317		0.0318		0.0362		0.0337		0.0333		0.0354	
Ri%/Ru%/P%/G%/S%														
SC%/Sa%/G%/C%/B%/Be%														
d16/d35/d50/d84/d95/d100	1/0.63/13.3/176/241.4/>20		9/4.65/11.9/124.6/163.3/2		2/0.4/0.8/111.2/151.8/256		C/SC/0.2/101.9/128.0/180.		SC/0.1/0.3/16.0/41.3/180.0		0.1/0.2/0.4/3.1/22.6/180		SC/0.1/0.3/20.5/54.6/256	
% of Reach with Eroding Banks	0%		0%		0%		0%		0%		0%		0%	

[1]Prior to MY3, bankfull dimensions were calculated using a fixed bankfull elevation.

[2]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 NCIRT and NCDMS (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height. MY3 dimensions were updated in MY4.

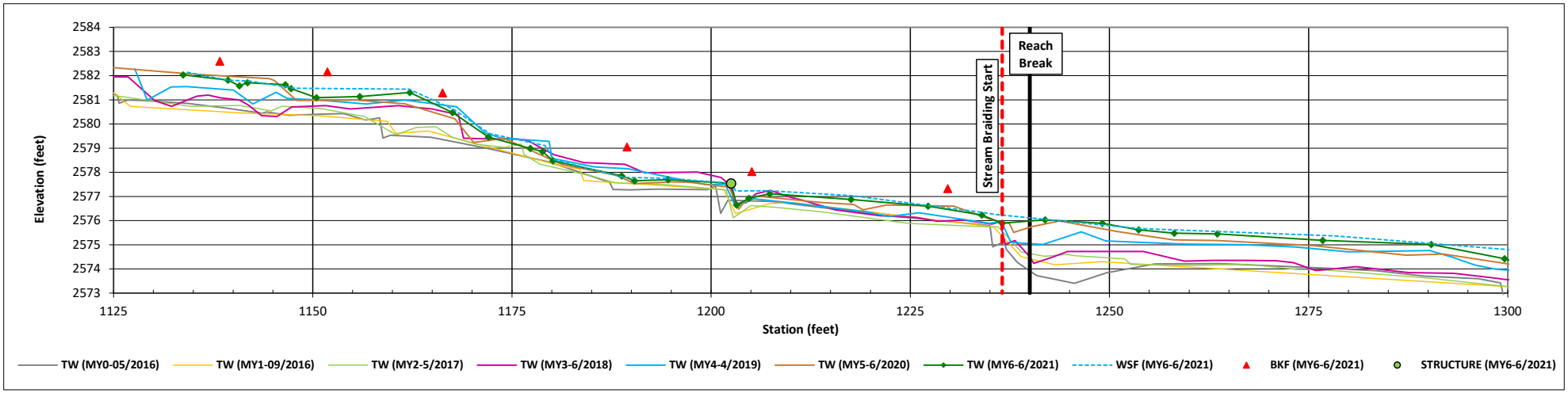
Longitudinal Profile Plots

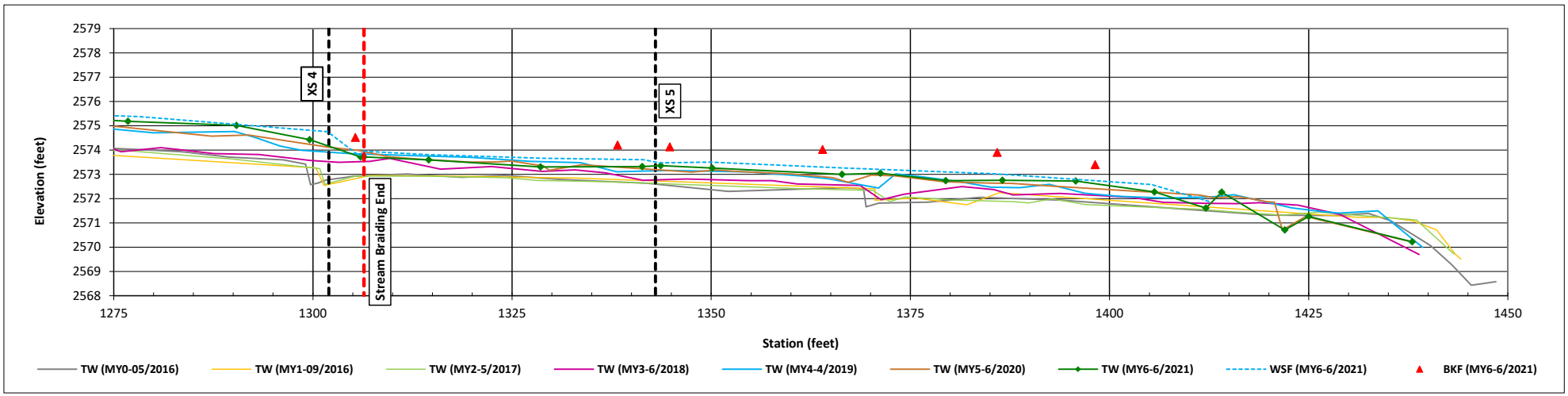
Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021

UT Glade Creek (STA 11+29 - STA 14+48)





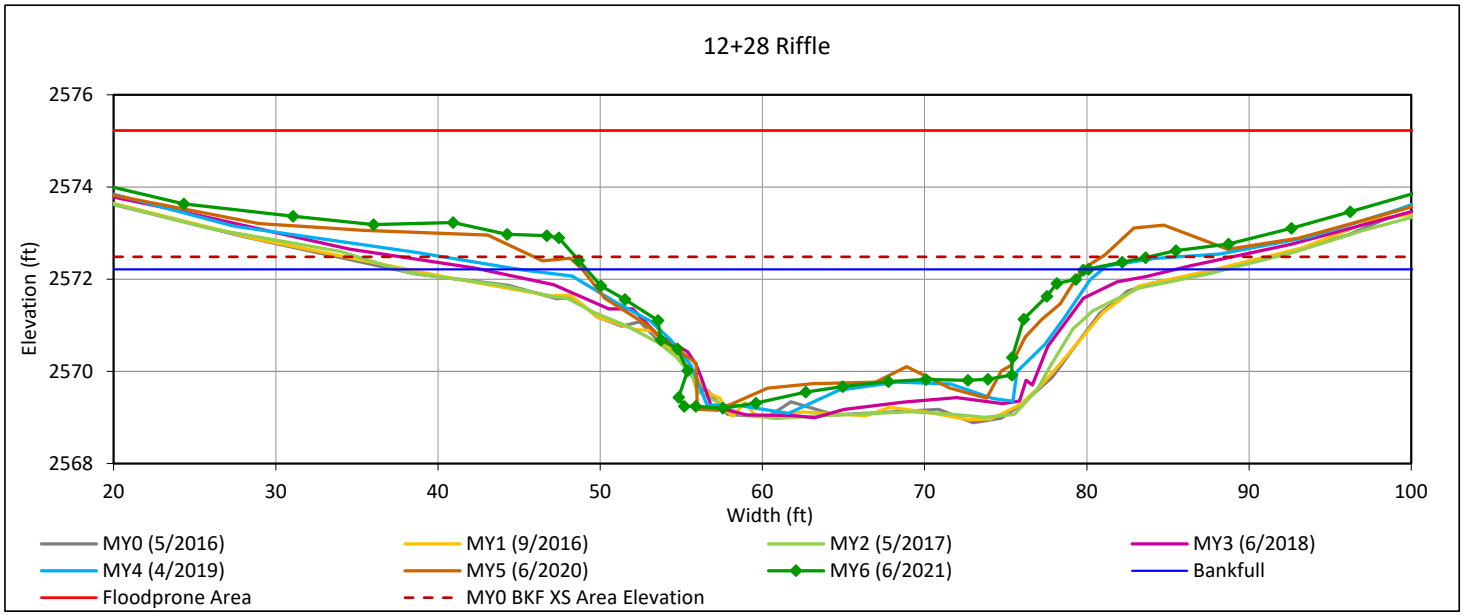
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021

Cross-Section 1 - Glade Creek



Bankfull Dimensions	
61.2	x-section area (ft.sq.)
30.8	width (ft)
2.0	mean depth (ft)
3.0	max depth (ft)
34.4	wetted perimeter (ft)
1.8	hydraulic radius (ft)
15.5	width-depth ratio
102	W flood prone area (ft)
3.3	entrenchment ratio
0.9	low bank height ratio

Survey Date: 6/2021

Field Crew: Wildlands Engineering

View Downstream

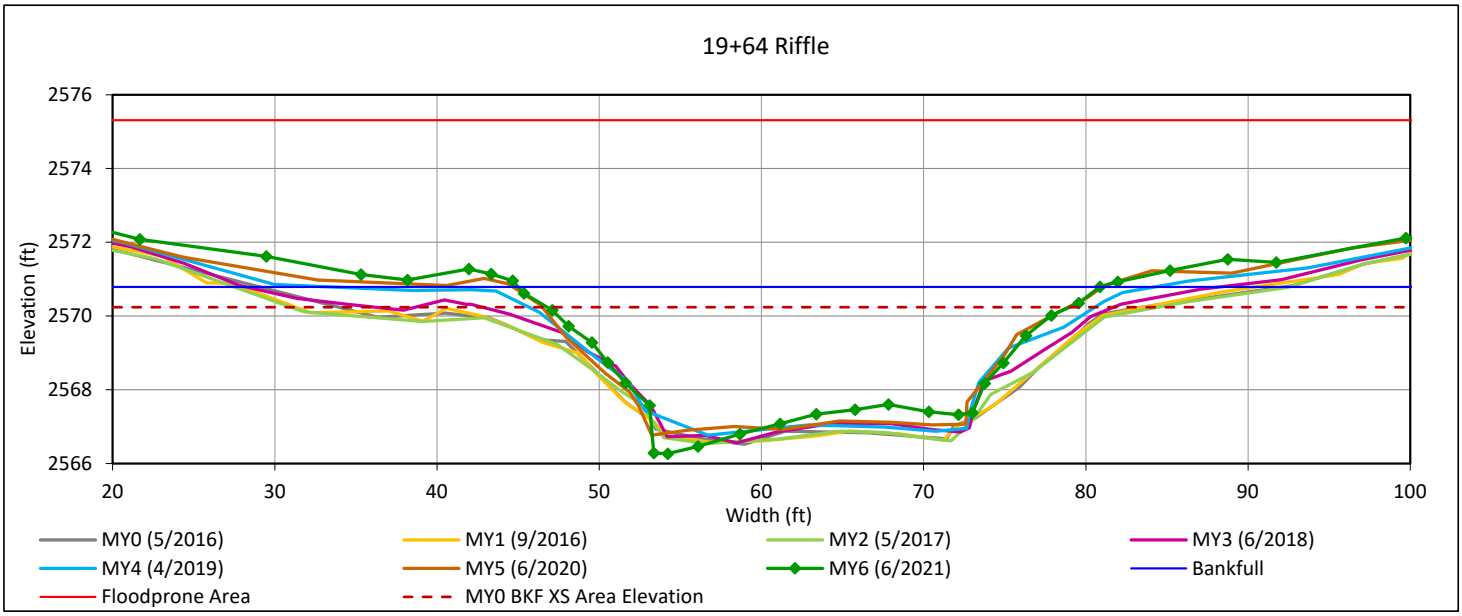
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021

Cross-Section 2 - Glade Creek



Bankfull Dimensions	
95.9	x-section area (ft.sq.)
35.9	width (ft)
2.7	mean depth (ft)
4.5	max depth (ft)
38.5	wetted perimeter (ft)
2.5	hydraulic radius (ft)
13.4	width-depth ratio
97.1	W flood prone area (ft)
2.7	entrenchment ratio
1.1	low bank height ratio

Survey Date: 6/2021

Field Crew: Wildlands Engineering

View Downstream

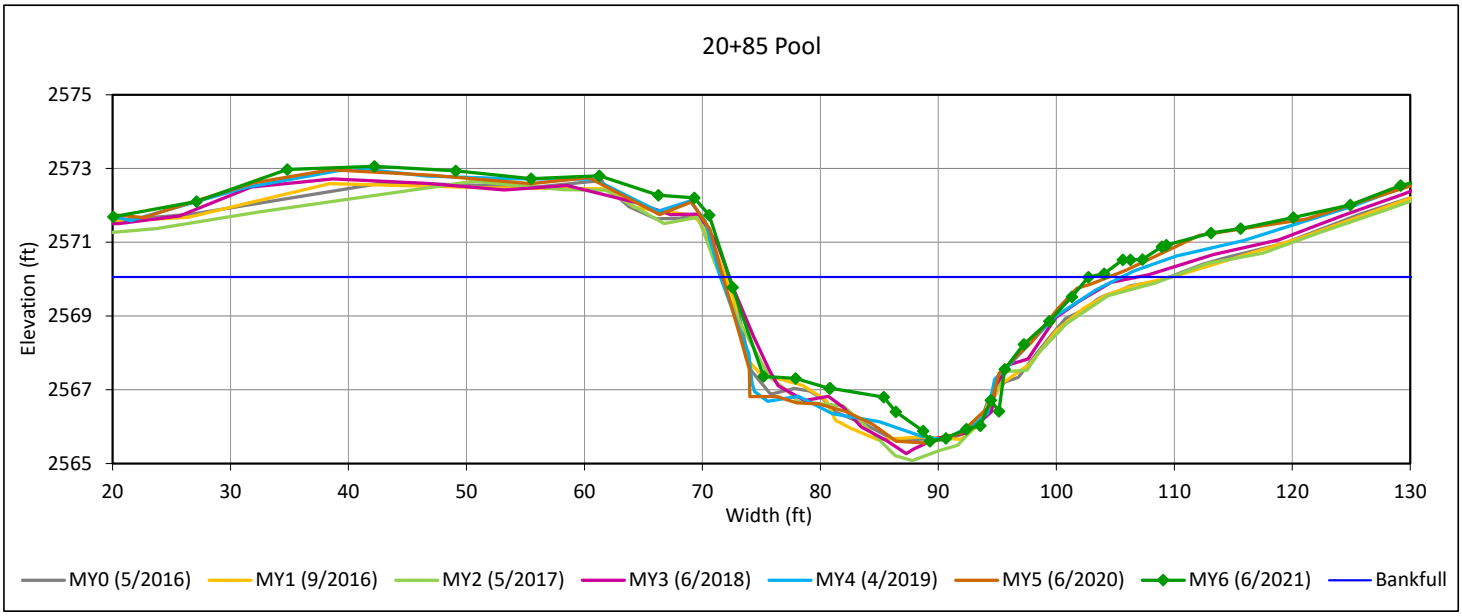
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021

Cross-Section 3 - Glade Creek



Bankfull Dimensions	
83.3	x-section area (ft.sq.)
30.4	width (ft)
2.7	mean depth (ft)
4.5	max depth (ft)
33.2	wetted perimeter (ft)
2.5	hydraulic radius (ft)
11.1	width-depth ratio

Survey Date: 6/2021

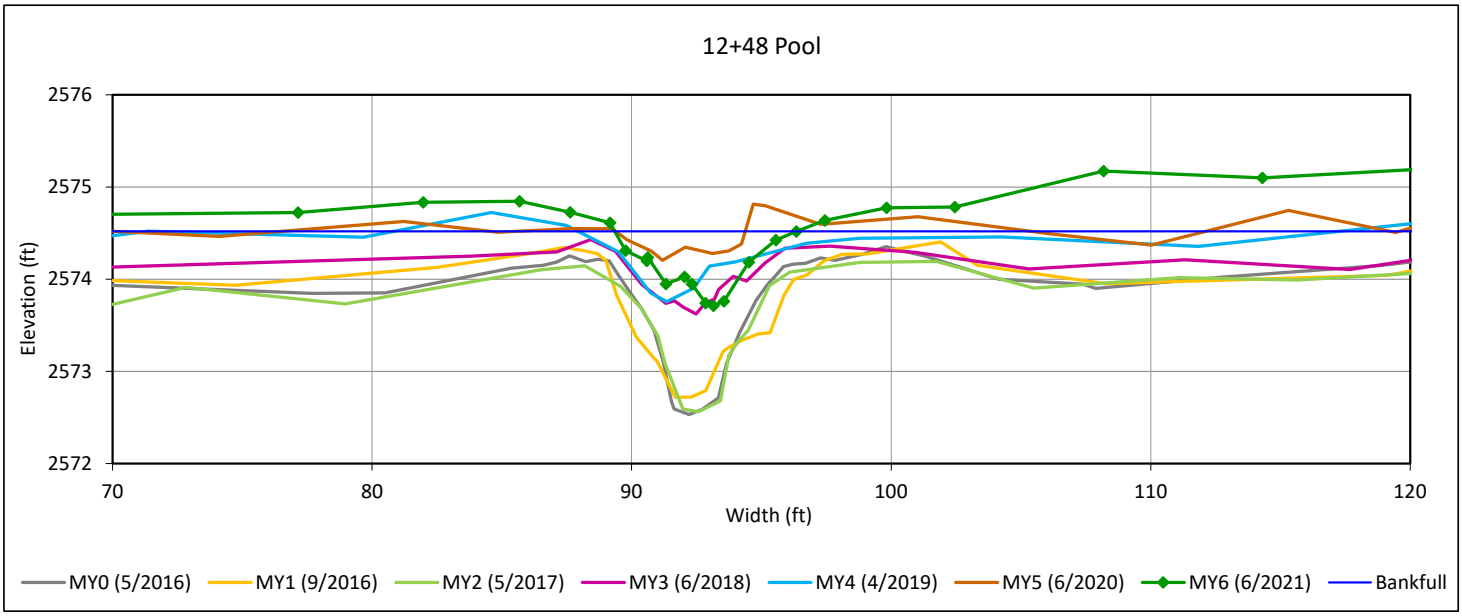
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Cross-Section 4 - UT to Glade Creek



Bankfull Dimensions	
2.8	x-section area (ft.sq.)
7.0	width (ft)
0.4	mean depth (ft)
0.8	max depth (ft)
7.3	wetted perimeter (ft)
0.4	hydraulic radius (ft)
17.5	width-depth ratio

Survey Date: 6/2021
Field Crew: Wildlands Engineering

View Downstream

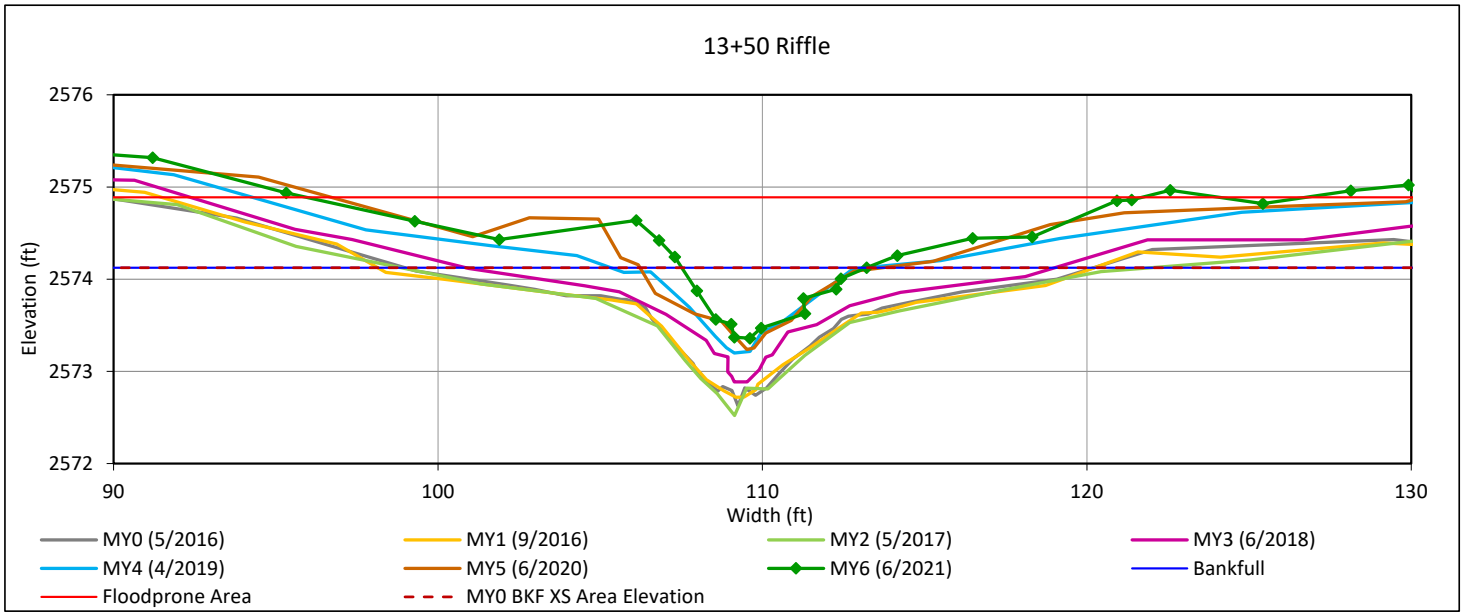
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021

Cross-Section 5 - UT to Glade Creek



Bankfull Dimensions	
2.4	x-section area (ft.sq.)
5.7	width (ft)
0.4	mean depth (ft)
0.8	max depth (ft)
6.2	wetted perimeter (ft)
0.4	hydraulic radius (ft)
13.7	width-depth ratio
29.4	W flood prone area (ft)
5.2	entrenchment ratio
1.0	low bank height ratio

Survey Date: 6/2021

Field Crew: Wildlands Engineering

View Downstream

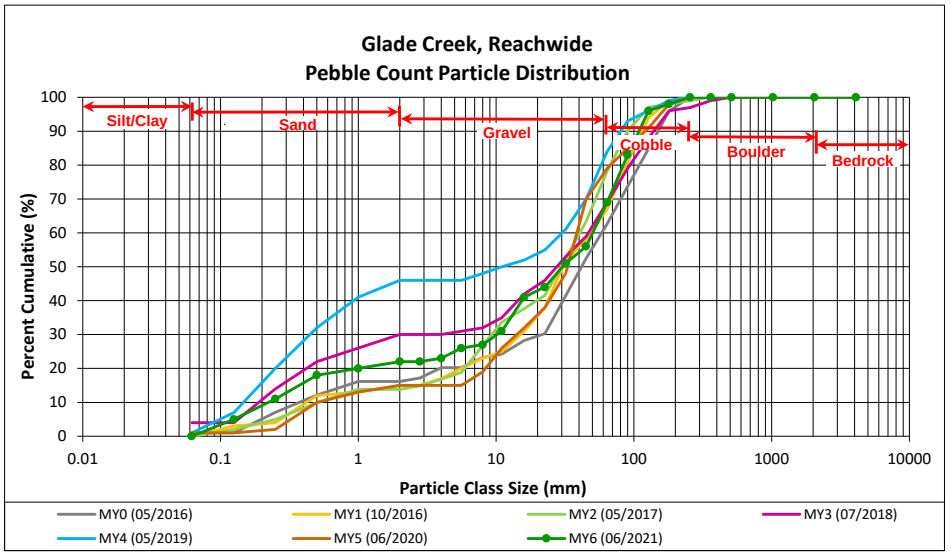
Reachwide and Cross-Section Pebble Count Plots

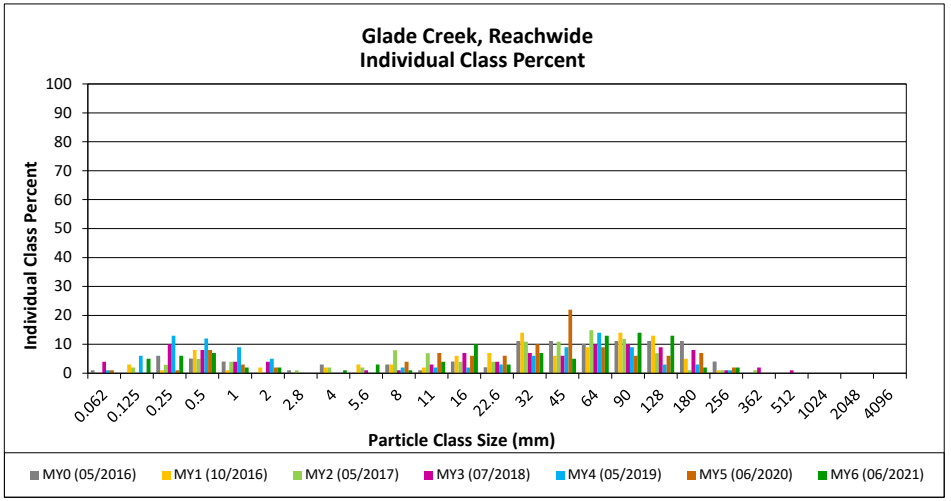
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Glade Creek, 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					0
SAND	Very fine	0.062	0.125		5	5	5	5
	Fine	0.125	0.250		6	6	6	11
	Medium	0.25	0.50		7	7	7	18
	Coarse	0.5	1.0		2	2	2	20
	Very Coarse	1.0	2.0	1	1	2	2	22
GRAVEL	Very Fine	2.0	2.8					22
	Very Fine	2.8	4.0		1	1	1	23
	Fine	4.0	5.6		3	3	3	26
	Fine	5.6	8.0		1	1	1	27
	Medium	8.0	11.0	2	2	4	4	31
	Medium	11.0	16.0	1	9	10	10	41
	Coarse	16.0	22.6		3	3	3	44
	Coarse	22.6	32	7		7	7	51
	Very Coarse	32	45	2	3	5	5	56
	Very Coarse	45	64	11	2	13	13	69
COBBLE	Small	64	90	12	2	14	14	83
	Small	90	128	11	2	13	13	96
	Large	128	180	2		2	2	98
	Large	180	256	1	1	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} =	0.4
D_{35} =	12.8
D_{50} =	30.4
D_{84} =	92.5
D_{95} =	124.6
D_{100} =	256.0





Reachwide and Cross-Section Pebble Count Plots

Glade Creek II Restoration Project

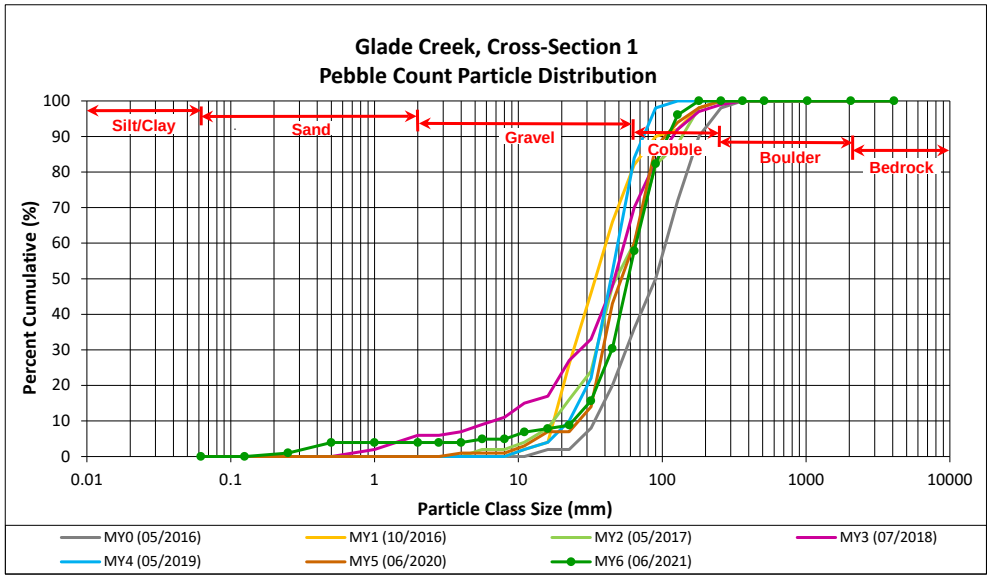
DMS Project No. 92343

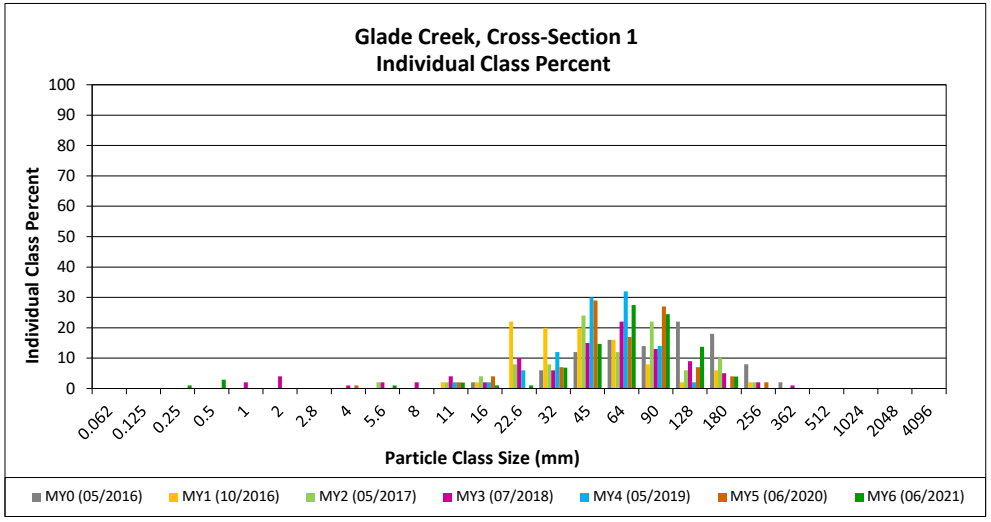
Monitoring Year 6/Closeout - 2021

Glade Creek, Cross-Section 1

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	1	1	1
	Medium	0.25	0.50	3	3	4
	Coarse	0.5	1.0			4
	Very Coarse	1.0	2.0			4
GRAVEL	Very Fine	2.0	2.8			4
	Very Fine	2.8	4.0			4
	Fine	4.0	5.6	1	1	5
	Fine	5.6	8.0			5
	Medium	8.0	11.0	2	2	7
	Medium	11.0	16.0	1	1	8
	Coarse	16.0	22.6	1	1	9
	Coarse	22.6	32	7	7	16
	Very Coarse	32	45	15	15	30
	Very Coarse	45	64	28	27	58
COBBLE	Small	64	90	25	25	82
	Small	90	128	14	14	96
	Large	128	180	4	4	100
	Large	180	256			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	**102**	**100**	**100**

Cross-Section 1	
Channel materials (mm)	
D_{16} =	32.2
D_{35} =	47.7
D_{50} =	57.9
D_{84} =	93.9
D_{95} =	124.5
D_{100} =	180.0





Reachwide and Cross-Section Pebble Count Plots

Glade Creek II Restoration Project

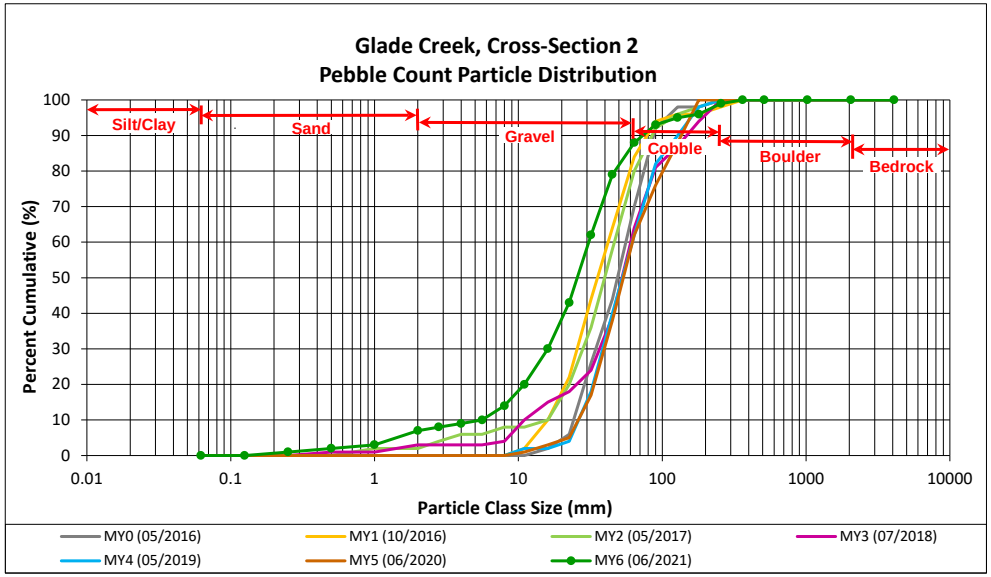
DMS Project No. 92343

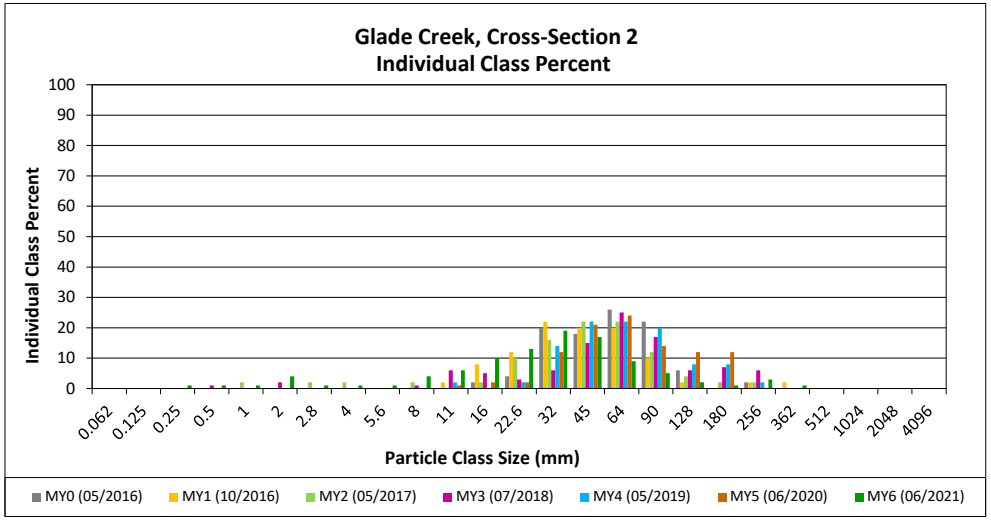
Monitoring Year 6/Closeout - 2021

Glade Creek, 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			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250	1	1	1
	Medium	0.25	0.50	1	1	2
	Coarse	0.5	1.0	1	1	3
	Very Coarse	1.0	2.0	4	4	7
GRAVEL	Very Fine	2.0	2.8	1	1	8
	Very Fine	2.8	4.0	1	1	9
	Fine	4.0	5.6	1	1	10
	Fine	5.6	8.0	4	4	14
	Medium	8.0	11.0	6	6	20
	Medium	11.0	16.0	10	10	30
	Coarse	16.0	22.6	13	13	43
	Coarse	22.6	32	19	19	62
	Very Coarse	32	45	17	17	79
	Very Coarse	45	64	9	9	88
COBBLE	Small	64	90	5	5	93
	Small	90	128	2	2	95
	Large	128	180	1	1	96
	Large	180	256	3	3	99
BOULDER	Small	256	362	1	1	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} =	8.9
D_{35} =	18.3
D_{50} =	25.7
D_{84} =	54.7
D_{95} =	128.0
D_{100} =	362.0





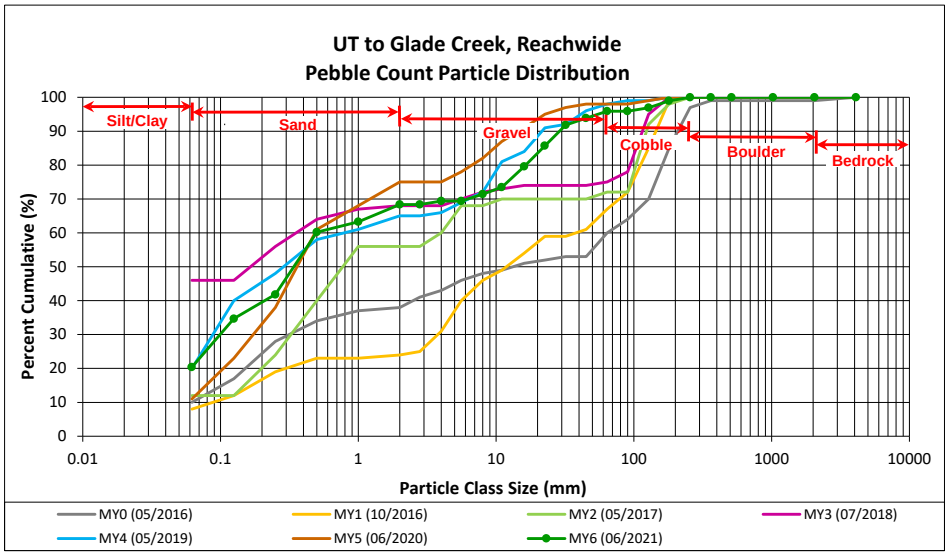
Reachwide and Cross-Section Pebble Count Plots

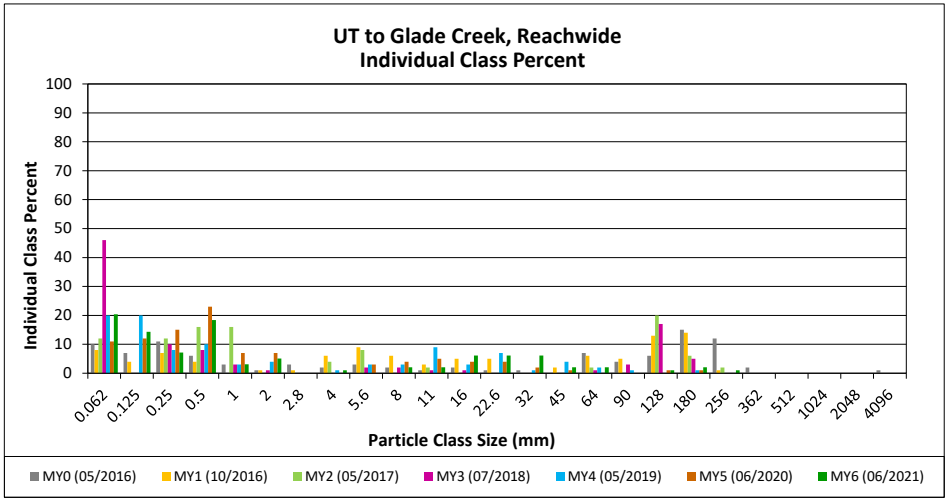
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

UT to Glade Creek, 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	5	15	20	20	20
SAND	Very fine	0.062	0.125	6	8	14	14	35
	Fine	0.125	0.250	4	3	7	7	42
	Medium	0.25	0.50	6	12	18	18	60
	Coarse	0.5	1.0	1	2	3	3	63
	Very Coarse	1.0	2.0	2	3	5	5	68
GRAVEL	Very Fine	2.0	2.8					68
	Very Fine	2.8	4.0	1		1	1	69
	Fine	4.0	5.6					69
	Fine	5.6	8.0	1	1	2	2	71
	Medium	8.0	11.0		2	2	2	73
	Medium	11.0	16.0	5	1	6	6	80
	Coarse	16.0	22.6	5	1	6	6	86
	Coarse	22.6	32	6		6	6	92
	Very Coarse	32	45	2		2	2	94
	Very Coarse	45	64	2		2	2	96
COBBLE	Small	64	90					96
	Small	90	128	1		1	1	97
	Large	128	180	1	1	2	2	99
	Large	180	256	1		1	1	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	**49**	**49**	**98**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	0.1
D_{50} =	0.3
D_{84} =	20.5
D_{95} =	54.6
D_{100} =	256.0





Reachwide and Cross-Section Pebble Count Plots

Glade Creek II Restoration Project

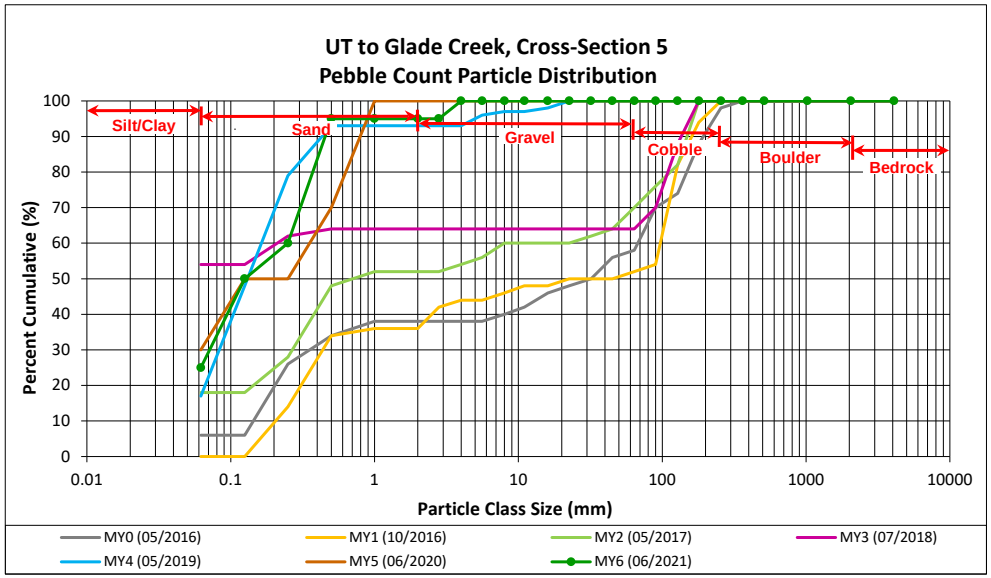
DMS Project No. 92343

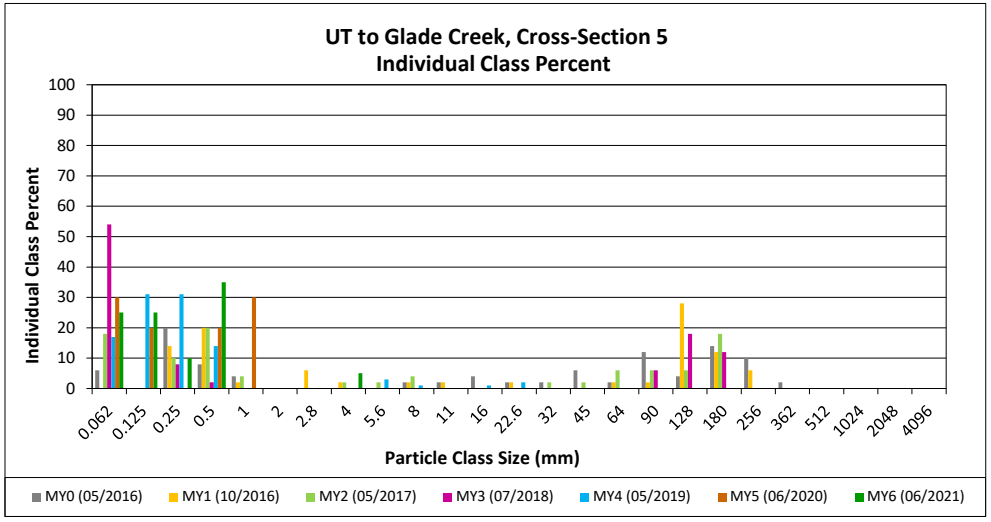
Monitoring Year 6/Closeout - 2021

UT to Glade Creek, Cross-Section 5

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	25	25	25
SAND	Very fine	0.062	0.125	25	25	50
	Fine	0.125	0.250	10	10	60
	Medium	0.25	0.50	35	35	95
	Coarse	0.5	1.0			95
	Very Coarse	1.0	2.0			95
GRAVEL	Very Fine	2.0	2.8			95
	Very Fine	2.8	4.0	5	5	100
	Fine	4.0	5.6			100
	Fine	5.6	8.0			100
	Medium	8.0	11.0			100
	Medium	11.0	16.0			100
	Coarse	16.0	22.6			100
	Coarse	22.6	32			100
	Very Coarse	32	45			100
	Very Coarse	45	64			100
COBBLE	Small	64	90			100
	Small	90	128			100
	Large	128	180			100
	Large	180	256			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 5	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	0.1
D_{50} =	0.1
D_{84} =	0.4
D_{95} =	0.5
D_{100} =	4.0





APPENDIX 5. Hydrology Summary Data and Plots

Table 15. Verification of Bankfull Events

Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Reach	MY of Occurrence	Date of Occurrence	Date of Data Collection	Method
Glade Creek	MY1	6/27/2016	10/4/2016	Crest Gage
	MY2	10/9/2017	12/4/2017	Wrackline
	MY3	2/11/2018	4/2/2018	Wrackline
	MY4	2/24/2019	3/11/2019	Crest Gage
	MY5	5/21/2020	6/8/2020	Wrackline
	MY6	5/26/2021	6/7/2021	Wrackline
UT to Glade Creek	MY1	6/27/2016	10/4/2016	Crest Gage
	MY2	10/9/2017	12/5/2017	Wrackline
	MY3	2/11/2018	4/2/2018	Crest Gage
	MY4	2/24/2019	3/11/2019	Crest Gage
	MY5	5/21/2020	6/8/2020	Crest Gage
	MY6	5/26/2021	6/7/2021	Crest Gage

Table 16. Wetland Gage Attainment Summary

Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 6/Closeout - 2021

Summary of Groundwater Gage Results for MY6						
Gage	Success Criteria Achieved/Max Consecutive Days During Growing Season (%)					
	MY1 (2016)	MY2 (2017)	MY3 (2018)	MY4 (2019)	MY5 (2020)	MY6 (2021)
1	Yes/127 Days (75.6%)	Yes/169 Days (100%)	Yes/169 Days (100%)	Yes/169 Days (100%)	Yes/169 Days (100%)	Yes/169 Days (100%)

Wetland success criteria is 12.5% of growing season (21 consecutive days).

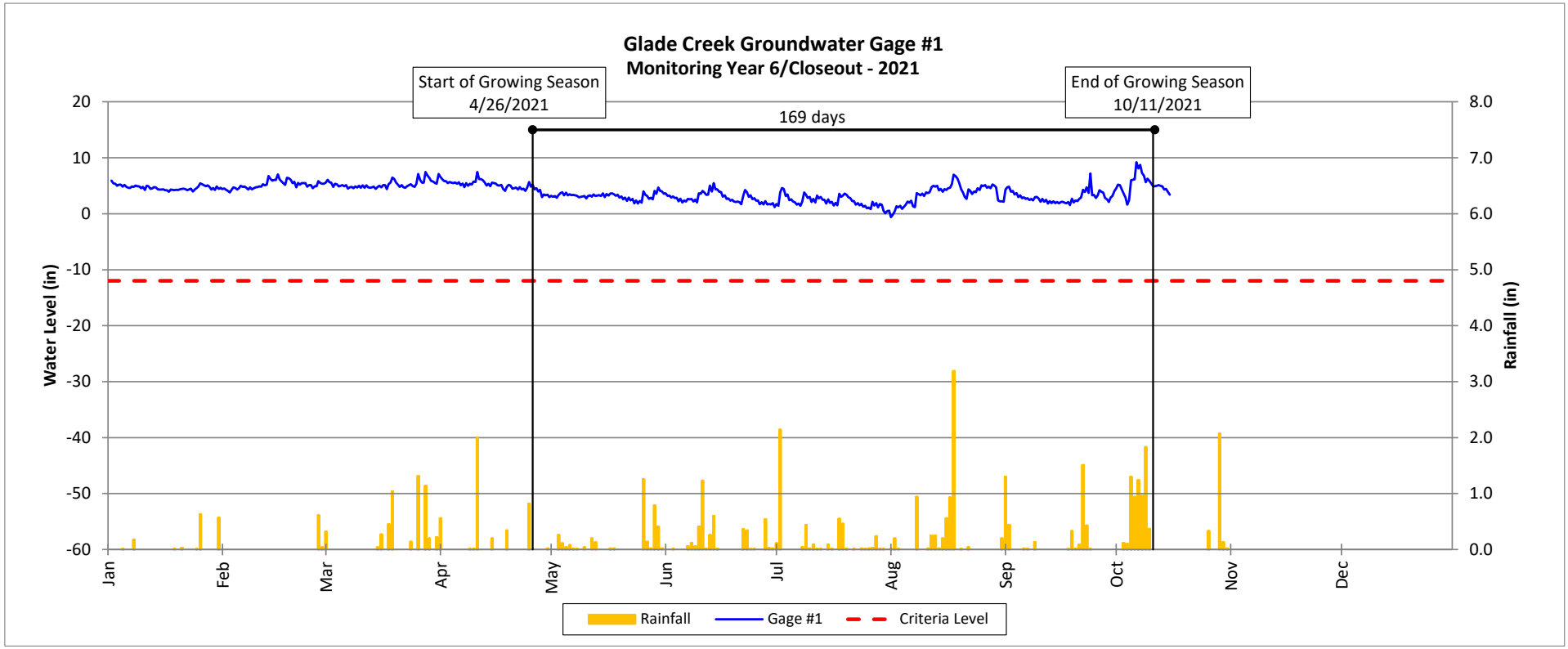
Groundwater Gage Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021

Wetland D

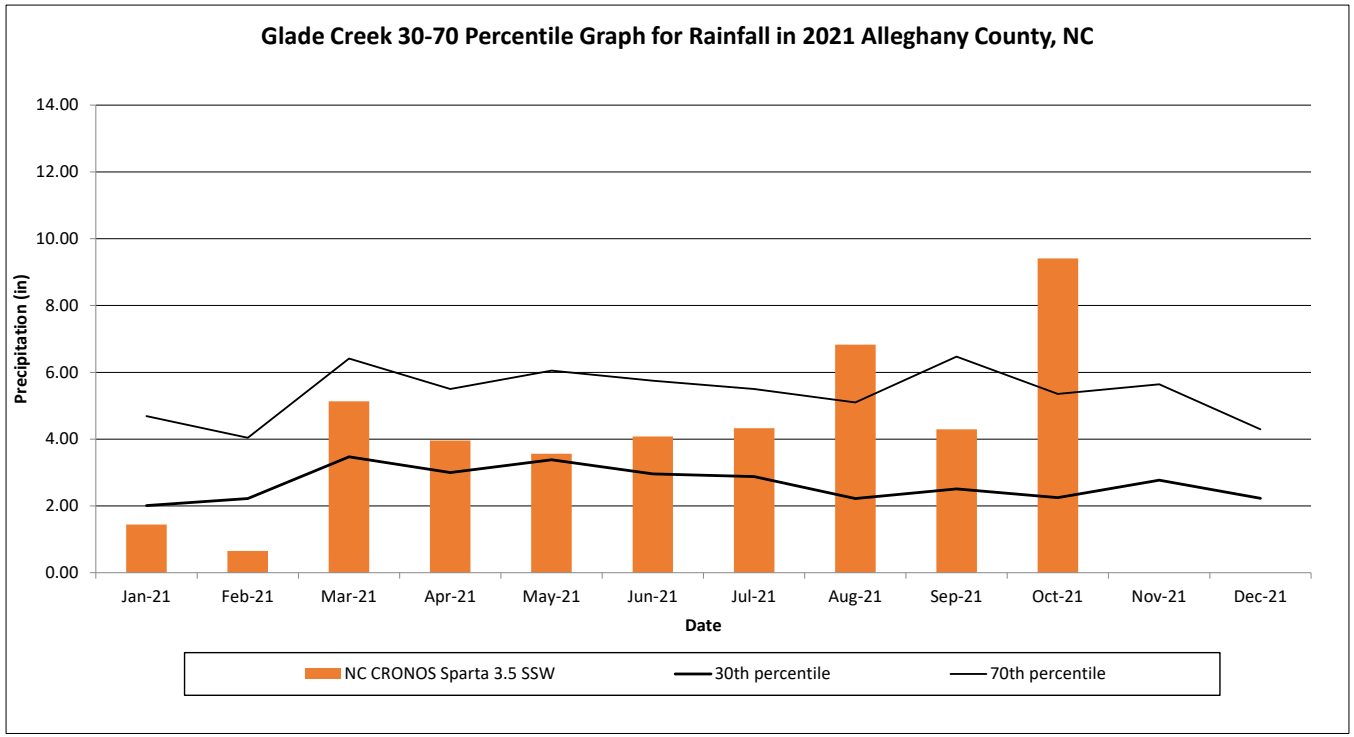


Monthly Rainfall Data

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 6/Closeout - 2021



[1] 2021 rainfall collected from NC CRONOS Station Name: Sparta 3.5 SSW (NCSU, 2021)

[2] 30th and 70th percentile rainfall data collected from weather station Sparta, NC8158 (USDA, 2021)

APPENDIX 6

As-Built Memorandum

Prepared for:	North Carolina Division of Mitigation Services (NC DMS)
Project Title:	Glade Creek II Restoration Project Repairs
Project No:	DMS No. 92343 Wildlands No. W02188
Date:	May 8, 2020

The Glade Creek II Restoration Project was constructed in 2015. During the 2019 IRT post-construction field review of the site, several areas were determined in need of repair. These areas included:

1. Wetland B: outlet headcut (approximate Glade Creek as-built stream station 22+75) and poor woody stem growth (0.74 acres)
2. Undercut brush mattress (approximate Glade Creek as-built stream station 22+95 to 23+50)
3. Left bank hillslope erosion (approximate Glade Creek as-built stream 24+25 to 24+75)

Wildlands Engineering, Inc. (Wildlands) submitted a repair plan for the above areas to NC DMS on April 7, 2020 and received plan approval on April 14, 2020. Wildlands Construction mobilized to the site on April 15, 2020 and demobilized on April 17, 2020. Wildlands installed live stakes on April 22, 2020 and Bruton Natural Systems, Inc. planted tublings, containers, and bare root species on April 25, 2020.

Changes made to the construction plans are detailed on the attached As-Built plan set. Planted woody species deviated from the plan based on nursery availability. Installed species by area and quantity are detailed below.

Riparian Area			
Scientific Name	**Common Name**	**Type**	**Quantity**
Nyssa sylvatica	Black gum	Bare Root	10
Diospyros virginiana	Persimmon	Bare Root	30
Hamamelis virginiana	Witch hazel	Bare Root	25
Acer rubrum	Red maple	Bare Root	40
Betula nigra	River birch	Bare Root	40
Platanus occidentalis	Sycamore	Bare Root	40
		Container	5
Salix nigra	Black willow	Bare Root	15
		Live stake	60-80
Liriodendron tulipifera	Yellow poplar	Container	5
Fraxinus pennsylvanica	Green ash	Container	5
Sambucus canadensis	Elderberry	Container	5
Cornus amomum	Silky dogwood	Container	5
Wetland Area			
Scientific Name	**Common Name**	**Type**	**Quantity**
Viburnum nudum	Possumhaw viburnum	Tubling	76
Alnus serrulata	Tag Alder	Tubling	76
Cephalanthus occidentalis	Buttonbush	Tubling	76
Cornus amomum	Silky dogwood	Tubling	77
Sambucus canadensis	Elderberry	Tubling	45

Brush toe geolift repair, left bank looking downstream

Brush toe geolift repair area from right bank, looking downstream

Wetland B outlet steps

Point bar grading and hillslope repair

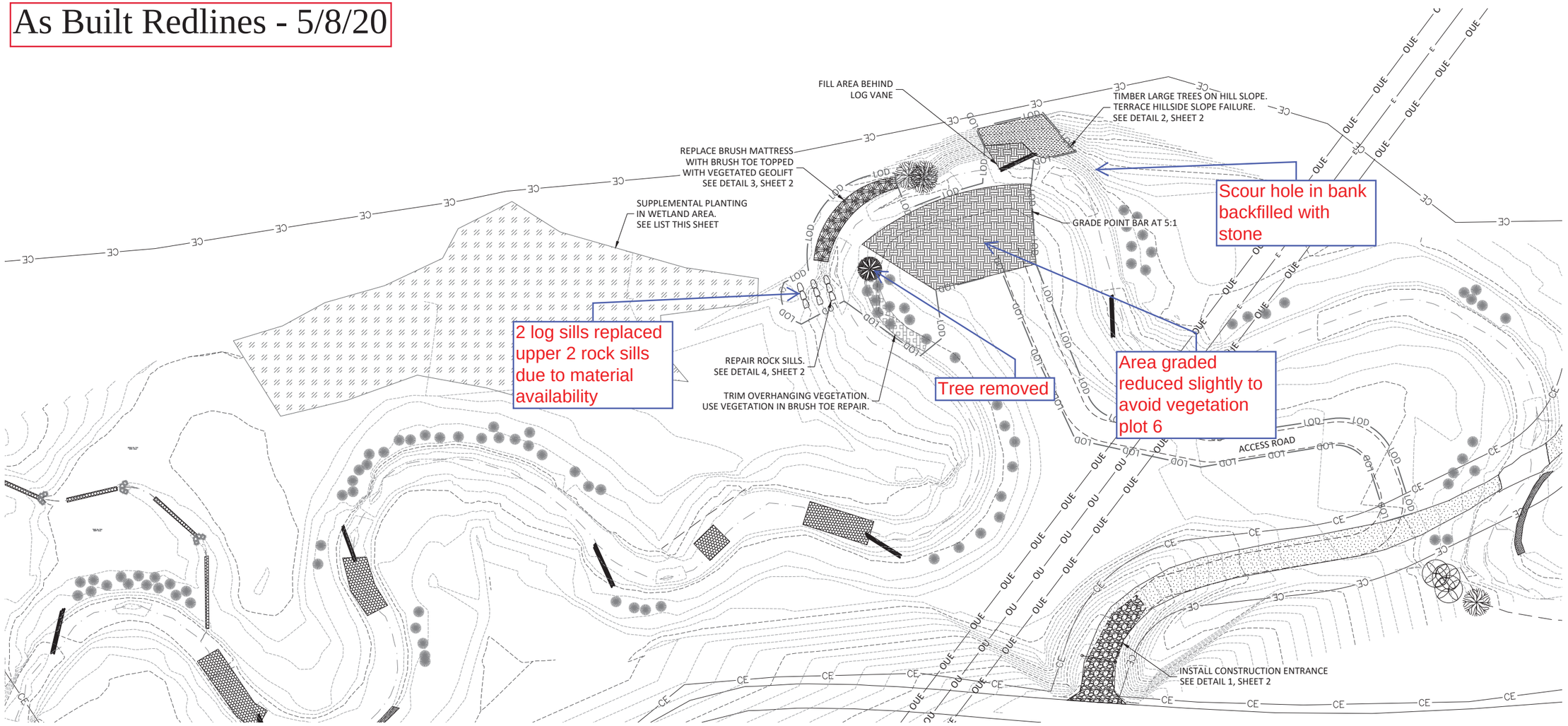
Wetland B planting

Construction access route stabilization

Appendix A:

As-Built Plan Sheets

As Built Redlines - 5/8/20



Planting List

Scientific Name	Common Name	Species Type
*Acer rubrum**	Red Maple	Tree
Alnus serrulata	Tag Alder	Shrub Tree
Carpinus caroliniana	American Hornbeam	Shrub Tree
Cercis canadensis	Eastern Redbud	Shrub Tree
Cornus amomum	Silky Dogwood	Shrub Tree
Diospyros virginiana	American Persimmon	Tree
*Fraxinus pennsylvanica**	Green Ash	Tree
Hamamelis virginiana	Witch Hazel	Shrub Tree
Lirodendron tulipifera	Tulip Poplar	Tree
Nyssa sylvatica	Black Gum	Tree
Physocarpus opulifolius	Nine Bark	Shrub Tree
Platanus occidentalis	Sycamore	Tree
Quercus rubra	Red Oak	Tree
Salix	Willow	Tree
Sambucus canadensis	Common Elderberry	Shrub Tree

*No more than 5% of planting
Planting shall be a mix of bare root and up to 25 container plants within the limits of disturbance.
Supplemental plants in the wetland area shall be bare roots.

See as-built memorandum for installed species list

Approved Date	Type	Planting Rate (lbs/acre)
Jan 1 - May 1	Rye Grain (Secale cereale)	120
	Ground Agricultural Limestone	2000
	10-10-10 Fertilizer	750
	Straw Mulch	4000
May 1 - Aug 15	German Millet (Setaria italica)	40
	Ground Agricultural Limestone	2000
	10-10-10 Fertilizer	750
	Straw Mulch	4000
Aug 15 - Dec 30	Rye Grain (Secale cereale)	120
	Ground Agricultural Limestone	2000
	10-10-10 Fertilizer	1000
	Straw Mulch	4000

Buffer Planting Zone			
Species	**Common Name**	**Stratum**	**Density (lbs/acre)**
Panicum rigidulum	Redtop Panicgrass	Herb	1
Chasmanthium latifolium	River Oats	Herb	1
Elymus virginiana	Virginia Wild Rye	Herb	3
Dichanthelium clandestinum	Deertongue	Herb	3
Sorghastrum nutans	Indiangrass	Herb	3
Schizachyrium scoparium	Little Bluestem	Herb	2
Panicum virgatum	Switchgrass	Herb	1
Rudbeckia hirta	Blackeyed Susan	Herb	1
Bidens aristosa	Showy Tickseed Sunflower	Herb	1
Helianthus angustifolius	Narrowleaf Sunflower	Herb	0.6
Coreopsis lanceolata	Lanceleaf Coreopsis	Herb	1
Chamaecrista fasciculata	Partridge Pea	Herb	1
Heliopsis helianthoides var. helianthoides	Oxeye Sunflower	Herb	1
Juncus tenuis	Path Rush	Herb	0.4

Note:
Permanent Riparian seeding in all disturbed areas within Conservation Easement

N

0' 40' 80' 120'
(HORIZONTAL)

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
License No. P-0831

Glade Creek II Repair
Alleghany County, North Carolina

Details

Revisions:

Date: April 8, 200
Job Number: WI2188
Project Engineer: EGR
Drawn By: JCK
Checked By: CDB

Sheet 1

April 7, 2020

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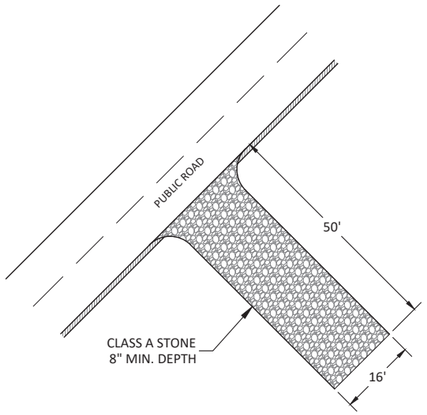
April 7, 2020

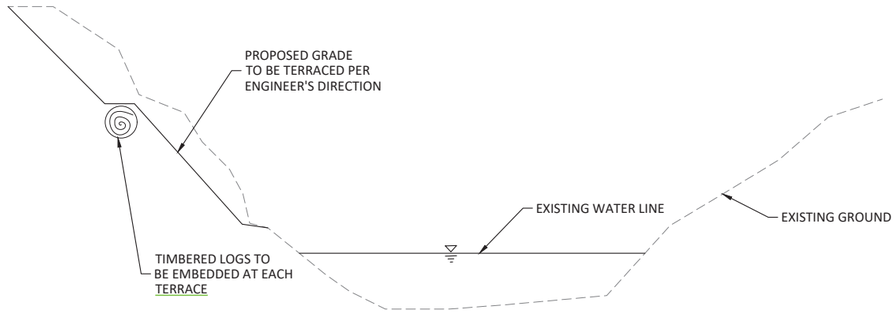
As Built Redlines - 5/8/20



NOTES:

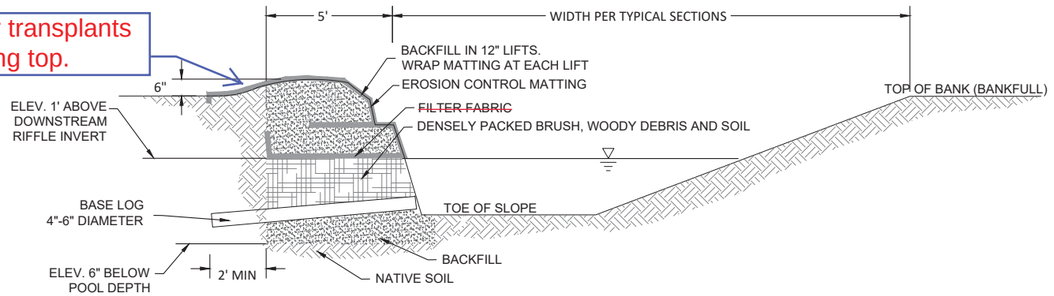
1. PROVIDE TURNING RADIUS SUFFICIENT TO ACCOMMODATE LARGE TRUCKS.
5. LOCATE CONSTRUCTION ENTRANCE AT ALL POINTS OF INGRESS AND EGRESS UNTIL SITE IS STABILIZED. PROVIDE FREQUENT CHECKS OF THE DEVICE AND TIMELY MAINTENANCE.
6. MUST BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR DIRECT FLOW OF MUD ONTO STREETS. PERIODIC TOP DRESSING WITH STONE WILL BE NECESSARY.
7. ANY MATERIAL TRACKED ONTO THE ROADWAY MUST BE CLEANED IMMEDIATELY.
8. USE CLASS A STONE OR OTHER COARSE AGGREGATE APPROVED BY THE ENGINEER.
9. PLACE FILTER FABRIC BENEATH STONE.

1/2 Construction Entrance
Not to Scale

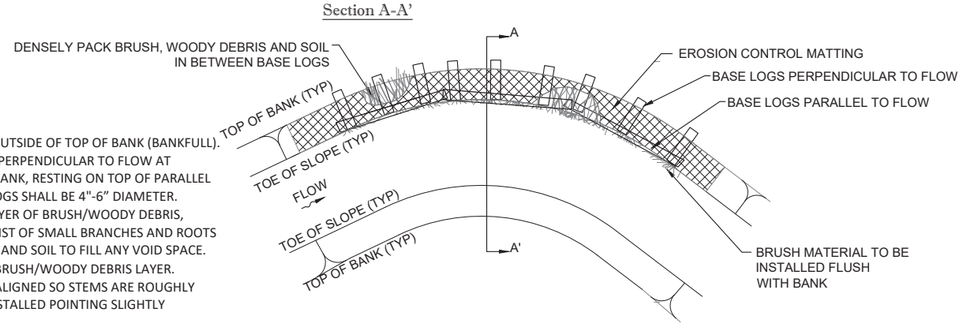


2/2 Terrace Slope
Not to Scale

Row of alder transplants installed along top.



Section A-A'

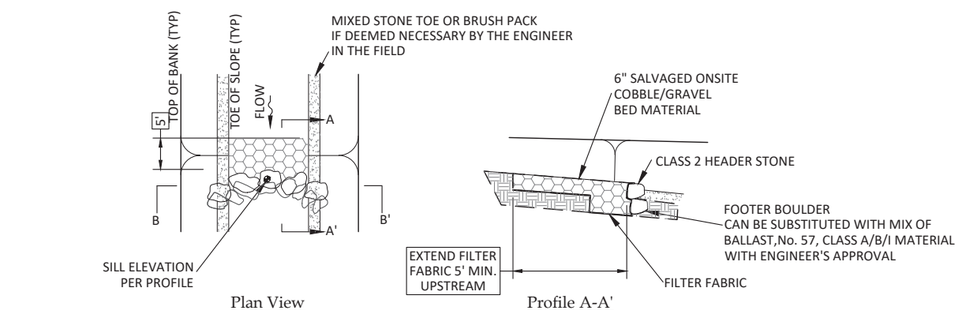


Plan View

NOTES:

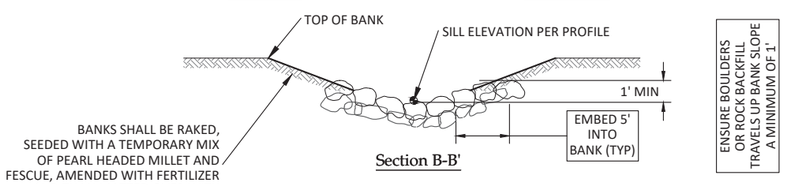
1. OVEREXCAVATE 3' OUTSIDE OF TOP OF BANK (BANKFULL).
2. INSTALL BASE LOGS PERPENDICULAR TO FLOW AT INTERVALS ALONG BANK, RESTING ON TOP OF PARALLEL BASE LOGS. BASE LOGS SHALL BE 4"-6" DIAMETER.
3. INSTALL A DENSE LAYER OF BRUSH/WOODY DEBRIS, WHICH SHALL CONSIST OF SMALL BRANCHES AND ROOTS COLLECTED ON-SITE AND SOIL TO FILL ANY VOID SPACE. LIGHTLY COMPACT BRUSH/WOODY DEBRIS LAYER.
4. BRUSH SHOULD BE ALIGNED SO STEMS ARE ROUGHLY PARALLEL AND IS INSTALLED POINTING SLIGHTLY UPSTREAM.
5. ~~INSTALL FILTER FABRIC OVER BRUSH/WOODY DEBRIS.~~
6. INSTALL A LAYER OF LIVE WHIPS ABOVE BRUSH.
7. BOTTOM OF FIRST COMPACTED EARTH LIFT TO BE PLACED 6" ABOVE NORMAL BASEFLOW.
8. NUMBER OF COMPACTED EARTH LIFTS TO VARY DEPENDING ON DESIGN TOP OF BANK HEIGHT.
9. SEED, MULCH AND INSTALL EROSION CONTROL MATTING AND BANK STABILIZATION PER PLANS.

3/2 Brush Toe
Not to Scale



Plan View

Profile A-A'



Section B-B'

4/2 Rock Sill
Not to Scale

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Glade Creek II Repair
Alleghany County, North Carolina

Details

Revisions:

Date: April 8, 200
Job Number: WI02188
Project Engineer: EGR
Drawn By: ICK
Checked By: CDR

Sheet 2

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APPENDIX 7 – Close Out Photos

April 2020 Repair Photos

LEFT BANK UNDERCUT BRUSH MATTRESS (STA 22+25)

Pre-construction - November 2019

Post construction - June 2020

OUTER BEND EROSION AREA (STA 22+25 to STA 23+25)

Pre-construction - November 2019

Post construction - April 2020

Post construction - Sep 2020

LEFT BANK HILLSLOPE EROSION AREA (STA 23+50)

Pre-construction - November 2019

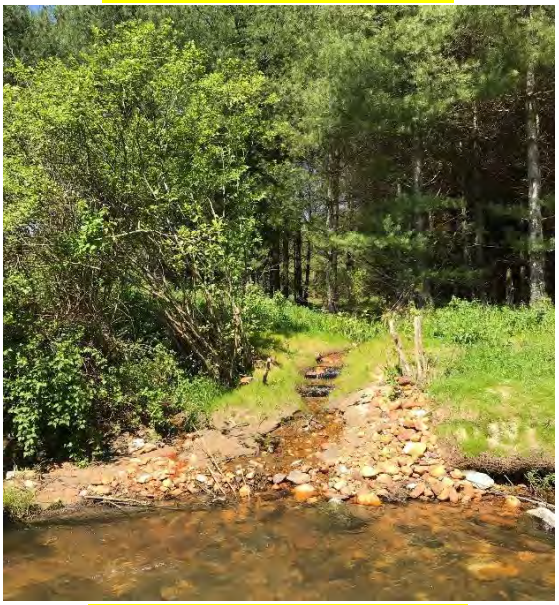
Post construction - April 2020

Post construction - June 2020

Wetland B Outlet Repair (STA 22+00)

Pre-construction - November 2019

Post construction - June 2020

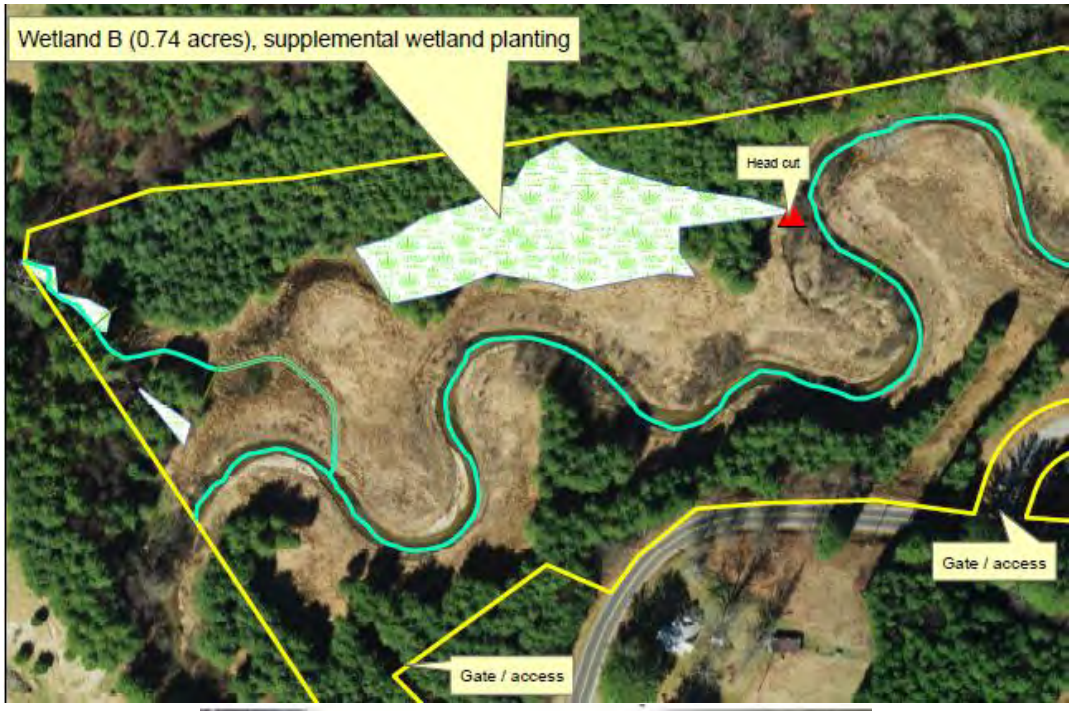


Post construction - August 2020

WETLAND SUPPLEMENTAL PLANTING (Wetland B 350 Stems)

April 2020

Wetland Area			
Scientific Name	**Common Name**	**Type**	**Quantity**
Viburnum nudum	Possumhaw viburnum	Tubling	76
Alnus serrulata	Tag Alder	Tubling	76
Cephalanthus occidentalis	Buttonbush	Tubling	76
Cornus amomum	Silky dogwood	Tubling	77
Sambucus canadensis	Elderberry	Tubling	45



Site-wide Photos

MY6/June 2021

Pre-Construction Glade Creek (May 2006)

As-Built-Construction Glade Creek (January 2016)

Monitoring Year 6 Glade Creek (June 2021)

As-Built-Construction Unnamed Tributary and Wetland B (January 2016)

Monitoring Year 6 / 2021 Unnamed Tributary