Mitigation Project Name	Best Site	County	Duplin	USACE Action ID	2012-01384
DMS ID	95353	Date Project Instituted	8/1/2012	NCDWR Permit No	2013-0865
River Basin	Cape Fear	Date Prepared	5/22/2018		
Cataloging Unit	03030007				

Credit Release Milestone	Stream Credits						Wetland Credits							
	Scheduled Releases (Stream)	Warm	Cool	Cold	Anticipated Release Year (Stream)	Actual Release Date (Stream)	Scheduled Releases (Forested)	Riparian Riverine	Riparian Non-riverine	Non-riparian	Scheduled Releases (Coastal)	Coastal	Anticipated Release Year (Wetland)	Actual Release Date (Wetland)
Potential Credits (Mitigation Plan)		10,213.000						5.330						
Potential Credits (As-Built Survey)		10,177.867						5.250						
1 (Site Establishment)	N/A				N/A	N/A	N/A				N/A		N/A	N/A
2 (Year 0 / As-Built)	30%	3,053.360			2016	2/19/2016	30%	1.575			30%		2016	2/19/2016
3 (Year 1 Monitoring)	10%	1,017.787			2016	4/25/2016	10%	0.525			10%		2016	4/25/2016
4 (Year 2 Monitoring)	10%	1,017.787			2017	10/20/2017	10%	0.525			15%		2017	10/20/2017
5 (Year 3 Monitoring)	10%	1,017.787			2018	4/25/2018	15%	0.788			20%		2018	4/25/2018
6 (Year 4 Monitoring)	5%				2019		5%				10%		2019	
7 (Year 5 Monitoring)	10%				2020		15%				15%		2020	
8 (Year 6 Monitoring)	5%				2021		5%				N/A		2021	
9 (Year 7 Monitoring)	10%				2022		10%				N/A		2022	
Stream Bankfull Standard	10%	1,017.787			2017	10/20/2017	N/A				N/A			
Total Credits Released to Date		7,124.507						3.413						

DEBITS (released credits only)

			Stream Restoration	Stream Enhancement I	Stream Enhancement II	Stream Preservation	Riparian Restoration	Riparian Creation	Riparian Enhancement	Riparian Preservation	Nonriparian Restoration	Nonriparian Creation	Nonriparian Enhancement	Nonriparian Preservation	Coastal Marsh Restoration	Coastal Marsh Creation	Coastal Marsh Enhancement	Coastal Marsh Preservation
Ratios			1	1.5	2.5	5	1	3	2	5	1	3	2	5	1	3	2	5
As-Built Amounts (feet and acres)			5,023.000	1,303.000	812.000	19,807.000	5.250											
As-Built Amounts (mitigation credits)			5,023.000	868.667	324.800	3,961.400	5.250											
Percentage Released			70%	70%	70%	70%	65%											
Released Amounts (feet / acres)			3,516.100	912.100	568.400	13,864.900	3.413											
Released Amounts (credits)			3,516.100	608.067	227.360	2,772.980	3.413											
NCDWR Permit	USACE Action ID	Project Name																
2016-1268	2007-01386	NCDOT TIP U-4751 - Military Cutoff Extension, New Hanover County	2,009.200	169.200		4,595.000												
Remaining Amounts (feet / acres)			1,506.900	742.900	568.400	9,269.900	3.413											
Remaining Amounts (credits)			1,506.900	495.267	227.360	1,853.980	3.413											

Contingencies (if any): None

Signature of Wilmington District Official Approving Credit Release

9/6/18
Date

1 - For NCDMS, no credits are released during the first milestone

2 - For NCDMS projects, the second credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the NCIRT by posting it to the NCDMS Portal, provided the following criteria have been met:

1) Approval of the final Mitigation Plan
2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property
3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan
4) Reciept of necessary DA permit authorization or written DA approval for porjects where DA permit issuance is not required

3 - A 10% reserve of credits is to be held back until the bankfull event performance standard has been met

BEST STREAM AND WETLAND RESTORATION PROJECT
MONITORING REPORT
MONITORING YEAR 4
FINAL

DUPLIN COUNTY, NORTH CAROLINA
CONTRACT NO. 004631 - PROJECT NO. 95353
USACE Action ID No. 2012-01384 -NCDWR Project No. 13-0865

Prepared for:

Division of Mitigation Services

North Carolina Department of Environment and Natural Resources
1652 Mail Service Center
Raleigh, NC 27699-1652

January 2019

302 Jefferson Street, Suite 110
Raleigh, NC 27605

Corporate Headquarters
5020 Montrose Blvd. Suite 650
Houston, TX 77006
Main: 713.520.5400

January 22, 2019

Jeff Schaffer
NC DEQ Division of Mitigation Services
217 West Jones Street
Raleigh, NC 27604

RE: Best Stream and Wetland Restoration Site: MY4 Monitoring Report (NCDMS ID 95353)

Listed below are comments provided by DMS on December 14, 2018 regarding the Best Stream and Wetland Restoration Site: Year 4 Monitoring Report and RES' responses.

1. **Digital drawings**:
   Ensure stream length attributes and wetland acre attributes in the respective shapefiles reflect assets/credits in Table 1 as required by contract and stated in DMS's Format, Data Requirements, and Content Guidance for Electronic Drawings Submitted to EEP version 1.0 (03/27/08).
   The design stream alignment shapefile and the Mitigation Plan wetland restoration shapefile is included in the Support Files.
   Table 5, UT4 shows an area of scour/erosion. Please provide GIS shapefile.
   Done.
   Tables 7 and 8 show stream problem areas and vegetation problem areas but there is no corresponding GIS shapefile. Please provide necessary shapefiles.
   The stream problem areas were repaired in December 2018. The GIS shapefile for the vegetation problem areas is included and labeled "Best_CCPV_Veg_Conditions_MY4".

2. Based on discussions from the 2016 IRT credit release, RES had the choice of submitting a credit modification request to the IRT to use credits based on As-Built or revert to approved mitigation plan credits. During the MY3 review, RES stated that they would not be submitting an asset revision request and would revert to the approved mitigation plan assets. Unfortunately, this was not done when the MY3 report was approved. Based on this, please revise all asset tables in Section 1.3, page 5 and Appendix A Table 1 to approved mitigation plan assets/credits.
   Done.

3. **Section 1.3, page 5**: Revise the first paragraph of this section to reflect that project assets/credits have now been reverted to approved mitigation plan assets/credits. What is in the report now is a regurgitation of what was written last year.
   Done.

4. **Section 5.1.5, page 17**: The report states that “Rainfall data reported by CRONOS station Albert Ellis Airport (KOAJ) indicated rainfall was below average during the months of February, March, June, and September.” Please verify data for September given that Hurricane Florence hit this area in mid- September 2018.
   The Albert Ellis Airport rain gauge malfunctioned during Hurricane Florence. More accurate rain data from the Williamsdale Field Lab was used to supplement the Albert Ellis Airport rain data.

5. **Appendix A**: Please submit Tables 1 through 4 as Excel files per the monitoring guidance.
   Done.

6. **Appendix B, Table 5 (all):** Provide description of red asterisk as footnote or remove if not necessary in both hardcopy and digital files.
   The red asterisk has been removed.

7. **Appendix D**: Make notation on appendix cover sheet and in Table of Contents that Stream Geomorphology Data/monitoring was not required for MY4.
   Done.

8. **Appendix E**:
   2018 Groundwater Monitoring Gauge Hydrographs: In reviewing these hydrographs, it appears that the entire growing season was not observed for the wetland assessment/gauge data collection. Please explain why not.
   The wetland assessment/gauge data only represents 91% of the growing season because the last monitoring site visit for 2018 was October 24. Despite missing data from the last 22 days of the growing season, all wetland gauges met the success criteria.
   Verify rainfall data for September. Looks low based on impacts from Hurricane Florence.
   The Albert Ellis Airport rain gauge malfunctioned during Hurricane Florence. More accurate rain data from the Williamsdale Field Lab was used to supplement the Albert Ellis Airport rain data.

9. Please print this report double-sided.

Best
Duplin County, North Carolina
DMS Project ID 95353

Cape Fear River Basin
HUC 03030007060010

Prepared by:

Resource Environmental Solutions, LLC
302 Jefferson Street, Suite 110
Raleigh, NC 27605
919-209-1061

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Figure 5. Stream Problem Photos
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1 PROJECT GOALS, BACKGROUND AND ATTRIBUTES

1.1 Location and Setting

The Best Stream and Wetland Site is located in Duplin County approximately two miles east of Beulaville, NC (**Figure 1**). To access the downstream end of the site from the town of Beulaville, travel 0.6 miles east on NC HWY 24, take a right onto Lyman Road (SR 1801), and continue 1.6 miles southeast to the crossing with Muddy Creek. Reaches UT7, UT8, UT9, UT10 and the lower end of Muddy Creek may all be accessed from Lyman Road. Reaches UT5 and UT6 are located just south of NC HWY 24, approximately 1.9 miles east of Beulaville. The upstream portion of the site may be accessed from two locations. Reaches UT1, UT2 and Muddy Creek are located to the south of NC HWY 24, opposite of the intersection of NC HWY 24 and Penny Road (SR 1720), approximately 2.8 miles east of Beulaville. To access reaches UT3, UT4 and Muddy Creek, travel 3.2 miles east on NC HWY 24 from Beulaville to Edwards Road (SR 1835), continue south for approximately 1.0 mile, turn right onto Put Lane, and follow the road down to Reaches UT3 and UT4.

1.2 Project Goals and Objectives

The Best stream and wetland mitigation project will provide numerous ecological and water quality benefits within the Cape Fear River Basin. While many of these benefits are limited to the project area, others, such as pollutant removal and improved aquatic and terrestrial habitat, have more far-reaching effects. Expected improvements to water quality, hydrology, and habitat are outlined below.

Design Goals and Objectives

Benefits Related to Water Quality	
Nutrient removal	Benefit will be achieved through filtering of runoff from adjacent CAFOs through buffer areas, the conversion of active farm fields to forested buffers, improved denitrification and nutrient uptake through buffer zones, and installation of BMPs at the headwaters of selected reaches and ditch outlets.
Sediment removal	Benefit will be achieved through the stabilization of eroding stream banks and reduction of sediment loss from field areas due to lack of vegetative cover. Channel velocities will also be decreased through a reduction in slope, therefore decreasing erosive forces.
Increase dissolved oxygen concentration	Benefit will be achieved through the construction of instream structures to increase turbulence and dissolved oxygen concentrations and lower water temperature to increase dissolved oxygen capacity.
Runoff filtration	Benefit will be achieved through the restoration of buffer areas that will receive and filter runoff, thereby reducing nutrients and sediment concentrations reaching water bodies downstream.
Benefits to Flood Attenuation	
Water storage	Benefit will be achieved through the restoration of buffer areas which will infiltrate more water during precipitation events than under current site conditions.
Improved groundwater recharge	Benefit will be achieved through the increased storage of precipitation in buffer areas, ephemeral depressions, and reconnection of existing floodplain. Greater storage of water will lead to improved infiltration and groundwater recharge.
Improved/restored hydrologic connections	Benefit will be achieved by restoring the stream to a natural meandering pattern with an appropriately sized channel, such that the channel's floodplain will be flooded more frequently at flows greater than the bankfull stage.
Benefits Related to Ecological Processes	
Restoration of habitats	Benefit will be achieved by restoring riparian buffer habitat to appropriate bottomland hardwood ecosystem.

Improved substrate and instream cover	Benefit will be achieved through the construction of instream structures designed to improve bedform diversity and to trap detritus. Substrate will become coarser as a result of the stabilization of stream banks and an overall decrease in the amount of fine materials deposited in the stream.
Addition of large woody debris	Benefit will be achieved through the addition of wood structures as part of the restoration design. Such structures may include log vanes, root wads, and log weirs.
Reduced temperature of water due to shading	Benefit will be achieved through the restoration of canopy tree species to the stream buffer areas.
Restoration of terrestrial habitat	Benefit will be achieved through the restoration of riparian buffer bottomland hardwood habitats.

The North Carolina Division of Mitigation Services (NCDMS) develops River Basin Restoration Priorities (RBRP) to guide its restoration activities within each of the state's 54 cataloging units. RBRPs delineate specific watersheds that exhibit both the need and opportunity for wetland, stream and riparian buffer restoration. These TLWs receive priority for DMS planning and restoration project funds. Currently, no Local Watershed Plan (LWP) is available for the project area.

The 2009 Cape Fear River Basin River Basin Restoration Priorities (RPRP) identified HUC 03030007060010 as a Targeted Local Watershed (TLW). The watershed is characterized by 52 percent agricultural land use area with Muddy Creek identified as Impaired for aquatic life because of a Fair benthic community rating. The Best Stream and Wetland Restoration Project was identified as a stream and wetland opportunity to improve water quality, habitat, and hydrology within the TLW.

The project goals address stressors identified in the TLW and include the following:

- Nutrient removal,
- Sediment removal,
- Reducing runoff from animal operations,
- Filtration of runoff, and
- Improved aquatic and terrestrial habitat.

The project goals will be addressed through the following project objectives:

- Establishing riparian buffer areas adjacent to CAFOs,
- Converting active farm field to forested buffers,
- Stabilization of eroding stream banks,
- Improving and protecting portions of headwater systems that discharge to a 303d listed stream,
- Reduction in stream bank slope,
- Restoration of riparian buffer bottomland hardwood habitats, and
- Construction of in-stream structures designed to improve bedform diversity and trap detritus.

The Best stream and wetland mitigation project is located within the northern (upstream) portion of the TLW and includes sections of Muddy Creek (303d listed) and headwater streams that discharge into Muddy Creek. Due to its location and improvements, the project provides numerous ecological and water quality benefits within the Cape Fear River Basin. While many of these benefits are limited to the project area, others, such as pollutant removal and improved aquatic and terrestrial habitat, have more far-reaching effects. Many of the project design goals and objectives, including restoration of riparian buffers to filter runoff from agricultural operations and improve terrestrial habitat, and construction of in-stream structures to improve habitat diversity, addresses the degraded water quality and nutrient input from farming that were identified as major watershed stressors in the 2009 Cape Fear RBRP.

1.3 Project Structure

Following 2016 monitoring the NCIRT requested a review of the differential between the Approved Mitigation Plan and Baseline Monitoring Report. RES does not plan on submitting an asset revision and will revert to the Approved Mitigation Plan assets. The assets under the "Proposed SMUs" and "Proposed WMUs" are the Approved Mitigation Plan assets.

Reach	Mitigation Type*	Proposed Length (LF)	Mitigation Ratio	Proposed SMUs	Baseline SMUs
UT1	P1 Restoration	1,723	1:1	1,723	1,757
UT1	SP & BE	303	1:5	61	56
UT2	P1 Restoration	2,770	1:1	2,770	2,772
UT2	SP & BE	309	1:5	62	66
UT3	Enhancement II	812	1:2.5	325	325
UT3	SP & BE	64	1:5	13	13
UT4	HV Restoration	510	1:1	510	494
UT4	SP & BE	655	1:5	131	129
UT5	SP & BE	4,043	1:5	809	809
UT6	Enhancement I	538	1:1.5	359	359
UT7	SP & BE	3,183	1:5	637	637
UT8	Enhancement I	825	1:1.5	550	510
UT8	SP & BE	313	1:5	63	63
UT9	SP & BE	1,171	1:5	234	221
UT10	SP & BE	768	1:5	154	154
Muddy Creek	SP & BE	9,073	1:5	1,815	1,815
	Total	**27,060**		**10,213**	**10,178**

*P1=Priority 1, SP & BE= Steram Preservation and Buffer Enhancement, HV= Headwater Valley
**The contracted amount of credits for this Site is 10,133 SMUs

Wetland	Mitigation Type	Mitigation Area (ac)	Mitigation Ratio	Proposed WMUs	Baseline WMUs
W1	Restoration	3.66	1:1	3.66	3.77
W2	Restoration	0.29	1:1	0.29	0.31
W3A	Restoration	0.58	1:1	0.58	0.58
W3B	Restoration	0.59	1:1	0.59	0.59
	Total	**5.12**		**5.12**	**5.25**

*The contracted amount of credits for this Site is 4.40 WMUs

1.3.1 Restoration Type and Approach

UT1

Priority Level 1 restoration was completed for UT1 to address all existing impairments, particularly the greatly oversized channel and lack of bedform diversity. The design approach included meandering the channel within the natural valley and backfilling the existing stream. A minimum 50 foot buffer was established and planted with native riparian vegetation. Because the pre-existing buffer was devoid of significant woody vegetation, woody debris was installed along the bed to

improve in-stream habitat. Livestock was excluded with fencing installed along the easement boundary. An existing CMP culvert located along the middle of the reach was removed and replaced downstream at station 13+75 to allow the landowner access to both sides of the property. Stream Preservation and Buffer Enhancement was completed for the downstream section of the channel where it flows through a forested buffer down to the confluence with Muddy Creek. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

UT2

Similar to UT1, Priority 1 restoration was completed for UT2 to address historic straightening and channel enlargement. The existing channel was backfilled, and the restored channel was relocated such that it meanders within the existing valley. A diffuse flow structure was installed at the ditch adjacent to the proposed crossing. The structure was placed such that flows from the existing ditch will be attenuated to establish sheet flow as the water enters the restored channel. All areas within the minimum 50 foot buffer were planted with native riparian vegetation. An existing 60” CMP culvert located at station 20+25 of the reach was removed and replaced with a 48” HDPE culvert to allow the landowner access to the entire property. Additionally, the existing culvert at the upstream end of UT2 was upgraded to a 48” HDPE culvert and reset to more effectively transition the existing channel upstream into the project stream. Priority Level I restoration was appropriate for this channel because it was the only mitigation approach that would address bed and bank instability, establish a forested riparian buffer, and significantly enhance aquatic habitat. Stream Preservation and Buffer Enhancement was completed for the most downstream section, where the channel enters the existing forested buffer, down to its confluence with Muddy Creek. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

UT3

Enhancement Level II was completed on Reach UT3 due to the channel’s stability and appropriate size. The design approach on this reach focused on improving the riparian buffer. The existing hog lagoon located within buffer on the west side of the reach has remained in place, preventing the generation of stream credits for approximately 600 linear feet. Through this section, the left buffer was extended out to a minimum of 75 feet along the left bank, and the right buffer was extended just past top of bank. The existing crossing located at station 8+50 was replaced and upgraded with a 30” HDPE pipe, allowing the landowner continued access across his property. Additional bank grading

and stabilization was included in the culvert replacement. The grading of pools and the installation of woody debris structures was performed along the reach to improve aquatic habitat. Upstream of the crossing, a 75-foot buffer was restored along the east bank where the channel currently flowed through an active pasture. A 100-foot buffer was implemented for the headwater origin point to further protect water quality from cattle access. Cattle have been excluded with fencing. All areas within the buffer were planted with native riparian vegetation. Stream Preservation and Buffer Enhancement was implemented along the downstream end where the channel enters the Muddy Creek floodplain. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

UT4

Headwater valley restoration was completed for the upper section of UT4. The existing channel was backfilled, and flow was directed from its current position east back to the historic valley location. A minor amount of earthwork was completed in the headwater valley restoration apart from ditch plugging to tie the existing ditch back to the natural valley. Areas within the 100 foot buffer that were disturbed or lacked riparian vegetation were planted. Cattle were excluded from the buffer through the installation of fencing. An existing 15” CPP culvert crossing located at station 8+50 of the reach was removed and replaced with triple 18” HDPE culverts. This crossing was relocated to the low spot in the valley to allow the landowner continued access to an agricultural field west of the channel. Downstream of the crossing, a smaller low flow channel was constructed within the natural valley. This segment now connects the upstream headwater valley section to the existing channel approximately 230 feet below the crossing. Due to the stable nature of the buffer along the downstream reach of UT4, Stream Preservation and Buffer Enhancement was implemented from just downstream of the crossing to the confluence with Muddy Creek. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

UT5

Stream Preservation and Buffer Enhancement was completed on UT5. The channel is stable throughout the easement and provides a variety of aquatic habitats. The easement boundary extends a minimum of 50 feet outward from the stream channel, or the limit of adjacent riparian wetlands, whichever is wider. The riparian buffer is an intact hardwood forest with localized areas of privet. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional

treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

UT6

Enhancement Level I was completed on UT6. The mitigation approach on this reach focused on bank stabilization, bedform diversity, and improving the riparian buffer. The existing channel was impaired by channelization, vertical un-vegetated banks, and a dense privet understory within the buffer. The grading of pools, grade control structures, and the installation of woody debris structures were implemented along the reach to improve aquatic habitat. All disturbed areas within the riparian buffer were planted with native riparian vegetation.

UT7

Stream Preservation and Buffer Enhancement was completed on UT7. The channel is stable throughout the easement and provides a variety of aquatic habitats. The easement boundary extends a minimum of 50 feet outward from the stream channel, or the limit of adjacent riparian wetlands, whichever is wider. The riparian buffer is an intact hardwood forest with localized areas of privet. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

UT8

Enhancement Level I was completed on UT8. The mitigation approach on this reach focused on bank stabilization, bedform diversity, and riparian buffer restoration. The existing channel was impaired by channelization, localized bank instability, and cleared agricultural land in the buffer. Stabilization activities included grading a floodplain bench, installing grade control structures, and installing woody debris structures to improve hydraulic efficiency and aquatic habitat. All disturbed areas within the riparian buffer were planted with native riparian vegetation. Stream Preservation and Buffer Enhancement was completed on 313 linear feet where the channel enters the existing forested buffer, down to its confluence with Muddy Creek. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

UT9
Stream Preservation and Buffer Enhancement was completed on UT9. The stream is channelized, but stable throughout the easement. The active channel is meandering within the larger excavated channel bottom. The riparian buffer is intact hardwood forest with localized areas of privet. The easement boundary extends a minimum of 50 feet outward from the stream channel, or to the limit of adjacent riparian wetlands, whichever is wider. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

UT10
Stream Preservation and Buffer Enhancement was completed on UT10. The channel is stable throughout the easement and provides a variety of aquatic habitats. The easement boundary extends a minimum of 50 feet outward from the stream channel, or the limit of adjacent riparian wetlands, whichever is wider. The riparian buffer is an intact hardwood forest with localized areas of privet. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

Muddy Creek
Stream Preservation and Buffer Enhancement was completed for the majority of Muddy Creek. The buffer was restored and increased to a width of 75 feet along the south side. Buffer enhancement activities included the treatment of invasive exotic species by herbicide applications and/or mechanical control as well as planting bare root seedlings in sparsely vegetated areas. RES will continue to conduct invasive species treatments on an as needed basis. Additional treatments will be dependent on monitoring results and regulatory agency guidance. These treatments will be timed in accordance with specific invasive exotic plant phenology for the most effective control. Considering such factors as the influence of established invasive exotics on adjacent land, it is not feasible to expect complete eradication of the targeted invasive species. However, RES does expect to achieve significant reduction of targeted invasive exotic species through this control plan. The goal of the treatment program is control of invasive exotic species such that the target natural communities are present and on a positive trajectory at project closeout.

Wetland W1
Wetland W1 is located at the headwater of UT1 and has a natural constriction at the outlet. The soil is a sandy loam/loamy sandy underlain by clayey textured subsoil that forms an effective restrictive

layer to groundwater loss. This area receives runoff from NC HWY 24. Based upon soil and landscape position, it is likely this area has a seasonal seepage along the upper boundary.

Site modifications included removal of dredged and excavated materials, plugging the ditch, and raising the streambed elevation to bring the water table closer to the ground surface. Additional temporal habitat was constructed to eliminate surface leveling and smoothing for agricultural use. The temporal habitat is variable to mimic sloughs, oxbows, root-tips and other shallow natural features. During monitoring, beaver activity will be controlled to allow the site to stabilize and vegetative community to establish. After the monitoring period, the site is designed to promote and tolerate beaver activity. No hydrologic trespass is anticipated due to beaver activity in this wetland. These modifications will increase storage and eliminate the rapid loss of surface water. This area may receive limited overbank flows due to location in the headwater of UT1. Subsoil ripping and roughing of the soil surface were performed to ameliorate soil compaction and create an uneven surface more conducive for surface water retention, infiltration, and increase storage that would be present in natural wetland systems.

Wetland W2
Wetland W2 is located at the toe slope along Muddy Creek and UT2. The soil is a sandy loam/loamy sandy underlain by sandy clay loam and sandy clay. This site is at a low elevation and is influenced by the water table on the floodplain of Muddy Creek. It is unlikely that groundwater loss is significant during most of the year. This area has a small watershed, but flooding from UT2 and Muddy Creek will increase hydrologic storage.

Hydrology was restored by removing dredge material along the channel and raising the streambed elevation, bringing the water table closer to the ground surface. Site modifications included subsoil ripping, crown removal, and surface roughing of the area. Additional temporal habitat was constructed to eliminate the surface leveling and smoothing for agricultural use. The temporal habitat is variable to mimic sloughs, root-tips and other shallow natural features. This ameliorates past soil leveling and compaction and creates an uneven surface more conducive of infiltration and storage that would be present in natural wetland systems.

Wetland W3
Wetland W3 is composed of two similar area (W3a and W3b) located at the toe slope along Muddy Creek. A low finger of soil separates them. The soil in these areas is a loamy sand/sandy loam. The surrounding upland is underlain by clayey subsoil that forms an effective restrictive layer that lateral flow rides provide additional hydrological input. A ditch is located upslope of these areas and alongside W3a that drains to Muddy Creek.

The soil is a sandy loam/loamy sand. The surrounding upland has a sandy clay loam and sandy clay that form an effective restrictive layer that lateral flow rides provide additional hydrological input. Both areas have small watersheds, but W3b receives groundwater seepage along the toe of slope diverted by the upslope ditch.

Hydrology was restored by filling ditches and enhancing the concave topography by removing soil material where cultivation had filled low features and leveled the surface to facilitate cultivation. Additional groundwater seepage diverted by the ditch was restored to these wetlands. Temporal habitat was constructed to eliminate the surface leveling and smoothing for agricultural use. Subsoil ripping and surface roughing of the area was performed to ameliorate soil compaction and create an uneven surface more conducive of infiltration and storage that would be present in natural wetland systems.

1.4 Project History, Contacts and Attribute Data

1.4.1 Project History

The Best Stream and Wetland Restoration Site was restored by Resource Environmental Solutions, LLC (RES) through a full-delivery contract awarded by NCDMS in 2012. **Tables 2, 3, and 4** in **Appendix A** provide a time sequence and information pertaining to the project activities, history, contacts, and baseline information.

1.4.2 Project Watersheds

The easement totals 142.7 acres and the project streams include ten unnamed tributaries to Muddy Creek and a portion of Muddy Creek extending from approximately 0.3 miles west of Edwards Road to 0.4 miles past Lyman Road. The total drainage area at the downstream limits of the project is 2,928 acres (4.58 mi^2). The land use in the project watershed is approximately 47 percent cultivated cropland, 21 percent evergreen and deciduous forest, 13 percent shrub/scrub, ten percent bottomland forest/hardwood swamp, three percent developed, and six percent managed herbaceous cover and pasture.

UT1 has a drainage area of 0.06 square miles (41 acres), and flows in a southerly direction to the confluence with Muddy Creek. UT2 flows south to its confluence with Muddy Creek and has a drainage area of 0.23 square miles (146 acres). UT3 is located to the south of Muddy Creek, opposite of UT2, and flows to the north and into Muddy Creek. This reach has a drainage area of 0.09 square miles (56 acres). UT4 is located to the west of UT3 and discharges to Muddy Creek. This reach has a drainage area of 0.13 square miles (82 acres). UT5 flows in a southerly direction from NC HWY 24 to Muddy Creek and has a drainage area of 0.59 square miles (380 acres). UT6 flows southeast to its confluence with UT5 and has a drainage area of 0.12 square miles (79 acres). UT7 flows in a southerly direction east of Lyman Road down to its confluence with UT5 before discharging to Muddy Creek. UT7 has a drainage area of 0.60 square miles (387 acres). UT8 has a drainage area of 0.09 square miles (56 acres), and flows in an easterly direction through a cultivated field east of Lyman Road down to the confluence with UT7. UT9 flows southeast to its confluence with Muddy Creek and has a drainage area of 0.06 square miles (36 acres). UT10 is the downstream-most tributary within the Best Site and flows in a westerly direction from a farm crossing west of Lyman Road down to Muddy Creek. UT10 has a drainage area of 0.48 square miles (306 acres). Muddy Creek is a stable swamp stream system with intact hardwood forest floodplain, extending from approximately 0.3 miles west of Edwards Road to 0.5 miles south of Lyman Road. Muddy Creek has a drainage area of 4.6 square miles (2,930 acres) at the downstream limits and has an existing length of 9,214 linear feet.

2 Success Criteria

The success criteria for the Best Site will follow accepted and approved success criteria presented in the USACE Stream Mitigation Guidelines and subsequent NCDMS and agency guidance. Specific success criteria components are presented below.

2.1 Stream Restoration

2.1.1 Bankfull Events

Two bankfull flow events must be documented within the seven-year monitoring period. The two bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until

two bankfull events have been documented in separate years. Bankfull events will be documented using crest gauges, auto-logging crest gauges, photographs, and visual assessments for evidence of debris rack lines.

2.1.2 Cross Sections

There should be little change in as-built cross-sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion), or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Starting in MY3, BHR was calculated on riffles using the baseline bankfull elevation. This method was used because the dimension of the channels has not changed enough to alter the bankfull elevation. None of the restoration riffle cross sections exceeded a 1.2 BHR. Two cross sections on Enhancement I reaches did exceed 1.2 but both have baseline bankfull elevations below top of bank. Cross-sections are classified using the Rosgen stream classification method, and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

2.1.3 Bank Pin Arrays

Bank pin arrays will be used as a supplemental method to monitor erosion on selected meander bends where there is not a cross section. Bank pin arrays will be installed along the outer bend of the meander. Bank pins will be installed just above the water surface and every two feet above the lowest pin. Bank pin exposure will be recorded at each monitoring event, and the exposed pin will be driven flush with the bank, there should be little change in as-built cross-sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion), or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen stream classification method, and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

2.1.4 Digital Image Stations

Digital images are used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal images should not indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

2.2 Wetland Restoration

Success criteria and monitoring for wetland hydrology within the wetland restoration areas on the site follows NCDMS Guidance dated 7 November 2011. The target minimum wetland hydroperiod is 9 percent of the growing season. Stream hydrology and water balance calculations indicate the wetland area will meet jurisdictional criteria (5 percent hydroperiod). However, due to immature vegetation and reduced PET, a longer success criterion is appropriate. Auto recording gauges are used to measure daily groundwater elevations throughout the Sampson County growing season in all 7 years of monitoring.

If a hydrology gauge location fails to meet these success criteria in the seven year monitoring period then monitoring may be extended, remedial actions may be undertaken, or groundwater modeling may be used to demonstrate the limits of wetland restoration.

2.3 Vegetation Success Criteria

Specific and measurable success criteria for plant density within the wetland restoration and riparian buffers on the site will follow NCDMS Guidance dated 7 November 2011. Vegetation monitoring plots are a minimum of 0.02 acres in size, and cover a minimum of two percent of the planted area. The following data is recorded for all trees in the plots: species, height, planting date (or volunteer), and grid location. Monitoring occurs in the fall of Years 1, 2, 3, 5, and 7. The interim measures of vegetative success for the site is the survival of at least 320 three-year old planted trees per acre at the end of Year 3, and 260 planted trees per acre at the end of Year 5. The final vegetative success criteria is the survival of 210 planted trees per acre at the end of Year 7 of the monitoring period.

Invasive and noxious species will be monitored and controlled so that none become dominant or alter the desired community structure of the site. If necessary, RES will develop a species-specific control plan.

2.4 Scheduling/Reporting

The monitoring program will be implemented to document system development and progress toward achieving the success criteria. The restored stream morphology is assessed to determine the success of the mitigation. The monitoring program will be undertaken for seven years or until the final success criteria are achieved, whichever is longer.

Monitoring reports will be prepared in the fall of each year of monitoring and submitted to NCDMS. The monitoring reports will include all information, and be in the format required by NCDMS in Version 2.0 of the NCDMS Monitoring Report Template (Oct. 2010).

3 MONITORING PLAN

Annual monitoring data will be reported using the DMS monitoring template. Annual monitoring shall be conducted for stream, wetland, and vegetation monitoring parameters as noted below.

3.1 Stream Restoration

3.1.1 As-Built Survey

An as-built survey was conducted following construction to document channel size, condition, and location. The survey includes a complete profile of thalweg, water surface, bankfull, and top of bank to compare with future geomorphic data. Longitudinal profiles will not be required in annual monitoring reports unless requested by NCDMS or USACE.

3.1.2 Bankfull Events

Six sets of manual and auto-logging crest gauges were installed on the site, one along UT1, UT2, UT3, UT4, UT6, and one along UT8. The auto logging crest gauges were installed within the channel and will continuously record flow conditions at an hourly interval. Manual crest gauges were installed on the bank at bankfull elevation. Crest gauges will be checked during each site visit to determine if a bankfull event has occurred since the last site visit. Crest gauge readings and debris rack lines will be photographed to document evidence of bankfull events. Flow days will be reported on headwater valley restoration reaches.

3.1.3 Cross Sections

A total of 31 permanent cross sections were installed to monitor channel dimensions and stability. Twelve cross sections were installed along UT1 where Priority 1 restoration was performed. Twelve cross sections (six pools and six shallows) were installed along UT2 also. UT4 has a total of two cross sections installed throughout its length. Stream segment UT6 has two cross sections installed along its length where enhancement activities were performed. On the UT8 side of the project, a total of three cross sections were installed. Cross sections were typically located at representative riffle and pool sections along each stream reach. Each cross section was permanently marked with 3/8 rebar pin to establish a monument location at each end. A marker pole was also installed at both ends of each cross section to allow ease locating during monitoring activities. Cross section surveys will be performed once a year during annual monitoring years 1, 2, 3, 5, and 7 and will include all breaks in slope including top of bank, bottom of bank, streambed, edge of water, and thalweg.

3.1.4 Digital Image Stations

Digital photographs will be taken at least once a year to visually document stream and vegetation conditions. This monitoring practice will continue for seven years following construction and planting. Permanent photo point locations at cross sections and vegetation plots have been established so that the same directional view and location may be repeated each monitoring year. Monitoring photographs will also be used to document any stream and vegetation problematic areas such as erosion, stream and bank instability, easement encroachment and vegetation damage.

3.1.5 Bank Pin Arrays

Eight bank pin array sets have been installed at pool cross sections located along UT1 and UT2. These bank pin arrays were installed along the upstream and downstream third of the meander. Bank pins are a minimum of three feet long, and have been installed just above the water surface and every two feet above the lowest pin. Bank pin exposure will be recorded at each monitoring event, and the exposed pin will be driven flush with the bank.

3.1.6 Visual Assessment Monitoring

Visual monitoring of all mitigation areas is conducted a minimum of twice per monitoring year by qualified individuals. The visual assessments include vegetation density, vigor, invasive species, and easement encroachments. Visual assessments of stream stability include a complete stream walk and structure inspection. Digital images are taken at fixed representative locations to record each monitoring event as well as any noted problem areas or areas of concern. Results of visual monitoring are presented in a plan view exhibit with a brief description of problem areas and digital images. Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal photos should indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral photos should not indicate excessive erosion or continuing degradation of the banks over time. A series of photos over time should indicate successional maturation of riparian vegetation.

3.1.7 Surface Flow

The headwater valley restoration area on UT4 will be monitored to document intermittent or seasonal surface flow. This will be accomplished through direct observation, photo documentation of dye tests, and continuous flow monitoring devices (pressure transducers). An auto logging crest gauge has been installed within the headwater valley channel and will continuously record flow conditions at an hourly interval. This gauge will be downloaded during each site visit to determine if intermittent or seasonal flows conditions are present.

3.2 Wetland Hydrology

Wetland hydrology will be monitored to document hydric conditions in the wetland restoration areas. This will be accomplished with automatic recording pressure transducer gauges installed in representative locations across the restoration areas and reference wetland areas. A total of twelve automatic recording pressure transducers (Auto-Wells) have been installed on the site. Nine auto-wells have been installed within the wetland restoration area and three within reference areas. The gauges will be downloaded quarterly and wetland hydroperiods will be calculated during the growing season. Gauge installation followed current regulatory and DMS guidance. Visual observations of primary and secondary wetland hydrology indicators will also be recorded during quarterly site visits.

3.3 Vegetation

A total of 23 vegetation plots were randomly established within the planted stream riparian buffer easement. Vegetation plots measure 10 meters by 10 meters or 5 meters by 20 meters (0.02 acres) and have all four corners marked with metal posts. Planted woody vegetation was assessed within each plot to establish a baseline dataset. Within each vegetation plot, each planted stem was identified for species, "X" and "Y" origin located, and measured for height. Reference digital photographs were also captured to document baseline conditions. Species composition, density, growth patterns, damaged stems, and survival ratios will be measured and reported on an annual basis. Vegetation plot data will be reported for each plot as well as an overall site average.

4 MAINTENANCE AND CONTINGENCY PLAN

All identified problematic areas or areas of concern such as stream bank erosion/instability, aggradation/degradation, lack of targeted vegetation, and invasive/exotic species which prevent the site from meeting performance success criteria will be evaluated on a case by case basis. These areas will be documented and remedial actions will be discussed amongst NCDMS staff to determine a plan of action. If it is determined remedial action is required, a plan will be provided.

4.1 Stream

Three stream problems were identified during the Year 4 monitoring period and have been mapped on the Current Conditions Plan View (CCPV) (**Figure 3**). The fence problem area reported in MY3 was repaired in January 2018. Stream problem area 1 (SPA1) consists of minor bank erosion on UT4 at station 10+20. This area appears stable and RES plans to continue to monitor these areas to see if they worsen. If conditions continue to worsen, livestakes and additional bank matting will be installed along the banks. Stream problem area 2 (SPA2) is located on UT4 from station 8+47 to 8+67. This area consists of ponding on the road, due to downstream issue at SPA3. The area involves adding fill material to eliminate the ponding on the road. SPA3 is located on UT4 from station 8+75 to 11+03 and is attributed to the subsidence of the plug that had been installed at construction. This problem is associated with the relic stream channel. Fill material needs to be added to raise the plug elevation in the relic channel. All stream problem areas are localized and the overall condition of the project streams on site are stable. Remedial action repair work was completed in December 2018.

4.2 Wetlands

No wetland problems areas were noted during the Year 4 monitoring period. Wetland hydrology and vegetation represent typical conditions of a site in Year 4 post construction monitoring. If any wetland problem areas are identified in the future, they will be documented and mapped on the CCPV (**Figure 3**) as part of the annual monitoring report. The Best Site wetland restoration areas are performing as designed and are on track to meeting wetland success criteria.

4.3 Vegetation

Two vegetation problems were identified during the Year 4 monitoring period. These vegetation problem areas are documented and mapped on the CCPV (**Figure 3**) as part of the annual monitoring report. The poor growth and low stem density areas reported in MY3 along UT1 and UT3 were replanted in January 2018. Vegetation problem area 1 (VPA1) is an area where the invasive species mimosa (*Albizia julibrissin*) and Chinese privet (*Ligustrum sinense*) are present along UT1 and Wetland 1. This area is approximately a tenth of an acre in size, and is well vegetated with native trees and native herbaceous cover. RES plans to continue treat the invasive species in this area. Vegetation problem area 2 (VPA2) is a low stem density area at the top of UT8. This area was replanted in December 2018.

5 YEAR 4 MONITORING CONDITIONS (MY4)

The Best Site Year 4 Monitoring activities were completed October 2018. All Year 4 monitoring data is present below and in the appendices. Morphological stream data was not collected in MY4 per the Approved Mitigation Plan.

5.1 Year 4 Monitoring Data Collection

5.1.1 Morphological State of the Channel

Morphological stream data was not collected in MY4 per the Approved Mitigation Plan. It will be collected and reported again in MY5 and MY7.

5.1.2 Vegetation

The Year 4 monitoring (MY4) vegetation survey was completed in October 2018 and resulted in an average of 753 planted stems per acre, well above the interim survival density of 260 stems per acre at the end of Year 5 monitoring. The average stems per vegetation plot was 19 planted stems. The minimum planted stem per acre was 243 and the maximum was 1,255. Vegetation Plot 2 fell one tree below the interim success criteria. This area is dominated by blackberry bushes and was replanted in January 2018 but not all the replanted stems in the plot survived. Volunteers were noted in a few vegetation plots on the site and were recorded within the CVS-EEP Data entry tool. The average planted stem height was 7 feet. Vegetation summary data tables can be found in **Tables 9a-c** and vegetation plot photos in **Figure 4**.

5.1.3 Photo Documentation

Permanent photo point locations have been established at cross sections, vegetation plots, stream crossings, and stream structures by RES staff. Any additional problem areas or areas of concern will also be documented with a digital photograph during monitoring activities. Stream digital photographs can be found in **Figure 5 and 7** and **Figures 4 and 6** for vegetation photos.

5.1.4 Stream Hydrology

Six sets of manual and auto-logging crest gauges were installed on the site, one along UT1, UT2, UT3, UT4, UT6, and one along UT8. The auto logging crest gauges were installed within the channel and will continuously record flow conditions at an hourly interval. Five of five crest gauges recorded bankfull events during the Year 4 monitoring period (**Table 13; Figure 8**). All crest gauges with a bankfull standard have met the success criteria. Crest Gauge 4 is located on a headwater valley restoration reach and it's success criteria is 30 days of continuous flow. This year's correction factor

was used to calculate the flow days in the monitoring years it was not reported. MY1 recorded 190 days of consecutive flow, MY2 had 288 days of consecutive flow, MY3 had 200 days of consecutive flow and MY4 recorded 282 consecutive days of flow.

5.1.5 Wetland Hydrology

A total of twelve wetland hydrology gauges are installed at the Best Site, nine in areas of wetland restoration and three as reference gauges in existing on-site wetland. Nine of the nine wetland restoration gauges achieved the success criteria by remaining continuously within the 12 inches of the soil surface for at least nine percent of the growing season. Groundwater gauge data indicate the hydroperiods being responsive to rainfall events. Rainfall data reported by CRONOS station Williamsdale Field Lab indicated rainfall was below average during the months of February, March, August, and October. All three reference gauges met the nine percent success criteria with. Wetland gauge and rainfall data is presented in **Appendix E.**

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Appendix A

Project Background History and Maps

Table 1. Project Components and Mitigation Credits
Table 2. Project Activity and Reporting History
Table 3. Project Contacts
Table 4. Project Information and Attributes
Figure 1. Project Vicinity Map
Figure 2. Current Conditions Plan View Map

Table 1. Project Components and Mitigation Credits
Best Stream and Wetland Restoration Project/DMS Project # 95353

Mitigation Credits

	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	6,237	3,976	5.12	N/A	N/A	N/A	N/A	N/A	N/A

Project Components

Project Component -or- Reach ID	Approved Mitigation Plan Stationing/Location (LF)	Existing Footage/Acreage	Approach (PI, PII etc.)	Restoration -or- Restoration Equivalent	Mitigation Plan Restoration Footage or Acreage	Mitigation Ratio	SMUs/ WMUs
UT1	0+47 to 18+00	1,551	PI	R	1,723	1 : 1.0	1,723
UT1	18+00 to 21+03	303	Preservation & BE	RE	303	1 : 5.0	61
UT2	2+30 to 30+30	2,552	PI	R	2,770	1 : 1.0	2,770
UT2	30+30 to 33+39	309	Preservation & BE	RE	309	1 : 5.0	62
UT3	0+00 to 8+42	1,458	EII	RE	812	1 : 2.5	325
UT3	14+58 to 15+22	64	Preservation & BE	RE	64	1 : 5.0	13
UT4	5+63 to 11+03	534	HV Restoration	R	510	1 : 1.0	510
UT4	11+03 to 17+58	655	Preservation & BE	RE	655	1 : 5.0	131
UT5	0+00 to 40+86	4,086	Preservation & BE	RE	4,043	1 : 5.0	809
UT6	0+62 to 6+00	538	EI	RE	538	1 : 1.5	359
UT7	0+44 to 32+27	3,183	Preservation & BE	RE	3,183	1 : 5.0	637
UT8	0+75 to 9+00	825	EI	RE	825	1 : 1.5	550
UT8	9+00 to 12+13	313	Preservation & BE	RE	313	1 : 5.0	63
UT9	0+64 to 11+71	1,171	Preservation & BE	RE	1,171	1 : 5.0	234
UT10	3+37 to 11+05	768	Preservation & BE	RE	768	1 : 5.0	154
Muddy Creek	0+35 to 92+49	9,214	Preservation & BE	RE	9,073	1 : 5.0	1,815
Wetland 1	---	3.66	Restoration	RE	3.66	1 : 1.0	3.66
Wetland 2	---	0.29	Restoration	RE	0.29	1 : 1.0	0.29
Wetland 3A	---	0.58	Restoration	RE	0.58	1 : 1.0	0.58
Wetland 3B	---	0.59	Restoration	RE	0.59	1 : 1.0	0.59

Component Summation

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	4,493	5.12				
Headwater Valley	510					
Enhancement I	1,363					
Enhancement II	812					
Creation						
Preservation	19,882					
High Quality Preservation						

BMP Elements

Element	Location	Purpose/Function	Notes
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---	---	---	---
---	---	---	---

BMP Elements

BR = Bioretention Cell; SF = Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond; DDP = Dry Detention Pond; FS = Filter Strip; S = Grassed, Swale; LS = Level Spreader; NI = Natural Infiltration Area; FB = Forested Buffer

Note: Credit calculations were originally calculated along the as-built thalweg. For Monitoring Year 3 forward, credits were updated to match the Approved Mitgation Plan stream centerlines per the April 3, 2017 Credit Release Meeting.

Table 2. Project Activity and Reporting History

Project Activity and Reporting History		
Best Stream and Wetland Restoration Project / DMS Project #95353		
Activity or Report	Data Collection Complete	Completion or Delivery
Mitigation Plan	NA	Oct-13
Final Design – Construction Plans	NA	Nov-14
Construction Completed	Sep-13	May-15
Site Planting Completed	May-15	May-15
Baseline Monitoring Document (Year 0 Monitoring – baseline)	Jul-15	Oct-15
Year 1 Monitoring	Dec-15	Mar-16
Year 2 Supplemental Replant/Repair Work	---	Apr-16
Year 2 Monitoring	Nov-16	Jan-17
Year 3 Monitoring	Nov-17	Feb-18
Year 4 Supplemental Planting	---	Jan-18
Year 4 Monitoring	Oct-18	Jan-19
Year 4 Supplemental Planting and Repair Work	---	Dec-18
Year 5 Monitoring		
Year 6 Monitoring		
Year 7 Monitoring		

Table 3. Project Contacts

Project Contacts Table Best Stream and Wetland Restoration Project /DMS Project # 95353	
Designer	WK Dickson and Co., Inc. 720 Corporate Center Drive Raleigh, NC 27607 (919) 782-0495 Frasier Mullen, PE
Construction Contractor	Wright Contracting PO Box 545 Siler City, NC 27344 (919) 663-0810 Joseph Wright
Planting Contractor	Resource Environmental Solutions, LLC 302 Jefferson Street, Suite 110 Raleigh, NC 27605 (919) 209-1061 David Godley
Seeding Contractor	Wright Contracting PO Box 545 Siler City, NC 27344 (919) 663-0810 Joseph Wright
Seed Mix Sources	Green Resource
Nursery Stock Suppliers	Arbogen, NC Forestry Services Nursery
Full Delivery Provider Project Manager:	Resource Environmental Solutions, LLC 302 Jefferson Street, Suite 110 Raleigh, NC 27605 Brad Breslow
Monitoring Performers Project Manager:	Resource Environmental Solutions, LLC 302 Jefferson Street, Suite 110 Raleigh, NC 27605 (919) 209-1061 Brian Hockett, PLS

Table 4. Project Information Summary

Project Information	
Project Name	Best Stream and Wetland Restoration Project
County	Duplin
Project Area (acres)	142.7
Project Coordinates (latitude and longitude)	34° 54' 44.011" N 77° 44' 57.344" W

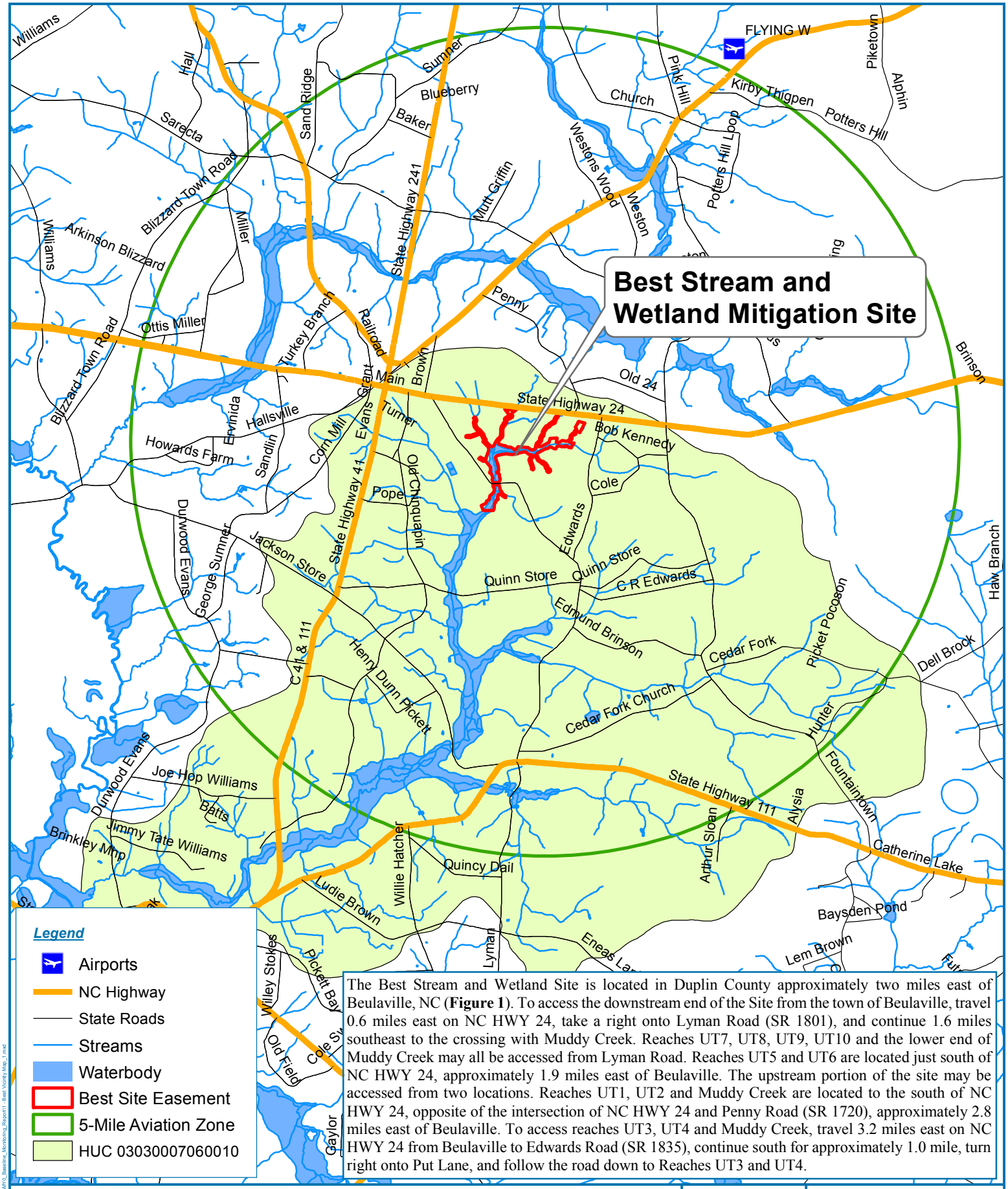
Project Watershed Summary Information	
Physiographic Province	Outer Coastal Plain
River Basin	Cape Fear
USGS Hydrologic Unit 8-digit	03030007
USGS Hydrologic Unit 14-digit	03030007060010
DWQ Sub-basin	03-06-22
Project Drainage Area (acres)	2,928 acres
Project Drainage Area Percentage of Impervious Area	6%
CGIA Land Use Classification	Woody wetlands, emergent herbaceous wetlands, cultivated crops, evergreen forest

Reach Summary Information (As-Built Conditions)						
Parameters	**UT1**	**UT2**	**UT3**	**UT4**	**UT5**	**UT6**
Length of reach (linear feet)	2,036	3,103	876	1,140	4,043	538
Valley Classification	X	X	X	X	X	X
Drainage area (acres)	41	146	56	82	380	79
NCDWQ stream identification score	32.50	31.50	33.00	33.75	36.75	30.50
NCDWQ Water Quality Classification	N/A	C Sw	N/A	N/A	C Sw	N/A
Morphological Description (stream type)	G5c	G5c	E5	G5c/E5	C5	E5
Evolutionary trend	Stage II	Stage II	Stage VI	Stage II/VI	Stage I	Stage II
Underlying mapped soils	GoA MkA NbB RaA	AuB McC MkA NbA NbB	McC MkA NbB	McC MkA NbB	MkA NbB	NbA NbB
Drainage class	well; mod. well; poorly	well; poorly	well; poorly	well; poorly	well; poorly	well
Soil Hydric status	Hydric	Hydric	Hydric	Hydric	Hydric	Not hydric
Slope	0.66%	0.44%	0.93%	0.42%	0.40%	0.12%
FEMA classification	N/A	N/A	N/A	N/A	AE (high risk)	N/A
Native vegetation community	pasture, cultivated	cultivated	pasture	mixed hardwood forest	mixed hardwoo d forest	mixed hardwood forest
Percent composition of exotic invasive vegetation	0	0	5	5	<40	<25

Reach Summary Information (continued)					
Parameters	**UT7**	**UT8**	**UT9**	**UT10**	**Muddy Creek**
Length of reach (linear feet)	3,183	1,078	1,107	768	9,214
Valley Classification	X	X	X	X	X
Drainage area (acres)	387	56	36	306	2930
NCDWQ stream identification score	38.50	30.50	32.00	34.00	43.25
NCDWQ Water Quality Classification	C Sw	N/A	N/A	C Sw	C Sw
Morphological Description (stream type)	C5	F5	E5	C5	E5
Evolutionary trend	Stage I	Stage II	Stage VI	Stage VI	Stage VI
Underlying mapped soils	McC MkA NbB	McC NbA NbB	McC MkA	McC MkA	McC MkA
Drainage class	well; poorly	well	well; poorly	well; poorly	well; poorly
Soil Hydric status	Hydric	Hydric	Hydric	Hydric	Hydric
Slope	0.40%	0.29%	0.80%	0.40%	0.11%
FEMA classification	AE (high risk)	N/A	AE (high risk)	AE (high risk)	AE (high risk)
Native vegetation community	mixed hardwood forest	cultivated	mixed hardwood forest	mixed hardwood forest	mixed hardwood forest
Percent composition of exotic invasive vegetation	<40	<5	<15	<20	<45

Wetland Summary Information (As-Built Conditions)				
Parameters	**Wetland 1**	**Wetland 2**	**Wetland 3A**	**Wetland 3B**
Size of Wetland (acres)	3.77	0.31	0.58	0.59
Wetland Type (non-riparian, riparian	Riparian	Riparian	Riparian	Riparian
Mapped Soil Series	Rains, Goldston	Noboco, Autyville, Marvyn, Gritney	Marvyn, Gritney, Muckalee loam	Marvyn, Gritney, Muckalee loam
Drainage class	Poorly	Mod. Well, Poorly	Poorly, Well	Poorly, Well
Soil Hydric Status	Yes	Hydric with Hydric Inclusions	Hydric with Hydric Inclusions	Hydric with Hydric Inclusions
Source of Hydrology	Runoff/Groundwater Discharge	Runoff/Groundwater Discharge	Runoff, Flooding, Groundwater Discharge	Runoff, Flooding, Groundwater Discharge
Hydrologic Impairment	Grazing Cattle and Incised Channel	Incised Channel	Ditched	Ditched
Native vegetation community	Forested	Cultivated	Cultivated	Cultivated
Percent composition of exotic invasive	0	0	0	0

Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States - Section 404	Yes	Yes	SAW-2012-01384
Waters of the United States - Section 401	Yes	Yes	DWR # 13-0865
Endangered Species Act	Yes	Yes	USFWS (Corr. Letter)
Historic Preservation Act	Yes	Yes	SHPO (Corr. Letter)
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	No	NA	N/A
FEMA Floodplain Compliance	Yes	Yes	EEP Floodplain Requirements Checklist
Essential Fisheries Habitat	No	NA	N/A



The Best Stream and Wetland Site is located in Duplin County approximately two miles east of Beulaville, NC (**Figure 1**). To access the downstream end of the Site from the town of Beulaville, travel 0.6 miles east on NC HWY 24, take a right onto Lyman Road (SR 1801), and continue 1.6 miles southeast to the crossing with Muddy Creek. Reaches UT7, UT8, UT9, UT10 and the lower end of Muddy Creek may all be accessed from Lyman Road. Reaches UT5 and UT6 are located just south of NC HWY 24, approximately 1.9 miles east of Beulaville. The upstream portion of the site may be accessed from two locations. Reaches UT1, UT2 and Muddy Creek are located to the south of NC HWY 24, opposite of the intersection of NC HWY 24 and Penny Road (SR 1720), approximately 2.8 miles east of Beulaville. To access reaches UT3, UT4 and Muddy Creek, travel 3.2 miles east on NC HWY 24 from Beulaville to Edwards Road (SR 1835), continue south for approximately 1.0 mile, turn right onto Put Lane, and follow the road down to Reaches UT3 and UT4.

Figure1
Project Vicinity Map
Best Stream and Wetland Restoration Site
Duplin County, North Carolina

Date: 9/15/2015

Drawn by: BSH

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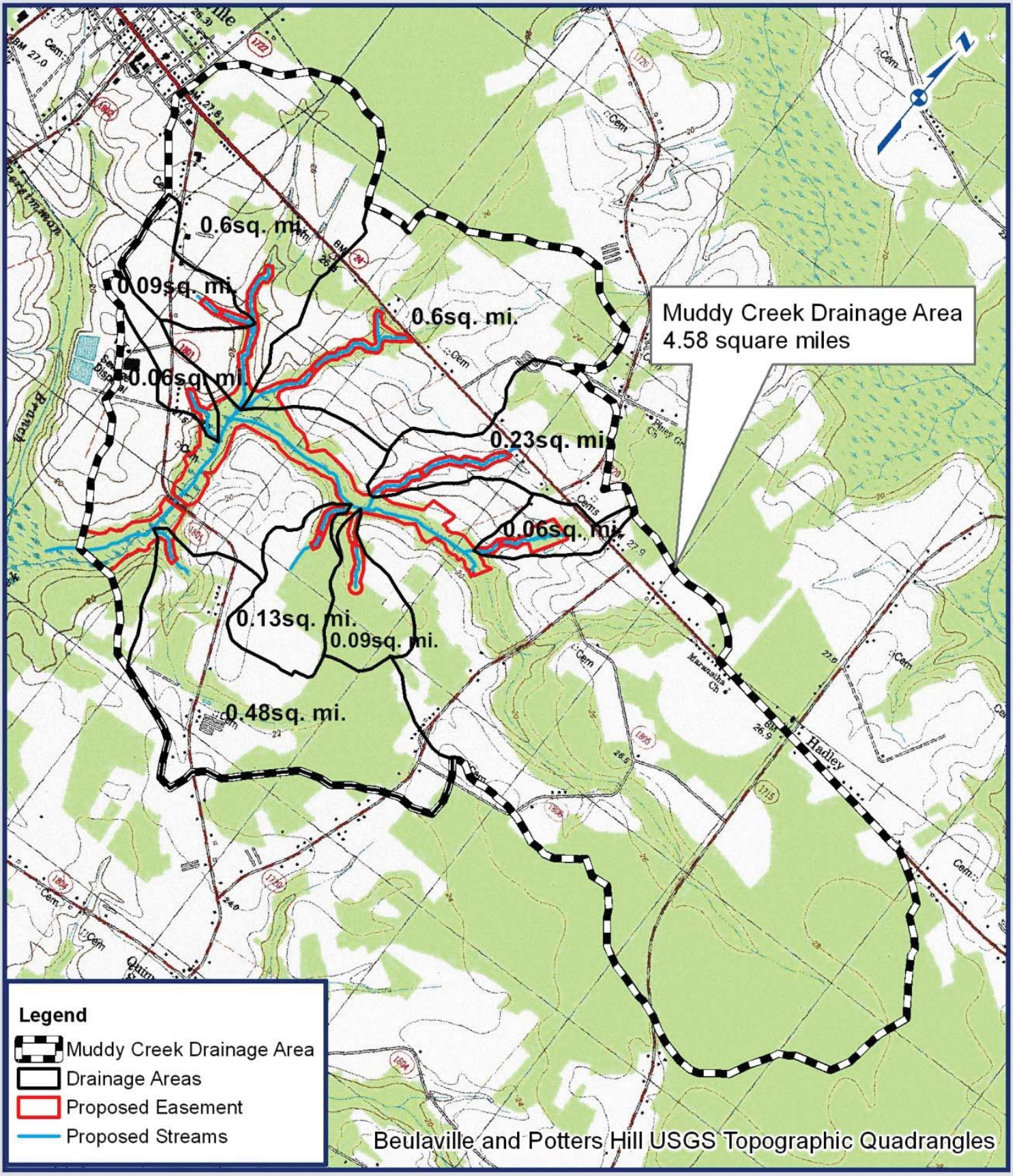


Figure 2.
USGS Map
Best Stream and Wetland Mitigation Site

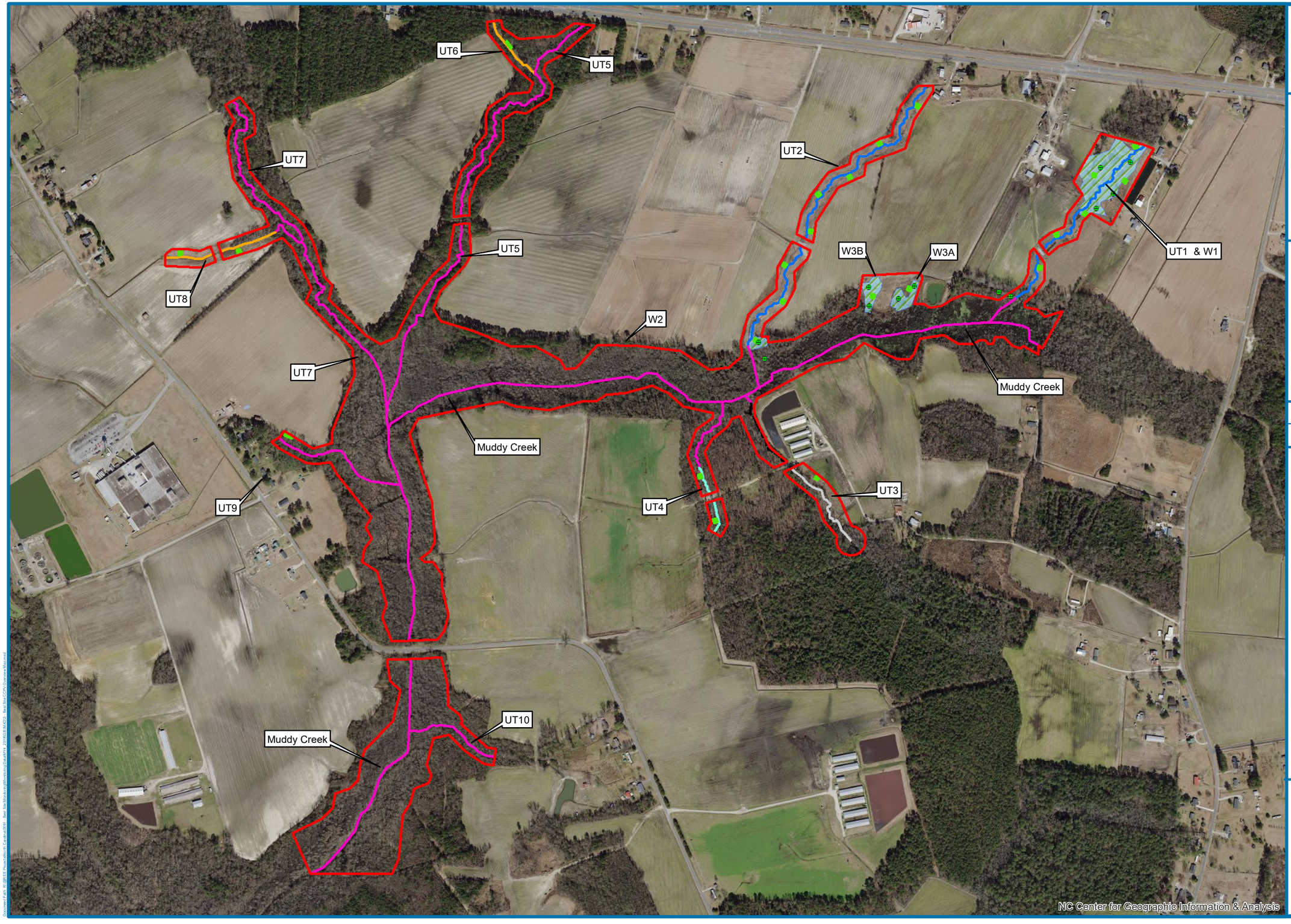
0 1,500 3,000 6,000 Feet

1 inch = 3,000 feet

Appendix B

Visual Assessment Data

Figure 3. Current Conditions Plan View Map (CCPV)
Table 5. Visual Stream Morphology Stability Assessment
Table 6. Vegetation Condition Assessment
Table 7. Stream Problem Areas
Table 8. Vegetation Problem Areas
Figure 4. Vegetation Problem Photos
Figure 5. Stream Problem Photos
Figure 6. Vegetation Problem Photos



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N
W E
S

0 350 700
Feet

1 inch = 700 feet

Figure 3

Best Stream and Wetland Restoration Project

Current Conditions Overview Map

MY4 2018

Date: 1/22/2019	Drawn by: RTM
	Review by: xxxxx

Legend

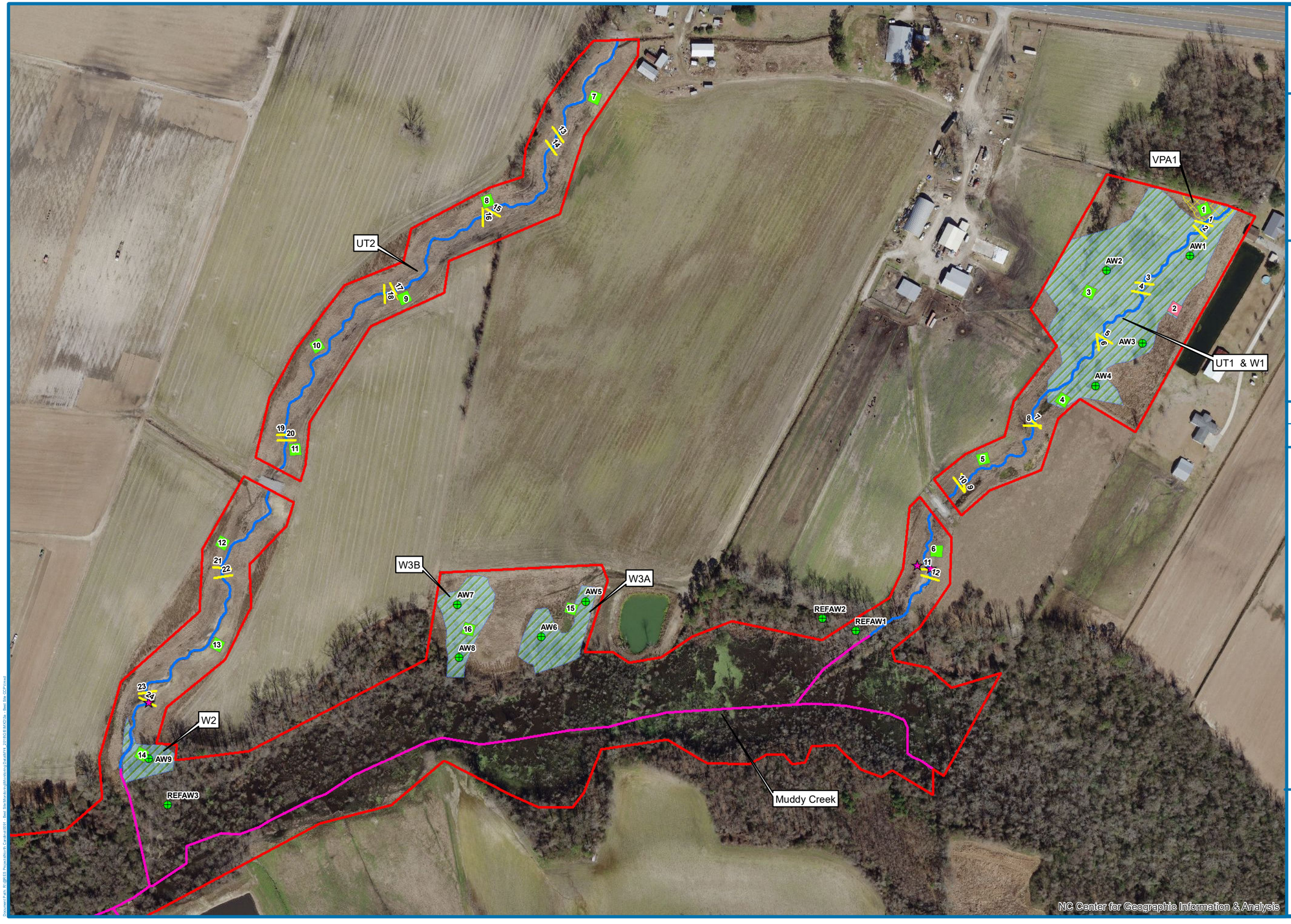
- Conservation Easement
- Wetland Restoration Area
- Vegetation Plots
- BE & Preservation
- Enhancement I
- Enhancement II
- Headwater Valley Rest.
- P1 Restoration
- No Credit
- Stream Structures

Wetland Hydroperiod

- >9%

Vegetation Condition Assessment

Invasive Species	Target Community: Present	Target Community: Marginal	Target Community: Absent
Absent	No Fill		
Present			



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N
W E
S

0 125 250
Feet

1 inch = 250 feet

Figure 3a

Best Stream and Wetland Restoration Project

Current Conditions Plan View

MY4 2018

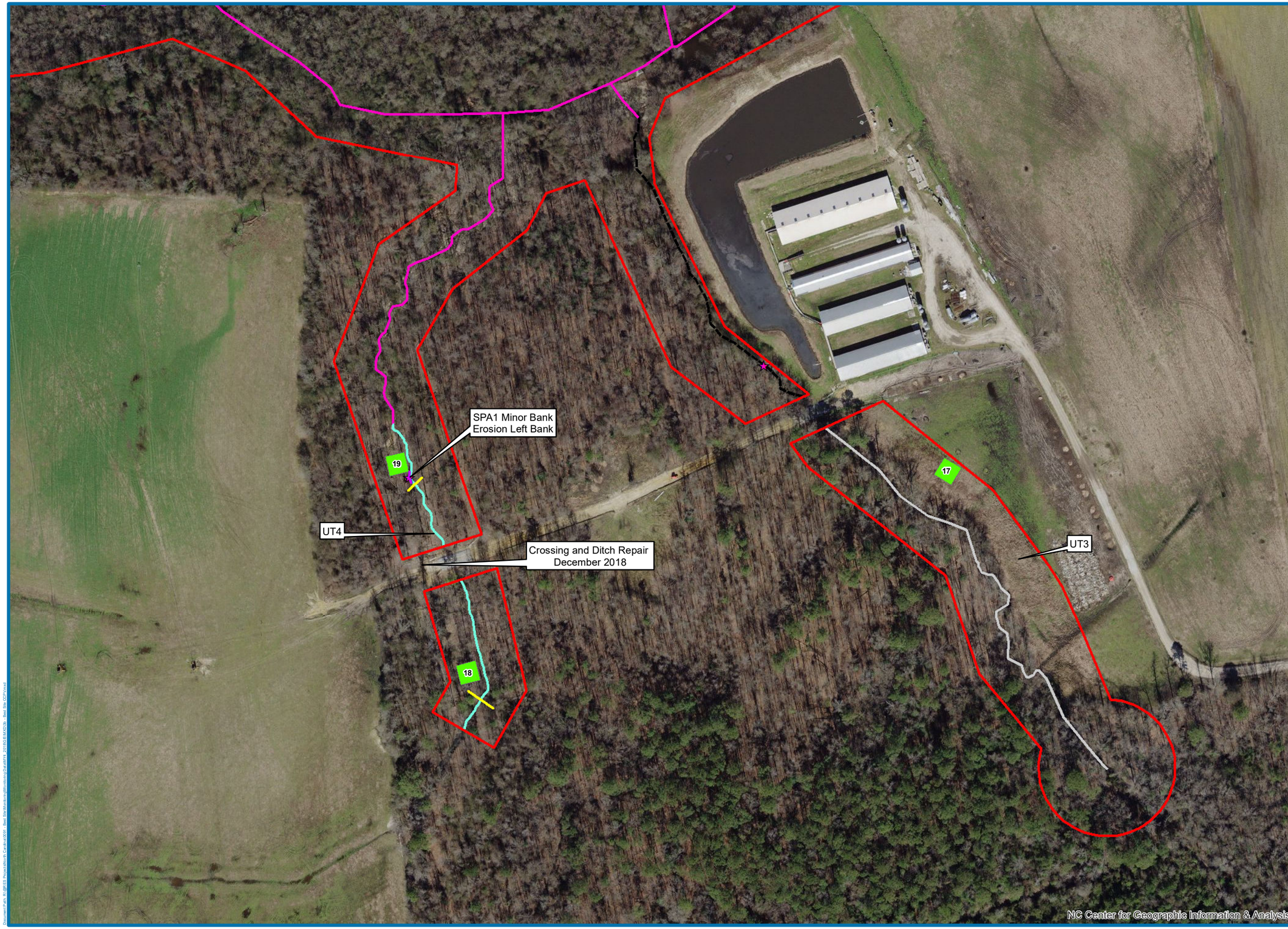
Date: 1/22/2019	Drawn by: RTM
	Review by: xxxxx

Legend

- Conservation Easement
- Vegetation Plot
  - >260 stems/acre
  - <260 stems/acre
- Wetland Restoration Area
- Cross Sections
- BE & Preservation
- Enhancement I
- Enhancement II
- Headwater Valley Rest.
- P1 Restoration
- Crest Gauge/RG Locations
- Wetland Hydroperiod
  - >9%

Vegetation Condition Assessment

Invasive Species	Target Community: Present	Target Community: Marginal	Target Community: Absent
Absent	No Fill		
Present			



res

N
W E
S

0 75 150
Feet

1 inch = 150 feet

Figure 3b

Best Stream and Wetland Restoration Project

Current Conditions Plan View

MY4 2018

Date: 1/22/2019	Drawn by: RTM
	Review by: xxxxx

Legend

- Conservation Easement
- **Vegetation Plot**
  - >260 stems/acre
  - <260 stems/acre
- Wetland Restoration Areas
- Crest Gauge/RG Locations
- Cross Sections
- BE & Preservation
- Enhancement I
- Enhancement II
- Headwater Valley Rest.
- P1 Restoration
- No Credit
- MY4 SPA

Vegetation Condition Assessment

Invasive Species	Target Community: Present	Target Community: Marginal	Target Community: Absent
Absent	No Fill		
Present			

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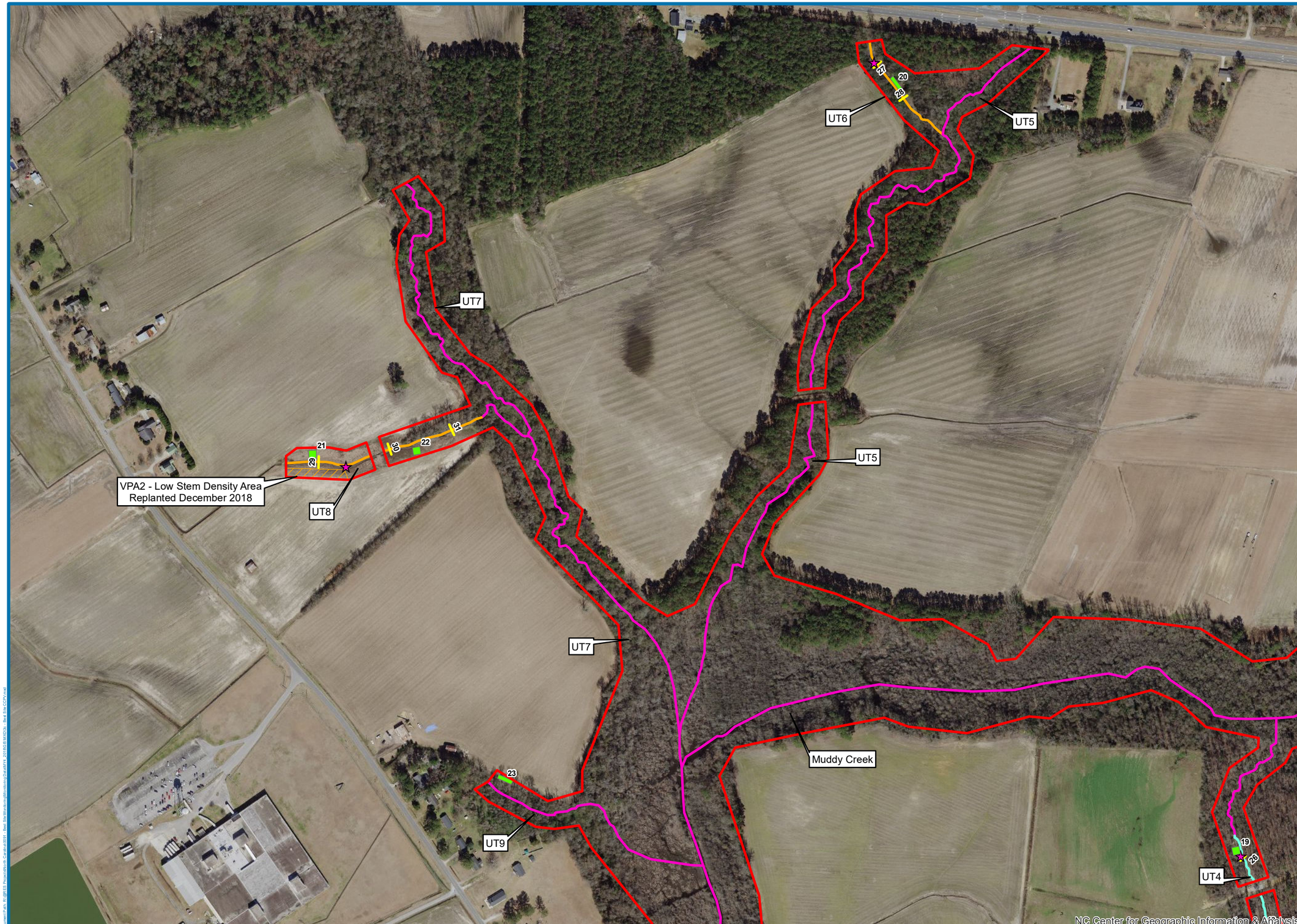

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N
W E
S

0 200 400
Feet

1 inch = 400 feet

Figure 3c

Best Stream and Wetland Restoration Project

Current Conditions Plan View

MY4 2018

Date: 1/22/2019	Drawn by: RTM
	Review by: xxxxx

Legend

- Conservation Easement
- **Vegetation Plot**
  - >260 stems/acre
  - <260 stems/acre
- Cross Sections
- BE & Preservation
- Enhancement I
- Enhancement II
- Headwater Valley Rest.
- P1 Restoration
- Crest Gauge/RG Locations

Vegetation Condition Assessment

Invasive Species	Target Community: Present	Target Community: Marginal	Target Community: Absent
Absent	No Fill		
Present			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT1**
Assessed Length **2036**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	19	19			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	19	19			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	19	19			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	19	19			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	19	19			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT2**
Assessed Length **3103**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	23	23			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	23	23			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	23	23			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	23	23			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	23	23			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT3**
Assessed Length **876**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	1	1			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	1	1			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	1	1			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence doesnot exceed 15%. (See guidance for this table in EEP monitoring guidance document)	1	1			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	1	1			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT4**
Assessed Length **1140**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			1	20	99%	0	20	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	1	20	99%	0	0	99%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	6	6			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	6	6			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	6	6			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	6	6			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	6	6			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT6**
Assessed Length **538**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	3	3			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	3	3			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence doesnot exceed 15%. (See guidance for this table in EEP monitoring guidance document)	3	3			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	3	3			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT8**
Assessed Length **765**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	3	3			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	3	3			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence doesnot exceed 15%. (See guidance for this table in EEP monitoring guidance document)	3	3			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	3	3			100%			

Table 6 — Vegetation Condition Assessment

Planted Acreage[1] **24.5**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres	Red Lines	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels.	0.1 acres	Orange Lines	1	0.24	1.0%
			Total	1	0.24	1.0%
3. 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 acres	Orange Lines	0	0.00	0.0%
			Cumulative Total	1	0.24	1.0%

Easement Acreage[2] **37.6**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF	Cross Hatch	1	0.13	0.3%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	Red Lines	0	0.00	0.0%

1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

2 = The acreage within the easement boundaries.

3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particulalry for situations where the conditon for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

Table 7. Stream Problem Areas Best Stream and Wetland Restoration Project - Project # 95353			
Feature Issue	**Station # / Range**	**Suspected Cause; Repair**	**Photo Number**
Minor Bank Erosion	UT 4 - Sta. 10+20	Rain events and high flows; seems stable, continue to monitor	SPA 1
Ponding on Road	UT 4 - Sta. 8+47 to 8+67	Rain events and high flow; added fill to road to reduce ponding in Dec 2018	SPA 2
Relic Channel and Plug Subsidence	UT4- Sta. 8+75 to 11+03	Rain events and high flows; added fill material to raise plugs in relic channel in Dec 2018	SPA 3

Table 8. Vegetation Problem Areas Best Stream and Wetland Restoration Project - Project # 95353			
Feature Category	**Station Numbers**	**Suspected Cause; Repair**	**Photo Number**
Invasives present	UT1 - Sta. 0+00 (0.13 ac)	Invasives present in easement due to offsite seed source; remove invasive by cutting down and applying herbicide	VPA 1
Low Stem Density	UT8	Low Soil Fertility, compaction, and competition with native weeds; Re-plant area with gallon containerized trees in Dec 2018	N/A

Figure 4. Vegetation Plot Photos

Vegetation Plot 1

Vegetation Plot 2

Vegetation Plot 3

Vegetation Plot 4

Vegetation Plot 5

Vegetation Plot 6

Vegetation Plot 7

Vegetation Plot 8

Vegetation Plot 9

Vegetation Plot 10

Vegetation Plot 11

Vegetation Plot 12

Vegetation Plot 13

Vegetation Plot 14

Vegetation Plot 15

Vegetation Plot 16

Vegetation Plot 17

Vegetation Plot 18

Vegetation Plot 19

Vegetation Plot 20

Vegetation Plot 21

Vegetation Plot 22

Vegetation Plot 23

Figure 5. MY4 Stream Problem Area Photos

SPA1 – Minor Bank Erosion UT 4 @ Sta. 10+10 to 10+30

SPA2 – Ponding on Road UT 4 @ Sta. 8+47 to 8+67*

SPA3 – Relic Channel Floodplain Plug Subsidence UT4 @ Sta. 8+75 to 11+03*

*Repair work completed in December 2018

Figure 6. Vegetation Problem Area Photos

VPA 1 – Invasives Present UT1 @ Sta. 0+00
(0.13ac)

Appendix C

Vegetation Plot Data

Table 9a. Planted Stem Count Summary
Table 9b. Planted Species Totals
Table 9c. Planted and Total Stem Counts (Species by Plot)

Table 9a. Vegetation Plot Criteria Attainment

Plot #	Planted Stems/Acre	Volunteer Stems/Acre	Total Stems/Acre	Success Criteria Met?	Average Stem Height (ft)
1	445	81	526	Yes	10.1
2	243	364	607	No	7.2
3	405	0	405	Yes	7.5
4	1133	0	1133	Yes	10.0
5	567	0	567	Yes	6.2
6	1174	121	1295	Yes	6.5
7	647	0	647	Yes	5.5
8	688	0	688	Yes	9.5
9	1174	0	1174	Yes	7.5
10	809	0	809	Yes	8.4
11	1255	0	1255	Yes	3.8
12	1133	81	1214	Yes	7.6
13	1012	0	1012	Yes	3.6
14	1012	0	1012	Yes	10.2
15	607	0	607	Yes	7.4
16	647	2428	3076	Yes	7.8
17	486	0	486	Yes	3.9
18	364	0	364	Yes	2.3
19	405	0	445	Yes	2.4
20	850	0	850	Yes	12.6
21	931	0	931	Yes	9.2
22	647	202	850	Yes	4.2
23	688	0	688	Yes	3.1
Project Avg	**753**	**143**	**897**	**Yes**	**7.0**

Table 9b. CVS Vegetation Plot Data Best Stream and Wetland Restoration Site	
Report Prepared By	Ryan Medric
Date Prepared	10/25/2018 0:00
database name	Best_MY4_CVS_Entrytool.mdb
database location	C:\Users\rmedric\Dropbox (RES)\@RES Projects\North Carolina\Best Site\Monitoring\Monitoring Data\MY4_2018\Vegetation Data
computer name	D4V0KGH2
file size	75464704
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	95353
project Name	Best Stream/Wetland Restoration Site
Description	
River Basin	Cape Fear
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	23

Best			Current Plot Data (MY4 2018)																																								
			95353-01-0001			95353-01-0002			95353-01-0003			95353-01-0004			95353-01-0005			95353-01-0006			95353-01-0007			95353-01-0008			95353-01-0009			95353-01-0010			95353-01-0011			95353-01-0012			95353-01-0013			95353-01-0014		
Scientific Name	**Common Name**	**Species Type**	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree			1																																						
Baccharis	baccharis	Shrub																																									
Betula nigra	river birch	Tree										2	2	2	2	2	2													1	1	1	1	1	1	3	3	3	2	2	2	1	1	1
Diospyros virginiana	common persimmon	Tree																																									
Fraxinus pennsylvanica	green ash	Tree													1	1	1	2	2	2																							
Liquidambar styraciflua	sweetgum	Tree			1			9												2																							
Liriodendron tulipifera	tuliptree	Tree										1	1	1	1	1	1			1										1	1	1				2	2	2						
Nyssa sylvatica	blackgum	Tree																															1	1	1	2	2	2						
Pinus taeda	loblolly pine	Tree																																									
Platanus occidentalis	American sycamore	Tree	2	2	2	1	1	1				13	13	13	1	1	1	5	5	5	8	8	8	3	3	3	14	14	14	4	4	4	1	1	1	6	6	6	10	10	10	6	6	6
Prunus serotina	black cherry	Tree																																									
Quercus	oak	Tree																			1	1	1																				
Quercus lyrata	overcup oak	Tree	4	4	4	3	3	3	5	5	5	3	3	3	6	6	6	15	15	15	3	3	3	1	1	1	3	3	3	7	7	7	1	1	1	8	8	8	7	7	7	10	10	10
Quercus michauxii	swamp chestnut oak	Tree				1	1	1	2	2	2										1	1	1	7	7	7	4	4	4	1	1	1	2	2	2	3	3	5	1	1	1			
Quercus myrtifolia	myrtle oak	Shrub Tree																																									
Quercus nigra	water oak	Tree	2	2	2	1	1	1				1	1	1																													
Quercus phellos	willow oak	Tree	1	1	1							8	8	8	3	3	3	7	7	7	3	3	3	5	5	5	3	3	3	1	1	1				1	1	1	1	1	1	1	1	1
Rhus copallinum	flameleaf sumac	shrub																																									
Salix	willow	Shrub or Tree																																									
Taxodium distichum	bald cypress	Tree	2	2	2				3	3	3													1	1	1	5	5	5	5	5	5	25	25	25	3	3	3	4	4	4	7	7	7
Unknown		Shrub or Tree																																									
		Stem count	11	11	13	6	6	15	10	10	10	28	28	28	14	14	14	29	29	32	16	16	16	17	17	17	29	29	29	20	20	20	31	31	31	28	28	30	25	25	25	25	25	25
		size (ares)	1			1			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			0.02			0.02		
		Species count	5	5	7	4	4	5	3	3	3	6	6	6	6	6	6	4	4	6	5	5	5	5	5	5	5	5	5	7	7	7	6	6	6	8	8	8	6	6	6	5	5	5
		Stems per ACRE	445	445	526	243	243	607	405	405	405	1133	1133	1133	567	567	567	1174	1174	1295	647	647	647	688	688	688	1174	1174	1174	809	809	809	1255	1255	1255	1133	1133	1214	1012	1012	1012	1012	1012	1012

Best			Current Plot Data (MY4 2018)																															Annual Means											
			95353-01-0015			95353-01-0016			95353-01-0017			95353-01-0018			95353-01-0019			95353-01-0020			95353-01-0021			95353-01-0022			95353-01-0023			MY4 (2018)			MY3 (2017)			MY2 (2016)			MY1 (2016)			MY0 (2015)		
Scientific Name	**Common Name**	**Species Type**	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree						25																								26			410									
Baccharis	baccharis	Shrub																																				6						
Betula nigra	river birch	Tree							4	4	4				1	1	1	1	1	1	2	2	2							20	20	20	15	15	18	15	15	15	20	20	20	26	26	26
Diospyros virginiana	common persimmon	Tree																																	3									
Fraxinus pennsylvanica	green ash	Tree							2	2	2										2	2	2	2	2	2				9	9	9	6	6	8	3	3	3						
Liquidambar styraciflua	sweetgum	Tree						35																		4						51			111			72			4			
Liriodendron tulipifera	tuliptree	Tree																												5	5	6	6	6	15	6	6	23	8	8	16	25	25	25
Nyssa sylvatica	blackgum	Tree																						2	2	2				5	5	5	5	5	8	3	3	3	5	5	5	6	6	6
Pinus taeda	loblolly pine	Tree																								1						1			19									
Platanus occidentalis	American sycamore	Tree							4	4	4				2	2	2	12	12	12	6	6	6	5	5	5				103	103	103	98	98	100	97	97	97	84	84	84	113	113	113
Prunus serotina	black cherry	Tree																																	3									
Quercus	oak	Tree																												1	1	1	2	2	2	7	7	7	11	11	11	48	48	48
Quercus lyrata	overcup oak	Tree				9	9	9				4	4	4	2	2	2				5	5	5	6	6	6	1	1	1	103	103	103	108	108	108	97	97	97	88	88	88	119	119	119
Quercus michauxii	swamp chestnut oak	Tree				5	5	5										8	8	8	1	1	1	1	1	1				37	37	39	45	45	49	59	59	59	72	72	72	86	86	86
Quercus myrtifolia	myrtle oak	Shrub Tree													1	1	1													1	1	1	1	1	1	1	1	1	1	1	1			
Quercus nigra	water oak	Tree										2	2	2	3	3	3										8	8	8	17	17	17	19	19	25	16	16	16	12	12	14	15	15	15
Quercus phellos	willow oak	Tree				1	1	1	2	2	2	3	3	3	2	2	2				2	2	2				8	8	8	52	52	52	56	56	56	66	66	66	66	66	68	90	90	90
Rhus copallinum	flameleaf sumac	shrub																																	7									
Salix	willow	Shrub or Tree																																	5									
Taxodium distichum	bald cypress	Tree	15	15	15	1	1	1													5	5	5							76	76	76	75	75	77	78	78	78	79	79	79	98	98	98
Unknown		Shrub or Tree																																					2	2	2	4	4	4
		Stem count	15	15	15	16	16	76	12	12	12	9	9	9	11	11	11	21	21	21	23	23	23	16	16	21	17	17	17	429	429	510	436	436	1025	448	448	543	448	448	464	630	630	630
		size (ares)	1			1			1			1			1			1			1			1			1			23			23			23			23			23		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.57			0.57			0.57			0.57			0.57		
		Species count	1	1	1	4	4	6	4	4	4	3	3	3	6	6	6	3	3	3	7	7	7	5	5	7	3	3	3	12	12	15	12	12	19	12	12	14	12	12	13	11	11	11
		Stems per ACRE	607	607	607	647	647	3076	486	486	486	364	364	364	445	445	445	850	850	850	931	931	931	647	647	850	688	688	688	755	755	897	767	767	1803	788	788	955	788	788	816	1108	1108	1108

Appendix D

Stream Geomorphology Data

(Not required for MY4)

Appendix E

Hydrology Data

Table 13. Documentation of Geomorphologically Significant Flow Events
Table 14. Rainfall Summary
Table 15a. Wetland Hydrology Criteria Attainment
Table 15b. Wetland Hydrology Summary
2018 Groundwater Monitoring Gauge Hydrographs
Figure 8. Crest Gauge Verification Photos
Figure 9. Headwater Valley Restoration Flow Chart

Table 13. Documentation of Geomorphologically Significant Flow Events

Crest Gauge	Stream Reach	Number of Bankfull Events	Date of Highest Bankfull Event	Maximum Bankfull Height (ft.)	Photo Number
Crest Gauge 1	UT-1	7	9/15/2018	0.95	1
Crest Gauge 2	UT-2	21	9/15/2018	2.91	2
Crest Gauge 3	UT-3	12	9/15/2018	3.03	3
Crest Gauge 5	UT-6	1	1/12/2018	1.25	4
Crest Gauge 6	UT-8	16	9/15/2018	3	5
Crest Gauge	**Stream Reach**	**Number of Consecutive Flow Days**		**Total Number of Flow Days**	
Crest Gauge 4	UT-4 (HWV)	282		282	

Table 14. 2018 Rainfall Summary

Month	Average	Normal Limits		Williamsdale Station Precipitation
		30 Percent	70 Percent	
January	4.33	3.32	5.03	4.24
February	3.23	2.14	3.87	1.16
March	4.50	3.23	5.32	4.00
April	3.16	1.70	3.85	6.26
May	3.68	2.69	4.34	9.40
June	4.49	3.11	5.34	5.44
July	6.06	4.16	7.22	6.46
August	5.40	3.12	6.56	2.54
September	5.00	2.04	6.07	18.29
October	3.21	1.62	3.92	1.06
November	2.89	1.83	3.49	3.19
December	3.24	2.14	3.88	6.83
Total	49.19	31.10	58.89	68.87

Table 15a. 2018 Wetland Hydrology Criteria Attainment

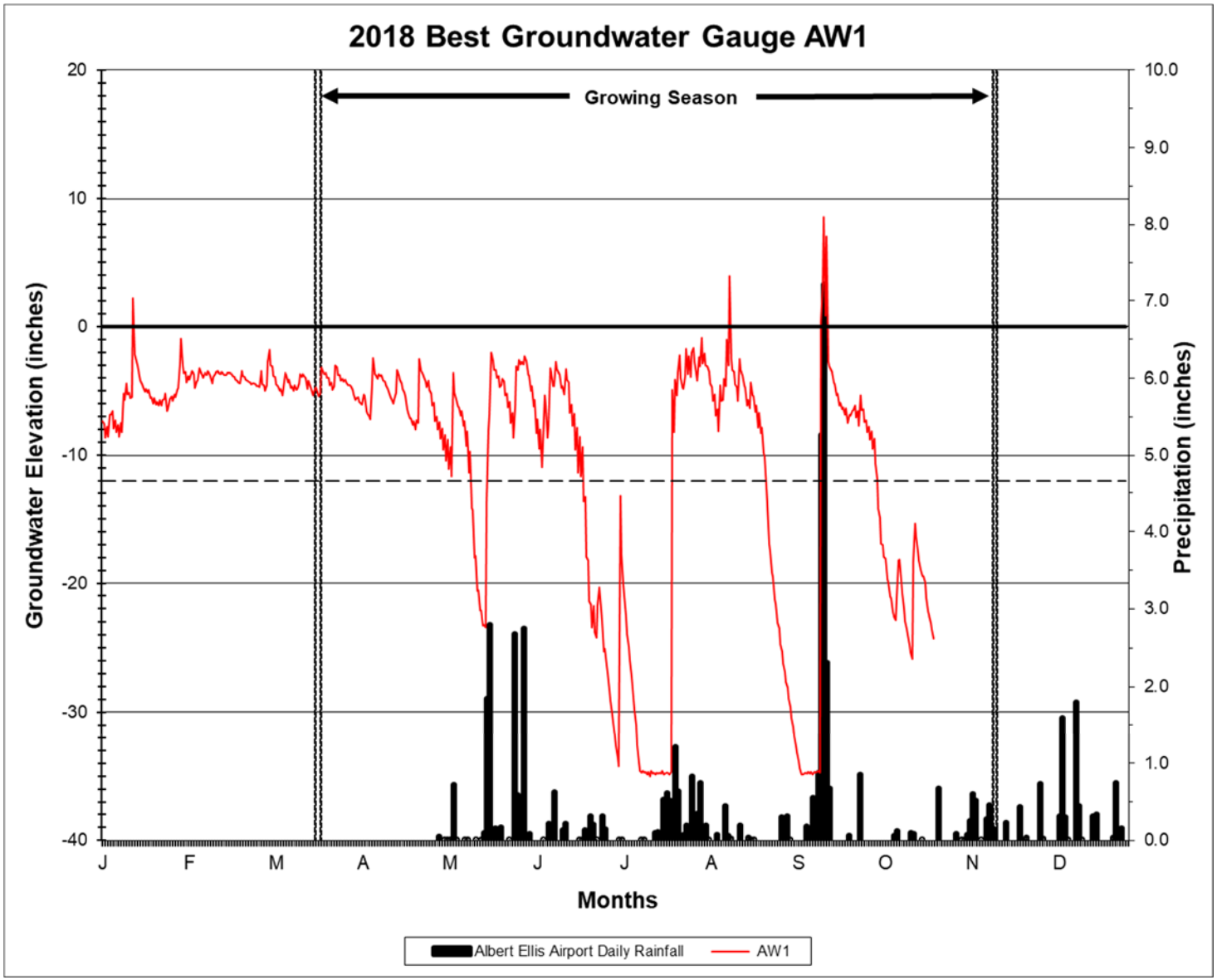
2018 Max Hydroperiod (Growing Season 17-Mar through 14-Nov, 242 days) Success Criterion 9% = 22 Consecutive Days					
	Consecutive		Cumulative		
Gauge	Days	Percent of growing Season	Days	Percent of growing Season	Occurrences
AW1	57	23	145	60	4
AW2	46	19	120	50	8
AW3	105	43	189	78	4
AW4	106	44	188	78	5
AW5	58	24	190	79	6
AW6	47	19	139	57	7
AW7	31	13	99	41	10
AW8	46	19	133	55	10
AW9	36	15	125	51	11
RAW1	57	23	166	69	4
RAW2	34	14	94	39	11
RAW3	48	20	146	60	8

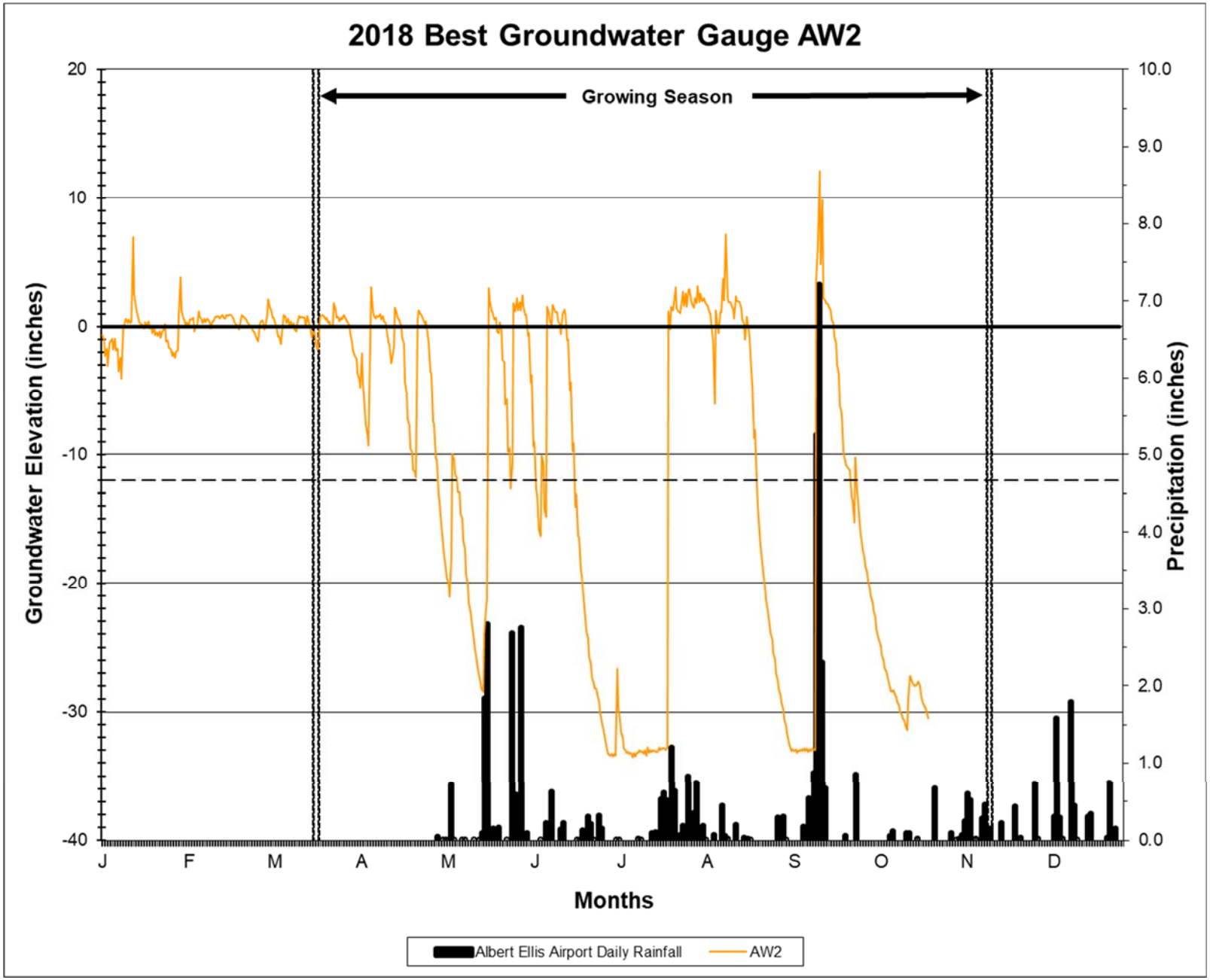
Table 15b. Wetland Hydrology Gauge Summary

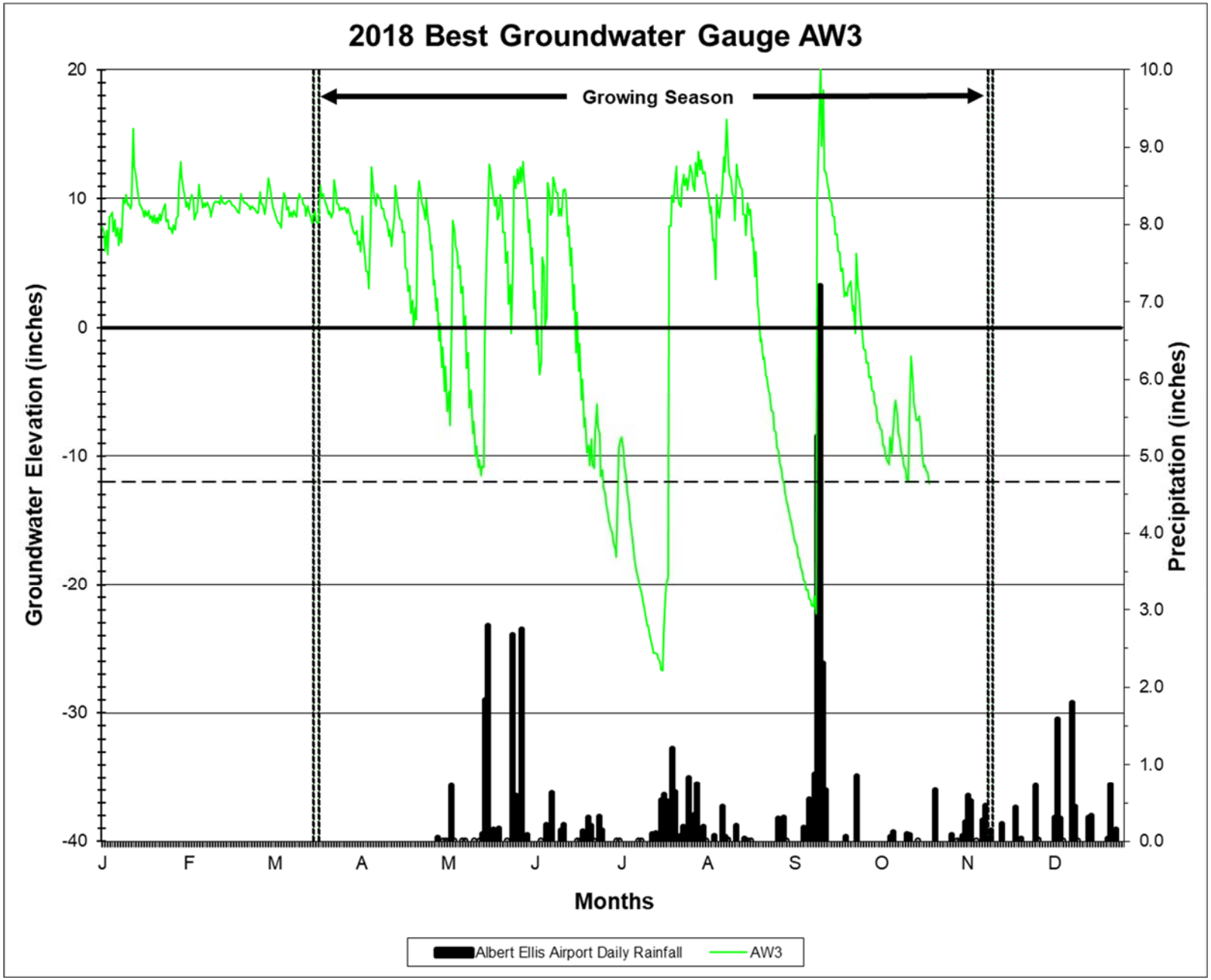
	MY1 - 2015		MY2 - 2016		MY3 - 2017		MY4 - 2018	
	Consecutive		Consecutive		Consecutive		Consecutive	
Gauge	Days	Percent of growing Season	Days	Percent of growing Season	Days	Percent of growing Season	Days	Percent of growing Season
AW1	49	20	53	22	53	22	57	23
AW2	18	7	18	7	49	20	46	19
AW3	88	36	99	41	118	49	105	43
AW4	88	36	97	40	117	48	106	44
AW5	51	21	103	43	120	49	58	24
AW6	28	12	42	17	55	23	47	19
AW7	22	9	17	7	13	5	31	13
AW8	24	10	32	13	16	7	46	19
AW9	24	10	18	7	14	6	36	15
RAW1	52	21	34	14	71	29	57	23
RAW2	46	19	10	4	24	10	34	14
RAW3	29	12	32	13	45	19	48	20

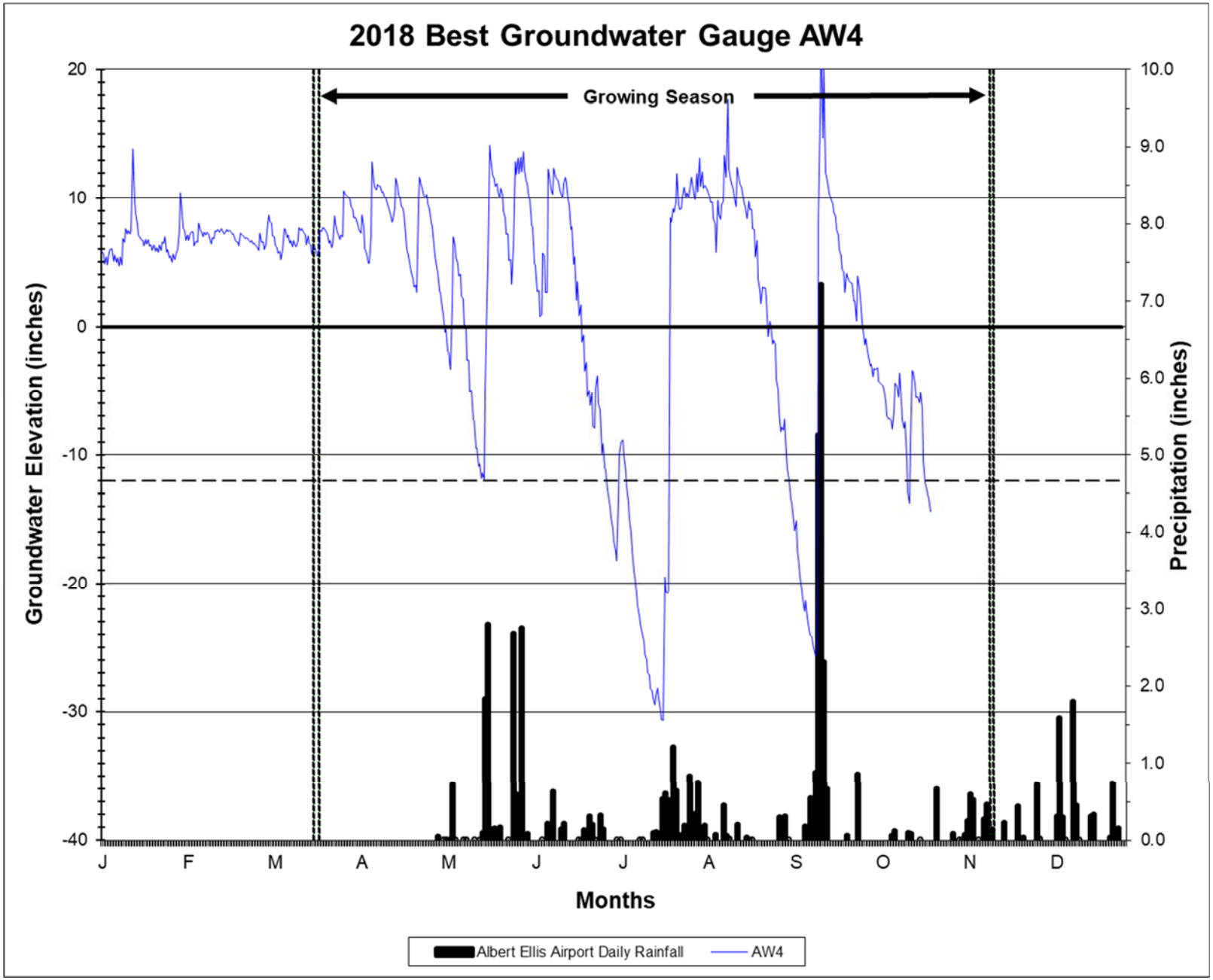
<5%
5-8%
≥9%

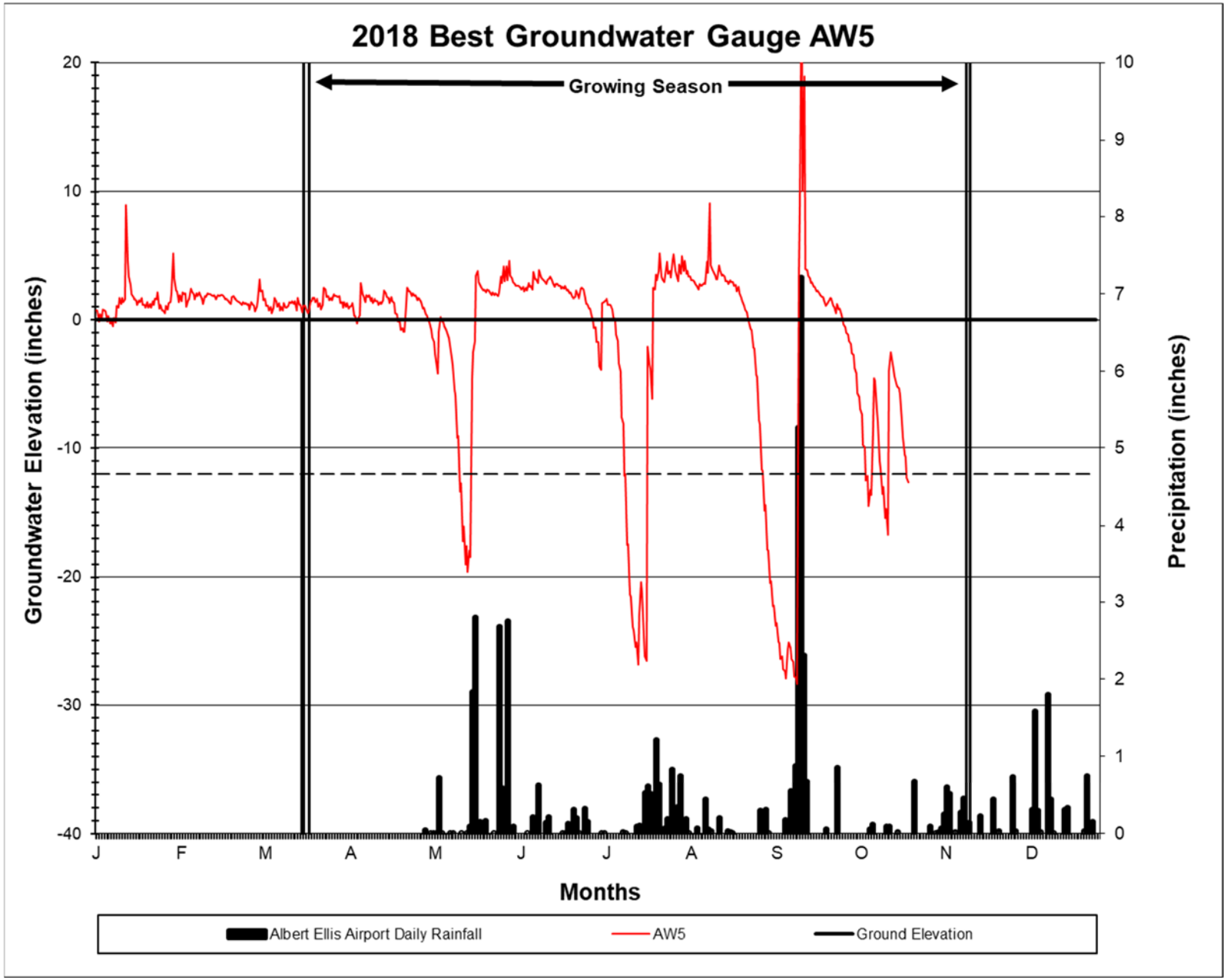
2018 Best Site Groundwater Monitoring Gauge Hydrographs

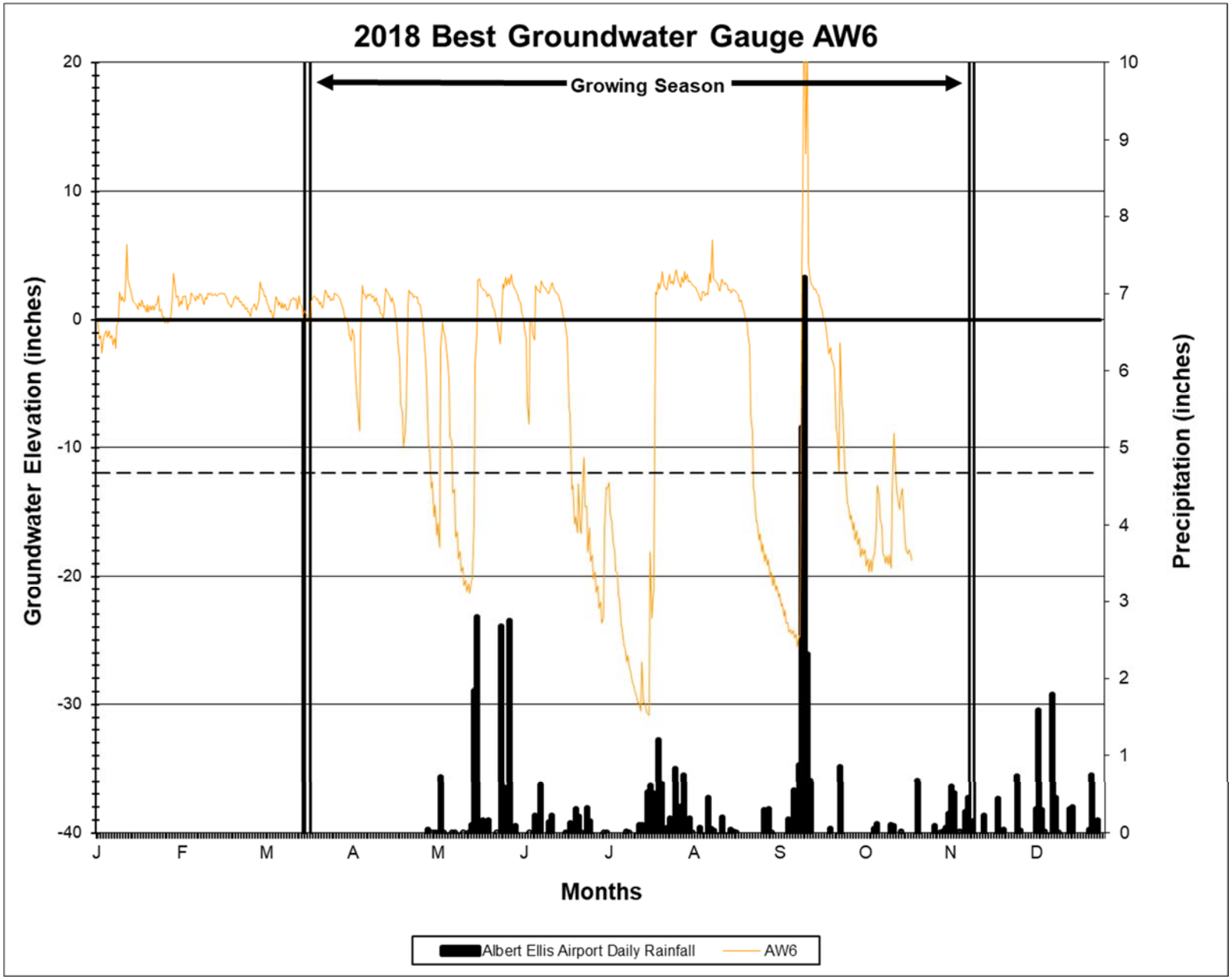


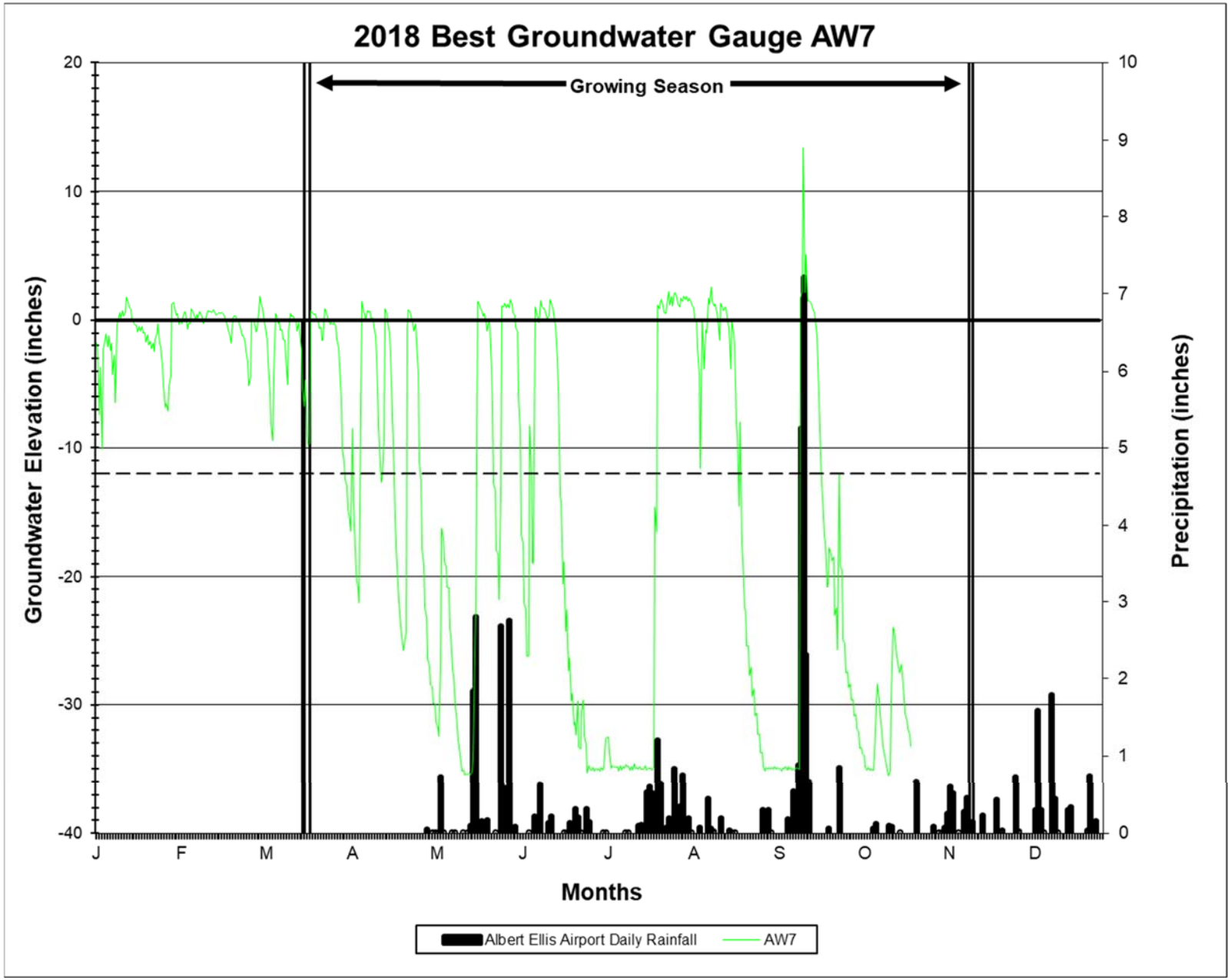

2018 Best Groundwater Gauge AW2
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
AW2

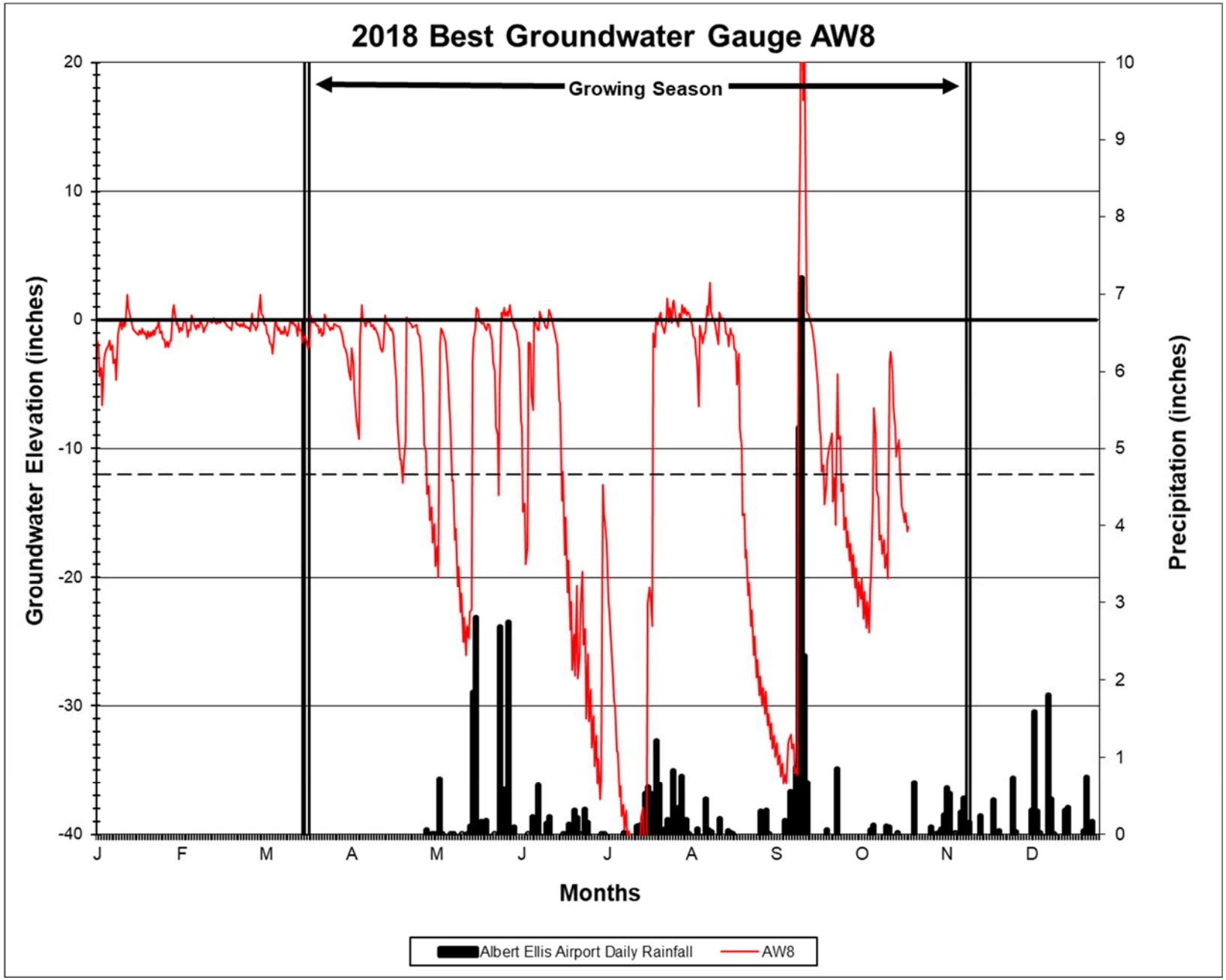

2018 Best Groundwater Gauge AW3
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
AW3

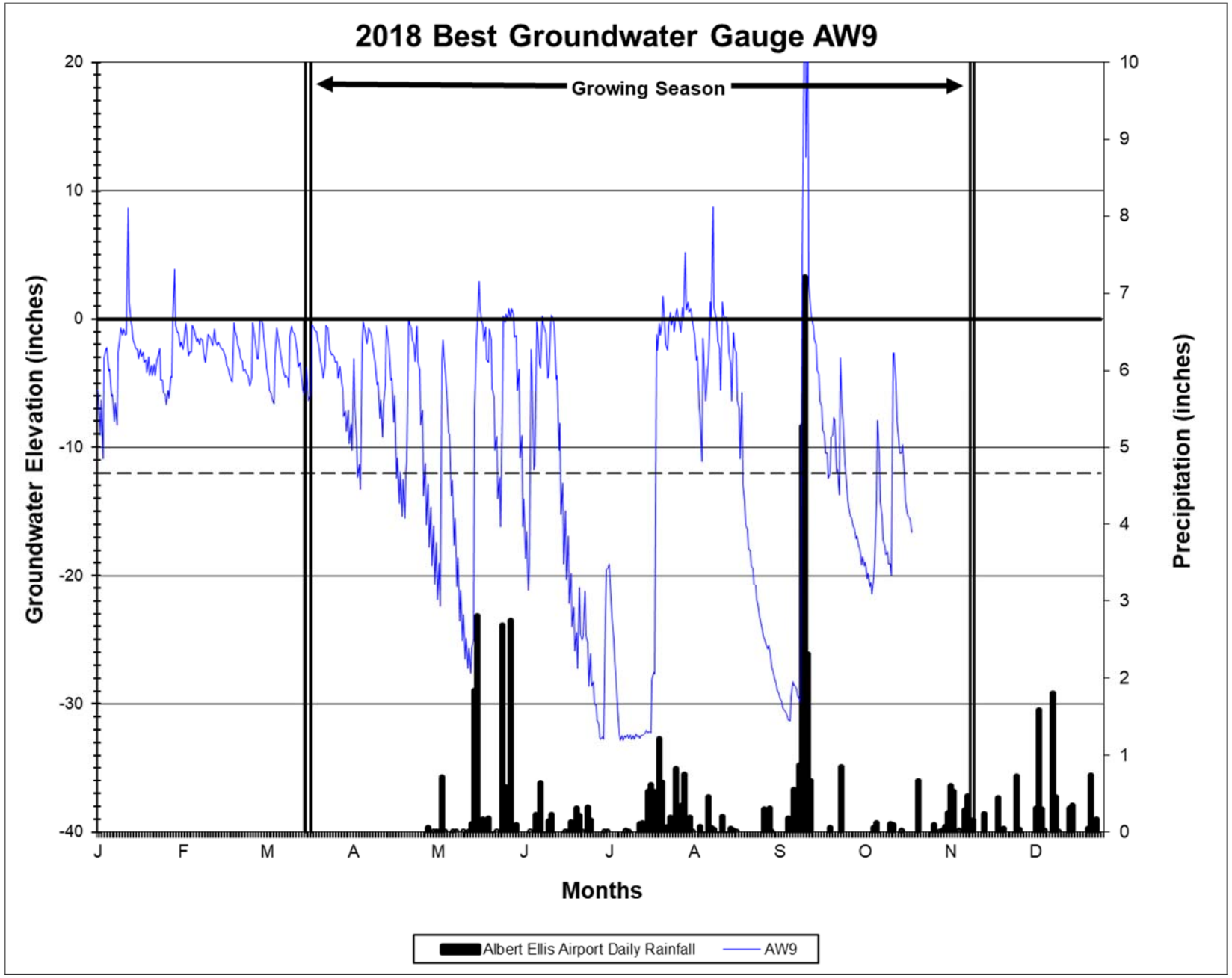

2018 Best Groundwater Gauge AW4
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
AW4

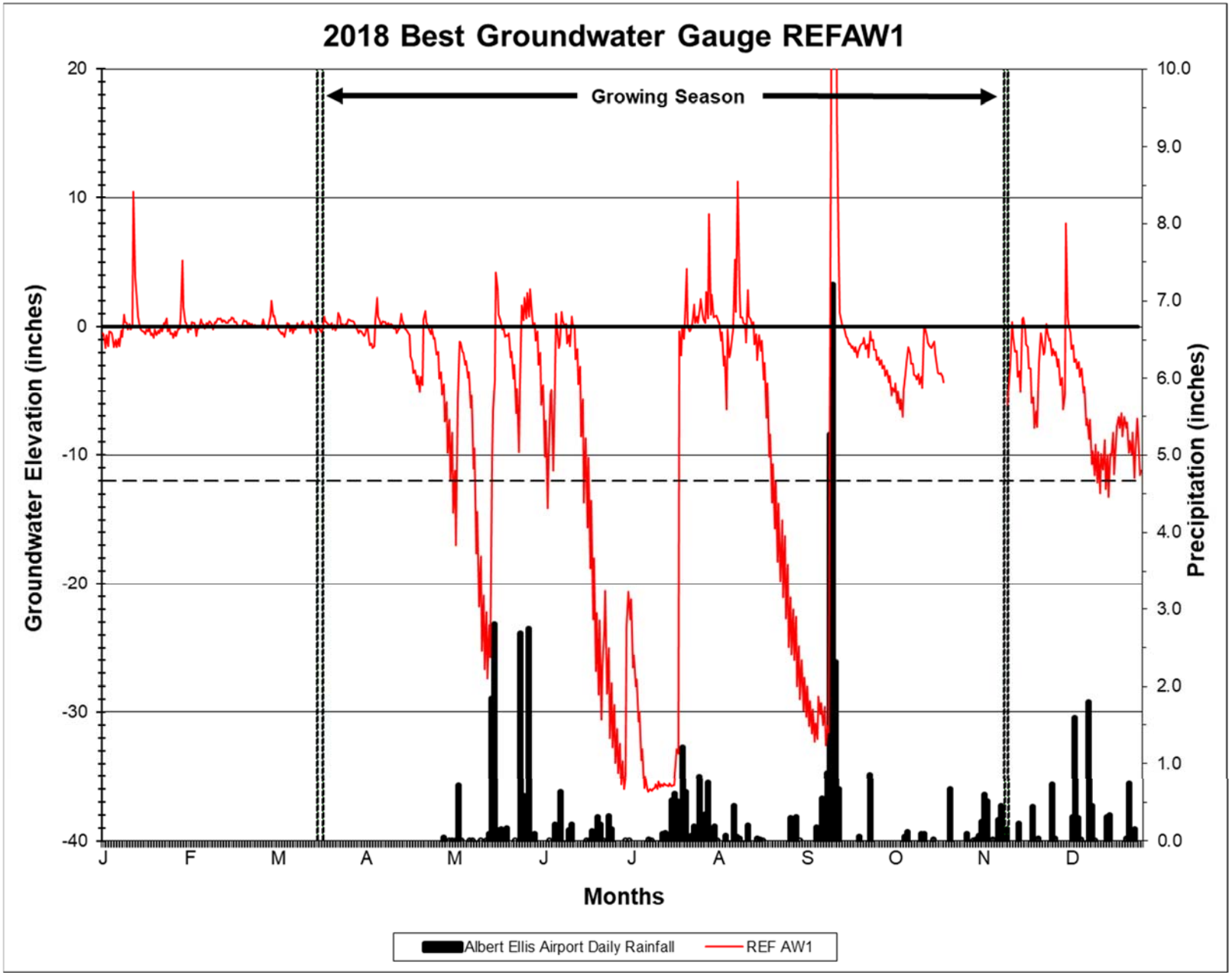

2018 Best Groundwater Gauge AW5
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10
9
8
7
6
5
4
3
2
1
0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
AW5
Ground Elevation

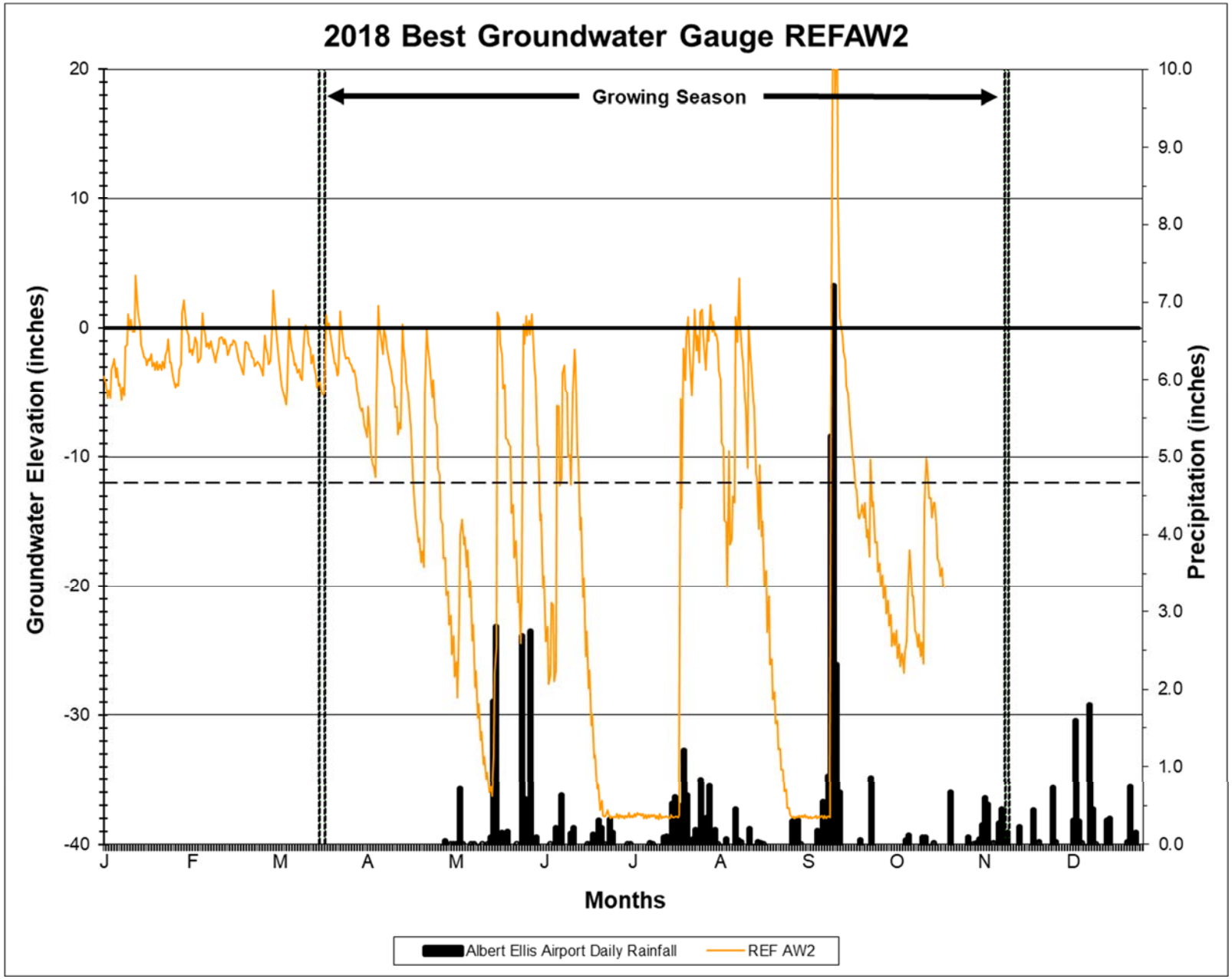

2018 Best Groundwater Gauge AW6
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10
9
8
7
6
5
4
3
2
1
0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
AW6


2018 Best Groundwater Gauge AW7
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10
9
8
7
6
5
4
3
2
1
0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
AW7


2018 Best Groundwater Gauge AW8
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10
9
8
7
6
5
4
3
2
1
0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
AW8


2018 Best Groundwater Gauge AW9
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10
9
8
7
6
5
4
3
2
1
0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
AW9


2018 Best Groundwater Gauge REFAW1
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
REF AW1


2018 Best Groundwater Gauge REFAW2
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
REF AW2

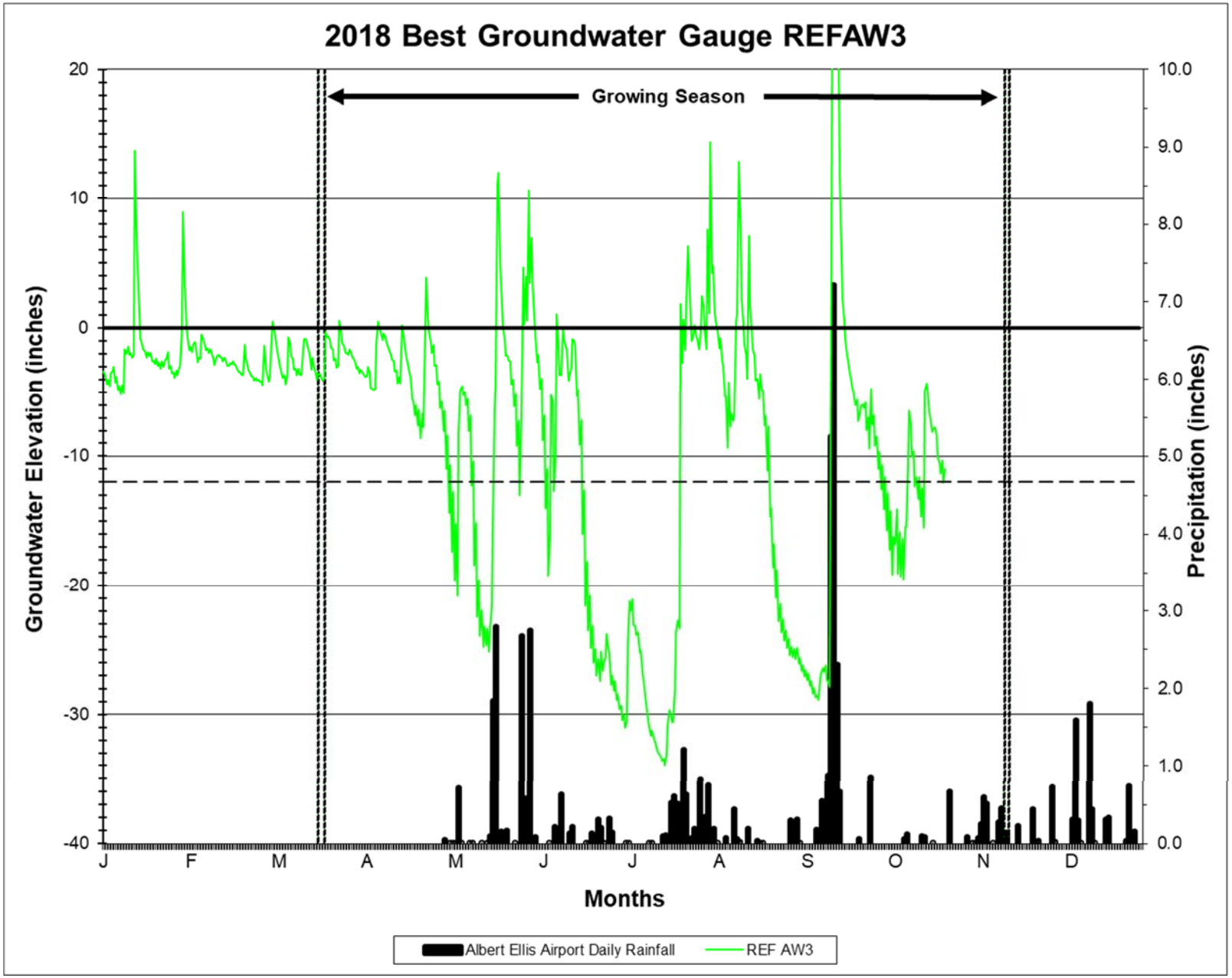

2018 Best Groundwater Gauge REFAW3
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
20
10
0
-10
-20
-30
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Albert Ellis Airport Daily Rainfall
REF AW3

Figure 8. Crest Gauge Verification Photos

Crest Gauge 1 Reading 0.95’

Crest Gauge 2 Reading 2.91’

Crest Gauge 3 Reading 3.03’

Crest Gauge 5 Reading 1.25’ (3/28/2018)

Crest Gauge 6 Reading 3.0’

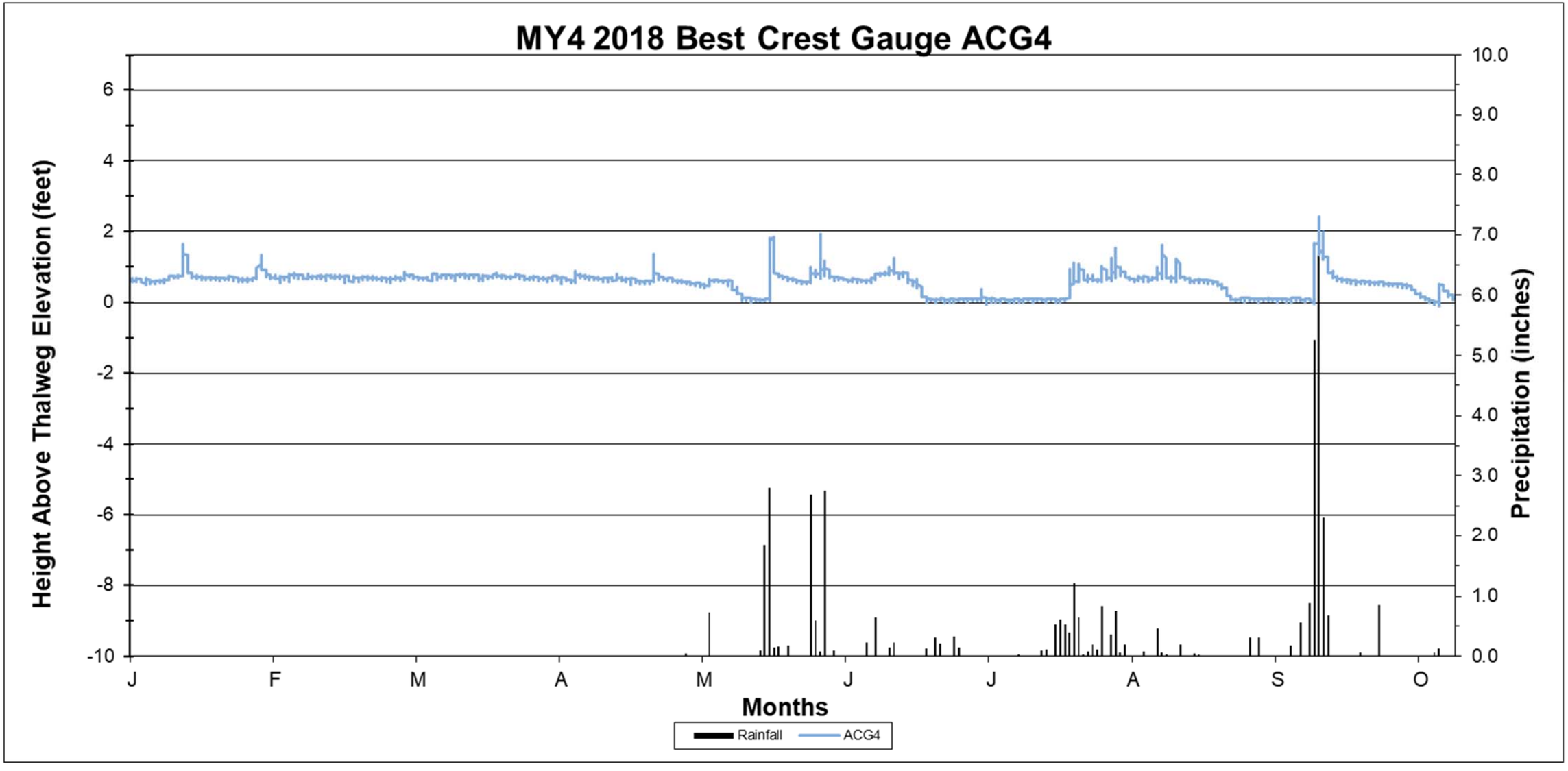



Figure 9. Headwater Valley Restoration Flow Chart