UT to Mill Swamp Restoration Project
Fifth Monitoring Measurement
Fourth Year of Credit Release - Final

Onslow County, North Carolina

DMS Project ID Number – 95019, DEQ Contract No. 003992

USACE Action ID: SAW-2011-02193, DWR# 20120916

Project Info:	Credit Release Year: 4 of 7 (Fifth site measurement since construction) Year of Data Collection: 2017 Year of Completed Construction: 2013 Submission Date: January 2018
Submitted To:	NCDEQ – Division of Mitigation Services 1652 Mail Service Center Raleigh, NC 27699-1652

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February 12, 2018

Jeff Schaffer
Eastern Supervisor, Project Management
NCDEQ Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

Subject: Task 10: Response Letter to DMS review comments regarding the Draft Year 4 Monitoring Report for the UT to Mill Swamp Restoration Project (#95019)
White Oak River Basin – CU#03030001, Onslow County, North Carolina
DEQ Contract No. 003992, Baker No. 124578

Dear Mr. Schaffer,

Please find enclosed the Final Year 4 Monitoring Report and our responses to your review comments received on January 29, 2018 regarding the UT to Mill Swamp Restoration Project located in Onslow County, NC. We have also provided the final digital files and required documentation in response to the referenced review comments below:

1. During the April 3, 2017 Credit Release meeting, the IRT decided that the assets for this project were to revert to those contained in the approved Mitigation Plan for stream and wetland credits. The approved stream credit is a total of 3,909 based on using headwater valley length for UT1b. The wetland credit reverted to 4.0 acres at a 1:1 ratio. Throughout this report, Baker is using assets and credits from both the approved mitigation plan and the as-built baseline report. Please change all references to linear footages, acres and credits in the report narrative to reflect the approved numbers.

Response: All references to the assets and credits were revised in the applicable report tables and narrative as requested.

2. Digital drawings:
   a. Digital files for each asset listed in Table 1 were provided in CADD but were not formatted or attributed as required in the EEP/DMS digital drawing guidance. The stream centerlines for example were submitted as a highly segmented polyline and were devoid of attributes such as reach ID. DMS would prefer to receive shapefiles for all of the features in the digital drawings requirements, but at a minimum, each asset (as listed in table 1 of the monitoring report) and each monitoring feature must be provided as a discreet, properly attributed polyline/polygon as required by contract and stated in table 2 of DMS's Format, Data Requirements, and Content Guidance for Electronic Drawings Submitted to EEP version 1.0 (03/27/08).

   b. In addition, during the review, DMS received a pop up warning that the spatial reference is missing for the As-Built_Streams_UTMillSwamp, Crossings_UTMillSwamp, FlowGauges_UTMillSwamp, TopOfBank_UTMillSwamp, UTMillSwamp_CrestGauge and XSections_UTMillSwamp layers.

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Response: All of the GIS shapefiles were reformatted and reassigned their correct spatial reference as requested.

3. Cover Page: Change the word "Permits:" to USACE Action ID.

Response: Cover page was revised as requested.

4. Executive Summary, page 3: In the fifth paragraph, the report states that only 2 gauges are meeting in the wetland restoration area on the north side of UT1c and the estimated restored area associated with these 2 gauges is 0.90 acres. Based on this, describe whether Baker will further refine these assets and remove the proposed wetland credits/area where gauges have consistently not met hydrologic success. Please note that the final credit release ledger submitted to the IRT for approval in 2017 requested on 4.00 WMUs per comment #1 above.

Response: Baker does not wish to modify the wetland restoration asset area at this time. As elaborated in the report, the start of the growing season was very dry in 2017, usually a wetter period of the year when wells often meet their success criteria. Despite this, several of the wells located in the north side of the UT1c that did not pass were very close (1-3 days) to meeting their 29-day requirement. Baker wishes to continue monitoring this area through at least one additional monitoring year in which it has received normal rainfall conditions, especially through the late winter/early spring time period.

5. Section 2: Even though the groundwater gauges are discussed in Section 2.2.2, explain why there is no section to specifically discuss the wetland assessment. Section 2.2.2 appears to be more associated with the stream portion of this project.

Response: A new wetlands-specific section was added to the report to provide a more detailed assessment and discussion of the wetland restoration areas.

6. Appendix A, Table 1: Update Table 1 as follows:
   a. Total stream credits in Mitigation Credit section – 3,909
   b. Total wetland credits in Mitigation Credit section – 4.0 per the approved mitigation plan.
   c. Reach UT1b in project components – change SMUs and LF to 1,996 (this HW valley length)
   d. Wetland Area #1 – change WMUs and AC to 4.0
   e. Stream Restoration LF in Component Summation section – 3,909 (3,509)
   f. Wetland Restoration AC in Component Summation section – 4.0
   g. Add the following footnote:

** Credit calculations were originally calculated along the as-built thalweg and updated to be calculated along stream centerlines and valley length for Monitoring Year 4 after discussions with NC IRT stemming from the April 3, 2017 Credit Release Meeting.*

Response: Table 1 was revised as requested.

7. Appendix E, Table 12: Add a footnote to describe whether Baker will further refine wetland assets and remove the proposed wetland credits/area where gauges 2, 6, 9, 10, 20, 21, 22 and 23 have consistently not met hydrologic success.

Response: Baker does not wish to refine wetland assets at this time and will continue to monitor all of the groundwater wells on the project.

If you have any questions or require additional information, please feel free to contact me at 919-481-5731 or via email at Scott.King@mbakerintl.com.

Sincerely,

Scott King, LSS

UT to Mill Swamp Restoration Project
Fifth Monitoring Measurement
Fourth Year of Credit Release - Final

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Report Prepared and Submitted by Michael Baker Engineering, Inc.

NC Professional Engineering License # F-1084

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* Note: The figures and tables marked above with an asterisk are not included as part of this Year 4 Monitoring Report, but were left listed in the Table of Contents to explain the otherwise out-of-sequence figure/table numbering and appendix designations. For clarity, Michael Baker wishes to preserve the continuity of the labeling for these features between monitoring years to avoid confusion (e.g. to allow Appendix C to always contain vegetation data, and Table 13 to always be the flow gauge success table, etc. in each monitoring report). These figures and tables had been included in past reports and will be included again as part of the Year 5 monitoring report for 2018.

1.0 EXECUTIVE SUMMARY

Michael Baker Engineering (Baker) restored 3,509 linear feet (LF) of perennial stream, 4.0 acres (AC) of riparian wetlands, and enhanced 600 LF of stream along an unnamed tributary (UT) to Mill Swamp in Onslow County, North Carolina (NC), (Appendix A). The total planted acreage was approximately 15.2 acres, and the permanent conservation easement is 19.6 acres. The UT to Mill Swamp Restoration Project (Site) is located in Onslow County, approximately three miles northwest of the Town of Richlands. The Site is located in the NC Division of Water Resources (NCDWR) sub-basin 03-05-02 and the NCDEQ Division of Mitigation Services (DMS) Targeted Local Watershed (TLW) 03030001-010020 of the White Oak River Basin. The project involved the restoration and enhancement of a Coastal Plain Headwater Small Stream Swamp system (NC WAM 2010, Schafale and Weakley 1990) from impairments within the project area due to past agricultural conversion, cattle grazing, and draining of floodplain wetlands by ditching activities.

The project goals directly addressed stressors identified in the White Oak River Basin Restoration Priority Plan (RBRP) such as degraded riparian conditions, channel modification, and excess sediment and nutrient inputs. The primary restoration goals, as outlined in the approved mitigation plan, are described below:

- Create geomorphically stable conditions along the unnamed tributaries across the Site,
- Implement agricultural Best Management Practices (BMPs) to reduce nonpoint source inputs to receiving waters,
- Protect and improve water quality by reducing bank erosion, nutrient and sediment inputs,
- Restore stream and wetland hydrology by connecting historic flow paths and promoting natural flood processes, and
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement.

To accomplish these goals, the following objectives were identified:

- Restore existing incised, eroding, and channelized streams by providing access to their historic floodplains,
- Prevent cattle from accessing the riparian buffer, reducing excessive bank erosion,
- Increase aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated bank erosion,
- Plant native species riparian buffer vegetation along stream bank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve bank stability, and shade the stream to decrease water temperature,
- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature, and
- Control invasive species vegetation within the project area and if necessary, continue treatments during the monitoring period.

The project as-built condition closely mimics that proposed by the design. Differences are outlined below:

- The Stream and Wetland Mitigation Plan (Mitigation Plan) specified the planting of riparian live stakes during construction; however, due to construction being completed during the growing season in May 2013 no live stakes were installed. During construction, it was determined that live stakes would be installed during the dormant season. It is noted that as of March 27, 2014, approximately 300 live stakes were installed along the stream banks in the restored single thread channel of the UT1c area.
- Permanent fencing along Reach UT3 was originally proposed 50 feet from both of the streambanks outside of the conservation easement; however, the landowner decided to use the northern pasture for hay production only, so fencing was installed only on the southern side of the reach to exclude cattle.

Special Notes:

In consideration of this report, the following timeline should be noted:

Completion of construction – 5/31/13

Completion of installation of tree and shrub bare roots – 6/13/13

Year 1 (2013) vegetation monitoring – 10/16/13

Live stake installation - 3/27/14

Year 1 (2013) supplemental vegetation monitoring – 5/18/14

Year 2* (2014) vegetation monitoring – 12/19/14

Year 2 (2015) vegetation monitoring – 11/13/15

Year 3 (2016) vegetation monitoring – November, 2016

Supplemental 3-foot bare roots installed in the area around Vegetation Plot 3 only – March 20, 2017

Year 4 (2017) vegetation assessment was conducted in October of 2017, but no formal monitoring plot data is required to be collected as part of Year 4 monitoring effort.

Supplemental Year 1 (5/18/14) vegetation monitoring was conducted in order to provide additional mortality data. This additional monitoring effort was done since the time that had elapsed between the installation of the tree and shrub bare roots (6/13/13) and Year 1 vegetation monitoring (10/16/13) was only 125 days of the growing season (March 18th through November 16th). Trees and shrubs grew for an additional 61 days of growing season from 3/18/14 through 5/18/14 in early 2014 and were supplementally monitored. A total of 186 days of growing season had elapsed since the trees were planted and the supplemental Year 1 vegetation monitoring was conducted. An additional 181 days within the growing season (5/19/14 through 11/16/14) had elapsed prior to Year 2 (2014) vegetation monitoring, providing the required minimum of 180 days of growing season growth as stated in the approved Mitigation Plan. As such, Baker considered the data collected on 12/19/14 to be Year 2 data and the data collected on 11/13/15 to be Year 3 data. However, the US Army Corps of Engineers has declined to release the credits generated from Year 2 (2014) citing too short of a period between plant installation and monitoring. As such, the 2015 monitoring report was considered Year 2. All references to Year 2 henceforth will indicate monitoring activities conducted during 2015. Data collected during 2014 that was previously considered monitoring Year 2 will be labeled as Year 2*.

In accordance with the Mitigation Plan and the DMS guidance document "Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation" dated 11/7/2011, no formal vegetation plot monitoring was performed, nor were any stream cross-sectional surveys conducted as part of this Year 4

monitoring effort. A visual assessment of these project features is emphasized this year, with the full vegetation plot and cross-section survey work to resume for the Year 5 monitoring in 2018.

During Year 4 monitoring, the planted acreage performance categories were functioning at 100 percent with no bare areas to report, no current low stem density areas, and no areas of poor growth rates. Vegetation plot data monitoring will again be conducted for the MY5 report.

Previously during Year 3 monitoring, it was reported that one vegetation plot (Plot 3) did not meet the Year 3 success criteria of 320 stems per acre, having only 243 planted stems per acre (though with an additional 6 natural volunteer stems within the plot). A closer evaluation of this spot confirmed that the observed thin densities were confined to a fairly small area and likely the result of shading from the surrounding mature forest. As such, the area around Veg Plot 3 totaling ~0.20 acres was subsequently planted in March of 2017 with additional stems of bald cypress (*Taxodium distichum*) from bare root, and water tupelo (*Nyssa aquatica*) planted from tubelings. This area was inspected again in November of 2017 and appeared to be doing well.

Invasive species areas of concern were observed and documented during Year 4 monitoring. One area of Chinese privet (*Ligustrum sinense*) re-sprouts totaling 0.58 acres was discovered along the left floodplain of the lower section of Reach UT1c. This is an area that had previously been treated for privet in November of 2016, and will again be treated in the upcoming monitoring year.

During Year 4 monitoring, six of the sixteen groundwater monitoring wells located along Reach UT1c met the wetland success criteria as stated in the Site Mitigation Plan. The gauges that met success criteria (MSAW1, MSAW4, MSAW5, MSAW8, MSAW19, and MSAW24) demonstrated consecutive hydroperiods of 12 percent or greater, and ranged from 12.8 to 46.1 percent of the growing season. The gauges that did not meet success criteria (See Table 12) demonstrated consecutive hydroperiods of 12 percent or less which ranged from 0.4 percent to 11.5 percent of the growing season. It should be noted that while MSAW7 is not meeting the success criteria, it is located outside of the wetland restoration and hydric soils boundary in the adjacent *upland* area, while MSAW3 is located on the wetland/upland boundary itself.

All of the wells located in the restored wetland area south of UT1c are meeting success criteria, and total 3.26 acres. The restored wetland area north of UT1c is 3.36 acres, but only had two wells meet success criteria for an estimated restored area of ~0.90 acres (see CCPV in Appendix B). Thus, the total wetland restoration acreage currently equals ~4.16 acres (or 4.16 WMUs) in MY4, which is in excess of the wetland mitigation credits stated in the approved Mitigation Plan.

Year 4 flow monitoring demonstrated that both flow gauges (MSFL1 and MSFL2) met the stated success criteria of 30 days or more of consecutive flow through reaches UT1a and UT1b. Both gauges demonstrated consecutive days of flow that ranged from 139 days (MSFL1, on UT1a) to 164 days (MSFL2, on UT1b). The gauges demonstrated similar patterns relative to rainfall events observed in the vicinity of the Site.

The Site was also found to have had at least two above-bankfull events based on the crest gauge readings during Year 4 monitoring.

Summary information/data related to the Site and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report Appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report and in the Mitigation Plan available on the North Carolina Division of Mitigation Services (NCDMS) website. All raw data supporting the tables and figures in the appendices is available from NCDMS upon request.

2.0 METHODOLOGY

The seven-year monitoring plan for the Site includes criteria to evaluate the success of the stream, wetland and vegetation components of the project. The methodology and report template used to evaluate these components adheres to the NCDMS monitoring guidance document dated November 7, 2011, which will continue to serve as the template for subsequent monitoring years. The specific locations of monitoring features: vegetation plots, permanent cross-sections, monitoring wells, flow gauges, and the crest gauge, are shown on the CCPV sheets found in Appendix B.

The final Year 4 monitoring gauge data were collected in November 2017. All visual site assessment data located in Appendix B were collected in October and November 2017.

2.1 Stream Assessment – Reach UT1a & UT1b

The UT1a and UT1b mitigation approach involved the restoration of historic flow patterns and flooding functions in a multi-thread headwater stream system. Monitoring efforts focus on visual observations to document stability and the use of water level monitoring gauges to document groundwater and flooding functions.

2.1.1 Hydrology

Two automated groundwater gauges (pressure transducers) are installed along well transects, with a total of four well transects installed in the UT1a and UT1b areas. The automated loggers are programmed to collect data at 6-hour intervals to record groundwater levels in UT1a and UT1b areas. Graphs of the groundwater data collected for these gauges during Year 4 monitoring are located in Appendix E.

Additionally, two flow gauges (pressure transducers) were installed to document the occurrence of extended periods of shallow surface ponding, indicative of flow. The gauges attempt to document flooding connectivity between the restored UT1a and UT1b reaches for at least 30 consecutive days under normal climatic conditions. Both gauges met this success criteria with consecutive days of flow that ranged from 139 days (MSFL1, on UT1a) to 164 days (MSFL2, on UT1b). The gauges demonstrated similar patterns relative to rainfall events observed in the vicinity of the Site. Flow data collected during Year 4 monitoring are located in Appendix E.

2.1.2 Photographic Documentation

The headwater stream reaches were photographed longitudinally beginning at the downstream portion of the Site and moving towards the upstream end of the Site. Photographs were taken looking upstream at delineated locations throughout the restored stream valley. The photograph points were established close enough together to provide an overall view of the reach lengths and valley crenulations. The angle of the photo depends on what angle provides the best view and was noted and continued in future photos. Selected UT1a and UT1b site photographs taken at established reference stations are found in Appendix B.

2.2 Stream Assessment – Reach UT1c

The UT1c mitigation approach involved the restoration of historic flow patterns and flooding functions in a single-thread headwater stream system. Monitoring efforts focus on visual observations, the use of groundwater level monitoring gauges, a crest gauge to document bankfull flooding events and established stream cross-sections to monitor channel stability.

Stream survey data is collected to a minimum of Class C Vertical and Class A Horizontal Accuracy using Leica TS06 Total Station and was georeferenced to the NAD83 State Plane Coordinate System, FIPS3200 in US Survey Feet, which was derived from the As-built Survey. This survey system collects point data with an accuracy of less than one tenth of a foot.

2.2.1 Morphologic Parameters and Channel Stability

A longitudinal profile was surveyed for the entire length of channel immediately after construction to document as-built baseline monitoring conditions (Year 0) only. The survey was tied to a permanent benchmark and measurements included thalweg, water surface, bankfull, and top of low bank. Each of these measurements was taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. Yearly longitudinal profiles will not be conducted during subsequent monitoring years unless channel instability has been documented or remedial actions/repairs are required by the USACE or DMS.

As per the Mitigation Plan and DMS monitoring guidance for this project, no cross-section survey data were collected for this Year 4 Monitoring assessment. Consequently, none of the cross-sectional survey graphs (Figure 5) or morphology data (Table 11) are presented in Appendix D as in previous monitoring reports. This data will again be included as part of the Year 5 report.

2.2.2 Hydrology

One crest gauge was installed on the floodplain at the bankfull elevation along the left top of bank on UT1c approximately at Station 45+50. In MY4, two above-bankfull events associated with storm events were documented by the crest gauge. The highest recorded reading was measured to be 1.20 feet and was estimated to have occurred on April 25, 2017. Crest gauge reading data are presented in Appendix E and gauge photographs are presented in Appendix B.

2.2.3 Photographic Documentation

Representative project photographs for MY4 were taken at the previously established photograph reference stations located along the enhanced and restored stream sections and are presented in Appendix B.

2.2.4 Visual Stream Morphological Stability Assessment

The visual stream morphological stability assessment involves the qualitative evaluation of lateral and vertical channel stability, and the integrity and overall performance of in-stream structures throughout the Project reach as a whole. Habitat parameters, and pool depth maintenance, are also measured and scored. During Year 4 monitoring, the entire project reach was walked, noting geomorphic conditions of the stream bed profile (riffle/pool facets); both stream banks, and engineered in-stream structures. All stream reaches appear stable and functioning. All stream beds are vertically stable, the pools are maintaining depth, stream banks are stable and vegetating, and in-stream structures are physically intact and performing as designed. No Stream Problem Areas (SPAs) were documented during Year 4 monitoring. A more detailed summary of the methodology and results for the visual stream stability assessment can be found in Appendix B, which includes supporting data tables.

2.3 Wetland Assessment

Following construction, ten automated groundwater monitoring wells were installed in the UT1c wetland restoration areas following USACE protocols (USACE 1997). An additional six monitoring wells were installed in the spring of 2016 in the left floodplain of UT1c for a more detailed evaluation in that location.

Graphs of the groundwater data collected from each well during the Year 4 monitoring can be found in Appendix E.

During the Year 4 monitoring, six of the sixteen groundwater monitoring wells located along Reach UT1c met the wetland success criteria as stated in the Site Mitigation Plan. The gauges that met success criteria (MSAW1, MSAW4, MSAW5, MSAW8, MSAW19, and MSAW24) demonstrated consecutive hydroperiods of 12 percent or greater, and ranged from 12.8 to 46.1 percent of the growing season. The gauges that did not meet success criteria (See Table 12) demonstrated consecutive hydroperiods of 12 percent or less which ranged from 0.4 percent to 11.5 percent of the growing season. It should be noted that while MSAW7 is not meeting the success criteria, it is located outside of the wetland restoration and hydric soils boundary in the adjacent *upland* area, while MSAW3 is located on the wetland/upland boundary itself.

All of the wells located in the restored wetland area south of UT1c are meeting success criteria, and total 3.26 acres. The restored wetland area north of UT1c is 3.36 acres, but only had two wells meet success criteria for an estimated restored area of ~0.90 acres (see CCPV in Appendix B). Thus, the total wetland restoration acreage currently equals ~4.16 acres (or 4.16 WMUs) in MY4, which is in excess of the wetland mitigation credits stated in the approved Mitigation Plan.

The total observed rainfall at the Albert Ellis airport (KOAJ) weather station located close to the site in Richlands, NC for the previous 12-month period from December 2016 through November 2017 was 46.2 inches, substantially less that the 30-year historic annual average of 56.5 inches, for a deficit of just over 10" of rainfall. Of particular note for the project this monitoring year, January, February, and March of 2017 were especially dry, with the latter two months recording rainfalls totals below their historic 30% probable averages. Using the NRCS method (Sprecher and Warne, 2000), drier-than-average antecedent conditions were confirmed as being present on site during the early portion of the growing season in the spring of 2017.

The noted lack of rainfall observed in the early part of the year was significant in that it negatively affects the hydrology present at the start of the growing season, typically the wettest time of year on the project when the hydrology success criteria is most likely to be met. A closer investigation into the groundwater well results reveals that many of the wells that did not meet the success criteria only missed by a few days out of the 29 days required to make the 12% threshold. In particular, wells MSAW-6 (1-day), MSAW-20 (3-days), and MSAW-21 (3-days) very each very close.

2.4 Vegetation Assessment

In order to determine if success criteria are achieved, vegetation-monitoring quadrants were installed and are monitored annually across the Site in accordance with the CVS-NCEEP Protocol for Recording Vegetation, Version 4.1 (2007). The vegetation monitoring plots are a minimum of two percent of the planted portion of the Site, with six plots established randomly within the planted UT1a, UT1b and UT1c riparian buffer areas per Monitoring Levels 1 and 2. No monitoring quadrants were established within the undisturbed wooded areas of UT1a and UT1b. The sizes of individual quadrants are 100 square meters for woody tree species.

As per the Mitigation Plan and DMS monitoring guidance for this project, there was no vegetation plot monitoring conducted for the Year 4 monitoring effort, and thus no vegetation data summary tables are included in Appendix C as in previous monitoring reports. However, as reported in Table 6a (Appendix B), the planted acreage performance categories were functioning at 100 percent with no bare areas to report, no current low stem density areas, and no areas of poor growth rates. Vegetation plot data monitoring will again be conducted for the MY5 report.

Previously during Year 3 monitoring, it was reported that one vegetation plot (Plot 3) did not meet the Year 3 success criteria of 320 stems per acre, having only 243 planted stems per acre (though with an additional 6 natural volunteer stems within the plot). A closer evaluation of this spot confirmed that the observed thin

densities were confined to a fairly small area and likely the result of shading from the surrounding mature forest. As such, the area around Veg Plot 3 totaling ~0.20 acres was subsequently planted in March of 2017 with additional stems of bald cypress (*Taxodium distichum*) from bare root, and water tupelo (*Nyssa aquatica*) planted from tubelings. This area was inspected again in November of 2017 and appeared to be doing well.

Invasive species areas of concern were observed and documented during Year 4 monitoring. One area of Chinese privet (*Ligustrum sinense*) re-sprouts totaling 0.58 acres was discovered along the left floodplain of the lower section of Reach UT1c. This is an area that had previously been treated for privet in November of 2016, and will again be treated in Monitoring Year 5.

At this time, no other areas of concern regarding the existing vegetation was observed along UT1a, UT1b or UT1c. Year 4 vegetation assessment information and photographs are provided in Appendix B.

3.0 REFERENCES

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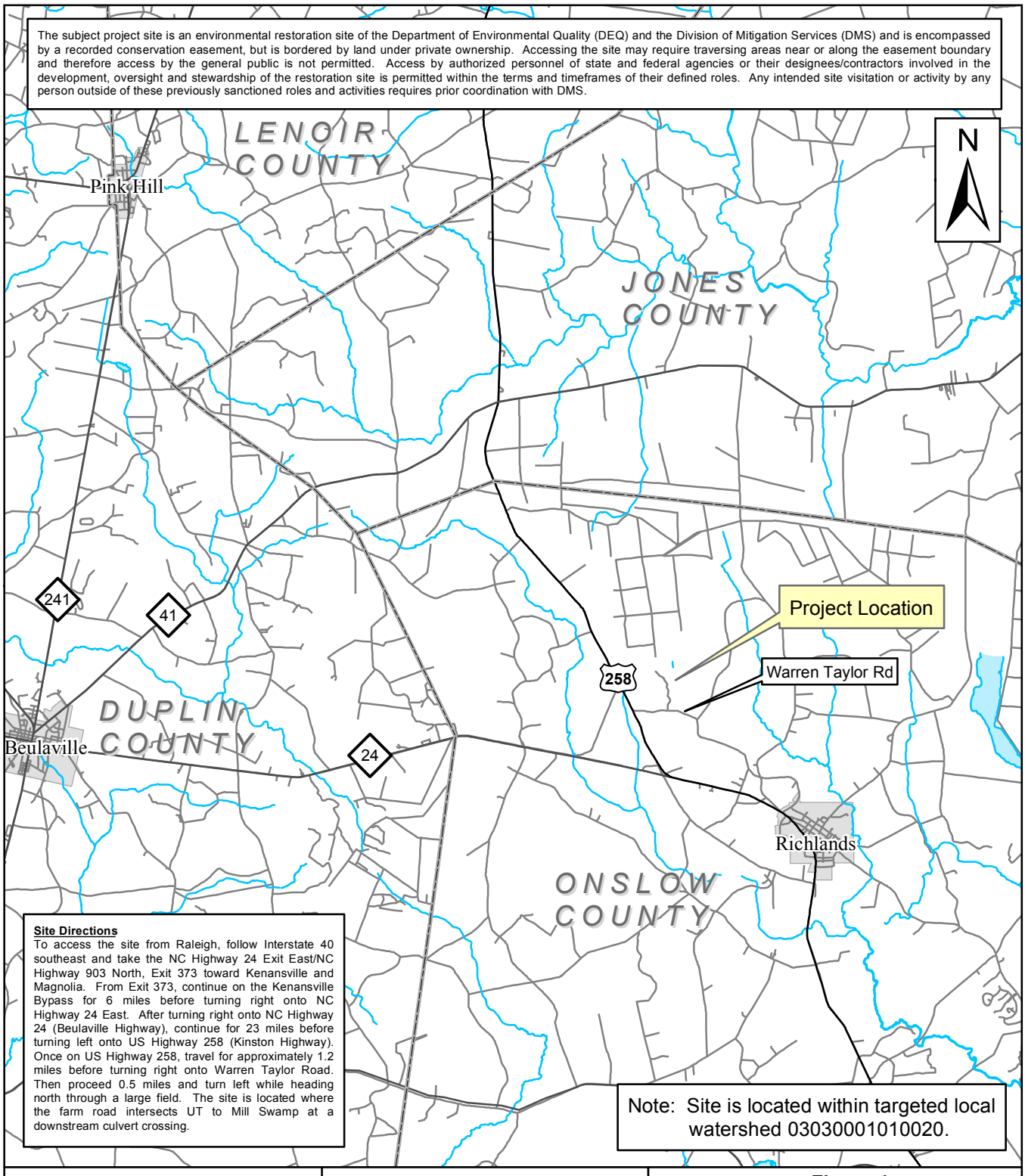
Appendix A

Project Vicinity Map and Background Tables



DMS Project # 95019

Onslow County

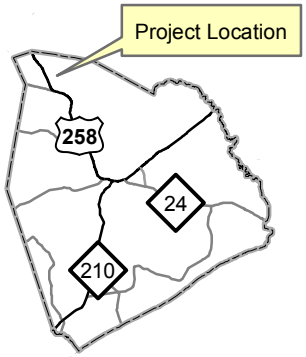


Figure 1
Project Vicinity Map
UT to Mill Swamp Site

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0 0.5 1 2 3
Miles

Table 1. Project Components and Mitigation Credits
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Mitigation Credits

	Stream	Riparian Wetland		Non-riparian Wetland	Buffer	Nitrogen Nutrient Offset	Phosphorus Nutrient Offset
Type	R, E1	R	E				
Totals	3,909 SMU	4.0 WMU	0				

Project Components

Project Component or Reach ID	Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration/ Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio
Reach UT1a	10+00 – 16+00	600 LF	Enhancement Level I	400 SMU	600 LF	1.5:1
Reach UT1b	16+00 – 36+93	2,131 LF	Headwater Restoration	1,996 SMU	1,996 LF	1:1
Reach UT1c	37+24 – 52+37	1,350 LF	Single thread Restoration	1,513 SMU	1,513 LF	1:1
Reach UT3	10+00 – 23+69	1,060 LF	Cattle Exclusion	N/A	N/A	N/A
Wetland Area #1	See plan sheets	0.0 AC	Restoration	4.0 WMU	4.0 AC	1:1

Component Summation

Restoration Level	Stream (LF)	Riparian Wetland (AC)		Non-riparian Wetland (AC)	Buffer (SF)	Upland (AC)
		Riverine	Non-Riverine			
Restoration	3,509	4.0				
Enhancement I	600					
Enhancement II						
Creation						
Preservation						
High Quality Preservation						

BMP Elements

Element	Location	Purpose/Function	Notes

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

*Note: Credit calculations were originally calculated along the as-built thalweg but have been updated to be calculated along stream centerlines and valley length for Monitoring Year 4 after discussions with NC IRT stemming from the April 3, 2017 Credit Release Meeting.

Table 2. Project Activity and Reporting History
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Mitigation Plan Prepared	N/A	N/A	Aug-13
Mitigation Plan Amended	N/A	N/A	Sep-13
Mitigation Plan Approved	N/A	N/A	Nov-13
Final Design – (at least 90% complete)	N/A	N/A	Mar-13
Construction Begins	N/A	N/A	Apr-13
Temporary S&E mix applied to entire project area	N/A	N/A	N/A
Permanent seed mix applied to entire project area	N/A	N/A	Jun-13
Planting of live stakes	Fall/Winter 2013	N/A	Mar-14
Planting of bare root trees	N/A	N/A	Jun-13
End of Construction	N/A	N/A	May-13
Survey of As-built conditions (Year 0 Monitoring-baseline)	N/A	Aug-13	Aug-13
Year 1 Monitoring	Dec-13	Dec-13	Jun-14
[1]Year 2* Monitoring	Dec-14	Dec-14	Jan-15
Year 2 Monitoring	Nov-15	Nov-15	Dec-15
Year 3 Monitoring	Dec-16	Nov-16	Dec-16
Year 4 Monitoring	Dec-17	Nov-17	Jan-18
Year 5 Monitoring	Dec-18	Nov-18	N/A
Year 6 Monitoring	Dec-19	Nov-19	N/A
Year 7 Monitoring	Dec-20	Nov-20	N/A

[1] As stated in the **Special Notes** section of the Excutive Summary: the US Army Corps of Engineers declined to release the credits generated from Year 2 (2014) citing too short of a period between plant installation and monitoring following construction. As such, this report (2017) will be considered Year 4. All references to Year 4 included in this report will indicate monitoring activities conducted during 2017. Data collected during 2014 that was previously considered monitoring Year 2 is labeled as Year 2*

Table 3. Project Contacts **UT to Mill Swamp Restoration Project: DMS Project ID No. 95019**	
Designer	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 Contact: Jake Byers, Tel. (828) 412-6101
Construction Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Bill Wright, Tel. 919-582-3575
Planting Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Bill Wright, Tel. 919-582-3575
Seeding Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Bill Wright, Tel. 919-582-3575
Seed Mix Sources	Green Resources, Tel. 336-855-6363
Nursery Stock Suppliers	Mellow Marsh Farm, 919-742-1200 ArborGen, 843-528-3204 Superior Tree, 850-971-5159
Monitoring Performers	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 Contact:
Stream Monitoring Point of Contact	Scott King, Tel. 919-481-5731
Vegetation Monitoring Point of Contact	Scott King, Tel. 919-481-5731
Wetland Monitoring Point of Contact	Scott King, Tel. 919-481-5731

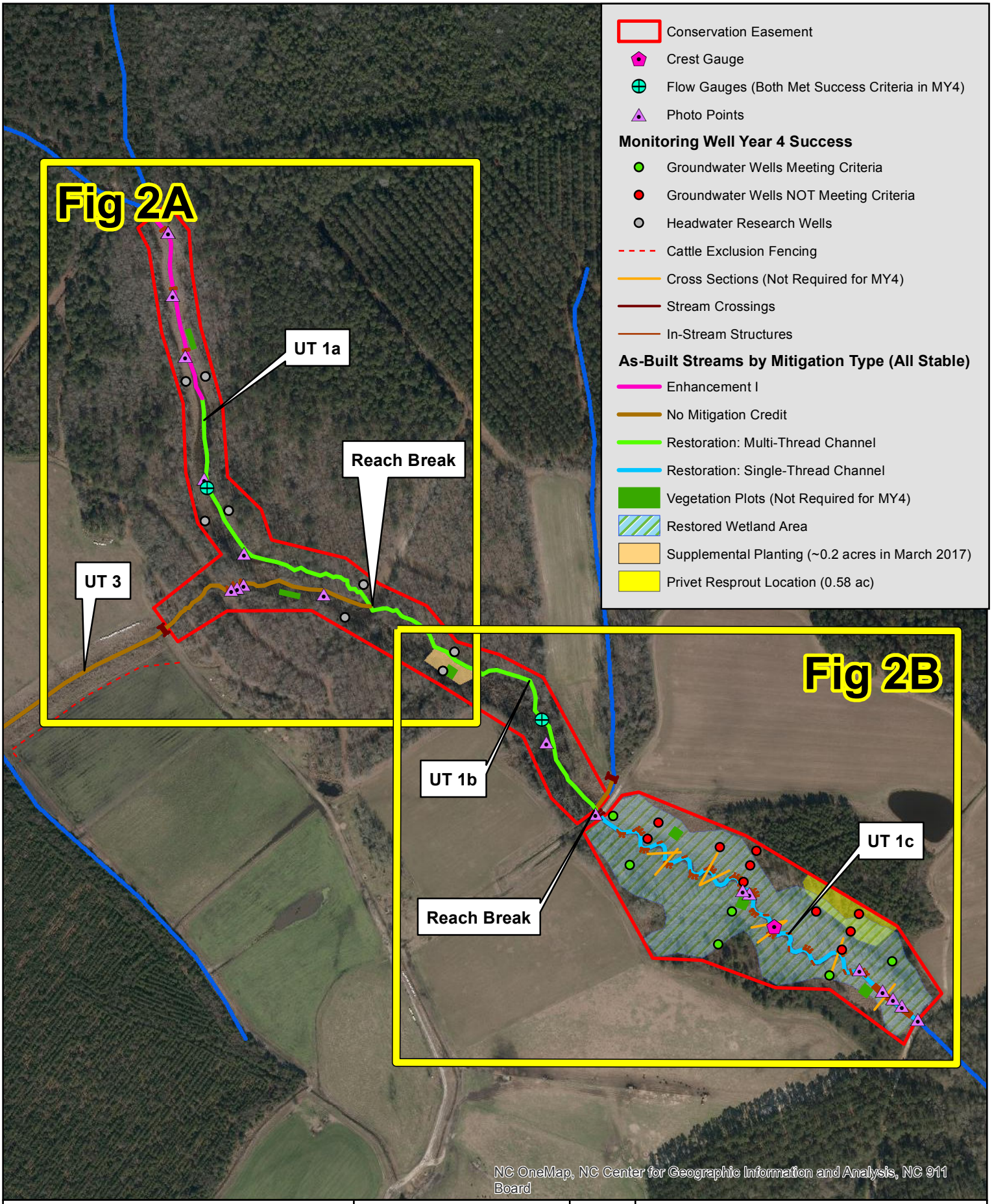
Table 4. Project Attributes
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Project Information			
Project Name	UT to Mill Swamp Restoration Project		
County	Onslow		
Project Area (acres)	19.6		
Project Coordinates (latitude and longitude)	34.9377 N, -77.5897 W		
Watershed Summary Information			
Physiographic Province	Inner Coastal Plain		
River Basin	White Oak		
USGS Hydrologic Unit 8-digit and 14-digit	03030001 / 03030001010020		
DWQ Sub-basin	03-05-02		
Project Drainage Area (AC)	421 (d/s main stem UT1)		
Project Drainage Area Percentage of Impervious Area	<1%		
CGIA Land Use Classification	2.01.03.99, Other Hay, Rotation, or Pasture; 413		
NCEEP Land Use Classification for UT to Mill Swamp Watershed (White Oak River Basin Restoration Priorities, 2010)	Forest (52%) Agriculture (44%) Impervious Cover (0.6%)		
Stream Reach Summary Information			
Parameters	**Reach UT1**	**Reach UT3**	
Length of Reach (LF)	4,091	1,060	
Valley Classification (Rosgen)	X	X	
Drainage Area (AC)	421	23	
NCDWQ Stream Identification Score	40.5	21	
NCDWQ Water Quality Classification	C; NSW	C; NSW	
Morphological Description (Rosgen stream type)	G/F (Channelized Headwater System)	Intermittent Ditch (N/A)	
Evolutionary Trend	Gc→F	Intermittent Ditch (N/A)	
Underlying Mapped Soils	Mk, St, Ly, FoA	Mk, St	
Drainage Class	Poorly drained, somewhat poorly drained	Poorly drained, somewhat poorly drained	
Soil Hydric Status	Hydric	Hydric	
Average Channel Slope (ft/ft)	0.0041	0.0058	
FEMA Classification	N/A	N/A	
Native Vegetation Community	Coastal Plain Small Stream Swamp	Coastal Plain Small Stream Swamp	
Percent Composition of Exotic/Invasive Vegetation	~10%	<5%	
Wetland Summary Information			
Parameters	**Wetland 1 (Non-Jurisdictional W1)**		
Size of Wetland (AC)	6.62 (3.36 north of UT1c, 3.26 south of UT1c)		
Wetland Type	Riparian Riverine		
Mapped Soil Series	Mk (Muckalee), St (Stallings), Ly (Lynchburg)		
Drainage Class	Poorly drained, somewhat poorly drained		
Soil Hydric Status	Hydric		
Source of Hydrology	Groundwater		
Hydrologic Impairment	Partially (disconnected floodplain from ditches and channel incision)		
Native Vegetation Community	Coastal Plain Small Stream Swamp, Successional		
Percent Composition of Exotic/Invasive Vegetation	9.7% (Before fall 2016 treatment event)		
Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes	See Mitigation Plan
Waters of the United States – Section 401	Yes	Yes	See Mitigation Plan
Endangered Species Act	No	N/A	See Mitigation Plan
Historic Preservation Act	No	N/A	See Mitigation Plan
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	See Mitigation Plan
FEMA Floodplain Compliance	No	N/A	See Mitigation Plan
Essential Fisheries Habitat	No	N/A	See Mitigation Plan

Source: White Oak River Basin Restoration Priorities, 2010 (http://www.http://portal.ncdenr.org/c/document_library/get_file?uuid=1c0b7e5a-9617-4a44-a5f8-df017873496b&groupId=60329)

Appendix B

Visual Assessment Data



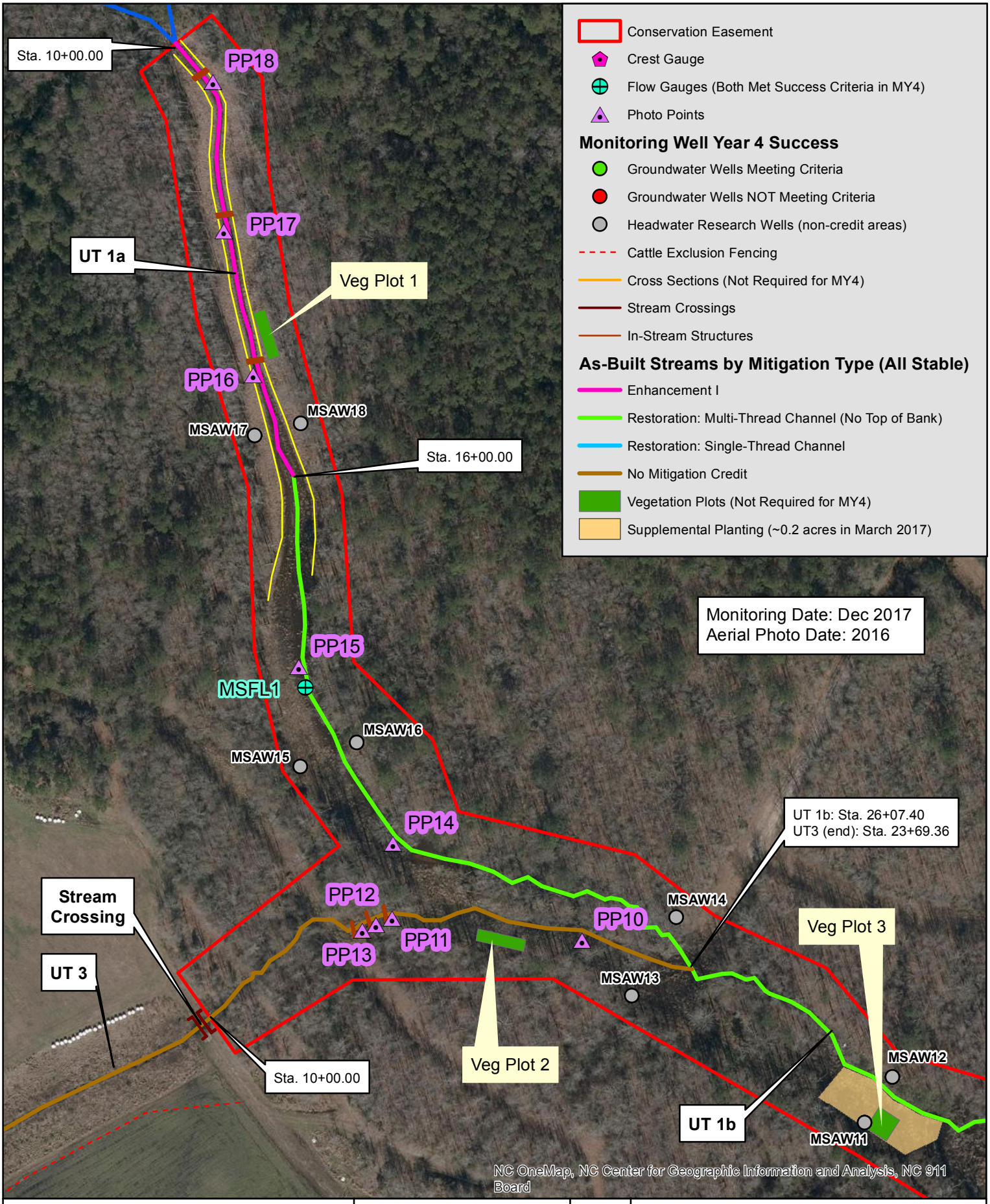
Michael Baker INTERNATIONAL

0 250 500 Feet

N

DMS Project # 95019

Figure 2 Index Map
Current Condition Plan View
Monitoring Year 4
UT to Mill Swamp Site



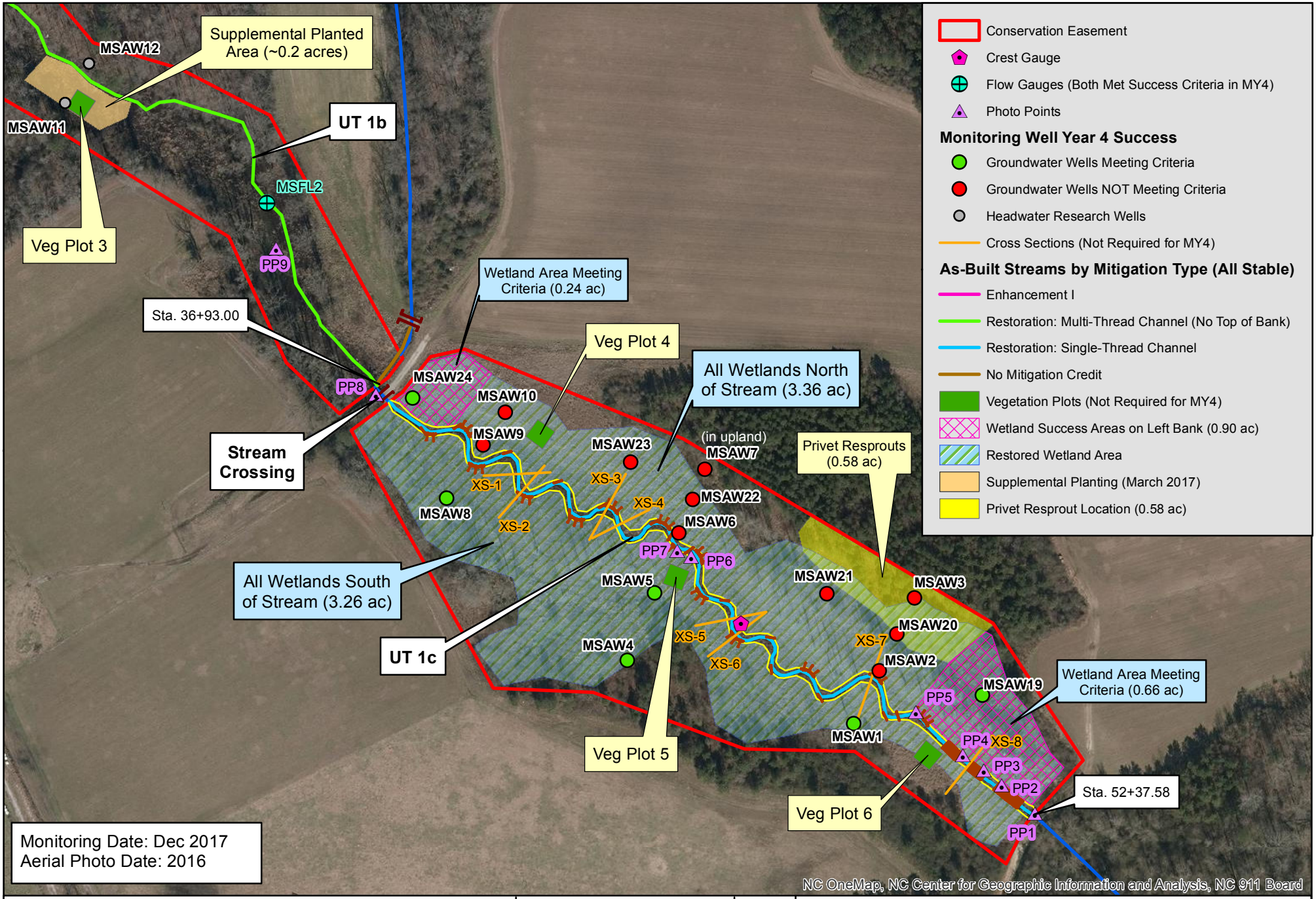
Michael Baker INTERNATIONAL

0 100 200 Feet

N

DMS Project # 95019

Figure 2A
Current Condition Plan View
Monitoring Year 4
UT to Mill Swamp Site



Michael Baker INTERNATIONAL

0 100 200 Feet

N

DMS Project # 95019

Figure 2B
Current Condition Plan View
Monitoring Year 4
UT to Mill Swamp Site

Table 5a. Visual Stream Morphology Stability Assessment
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Reach ID: UT1c

Assessed Length (LF): 1,513

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0%	100%			
	2. Riffle Condition	1. Texture Substrate	3	3			100%			
	3. Meander Pool Condition	1. Depth	22	22			100%			
		2. Length	22	22			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	19	19			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	19	19			100%			
2. 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			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
		Totals			0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	8	8			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	8	8			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	8	8			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth	8	8			100%			

Table 5b. Stream Problem Areas (SPAs) UT to Mill Swamp Restoration Project: DMS Project ID No. 95019			
Feature Issue	**Station Number**	**Suspected Cause**	**Photo Number**
N/A	N/A	N/A	N/A

Table 6a. Vegetation Conditions Assessment
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Total Planted Acreage:	**15.2**					
Vegetation Category	**Defintions**	**Mapping Threshold (acres)**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Planted Acreage**
1. Bare Areas	Very limited cover both woody and herbaceous material.	0.1	NA	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4 or 5 stem count criteria.	0.1	NA	0	0.00	0.0%
			Total	**0**	**0.00**	0.0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems or a size class that are obviously small given the monitoring year.	0.25	NA	0	0.00	0.0%
			Cumulative Total	**0**	**0.00**	0.0%
Easement Acreage:	**19.6**					
Vegetation Category	**Defintions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Easement Acreage**
5. Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale)	1000 ft²	Yes	1	0.58	3.0%
6. Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale)	none	NA	0	0.00	0.0%

Table 6b. Vegetation Problem Areas (VPAs)
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Feature Issue	Vegetation Problem Area (as shown on CCPV)	Suspected Cause	Photo Number
Invasive/Exotic Populations	#1 (See CCPV)	Resprouts of *Ligustrum sinense*	Photos 1-3

UT to Mill Swamp: Stream Photographs

Photo Point 1 – Upstream at Culvert

Photo Point 2 – Log Jam

Photo Point 3 – Log Jam

Photo Point 4 – Log Weir/Log Jam

Photo Point 5 – Log Weir

Photo Point 6 – Log Weir

UT to Mill Swamp: Stream Photographs

Photo Point 7 – Log Weir

Photo Point 8 – UT1b Upstream

Photo Point 9 – UT1b at Flow Gauge #2

Photo Point 10 – UT3 above confluence

Photo Point 11 – UT3 Log Weir

Photo Point 12 – UT3 Log Weir

UT to Mill Swamp: Stream Photographs

Photo Point 13 – UT3 Log Weir

Photo Point 14 – UT1b view upstream

Photo Point 15 – UT1b view upstream

Photo Point 16 – Log Weir

Photo Point 17 – Log Weir

Photo Point 18 – Log Weir

UT to Mill Swamp: Crest Gauge and Flow Cameras

Crest gauge reading, 1.18 ft from 1/2/17 storm

Crest gauge reading, 1.20 ft from 4/25/17 storm

Flow Camera #1 – 1/2/17 (storm event)

Flow Camera #1 – 3/18/17 (storm event)

Flow Camera #1 – 4/25/17 (storm event)

Flow Camera #2 – 2/16/17 (storm event)

UT to Mill Swamp: Crest Gauge and Flow Cameras

Flow Camera #2 – 3/19/17 (storm event)

Flow Camera #2 – 4/26/17 (storm event)

UT to Mill Swamp: Vegetation Problem Areas (VPAs)

VPA (*Ligustrum sinense* resprouts) 11/21/2017

VPA (*Ligustrum sinense* resprouts) 11/21/2017

VPA (*Ligustrum sinense* resprouts) 11/21/2017

Ligustrum sinense (previously treated in Nov 2016)

Appendix C

Vegetation Plot Data*

***No vegetation plot monitoring was required for Year 4**

Appendix D

Stream Survey Data*

***No cross-section stream survey monitoring was required for Year 4**

Appendix E

Hydrologic Data

Table 12. Wetland Restoration Area Well Success
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Well ID	Percentage of Consecutive Days <12 inches from Ground Surface[1]					Most Consecutive Days Meeting Criteria[2]					Percentage of Cumulative Days <12 inches from Ground Surface[1]					Cumulative Days Meeting Criteria[3]				
	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)
UT1c Cross-Sectional Well Arrays (Installed July 2013)																				
MSAW1	4.4	29.1	20.8	24.6	14.8	10.8	70.8	50.5	59.8	36.0	53.5	56.8	52.1	66.5	37.4	130.0	138.0	126.5	161.5	91.0
MSAW2	0.7	3.3	6.5	4.0	2.5	1.8	8.0	15.8	9.8	6.0	3.5	20.2	26.3	19.8	22.2	8.5	49.0	64.0	48.0	54.0
MSAW3 (on boundary)	0.0	0.3	0.6	0.6	0.4	0.0	0.8	1.5	1.5	1.0	0.0	1.0	2.1	0.8	0.4	0.0	2.5	5.0	2.0	1.0
MSAW4	10.3	27.8	36.4	31.2	46.1	25.0	67.5	88.5	75.8	112.0	97.0	74.2	61.0	83.4	80.2	235.7	180.3	148.3	202.8	195.0
MSAW5	3.3	21.2	19.7	31.1	25.1	8.0	51.5	47.8	75.5	61.0	40.5	51.9	51.6	58.3	52.7	98.4	126.0	125.5	141.8	128.0
MSAW6	1.1	3.8	7.0	4.2	11.5	2.8	9.3	17.0	10.3	28.0	9.5	23.3	28.3	19.7	25.1	23.1	56.5	68.8	47.8	61.0
MSAW7 (in upland)	0.2	3.7	2.7	2.1	1.6	0.5	9.0	6.5	5.0	4.0	0.3	10.9	14.6	7.1	6.6	0.7	26.5	35.5	17.3	16.0
MSAW8	14.1	47.3	37.7	31.1	36.2	34.3	115.0	91.5	75.5	88.0	96.8	73.9	66.3	83.0	79.4	235.2	179.6	161.0	201.8	193.0
MSAW9	2.5	4.5	8.6	5.7	9.5	6.0	11.0	21.0	13.8	23.0	44.5	33.0	28.6	41.7	39.9	108.1	80.3	69.5	101.3	97.0
MSAW10	0.0	0.6	5.3	2.1	4.9	0.0	1.5	13.0	5.0	12.0	0.0	1.1	13.1	16.8	30.5	0.0	2.8	31.8	40.8	74.0
Supplemental UT1c Monitoring Wells (Installed February/March 2016)																				
**MSAW19	--	--	--	8.7	12.8	--	--	--	21.3	31.0	--	--	--	43.8	42.4	--	--	--	106.5	103.0
**MSAW20	--	--	--	3.7	6.6	--	--	--	9.0	16.0	--	--	--	10.1	20.2	--	--	--	24.5	49.0
**MSAW21	--	--	--	3.7	10.7	--	--	--	9.0	26.0	--	--	--	12.7	17.7	--	--	--	30.8	43.0
**MSAW22	--	--	--	2.8	5.8	--	--	--	6.8	14.0	--	--	--	14.0	23.5	--	--	--	34.0	57.0
**MSAW23	--	--	--	3.1	9.9	--	--	--	7.5	24.0	--	--	--	23.7	32.9	--	--	--	57.5	80.0
**MSAW24	--	--	--	31.2	26.3	--	--	--	75.8	64.0	--	--	--	72.1	83.1	--	--	--	175.3	202.0
Headwater Research Cross-Sectional Well Arrays on UT1a and UT1b (Installed July 2013)																				
MSAW11	4.7	21.2	32.3	40.1	36.0	11.5	51.5	78.5	97.5	87.5	38.5	72.4	76.7	84.9	68.3	93.6	176.0	186.5	206.3	166.0
MSAW12	0.7	15.4	10.1	7.6	14.5	1.8	37.5	24.5	18.5	35.3	7.0	19.1	24.9	27.4	15.1	17.0	46.5	60.5	66.5	36.8
MSAW13	6.5	46.5	40.0	40.0	36.0	15.8	113.0	97.3	97.3	87.5	81.5	80.0	82.2	84.8	66.0	198.0	194.5	199.8	206.0	160.5
MSAW14	0.6	39.1	18.3	17.9	25.6	1.5	95.0	44.5	43.5	62.3	4.0	31.0	46.7	61.6	32.7	9.7	75.3	113.5	149.8	79.5
MSAW15	0.8	0.9	2.4	1.6	1.1	2.0	2.3	5.8	4.0	2.8	4.0	3.9	5.1	6.7	2.0	9.7	9.5	12.5	16.3	4.8
MSAW16	2.4	2.8	2.3	2.1	1.2	5.8	6.8	5.5	5.0	3.0	14.5	13.0	11.5	7.1	2.2	35.2	31.5	28.0	17.3	5.3
MSAW17	0.0	0.1	0.7	0.3	0.2	0.0	0.3	1.8	0.8	0.5	0.0	0.1	1.3	0.5	0.2	0.0	0.3	3.3	1.3	0.5
MSAW18	3.8	10.2	7.4	2.2	1.2	9.3	24.8	18.0	5.3	3.0	18.5	15.3	20.8	10.7	3.6	45.0	37.3	50.5	26.0	8.8

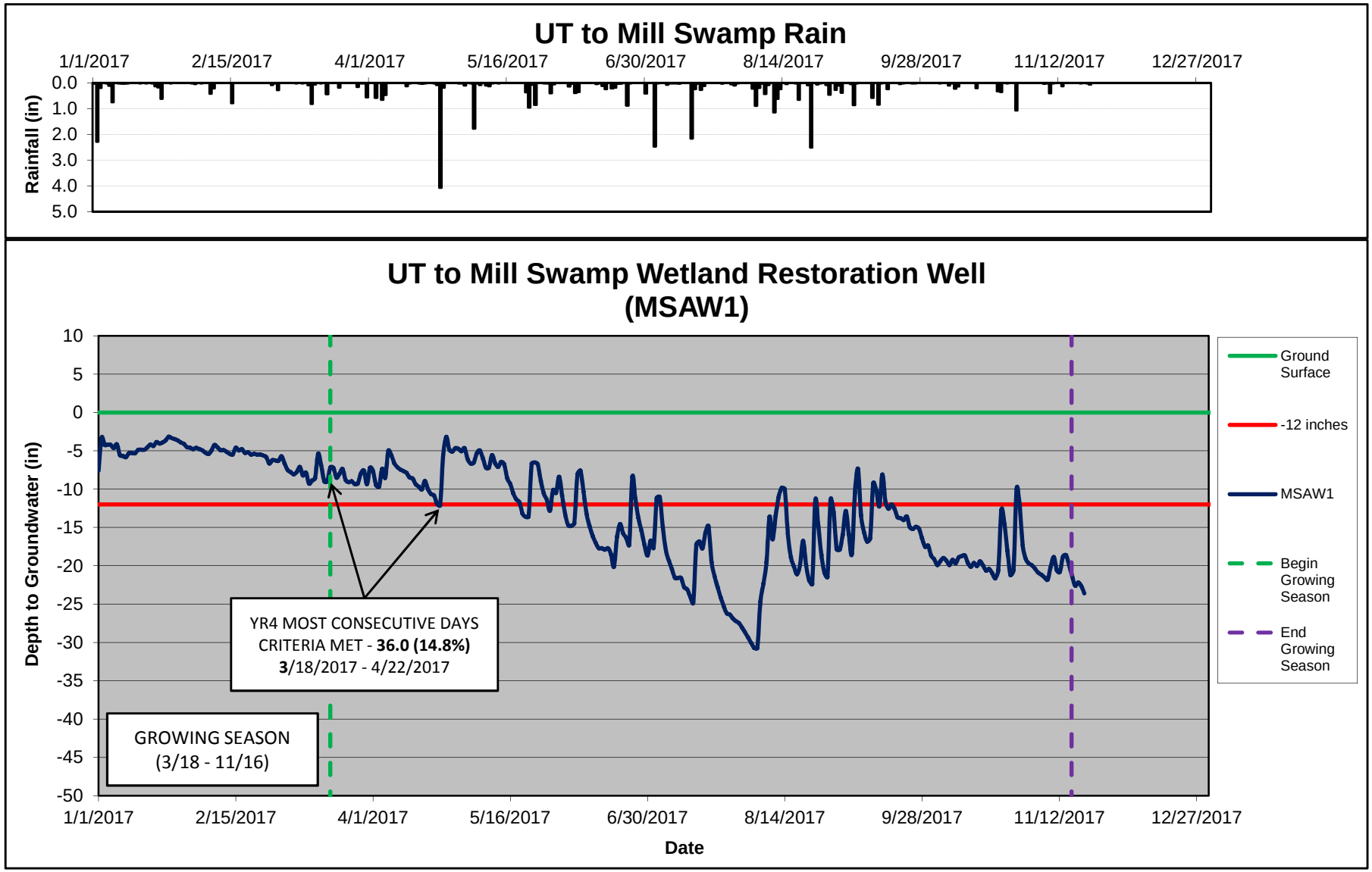
Notes:
[1]Indicates the percentage of the single greatest consecutive or cumulative number of days within the monitored growing season with a water 12 inches or less from the soil surface.
[2]Indicates the single greatest consecutive number of days within the monitored growing season with a water table 12 inches or less from the soil surface.
[3]Indicates the total cumulative number of days within the monitored growing season with a water table 12 inches or less from the soil surface.

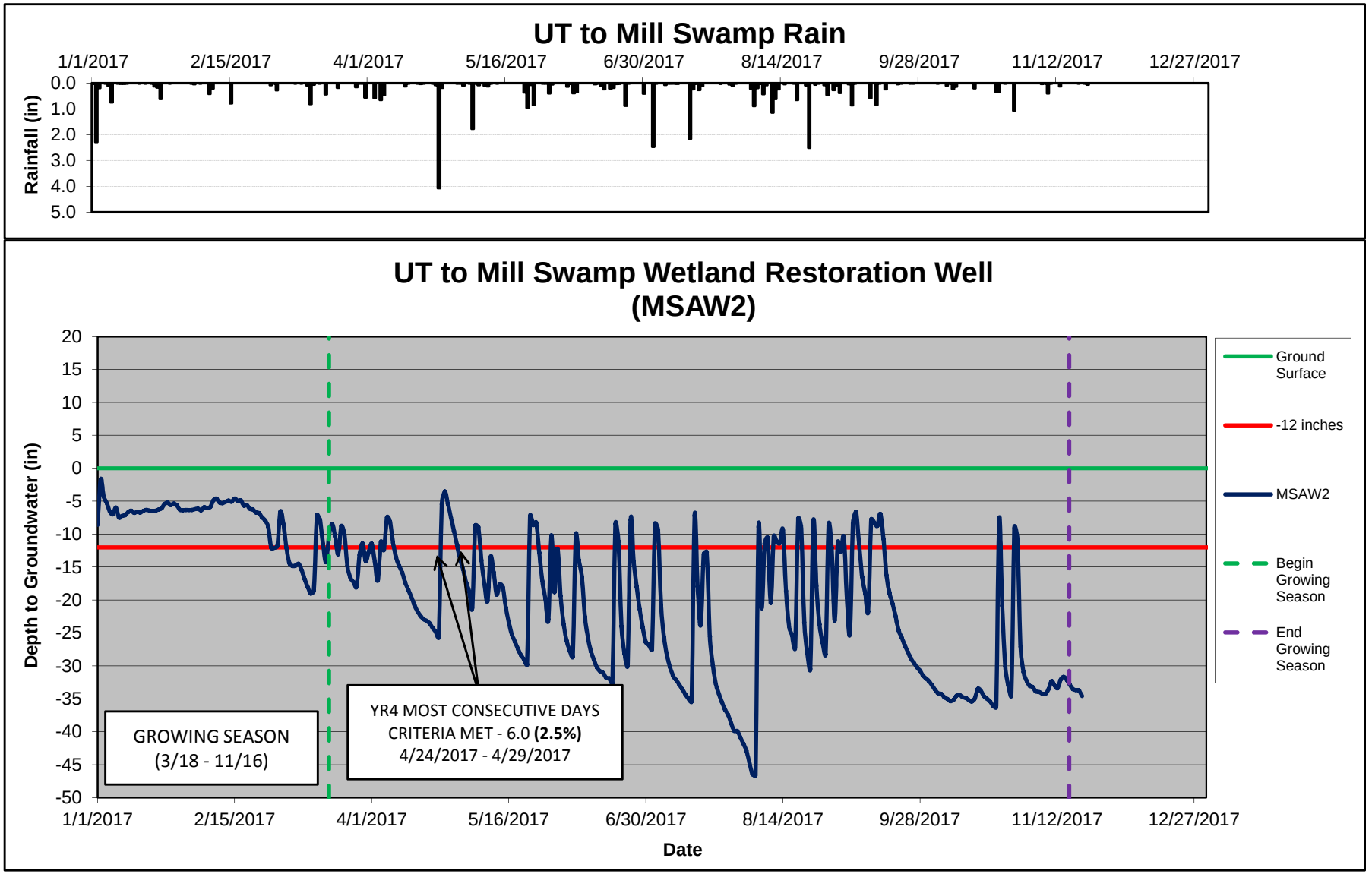
Growing season for Onslow County is from March 18 to November 16 and is **243** days long. 12% of the growing season is **29** days.

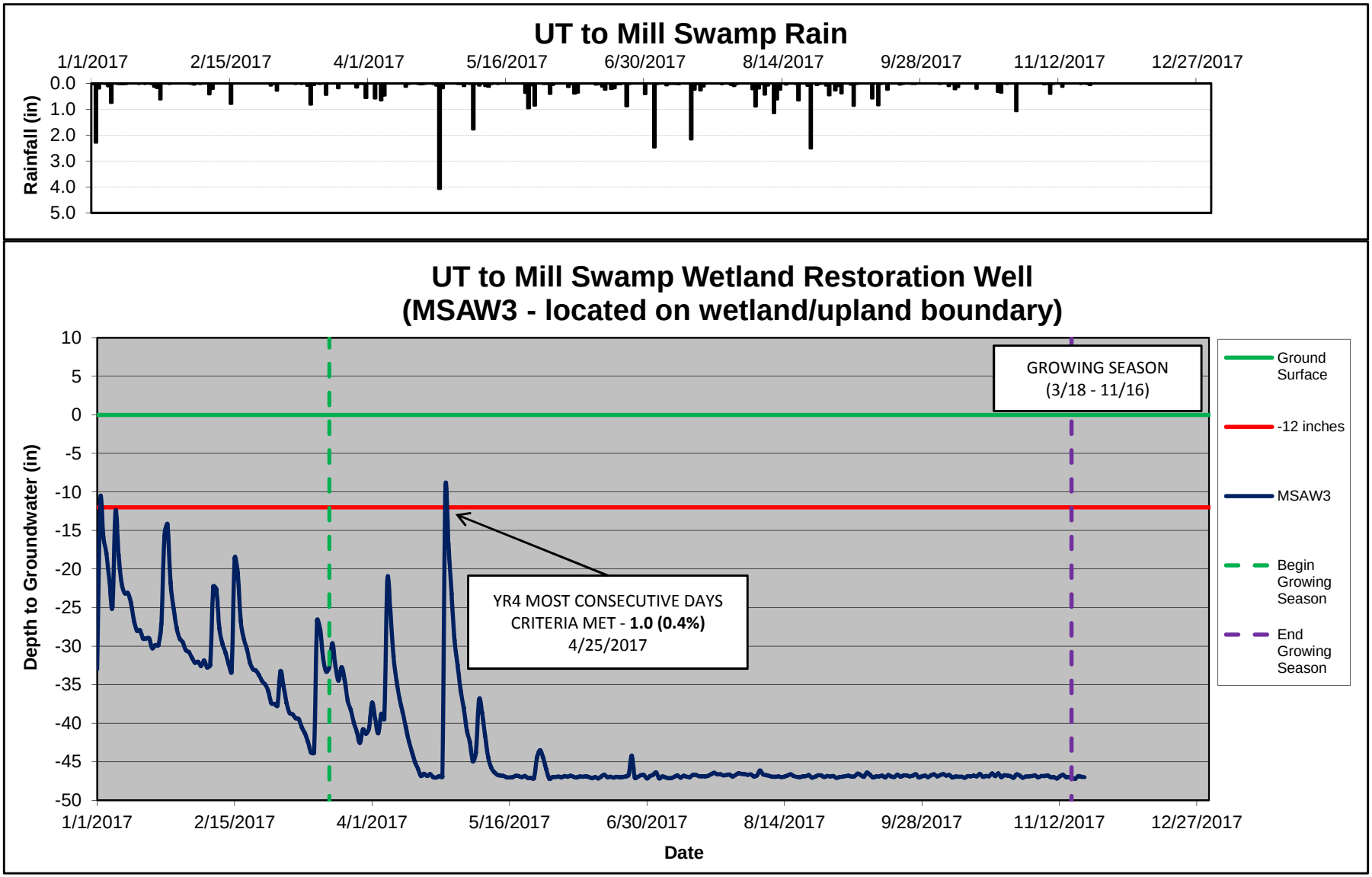
HIGHLIGHTED indicates wells that *did not* to meet the success criteria for the most consecutive number of days within the monitored growing season with a water 12 inches or less from the soil surface. Following Year 4 wetland monitoring, six of sixteen wells exhibited hyrdroperiods greater than 12% during the 2017 growing season. These wells will be observed closely throughout monitoring Year 5.

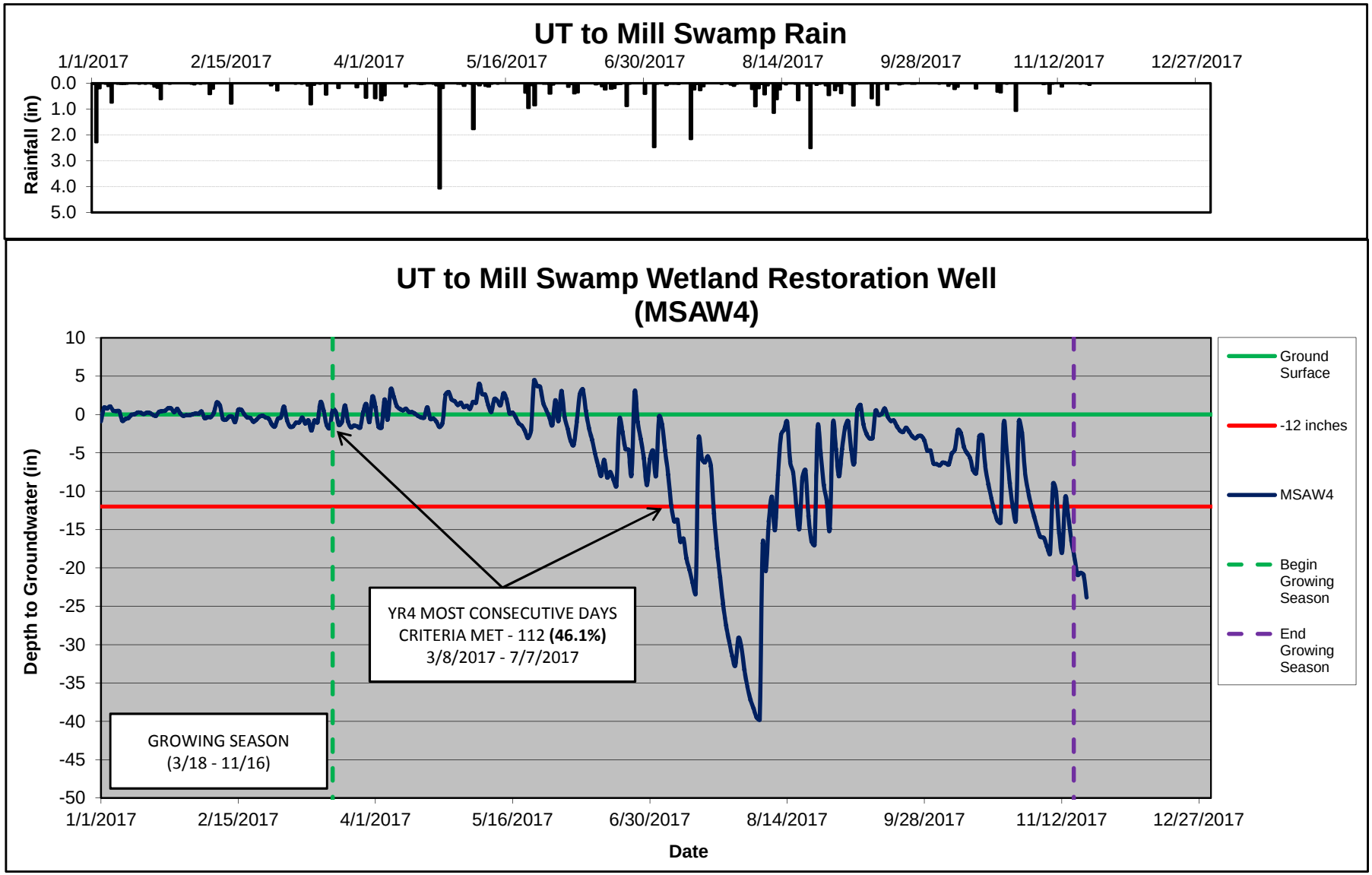
**To gather additional well data in the UT1c restoration area, In-Situ groundwater monitoring dataloggers AW19 -AW23 were installed on 2/26/2016, AW24 was installed on 3/10/2016. The installation of the additional dataloggers was completed during the 2016 spring wet season when groundwater levels were normally closer to the ground surface.

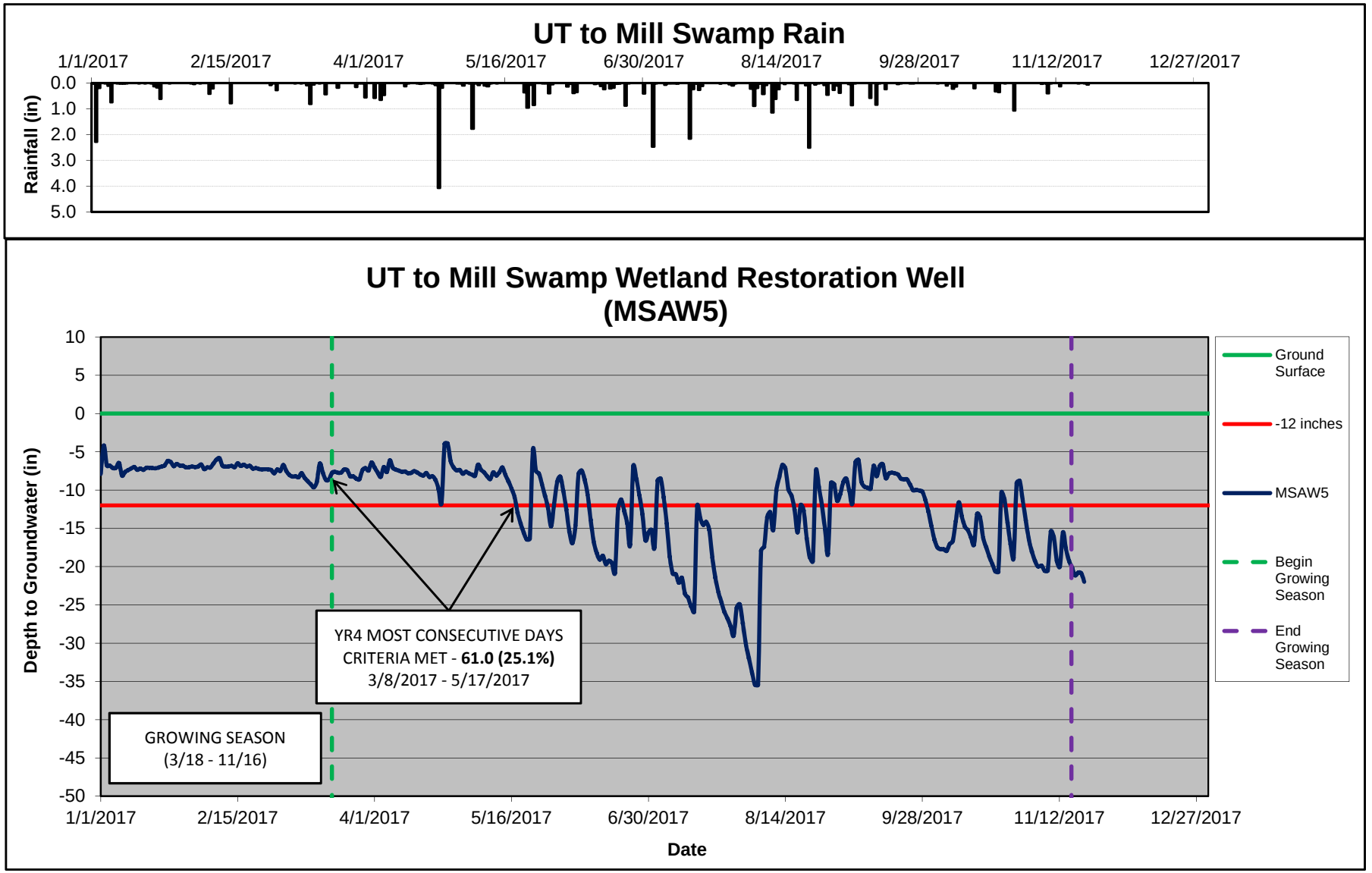
Figure 4.

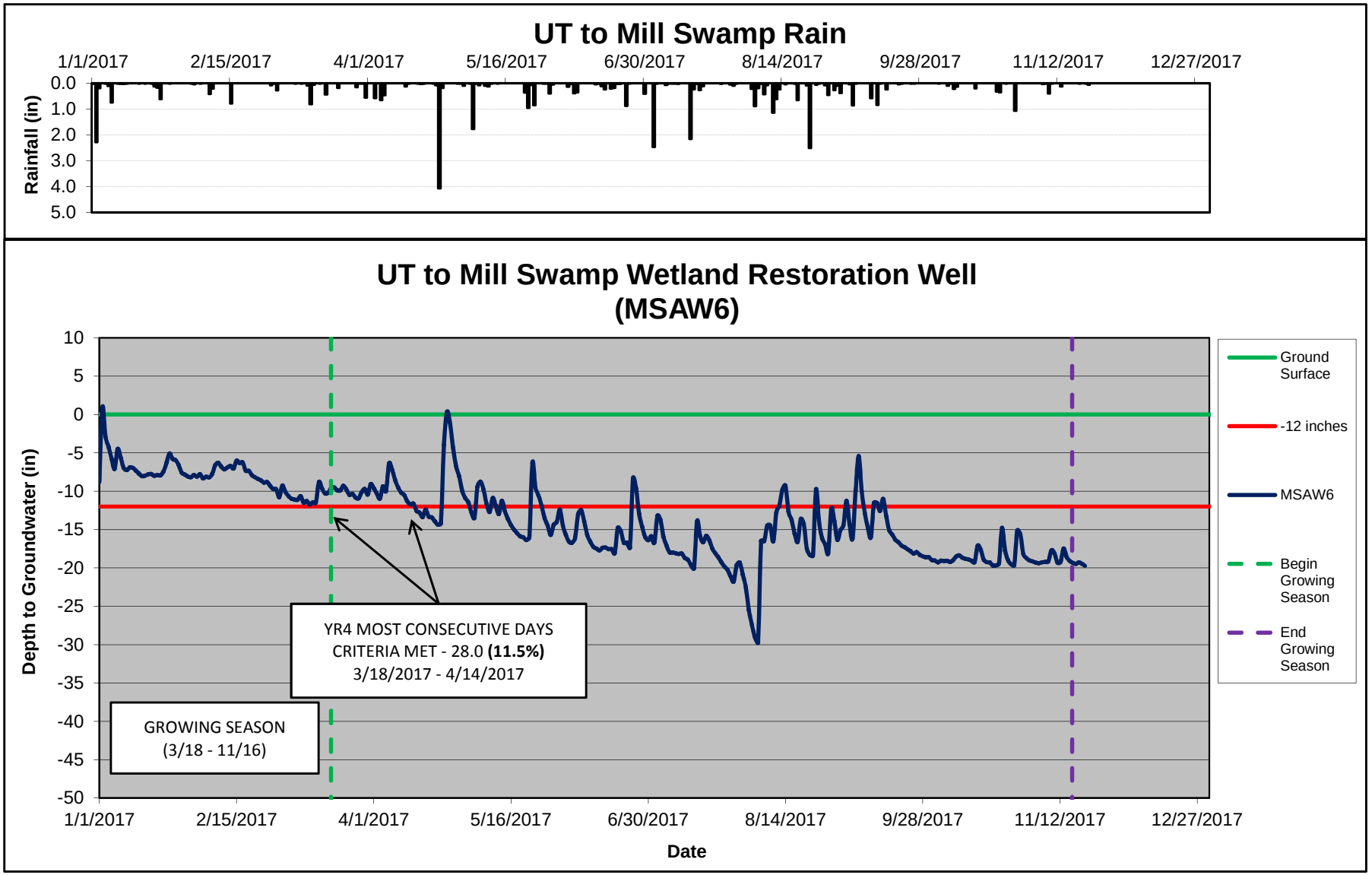

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well (MSAW1)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR4 MOST CONSECUTIVE DAYS CRITERIA MET - 36.0 (14.8%) 3/18/2017 - 4/22/2017
GROWING SEASON (3/18 - 11/16)
Ground Surface
-12 inches
MSAW1
Begin Growing Season
End Growing Season
Date

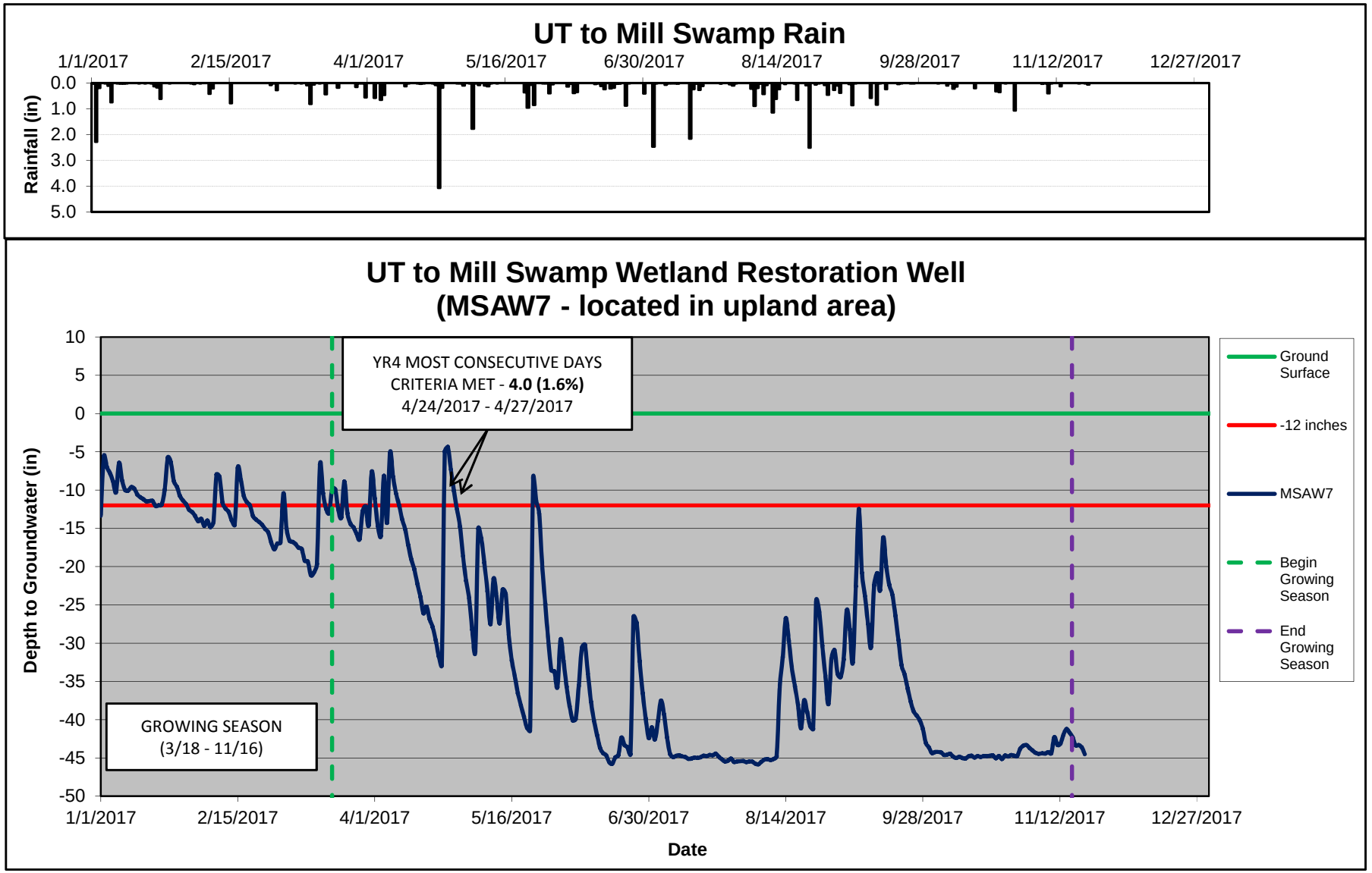

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW2)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 6.0 (2.5%)
4/24/2017 - 4/29/2017
Ground Surface
-12 inches
MSAW2
Begin Growing Season
End Growing Season
Date

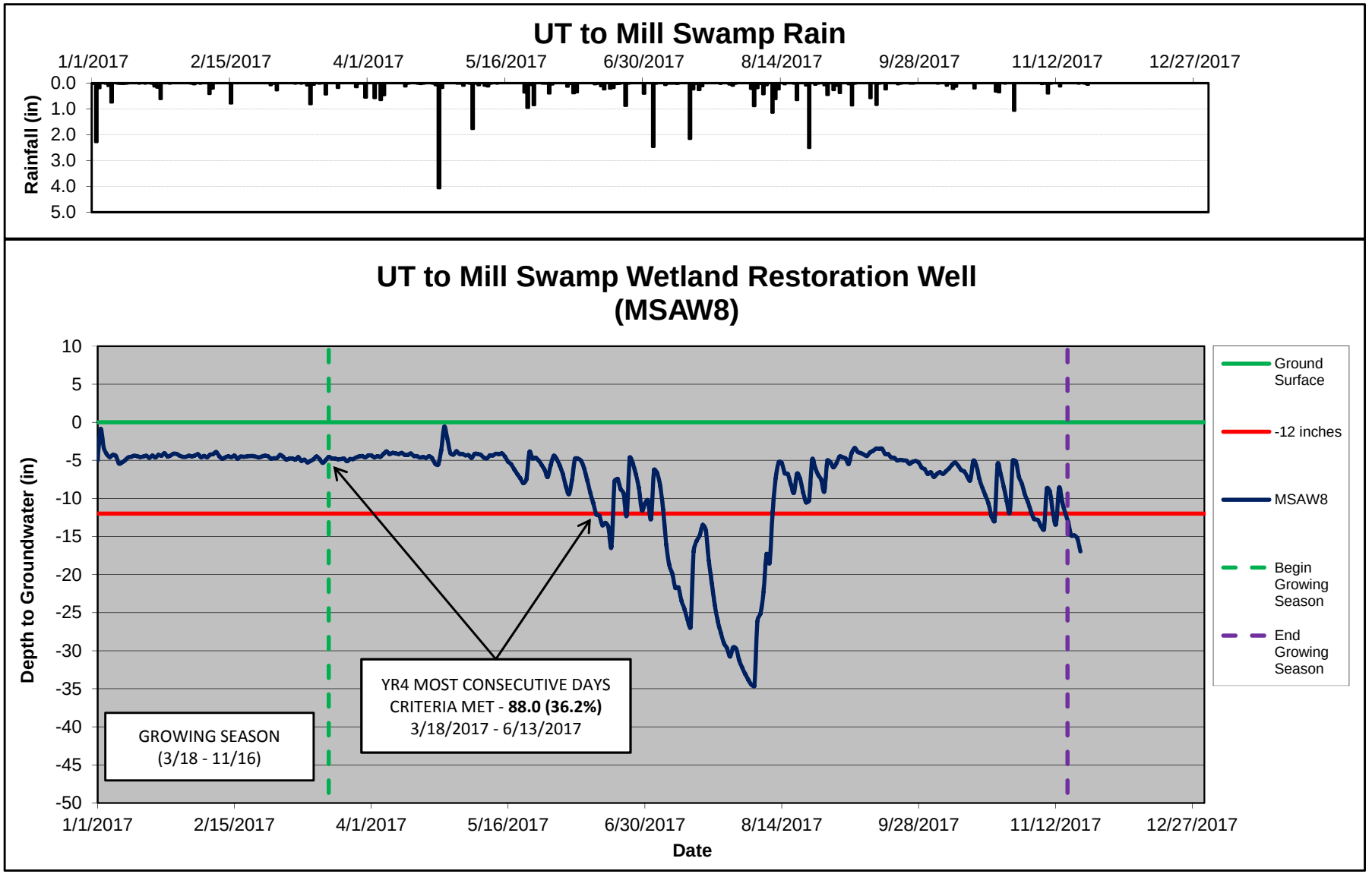

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW3 - located on wetland/upland boundary)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 1.0 (0.4%)
4/25/2017
Ground Surface
-12 inches
MSAW3
Begin Growing Season
End Growing Season
Date

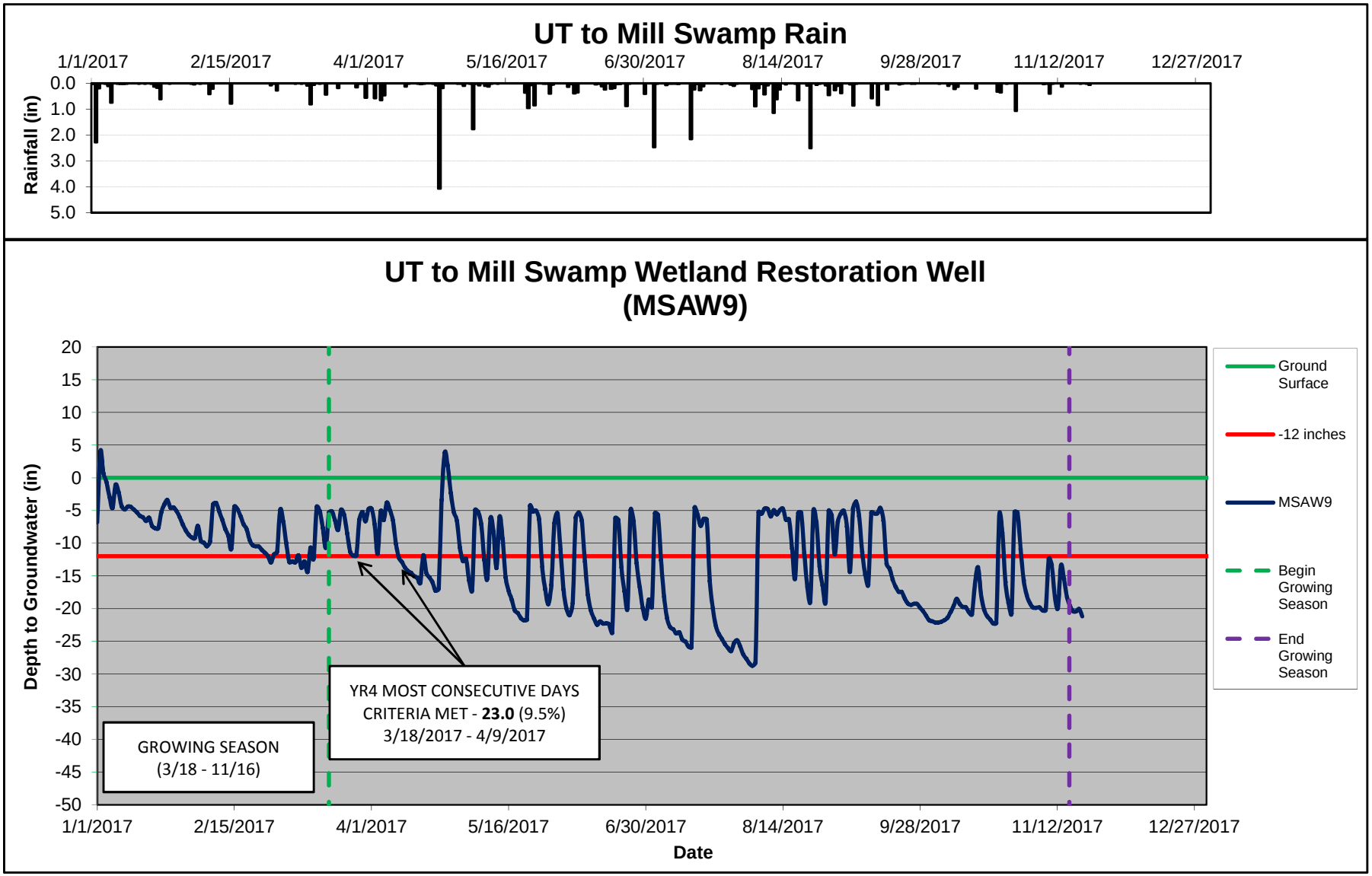

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well (MSAW4)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR4 MOST CONSECUTIVE DAYS CRITERIA MET - 112 (46.1%) 3/8/2017 - 7/7/2017
GROWING SEASON (3/18 - 11/16)
Ground Surface
-12 inches
MSAW4
Begin Growing Season
End Growing Season
Date

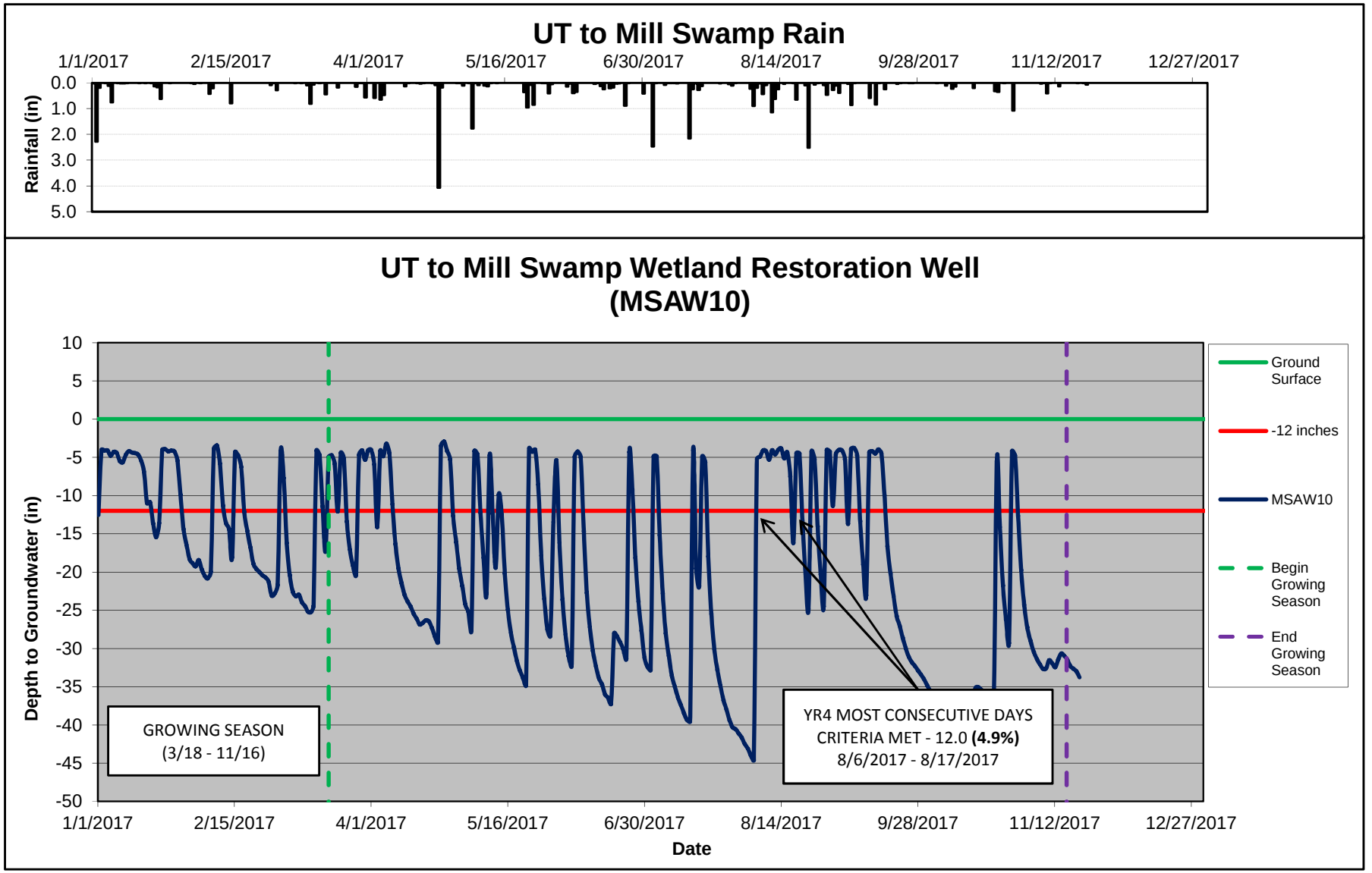

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW5)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 61.0 (25.1%)
3/8/2017 - 5/17/2017
GROWING SEASON
(3/18 - 11/16)
Ground Surface
-12 inches
MSAW5
Begin Growing Season
End Growing Season
Date

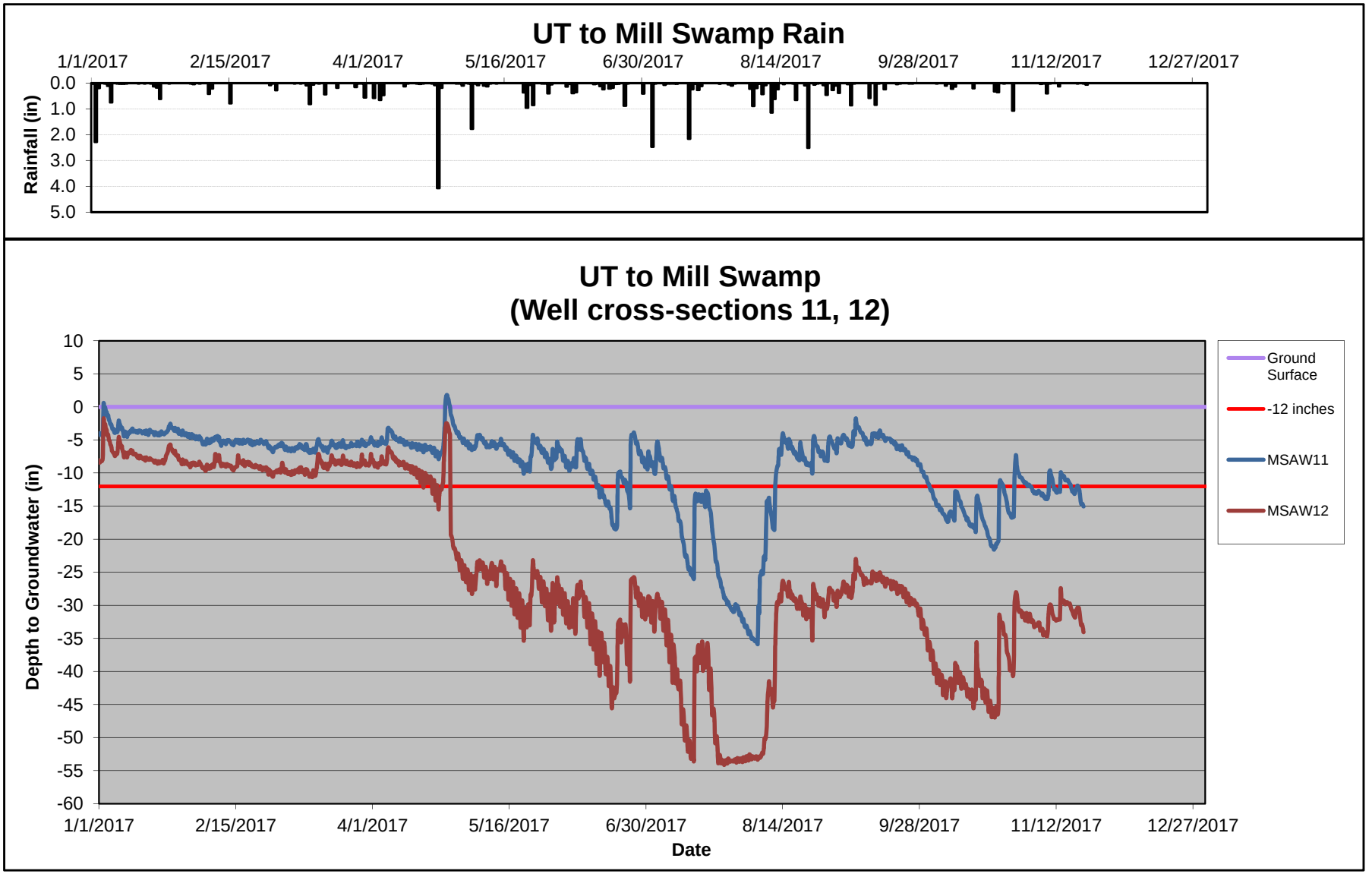

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW6)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 28.0 (11.5%)
3/18/2017 - 4/14/2017
GROWING SEASON
(3/18 - 11/16)
Ground Surface
-12 inches
MSAW6
Begin Growing Season
End Growing Season
Date

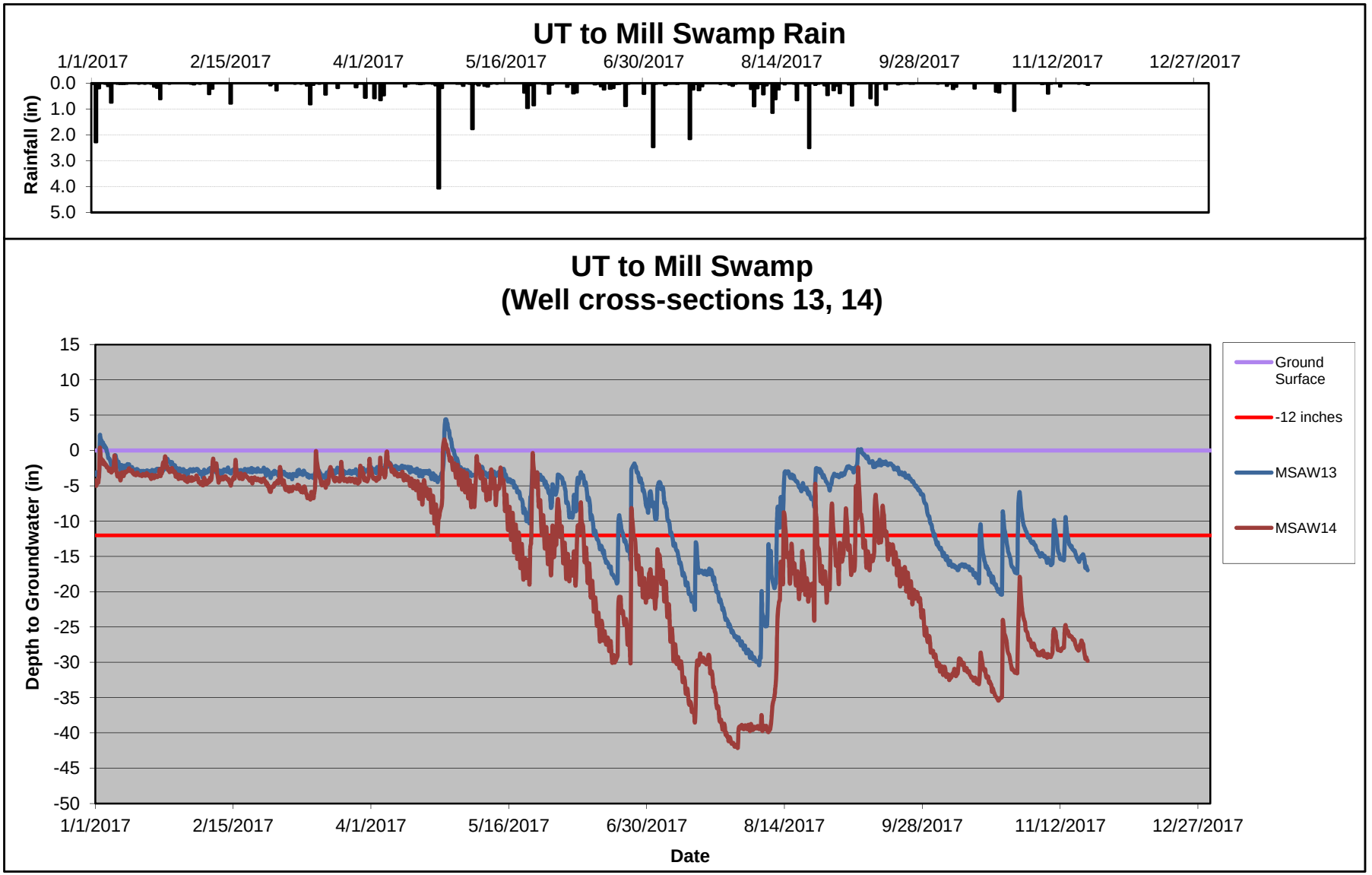

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW7 - located in upland area)
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 4.0 (1.6%)
4/24/2017 - 4/27/2017
GROWING SEASON
(3/18 - 11/16)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Ground Surface
-12 inches
MSAW7
Begin Growing Season
End Growing Season
Date

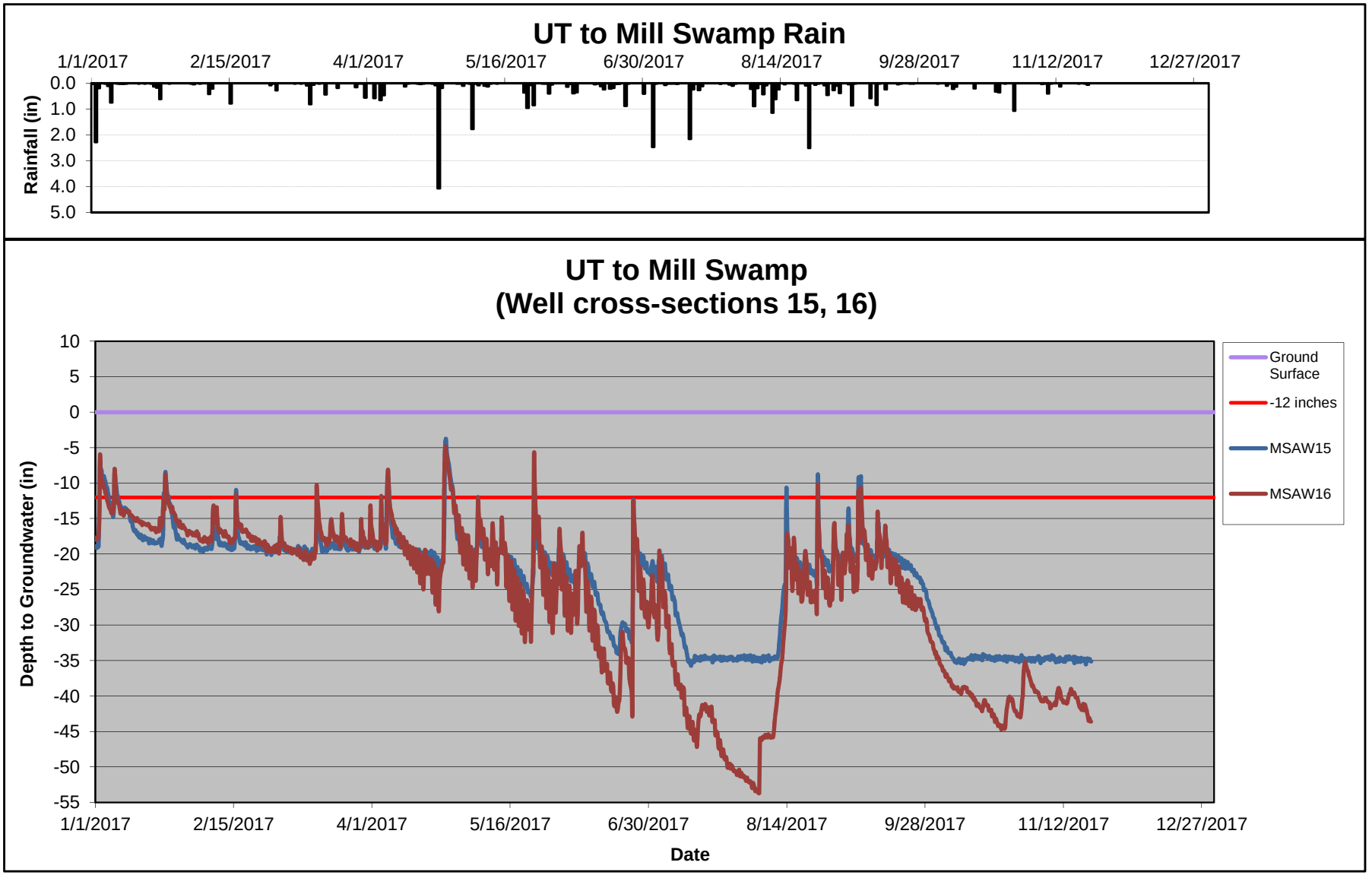

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW8)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 88.0 (36.2%)
3/18/2017 - 6/13/2017
Ground Surface
-12 inches
MSAW8
Begin Growing Season
End Growing Season
Date

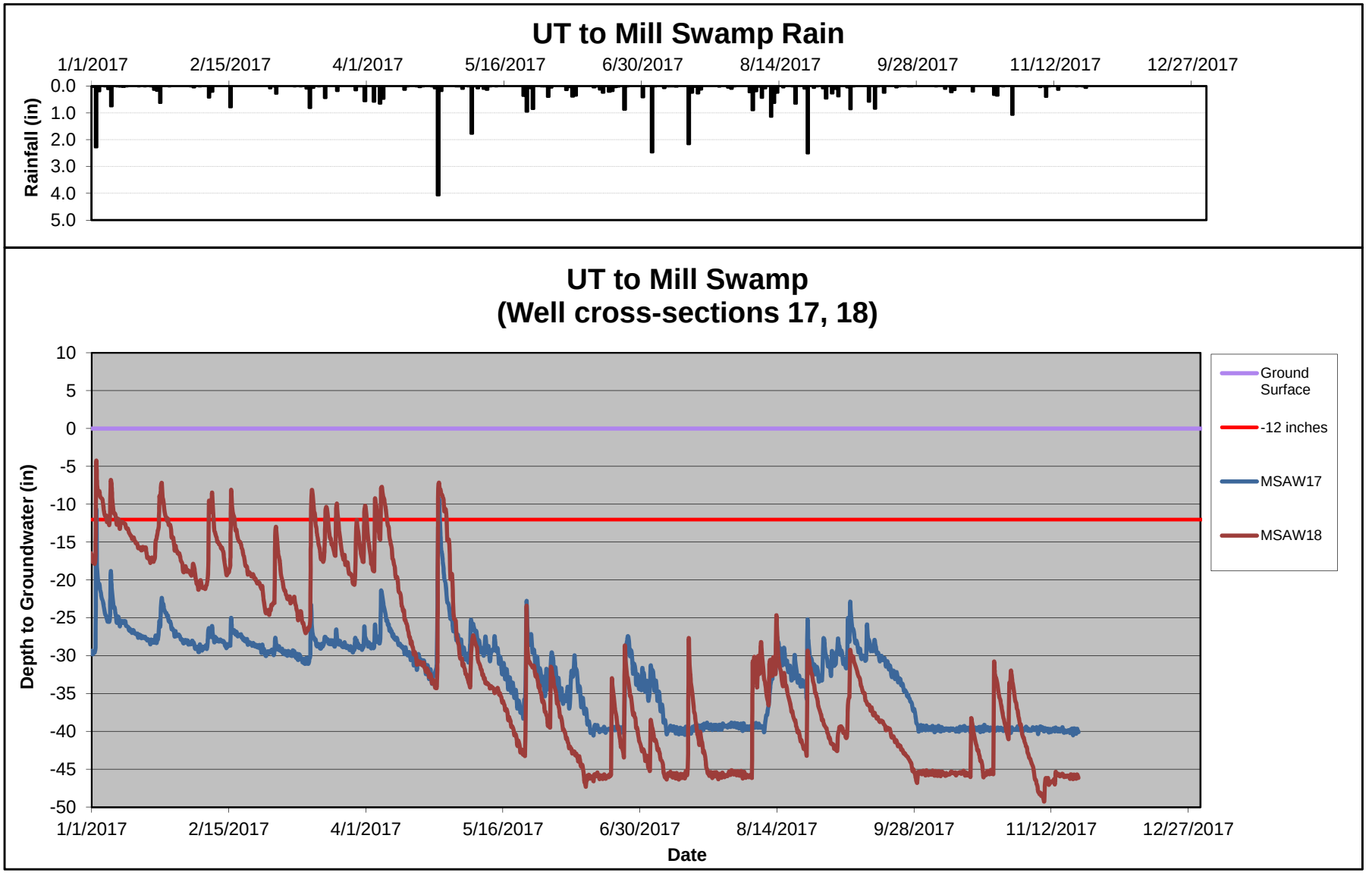

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW9)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 23.0 (9.5%)
3/18/2017 - 4/9/2017
Ground Surface
-12 inches
MSAW9
Begin Growing Season
End Growing Season
Date

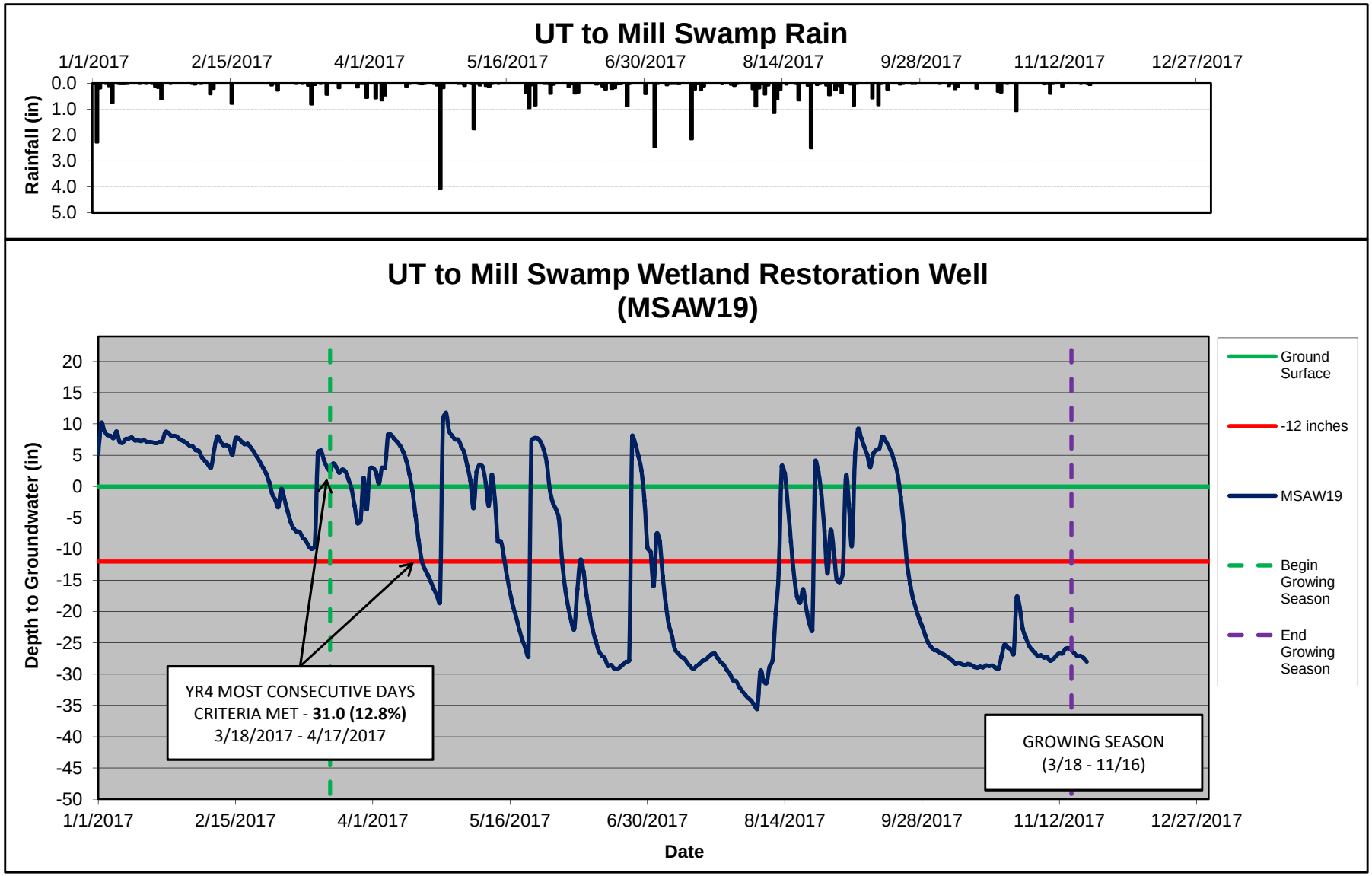

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW10)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 12.0 (4.9%)
8/6/2017 - 8/17/2017
Ground Surface
-12 inches
MSAW10
Begin Growing Season
End Growing Season
Date

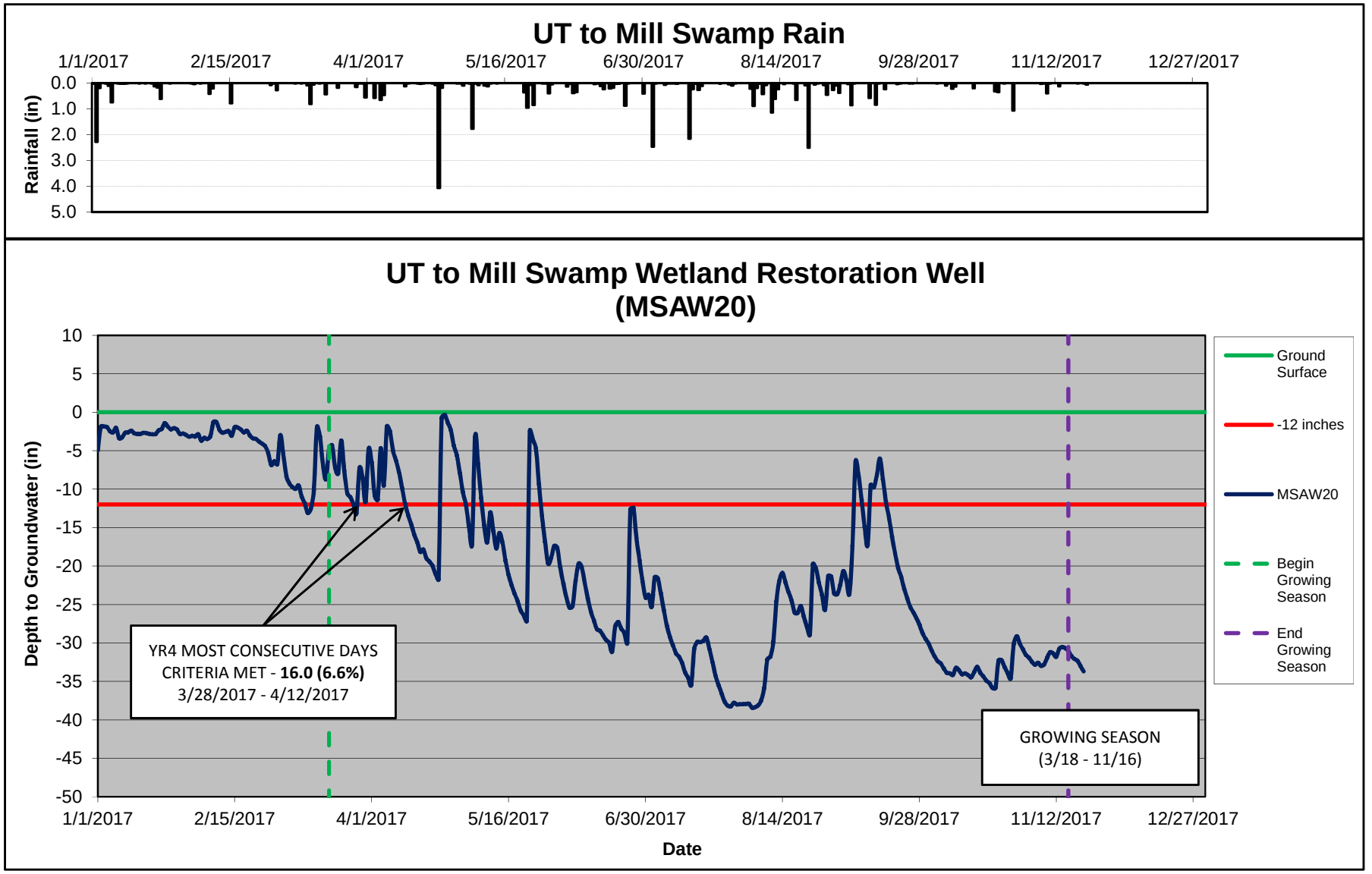

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp
(Well cross-sections 11, 12)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
Ground Surface
-12 inches
MSAW11
MSAW12
Date

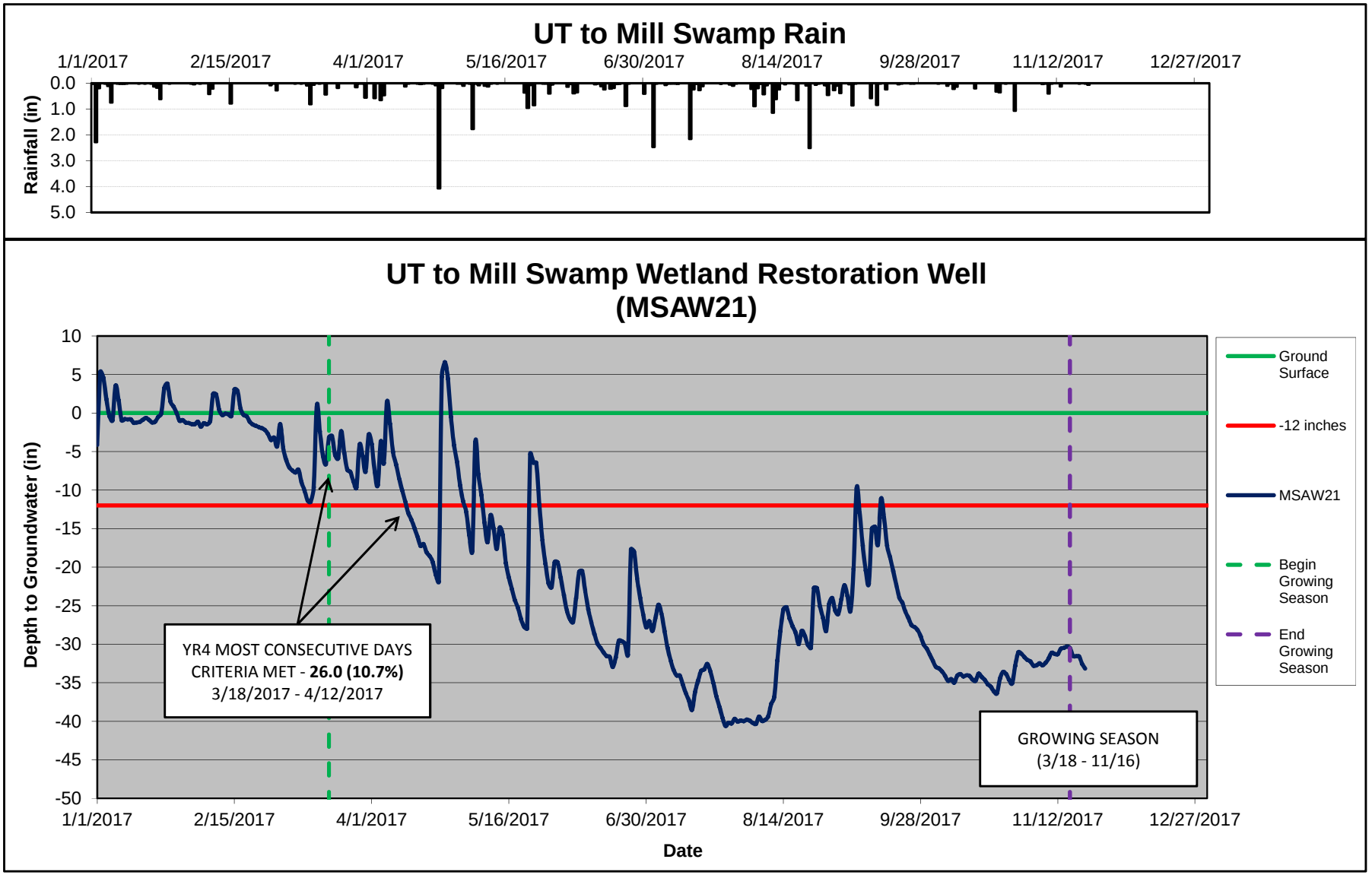

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp
(Well cross-sections 13, 14)
Depth to Groundwater (in)
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Ground Surface
-12 inches
MSAW13
MSAW14
Date

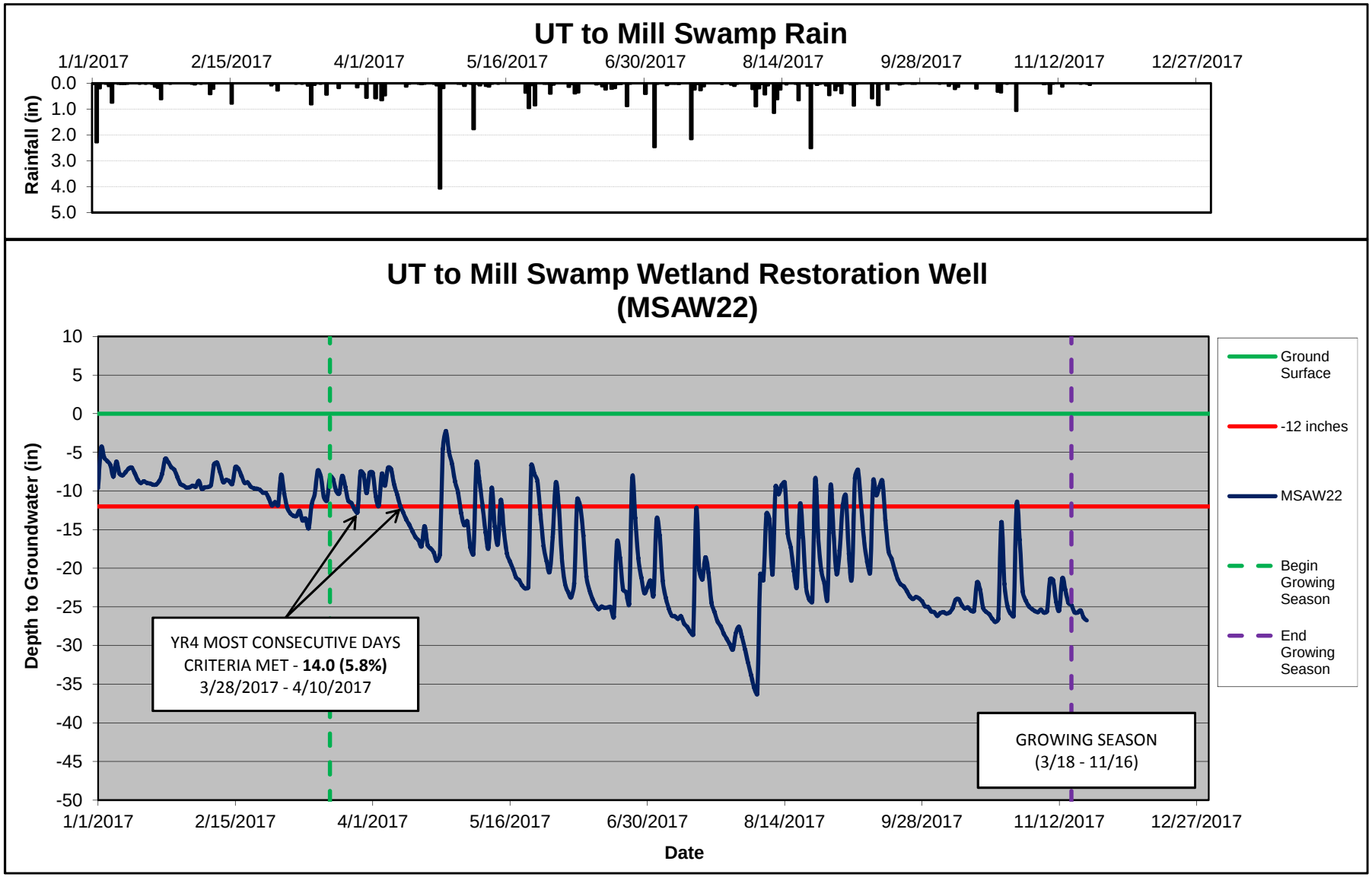

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp
(Well cross-sections 15, 16)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
Ground Surface
-12 inches
MSAW15
MSAW16
Date

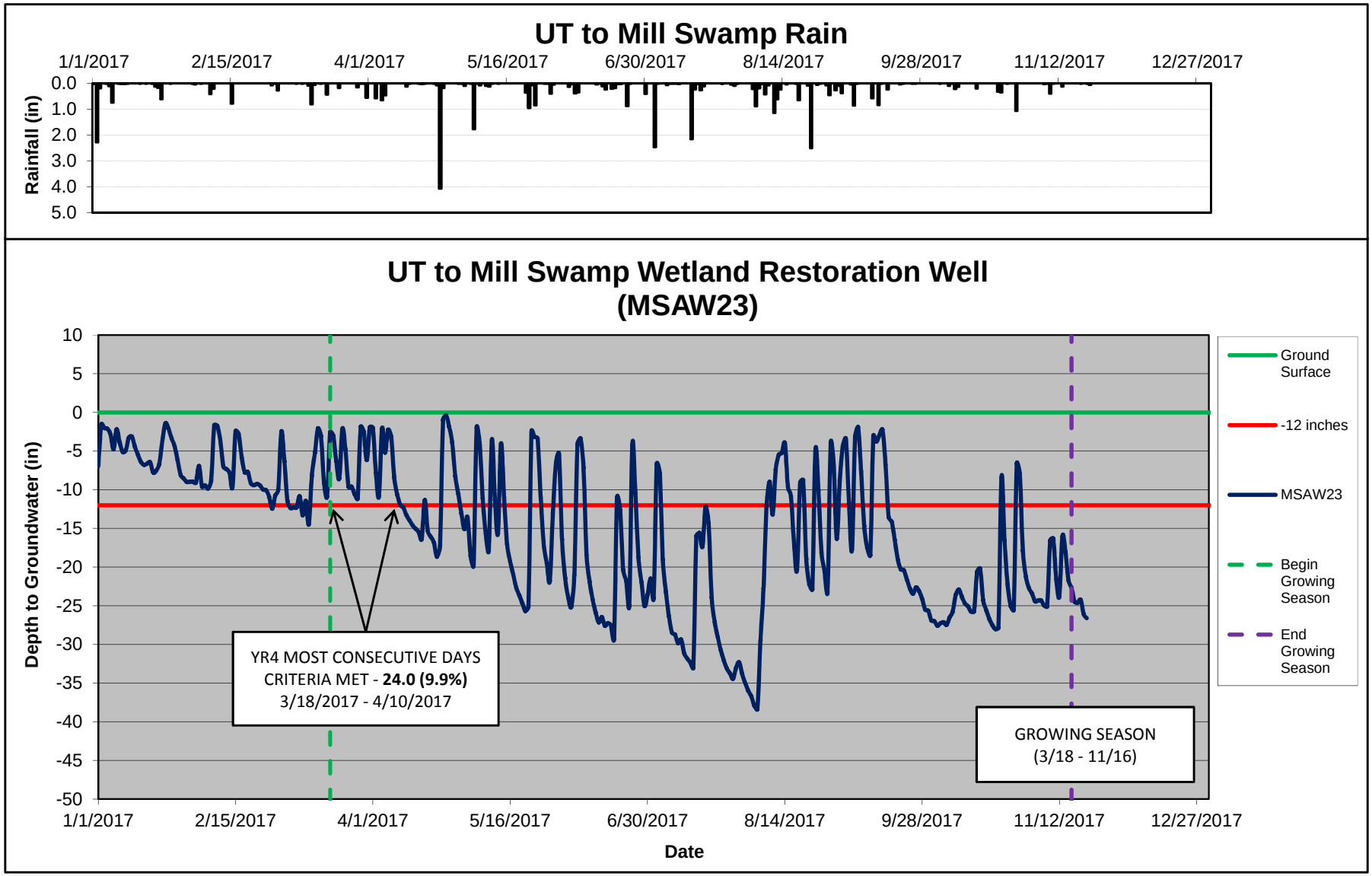

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp
(Well cross-sections 17, 18)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Ground Surface
-12 inches
MSAW17
MSAW18
Date


UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW19)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 31.0 (12.8%)
3/18/2017 - 4/17/2017
GROWING SEASON
(3/18 - 11/16)
Ground Surface
-12 inches
MSAW19
Begin Growing Season
End Growing Season
Date


UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW20)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 16.0 (6.6%)
3/28/2017 - 4/12/2017
GROWING SEASON
(3/18 - 11/16)
Ground Surface
-12 inches
MSAW20
Begin Growing Season
End Growing Season
Date


UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW21)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 26.0 (10.7%)
3/18/2017 - 4/12/2017
GROWING SEASON
(3/18 - 11/16)
Ground Surface
-12 inches
MSAW21
Begin Growing Season
End Growing Season
Date


UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW22)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 14.0 (5.8%)
3/28/2017 - 4/10/2017
GROWING SEASON
(3/18 - 11/16)
Ground Surface
-12 inches
MSAW22
Begin Growing Season
End Growing Season
Date


UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW23)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 24.0 (9.9%)
3/18/2017 - 4/10/2017
GROWING SEASON
(3/18 - 11/16)
Ground Surface
-12 inches
MSAW23
Begin Growing Season
End Growing Season
Date

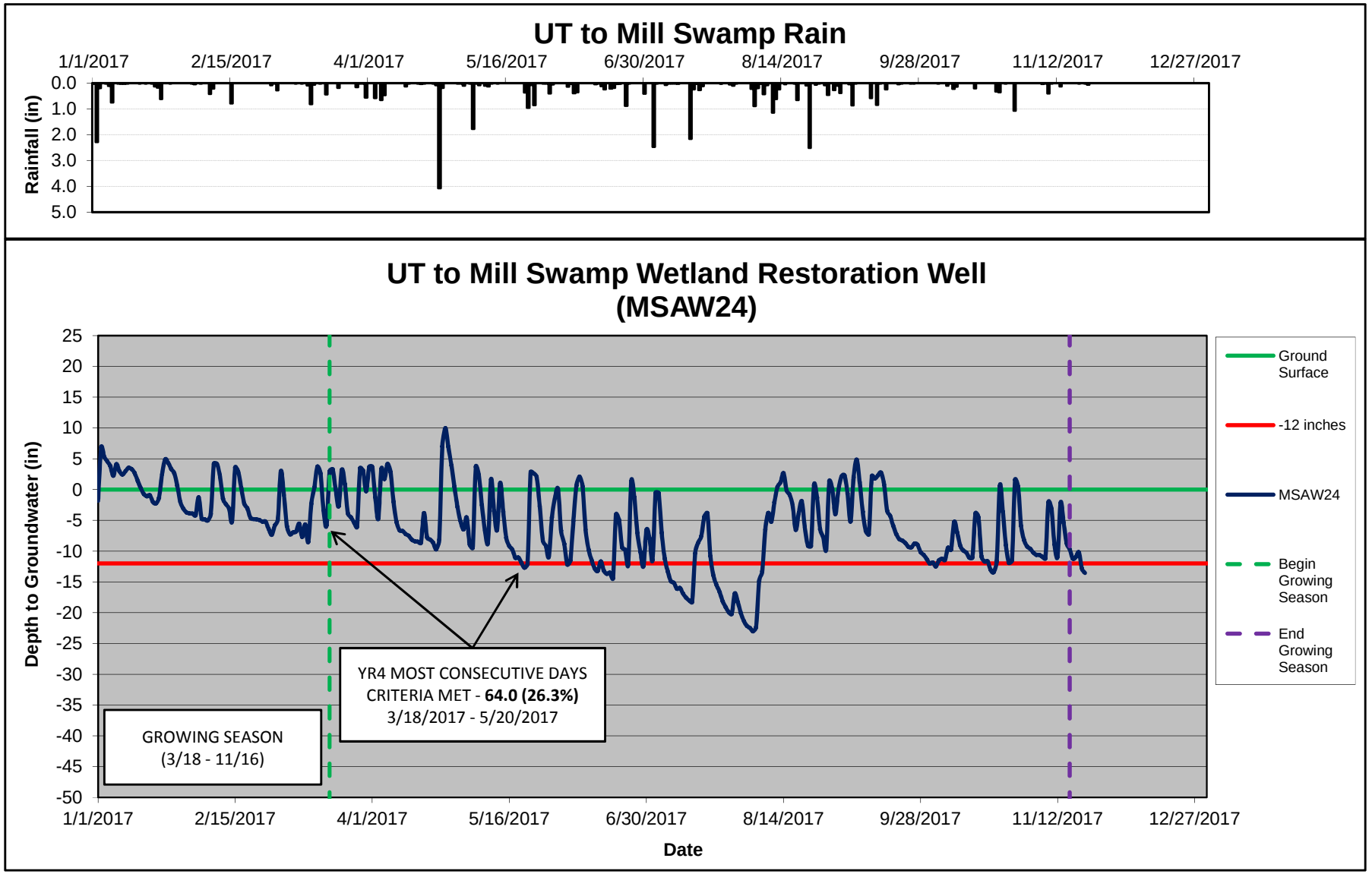

UT to Mill Swamp Rain
1/1/2017
2/15/2017
4/1/2017
5/16/2017
6/30/2017
8/14/2017
9/28/2017
11/12/2017
12/27/2017
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
5.0
UT to Mill Swamp Wetland Restoration Well
(MSAW24)
Depth to Groundwater (in)
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR4 MOST CONSECUTIVE DAYS
CRITERIA MET - 64.0 (26.3%)
3/18/2017 - 5/20/2017
Ground Surface
-12 inches
MSAW24
Begin Growing Season
End Growing Season
Date

Table 13. Flow Gauge Success
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Flow Gauge ID	Most Consecutive Days Meeting Criteria[1]								Cumulative Days Meeting Criteria[2]							
	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 5 (2018)	Year 6 (2019)	Year 7 (2020)	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 5 (2018)	Year 6 (2019)	Year 7 (2020)
Flow Gauges (Installed July 17, 2015)																
MSFL1	8.9	30.8	51.0	59.0	139.0	-	-	-	34.3	242.3	137.3	187.0	213.0	-	-	-
MSFL2	35.2	131.4	151.6	105.0	164.0	-	-	-	79.1	326.6	186.1	231.0	243.0	-	-	-

Notes:

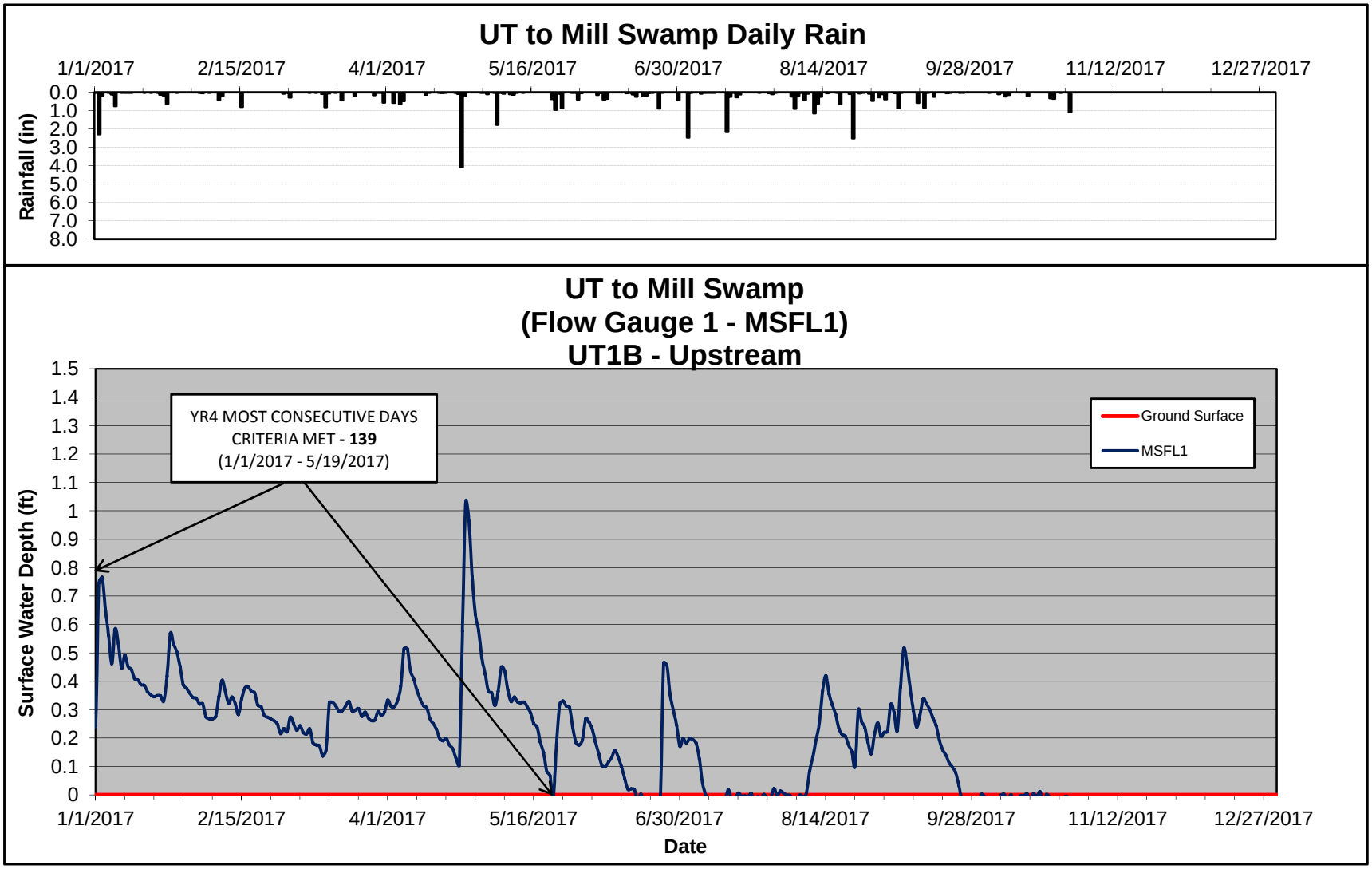
[1]Indicates the single greatest number of consecutive days within the monitoring year where flow was measured.

[2]Indicates the total number of days within the monitoring year where flow was measured.

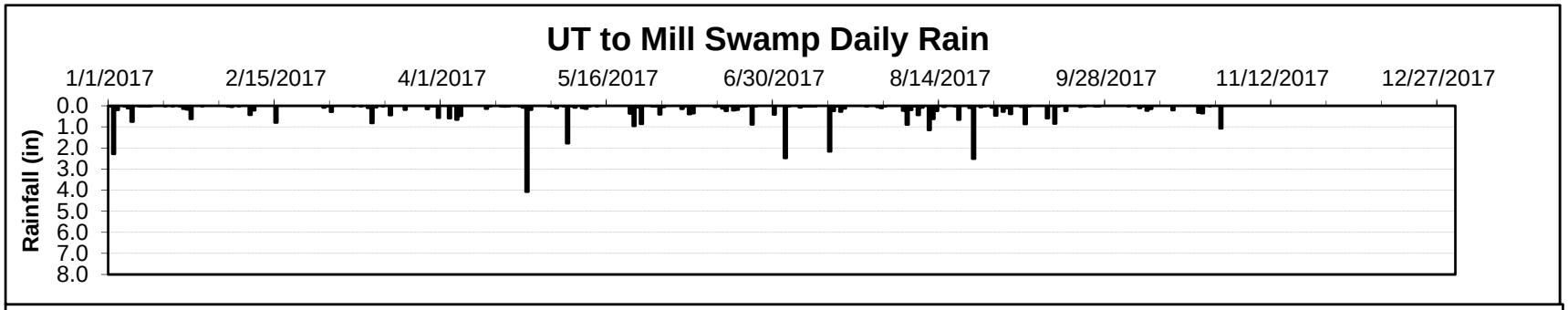
Success Criteria per UT to Mill Swamp Mitigation Plan: A surface water flow event will have been considered to have occurred when flow duration is recorded for a **minimum of 30 consecutive days during the monitoring year**. Two surface water flow events must be documented within a five-year monitoring period; otherwise, monitoring will continue for seven years or until two flow events have been documented in separate years.

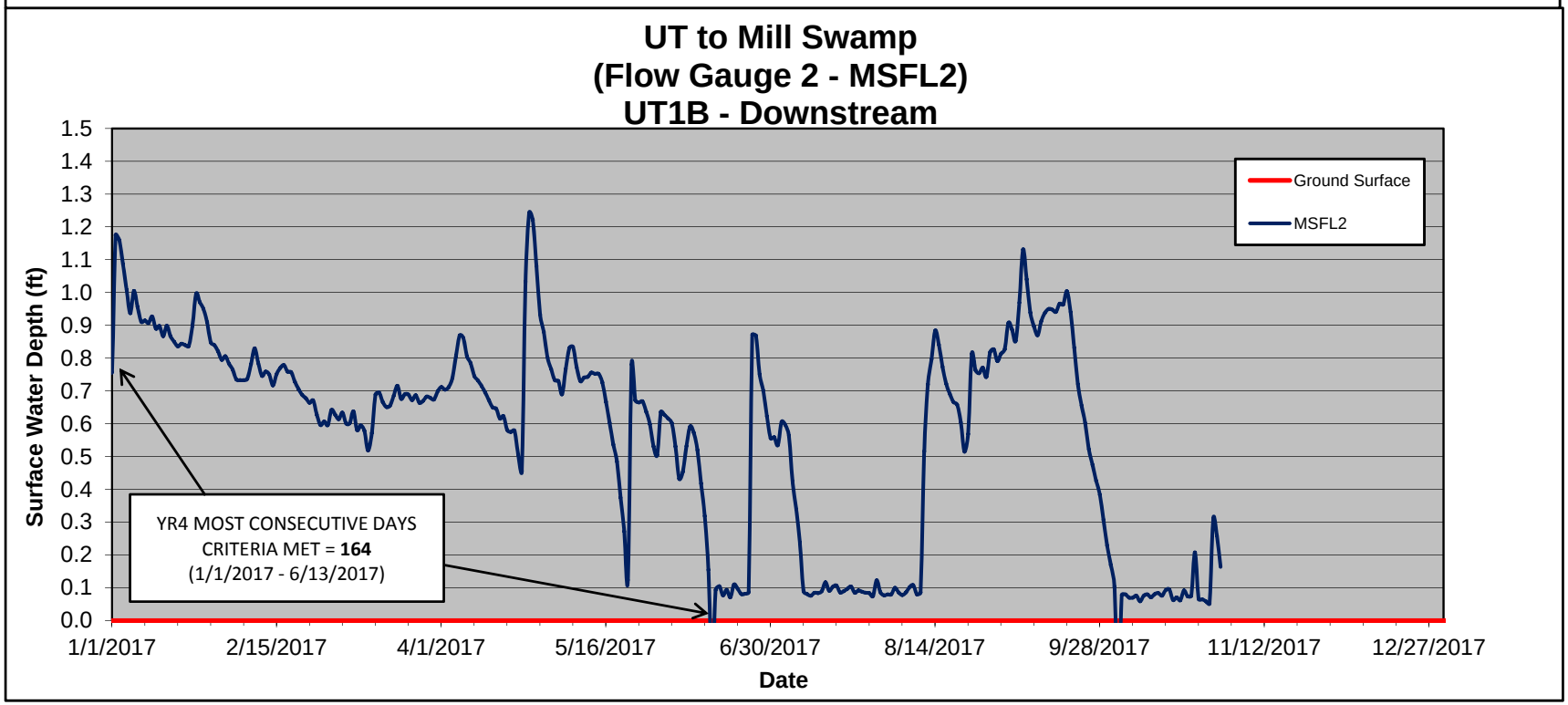
Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.1 feet in depth.

Figure 5.



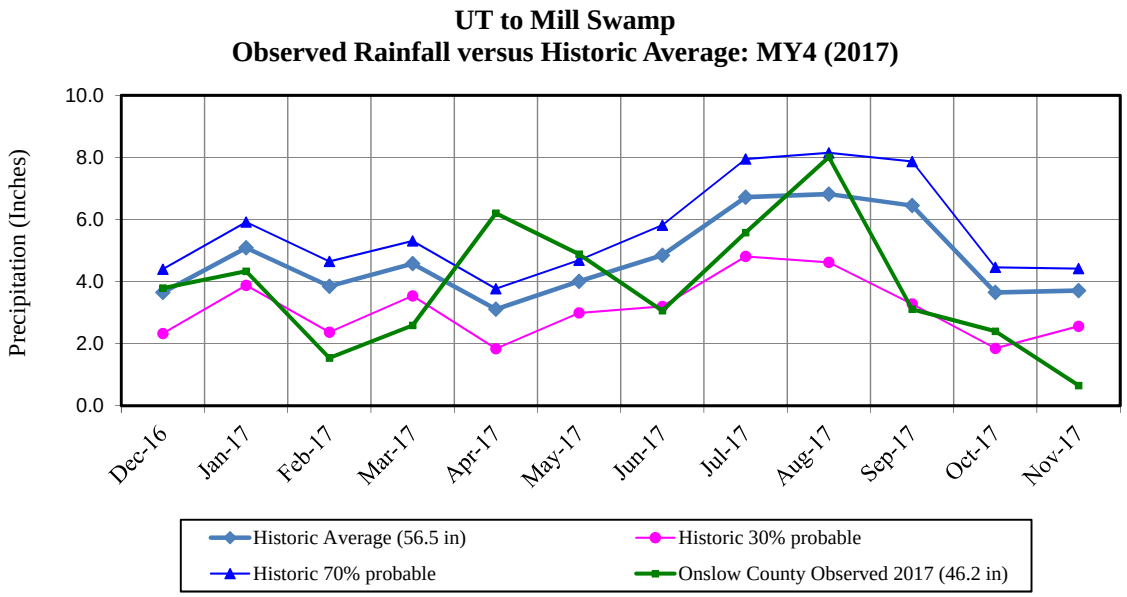
* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.1 feet in depth.





* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.1 feet in depth.

Figure 6. Observed Rainfall versus Historic Average



Note: Data from nearest NC-CRONOS station KOAJ

Table 14. Verification of Bankfull Events
UT to Mill Swamp Restoration Project: DMS Project No. 95019

Date of Data Collection	Estimated Occurrence of Bankfull Event	Method of Data Collection	Gauge Reading (feet)
Year 1 (2013)			
10/16/2013	10/11/2013	Crest Gauge	0.17
12/24/2013	12/15/2013	Crest Gauge	0.19
Year 2* (2014)			
3/27/2014	3/7/2014	Crest Gauge	0.32
10/14/2014	8/4/2014	Crest Gauge	0.56
12/19/2014	11/26/2014	Crest Gauge	0.27
Year 2 (2015)			
1/24/2015	1/24/2015	Crest Gauge	0.59
4/27/2015	2/26/2015	Crest Gauge	1.07
6/23/2015	5/11/2015	Crest Gauge	1.61
11/12/2015	10/3/2015	Crest Gauge	1.54
Year 3 (2016)			
3/10/2016	2/5/2016	Crest Gauge	1.44
11/22/2016	10/8/2016 (Hurricane Matthew)	Crest Gauge	2.32
Year 4 (2017)			
3/20/2017	1/2/2017	Crest Gauge	1.18
6/2/2017	4/25/2017	Crest Gauge	1.20