# Key Branch Stream and Wetland Restoration Site
# Year-7 Annual Monitoring Report (2010)

**Anson County, North Carolina**
**WBS Element 34398.4.1**
**TIP No. R-2239WM**
**NCEEP Project 206**

**Submitted to:**

North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

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## SUMMARY

The 118 acre Key Branch Stream and Wetland Restoration Site (hereafter referred to as the "Site") located in Anson County, was constructed in 2003. The Site covers approximately 6,200 linear feet of restored channel and 108.9 acres of wetland restoration. Approximately 47,800 bottomland hardwood trees were planted on 70.2 acres of the Site. To be successful, the Site must meet jurisdictional success criteria for both wetland hydrology and vegetation for five consecutive years or until the Site is deemed successful. Additionally, the stream must show vertical and horizontal stability within the channel with respect to as-built conditions. The following report details the Year-7 monitoring of wetland hydrology, wetland vegetation, and stream stability during the 2010 monitoring season.

Thirteen groundwater gauges were monitored in 2010, of which seven met the success criteria for jurisdictional hydrology (saturation within 12 inches of the surface for greater than 12.5 percent of the growing season). Five of the additional gauges did not meet success criteria, but maintained saturation near the surface for more than 10 percent of the growing season. All gauges attained their longest saturation period at the beginning of the growing season. The remaining gauge (Gauge 13) was replaced late in the growing season after continued malfunctions early in the growing season. Gauge 13 was replaced late in the growing season, in preparation for the upcoming season.

Four vegetation plots established under North Carolina Department of Transportation (NCDOT) protocol, and four riparian vegetation plots established following replanting in 2005 were monitored to measure woody stem density. In the current monitoring year, the Site had an average tree density of 228 trees per acre for the stream restoration acreage (riparian vegetation plots) and an average tree density of 692 trees per acre within the wetland restoration acreage (wetland vegetation plots). This provides an overall average of 460 trees per acre which is significantly higher than the minimum success criteria of 260 trees per acre.

Success criteria for the restored stream reach has been established to confirm that no significant changes have occurred to the dimension, pattern, profile, and bed material over the monitoring period. Location surveys of the constructed features were conducted to verify the performance of the stream. A total station survey was performed to describe the stream longitudinal profile and 12 permanent stream cross-sections. Overall, the stream channel bed form and banks are stable. Engineered structures placed within the restored channel were found to be visually absent and non-functioning towards their originally intended purpose. Based on the cross-sections, longitudinal profile and visual observations, the channel dimensions have not changed significantly compared to as-built conditions.

# 1.0 INTRODUCTION

## 1.1. Project Description

The Key Branch Stream and Wetland Restoration Site is located in Anson County and encompasses approximately 118 acres. It is situated between Lower White Store Road (SR 1252) and Mineral Springs Church Road (SR 1240) (Figure 1).

## 1.2. Purpose

In order to demonstrate successful mitigation, the Site must be monitored for a minimum of five years or until success criteria are achieved. Success criteria are based on federal and state guidelines for stream and wetland mitigation. Criteria for wetland hydrologic conditions, restored stream channel stability, and vegetation survival are included in this document. The following report describes the results of the hydrologic, vegetation, and restored stream channel monitoring during the 2010 growing season at the Key Branch Mitigation Site.

## 1.3. Project History

| | |
|---|---|
| Fall 2003 | Construction |
| November 2003 | Site Planted |
| March-November 2004 | Hydrologic Monitoring (Year 1) |
| July 2004 | Stream and Vegetation Monitoring (Year 1) |
| February 2005 | Site Replanted |
| March-November 2005 | Hydrologic Monitoring (Year 2) |
| August 2005 | Stream and Vegetation Monitoring (Year 2) |
| March-November 2006 | Hydrologic Monitoring (Year 3) |
| September 2006 | Stream and Vegetation Monitoring (Year 3) |
| March-November 2007 | Hydrologic Monitoring (Year 4) |
| September 2007 | Vegetation Monitoring (Year 4) |
| October 2008 | Hydrologic Monitoring (Year 5) |
| October 2008 | Vegetation Monitoring (Year 5) |
| August 2009 | Hydrologic Monitoring (Year 6) |
| August 2009 | Vegetation Monitoring (Year 6) |
| September 2010 | Hydrologic Monitoring (Year 7) |
| September 2010 | Stream and Vegetation Monitoring (Year 7) |

# 2.0 HYDROLOGY

## 2.1. Success Criteria

In accordance with federal and state guidelines for wetland mitigation, the success criteria for hydrology requires that these areas be inundated or saturated (within 12 inches of the surface) by surface or groundwater consecutively for at least 12.5 percent of the growing season. Areas inundated for less than 5 percent of the growing season are classified as non-wetlands. Areas inundated between 5 percent and 12.5 percent of the growing season can be classified as wetlands depending upon such factors as the presence of wetland vegetation and hydric soils.

The growing season in Anson County begins March 11 and ends November 23 (258 days). These dates correspond to a 50 percent probability that air temperatures will not drop below 28°F or lower after March 22 and before November 15. Minimum wetland hydrology is required for at least 12.5 percent of this growing season; for Anson County, 12.5 percent equals 30 consecutive days. Local climate must represent average conditions for the area.

## 2.2. Hydrologic Description

On-site hydrologic monitoring is facilitated by thirteen, continuously recording groundwater gauges located throughout the wetland restoration area (Figure 2). During the 2010 monitoring season, groundwater data was collected monthly from all monitoring gauges.

## 2.3. Results of Hydrologic Monitoring

### 2.3.1. Site Data

The maximum number of consecutive days that groundwater was within 12 inches of the surface was determined for each groundwater gauge. This number was converted into a percentage of the 258-day growing season. The results are summarized in Table 1.

Appendix B contains hydrographs of the water depth for each groundwater gauge. In general, groundwater levels show a typical pattern of flooding or high water table during the winter to early spring, followed by a summer and early fall drawdown period, punctuated by peaks of associated precipitation events.

**Table 1.** Key Branch Hydrologic Monitoring Results

| Monitoring Gauge | <5% | 5-12.5% | >12.5% | Actual % | Success Dates | Number of Days Gauges met Success Criteria |
|---|---|---|---|---|---|---|
| KBMG1 | | | ✓ | 67.8 | March 11 – September 1 | 175 |
| KBMG2 | | | ✓ | 13.6 | May 5 – June 20 | 35 |
| KBMG3 | | | ✓ | 21.7 | March 11 – May 5 | 56 |
| KBMG5 | | ✓ | | 10.9 | March 11 – April 7 | 28 |
| KBMG6 | | | ✓ | 44.6 | March 11 – July 3 | 115 |
| KBMG7 | | | ✓ | 43.8 | March 11 – July 1 | 113 |
| KBMG8 | | | ✓ | 14.7 | March 11 – April 17 | 38 |
| KBMG9 | | ✓ | | 11.6 | March 11 – April 9 | 30 |
| KBMG10 | | ✓ | | 12.0 | March 11 – April 10 | 31 |
| KBMG11 | | ✓ | | 12.0 | March 11 – April 10 | 31 |
| KBMG12 | | | ✓ | 48.4 | March 11 – July 3 | 125 |
| KBMG13* | ✓ | | | 0 | N/A | 0 |
| KBMG14 | | ✓ | | 10.5 | March 11 – April 6 | 27 |

*gauge malfunctions repeatedly throughout monitoring period

### 2.3.2. Climatic Data

Figure 3 shows a comparison of 2010 monthly rainfall to historical precipitation for the area. The figure shows average rainfall data collected between 1948 and 2010 and compares 30 percent and 70 percent of all observations with the actual 2010 monthly rainfall amount to determine average. (Climate data only available through August 2010)

The Site experienced 6 months of average rainfall throughout the monitoring period. The months of April and June received below average rainfall. April and June experienced amounts less than half of the monthly average. On balance, the yearly precipitation was close to the historical average.

## 3.0 STREAM ASSESSMENT

### 3.1. Stream Monitoring Requirements

The Key Branch monitoring plan requires an assessment of geomorphologic parameters in keeping with the U.S. Army Corps of Engineers (USACE) “Stream Mitigation Guidelines”, dated April 2003. The monitoring plan includes the protocol and provisions for providing photographs and channel stability analysis on a yearly basis. PBS&J used GPS equipment along with metal detectors to locate existing cross section pins. Twelve permanent cross-sections were located and surveyed. The existing cross-sections were divided evenly between riffle and pool bed features. A 3000 foot longitudinal profile of the restored channel was surveyed beginning near station 13+00. Bank stability and overall condition of the site was assessed during the cross-section and longitudinal profile surveys. Lateral photographs were collected at each cross-section (Appendix D). A stream monitoring gauge located in the channel provides stream elevation data to verify bankfull events.

### 3.2. Post Construction Conditions

The Key Branch project involved the construction of approximately 6200 linear feet of channel using a Priority 1 restoration approach. All of the riparian buffer mitigation was categorized as Priority 2 enhancement. Engineered structures included j-hook vanes, log vanes, rock cross vanes, rootwad revetments, step pools, and additional bank sloping. A step pool was installed at the beginning and end of the reach to maintain grade. A rootwad complex was installed in the apex of numerous bends with cover logs for habitat. Cross vanes, log vanes, and j-hook vanes were installed throughout the reach to direct higher flow velocities into the center of the channel. Throughout the entire reach the inner berm was maintained, enhanced, or created as channel modifications were made.

### 3.3 Results of Stream Monitoring

The mitigation plan stipulated placing a cross-section every 20 bankfull widths, a total of twelve cross sections were surveyed. Three cross-sections were identified as riffles, cross sections 5, 10, and 12. For this report, only cross sections containing riffles were used in the comparison of channel morphology presented below in Table 4. Data shown in Table 3 includes all cross sections surveyed along the reach. The stream channel was dry at the time of survey; therefore no water surface was recorded. The stream gauge registered three bankfull events during the 2010 monitoring year (March 13, March 30, and July 4)

Since the construction of Key Branch, a beaver impoundment located approximately 150 feet upstream of the end of the project has caused the water to back up throughout the reach (see Figure 2, Appendix A). Two additional beaver impoundments found at the start of the site have been removed as recent as November 2010 (see photos in

Appendix C). EEP dispatched wildlife control specialists on multiple occasions over the projects monitoring period to remove beaver and the associated dams, however, the combination of the sites size, wetland extent and abundant beaver population surrounding the site has made for persistent recolonization. Creeping water primrose (*Ludwigia hexapetala),* an exotic invasive, was found growing densely throughout the stream channel.

## Table 2. Baseline Stream Data Summary
## Key Branch Stream and Wetland Restoration Site - EEP Project 206

| Parameter | Gauge[2] | Regional Curve | | | Pre-Existing Condition | | | | | | Reference Reach(es) Data | | | | | | Design | | | Monitoring Baseline | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dimension and Substrate - Riffle Only** | | LL | UL | Eq. | Min | Mean | Med | Max | SD[5] | n | Min | Mean | Med | Max | SD[5] | n | Min | Med | Max | Min | Mean | Med | Max | SD[5] | n |
| Bankfull Width (ft) | NA* | | | | | | | | | | 27 | | 35 | | | | 22 | 25 | | NA* | NA* | NA* | NA* | NA* | NA* |
| Floodprone Width (ft) | | | | | | | | | | | >200 | | >200 | | | | >150 | >150 | | NA* | NA* | NA* | NA* | NA* | NA* |
| Bankfull Mean Depth (ft) | NA* | | | | | | | | | | 1.01 | | 1.16 | | | | 0.65 | 0.93 | | NA* | NA* | NA* | NA* | NA* | NA* |
| [1]Bankfull Max Depth (ft) | NA* | | | | | | | | | | 1.75 | | 2.17 | | | | 1.15 | 1.74 | | NA* | NA* | NA* | NA* | NA* | NA* |
| Bankfull Cross Sectional Area ($ft^2$) | NA* | | | | | | | | | | 35 | | 37 | | | | 17 | 21 | | NA* | NA* | NA* | NA* | NA* | NA* |
| Width/Depth Ratio | NA* | | | | | | | | | | 27 | | 34 | | | | 27 | 34 | | NA* | NA* | NA* | NA* | NA* | NA* |
| Entrenchment Ratio | NA* | | | | | | | | | | >7 | | >7 | | | | >7 | >7 | | NA* | NA* | NA* | NA* | NA* | NA* |
| [1]Bank Height Ratio | NA* | | | | | | | | | | | | | | | | | | | NA* | NA* | NA* | NA* | NA* | NA* |
| **Profile** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Riffle Length (ft) | | | | | | | | | | | | | | | | | | | | NA* | NA* | NA* | NA* | NA* | NA* |
| Riffle Slope (ft/ft) | | | | | | | | | | | | | | | | | | | | NA* | NA* | NA* | NA* | NA* | NA* |
| Pool Length (ft) | | | | | | | | | | | | | | | | | | | | NA* | NA* | NA* | NA* | NA* | NA* |
| Pool Max depth (ft) | | | | | | | | | | | | | | | | | | | | NA* | NA* | NA* | NA* | NA* | NA* |
| Pool Spacing (ft) | | | | | | | | | | | | | | | | | | | | NA* | NA* | NA* | NA* | NA* | NA* |
| **Pattern** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Channel Beltwidth (ft) | | | | | | | | | | | | | | | | | 160 | NA* | 180 | NA* | NA* | NA* | NA* | NA* | NA* |
| Radius of Curvature (ft) | | | | | | | | | | | 50.0 | | 72.8 | | | | 35 | NA* | 60 | NA* | NA* | NA* | NA* | NA* | NA* |
| Rc:Bankfull width (ft/ft) | | | | | | | | | | | | | | | | | | | | NA* | NA* | NA* | NA* | NA* | NA* |
| Meander Wavelength (ft) | | | | | | | | | | | 370 | | 465 | | | | 265 | NA* | 378 | NA* | NA* | NA* | NA* | NA* | NA* |
| Meander Width Ratio | | | | | | | | | | | 6.3 | | 8.1 | | | | 6.3 | NA* | 8.1 | NA* | NA* | NA* | NA* | NA* | NA* |

| Parameter | Gauge[2] | Regional Curve | | | Pre-Existing Condition | Reference Reach(es) Data | Design | Monitoring Baseline |
|---|---|---|---|---|---|---|---|---|
| **Transport parameters** | | | | | | | | |
| Reach Shear Stress (competency) $lb/f^2$ | | | | | | | | |
| Max part size (mm) mobilized at bankfull | | | | | | | | |
| Stream Power (transport capacity) $W/m^2$ | | | | | | | | |
| **Additional Reach Parameters** | | | | | | | | |
| Rosgen Classification | | | | | | C6 | C6 | |
| Bankfull Velocity (fps) | | | | | | | | |
| Bankfull Discharge (cfs) | | | | | | | | |
| Valley length (ft) | | | | | | 1590 | | |
| Channel Thalweg length (ft) | | | | | | 1065 | 6182 | |
| Sinuosity (ft) | | | | | | 1.49 | 1.49 | |
| Water Surface Slope (Channel) (ft/ft) | | | | | | 0.19 | 0.005 | |
| BF slope (ft/ft) | | | | | | | | |
| [3]Bankfull Floodplain Area (acres) | | | | | | | | |
| [4]% of Reach with Eroding Banks | | | | | | | | |
| Channel Stability or Habitat Metric | | | | | | | | |
| Biological or Other | | | | | | | | |

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section surveys and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing survey data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

## Table 3 Morphology and Hydraulic Monitoring Summary

## Key Branch Stream and Wetland Restoration Site - EEP Project 206

| Cross Section 1 (Glide) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 18.6 | 18.4 | 19 | 19.7 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 0.7 | 0.9 | 1 | 0.9 | | | |
| Bankfull Max Depth (ft) | 1.5 | 1.6 | 2 | 1.9 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 13 | 16.2 | 19.5 | 16.9 | | | |
| Bankfull Width/Depth Ratio | 26.6 | 20.9 | 19 | 21.9 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 5.1 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 2 (Run) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 20.2 | 23.8 | 26.1 | 24 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1.1 | 1.5 | 1.3 | 1.3 | | | |
| Bankfull Max Depth (ft) | 2 | 2.6 | 2.6 | 2.3 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 22.2 | 35.2 | 34.2 | 31.4 | | | |
| Bankfull Width/Depth Ratio | 18.4 | 16.1 | 20 | 18.5 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 4.2 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 3 (Pool) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 18.1 | 28.3 | 29 | 21.8 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1 | 1.2 | 1.2 | 1.3 | | | |
| Bankfull Max Depth (ft) | 1.9 | 2.5 | 2.9 | 2.3 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 18.1 | 33.4 | 35.1 | 28.1 | | | |
| Bankfull Width/Depth Ratio | 18.1 | 24 | 24.2 | 16.8 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 4.6 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 4 (Pool) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 17.3 | 21.3 | 19.5 | 20 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1.2 | 1.1 | 1.2 | 1.3 | | | |
| Bankfull Max Depth (ft) | 2.2 | 2.1 | 2.1 | 2.4 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 20.8 | 24.2 | 23 | 26 | | | |
| Bankfull Width/Depth Ratio | 14.4 | 18.7 | 16.3 | 15.4 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 5 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 5 (Riffle) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 20.9 | 22.9 | 22 | 22.5 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1 | 1 | 1.1 | 1.1 | | | |
| Bankfull Max Depth (ft) | 1.8 | 2.8 | 2.1 | 1.9 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 20.9 | 23.3 | 25.2 | 24.1 | | | |
| Bankfull Width/Depth Ratio | 20.9 | 22.5 | 20 | 20.5 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 4.4 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 6 (Glide) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 19.7 | 21 | 21 | 25.1 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1.1 | 1.1 | 1.1 | 0.9 | | | |
| Bankfull Max Depth (ft) | 2 | 2.1 | 2 | 1.9 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 21.7 | 23.8 | 23.3 | 23.7 | | | |
| Bankfull Width/Depth Ratio | 17.9 | 18.5 | 19.1 | 27.9 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 4 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 7 (Run) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 22.9 | 19.9 | 20.7 | 30 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1.1 | 1.2 | 1.2 | 0.8 | | | |
| Bankfull Max Depth (ft) | 2 | 1.8 | 1.9 | 1.7 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 25.2 | 23.6 | 25 | 22.8 | | | |
| Bankfull Width/Depth Ratio | 20.8 | 16.8 | 17.3 | 37.5 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 3.3 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 8 (Pool) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 21.9 | 19.9 | 19 | 21.2 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1.2 | 1.2 | 1.3 | 1.1 | | | |
| Bankfull Max Depth (ft) | 2.3 | 2.3 | 2.5 | 2 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 25.9 | 24.1 | 25.5 | 22.8 | | | |
| Bankfull Width/Depth Ratio | 18.5 | 16.4 | 14.6 | 19.3 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 4.7 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 9 (Glide) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 20 | 19.9 | 20 | 22.8 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1.3 | 1.2 | 1.2 | 1 | | | |
| Bankfull Max Depth (ft) | 2.2 | 2 | 2 | 1.9 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 26 | 23.8 | 23.7 | 23.1 | | | |
| Bankfull Width/Depth Ratio | 15.4 | 16.6 | 16.7 | 22.8 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 4.4 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 10 (Riffle) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 21.1 | 20 | 27 | 22.2 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 0.9 | 1 | 0.9 | 0.8 | | | |
| Bankfull Max Depth (ft) | 1.6 | 1.7 | 1.8 | 1.4 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 19 | 20.5 | 24.3 | 17.1 | | | |
| Bankfull Width/Depth Ratio | 23.4 | 19.5 | 30.1 | 27.8 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 4.5 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 11 (Run) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 27.6 | 26 | 31 | 21.5 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1.1 | 1.2 | 1 | 0.9 | | | |
| Bankfull Max Depth (ft) | 2.2 | 2.4 | 2.3 | 1.5 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 30.4 | 31.9 | 31.4 | 18.6 | | | |
| Bankfull Width/Depth Ratio | 25.1 | 21.2 | 30.6 | 23.9 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 4.7 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

| Cross Section 12 (Riffle) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Based on fixed baseline bankfull elevation[1] | MY1 | MY2 | MY3 | MY7 | MY8 | MY+ | MY+ |
| Record elevation (datum) used | | | | | | | |
| Bankfull Width (ft) | 26.9 | 22.9 | 21.2 | 21.5 | | | |
| Floodprone Width (ft) | >100 | >100 | >100 | >100 | | | |
| Bankfull Mean Depth (ft) | 1 | 0.9 | 0.9 | 0.8 | | | |
| Bankfull Max Depth (ft) | 2.1 | 1.9 | 2 | 1.6 | | | |
| Bankfull Cross Sectional Area ($ft^2$) | 26.9 | 20.5 | 20 | 18.2 | | | |
| Bankfull Width/Depth Ratio | 26.9 | 25.6 | 23.5 | 26.9 | | | |
| Bankfull Entrenchment Ratio | >5 | >5 | >5 | 4.7 | | | |
| Bankfull Bank Height Ratio | 1 | 1 | 1 | 1 | | | |
| Cross Sectional Area between end pins ($ft^2$) | | | | | | | |
| d50 (mm) | Silt | Silt | Silt | Silt | | | |

It is uncertain if the monitoring datum has been consistent over the monitoring history, which may influence calculated values.
MY1, MY2, MY3 data from a prior performer is not available.

**Table 4** **Visual Stream Morphology Stability Assessment**

| Major Channel Category | Channel Sub-Category | Metric | Number Stable, Performing as Intended | Total Number in As-built | Number of Unstable Segments | Amount of Unstable Footage | % Stable, Performing as Intended | Number with Stabilizing Woody Vegetation | Footage with Stabilizing Woody Vegetation | Adjusted % for Stabilizing Woody Vegetation |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Bed | 1. **Vertical Stability** (Riffle and Run units) | 1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars) | | | 0 | 0 | 0% | | | |
| | | 2. Degradation - Evidence of downcutting | | | 0 | 0 | 0% | | | |
| | 2. Riffle Condition | 1. Texture/Substrate - Riffle maintains coarser substrate | 49 | 49 | | | 100% | | | |
| | 3. Meander Pool Condition | 1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth $\geq$ 1.6) | 52 | 52 | | | 100% | | | |
| | | 2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle) | 52 | 52 | | | 100% | | | |
| | 4.Thalweg Position | 1. Thalweg centering at upstream of meander bend (Run) | 52 | 52 | | | 100% | | | |
| | | 2. Thalweg centering at downstream of meander (Glide) | 49 | 49 | | | 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 | NA |
| | 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 | NA |
| | 3. Mass Wasting | Bank slumping, calving, or collapse | | | 0 | 0 | 100% | 0 | 0 | NA |
| | | | | Totals | 0 | 0 | 100% | 0 | 0 | NA |
| 3. Engineered Structures | 1. Overall Integrity | Structures physically intact with no dislodged boulders or logs. | 46 | 46 | | | 100% | | | |
| | 2. Grade Control | Grade control structures exhibiting maintenance of grade across the sill. | 46 | 46 | | | 100% | | | |
| | 2a. Piping | Structures lacking any substantial flow underneath sills or arms. | 46 | 46 | | | 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) | 46 | 46 | | | 100% | | | |
| | 4. Habitat | Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio $\geq$ 1.6 Rootwads/logs providing some cover at base-flow. | 46 | 46 | | | 100% | | | |

**Table 5 Monitoring Data - Stream Reach Data Summary**
**Key Branch Stream and Wetland Restoration Site - EEP Project 206**

| Parameter | MY-1 | | | | | | MY-2 | | | | | | MY-3 | | | | | | MY- 7 | | | | | | MY- 8 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dimension and Substrate - Riffle only** | Min | Mean | Med | Max | SD[4] | n | Min | Mean | Med | Max | SD[4] | n | Min | Mean | Med | Max | SD[4] | n | Min | Mean | Med | Max | SD[4] | n | Min | Mean | Med | Max | SD[4] | n |
| Bankfull Width (ft) | | | | | | | | | | | | | | | | | | | 22.97 | 21.93 | 23.4 | 22.07 | | | | | | | | |
| Floodprone Width (ft) | | | | | | | | | | | | | | | | | | | >100 | >100 | >100 | >100 | | | | | | | | |
| Bankfull Mean Depth (ft) | | | | | | | | | | | | | | | | | | | 0.967 | 0.967 | 0.967 | 0.9 | | | | | | | | |
| [1]Bankfull Max Depth (ft) | | | | | | | | | | | | | | | | | | | 1.833 | 2.133 | 1.967 | 1.633 | | | | | | | | |
| Bankfull Cross Sectional Area ($ft^2$) | | | | | | | | | | | | | | | | | | | 22.27 | 21.43 | 23.17 | 19.8 | | | | | | | | |
| Width/Depth Ratio | | | | | | | | | | | | | | | | | | | 23.73 | 22.53 | 24.53 | 25.07 | | | | | | | | |
| Entrenchment Ratio | | | | | | | | | | | | | | | | | | | >5 | >5 | >5 | 4.533 | | | | | | | | |
| [1]Bank Height Ratio | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | 1 | | | | | | | | |
| **Profile** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Riffle Length (ft) | NA | | NA | NA | | | 11 | | 61 | 120 | | | 40 | | 65 | 135 | | | 2.1 | 10.42 | 46.4 | 18.41 | 24.5 | 49 | | | | | | |
| Riffle Slope (ft/ft) | NA | | NA | NA | | | 0 | | 0.006 | 0.037 | | | 0.001 | | 0.004 | 0.011 | | | 0.000 | 0.011 | 0.001 | 0.072 | 0.005 | 49 | | | | | | |
| Pool Length (ft) | NA | | NA | NA | | | 22 | | 46 | 70 | | | 28 | | 75 | 178 | | | 3.73 | 14.09 | 29.7 | 23.19 | 9.09 | 52 | | | | | | |
| Pool Max depth (ft) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pool Spacing (ft) | NA | | NA | NA | | | 39 | | 113 | 252 | | | 32 | | 111 | 246 | | | 9.3 | 18.9 | 76.8 | 32.1 | 28.9 | 52 | | | | | | |
| **Pattern** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Channel Beltwidth (ft) | NA | | NA | NA | | | 91 | | 118 | 144 | | | 91 | | 118 | 144 | | | 6.9 | 56.9 | 57 | 129 | 35.3 | | | | | | | |
| Radius of Curvature (ft) | NA | | NA | NA | | | 12 | | 26 | 37 | | | 12 | | 26 | 37 | | | 18 | 39.7 | 40 | 73 | 14.4 | | | | | | | |
| Rc:Bankfull width (ft/ft) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Meander Wavelength (ft) | NA | | NA | NA | | | 179 | | 189 | 215 | | | 179 | | 189 | 215 | | | 58 | 138.9 | 139 | 207 | 42.3 | | | | | | | |
| Meander Width Ratio | NA | | NA | NA | | | NA | | 5.3 | NA | | | NA | | 5.3 | NA | | | 0.3 | 2.6 | 2.6 | 5.8 | 1.6 | | | | | | | |
| **Additional Reach Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rosgen Classification | C6 | | | | | | C6 | | | | | | C6 | | | | | | C6 | | | | | | | | | | | |
| Channel Thalweg length (ft) | | | | | | | 3023 | | | | | | 3023 | | | | | | 3023 | | | | | | | | | | | |
| Sinuosity (ft) | | | | | | | 1.5 | | | | | | 1.5 | | | | | | 1.5 | | | | | | | | | | | |
| Water Surface Slope (Channel) (ft/ft) | | | | | | | 0.00041 | | | | | | 0.00055 | | | | | | NA (dry channel) | | | | | | | | | | | |
| BF slope (ft/ft) | | | | | | | 0.000245 | | | | | | 0.00049 | | | | | | 0.00057 | | | | | | | | | | | |
| [3]Ri% / Ru% / P% / G% / S% | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [3]SC% / Sa% / G% / C% / B% / Be% | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [3]d16 / d35 / d50 / d84 / d95 / | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| [2]% of Reach with Eroding Banks | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Channel Stability or Habitat Metric | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biological or Other | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Shaded cells indicate data not available.
1 = The distributions for these parameters can include information from both the cross-section surveys and the longitudinal profile.
2 = Proportion of reach exhibiting banks that are eroding based on the visual survey from visual assessment table
3 = Riffle, Run, Pool, Glide, Step; Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock; dip = max pave, disp = max subpave
4. = Of value/needed only if the n exceeds 3

## 4.0 VEGETATION ASSESSMENT

### 4.1. Success Criteria

According to the 2003 USACE Stream Mitigation Guidelines, the success criteria for vegetation requires that at least 320 stems per acre must survive after the completion of the third growing season. The required survival criterion will decrease by 10 percent per year after the third year of vegetation monitoring (i.e., for an expected 290 stems per acre for Year 4, 260 stems per acre for Years 5, 6, and 7. NCDOT Stem Counting Protocol was used as the standard sampling methodology.

### 4.2. Description of Species

Based on the mitigation plan, the wetland restoration area and the riparian restoration area were to be planted with the following species:

Wetland
*Quercus pagoda* (Cherrybark Oak)
*Quercus phellos* (Willow Oak)
*Quercus michauxii* (Swamp Chestnut Oak)
*Quercus lyrata* (Overcup Oak)
*Quercus nigra* (Water Oak)
*Ulmus americana* (American Elm)
*Fraxinus pennsylvanica* (Green Ash)
*Betula nigra* (River Birch)

Riparian
*Betula nigra* (River Birch)
*Salix nigra* (Black Willow)
*Cephalanthus occidentalis* (Buttonbush)
*Cornus amomum* (Silky dogwood)

### 4.3. Results of Vegetation Monitoring

The average stem density for the riparian plots were less than the 260 stems per acre needed for the success criteria; however, the overall average for the Site was 460 stems per acre, which is significantly more than the criteria needed for success. (Photographs from the vegetation plots are provided in Appendix C)

**Table 6. Results of Riparian Vegetation Plots Monitoring**

| Riparian Plots | Betula nigra | Cephalanthus occidentalis | Franxinus pennsylvanica | Quercus laurifolia | Quercus lyrata | Quericus michauxii | Quercus nigra | Quercus pagoda | Salix nigra | Ulmus alata | Total Stems | Density (Trees/acre) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **R1** | 5 | 0 | 12 | 2 | 6 | 0 | 2 | 2 | 10 | 0 | 39 | 390 |
| **R5** | 4 | 1 | 0 | 0 | 4 | 1 | 0 | 0 | 2 | 0 | 12 | 120 |
| **R6** | 3 | 0 | 3 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 12 | 120 |
| **R10** | 1 | 0 | 11 | 1 | 8 | 6 | 0 | 0 | 0 | 1 | 28 | 280 |
| **TOTAL** | 13 | 1 | 26 | 3 | 20 | 9 | 4 | 2 | 12 | 1 | 91 | 910 |
| **Average Tree Density: 228** | | | | | | | | | | | | |

**Table 7. Results of Wetland Vegetation Plots Monitoring**

| Wetland Plots | Acer negundo | Acer rubrum | Betula nigra | Diospyros virginiana | Fraxinus pennsylvanica | Liquidambar styraciflua | Quercus laurifolia | Quercus lyrata | Quercus michauxii | Quercus nigra | Sambucus canadensis | Ulmus alata | Total Stems | Density (trees/acre) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **D2** | 0 | 0 | 2 | 0 | 4 | 0 | 4 | 14 | 2 | 6 | 1 | 0 | 33 | 579 |
| **D3** | 0 | 0 | 4 | 0 | 38 | 0 | 4 | 9 | 0 | 0 | 0 | 6 | 61 | 1070 |
| **D5** | 0 | 1 | 6 | 1 | 10 | 2 | 4 | 6 | 8 | 2 | 0 | 0 | 40 | 400 |
| **D8** | 1 | 2 | 2 | 0 | 7 | 1 | 1 | 18 | 6 | 3 | 0 | 0 | 41 | 719 |
| **TOTALS** | 1 | 3 | 14 | 1 | 59 | 3 | 13 | 47 | 16 | 11 | 1 | 6 | 175 | 2768 |
| **Average Tree Density: 692** | | | | | | | | | | | | | | |

**Table 8. Riparian Plot Vegetation Summary Data**

| Species | Riparian Plot Numbers | | | | |
|---|---|---|---|---|---|
| | Year | 1 | 5 | 6 | 10 |
| ***Betula nigra* (River birch)** | 2005 | 2 | 1 | 0 | 0 |
| | 2006 | 2 | 1 | 0 | 0 |
| | 2007 | 1 | 1 | 0 | 0 |
| | 2008 | 5 | 4 | 3 | 1 |
| | 2009 | 5 | 4 | 3 | 1 |
| | 2010 | 5 | 4 | 3 | 1 |
| ***Fraxinus pennsylvanica* (Green ash)** | 2005 | 0 | 1 | 1 | 1 |
| | 2006 | 1 | 1 | 3 | 3 |
| | 2007 | 0 | 1 | 2 | 3 |
| | 2008 | 12 | 0 | 3 | 12 |
| | 2009 | 12 | 0 | 3 | 11 |
| | 2010 | 12 | 0 | 3 | 11 |
| ***Quercus laurifolia* (Laurel oak)** | 2005 | 0 | 0 | 0 | 0 |
| | 2006 | 0 | 0 | 0 | 0 |
| | 2007 | 0 | 0 | 1 | 1 |
| | 2008 | 2 | 0 | 0 | 0 |
| | 2009 | 2 | 0 | 0 | 0 |
| | 2010 | 2 | 0 | 0 | 1 |
| ***Quercus lyrata* (Overcup oak)** | 2005 | 1 | 1 | 4 | 0 |
| | 2006 | 0 | 0 | 4 | 0 |
| | 2007 | 0 | 1 | 3 | 0 |
| | 2008 | 5 | 2 | 2 | 7 |
| | 2009 | 6 | 4 | 2 | 8 |
| | 2010 | 6 | 4 | 2 | 8 |
| ***Quercus michauxii* (Swamp chestnut oak)** | 2005 | 0 | 0 | 0 | 1 |
| | 2006 | 0 | 0 | 0 | 0 |
| | 2007 | 0 | 0 | 0 | 2 |
| | 2008 | 0 | 1 | 2 | 6 |
| | 2009 | 0 | 1 | 2 | 6 |
| | 2010 | 0 | 1 | 2 | 6 |
| ***Salix nigra* (Black willow)** | 2005 | 1 | 1 | 7 | 0 |
| | 2006 | 1 | 3 | 7 | 0 |
| | 2007 | 1 | 3 | 5 | 0 |
| | 2008 | 10 | 1 | 0 | 0 |
| | 2009 | 10 | 2 | 0 | 0 |
| | 2010 | 10 | 2 | 0 | 0 |

**Table 9. Wetland Plot Vegetation Summary Data**

| Species | Wetland Plot Numbers | | | | |
|---|---|---|---|---|---|
| | **Year** | **2** | **3** | **5** | **8** |
| ***Betula nigra* (River birch)** | 2005 | 0 | 3 | 0 | 1 |
| | 2006 | 0 | 3 | 1 | 1 |
| | 2007 | 1 | 4 | 4 | 2 |
| | 2008 | 2 | 4 | 3 | 1 |
| | 2009 | 2 | 4 | 4 | 2 |
| | 2010 | 2 | 4 | 6 | 2 |
| ***Fraxinus pennsylvanica* (Green ash)** | 2005 | 3 | 11 | 0 | 4 |
| | 2006 | 2 | 16 | 0 | 4 |
| | 2007 | 4 | 32 | 6 | 11 |
| | 2008 | 6 | 33 | 10 | 3 |
| | 2009 | 4 | 38 | 9 | 7 |
| | 2010 | 4 | 38 | 10 | 7 |
| ***Quercus laurifolia* (Laurel oak)** | 2005 | 7 | 0 | 0 | 0 |
| | 2006 | 3 | 0 | 2 | 0 |
| | 2007 | 8 | 2 | 4 | 4 |
| | 2008 | 1 | 1 | 3 | 0 |
| | 2009 | 4 | 4 | 5 | 1 |
| | 2010 | 4 | 4 | 4 | 1 |
| ***Quercus lyrata* (Overcup oak)** | 2005 | 14 | 11 | 4 | 0 |
| | 2006 | 5 | 11 | 4 | 3 |
| | 2007 | 8 | 8 | 10 | 15 |
| | 2008 | 14 | 11 | 4 | 19 |
| | 2009 | 14 | 9 | 6 | 18 |
| | 2010 | 14 | 9 | 6 | 18 |
| ***Quercus michauxii* (Swamp chestnut oak)** | 2005 | 2 | 0 | 2 | 4 |
| | 2006 | 2 | 0 | 1 | 4 |
| | 2007 | 2 | 0 | 6 | 6 |
| | 2008 | 2 | 0 | 8 | 5 |
| | 2009 | 2 | 0 | 8 | 6 |
| | 2010 | 2 | 0 | 8 | 6 |
| ***Quercus pagoda* (Cherrybark oak)** | 2005 | 0 | 0 | 8 | 7 |
| | 2006 | 3 | 0 | 1 | 0 |
| | 2007 | 0 | 0 | 0 | 1 |
| | 2008 | 0 | 0 | 0 | 0 |
| | 2009 | 0 | 0 | 0 | 0 |

| Species | Wetland Plot Numbers | | | | |
|---|---|---|---|---|---|
| | **Year** | **2** | **3** | **5** | **8** |
| | 2010 | 0 | 0 | 0 | 0 |
| ***Quercus phellos* (Willow oak)** | 2005 | 2 | 1 | 0 | 0 |
| | 2006 | 0 | 2 | 0 | 0 |
| | 2007 | 1 | 1 | 0 | 0 |
| | 2008 | 0 | 0 | 0 | 0 |
| | 2009 | 0 | 0 | 0 | 0 |
| | 2010 | 0 | 0 | 0 | 0 |
| ***Salix nigra* (Black willow)** | 2005 | 0 | 0 | 0 | 0 |
| | 2006 | 0 | 0 | 0 | 0 |
| | 2007 | 0 | 0 | 0 | 0 |
| | 2008 | 0 | 0 | 0 | 0 |
| | 2009 | 0 | 0 | 0 | 0 |
| | 2010 | 0 | 0 | 0 | 0 |

# 5.0 REFERENCES

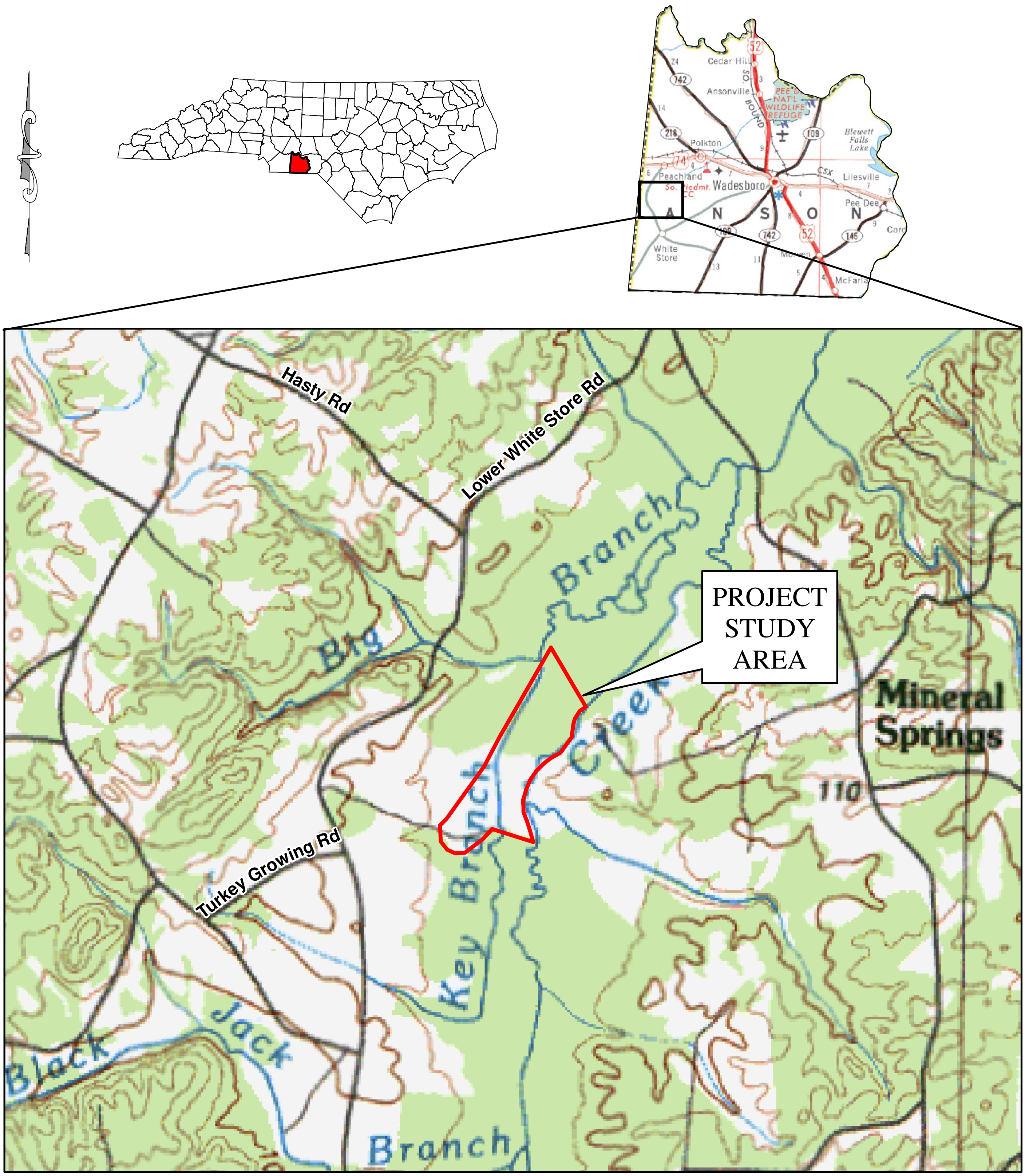
State Climate Office of North Carolina. CRONOS precipitation database [online]. Retrieved 11-29-10.

NRCS USDA. National Water and Climate Center. Climate Information- Wetlands Retrieval for Anson County Growing Season [online]. Retrieved 11-29-10. http://www.wcc.nrcs.usda.gov/cgibin/getwetco.pl?state=nc

Stream Mitigation Guidelines, April 2003. Authored by a workgroup consisting of USACE (Wilmington District, USEPA, NCWRC and NCDWQ). Riparian Restoration pg. 18.

# APPENDIX A

FIGURES




Directions:
Go west on Hwy 74 from Wadesboro in Anson County to Peachland.
Turn left onto Mineral Springs Church Rd. and then right onto Lower White Store Road.
Pass Hasty Rd. and then just before Turkey Growing Rd, turn left into Key Branch Site on a gravel road.

0 1,500 3,000 6,000 Feet

PBSJ

Client: Ecosystem Enhancement Program

## SITE LOCATION

KEY BRANCH STREAM & WETLAND RESTORATION SITE

Anson County, North Carolina

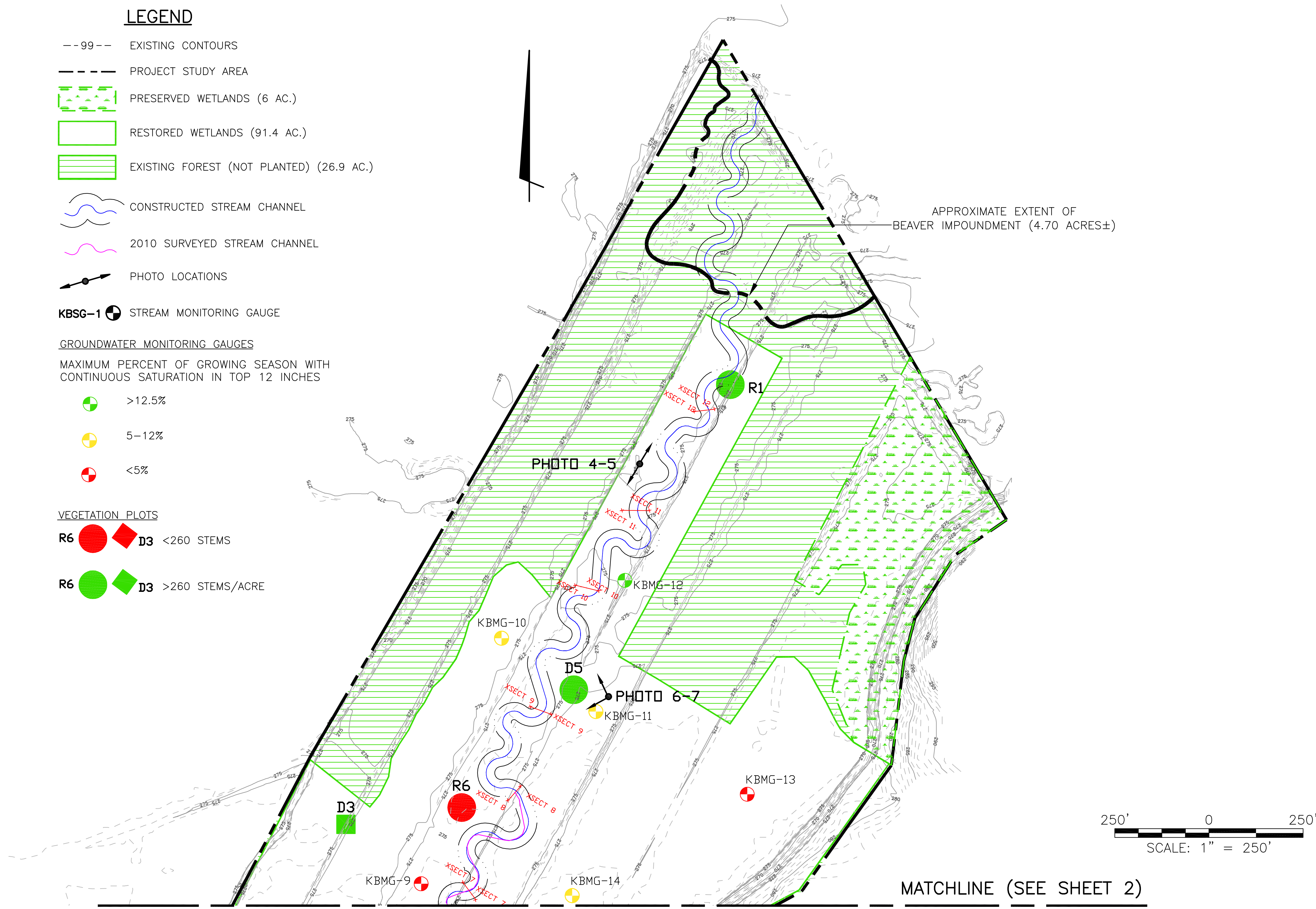
| Dwn By: | Ckd By: |
|---|---|
| TAL | MCG |

Date: DEC 2009

Scale: AS SHOWN

ESC Project No. 08-414

FIGURE 1




PBS&J
an Atkins company

REVISIONS

Client:

Ecosystem Enhancement PROGRAM

Project:

KEY BRANCH STREAM & WETLAND RESTORATION SITE

ANSON COUNTY, NORTH CAROLINA

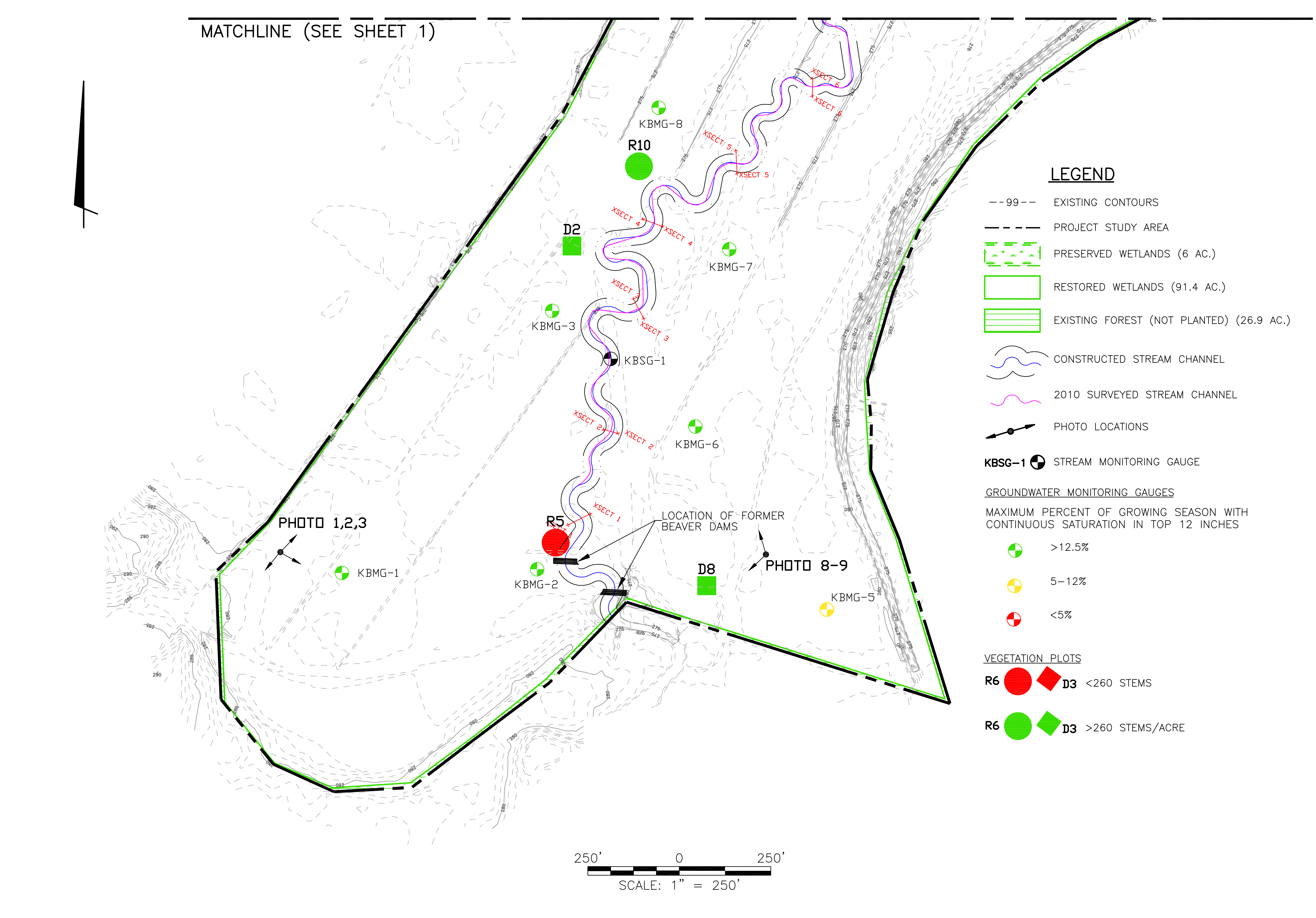
Title:

CURRENT CONDITIONS PLAN VIEW

| Dwn. By: RLG | Ckd. By: JWG |
|---|---|
| Date: DEC 2010 | Scale: 1"=250' |
| Project No.: 100005068 | |

FIGURE

2A




PBS&J
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REVISIONS

Client:
Ecosystem Enhancement PROGRAM

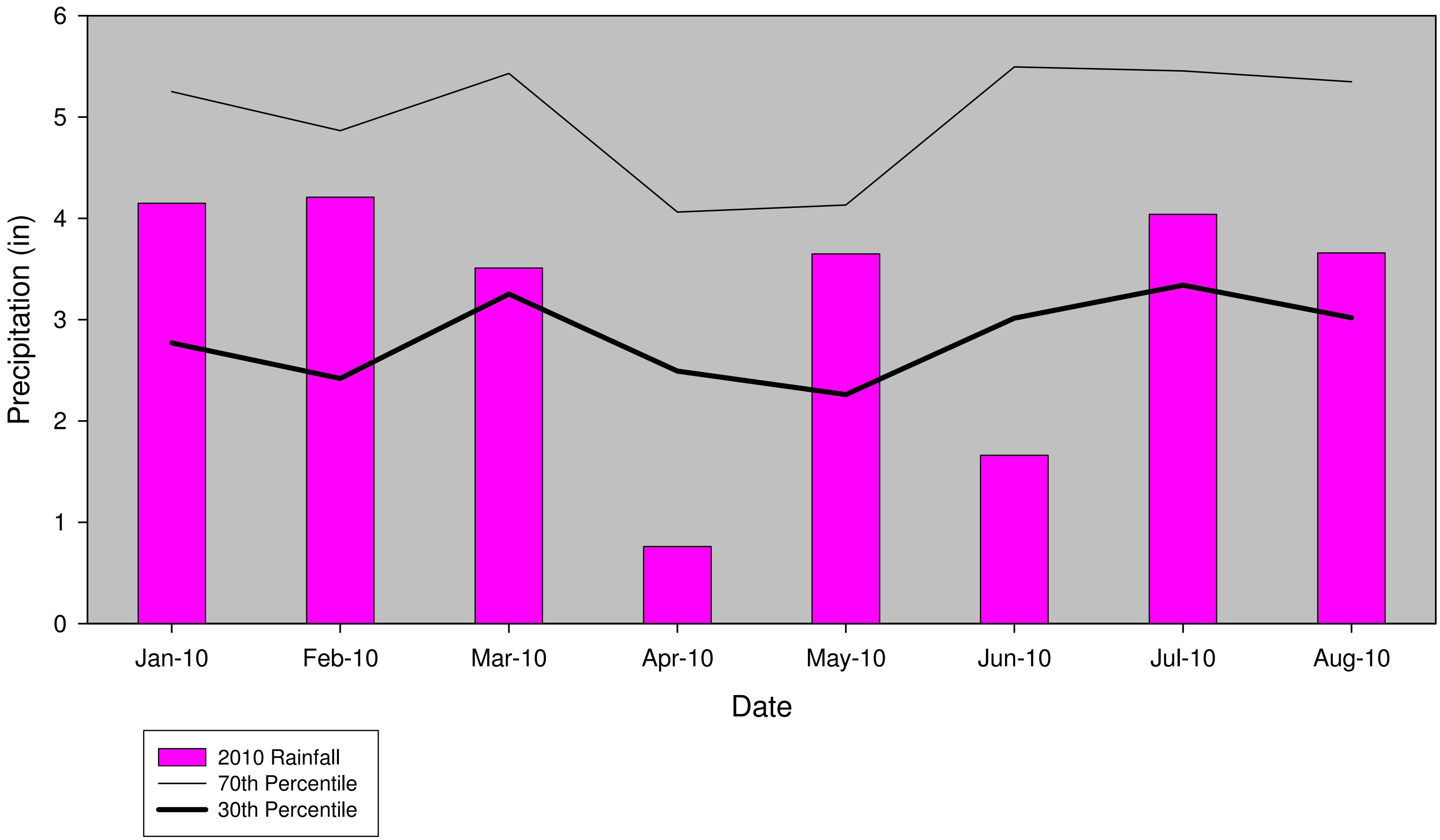
Project:
KEY BRANCH STREAM & WETLAND RESTORATION SITE
ANSON COUNTY, NORTH CAROLINA

Title:
CURRENT CONDITIONS PLAN VIEW

| Dwn. By: RLG | Ckd. By: JWG |
|---|---|
| Date: DEC 2010 | Scale: 1"=250' |
| Project No.: 100005068 | |

FIGURE
2B

**Fig 3. Key Branch 30-70 Percentile Graph 2010**
**Wadesboro, NC**



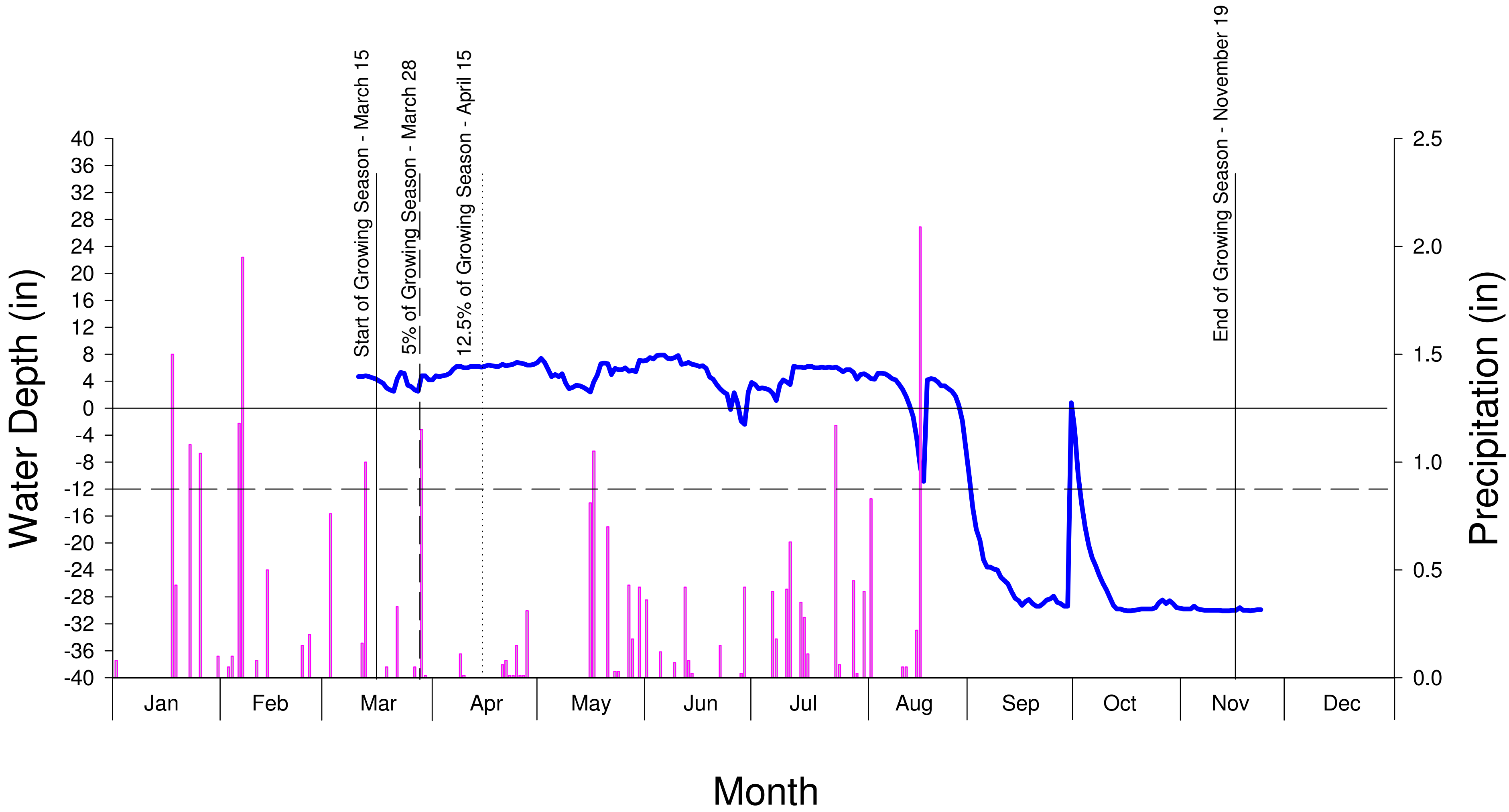
# APPENDIX B

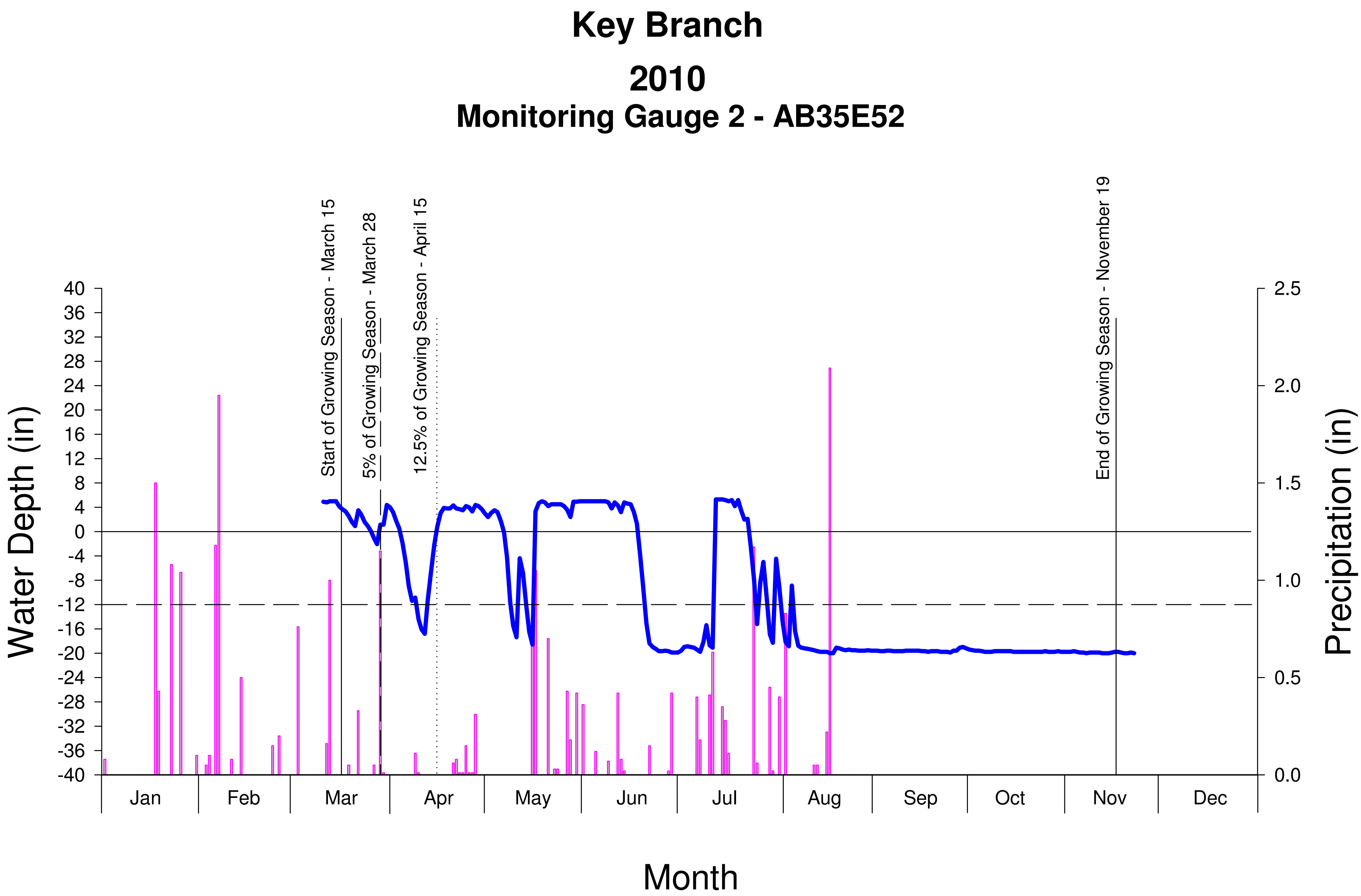
GROUNDWATER GAUGE HYDROGRAPHS

# Key Branch

## 2010

### Monitoring Gauge 1 - 1130E7CF



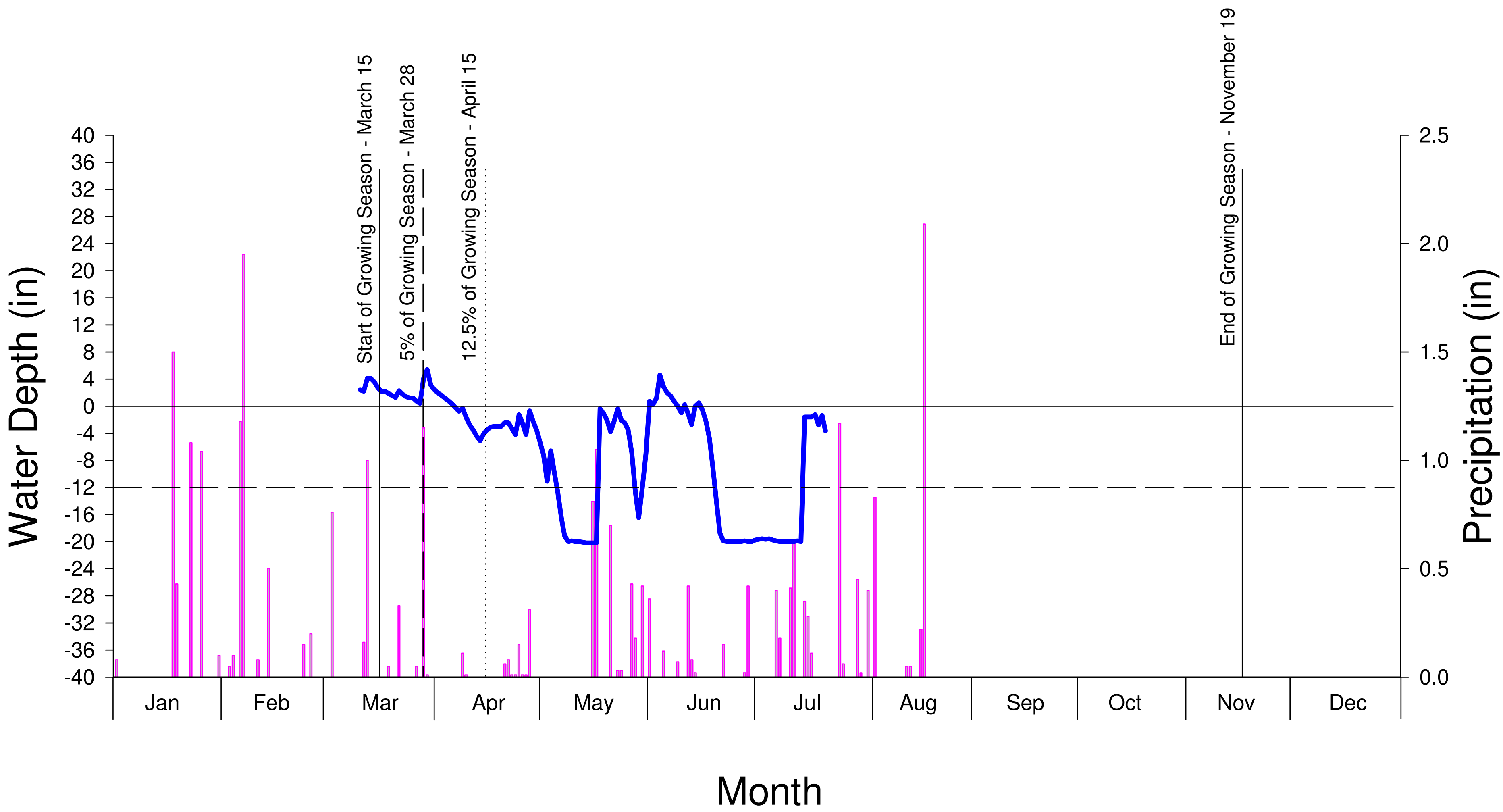


Key Branch
2010
Monitoring Gauge 2 - AB35E52
Start of Growing Season - March 15
5% of Growing Season - March 28
12.5% of Growing Season - April 15
End of Growing Season - November 19
Water Depth (in)
Precipitation (in)
Month
40
36
32
28
24
20
16
12
8
4
0
-4
-8
-12
-16
-20
-24
-28
-32
-36
-40
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

# Key Branch

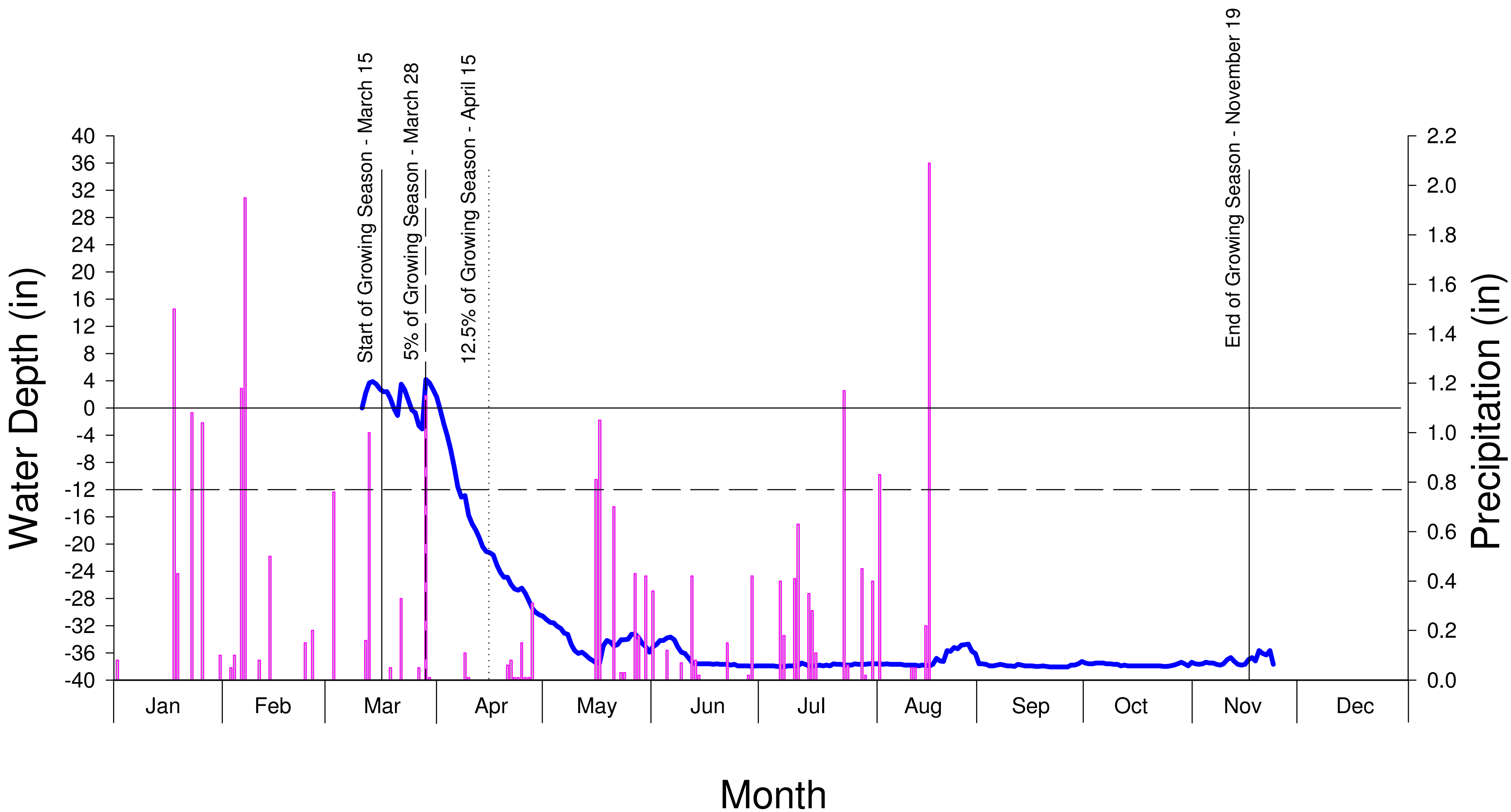
## 2010

### Monitoring Gauge 3 - A28C2B0

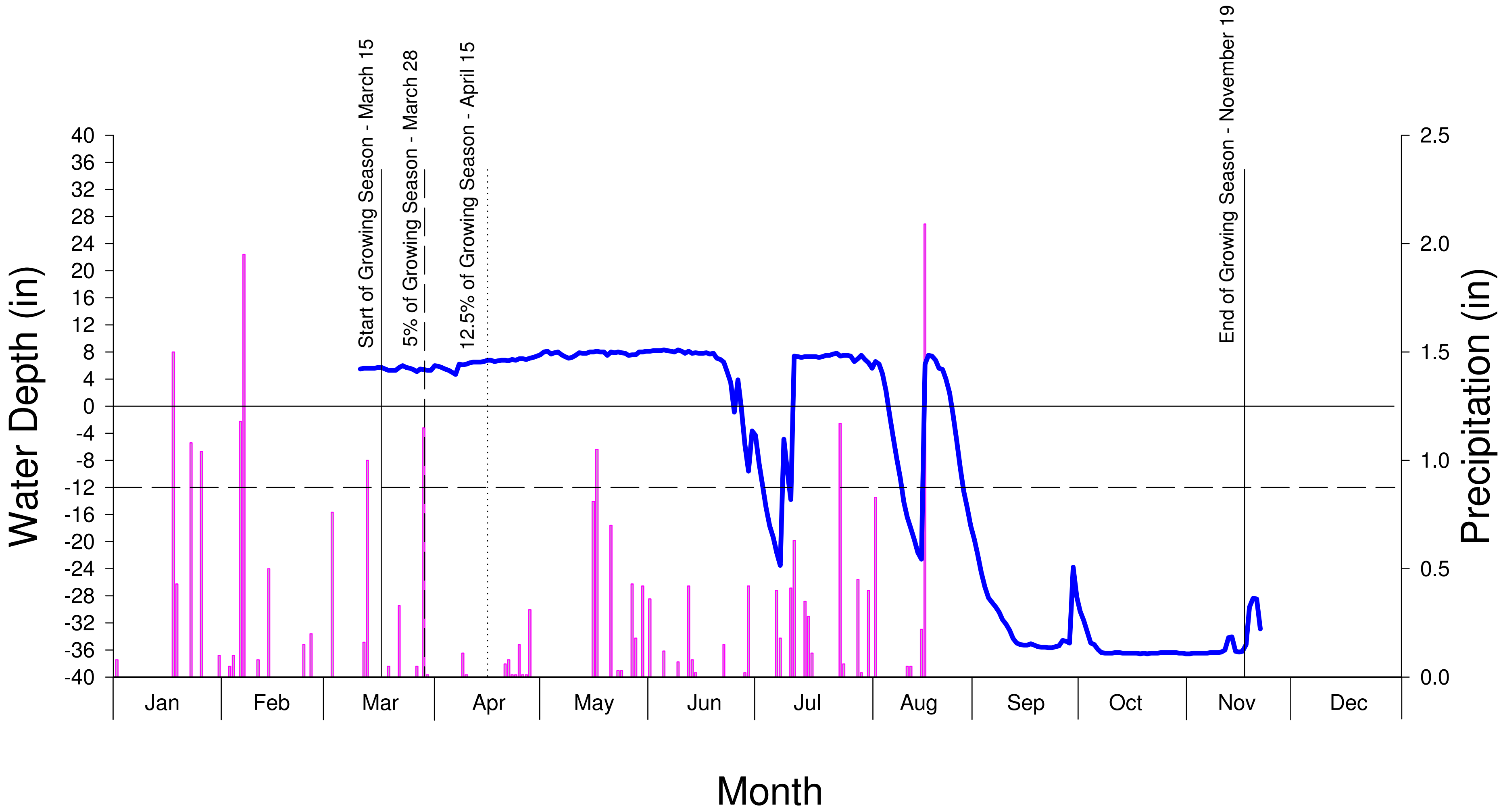


# Key Branch

## 2010
## Monitoring Gauge 5 - A286E29



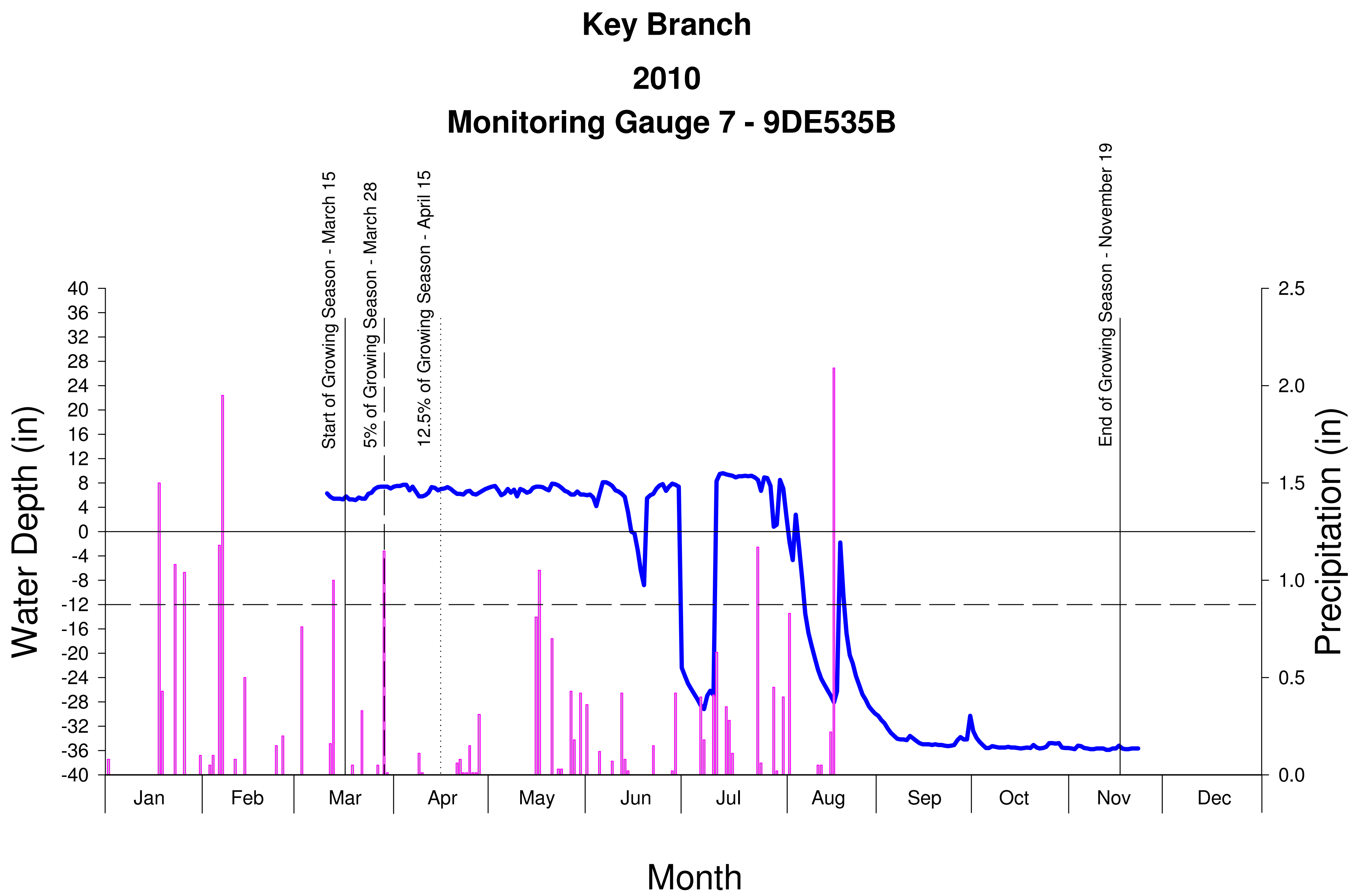
# Key Branch
# 2010
## Monitoring Gauge 6 - 9DE7A19



Monitoring Year 7 (2010)

B-7

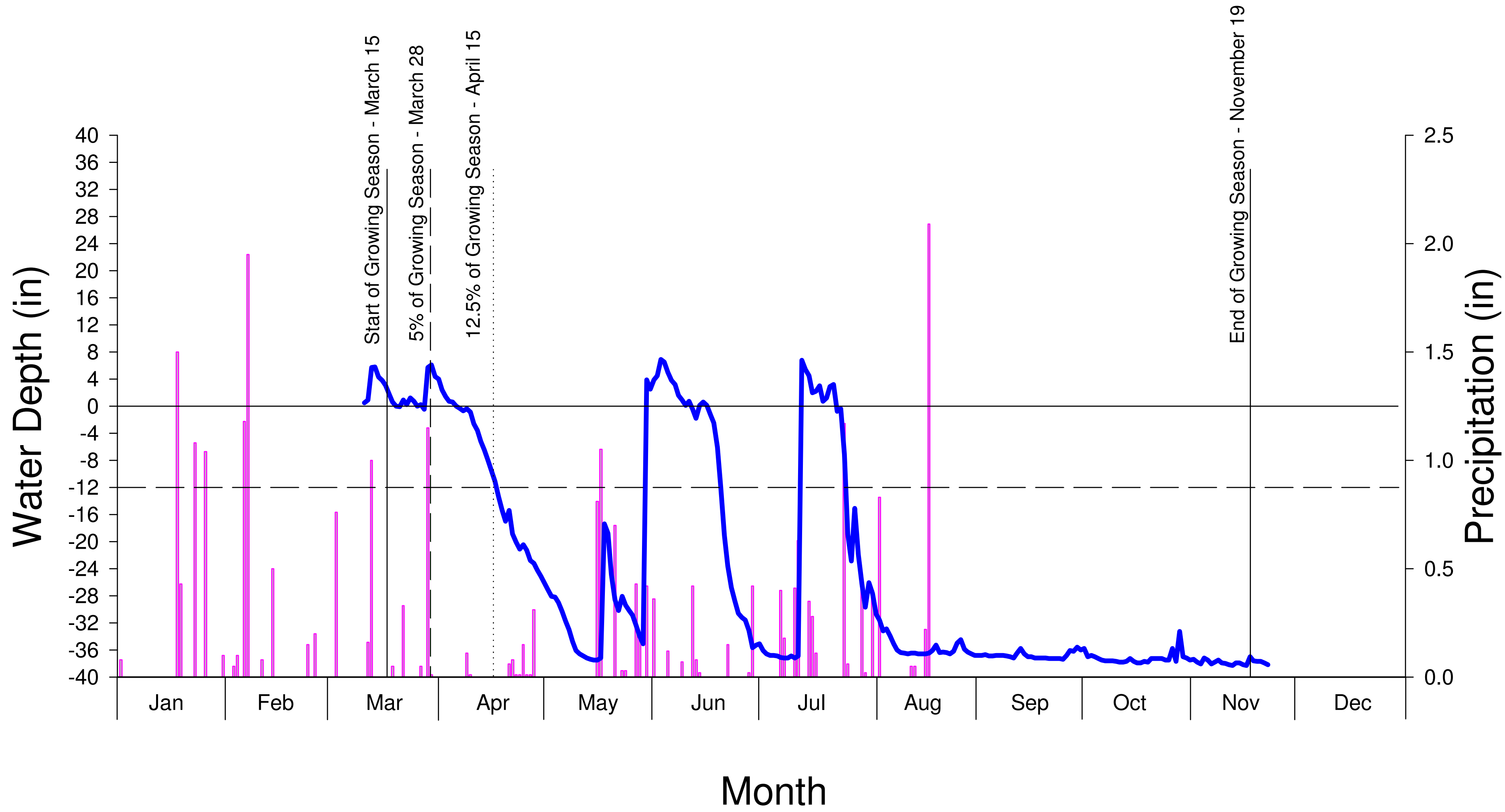
December 2010



# Key Branch

## 2010

## Monitoring Gauge 8 - A28A565



Monitoring Year 7 (2010)

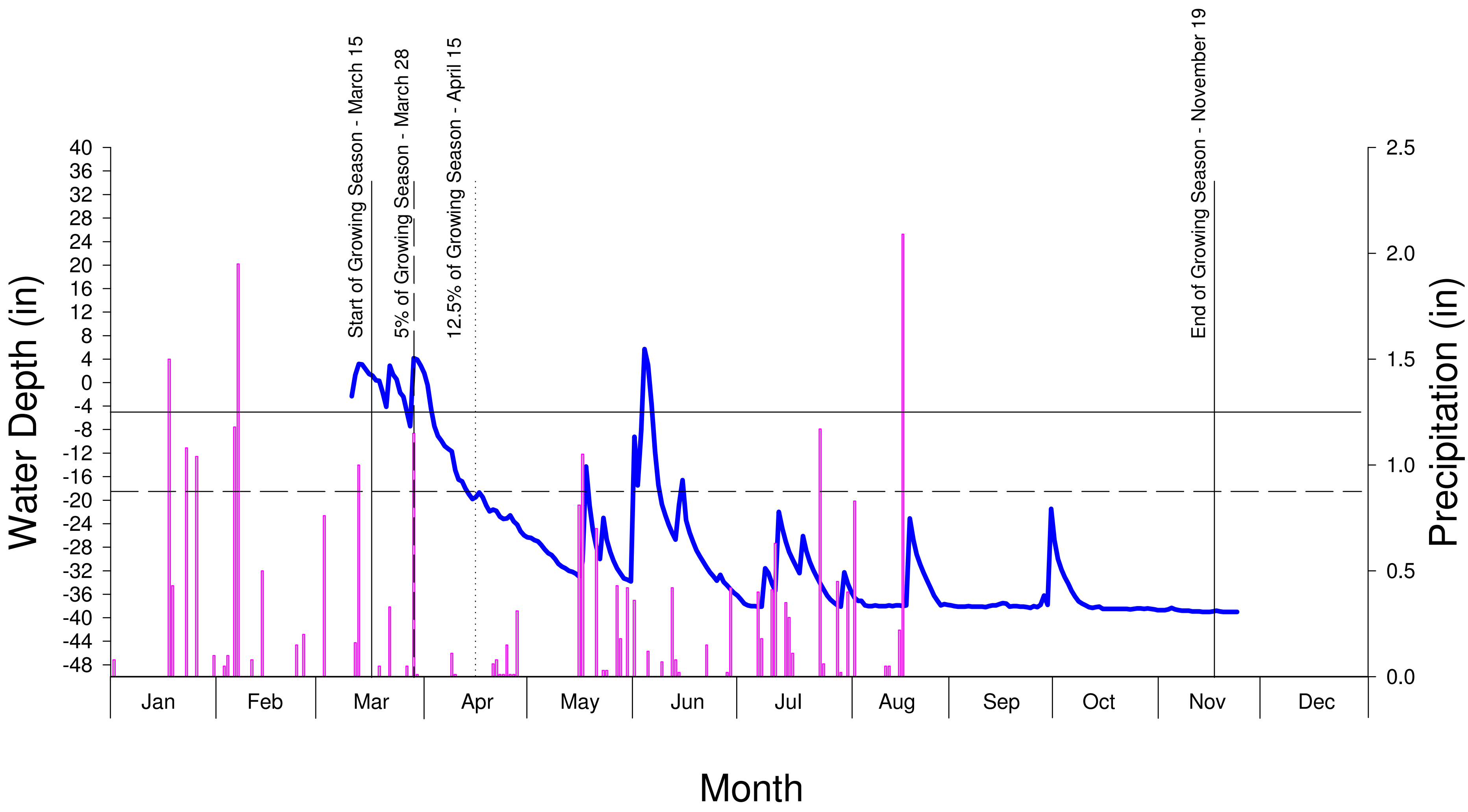
B-9

December 2010

# Key Branch

## 2010

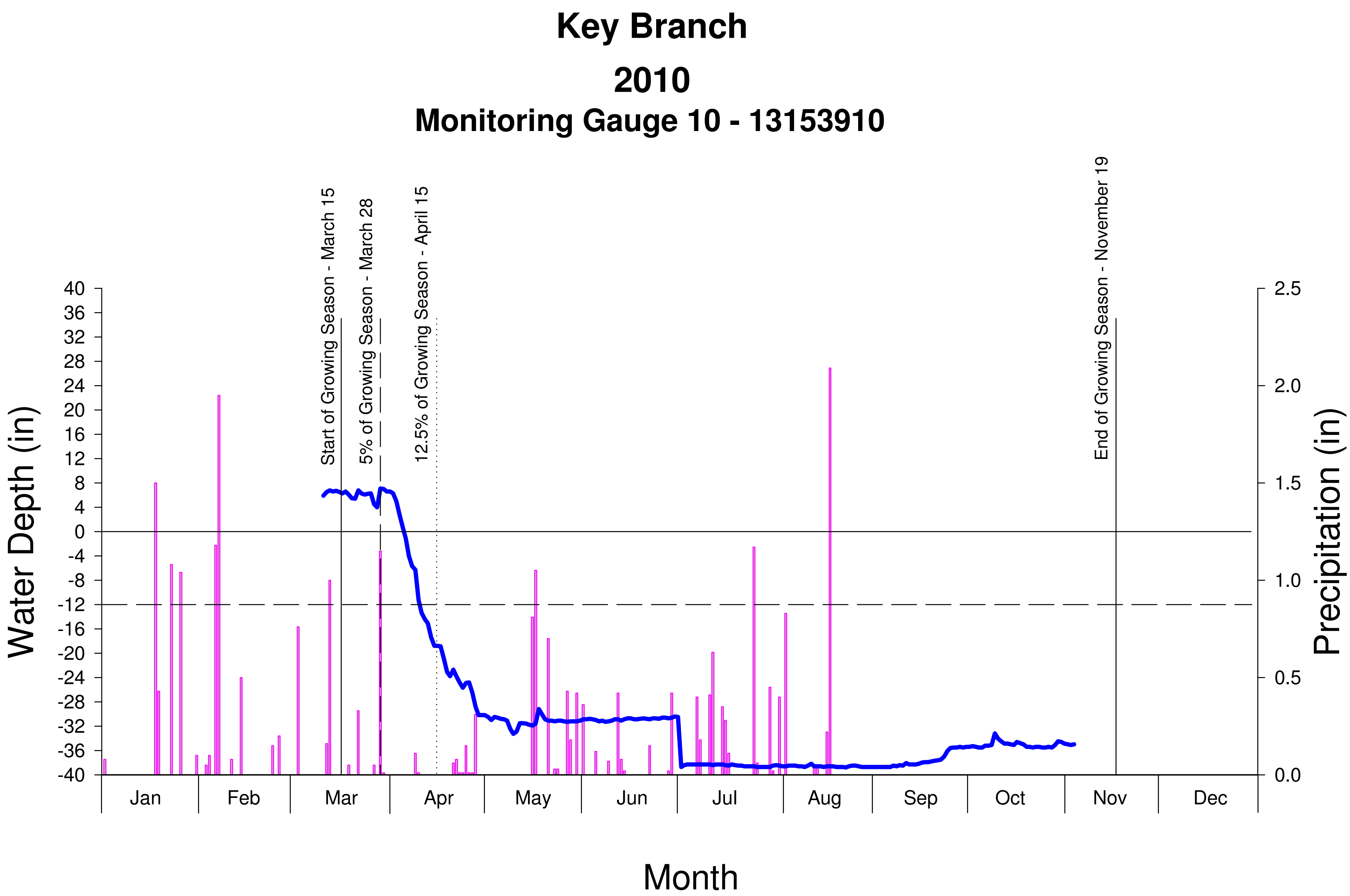
## Monitoring Gauge 9 - A28A3CC

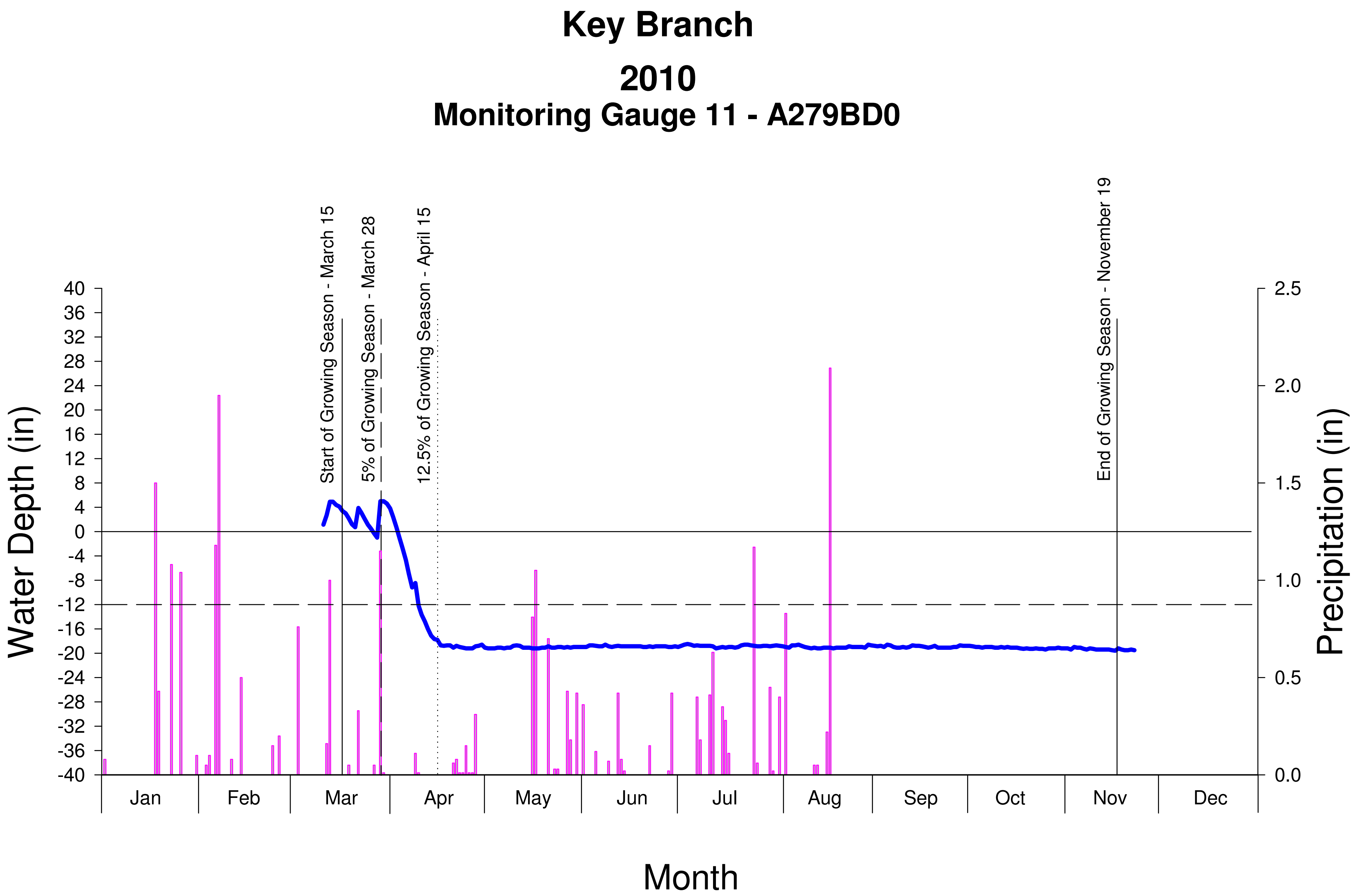


Monitoring Year 7 (2010)

B-10

December 2010

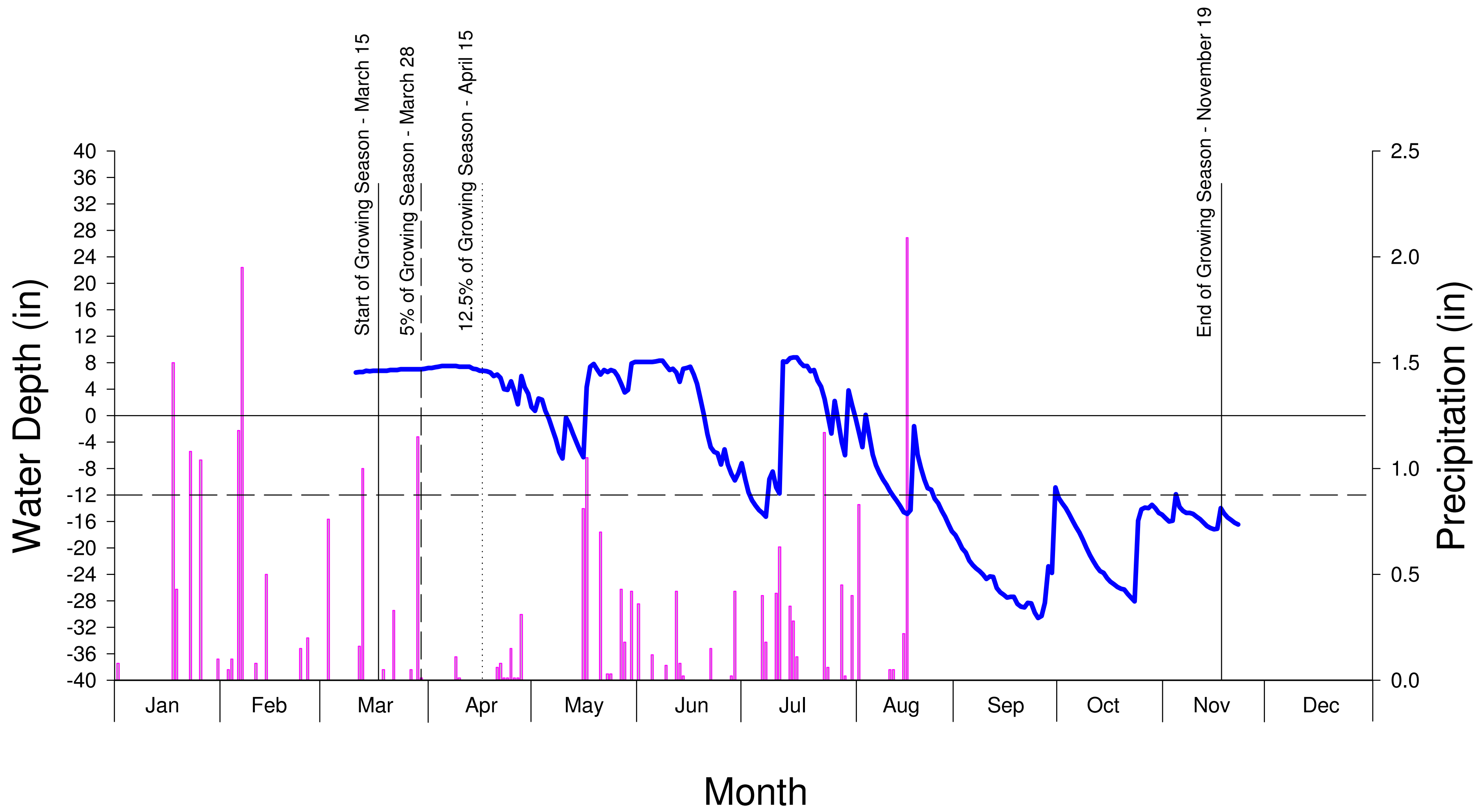


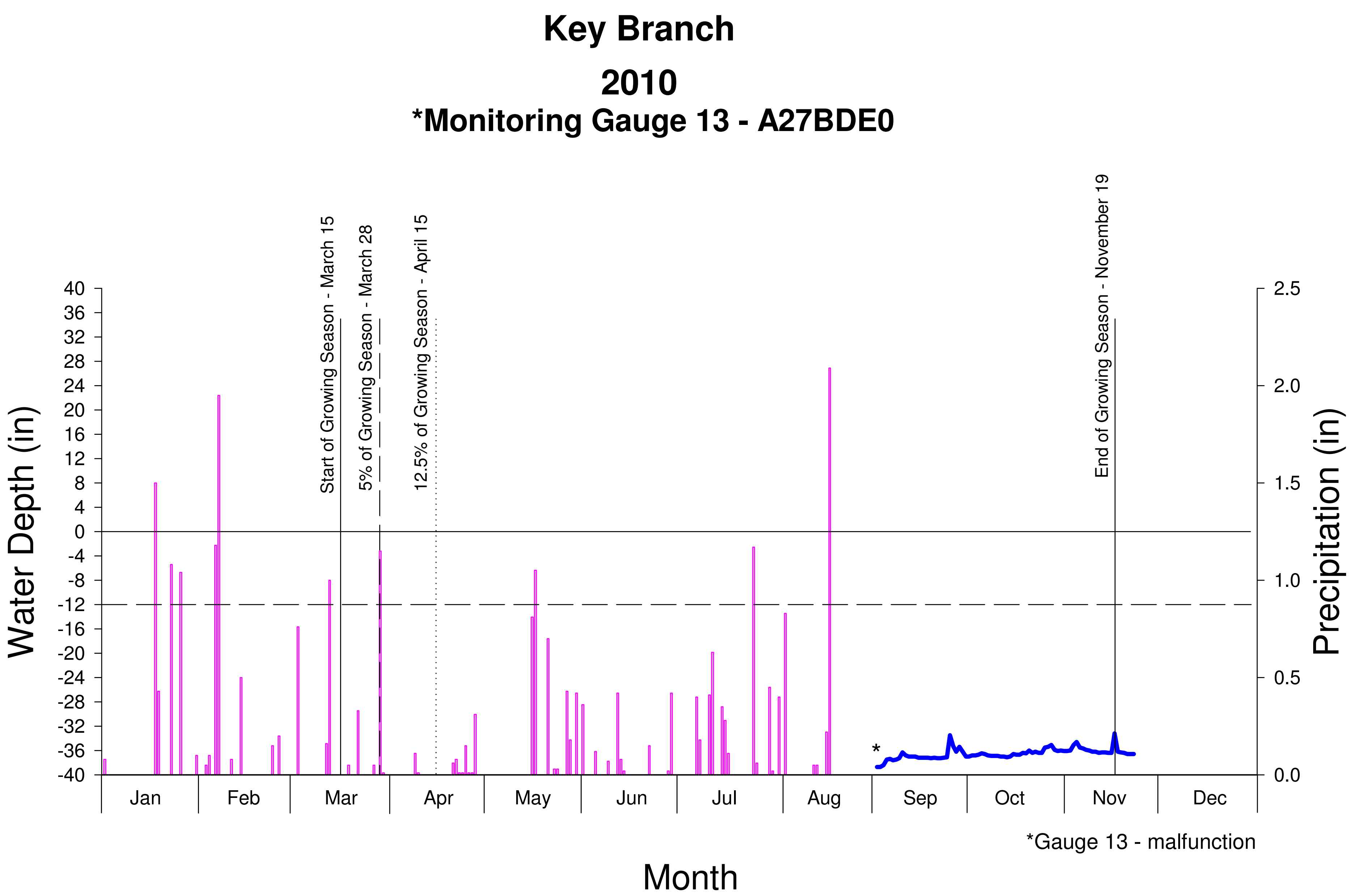

Key Branch
2010
Monitoring Gauge 11 - A279BD0
Start of Growing Season - March 15
5% of Growing Season - March 28
12.5% of Growing Season - April 15
End of Growing Season - November 19
Water Depth (in)
Precipitation (in)
40
36
32
28
24
20
16
12
8
4
0
-4
-8
-12
-16
-20
-24
-28
-32
-36
-40
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

# Key Branch

## 2010

## Monitoring Gauge 12 - A287DCE

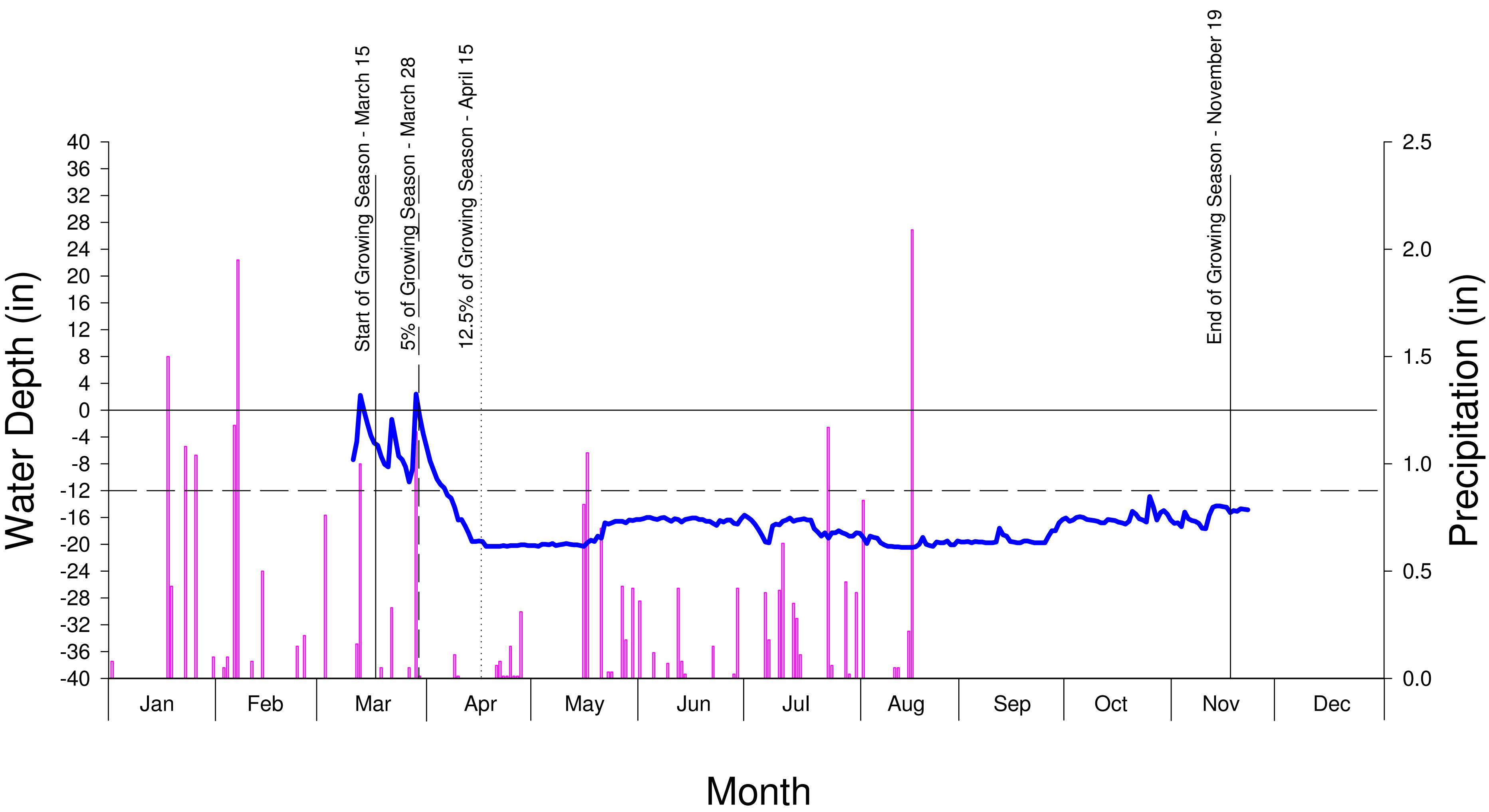



Key Branch
2010
*Monitoring Gauge 13 - A27BDE0
Start of Growing Season - March 15
5% of Growing Season - March 28
12.5% of Growing Season - April 15
End of Growing Season - November 19
Water Depth (in)
Precipitation (in)
40
36
32
28
24
20
16
12
8
4
0
-4
-8
-12
-16
-20
-24
-28
-32
-36
-40
2.5
2.0
1.5
1.0
0.5
0.0
*
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
*Gauge 13 - malfunction
Month

# Key Branch

## 2010

## Monitoring Gauge 14 - A28BFDE



# APPENDIX C

SITE PHOTOS

Photo Station 1 - looking north

Photo Station 2 - facing east

Photo Station 3 – facing south

Photo Station 4 - facing north

Photo Station 5 – facing south

Photo Station 6 - facing northwest

Photo Station 7 – facing southwest

Photo Station 8 - facing northwest

Photo Station 9 – facing southwest

Beaver impoundment July 1, 2010

After beaver dam removed. November 23, 2010

# APPENDIX D

STREAM SURVEY DATA

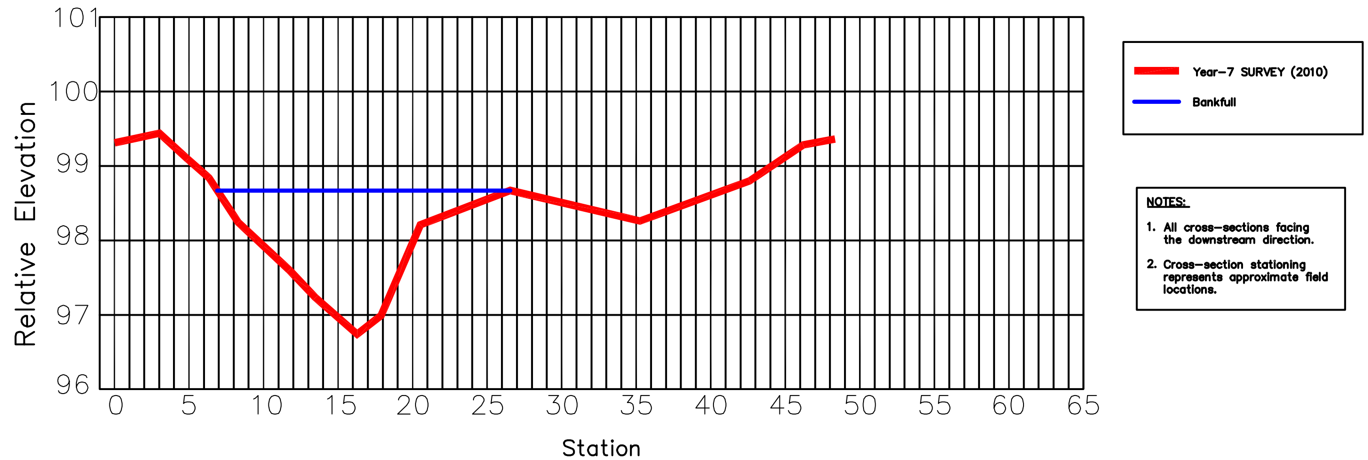
## Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 99.31 | LPIN |
| 3.02 | | 99.44 | |
| 4.91 | | 99.09 | |
| 6.34 | | 98.84 | |
| 8.31 | | 98.24 | |
| 11.73 | | 97.60 | |
| 13.49 | | 97.23 | |
| 16.27 | | 96.74 | |
| 17.88 | | 96.99 | |
| 20.52 | | 98.21 | |
| 26.54 | | 98.67 | |
| 35.26 | | 98.26 | |
| 42.61 | | 98.80 | |
| 46.21 | | 99.28 | |
| 48.34 | | 99.36 | RPIN |

### Summary Data

| | |
|---|---|
| Bankful Cross-Sectonal Area | 16.9 |
| Bankfull Width | 19.7 |
| Bankfull Mean Depth | 0.9 |
| Bankfull Max Depth | 1.9 |
| Width/Depth Ratio | 21.9 |
| Entrenchment Ratio | 5.1 |
| Classification | N/A |

## Cross-Section 1 – Glide




Cross-section, upstream looking downstream

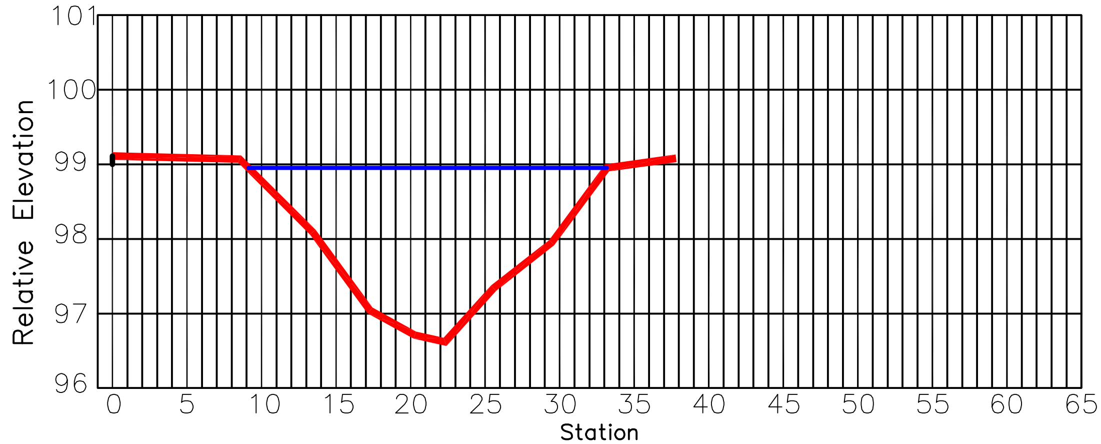
Cross-section, looking at right bank

| Title | Cross-Section 1 | | |
|---|---|---|---|
| Ecosystem Enhancement Program / PBS&J an Atkins company | Project: Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
| | | Figure | Cross-Section 1 |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 14+00 |

## Cross-Section 2 – Run

### Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 99.11 | LPIN |
| 8.53 | | 99.07 | |
| 13.43 | | 98.09 | |
| 17.27 | | 97.04 | |
| 20.28 | | 96.71 | |
| 22.31 | | 96.62 | |
| 25.56 | | 97.34 | |
| 29.47 | | 97395 | |
| 33.17 | | 98.95 | |
| 37.81 | | 99.08 | RPIN |




Year-7 SURVEY (2010)

Bankfull

**NOTES:**

1. All cross-sections facing the downstream direction.
2. Cross-section stationing represents approximate field locations.

### Summary Data

| | |
|---|---|
| Bankful Cross-Sectonal Area | 31.4 |
| Bankfull Width | 24.0 |
| Bankfull Mean Depth | 1.3 |
| Bankfull Max Depth | 2.3 |
| Width/Depth Ratio | 18.5 |
| Entrenchment Ratio | 4.2 |
| Classification | N/A |

Cross-section, upstream looking downstream

Cross-section, looking at right bank

| Title | Cross-Section 2 |
|---|---|

| | | |
|---|---|---|
| Project | Key Branch Wetland and Stream Restoration Site, Anson County | |
| Project # | 206 | |
| Figure | Cross-Section 2 | |

| Survey Date | Survey Weather | Field Team | Location |
|---|---|---|---|
| 9/13/10 – 9/14/10 | Sunny | Michael Gloden, Jeremy Schmid, Jens Geratz | Station 17+00 |

Ecosystem Enhancement PROGRAM

PBSJ an Atkins company

EEP Project No. 206

D3

Key Branch Restoration Site

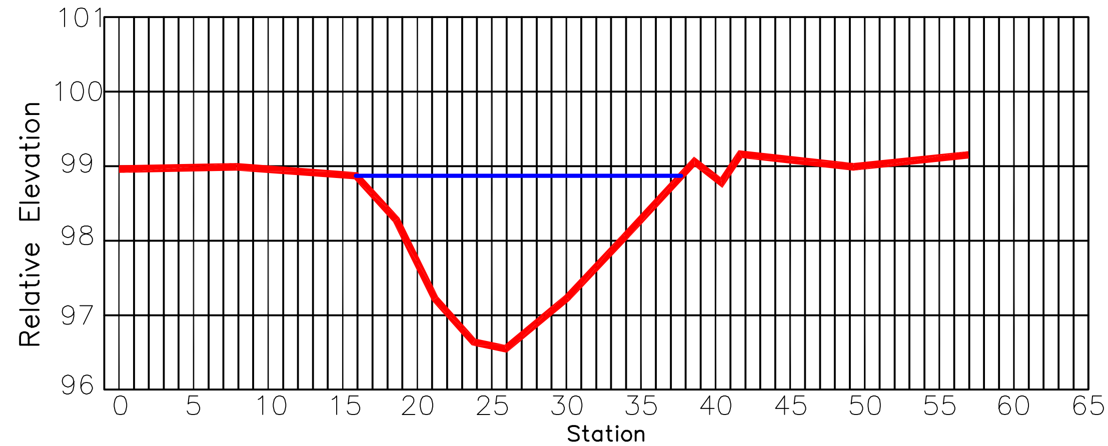
## Cross-Section 3 – Pool

**Survey Data**

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 98.96 | LPIN |
| 7.87 | | 98.99 | |
| 15.89 | | 98.87 | |
| 18.59 | | 98.28 | |
| 21.19 | | 97.22 | |
| 23.78 | | 96.64 | |
| 25.91 | | 96.55 | |
| 30.04 | | 97.23 | |
| 33.95 | | 98.06 | |
| 38.58 | | 99.06 | |
| 40.40 | | 98.78 | |
| 41.66 | | 99.16 | |
| 49.25 | | 98.99 | |
| 56.97 | | 99.15 | RPIN |

**Summary Data**

| | |
|---|---|
| Bankful Cross-Sectonal Area | 28.1 |
| Bankfull Width | 21.8 |
| Bankfull Mean Depth | 1.3 |
| Bankfull Max Depth | 2.3 |
| Width/Depth Ratio | 16.8 |
| Entrenchment Ratio | 4.6 |
| Classification | N/A |




Year-7 SURVEY (2010)

Bankfull

**NOTES:**

1. All cross-sections facing the downstream direction.
2. Cross-section stationing represents approximate field locations.

Cross-section, upstream looking downstream

Cross-section, looking at right bank

| Title | Cross-Section 3 |
|---|---|

| | | | |
|---|---|---|---|
| Ecosystem Enhancement Program / PBS&J an Atkins company | Project: Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
| | | Figure | Cross-Section 3 |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 22+50 |

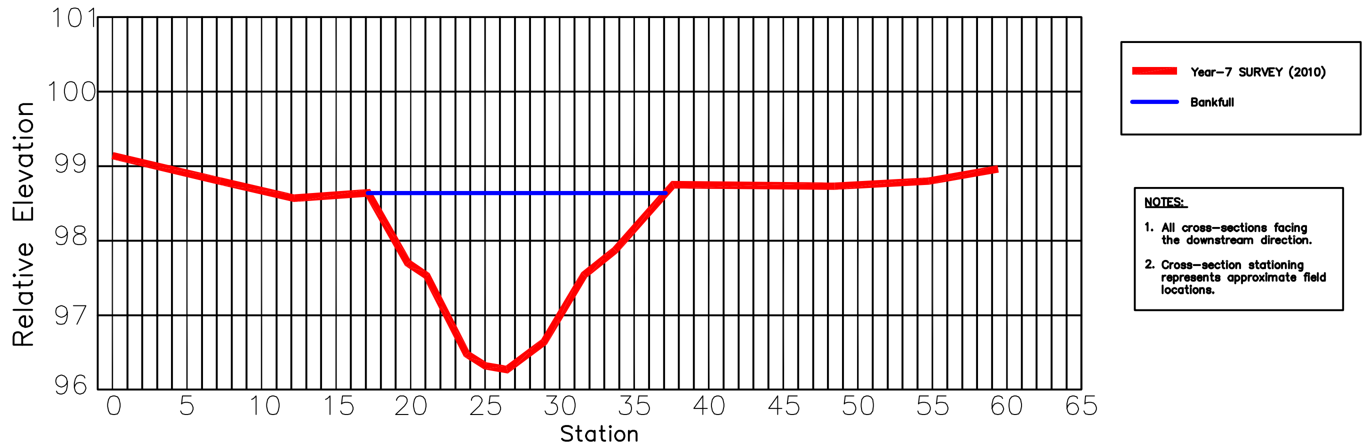
## Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 99.14 | LPIN |
| 7.21 | | 98.80 | |
| 12.18 | | 98.57 | |
| 17.13 | | 98.64 | |
| 19.81 | | 97.70 | |
| 21.08 | | 97.53 | |
| 23.76 | | 96.48 | |
| 25.01 | | 96.32 | |
| 26.46 | | 96.27 | |
| 28.96 | | 96.64 | |
| 31.63 | | 97.54 | |
| 33.72 | | 97.87 | |
| 37.60 | | 98.75 | |
| 48.44 | | 98.73 | |
| 54.76 | | 98.80 | |
| 59.41 | | 98.96 | RPIN |

### Summary Data

| | |
|---|---|
| Bankful Cross-Sectonal Area | 26.0 |
| Bankfull Width | 20.0 |
| Bankfull Mean Depth | 1.3 |
| Bankfull Max Depth | 2.4 |
| Width/Depth Ratio | 15.4 |
| Entrenchment Ratio | 5.0 |
| Classification | N/A |

## Cross-Section 4 - Pool




Cross-section, upstream looking downstream

Cross-section, looking at right bank

| | |
|---|---|
| Title | Cross-Section 4 |

Ecosystem Enhancement Program — PBS&J an Atkins company

| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
|---|---|---|---|
| | | Figure | Cross-Section 4 |
| Survey Date 9/13/10 - 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 26+50 |

EEP Project No. 206

D5

Key Branch Restoration Site

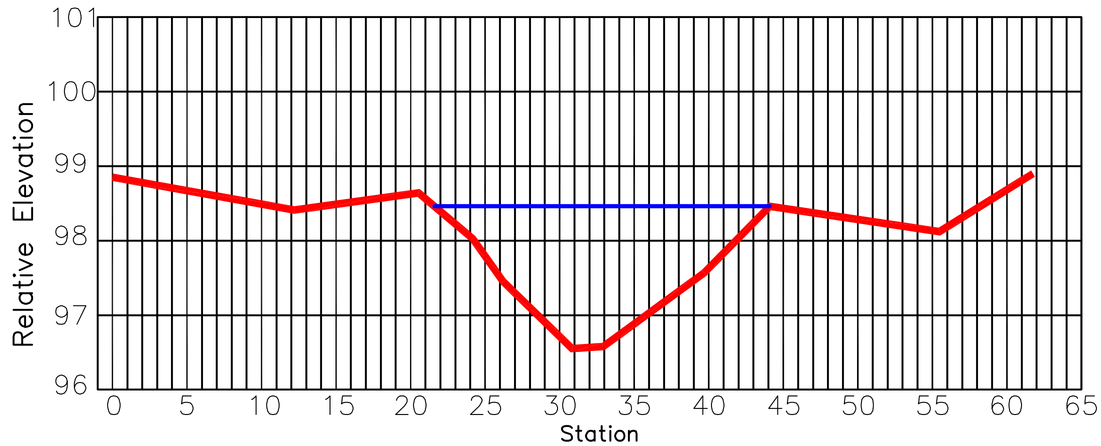
## Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 98.85 | LPIN |
| 12.20 | | 98.41 | |
| 20.52 | | 98.64 | |
| 24.15 | | 98.03 | |
| 26.20 | | 97.45 | |
| 30.83 | | 96.55 | |
| 32.93 | | 96.58 | |
| 39.70 | | 97.57 | |
| 44.08 | | 98.46 | |
| 55.48 | | 98.12 | |
| 61.76 | | 98.90 | RPIN |

## Summary Data

| | |
|---|---|
| Bankful Cross–Sectonal Area | 24.1 |
| Bankfull Width | 22.5 |
| Bankfull Mean Depth | 1.1 |
| Bankfull Max Depth | 1.9 |
| Width/Depth Ratio | 20.5 |
| Entrenchment Ratio | 4.4 |
| Classification | C6 |

## Cross–Section 5 – Riffle




**NOTES:**

1. All cross–sections facing the downstream direction.
2. Cross–section stationing represents approximate field locations.

Cross–section, upstream looking downstream

Cross–section, looking at right bank

| Title | Cross-Section 5 |
|---|---|

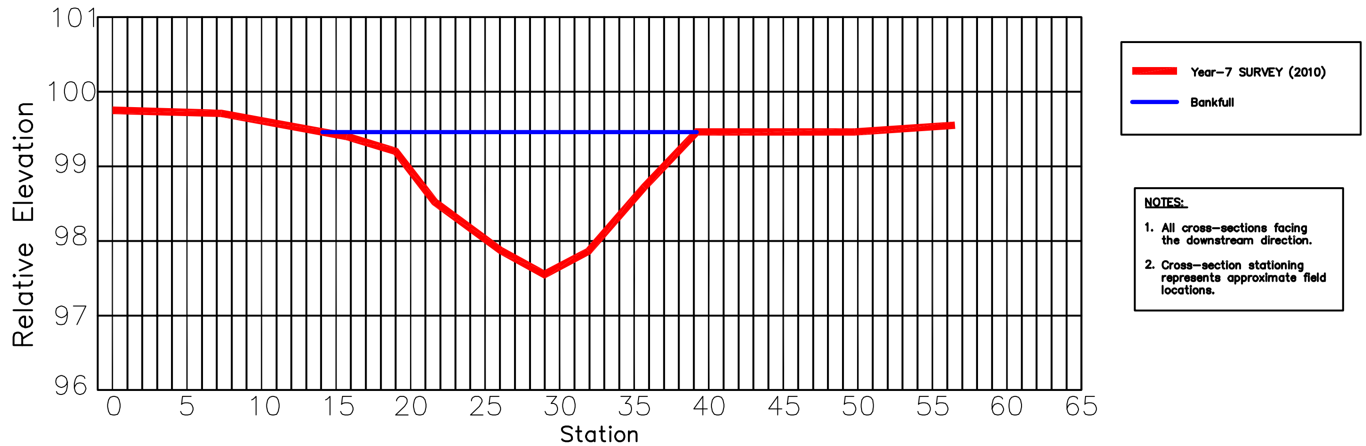
Ecosystem Enhancement Program | PBS&J an Atkins company

| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
|---|---|---|---|
| | | Figure | Cross–Section 5 |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 31+00 |

## Cross–Section 6 – Glide

### Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 99.75 | LPIN |
| 7.29 | | 99.71 | |
| 15.71 | | 99.40 | |
| 18.99 | | 99.20 | |
| 21.62 | | 98.52 | |
| 26.06 | | 97.87 | |
| 29.97 | | 97.55 | |
| 31.93 | | 97.86 | |
| 35.66 | | 98.72 | |
| 39.20 | | 99.46 | |
| 49.80 | | 99.46 | |
| 56.51 | | 99.55 | RPIN |



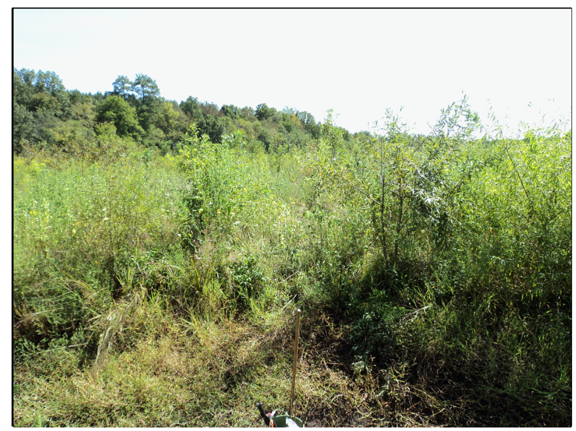

**NOTES:**

1. All cross–sections facing the downstream direction.
2. Cross–section stationing represents approximate field locations.

### Summary Data

| | |
|---|---|
| Bankful Cross–Sectonal Area | 23.7 |
| Bankfull Width | 25.1 |
| Bankfull Mean Depth | 0.9 |
| Bankfull Max Depth | 1.9 |
| Width/Depth Ratio | 27.9 |
| Entrenchment Ratio | 4.0 |
| Classification | N/A |

Cross–section, upstream looking downstream



Cross–section, looking at right bank

| Title | Cross-Section 6 |
|---|---|

Ecosystem Enhancement Program — PBS&J an Atkins company

| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
|---|---|---|---|
| | | Figure | Cross–Section 6 |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 35+00 |

EEP Project No. 206

D7

Key Branch Restoration Site

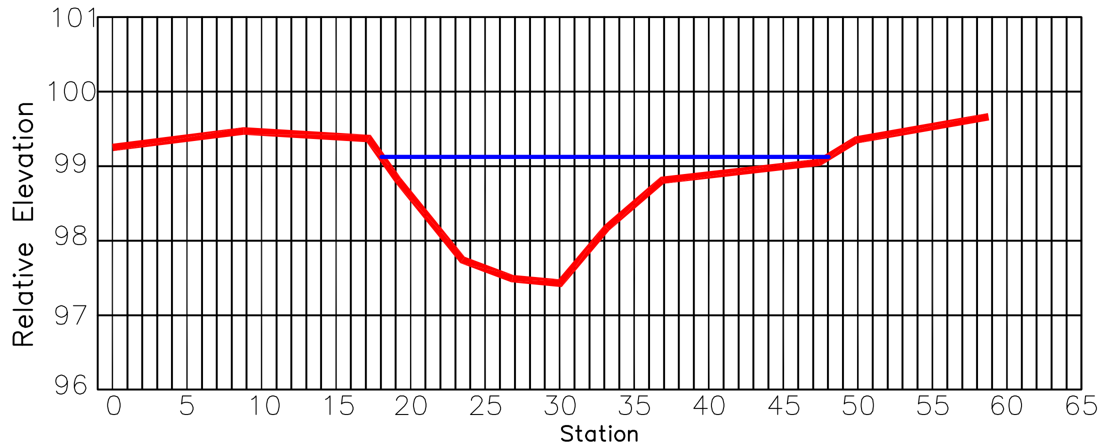
## Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 99.25 | LPIN |
| 8.95 | | 99.47 | |
| 11.41 | | 99.37 | |
| 21.95 | | 98.81 | |
| 25.68 | | 97.74 | |
| 28.81 | | 97.49 | |
| 32.00 | | 97.43 | |
| 35.35 | | 98.17 | |
| 39.68 | | 98.81 | |
| 41.65 | | 99.05 | |
| 50.03 | | 99.35 | |
| 58.83 | | 99.66 | RPIN |

### Summary Data

| | |
|---|---|
| Bankful Cross–Sectonal Area | 22.8 |
| Bankfull Width | 30.0 |
| Bankfull Mean Depth | 0.8 |
| Bankfull Max Depth | 1.7 |
| Width/Depth Ratio | 37.5 |
| Entrenchment Ratio | 3.3 |
| Classification | N/A |

## Cross–Section 7 – Run

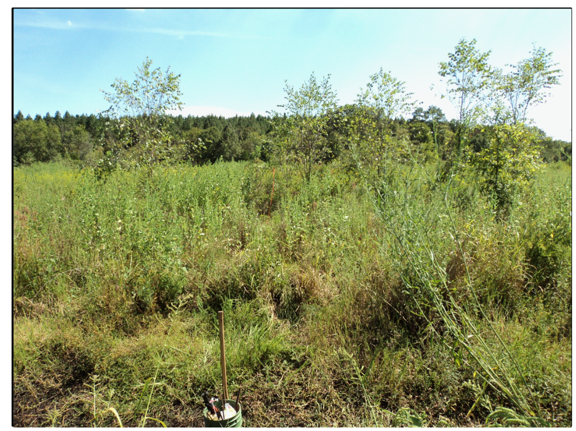



Year–7 SURVEY (2010)
Bankfull

**NOTES:**

1. All cross–sections facing the downstream direction.
2. Cross–section stationing represents approximate field locations.

Cross–section, upstream looking downstream



Cross–section, looking at right bank

| Title | Cross-Section 7 |
|---|---|

Ecosystem Enhancement Program | PBS&J an Atkins company

| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
|---|---|---|---|
| | | Figure | Cross–Section 7 |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 39+50 |

EEP Project No. 206 | D8 | Key Branch Restoration Site

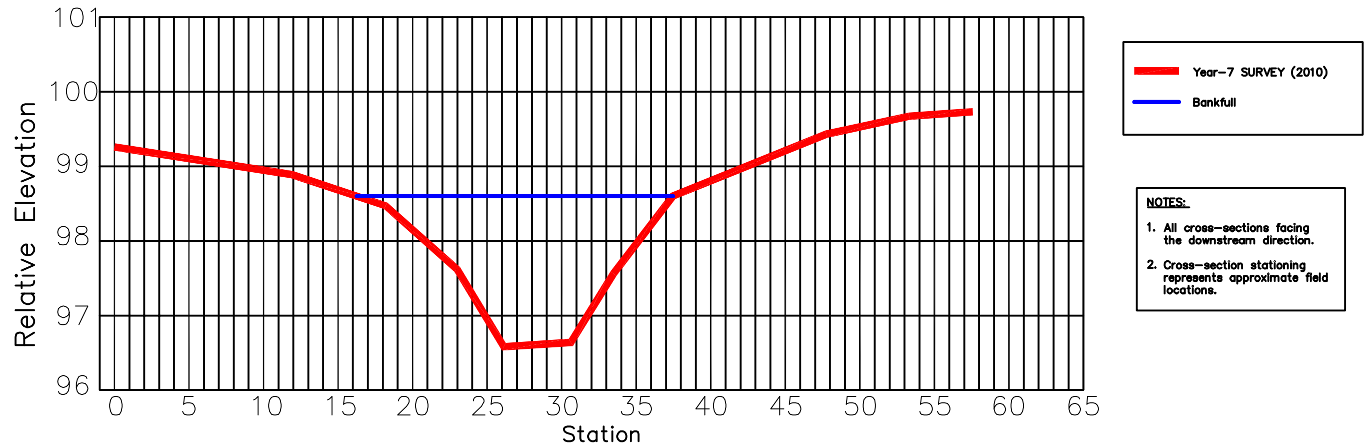
## Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 99.26 | LPIN |
| 11.89 | | 98.89 | |
| 18.19 | | 98.47 | |
| 22.98 | | 97.62 | |
| 26.12 | | 96.58 | |
| 30.62 | | 96.64 | |
| 33.47 | | 97.56 | |
| 37.47 | | 98.60 | |
| 47.74 | | 99.43 | |
| 53.30 | | 99.67 | |
| 57.58 | | 99.73 | RPIN |

## Summary Data

| | |
|---|---|
| Bankful Cross-Sectonal Area | 22.8 |
| Bankfull Width | 21.2 |
| Bankfull Mean Depth | 1.1 |
| Bankfull Max Depth | 2.0 |
| Width/Depth Ratio | 19.3 |
| Entrenchment Ratio | 4.7 |
| Classification | N/A |

## Cross–Section 8 – Pool




Cross–section, upstream looking downstream

Cross–section, looking at right bank

| Title | Cross-Section 8 |
|---|---|

Ecosystem Enhancement Program | PBSJ an Atkins company

| | | | |
|---|---|---|---|
| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
| | | Figure | Cross–Section 8 |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 44+00 |

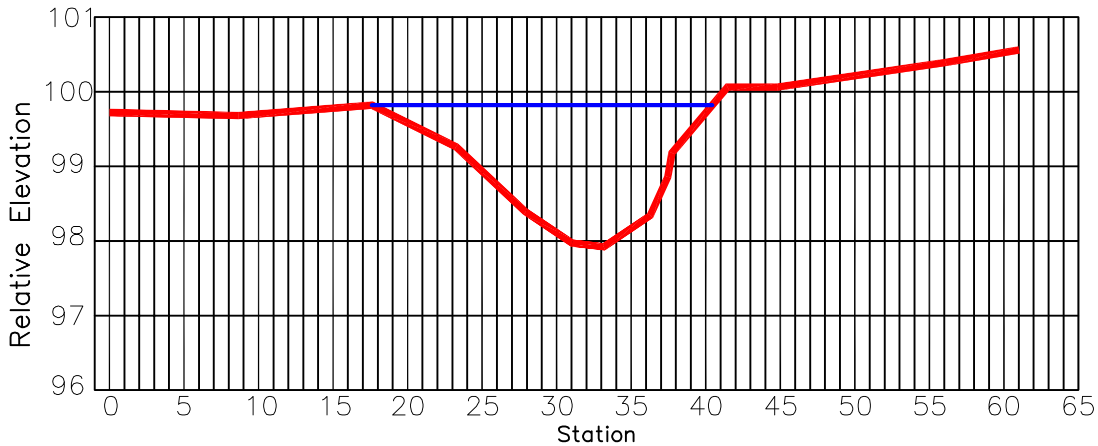
## Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 99.72 | LPIN |
| 8.65 | | 99.68 | |
| 17.62 | | 99.82 | |
| 23.27 | | 99.26 | |
| 27.92 | | 98.39 | |
| 31.04 | | 97.97 | |
| 33.18 | | 97.92 | |
| 36.28 | | 98.34 | |
| 37.47 | | 98.86 | |
| 37.75 | | 99.18 | |
| 41.46 | | 100.06 | |
| 44.83 | | 100.06 | |
| 56.12 | | 100.39 | |
| 61.03 | | 100.56 | RPIN |

### Summary Data

| | |
|---|---|
| Bankful Cross-Sectonal Area | 23.1 |
| Bankfull Width | 22.8 |
| Bankfull Mean Depth | 1.0 |
| Bankfull Max Depth | 1.9 |
| Width/Depth Ratio | 22.8 |
| Entrenchment Ratio | 4.4 |
| Classification | N/A |

## Cross-Section 9 - Glide




Year-7 SURVEY (2010)
Bankfull

**NOTES:**
1. All cross-sections facing the downstream direction.
2. Cross-section stationing represents approximate field locations.

Cross-section, upstream looking downstream

Cross-section, looking at right bank

| Title | Cross-Section 9 | | |
|---|---|---|---|
| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
| | | Figure | Cross-Section 9 |
| Survey Date: 9/13/10 - 9/14/10 | Survey Weather: Sunny | Field Team: Michael Gloden, Jeremy Schmid, Jens Geratz | Location: Station 48+00 |

Ecosystem Enhancement PROGRAM

PBSJ an Atkins company

EEP Project No. 206

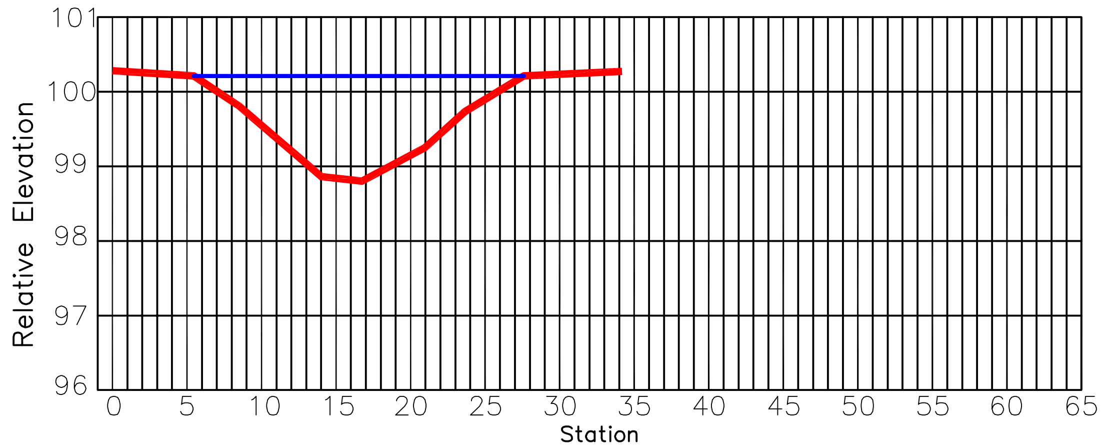
D10

Key Branch Restoration Site

| Survey Data | | | |
|---|---|---|---|
| Station | | Elevation | Feature |
| 0 | | 100.28 | LPIN |
| 5.45 | | 100.21 | |
| 8.48 | | 99.81 | |
| 14.02 | | 98.86 | |
| 16.74 | | 98.80 | |
| 20.96 | | 99.25 | |
| 23.63 | | 99.73 | |
| 27.60 | | 100.21 | |
| 34.18 | | 100.27 | RPIN |

| Summary Data | |
|---|---|
| Bankful Cross-Sectonal Area | 17.1 |
| Bankfull Width | 22.2 |
| Bankfull Mean Depth | 0.8 |
| Bankfull Max Depth | 1.4 |
| Width/Depth Ratio | 27.8 |
| Entrenchment Ratio | 4.5 |
| Classification | C6 |

## Cross-Section 10 – Riffle




Year-7 SURVEY (2010)

Bankfull

**NOTES:**

1. All cross-sections facing the downstream direction.
2. Cross-section stationing represents approximate field locations.

Cross-section, upstream looking downstream

Cross-section, looking at right bank

| Title | Cross-Section 10 | | |
|---|---|---|---|
| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
| | | Figure | Cross-Section 10 |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 53+00 |

Ecosystem Enhancement PROGRAM

PBSJ an Atkins company

EEP Project No. 206

D11

Key Branch Restoration Site

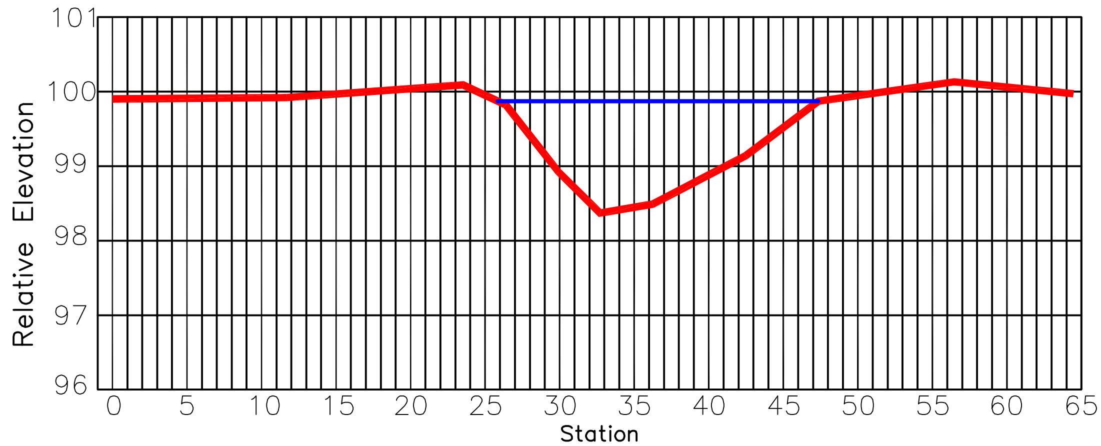
## Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 99.90 | LPIN |
| 11.70 | | 99.92 | |
| 23.51 | | 100.09 | |
| 26.38 | | 99.82 | |
| 29.93 | | 98.92 | |
| 32.72 | | 98.37 | |
| 36.24 | | 98.49 | |
| 42.49 | | 99.14 | |
| 47.35 | | 99.87 | |
| 56.45 | | 100.13 | |
| 64.47 | | 99.97 | RPIN |

## Summary Data

| | |
|---|---|
| Bankful Cross–Sectonal Area | 18.6 |
| Bankfull Width | 21.5 |
| Bankfull Mean Depth | 0.9 |
| Bankfull Max Depth | 1.5 |
| Width/Depth Ratio | 23.9 |
| Entrenchment Ratio | 4.7 |
| Classification | N/A |

## Cross–Section 11 – Run




Year–7 SURVEY (2010)
Bankfull

NOTES:
1. All cross–sections facing the downstream direction.
2. Cross–section stationing represents approximate field locations.

Cross–section, upstream looking downstream

Cross–section, looking at right bank

| Title | Cross-Section 11 |
|---|---|

| | | | |
|---|---|---|---|
| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
| | | Figure | Cross–Section 11 |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 56+75 |

Ecosystem Enhancement PROGRAM

PBS&J an Atkins company

EEP Project No. 206

D12

Key Branch Restoration Site

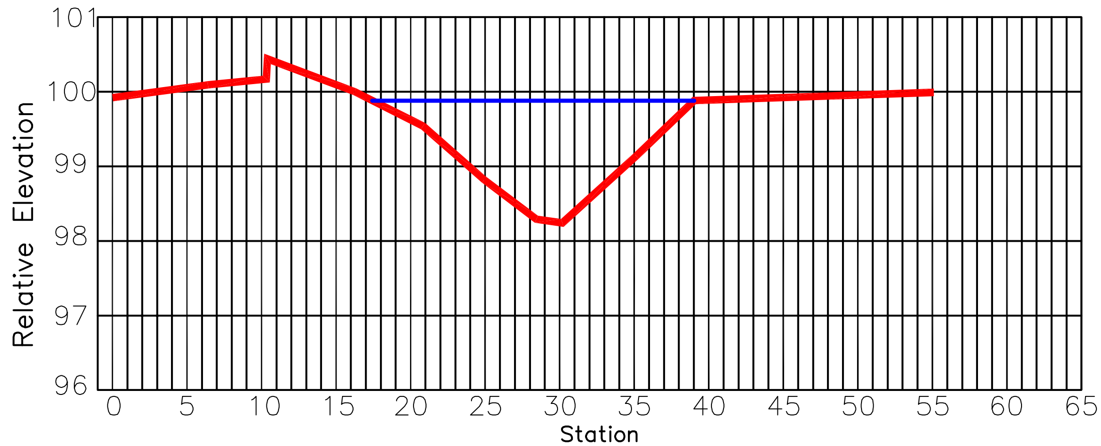
## Survey Data

| Station | | Elevation | Feature |
|---|---|---|---|
| 0 | | 99.92 | LPIN |
| 6.41 | | 100.09 | |
| 10.33 | | 100.17 | |
| 10.40 | | 100.44 | |
| 16.23 | | 100.00 | |
| 20.83 | | 99.54 | |
| 24.94 | | 98.82 | |
| 28.44 | | 98.29 | |
| 30.18 | | 98.24 | |
| 35.13 | | 99.14 | |
| 39.02 | | 99.88 | |
| 47.97 | | 99.94 | |
| 55.10 | | 99.99 | RPIN |

## Summary Data

| | |
|---|---|
| Bankful Cross-Sectonal Area | 18.2 |
| Bankfull Width | 21.5 |
| Bankfull Mean Depth | 0.8 |
| Bankfull Max Depth | 1.6 |
| Width/Depth Ratio | 26.9 |
| Entrenchment Ratio | 4.7 |
| Classification | C6 |

## Cross-Section 12 – Riffle




**NOTES:**

1. All cross-sections facing the downstream direction.
2. Cross-section stationing represents approximate field locations.

Cross-section, upstream looking downstream

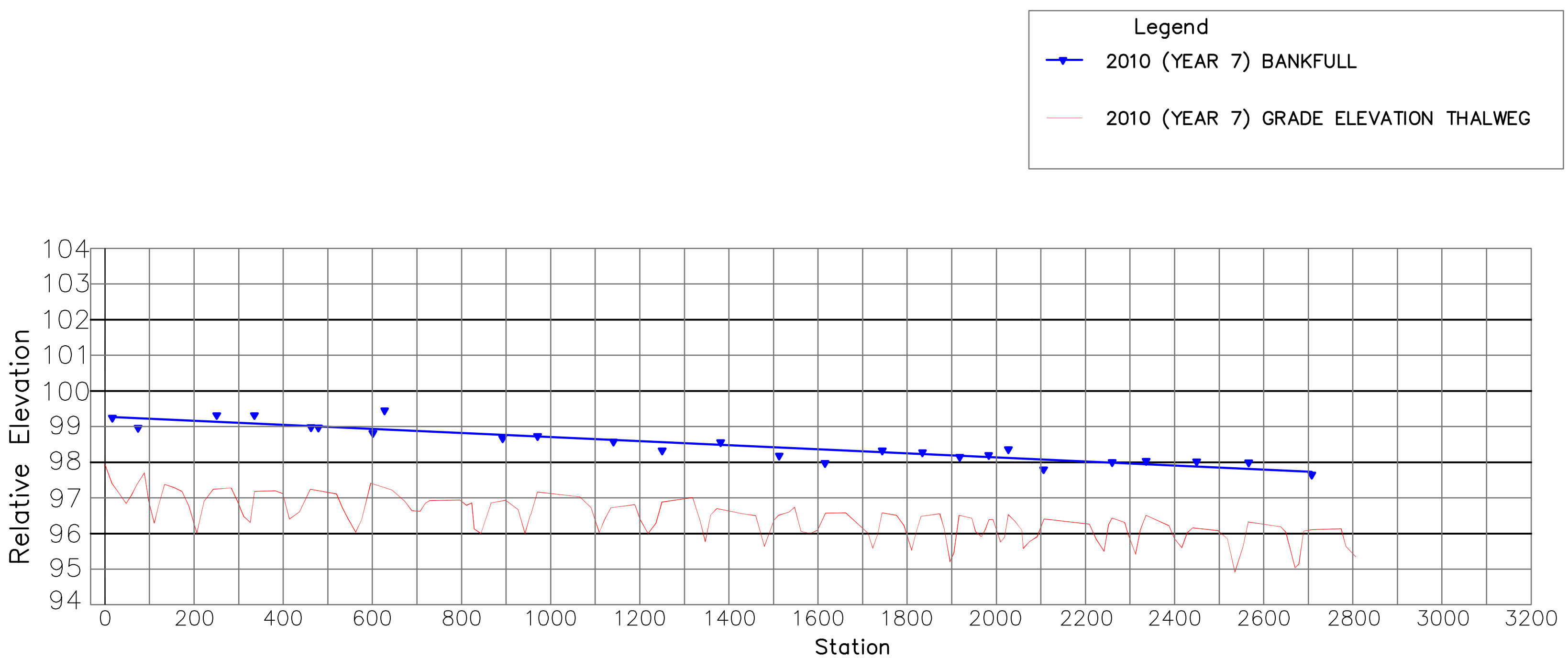
Cross-section, looking at right bank

| Title | Cross-Section 12 |
|---|---|

| | | | |
|---|---|---|---|
| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
| | | Figure | Cross-Section 12 |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station 61+00 |

PBS&J an Atkins company

## Longitudinal Profile




BANKFULL SLOPE: 0.00057

NOTE: NO WATER IN CHANNEL AT TIME OF SURVEY.

| Title | Longitudinal Profile | | |
|---|---|---|---|
| Project | Key Branch Wetland and Stream Restoration Site, Anson County | Project # | 206 |
| | | Figure | Longitudinal Profile |
| Survey Date 9/13/10 – 9/14/10 | Survey Weather Sunny | Field Team Michael Gloden, Jeremy Schmid, Jens Geratz | Location Station |