# Suck Creek Stream Restoration
## Project No. 368
## 2008 Monitoring Report (Final): Year 5 of 5

**March 2009**

Prepared for: NCDENR-EEP
1652 Mail Service Center
Raleigh, NC 27699-1652

Prepared by: Jordan, Jones, & Goulding
9101 Southern Pine Blvd., Suite 160
Charlotte, NC 28273

Design Firm: The Louis Berger Group, Inc.
1001 Wade Avenue, Suite 400
Raleigh, NC 27605

Ecosystem Enhancement Program

NCDENR

JJG

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# EXECUTIVE SUMMARY

# Executive Summary

The Suck Creek Stream Restoration Project (Site) is located on the Richardson Farm in Moore County, North Carolina, immediately west of the Town of Carthage. The stream restoration project consisted of restoring 3,260 linear feet (lf) of Suck Creek, restoring 7.8 acres (ac) of associated riparian zone, providing controlled cattle crossings, and fencing the riparian corridor to exclude cattle access. The following goals were established for the Site (The lf and ac listed in the project goals below are not the same as the final as-built lf and acreage for stream and wetland restoration/enhancement work completed).

1. Restore 3,260 lf of Suck Creek through geomorphic modification through dimension, pattern, and profile adjustments, and cattle exclusion.
2. Establish a riparian zone (7.8 ac) surrounding restored sections of Suck Creek.
3. Improve the habitat within the channel and the riparian zone.
4. Provide cattle exclusion fencing and controlled crossings to protect the restoration effort.
5. Provide perpetual protection of the riparian area and stream with a conservation easement.

The Site was restored by relocating approximately 3,260 lf of the existing channel to establish a stable C4 stream type channel (Priority 1). Suck Creek's riparian areas were planted to improve habitat, stabilize streambanks, and reduce ambient water temperature. A sinuous, stable pattern with riffle-pool bed features was constructed. Cross vanes, log vanes, root wads, and constructed riffles were installed to provide bank stabilization and maintain grade control. Approximately 7.8 ac of riparian buffer were preserved by fencing the entire Site to exclude cattle access and establish controlled cattle crossings. Riparian areas along the channel were planted with native grasses and woody stem vegetation. Streambanks were stabilized with geotextile matting, native grasses, and likestakes. This report serves as the 5th year of the 5 year monitoring plan for the Site.

The 2008 vegetation plot monitoring results indicate that the Site appears to be meeting vegetation success criteria. Thick herbaceous growth covers nearly all of the streambanks and riparian zone. The herbaceous growth is dominated by tall wormwood (*Artemisia caudata*) and whorled coreopsis (*Coreopsis verticillata*). The thickest woody stem growth occurs on the streambanks. Natural recruited volunteers such as black willow (*Salix nigra*) and river birch (*Betula nigra*) have formed dense, irregular patches along the streambanks. Regeneration from likestakes also contributes to the higher woody stem densities observed along streambanks. Stem density rapidly decreases with distance away from the streambanks. Sycamore (*Platanus occidentalis*) and sweet gum (*Liquidambar styraciflua*) are the most common woody plants outside of the streambanks.

Seven (plots 3-9) of the nine previously established vegetation monitoring plots were monitored within the riparian buffer for the 2008 monitoring year. The survival rate for the woody vegetation monitored for 2008 is 50%. The monitoring data indicates an average of 10 stems per plot. Using the monitoring plots size of 10m x 10m (0.025 ac), the site density is approximately 400 planted stems per acre. The success goal in year 5 for planted woody vegetation is 260 stems per acre. Furthermore, many natural recruitment stems were observed within the seven plots monitored. If these volunteers were also included in the stem average and site density calculation, then the number would increase dramatically. The site has satisfied this goal for monitoring year 5.

Results from the 2008 stream monitoring effort indicate that Suck Creek is maintaining vertical and lateral stability. A few problem areas were observed, such as moderate bank erosion, in-stream vegetation, beaver dams, and inundated/backwater areas. Areas with in-stream vegetation growth could potentially result in localized areas of aggradation, and lead to lateral and/or vertical shifts in the stream. These areas will continue to be monitored closely for significant adjustments in the bed features and the channel thalweg. It is recommended that the beaver activity and the associated dams should be removed to prevent inundation areas from evolving and to restore the natural hydrologic flow regime.

Overall, the Site appears to be stable and has met stream and vegetation goals for monitoring year 5.

# SECTION 1
# PROJECT BACKGROUND

# SECTION 1
## PROJECT BACKGROUND

The background information provided in this report is referenced from the mitigation plan and previous monitoring reports prepared by Kimley-Horn and Associates, Inc. and The Louis Berger Group.

### 1.1 Location and Setting

The Site is located on the Richardson Farm in Moore County, North Carolina, immediately west of the Town of Carthage (Figure 1.1). The stream restoration project consisted of restoring 3,260 lf of Suck Creek, restoring 7.8 ac of associated riparian zone, providing controlled cattle crossings, and fencing the riparian corridor to exclude cattle access.

To access the site from Raleigh, follow US-1 south to US 15/501 toward Carthage. When approaching Carthage, take NC-24/Monroe Street into downtown. Go through the downtown traffic circle to Dowd Road (SR 1240). Take Dowd Road west away from Carthage for approximately 1.5 miles. Take a right onto Beulah Hill Church Road / Mt. Carmel Road (SR 1210). After approximately 1.5 miles, turn right onto Richardson Farm Road (SR 1290), which is a gravel road. Follow Richardson Farm Road to the primary residence and then turn left onto a gravel road. Follow the gravel road past the cattle nursery and chicken barns. The upper section of the project stream is located at the bottom of the hill.

### 1.2 Mitigation Structure and Objectives

Suck Creek is located within the Southeastern Plains Physiographic Region. The Suck Creek site drains a portion of the Deep River Subbasin (HUC 03030003) and the North Carolina Department of Water Quality (NCDWQ) Subbasin 03-06-10 of the Cape Fear River Basin. Suck Creek runs through the agricultural property of Bobby Richardson and family. Prior to restoration, the site was predominantly utilized for cattle grazing. Historically, the land was cleared to provide pasture land, with access to the stream for cattle watering. Suck Creek appears to previously have been channelized / straightened. These activities are thought to have inhibited stream channel stability; therefore, producing an incised, eroded stream. Furthermore, the channel incision may have caused adjacent hydric soils to become less saturated. The following goals were established for the Site (The lf and ac listed in the project goals below are not the same as the final as-built lf and acreage for restoration work completed).

1. Restore 3,260 lf of Suck Creek through geomorphic modification through dimension, pattern, and profile adjustments, and cattle exclusion.
2. Establish a riparian zone (7.8 ac) surrounding restored sections of Suck Creek.
3. Improve the habitat within the channel and the riparian zone.
4. Provide cattle exclusion fencing and controlled crossings to protect the restoration effort.
5. Provide perpetual protection of the riparian area and stream with a conservation easement.

The Site was restored by relocating approximately 3,260 lf of the existing channel to establish a stable C4 stream type channel (Priority 1). Suck Creek's riparian areas were planted to improve habitat, stabilize streambanks, and reduce ambient water temperature. A sinuous, stable pattern, with riffle-pool bed features was constructed. Cross vanes, log vanes, root wads, and constructed riffles were installed to provide bank stabilization and maintain grade control. Approximately 7.8 ac of riparian buffer establishment were preserved by fencing in the entire site to exclude cattle access to Suck Creek and establishing controlled cattle crossings (Table 1.1). Riparian areas along the channel were planted with native grasses and woody stem vegetation. Streambanks were stabilized with geotextile matting, native grasses, and likestakes.

**Table 1.1**
**Project Mitigation Structure and Objectives**
**Suck Creek/Project No. 368**

| Segment/Reach | Mitigation Type | Approach | Linear Footage or Acres | Stationing (ft) | Comments | |
|---|---|---|---|---|---|---|
| Main Channel | Restoration | P1 | 2,963 lf | 0+00-29+63 | Channel restoration, relocation with use of grade control and bank protection structures. | |
| Riparian area | Restoration | --- | 7.8 ac | --- | Buffer Restoration/Replanting | |
| **Component Summations** | | | | | | |
| **Restoration Level** | **Stream (lf)** | **Wetland (ac)** | | **Upland (ac)** | **Buffer (ac)** | **BMP** |
| | | **Riparian** | **Non-Riparian** | | | |
| Restoration (R) | 2,963 | N/A | N/A | N/A | 7.8 | N/A |
| Enhancement (E) | N/A | N/A | N/A | N/A | N/A | N/A |
| Enhancement I (E) | N/A | N/A | N/A | N/A | N/A | N/A |
| Enhancement II (E) | N/A | N/A | N/A | N/A | N/A | N/A |
| Creation (C) | N/A | N/A | N/A | N/A | N/A | N/A |
| Preservation (P) | N/A | N/A | N/A | N/A | N/A | N/A |
| HQ Preservation (P) | N/A | N/A | N/A | N/A | N/A | N/A |
| **Totals** | **2,963** | **N/A** | **N/A** | **N/A** | **7.8** | **N/A** |

*The final linear footage and acreage listed above is the based on the as-built values constructed on-site.

## 1.3 Project History and Background

The stream restoration was designed by Kimley-Horn and Associates, Inc. Monitoring has been conducted annually from 2004 to present. This report serves as year 5 of the 5 year monitoring plan for the Site. Tables 1.2 and 1.3 provide detailed project activity, history and contact information for this project. Table 1.4 provides more in-depth watershed/site background for Suck Creek.

**Table 1.2**
**Project Activity and Reporting History**
**Suck Creek/Project No. 368**

| Activity or Report | Data Collection Completed | Actual Completion or Delivery |
|---|---|---|
| Restoration Plan | unknown | unknown |
| Final Design-90% | unknown | 2002 |
| Construction | unknown | unknown |
| Temporary S&E mix applied to entire project area* | unknown | unknown |
| Permanent seed mix applied to reach | unknown | April 2003 |
| Mitigation Plan/ As-Built (Year 0 Monitoring) | unknown | July 2004 |
| Year 1 Monitoring | June 2005 | December 2004 |
| Year 2 Monitoring | September 2006 | December 2005 |
| Year 3 Monitoring | August 2006 | November 2006 |
| Year 4 Monitoring | August 2007 | January 2007 |
| Year 5 Monitoring | May 2008 | February 2009 |

*Seed and mulch are added as each section of construction is completed.

**Table 1.3**
**Project Contacts**
**Suck Creek /Project No. 368**

<table>
<tr><td>Designer</td><td>Mr. Will Wilhelm<br>Kimley-Horn and Associates, Inc.<br>PO Box 33068<br>Raleigh, NC 27636</td></tr>
<tr><td>Contractor's Name</td><td rowspan="3">Mr. Bill Wright<br>Shamrock Environmental Corporation<br>PO Box 14987<br>Greensboro, NC 27415</td></tr>
<tr><td>Planting Contractor</td></tr>
<tr><td>Seeding Contractor</td></tr>
<tr><td colspan="2">Monitoring Performers</td></tr>
<tr><td>Year 1</td><td>Kimley-Horn and Associates, Inc.<br>PO Box 33068<br>Raleigh, NC 27636</td></tr>
<tr><td>Year 2-4</td><td>The Louis Berger Group<br>1513 Walnut Street, Suite 250<br>Cary, NC 27511</td></tr>
<tr><td>Year 5</td><td>Jordan, Jones, & Goulding<br>9101 Southern Pine Blvd., Suite 160<br>Charlotte, NC 28273</td></tr>
<tr><td>Stream Monitoring, POC</td><td rowspan="2">Kirsten Young, 704-527-4106 ext.246</td></tr>
<tr><td>Vegetation Monitoring, POC</td></tr>
</table>

**Table 1.4**
**Project Background**
**Suck Creek/Project No. 368**

| | |
|---|---|
| Project County | Moore County, North Carolina |
| Drainage Area (upper reach) | 4.7 sq. mi |
| Drainage Area (Lower reach) | 4.8 sq. mi |
| Drainage impervious cover estimate | < 2% |
| Stream Order | 2nd |
| Physiographic Region | Piedmont |
| Ecoregion | Sand Hills |
| Rosgen Classification of As-built | C4 |
| Cowardin Classification | Riverine Lower Perennial Unconsolidated Bottom Sand Substrate (R2UB2) |
| Dominant soil types | Chewacla silt loam, Tetotum silt loam |
| Reference site ID | Upstream of project site and Richland Creek |
| USGS HUC for Project and Reference | 03030003 |
| NCDWQ Sub-basin for Project and Reference | 03-06-10 |
| NCDWQ classification for Project and Reference | C |
| NCDWQ classification of Reach 1 | C |
| NCDWQ classification of Reach 2 | C |
| Any portion of any project segment 303d list? | No |
| Any portion of any project segment upstream of a 303d listed segment? | No |
| Reason for 303d listing or stressor? | N/A |
| % of project easement fenced? | 100% |

## 1.4 Monitoring Plan View

The monitoring plan view map (Figure 1.2) illustrates the location of the longitudinal profile stations, cross-section stations, vegetation plots, photo points, and gauges. A total of four cross-sections were previously established within Suck Creek. Approximately 900 lf of longitudinal profile was monitored. Seven of the nine previously established vegetation plots were monitored in 2008. Photographs were taken upstream and downstream at each cross-section and at existing photo points.

# SECTION 2
# PROJECT CONDITION AND MONITORING RESULTS

# SECTION 2

## PROJECT CONDITION AND MONITORING RESULTS

The following monitoring results are from the 2008 (year 5 of 5) survey completed in May and June 2008.

## 2.1 Vegetation Assessment

JJG conducted the vegetative assessment and vegetative plot analysis June 2008 per the 2006 CVS-EEP Level 2 protocol (Lee et al., 2006). Seven of the nine CVS/EEP plots were surveyed in 2008 per the North Carolina Ecosystem Enhancement Program (NCEEP) request (Mac Haupt) dated February 9, 2008. Success criteria for vegetation were established in July 2004 by Kimley-Horn and Associates. Planted zones related to the stream restoration consist of the streambank and the buffer area adjacent to the stream. The riparian zone begins at the top of bank and proceeds perpendicular to the stream. The planted streambank initiates at base flow elevation and extends to the top of bank. The overall success of these two particular planted zones is good. Livestakes and herbaceous species along the streambank are healthy and abundant. The riparian buffer is dominated by a thick herbaceous layer with numerous shrubs and saplings throughout. Natural recruitment vegetation appears to be dominant, which is most likely due to the native seed bank.

### 2.1.1 Soil Data

Suck Creek is situated within an agricultural valley in the Sand Hills EcoRegion of the North Carolina Piedmont Physiographic region. Based on the Generalized Geologic Map of North Carolina, the local geology consists of sedimentary rocks, including sand, sandstone, and clay. Predominant soil types located within the project watershed include Chewacla soils and Tetotum silt loam. Researchable data indicates that the soils within the project area are those found in alluvial landforms in this physiographic region; however, grading and filling activities during construction likely have disturbed the parent soil material.

### 2.1.2 Vegetative Current Condition

The following general observations were noted regarding the riparian area and associated vegetation. Please refer to Appendix 1.1 and 1.2 for more details on vegetative current condition areas and photos.

- Herbaceous seeding appears to provide adequate soil cover on both the floodplain and streambanks.

### 2.1.3 Vegetative Current Condition Plan View

Please refer to Appendix 3 for location of vegetative current condition areas onsite and Appendix 1.2 for representative vegetation current condition photos.

### 2.1.4 Stem Counts

Thick herbaceous growth covers nearly all of the streambanks and riparian zone. The herbaceous growth is dominated by tall wormwood (*Artemisia caudata*) and whorled coreopsis (*Coreopsis verticillata*). Natural recruited volunteers such as black willow (*Salix nigra*) and river birch (*Betula nigra*) have formed dense, irregular patches along the streambanks. This has contributed to the streambanks dense woody stem vegetation growth as well as the regeneration from likestakes along the streambanks. Stem density rapidly decreases with distance away from the streambanks. Sycamore (*Platanus occidentalis*) and sweet gum (*Liquidambar styraciflua*) are the most common woody plants outside of the streambanks.

The 2008 survival rate for the woody vegetation monitored is 50%. The monitoring data indicates an average of 10 stems per plot. Using the monitoring plots size of 10m x 10m (0.025 ac), the site density is approximately 400 planted stems per acre. The year 5 success goal as determined in the 2004 mitigation plan for planted woody vegetation is 260 stems per acre. Furthermore, many natural recruitment stems were observed within all seven plots. If these volunteers were also included in the stem average and site density calculation, then the number would increase dramatically. The site has satisfied this goal for monitoring year 5.

In conclusion, the vegetation throughout the stream and riparian restoration project meets the success requirements. Although some loss of streambank vegetation has occurred, the overall growth of the riparian buffer is good. Per the success criterion for the 2008 monitoring year, the Site has exceeded the year 5 mitigation goal of 260 stems per acre.

### 2.1.5 Vegetation Plot Photos

Please refer to Appendix 1.3 for photographs of the monitoring plots.

## 2.2 Stream Assessment

Stream dimension, pattern, profile, and substrate were evaluated within 900 lf of the stream restoration site. The stream assessment included walking the entire stream reach and monitoring 900 lf of longitudinal profile and four (4) pre-established cross-sections. Please refer to Table 2.1 and Appendix 2 for the stability assessment, stream photographs, and raw data, Table 2.2 for the baseline morphology and hydraulic as-built summary, Table 2.3 for monitoring years 2004-2008 morphology and hydraulic summary, and Appendix 3 for the current condition plan view map.

### 2.2.1 Stream Current Condition Plan View

Please refer to Appendix 3 for location of stream current condition areas onsite.

### 2.2.2 Stream Current Condition Table

Please refer to Appendix 2.1 for the stream current condition table.

### 2.2.3 Numbered Issues Photo Section

Please refer to Appendix 2.2 for representative stream current condition photos.

### 2.2.4 Fixed Photo Station Photos

Please refer to Appendix 2.3 for stream photo station photos and Appendix 2.4 for stream cross-section photos.

### 2.2.5 Stability Assessment

Overall, the pattern, profile, and dimension of the restored channel appear to be stable. After reviewing last year's monitoring report a few bank stability conditions appear to have advanced since the previous monitoring year. In-stream thalweg conditions appear to have also shifted due to in-stream vegetation growth and beaver activity. The following general observations were noted.

- In a few outer bends, there are areas of moderate to severe bank erosion. Most of these areas of bank instability appear to be new conditions, not previously addressed in the 2007 monitoring report. Station 17+62 and 20+70 are the only erosional areas noted in previous monitoring reports. JJG was not able to determine in the 2008 monitoring year whether or not the bank conditions noted in earlier reports have advanced from the previous monitoring year (2007).
- The majority of structures appear to be in good condition; however, moderate to severe scouring is occurring along the outer arm of one structure. At stationing 17+12, the cross vane was determined to be stressed, due to severe bank scour around the boulder arms.
- Several mid-channel bars have formed throughout the Site (Approximate stationing 4+08, 7+25, 10+65, 11+79, and 19+08). Typically this is due to in-stream vegetation growth occurring sporadically throughout the entire stream restoration project creating abnormal flow conditions.
- Beaver activity is evident at the lower end of the Site. Approximately at station 28+13 there is a well established beaver dam which has created inundated conditions upstream (approximate station from 23+65 through 28+13). Flow is contained within the top of bank (bankfull) elevation and had not yet backed up onto the floodplain at the time of the stream survey was conducted.

*Upper Reach*

Cross-sections 1 and 2 are located within the Upper Reach. No significant changes in channel dimension were observed that indicate vertical or lateral instability is occurring.

The average water surface slope and the average bankfull slope were very similar for the surveyed reach, 0.0020 ft/ft and 0.0022 ft/ft, respectively. The surveyed water surface slope was the same as the proposed 0.0020 ft/ft and also similar to the previous monitoring years surveyed slopes. The profile appears stable and is not showing significant vertical incision; however, fine silt deposition has impacted the streambed morphology. In-stream vegetation growth and abnormal rainfall conditions over the monitoring years are most likely attributing to the increase in sediment deposition. Several compound pools have developed throughout the reach, most likely due to the increase of in-stream vegetation growth and sediment deposition.

*Lower Reach*

Cross-sections 3 and 4 are located within the Lower Reach. Both cross-section 3 and 4 appear to be stable with minimal erosion occurring. The average water surface slope and the average bankfull slope were different for the 2008 surveyed reach, 0.0004 ft/ft and 0.0023 ft/ft, respectively. These differences are most likely due to the inundated conditions occurring in the lower reach from beaver activities. The surveyed water surface slope was slightly higher than the proposed 0.0020 ft/ft, but had a lower slope compared to the previous surveyed slopes in 2005. The profile appears stable and is not showing significant shifting in the bed features; however, results indicate there is a slight change. This change could be due to the abnormal flow conditions occurring within the channel due to the in-stream vegetation and beaver activity.

In summary, the Upper and Lower Reach stream dimension, pattern, and profile appear stable. To accurately assess the Suck Creek pattern and profile data, this year's (2008) monitoring data results and visual assessments were only compared to the monitoring years 1-3 (2004-2006) data results. The monitoring data provided from the 2007 monitoring year was inconsistent with the other monitoring years and therefore it was removed from the longitudinal plots and calculations. The 2007 longitudinal data provided appears to have utilized a different datum elevation than the other monitoring data. When plotted with the other annual data the 2007 profile data indicated a significant elevation drop in the channel thalweg, which does not appear to have occurred. Furthermore, historic drought conditions were occurring statewide during the 2007 monitoring year that were most likely not conducive to illustrate such a significant drop in the thalweg as shown in the 2007 data. A few problem areas were observed, such as moderate bank erosion, in-stream vegetation, beaver dams, and inundated/backwater areas. Areas with in-stream vegetation growth have provided secondary habitat, but could potentially result in localized areas of aggradation and lead to lateral and/or vertical shifts in the stream. The channel appears to be functioning in the areas where beaver activity has not impacted the channel hydrology.

**Table 2.1**
**Categorical Stream Feature Visual Stability Assessment**
**Suck Creek/Project No. 368**

| Upper Reach | MY1 (2004) | MY2 (2005) | MY3 (2006) | MY4 (2007) | MY5 (2008) |
|---|---|---|---|---|---|
| A. Riffles | N/A | 88% | 88% | 88% | 88% |
| B. Pools | N/A | 88% | 88% | 88% | 88% |
| C. Thalweg | N/A | 100% | 100% | 100% | 100% |
| D. Meanders | N/A | 100% | 100% | 100% | 100% |
| E. Bed General | N/A | 99% | 99% | 94% | 99% |
| F. Bank | N/A | 99% | 99% | 94% | 100% |
| G. Vanes | N/A | 100% | 100% | 100% | 100% |
| H. Wads/ Boulders | N/A | 100% | 100% | 100% | 100% |

| Lower Reach | MY1 (2004) | MY2 (2005) | MY3 (2006) | MY4 (2007) | MY5 (2008) |
|---|---|---|---|---|---|
| A. Riffles | N/A | 94% | 94% | 94% | 75% |
| B. Pools | N/A | 100% | 100% | 100% | 100% |
| C. Thalweg | N/A | 100% | 100% | 100% | 100% |
| D. Meanders | N/A | 99% | 99% | 99% | 94% |
| E. Bed General | N/A | 100% | 100% | 96% | 100% |
| F. Bank | N/A | 100% | 100% | 96% | 99% |
| G. Vanes | N/A | 85% | 85% | 84% | 95% |
| H. Wads/ Boulders | N/A | 96% | 96% | 96% | 100% |

### 2.2.6 Quantitative Measures Tables

Tables 2.2 and 2.3 display morphological summary data from all monitoring years. Raw survey data can be found in Appendix 2.

**Table 2.2**
**Baseline Morphology and Hydraulic As-Built Summary**
**Suck Creek/Project No. 368**

| | USGS Gage Data | | | Regional Curve Interval | | | Pre-Existing Condition | Project Reference Stream | | Design | As-Built | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Upper Reach | | Lower Reach | |
| **DIMENSION** | Min | Max | Med | Min | Max | Med | | *Reach I* | *Reach II* | | Riffle | Pool | Riffle | Pool |
| Bankfull Width (ft) | USGS Gage Data is unavailable for this stream | | | - | | | 12.3-15.8 | 16.2-16.7 | 15-20 | 15-20 | 21.2 | 27.3 | 20.7 | 31.0 |
| Floodprone Width (ft) | | | | | | | 18-21 | 50.0-53.3 | N/A | 60-66 | N/A | N/A | N/A | N/A |
| Bankfull Cross-sectional Area ($ft^2$) | | | | | | | 12.8-22.8 | 15.0-15.2 | 18-36 | 18-36 | 18.1 | 35.2 | 27.4 | 33.0 |
| Bankfull Mean Depth (ft) | | | | | | | 1.0-1.4 | 0.9-0.9 | 1.2-1.8 | 1.2-1.8 | 0.9 | 1.3 | 1.3 | 1.1 |
| Bankfull Max Depth (ft) | | | | | | | 1.3-1.5 | 1.4-1.5 | 1.9-2.1 | 1.8-2.9 | 1.6 | 2.3-3.7 | 2.2 | 2.8-3.7 |
| Width/Depth Ratio | | | | | | | 8.8-15.8 | 17.5-18.0 | 8.3-16.7 | 8.3-16.7 | 23.6 | 21.0 | 15.9 | 28.2 |
| Entrenchment Ratio | | | | | | | 1.3-1.4 | 3.0-3.3 | 1.3-1.6 | 3.0-3.3 | N/A | N/A | N/A | N/A |
| Wetted Perimeter (ft) | | | | | | | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Hydraulic Radius (ft) | | | | | | | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Bank Height Ratio | | | | | | | 1.1-2.3 | 1.0 | N/A | 1.0-1.2 | N/A | N/A | N/A | N/A |
| **PATTERN** | | | | | | | | | | | | | | |
| Channel Beltwidth (ft) | - | | | - | | | 15-35 | 25-40 | N/A | 30-400 | 20-104 | | 34-91 | |
| Radius of Curvature (ft) | | | | | | | 24.4-52.0 | 14-26 | N/A | 24-60 | 35-55 | | 14-65 | |
| Meander Wave Length (ft) | | | | | | | 75-129 | 90-94 | N/A | 112-280 | 120-265 | | 102-174 | |
| Meander Width Ratio | | | | | | | 1.1-2.5 | 1.52-2.43 | 1.52-20 | N/A | N/A | | N/A | |
| **PROFILE** | | | | | | | | | | | | | | |
| Riffle Length (ft) | - | | | - | | | N/A | N/A | N/A | N/A | 10-27 | | 17-42 | |
| Riffle Slope (ft/ft) | | | | | | | 0-1.6 | 0.014-0.041 | N/A | 0.0045-0.0096 | 0.005-0.01 | | 0.008-0.008 | |
| Pool Length (ft) | | | | | | | N/A | N/A | N/A | N/A | 20-68 | | 86-128 | |
| Pool to Pool Spacing (ft) | | | | | | | 37-246 | 37.3-95.8 | N/A | 60-140 | 54-83 | | 83-171 | |
| **SUBSTRATE** | | | | | | | | | | | | | | |
| D50 (mm) | - | | | - | | | 7.7 | 40 | 8.4 | N/A | 13.2-17.9* | | 20.0-0.8* | |
| D85 (mm) | | | | | | | 18 | 129 | 18 | N/A | 30.8-32* | | 33.4-10* | |

| **ADDITIONAL REACH PARAMETERS** | USGS Gage Data | Regional Curve Interval | Pre-Existing Condition | Project Reference Stream | | Design | As-Built |
|---|---|---|---|---|---|---|---|
| Valley Length (ft) | - | - | N/A | N/A | N/A | N/A | N/A |
| Channel Length (ft) | | | N/A | N/A | N/A | N/A | N/A |
| Sinuosity | | | 1.2 | 1.2 | | 1.0-1.6 | N/A |
| Water Surface Slope (ft/ft)** | | | 0.0030 | 0.0133 | 0.018 | 0.0025-0.0040 | 0.0020*** |
| Bankfull Slope (ft/ft) | | | N/A | N/A | N/A | N/A | N/A |
| Rosgen Classification | | | G4->F4 | C4 | B4 | C4 | N/A |

Cells noted with a (N/A/-), data was not provided
*Indicate riffle-pool calculated numbers for channel dimensions, not actual range of values
**Average Stream Slope (Savg = (Svalley/k))
***Reported as Bankfull slope in as-built

**Table 2.3**
**Morphology and Hydraulic Monitoring Summary**
**Suck Creek/Project No. 368**

| **DIMENSION** | **Cross-Section 1-Riffle** | | | | | **Cross-Section 2-Pool** | | | | | **Cross-Section 3-Pool** | | | | | **Cross-Section 4-Riffle** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **MY1 (2004)** | **MY2 (2005)** | **MY3 (2006)** | **MY4 (2007)** | **MY5 (2008)** | **MY1 (2004)** | **MY2 (2005)** | **MY3 (2006)** | **MY4 (2007)** | **MY5 (2008)** | **MY1 (2004)** | **MY2 (2005)** | **MY3 (2006)** | **MY4 (2007)** | **MY5 (2008)** | **MY1 (2004)** | **MY2 (2005)** | **MY3 (2006)** | **MY4 (2007)** | **MY5 (2008)** |
| Bankfull Width (ft) | 27.30 | 26.20 | 24.70 | 26.40 | 25.00 | 21.20 | 19.20 | 17.00 | 20.20 | 20.56 | 31.00 | 9.90 | 10.50 | 11.20 | 12.77 | 20.70 | 16.60 | 16.60 | 16.40 | 16.23 |
| Floodprone Width (ft) | N/A | N/A | N/A | N/A | 53.19 | N/A | N/A | N/A | N/A | 39.47 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 52.91 |
| Bankfull Cross-sectional Area ($ft^2$) | 34.30 | 32.50 | 28.80 | 33.20 | 31.07 | 18.10 | 15.20 | 15.70 | 17.00 | 15.66 | 33.00 | 13.40 | 11.40 | 19.60 | 20.05 | 27.40 | 20.90 | 20.50 | 22.30 | 21.37 |
| Bankfull Mean Depth (ft) | 1.80 | 1.20 | 1.20 | 1.30 | 1.24 | 0.90 | 0.80 | 0.90 | 0.80 | 0.76 | 1.10 | 1.40 | 1.10 | 1.80 | 1.57 | 1.30 | 1.30 | 1.20 | 1.40 | 1.32 |
| Bankfull Max Depth (ft) | 2.80 | 2.70 | 2.70 | 2.80 | 2.72 | 1.60 | 1.60 | 1.60 | 1.70 | 1.63 | 2.80 | 1.60 | 1.40 | 2.10 | 2.48 | 2.20 | 2.00 | 1.90 | 2.10 | 2.00 |
| Width/Depth Ratio | 15.17 | 21.10 | 21.10 | 20.90 | 20.16 | 25.00 | 24.20 | 18.50 | 23.90 | 27.05 | 29.20 | 7.30 | 9.70 | 6.40 | 8.13 | 15.60 | 13.20 | 13.40 | 12.10 | 12.30 |
| Entrenchment Ratio | 2.10 | N/A | N/A | N/A | 2.13 | 2.80 | N/A | N/A | N/A | 1.92 | 2.50 | N/A | N/A | N/A | N/A | 3.20 | N/A | N/A | N/A | 3.26 |
| Wetted Perimeter (ft) | N/A | 27.30 | 25.80 | 27.50 | 26.34 | N/A | 19.70 | 17.60 | 21.00 | 21.09 | N/A | 11.70 | 12.00 | 13.30 | 14.83 | N/A | 13.20 | 17.70 | 17.90 | 17.52 |
| Hydraulic Radius (ft) | N/A | 1.20 | 1.10 | 1.20 | 1.18 | N/A | 0.80 | 0.90 | 0.80 | 0.74 | N/A | 1.10 | 0.90 | 1.50 | 1.35 | N/A | 1.20 | 1.20 | 1.20 | 1.22 |
| Bank Height Ratio | N/A | N/A | N/A | N/A | 1.00 | N/A | N/A | N/A | N/A | 1.00 | N/A | N/A | N/A | N/A | 1.00 | N/A | N/A | N/A | N/A | 1.00 |
| **SUBSTRATE** | | | | | | | | | | | | | | | | | | | | |
| D50 (mm) | 17.90 | 14.80 | N/A | 6.00 | 0.04 | 13.20 | 7.30 | 0.70 | 6.00 | 0.32 | 0.80 | 0.80 | N/A | 4.00 | 0.05 | 20.00 | 0.70 | 0.50 | 4.00 | 0.05 |
| D84 (mm) | 32.00 | 32.00 | N/A | 16.00 | 24.48 | 30.80 | 34.00 | 23.00 | 16.00 | 22.60 | 10.00 | 9.00 | N/A | 11.00 | 2.80 | 33.40 | 5.00 | 133.00 | 11.00 | 1.00 |
| **Upper Reach** | **MY1 (2004)** | | | **MY2 (2005)** | | | **MY3 (2006)** | | | **MY4 (2007)** | | | **MY5 (2008)** | | | | | | | |
| **PATTERN** | Min | Max | Med | Min | Max | Med | Min | Max | Med | Min | Max | Med | Min | Max | Med | | | | | |
| Channel beltwidth (ft) | 21 | 99 | N/A | 27 | 13 | 20 | 27 | 13 | 20 | 13 | 27 | 20 | 24 | 104 | 45 | | | | | |
| Radius of curvature (ft) | 32 | 69 | N/A | 30 | 33 | 31.5 | 30 | 33 | 31.5 | 30 | 33 | 31.5 | 40 | 65 | 40 | | | | | |
| Meander wavelength (ft) | 130 | 265 | N/A | 141 | 160 | 150 | 141 | 160 | 150 | 141 | 160 | 150 | 120 | 270 | 183 | | | | | |
| Meander width ratio | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1 | 5 | 2 | | | | | |
| **PROFILE** | | | | | | | | | | | | | | | | | | | | |
| Riffle Length (ft) | 10 | 42 | N/A | 75 | 32 | 30 | 26 | 11 | 3 | 8 | 17 | 13 | 7 | 21 | 15 | | | | | |
| Riffle Slope (ft/ft) | 0.005 | 0.010 | N/A | 0.100 | 0.090 | 0.010 | 0.410 | 0.380 | 0.050 | 0.012 | 0.060 | 0.031 | 0.012 | 0.028 | 0.013 | | | | | |
| Pool Length (ft) | 20 | 128 | N/A | 45 | 18 | 7 | 86 | 56 | 12 | 9 | 27 | 18 | 17 | 91 | 26 | | | | | |
| Pool to Pool Spacing (ft) | 54 | 171 | N/A | 88 | 68 | 53 | 99 | 64 | 51 | 9 | 122 | 52 | 17 | 85 | 57 | | | | | |
| **Lower Reach** | **MY1 (2004)** | | | **MY2 (2005)** | | | **MY3 (2006)** | | | **MY4 (2007)** | | | **MY5 (2008)** | | | | | | | |
| **PATTERN** | Min | Max | Med | Min | Max | Med | Min | Max | Med | Min | Max | Med | Min | Max | Med | | | | | |
| Channel beltwidth (ft) | 21 | 99 | N/A | 13 | 27 | 20 | 13 | 27 | 20 | 13 | 27 | 20 | 28 | 100 | 70 | | | | | |
| Radius of curvature (ft) | 32 | 69 | N/A | 30 | 33 | 31.5 | 30 | 33 | 31.5 | 30 | 33 | 31.5 | 15 | 55 | 45 | | | | | |
| Meander wavelength (ft) | 130 | 265 | N/A | 141 | 160 | 150 | 141 | 160 | 150 | 141 | 160 | 150 | 55 | 140 | 93 | | | | | |
| Meander width ratio | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1 | 5 | 3 | | | | | |
| **PROFILE** | | | | | | | | | | | | | | | | | | | | |
| Riffle Length (ft) | 10 | 42 | N/A | 56 | 26 | 8 | 27 | 21 | 8 | 8 | 31 | 19 | 7 | 25 | 19 | | | | | |
| Riffle Slope (ft/ft) | 0.005 | 0.010 | N/A | 0.08 | 0.03 | 0.006 | 0.07 | 0.021 | 0.013 | 0 .005 | .048 | 0.024 | 0.005 | 0.120 | 0.017 | | | | | |
| Pool Length (ft) | 20 | 128 | N/A | 34 | 20 | 10 | 77 | 35 | 19 | 19 | 66 | 40 | 29 | 85 | 72 | | | | | |
| Pool to Pool Spacing (ft) | 54 | 171 | N/A | 123 | 83 | 77 | 119 | 84 | 23 | 21 | 126 | 67 | 30 | 136 | 88 | | | | | |

**Table 2.3 cont.**
**Morphology and Hydraulic Monitoring Summary**
**Suck Creek/Project No. 368**

| ADDITIONAL REACH PARAMETERS | MY1 (2004) | MY2 (2005) | | MY3 (2006) | | MY4 (2007) | | MY5 (2008) | |
|---|---|---|---|---|---|---|---|---|---|
| | | UR | LR | UR | LR | UR | LR | UR | LR |
| Valley Length (ft) | N/A | 411 | 386 | 411 | 386 | 411 | 386 | 411 | 386 |
| Channel Length (ft) | N/A | 515 | 408 | 515 | 408 | 515 | 408 | 515 | 408 |
| Sinuosity | N/A | 1.25 | 1.05 | 1.25 | 1.05 | 1.25 | 1.05 | 1.25 | 1.05 |
| Water Surface Slope (ft/ft) | N/A | 0.0022 | 0.0017 | 0.0020 | 0.0021 | 0.0019 | 0.0001 | 0.0020 | 0.0004 |
| Bankfull Slope (ft/ft) | N/A | 0.0023 | 0.0029 | 0.0054 | 0.0035 | 0.0080 | 0.0008 | 0.0022 | 0.0023 |
| Rosgen Classification | C5 | C5 | | C5 | | C5 | | C5 | |

### 2.2.7 Hydrologic Criteria

The Suck Creek Stream Restoration Project has a stream gauge located on site within the upper reach of the Site. Five recorded bankfull events or greater occurred on site during the 2008 monitoring period. Table 2.4 summarized the recorded bankfull or greater results below. Please refer to Appendix 2.9 for a graphical display of the Site's hydrology.

**Table 2.4**
**Verification of Bankfull Events**
**Suck Creek/Project No. 368**

| Date of Collection | Date of Occurrence | Method | Photo # (if available) |
|---|---|---|---|
| N/A | 1/6/2007 | Stream Gauge | N/A |
| N/A | 2/14/2007 | Stream Gauge | N/A |
| N/A | 3/2/2007 | Stream Gauge | N/A |
| N/A | 3/17/2007 | Stream Gauge | N/A |
| N/A | 4/12/2007 | Stream Gauge | N/A |
| N/A | 4/16/2007 | Stream Gauge | N/A |
| N/A | 5/13/2007 | Stream Gauge | N/A |
| Spring/Summer 2007 | Unknown | Visual Assessment | N/A |
| N/A | March 8, 2008 | Stream Gauge | N/A |
| N/A | April 5, 2008 | Stream Gauge | N/A |
| N/A | April 29, 2008 | Stream Gauge | N/A |
| N/A | September 6, 2008 | Stream Gauge | N/A |
| N/A | September 27, 2008 | Stream Gauge | N/A |

# SECTION 3
# METHODOLOGY

# SECTION 3
## METHODOLOGY

### 3.1 Methodology

Methods employed for the Site were a combination of those established by standard regulatory guidance and procedures documents and as well as previous monitoring reports completed by Kimley-Horn and Associates, Inc. and The Louis Berger Group. Geomorphic and stream assessments were performed following guidelines outlined in the Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration a Natural Channel Design Handbook (Doll et al, 2003). Vegetation assessments were performed following the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2006). JJG used the *Manual of the Vascular Flora of the Carolinas* by Albert R. Radford, Harry E. Ahles, and C. Ritchie Bell as the taxonomic standard for vegetation nomenclature for this report.

# SECTION 4
# REFERENCES

# SECTION 4
## REFERENCES


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

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

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Lee, Michael T., Peet, Robert K., Steven D., Wentworth, Thomas R. (2006). CVS-EEP Protocol for Recording Vegetation Version 4.0. Retrieved from http://www.nceep.net/business/monitoring/veg/datasheets.htm.

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

The Louis Berger Group 2005-2007. Annual Monitoring Report (Year 2, 3, and 4 of 5) (Suck Creek Stream Restoration). Raleigh, NC.

Weakley, A.S. 2008. *Flora of the Carolinas, Virginia, Georgia, Northern Florida, and Surrounding Areas* (Draft April 2008). University of North Carolina at Chapel Hill: Chapel Hill, NC.

# SECTION 5
# FIGURES

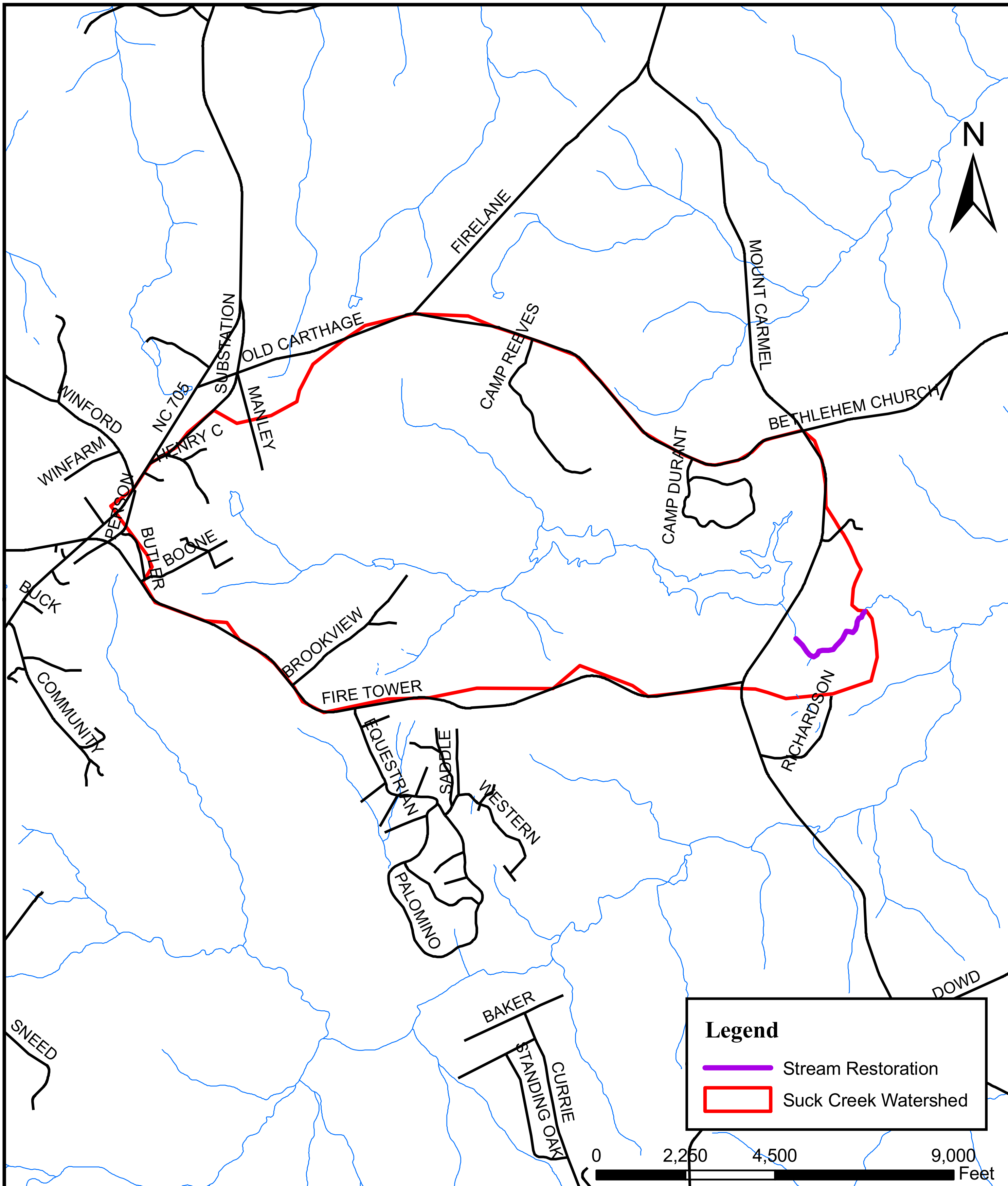
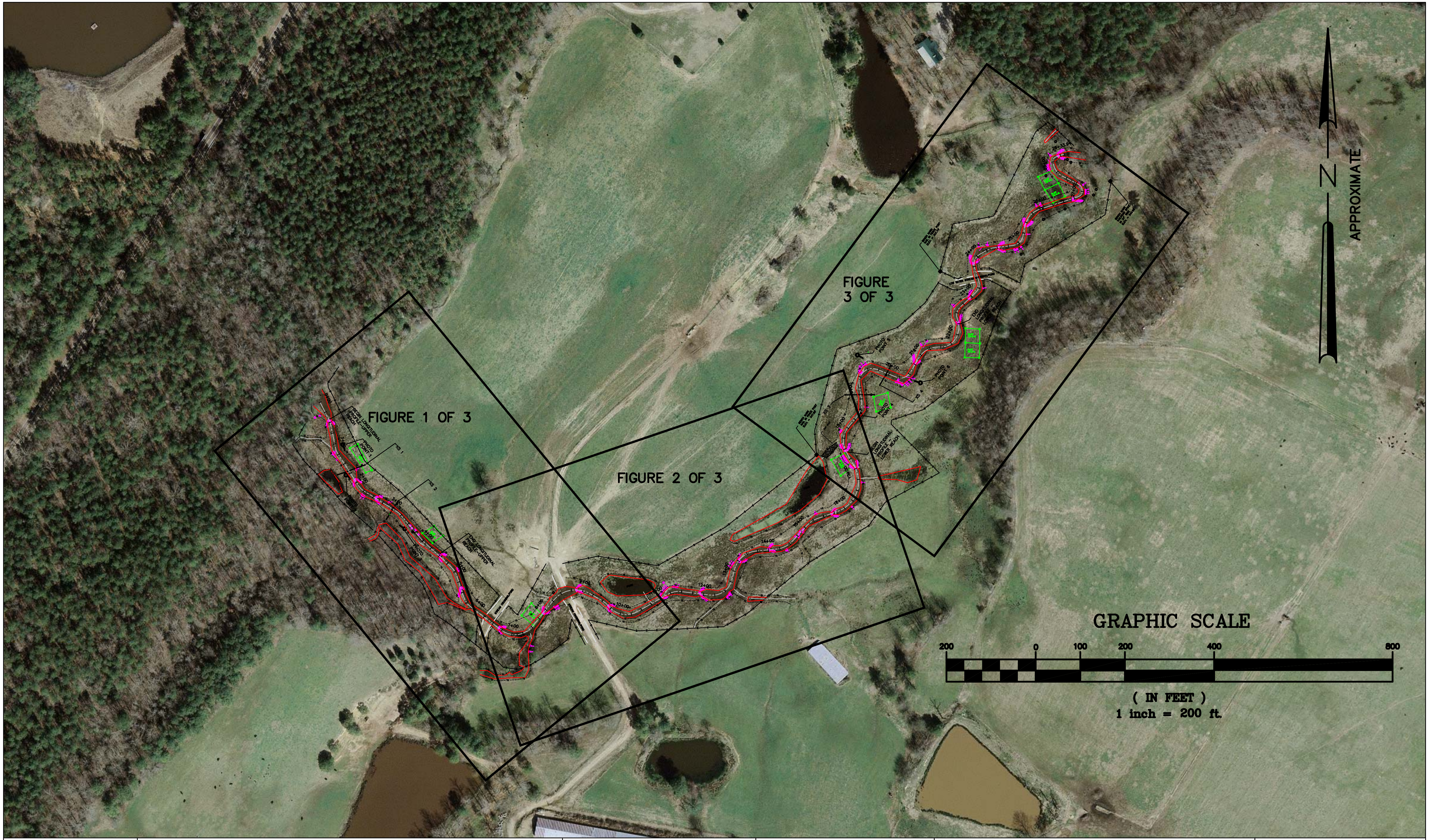



Figure 1.1 Project Location and Watershed Map
Suck Creek Stream Restoration
Moore County, NC
Year 5 of 5

Project No. 368
February 2009




NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 368
MOORE COUNTY
NORTH CAROLINA
MONITORING
YEAR 5 of 5

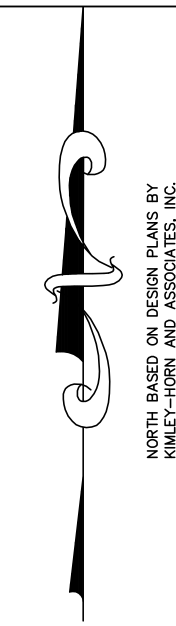
NC ECOSYSTEM ENHANCEMENT PROGRAM
SUCK CREEK STREAM RESTORATION

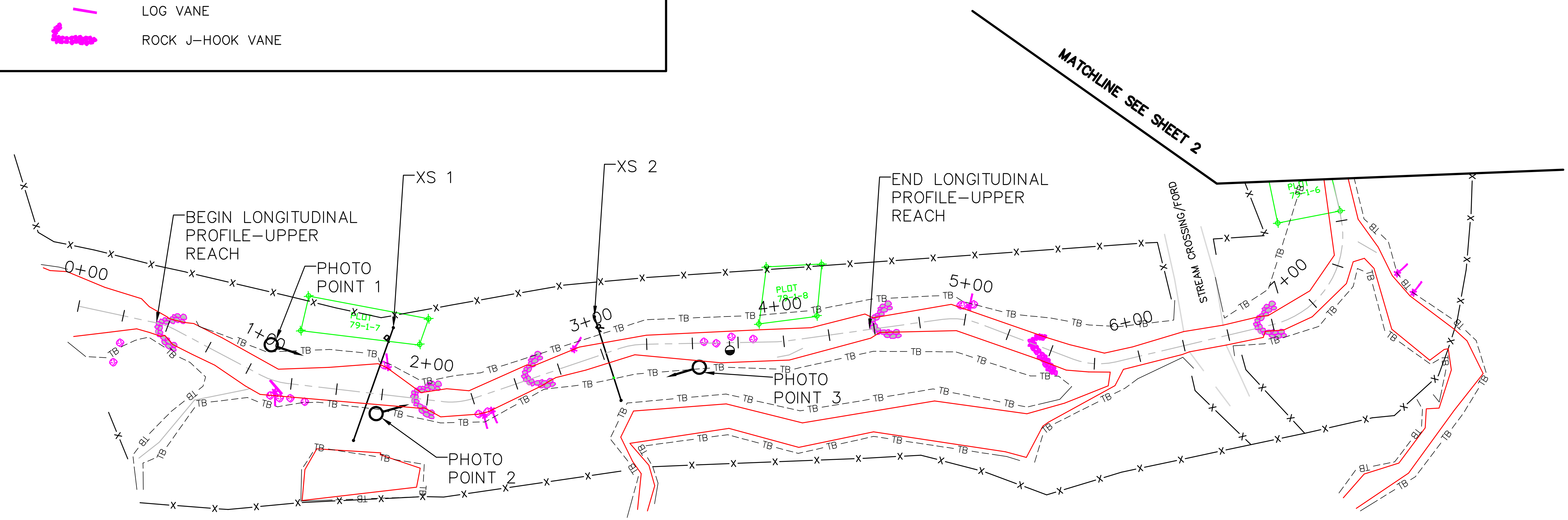
FIGURE 1.2
MONITORING PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=200'
JOB NO.: 03060004
FIGURE KEY

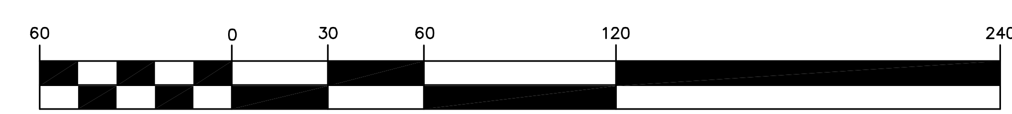
## LEGEND

- SUCK CREEK (centerline)
- EDGE OF WATER
- TOP OF BANK
- BOULDER CLUSTER
- ROOT WAD
- BOULDER
- ROCK CROSS VANE
- LOG VANE
- ROCK J–HOOK VANE
- FENCE
- POOL CROSS SECTION
- RIFFLE CROSS SECTION
- PHOTO POINT
- VEGETATION PLOT
- CREST GAUGE




GRAPHIC SCALE




( IN FEET )
1 inch = 60 ft.

Original survey Issued and sealed by
ROGER D. MORGAN, PLS
N.C. Registration No. L–3847
JUNE 2, 2003
This media should not be considered
a certified document.

Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 368
MOORE COUNTY
NORTH CAROLINA
MONITORING
YEAR 5 of 5

JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
SUCK CREEK STREAM RESTORATION

FIGURE 1.2
MONITORING PLAN VIEW

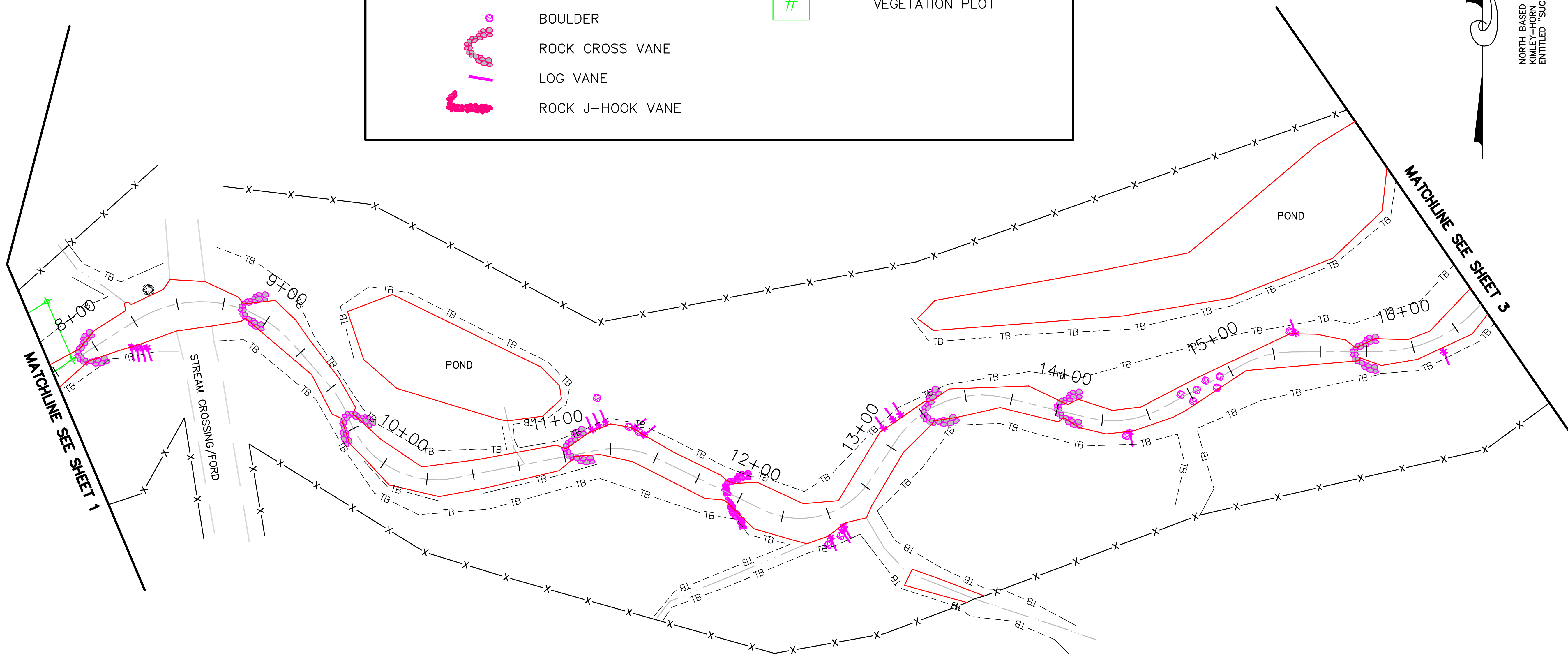
DATE : FEBRUARY 2009
SCALE : 1"=60'
JOB NO.: 03060004

SHEET 1 OF 3

## LEGEND

- ℄ SUCK CREEK
- EDGE OF WATER
- TOP OF BANK
- BOULDER CLUSTER
- ROOT WAD
- BOULDER
- ROCK CROSS VANE
- LOG VANE
- ROCK J–HOOK VANE
- FENCE
- POOL CROSS SECTION
- RIFFLE CROSS SECTION
- PHOTO POINT
- VEGETATION PLOT

NORTH BASED ON DESIGN PLANS BY KIMLEY–HORN AND ASSOCIATES, INC. ENTITLED "SUCK CREEK – MOORE COUNTY"




Original survey Issued and sealed by
ROGER D. MORGAN, PLS
N.C. Registration No. L–3847
JUNE 2, 2003
This media should not be considered a certified document.

GRAPHIC SCALE

60 0 30 60 120 240

( IN FEET )
1 inch = 60 ft.

Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 368
MOORE COUNTY
NORTH CAROLINA
MONITORING
YEAR 5 of 5

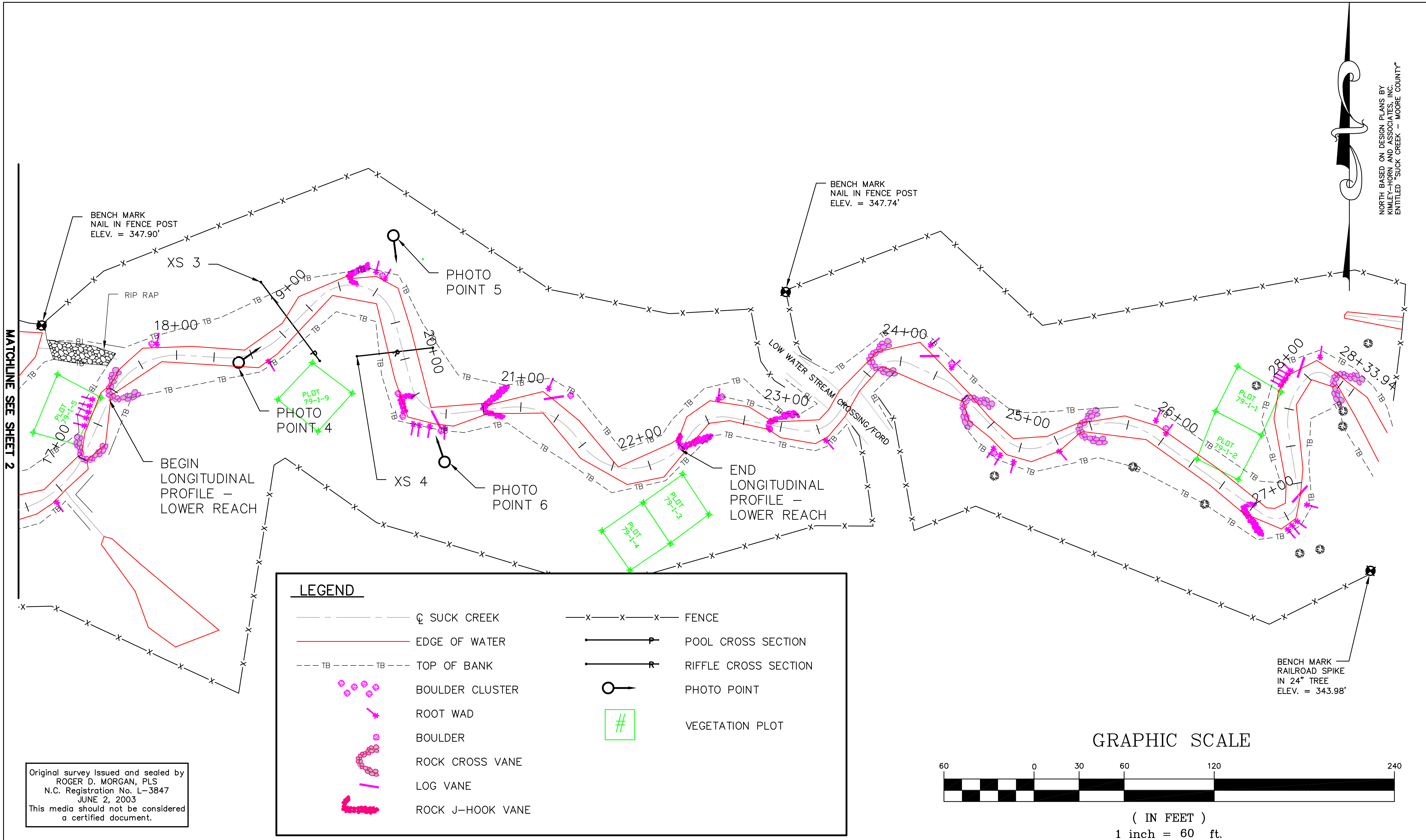
JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
SUCK CREEK STREAM RESTORATION

FIGURE 1.2
MONITORING PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=60'
JOB NO.: 03060004

SHEET 2 OF 3




Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 368
MOORE COUNTY
NORTH CAROLINA
MONITORING
YEAR 5 of 5

JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
SUCK CREEK STREAM RESTORATION

FIGURE 1.2
MONITORING PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=60'
JOB NO.: 03060004

SHEET 3 OF 3

# Click on the Desired Link Below

## Appendix 1

## Appendix 2

## Appendix 3

# SECTION 6
# APPENDICES

**Appendix 1 - Vegetation Raw Data**

**Appendix 2 - Geomorphic and Stream Stability Data**

**Appendix 3 –Current Condition Plan View (Integrated)**

# APPENDIX 1
## VEGETATION RAW DATA

1. **Vegetation Survey Data Tables***

2. **Representative Vegetation Current Condition Photos**

3. **Vegetation Monitoring Plot Photos**

*Raw data tables have been provided electronically.

Suck Creek (2,963 lf)

| Feature Issue | Station Numbers | Suspected Cause | Photo ID # |
|---|---|---|---|
| In-Stream Vegetation | 0+47.98-1+00 | Herbaceous species in main channel | 1 |
| | 1+25-1+91 | | |
| | 2+78-3+86 | | |
| | 4+69-5+00 | | |
| | 5+06-5+36 | | |
| | 9+82-11+00 | | |
| | 14+27-14+68 | | |
| | 16+48-16+66 | | |
| | 17+94-18+23 | | |
| | 19+75-20+14 | | |
| | 21+08-21+64 | | |

LB - Left Bank Looking Downstream, RB - Right Bank Looking Downstream, BB - Both Banks, TOB - Top of Bank
Please refer to Appendix 1.2 for Current Condition Photos

**Table 1. Vegetation Metadata**

| | |
|---|---|
| **Report Prepared By** | Kirsten Young |
| **Date Prepared** | 7/30/2008 10:45 |
| **database name** | Berger-2008-A-VMD-entrytool-v2.2.5.mdb |
| **database location** | C:\Documents and Settings\kyoung\Local Settings\Temp |
| **DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT------------** | |
| **Metadata** | This worksheet, which is a summary of the project and the project data. |
| **Plots** | List of plots surveyed. |
| **Vigor** | Frequency distribution of vigor classes. |
| **Vigor by Spp** | Frequency distribution of vigor classes listed by species. |
| **Damage** | List of most frequent damage classes with number of occurrences and percent |
| **Damage by Spp** | Damage values tallied by type for each species. |
| **Damage by Plot** | Damage values tallied by type for each plot. |
| **Stem Count by Plot and Spp** | Count of living stems of each species for each plot; dead and missing stems |
| **PROJECT SUMMARY-------------------------------------** | |
| **Project Code** | 79 |
| **project Name** | Suck Creek |
| **Description** | Stream Restoration |
| **length(ft)** | |
| **stream-to-edge width (ft)** | |
| **area (sq m)** | |
| **Required Plots (calculated)** | |
| **Sampled Plots** | 7 |

**Table 2. Vegetation Vigor by Species**

| | Species | 4 | 3 | 2 | 1 | 0 | Missing | Unknown |
|---|---|---|---|---|---|---|---|---|
| | *Alnus serrulata* | 2 | | | | | 1 | |
| | *Betula nigra* | 31 | 1 | | | | | |
| | *Celtis occidentalis* | 1 | | | | | 1 | |
| | *Cornus amomum* | | | 1 | | | 1 | |
| | *Diospyros virginiana* | | 1 | | | | | |
| | *Fraxinus pennsylvanica* | 4 | 3 | | | | 1 | |
| | *Liquidambar styraciflua* | | 1 | | | | | |
| | *Pinus taeda* | 3 | 1 | | | | 2 | |
| | *Quercus phellos* | 1 | | 1 | | | | |
| | *Salix nigra* | 8 | 1 | | | | 8 | |
| | *Platanus occidentalis* | 5 | 1 | | | | | |
| | *Acer rubrum* | | 1 | 3 | | | | |
| **TOT:** | **12** | **55** | **10** | **5** | | | **14** | |

**Table 3. Vegetation Damage by Species**

| | Species | All Damage Categories | (no damage) |
|---|---|---|---|
| | *Acer rubrum* | 4 | 4 |
| | *Alnus serrulata* | 4 | 4 |
| | *Betula nigra* | 32 | 32 |
| | *Celtis occidentalis* | 2 | 2 |
| | *Cornus amomum* | 2 | 2 |
| | *Diospyros virginiana* | 1 | 1 |
| | *Fraxinus pennsylvanica* | 8 | 8 |
| | *Liquidambar styraciflua* | 1 | 1 |
| | *Pinus taeda* | 6 | 6 |
| | *Platanus occidentalis* | 6 | 6 |
| | *Quercus phellos* | 2 | 2 |
| | *Salix nigra* | 17 | 17 |
| **TOT:** | **12** | **85** | **85** |

**Table 4. Vegetation Damage by Plot**

| | plot | All Damage Categories | (no damage) |
|---|---|---|---|
| | 79-1-3-year:5 | 13 | 13 |
| | 79-1-4-year:5 | 9 | 9 |
| | 79-1-5-year:5 | 7 | 7 |
| | 79-1-6-year:5 | 26 | 26 |
| | 79-1-7-year:5 | 18 | 18 |
| | 79-1-8-year:5 | 11 | 11 |
| | 79-1-9-year:5 | 1 | 1 |
| **TOT:** | **7** | **85** | **85** |

**Table 5. Stem Count by Plot and Species**

| | Species | Total Planted Stems | # plots | avg# stems | plot 79-1-3-year:5 | plot 79-1-4-year:5 | plot 79-1-5-year:5 | plot 79-1-6-year:5 | plot 79-1-7-year:5 | plot 79-1-8-year:5 | plot 79-1-9-year:5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acer rubrum* | 4 | 2 | 2 | | 3 | | 1 | | | |
| | *Alnus serrulata* | 2 | 2 | 1 | | | | 1 | | 1 | |
| | *Betula nigra* | 32 | 4 | 8 | 1 | | | 9 | 13 | 9 | |
| | *Celtis occidentalis* | 1 | 1 | 1 | | | | | 1 | | |
| | *Cornus amomum* | 1 | 1 | 1 | | | 1 | | | | |
| | *Diospyros virginiana* | 1 | 1 | 1 | | | 1 | | | | |
| | *Fraxinus pennsylvanica* | 7 | 4 | 2 | 1 | | 3 | | 2 | 1 | |
| | *Liquidambar styraciflua* | 1 | 1 | 1 | | 1 | | | | | |
| | *Pinus taeda* | 4 | 3 | 1 | 1 | 2 | | 1 | | | |
| | *Platanus occidentalis* | 6 | 2 | 3 | | 1 | | 5 | | | |
| | *Quercus phellos* | 2 | 2 | 1 | 1 | 1 | | | | | |
| | *Salix nigra* | 9 | 4 | 2 | 1 | | 1 | 6 | 1 | | |
| **TOT:** | **12** | **70** | **12** | **2** | **5** | **8** | **6** | **23** | **17** | **11** | **0** |

1. In-Stream Vegetation (5/2008)

2. Beaver Chews (5/2008)

| | | |
|---|---|---|
| Prepared For: | Suck Creek Stream Restoration<br>Year 5 of 5 | Date: February 2009<br>Project No.: 368 |
| Ecosystem Enhancement PROGRAM | **Appendix 1.2 Representative Stream Current Condition Photos** | JJG |

Monitoring Plot 3 (6/2008)

Monitoring Plot 4 (6/2008)

Monitoring Plot 5 (6/2008)

Monitoring Plot 6 (6/2008)

| Prepared For: | Suck Creek Stream Restoration<br>Year 5 of 5 | Date: February 2009<br>Project No.: 368 |
|---|---|---|
| Ecosystem Enhancement Program | **Appendix 1.3 Vegetation Monitoring Plot Photos** | |

Monitoring Plot 7 (6/2008)

Monitoring Plot 8 (6/2008)

Monitoring Plot 9 (6/2008)

| Prepared For: | Suck Creek Stream Restoration<br>Year 5 of 5 | Date: February 2009<br>Project No.: 368 |
|---|---|---|
| Ecosystem Enhancement Program | **Appendix 1.3 Vegetation Monitoring Plot Photos** | JJG |

# APPENDIX 2
## GEOMORPHIC AND STREAM STABILITY DATA

1. **Stream Current Condition Table**
2. **Representative Stream Current Condition Photos**
3. **Stream Photo Station Photos**
4. **Stream Cross-Section Photos**
5. **Qualitative Visual Stability Assessment**
6. **Cross-Section Plots and Raw Data Tables***
7. **Longitudinal Plots and Raw Data Tables***
8. **Pebble Count Plots and Raw Data Tables***
9. **Stream Gauge Plot and Raw Data Tables***

*Raw data tables have been provided electronically.

Suck Creek (2,963 lf)

| Feature Issue | Station Numbers | Suspected Cause | Photo ID # |
|---|---|---|---|
| Bank Erosion - Moderate | 9+80 | Scour along streambank-BB | 1 |
| | 17+62 | Scour along streambank-RB | |
| | 18+59-18+74 | | |
| | 20+51-20+57 | | |
| | 20+70-20+87 | | |
| Structure - Stressed | 17+12 | Bank Scour on upstream side of left arm | 2 |
| Aggradation | 4+08 | Mid-Channel Bar | 3 |
| | 7+25 | | |
| | 10+65 | | |
| | 11+79 | | |
| | 19+08 | | |
| Beaver Dam | 28+13 | Beaver Activity | 5 |
| Beaver Chews | N/A | N/A | 6 |
| Channel Inundation | 23+65-28+13 | Water at bankfull, but not over TOB | 7 |

LB - Left Bank Looking Downstream, RB - Right Bank Looking Downstream, BB - Both Banks, TOB - Top of Bank
Please refer to Appendix 2.2 for Current Condition Photos

1. Bank Erosion: Moderate (5/2008)

2. Structure-Stressed (5/2008)

3. Aggradation-Mid-channel Bar (5/2008)

4. In-Stream Vegetation (5/2008)

| Prepared For: | Suck Creek Stream Restoration<br>Year 5 of 5 | Date: February 2009<br>Project No.: 368 |
|---|---|---|
| Ecosystem Enhancement Program | **Appendix 2.2 Representative Stream Current Condition Photos** | JJG |

5. Beaver Dam (5/2008)

6. Beaver Chews (5/2008)

7. Inundation (5/2008)

| Prepared For: | Suck Creek Stream Restoration<br>Year 5 of 5 | Date: February 2009<br>Project No.: 368 |
|---|---|---|
| Ecosystem Enhancement Program | **Appendix 2.2 Representative Stream Current Condition Photos** | JJG |

Photo Point 1-View Downstream (6/2008)

Photo Point 2-View Downstream (6/2008)

Photo Point 3-View Upstream (6/2008)

Photo Point 4-View Downstream (6/2008)

| Prepared For: | Suck Creek Stream Restoration<br>Year 5 of 5 | Date: February 2009<br>Project No.: 368 |
|---|---|---|
| Ecosystem Enhancement Program | **Appendix 2.3 Stream Photo Station Photos** | |

Photo Point 5-View Downstream (6/2008)

Photo Point 6-View Upstream (6/2008)

| | | |
|---|---|---|
| Prepared For: | Suck Creek Stream Restoration<br>Year 5 of 5 | Date: February 2009<br>Project No.: 368 |
| | **Appendix 2.3 Stream Photo Station Photos** | |

Cross-Section 1:  View Upstream (6/2008)

Cross-Section 1:  View Downstream (6/2008)

Cross-Section 2:  View Upstream (6/2008)

Cross-Section 2:  View Downstream (6/2008)

| Prepared For: | Suck Creek Stream Restoration<br>Year 5 of 5 | Date: February 2009<br>Project No.: 368 |
| --- | --- | --- |
| Ecosystem Enhancement Program | **Appendix 2.4 Stream Cross-Section Photos** | |

Cross-Section 3:  View Upstream (6/2008)

Cross-Section 3:  View Downstream (6/2008)

Cross-Section 4:  View Upstream (6/2008)

Cross-Section 4:  View Downstream (6/2008)

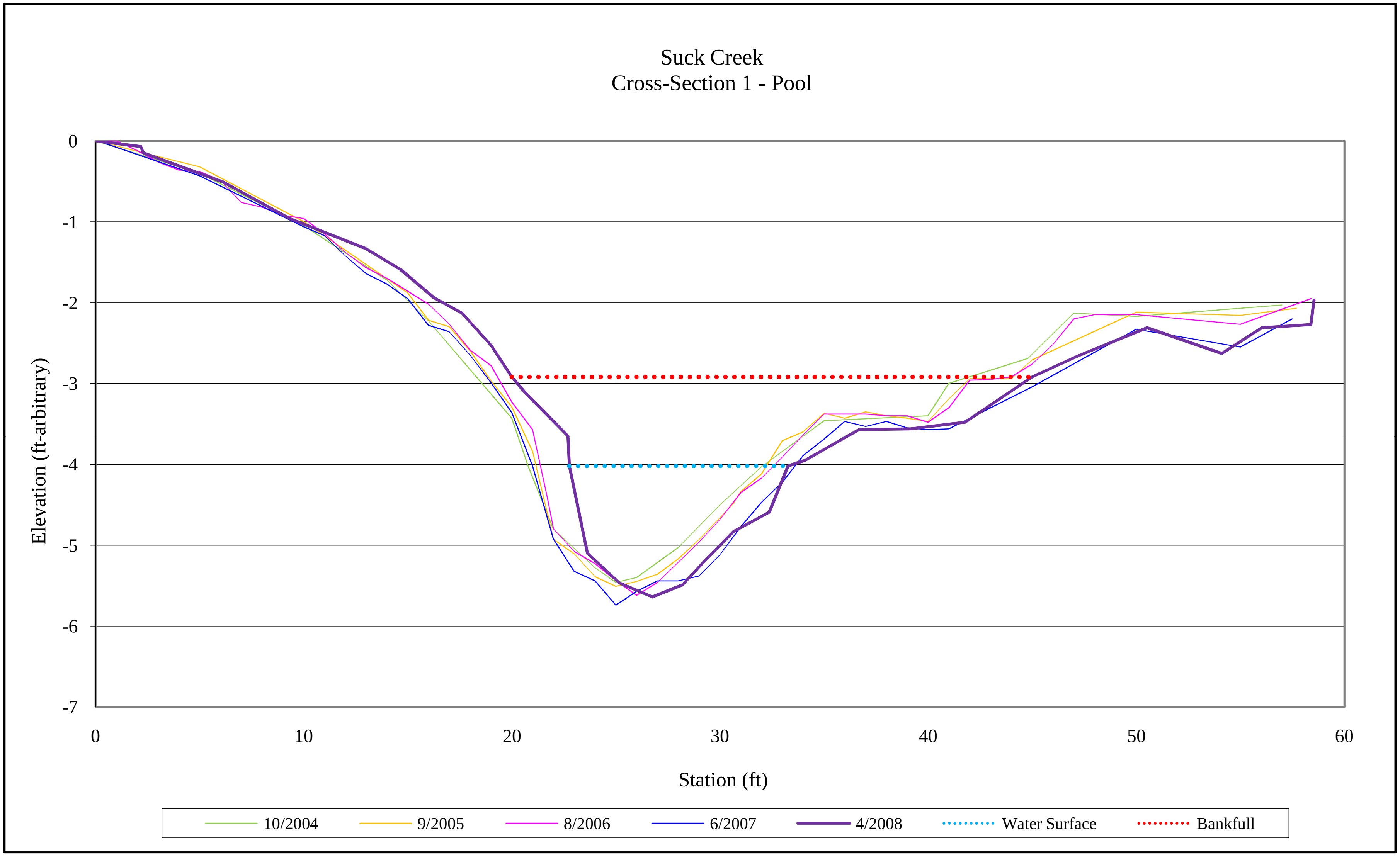
| Prepared For: | Suck Creek Stream Restoration<br>Year 5 of 5 | Date: February 2009<br>Project No.: 368 |
|---|---|---|
| Ecosystem Enhancement Program | **Appendix 2.4 Stream Cross-Section Photos** | |

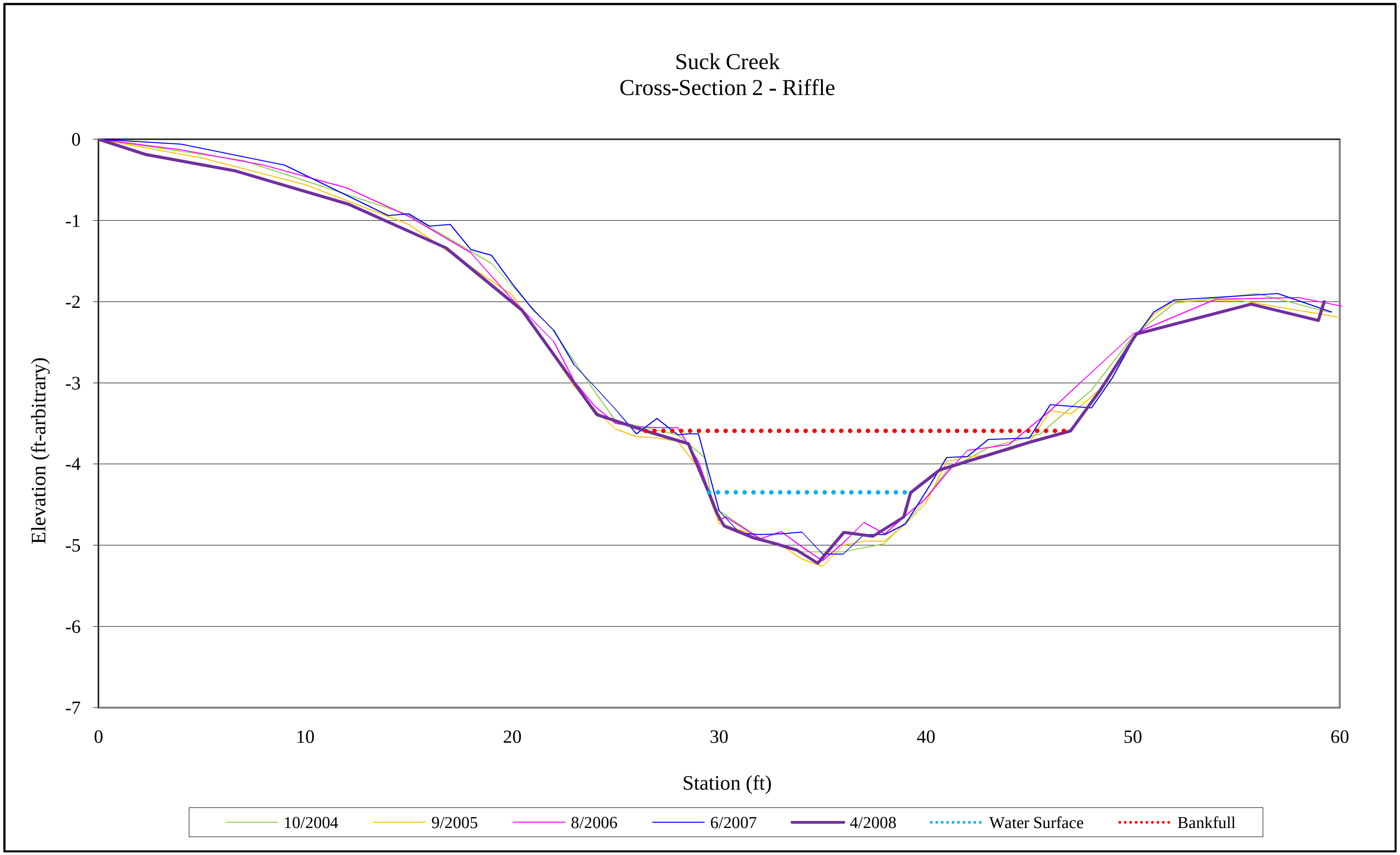
Upper Reach-875 lf

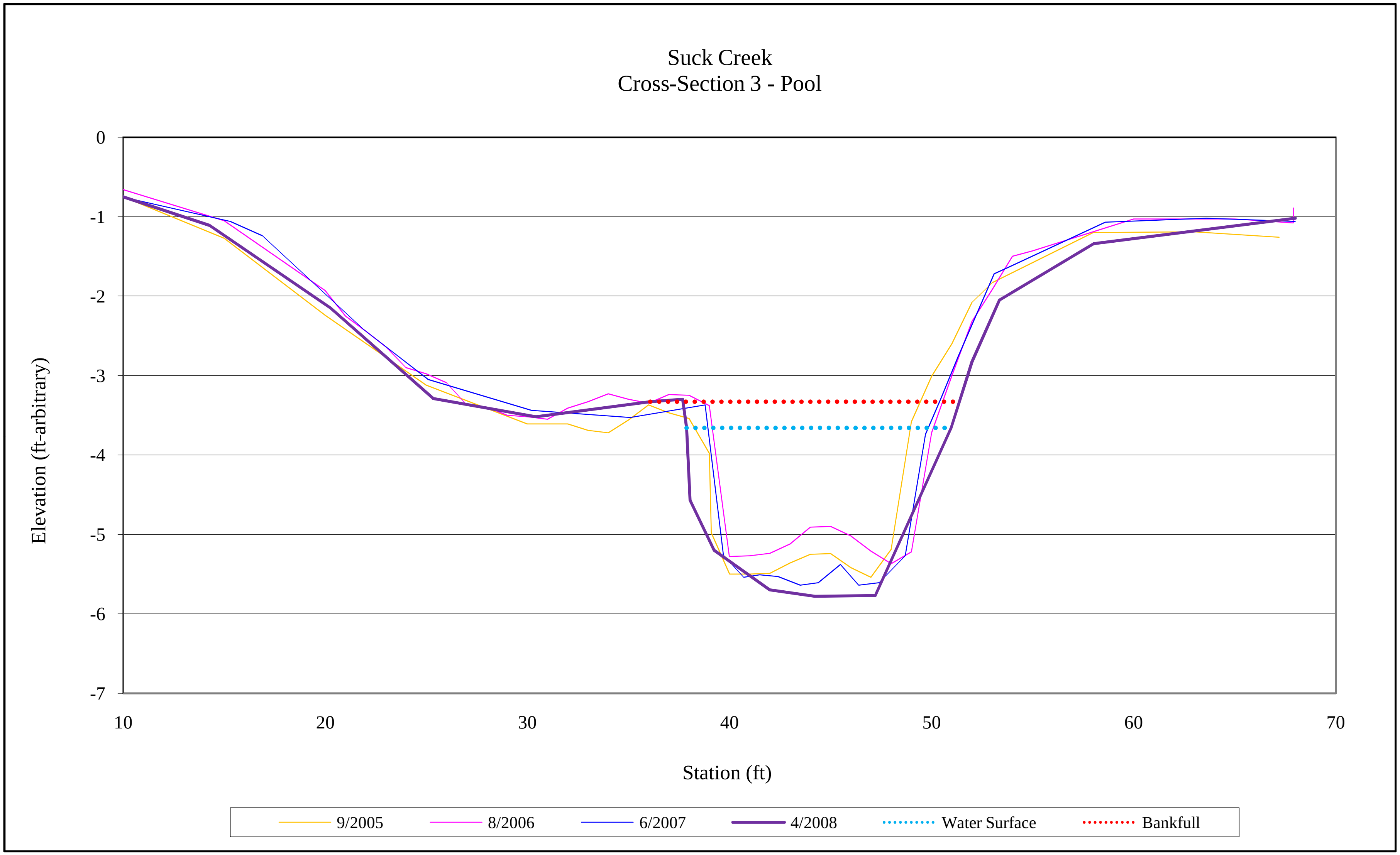
| **Feature Category** | | (# Stable) Number Performing as Intended | Total Number assessed per As-Built survey | Total Number/ feet in unstable state | % Perform in Stable Condition | Feature Perform Mean or Total |
|---|---|---|---|---|---|---|
| A. Riffles | 1. Present? | 7 | | | 88% | |
| | 2. Armor Stable? | N/A | | | | |
| | 3. Facet grade appears stable? | 7 | | N/A | 88% | **88%** |
| | 4. Minimal evidence of embedding/fining? | 7 | | | 88% | |
| | 5. Length appropriate? | 7 | 8 | | 88% | |
| B. Pools | 1. Present? | 7 | | | 88% | |
| | 2. Sufficiently deep? | 7 | | N/A | 88% | **88%** |
| | 3. Length Appropriate? | 7 | 8 | | 88% | |
| C. Thalweg | 1. Upstream of meander bend centering? | 8 | | N/A | 100% | **100%** |
| | 2. Downstream of meander centering? | 8 | 8 | | 100% | |
| D. Meanders | 1. Outer bend in state of limited/controlled erosion? | 7 | 7 | | 100% | |
| | 2. Of those eroding, # w/concomitant point bar formation? | N/A | | N/A | 100% | **100%** |
| | 3. Apparent Rc within spec? | 7 | | | 100% | |
| | 4. Sufficient floodplain access and relief? | 7 | 7 | | 100% | |
| E. Bed General | 1. General channel bed aggradation areas (bar formation)? | N/A | | 2/20 | 98% | **99%** |
| | 2. Channel bed degradation - areas of increasing down-cutting or head cutting? | | | 0 | 100% | |
| F. Bank | 1. Actively eroding, wasting, or slumping bank | N/A | | 0 | 100% | **100%** |
| G. Vanes | 1. Free of back or arm scour? | 7 | | | 100% | |
| | 2. Height appropriate? | N/A | | N/A | N/A | **100%** |
| | 3. Angle and geometry appear appropriate? | | | | | |
| | 4. Free of piping or other structural failures? | 7 | 7 | | 100% | |
| H. Wads/ Boulders | 1. Free of scour? | 7 | | | 100% | |
| | 2. Footing stable? | 7 | 7 | N/A | 100% | **100%** |

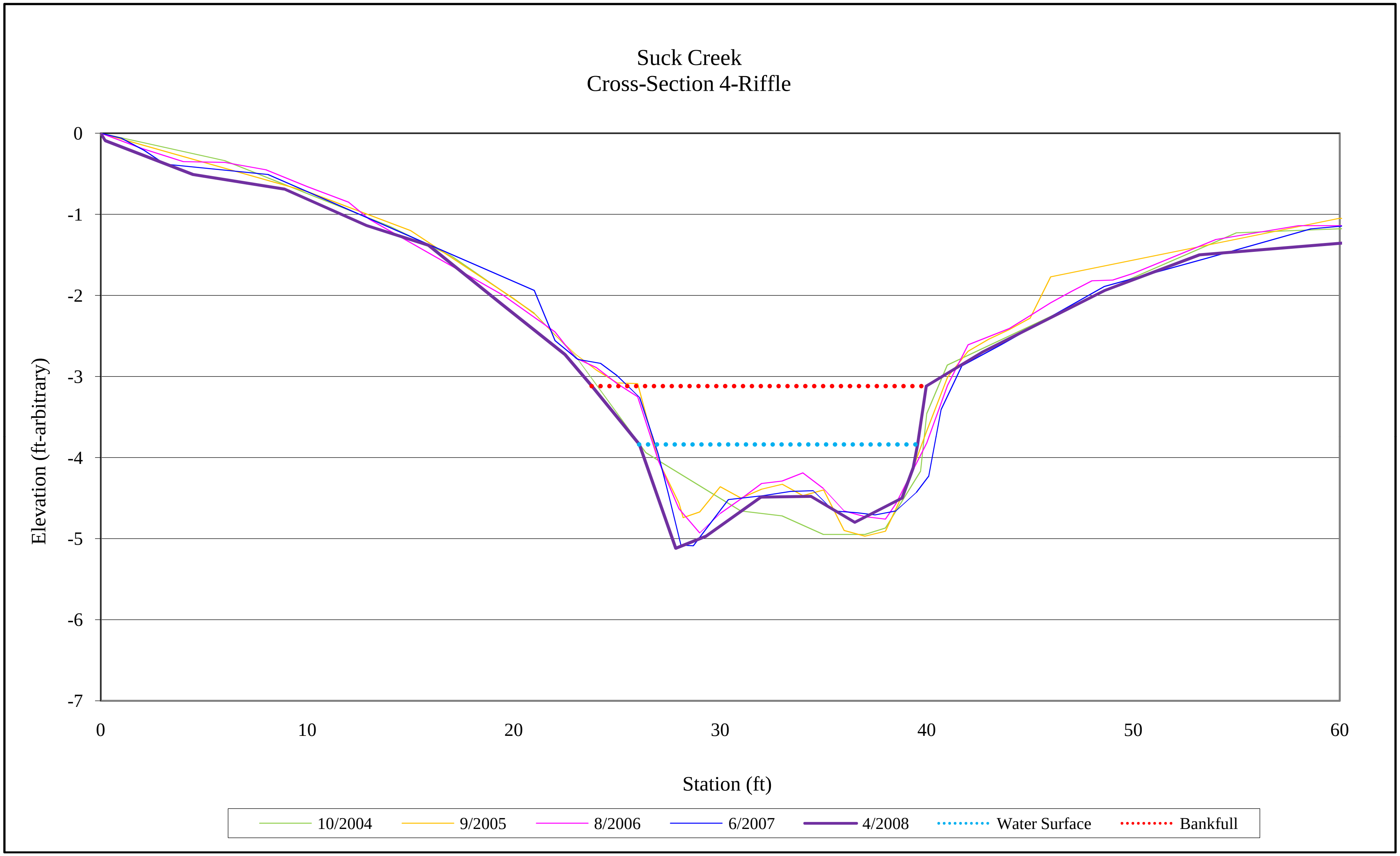
Lower Reach-2088 lf

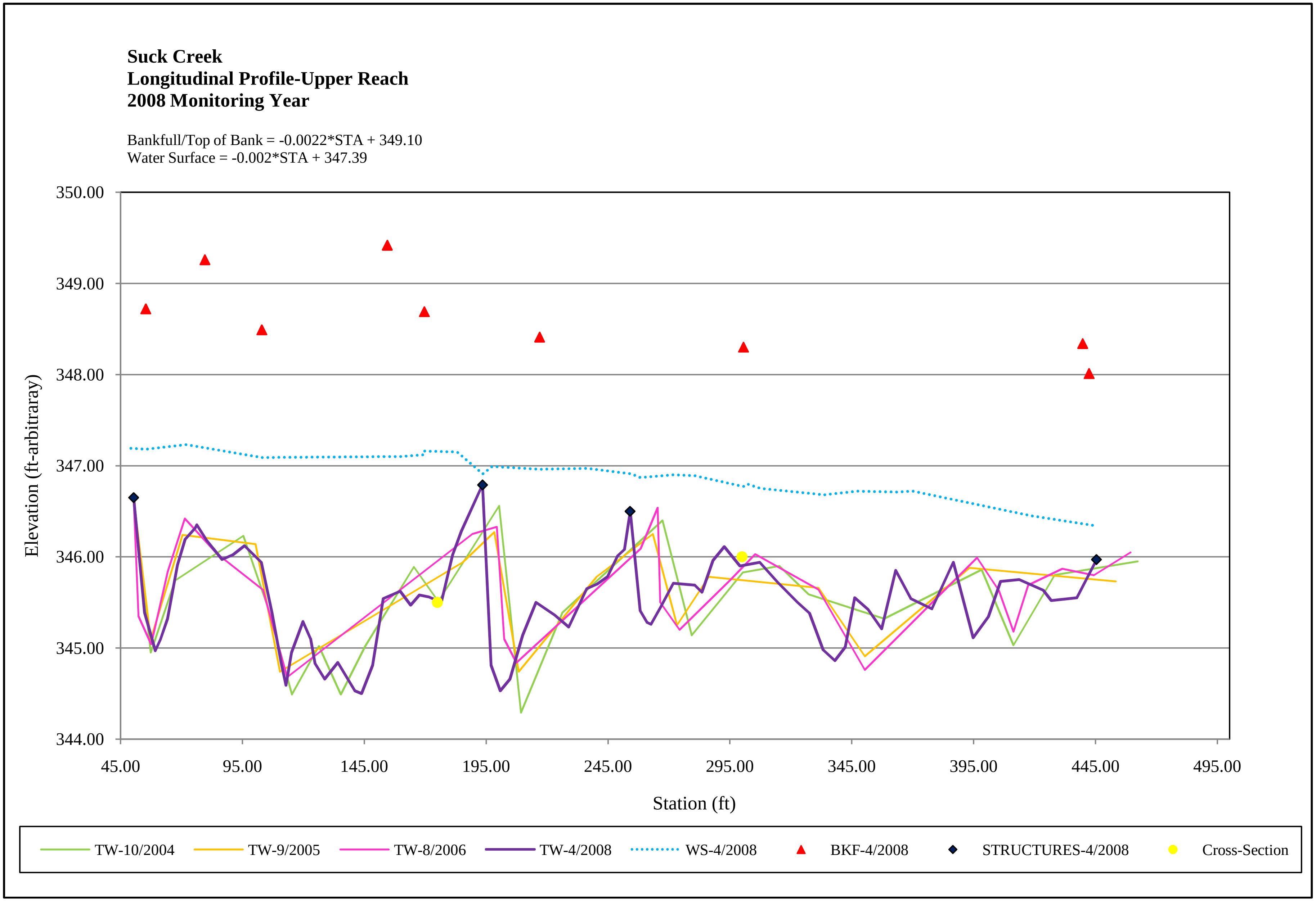
| **Feature Category** | | (# Stable) Number Performing as Intended | Total Number assessed per As-Built survey | Total Number/ feet in unstable state | % Perform in Stable Condition | Feature Perform Mean or Total |
|---|---|---|---|---|---|---|
| A. Riffles | 1. Present? | 23 | 23 | N/A | 100% | **75%** |
| | 2. Armor Stable? | N/A | | | N/A | |
| | 3. Facet grade appears stable? | 23 | | | 100% | |
| | 4. Minimal evidence of embedding/fining? | 0 | | | 0% | |
| | 5. Length appropriate? | 23 | | | 100% | |
| B. Pools | 1. Present? | 24 | 24 | N/A | 100% | **100%** |
| | 2. Sufficiently deep? | 24 | | | 100% | |
| | 3. Length Appropriate? | 24 | | | 100% | |
| C. Thalweg | 1. Upstream of meander bend centering? | 21 | 21 | N/A | 100% | **100%** |
| | 2. Downstream of meander centering? | 21 | | | 100% | |
| D. Meanders | 1. Outer bend in state of limited/controlled erosion? | 16 | 21 | N/A | 76% | **94%** |
| | 2. Of those eroding, # w/concomitant point bar formation? | 21 | | | 100% | |
| | 3. Apparent Rc within spec? | 21 | | | 100% | |
| | 4. Sufficient floodplain access and relief? | 21 | | | 100% | |
| E. Bed General | 1. General channel bed aggradation areas (bar formation)? | N/A | | 3/30 | 99% | **99%** |
| | 2. Channel bed degradation - areas of increasing down-cutting | | | 0 | 100% | |
| F. Bank | 1. Actively eroding, wasting, or slumping bank | N/A | | 3/38 | 99% | **99%** |
| G. Vanes | 1. Free of back or arm scour? | 18 | 19 | N/A | 95% | **95%** |
| | 2. Height appropriate? | N/A | | | N/A | |
| | 3. Angle and geometry appear appropriate? | | | | | |
| | 4. Free of piping or other structural failures? | 18 | | | 95% | |
| H. Wads/ Boulders | 1. Free of scour? | 26 | 26 | N/A | 100% | **100%** |
| | 2. Footing stable? | 26 | | | 100% | |

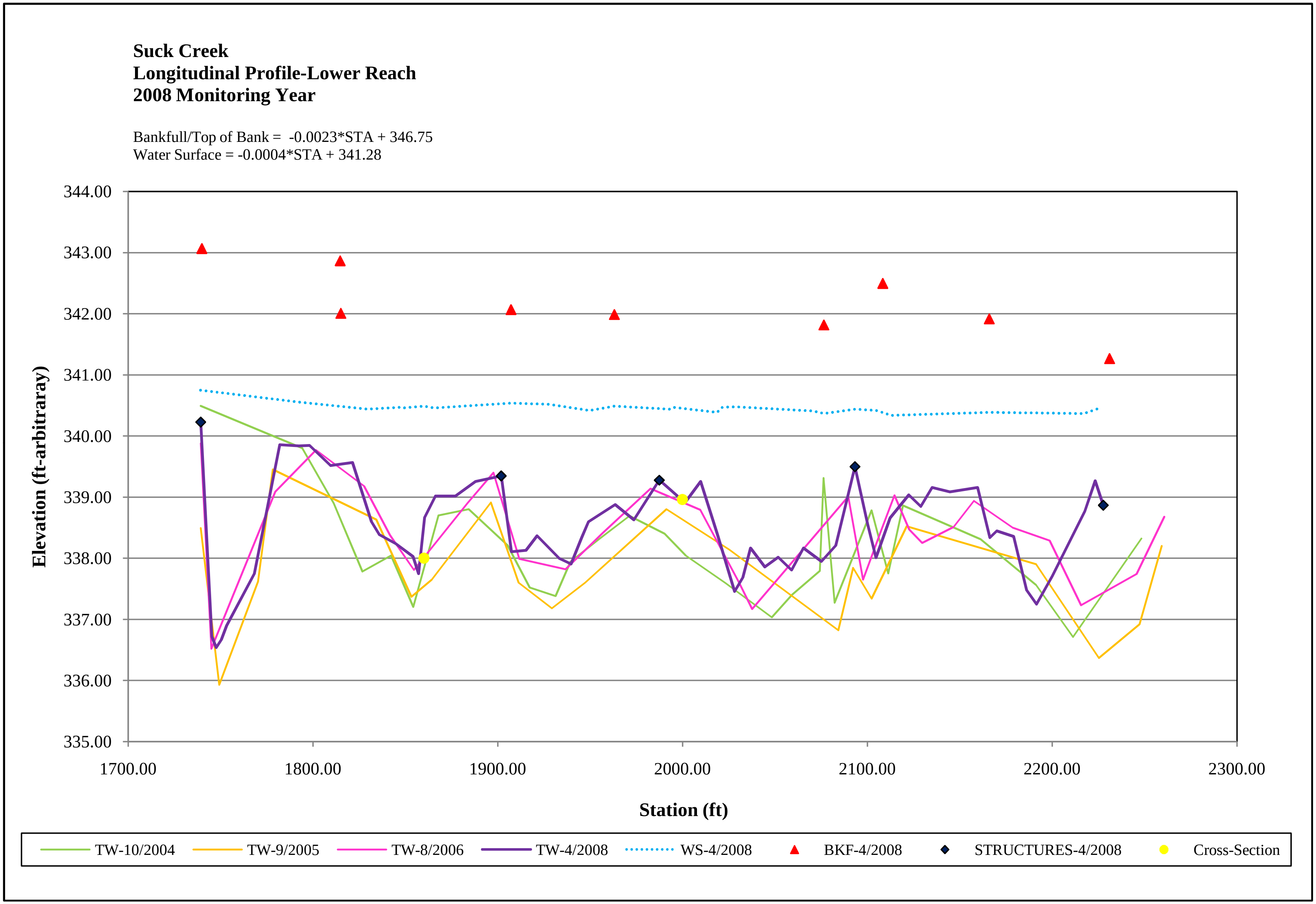

Suck Creek
Cross-Section 1 - Pool
Elevation (ft-arbitrary)
0
-1
-2
-3
-4
-5
-6
-7
0
10
20
30
40
50
60
Station (ft)
10/2004
9/2005
8/2006
6/2007
4/2008
Water Surface
Bankfull

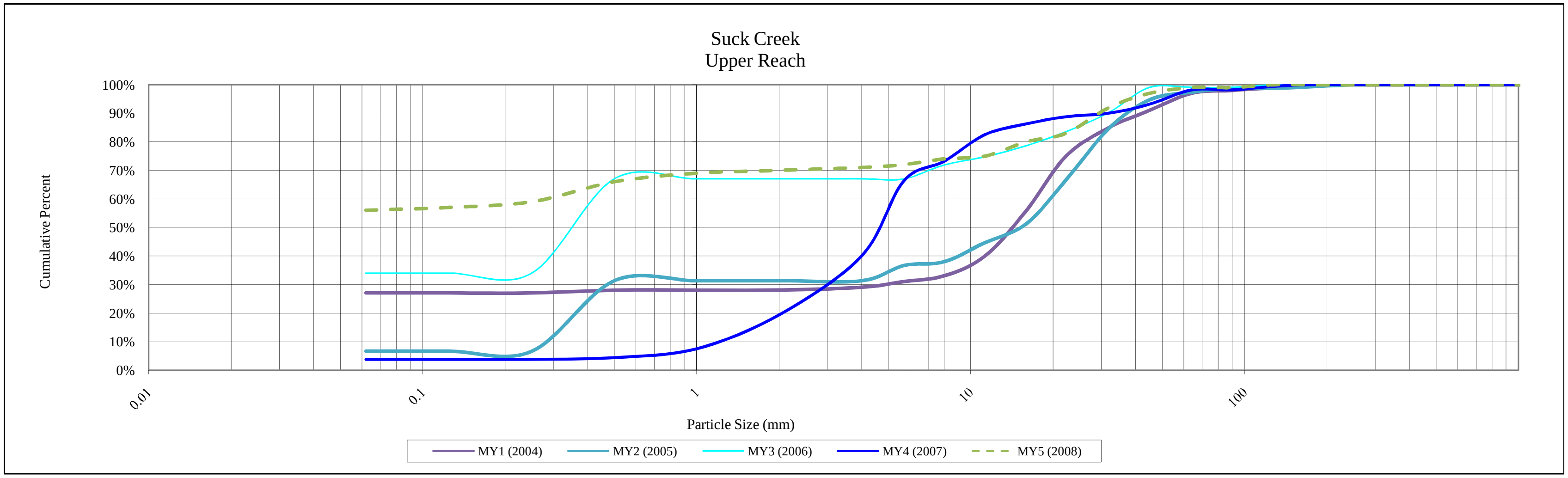

Suck Creek
Cross-Section 2 - Riffle
0
-1
-2
-3
-4
-5
-6
-7
Elevation (ft-arbitrary)
0
10
20
30
40
50
60
Station (ft)
10/2004
9/2005
8/2006
6/2007
4/2008
Water Surface
Bankfull


Suck Creek
Cross-Section 3 - Pool
0
-1
-2
-3
-4
-5
-6
-7
Elevation (ft-arbitrary)
10
20
30
40
50
60
70
Station (ft)
9/2005
8/2006
6/2007
4/2008
Water Surface
Bankfull

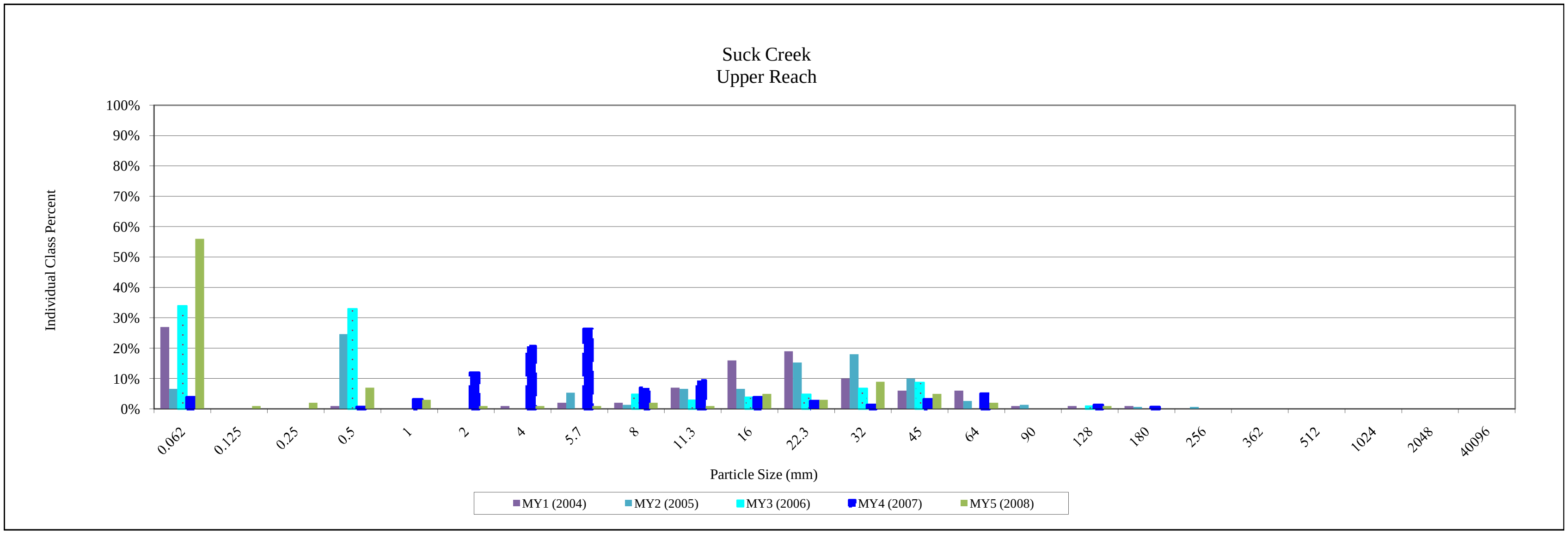

Suck Creek
Cross-Section 4-Riffle
0
-1
-2
-3
-4
-5
-6
-7
Elevation (ft-arbitrary)
0
10
20
30
40
50
60
Station (ft)
10/2004
9/2005
8/2006
6/2007
4/2008
Water Surface
Bankfull


Suck Creek
Longitudinal Profile-Upper Reach
2008 Monitoring Year
Bankfull/Top of Bank = -0.0022*STA + 349.10
Water Surface = -0.002*STA + 347.39
350.00
349.00
348.00
347.00
346.00
345.00
344.00
Elevation (ft-arbitraray)
45.00
95.00
145.00
195.00
245.00
295.00
345.00
395.00
445.00
495.00
Station (ft)
TW-10/2004
TW-9/2005
TW-8/2006
TW-4/2008
WS-4/2008
BKF-4/2008
STRUCTURES-4/2008
Cross-Section

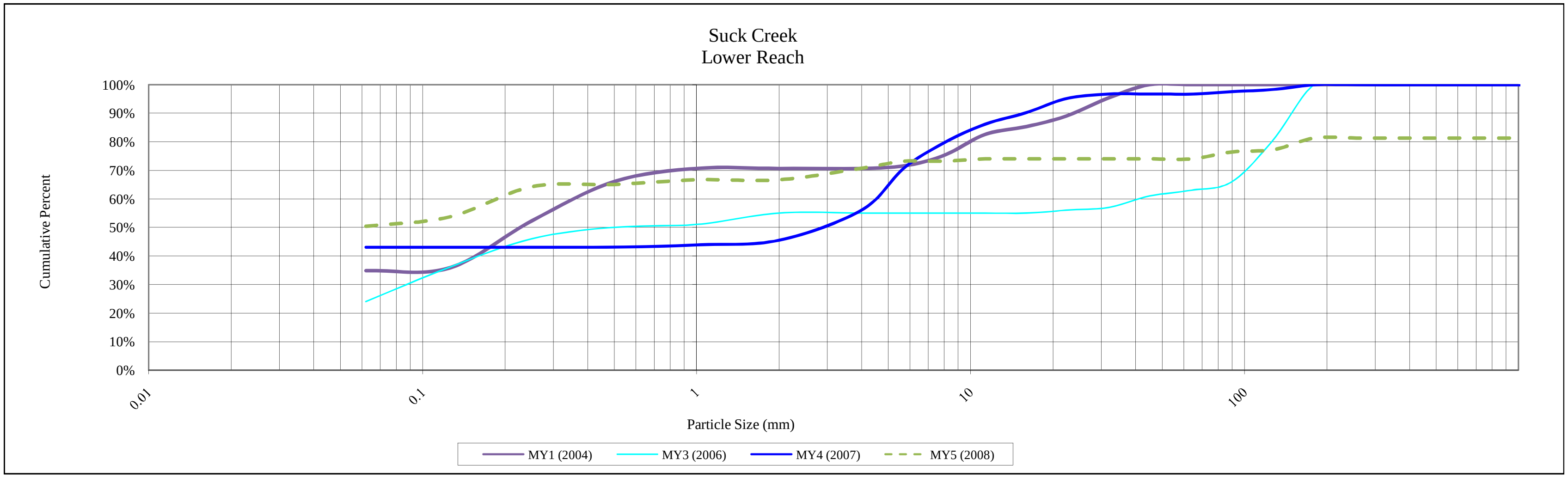

Suck Creek
Longitudinal Profile-Lower Reach
2008 Monitoring Year
Bankfull/Top of Bank = -0.0023*STA + 346.75
Water Surface = -0.0004*STA + 341.28
344.00
343.00
342.00
341.00
340.00
339.00
338.00
337.00
336.00
335.00
Elevation (ft-arbitraray)
1700.00
1800.00
1900.00
2000.00
2100.00
2200.00
2300.00
Station (ft)
TW-10/2004
TW-9/2005
TW-8/2006
TW-4/2008
WS-4/2008
BKF-4/2008
STRUCTURES-4/2008
Cross-Section

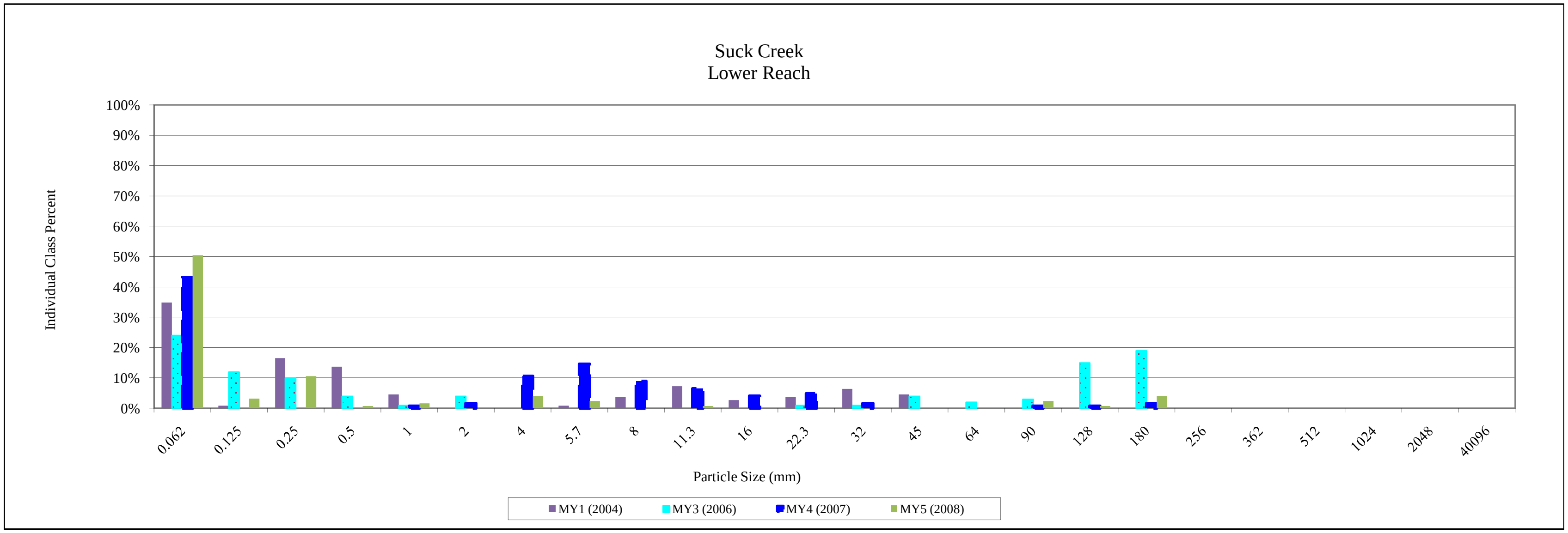


Suck Creek
Upper Reach
Cumulative Percent
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
Particle Size (mm)
MY1 (2004)
MY2 (2005)
MY3 (2006)
MY4 (2007)
MY5 (2008)

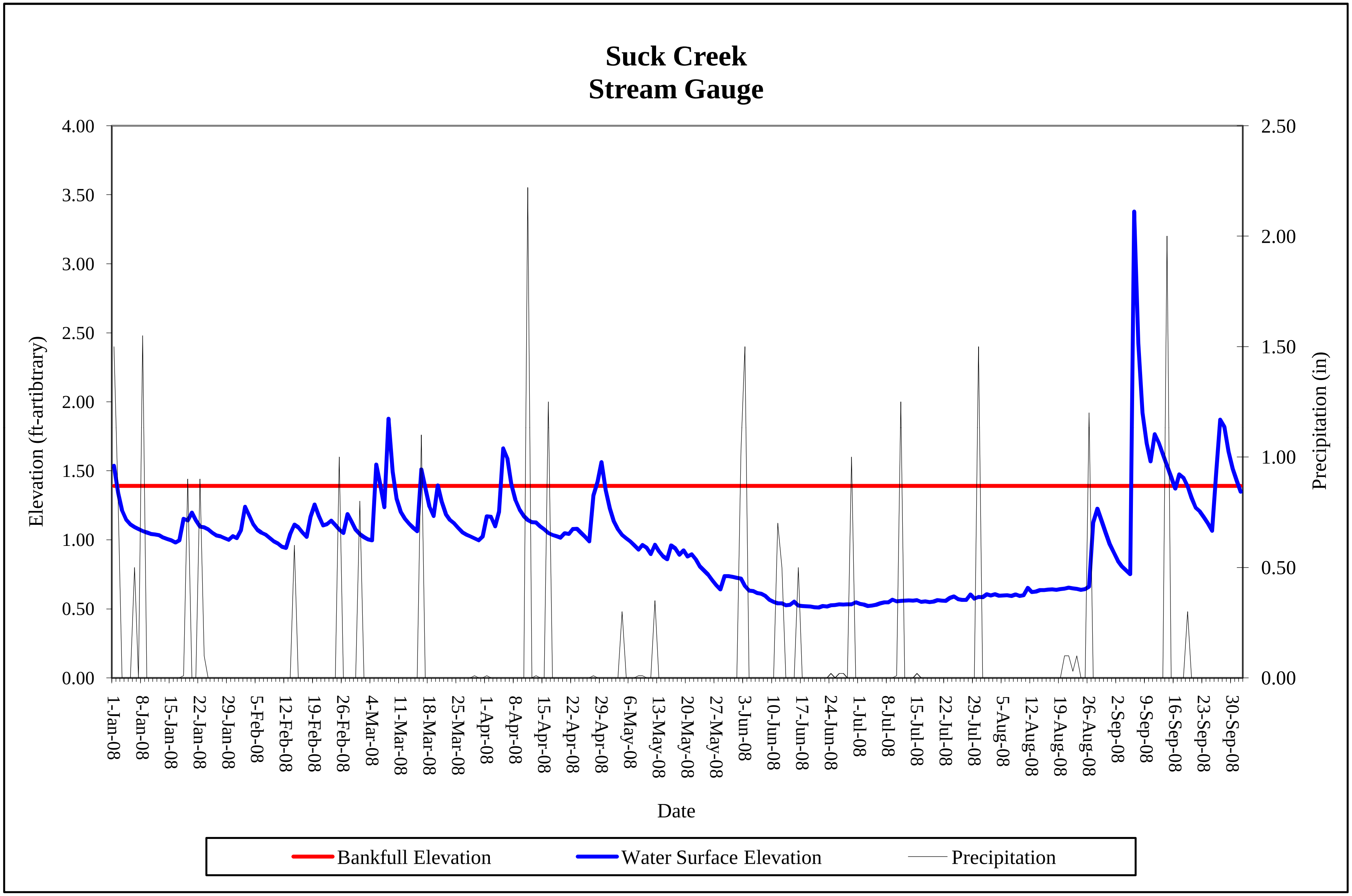



Suck Creek
Upper Reach
Individual Class Percent
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.062
0.125
0.25
0.5
1
2
4
5.7
8
11.3
16
22.3
32
45
64
90
128
180
256
362
512
1024
2048
40096
Particle Size (mm)
MY1 (2004)
MY2 (2005)
MY3 (2006)
MY4 (2007)
MY5 (2008)



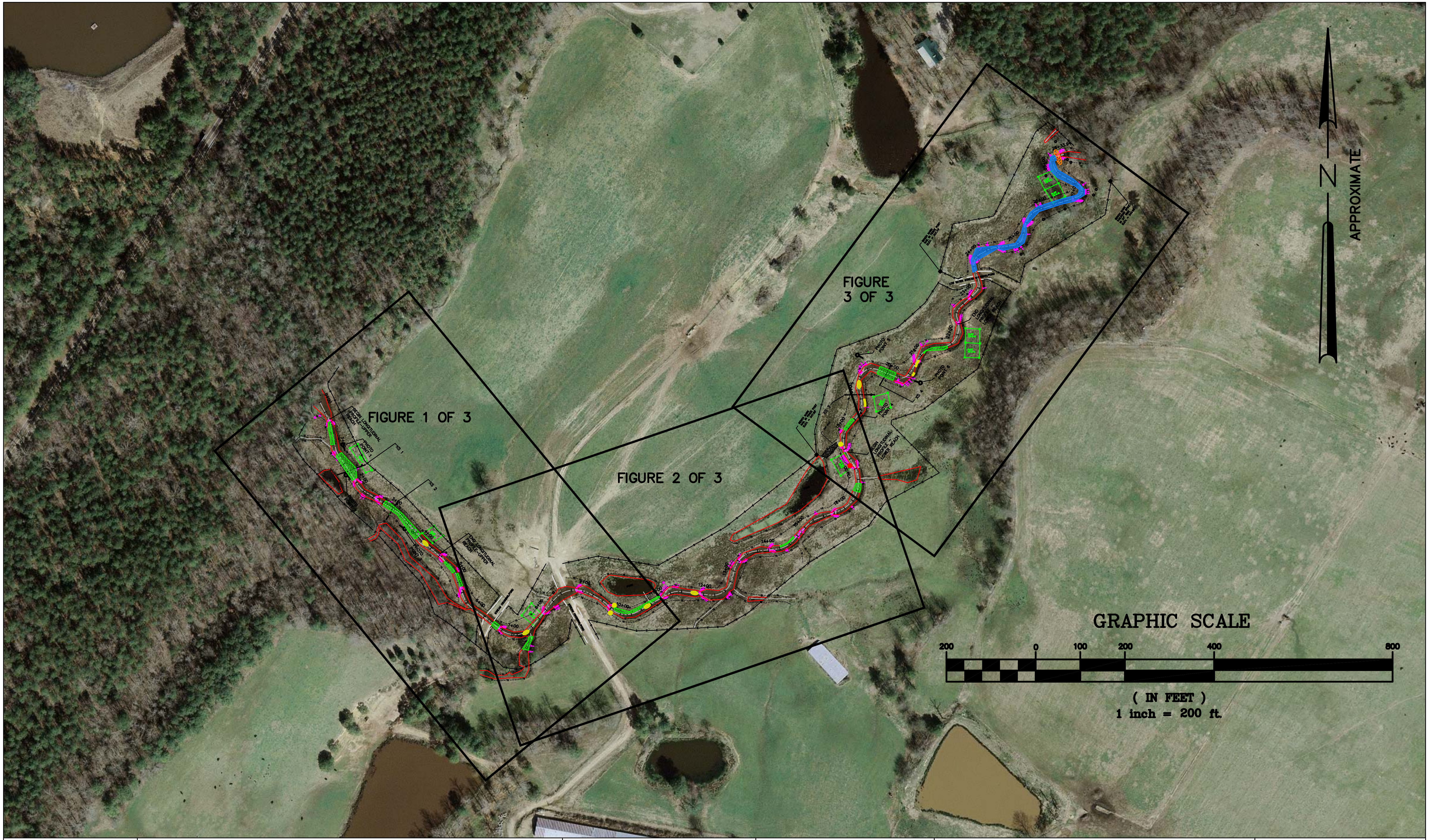

Appendix 2.8 Pebble Count Plots and Raw Appendix 2.8 Pebble Count Plots and Raw Data Tables
Suck Creek Stream Restoration
Year 5 of 5



Suck Creek
Stream Gauge
Elevation (ft-artibtrary)
Precipitation (in)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2.50
2.00
1.50
1.00
0.50
0.00
1-Jan-08
8-Jan-08
15-Jan-08
22-Jan-08
29-Jan-08
5-Feb-08
12-Feb-08
19-Feb-08
26-Feb-08
4-Mar-08
11-Mar-08
18-Mar-08
25-Mar-08
1-Apr-08
8-Apr-08
15-Apr-08
22-Apr-08
29-Apr-08
6-May-08
13-May-08
20-May-08
27-May-08
3-Jun-08
10-Jun-08
17-Jun-08
24-Jun-08
1-Jul-08
8-Jul-08
15-Jul-08
22-Jul-08
29-Jul-08
5-Aug-08
12-Aug-08
19-Aug-08
26-Aug-08
2-Sep-08
9-Sep-08
16-Sep-08
23-Sep-08
30-Sep-08
Date
Bankfull Elevation
Water Surface Elevation
Precipitation

# APPENDIX 3
## CURRENT CONDITION PLAN VIEW (INTEGRATED)

1. **Current Condition Plan View Map (Integrated)**




Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

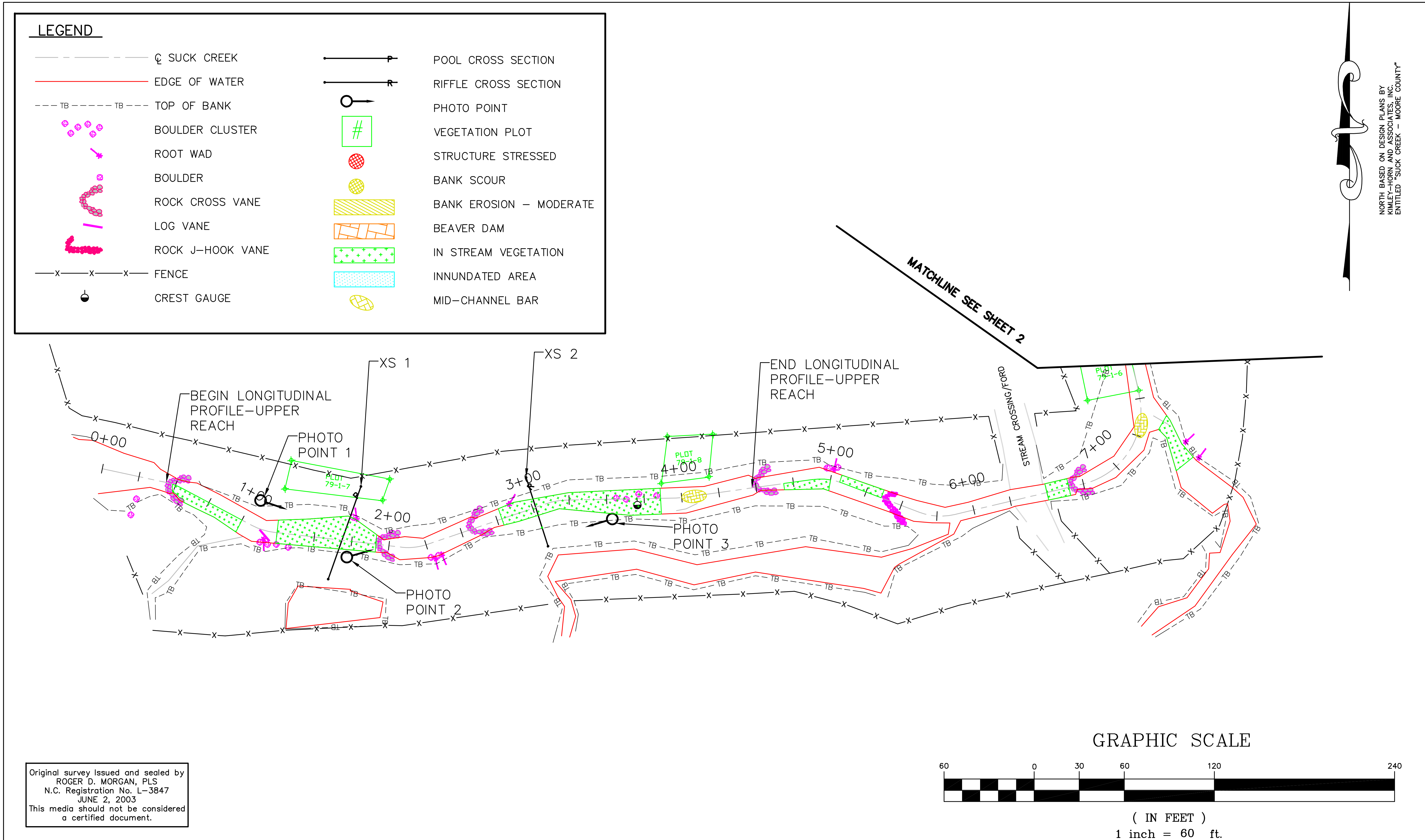
PROJECT NO. 368
MOORE COUNTY
NORTH CAROLINA
MONITORING
YEAR 5 of 5

NC ECOSYSTEM ENHANCEMENT PROGRAM
SUCK CREEK STREAM RESTORATION

APPENDIX 3
CURRENT CONDITION PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=200'
JOB NO.: 03060004

FIGURE KEY




Original survey Issued and sealed by
ROGER D. MORGAN, PLS
N.C. Registration No. L-3847
JUNE 2, 2003
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Ecosystem Enhancement PROGRAM

NOTES:
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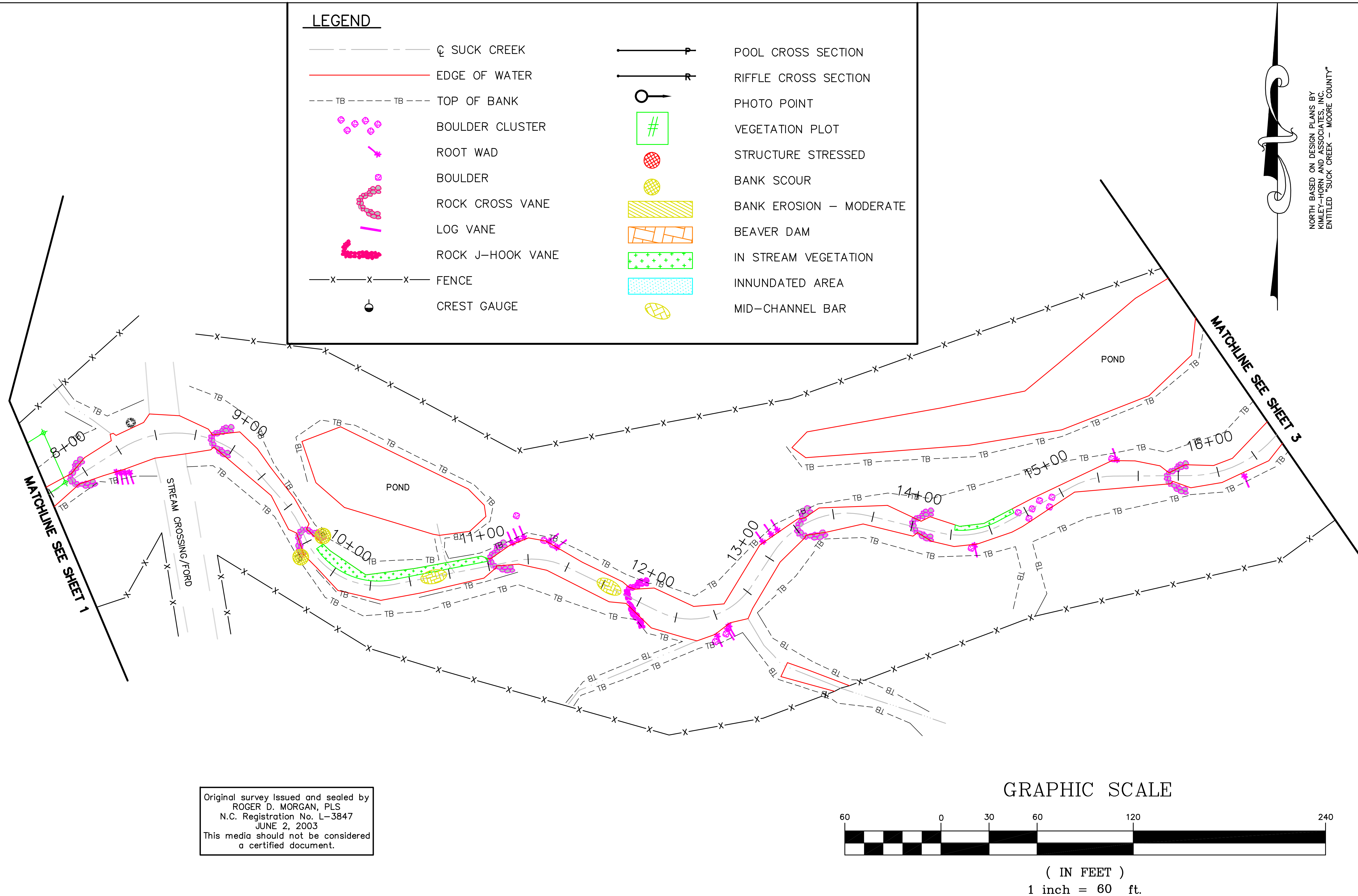
PROJECT NO. 368
MOORE COUNTY
NORTH CAROLINA
MONITORING
YEAR 5 of 5

JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
SUCK CREEK STREAM RESTORATION

APPENDIX 3
CURRENT CONDITION PLAN VIEW

| | |
|---|---|
| DATE : | FEBRUARY 2009 |
| SCALE : | 1"=60' |
| JOB NO.: | 03060004 |
| SHEET | 1 OF 3 |




Ecosystem Enhancement Program

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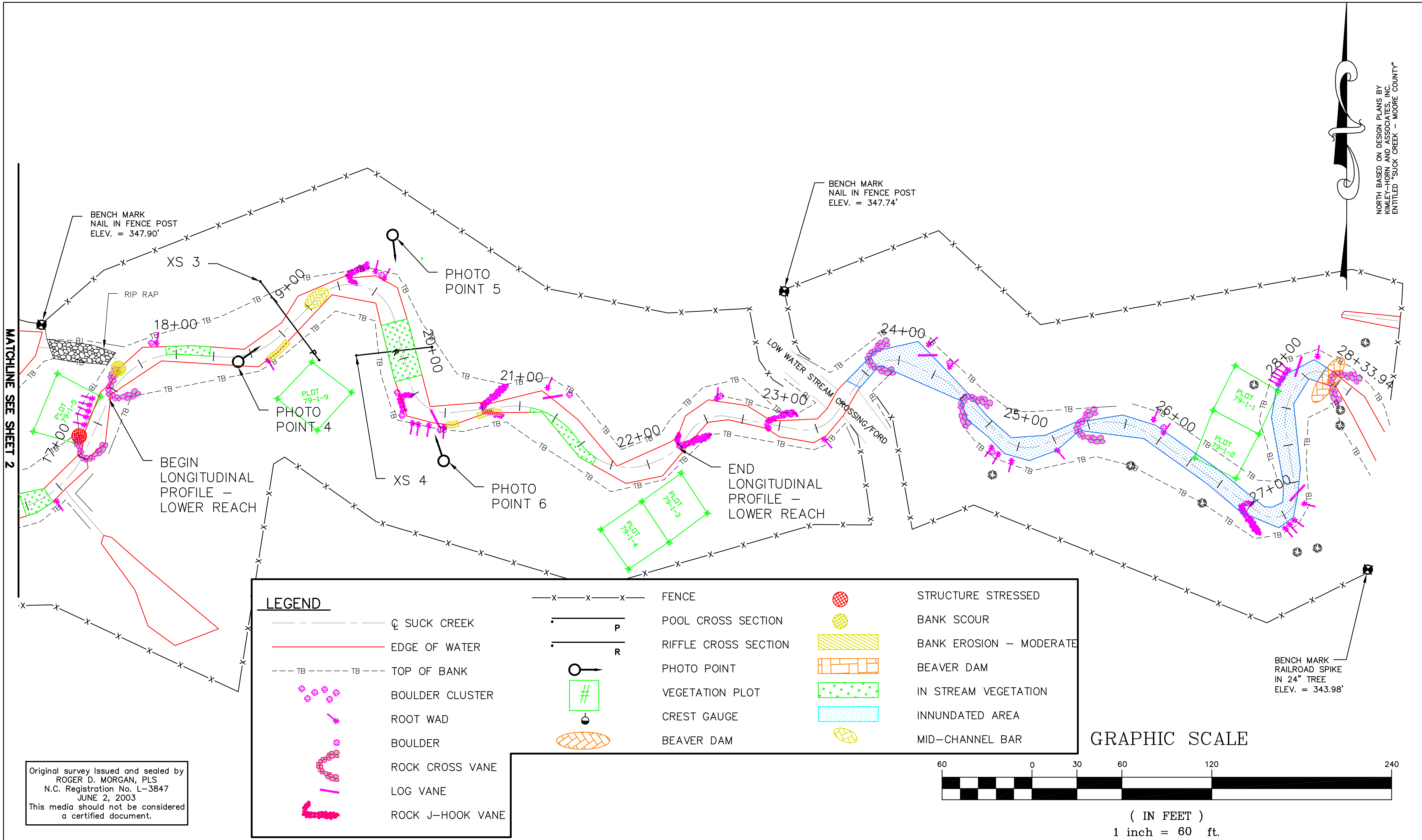
PROJECT NO. 368
MOORE COUNTY
NORTH CAROLINA
MONITORING
YEAR 5 of 5

JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
SUCK CREEK STREAM RESTORATION

APPENDIX 3
CURRENT CONDITION PLAN VIEW

| | |
|---|---|
| DATE : | FEBRUARY 2009 |
| SCALE : | 1"=60' |
| JOB NO.: | 03060004 |
| SHEET | 2 OF 3 |

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PROJECT NO. 368
MOORE COUNTY
NORTH CAROLINA
MONITORING
YEAR 5 of 5

JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
SUCK CREEK STREAM RESTORATION

APPENDIX 3
CURRENT CONDITION PLAN VIEW

DATE : FEBRUARY 2009
SCALE : 1"=60'
JOB NO.: 03060004

SHEET 3 OF 3