

**FINAL  
ANNUAL MONITORING REPORT  
IRWIN CREEK  
RESTORATION SITE  
MECKLENBURG COUNTY, NORTH CAROLINA  
(EEP Project Number 192, Contract Number 004502)**

Monitoring Year 4 of 5 (2014)



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



November 2014

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Submitted to:  
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November 2014

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## 1.0 EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) has completed level II stream enhancement and wetland creation at the Irwin Creek Restoration Site (hereafter referred to as the “Site”) to assist in fulfilling stream and wetland mitigation goals in the area. This report (compiled based on EEP’s *Procedural Guidance and Content Requirements for EEP Monitoring Reports* Version 1.4 dated 11/7/11) summarizes data for year 4 (2014) monitoring.

The goals and objectives of this project focus on improving local water quality, habitat, and stream stability. The project approach was designed to provide restoration-oriented improvements to maximize environmental benefits while working within Site constraints and technical guidelines. These goals were accomplished by the following.

1. Creating a floodplain bench including off-line wetlands to reduce the amount of sediment entering the stream by acting as a repository for soils suspended in the water column during high flow events, providing water storage to further allow sediment to settle out, and slow recharge of stormwater into the groundwater subsurface network.
2. Enhancing vegetation to provide habitat/food sources, shade the stream, filter overland runoff, and remove soil particles and other nutrients from stormwater.
3. Protecting a Site identified in a watershed that is listed as impaired for elevated levels of fecal coliform bacteria and turbidity (NCEEP 2007).

The Site is located on the western side of the City of Charlotte, approximately 2 miles southeast of the Charlotte Douglas International Airport, in Mecklenburg County. The Site is located in United States Geological Survey Hydrologic Unit 03050103020020 (North Carolina Division of Water Quality [NCDWQ] Subbasin 03-08-34) of the Catawba River Basin and will service USGS 8-digit Cataloging Unit (CU) 03050103.

The Site is located in an EEP Targeted Local Watershed within the Sugar Creek watershed; this watershed in conjunction with the Little Sugar, McMullen, and McAlpine Creek watersheds in CU 03050103 drain point and nonpoint sources of pollution from the metropolitan center of Charlotte severely impacting aquatic health of the watershed. The waters are listed as impaired for elevated levels of fecal coliform bacteria and turbidity; the main goal in this CU is to provide better stormwater management (NCEEP 2007).

Prior to construction, the Site was located within a FEMA buyout area where several homes were demolished and removed. Surrounding land uses include commercial and residential areas with narrow riparian corridors adjacent to streams; greater than 85-90 percent of the contributing watershed having been cleared and developed.

This project was constructed between the spring and early winter of 2009. The project consisted of enhancement (level II) of 980 linear feet of stream by laying back stream banks, excavating an extensive 90- to 100-foot wide floodplain bench along the entire project stream length and planting with native forest species. Several structures were left at the downstream end of the Site rather than removing them to avoid disturbance to the stream banks. In November 2013, the three large step-structures on the downstream portion of the site were removed, and the material was used to repair erosion on the left bank

further upstream. The left bank appears to be stable, with vegetation establishing, and the stream is functioning as designed. Site activities provide 653 Stream Mitigation Units. The Site is protected by a permanent conservation easement held by the State of North Carolina.

Success criteria for stream enhancement will include 1) success of riparian vegetation and 2) documentation of two bankfull channel events. A crest gauge is located within the Site to assist with documentation of bankfull events (Figure 2, Appendix B). Seven bankfull events have occurred since last reported in the year 3 (2012) Annual Monitoring Report for a total of thirteen bankfull events.

On November 22, 2013, the entire Site was replanted by the Mecklenburg Stormwater Services Group with 1500 bare root seedlings in tree tubes and 300 lvestakes as follows.

#### **Bare Root Seedlings**

|     |  |
|-----|--|
| 125 | river birch ( <i>Betula nigra</i> )                |
| 75  | tulip poplar ( <i>Liriodendron tulipifera</i> )    |
| 100 | red maple ( <i>Acer rubrum</i> )                   |
| 100 | swamp chestnut oak ( <i>Quercus michauxii</i> )    |
| 200 | silky dogwood ( <i>Cornus amomum</i> )             |
| 100 | ironwood ( <i>Carpinus caroliniana</i> )           |
| 100 | eastern redbud ( <i>Cercis canadensis</i> )        |
| 200 | red mulberry ( <i>Morus rubra</i> )                |
| 125 | American sycamore ( <i>Platanus occidentalis</i> ) |
| 75  | green ash ( <i>Fraxinus pennsylvanica</i> )        |
| 100 | southern arrowwood ( <i>Viburnum dentatum</i> )    |
| 200 | winterberry ( <i>Ilex opaca</i> )                  |

**1500 TOTAL**

#### **Livestakes**

|     |  |
|-----|--|
| 100 | silky dogwood ( <i>Cornus amomum</i> )             |
| 100 | American elderberry ( <i>Sambucus canadensis</i> ) |
| 100 | buttonbush ( <i>Cephalanthus occidentalis</i> )    |

**300 TOTAL**

Vegetation success criteria dictate that an average density of 320 stems per acre must be surviving in the first three monitoring years. Subsequently, 290 stems per acre must be surviving in year 4 and 260 stems per acre in year 5. Stem counts will be based on an average of the evaluated vegetation plots.

Baseline vegetation counts, conducted in February 2014 indicated 745 planted stems per acre (excluding lvestakes) within vegetation plots. Based on the number of stems counted during year 4 (2014) annual monitoring conducted in July 2014, average densities were measured at 502 planted stems per acre (excluding lvestakes) surviving. The dominant species identified at the Site were planted stems of river birch (*Betula nigra*), common winterberry (*Ilex verticillata*), and southern arrowwood (*Viburnum dentatum*). As a planned management measure to limit herbaceous competition for the new stems, the Mecklenburg Stormwater Services Group mowed the planting area prior to and after the planting. During the second mowing of the Site, several trees were destroyed. Each individual vegetation plot met success criteria when counting planted stems alone with the exception of plot 4, which had several stems destroyed by mowers. Overall, the surviving planted stems are vigorous and viable.

One small patch of kudzu (*Pueraria lobata*) was observed in the streamside assemblage on the left bank of Irwin Creek in the upstream portion of the Site (Figure 2, Appendix B).

Summary information and data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in tables and figures within this report's appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on EEPs website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.

## **2.0 METHODOLOGY**

### **2.1 Vegetation Assessment**

Five vegetation plots were established and marked after construction with four foot metal U-bar post demarking the corners with a ten foot, three-quarter inch PVC at the origin. The plots are 10 meters square and are located randomly within the Site. These plots were surveyed in July for the year 4 (2014) monitoring season using the *CVS-EEP Protocol for Recording Vegetation, Version 4.2* (Lee et al. 2008) (<http://cvs.bio.unc.edu/methods.htm>); results are included in Appendix C. The taxonomic standard for vegetation used for this document was *Flora of the Southern and Mid-Atlantic States* (Weakley 2012).

## **3.0 REFERENCES**

Lee, Michael T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation, Version 4.2. (online). Available: <http://cvs.bio.unc.edu/methods.htm>.

National Oceanic and Atmospheric Administration (NOAA). 2004. Climatology of the United States No. 20; Monthly Station Climate Summaries, 1971-2000. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Asheville, North Carolina.

North Carolina Ecosystem Enhancement Program (NCEEP). 2007. Catawba River Basin Restoration Priorities. Available: <http://www.nceep.net/services/restplans/RBRPCatawba2007.pdf> [June 2010]. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, North Carolina.

Weakley, Alan S. 2012. Flora of the Southern and Mid-Atlantic States. Available online at: <http://www.herbarium.unc.edu/WeakleysFlora.pdf> [September 28, 2012]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.

Weather Underground. 2014. Station at Charlotte Douglas International Airport (KCLT) in Charlotte, North Carolina. (online). Available: <http://www.wunderground.com/history/airport/KCLT/2014/09/19/CustomHistory.html> [September 19, 2014].

## APPENDIX A

### PROJECT VICINITY MAP AND BACKGROUND TABLES

Figure 1. Vicinity Map

Table 1. Project Components and Mitigation Credits

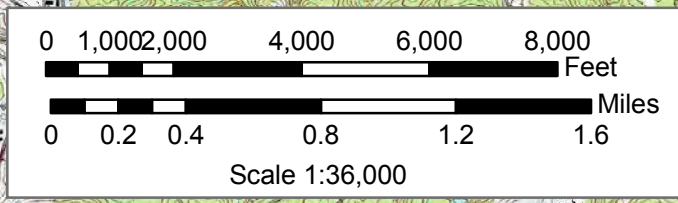
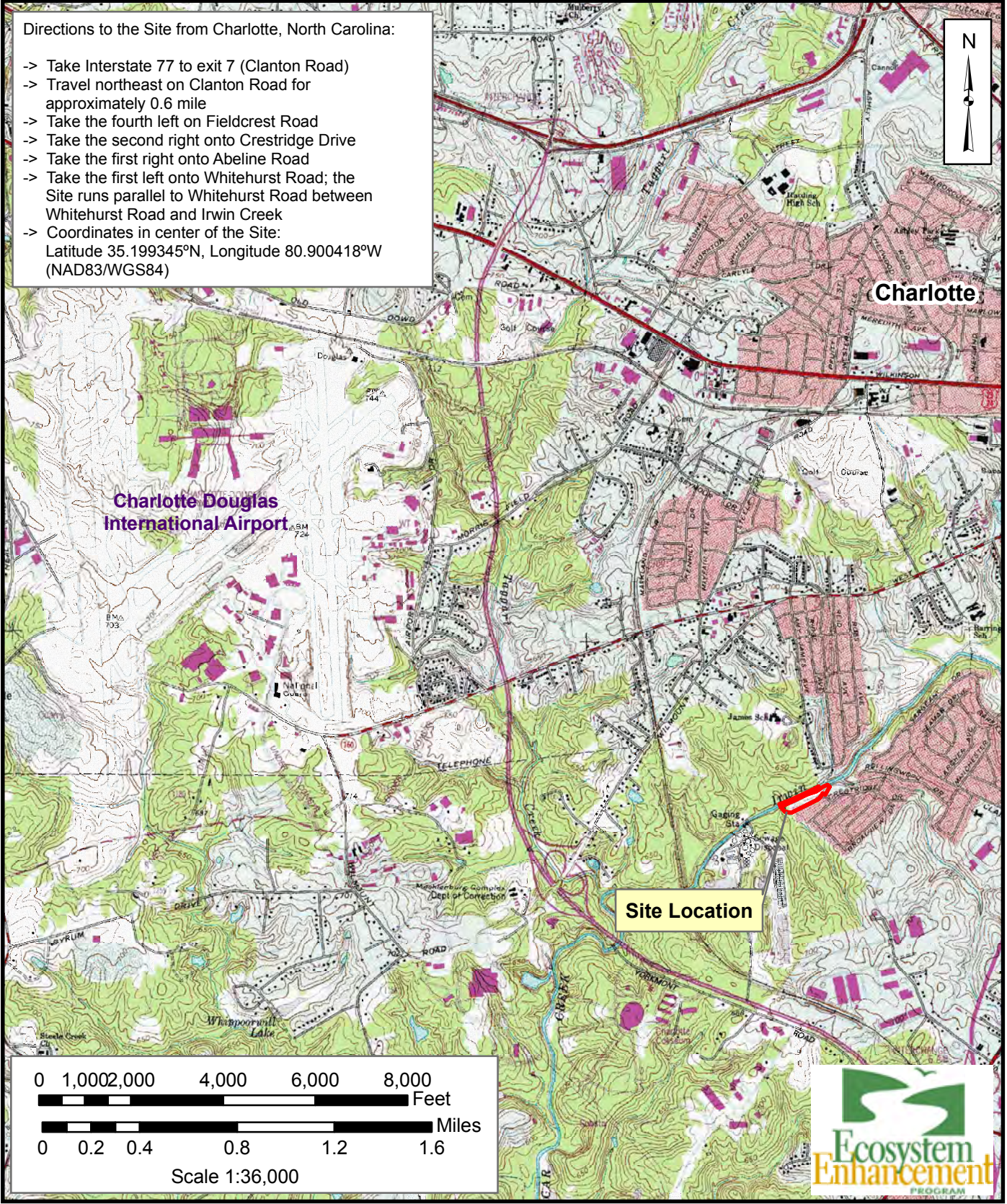
Table 2. Project Activity and Reporting History

Table 3. Project Contacts Table

Table 4. Project Baseline Information and Attributes

Directions to the Site from Charlotte, North Carolina:

- > Take Interstate 77 to exit 7 (Clanton Road)
- > Travel northeast on Clanton Road for approximately 0.6 mile
- > Take the fourth left on Fieldcrest Road
- > Take the second right onto Crestridge Drive
- > Take the first right onto Abeline Road
- > Take the first left onto Whitehurst Road; the Site runs parallel to Whitehurst Road between Whitehurst Road and Irwin Creek
- > Coordinates in center of the Site:  
Latitude 35.199345°N, Longitude 80.900418°W  
(NAD83/WGS84)



20 Enterprise Street  
Suite 7  
Raleigh, NC 27607  
(919) 215-1693

VICINITY MAP  
IRWIN CREEK STREAM RESTORATION SITE  
EEP PROJECT NUMBER 192  
Mecklenburg County, North Carolina

|          |           |
|----------|-----------|
| Dwn. by: | CLF       |
| Date:    | June 2010 |
| Project: | 10-009    |

FIGURE  
**1**



**Table 1. Project Components and Mitigation Credits  
Irwin Creek Restoration Site/EEP Project Number 192**

| Mitigation Credits             |               |                                     |                        |  |  |                  |   |
|--------------------------------|---------------|-------------------------------------|------------------------|--|--|------------------|---|
| Stream                         |               |                                     |                        | Riverine Riparian Wetland              |  |                  |   |
| Type                           | Restoration   |                                     | Restoration Equivalent |  | Restoration                            |                  | Restoration Equivalent  |
| Totals                         | --            |                                     | 653                    |  | --                                     |                  | --  |
| Projects Components            |               |                                     |                        |  |  |                  |   |
| Project Component/<br>Reach ID | Station Range | Existing Linear Footage/<br>Acreage | Priority Approach      | Restoration/<br>Restoration Equivalent | Restoration Linear Footage/<br>Acreage | Mitigation Ratio | Comment   |
| Irwin Creek                    | --            | 980                                 | Level II               | Enhancement                            | 980                                    | 1.5:1*           | Laying back stream banks, excavation of a 90- to 100-foot wide floodplain bench along the entire project, and planting with native forest vegetation. |
| Component Summation            |               |                                     |                        |  |  |                  |   |
| Restoration Level              |               | Stream (linear footage)             |                        |  | Riparian Wetland (acreage)             |                  |   |
| Enhancement (Level II)         |               | 980                                 |                        |  | Riverine                               |                  |   |
| Creation                       |               | --                                  |                        |  | --                                     |                  |   |
| <b>Totals</b>                  |               | <b>980</b>                          |                        |  | <b>--</b>                              |                  |   |
| <b>Mitigation Units</b>        |               | <b>653 SMUs*</b>                    |                        |  | <b>--</b>                              |                  |   |

\* A ratio of 1.5:1 was used due to the extensive excavation of a 90- to 100-foot wide floodplain bench along the entire project.

**Table 2. Project Activity and Reporting History  
Irwin Creek Restoration Site/EEP Project Number 192**

**Elapsed Time Since Grading Complete: 5.5 years**  
**Elapsed Time Since Planting Complete: 10 Months**  
**Number of Reporting Years: 4**

| <b>Activity or Deliverable</b>     | <b>Data Collection Complete</b> | <b>Completion or Delivery</b> |
|------------------------------------|---------------------------------|-------------------------------|
| Restoration Plan                   | --                              | October 2003                  |
| Site Construction and 1st Planting | --                              | Spring 2009                   |
| 2nd Planting                       | --                              | Late fall/early winter 2009   |
| 3 <sup>rd</sup> Planting           | --                              | March 2011                    |
| As-built Analysis Report           | --                              | March 2010                    |
| As-built Record Drawings           | --                              | March 2010                    |
| Baseline Monitoring Document       | June 2010                       | October 2010                  |
| Year 1 (2010) Monitoring Document  | November 2010                   | October 2010                  |
| Year 2 (2011) Monitoring Document  | November 2011                   | December 2011                 |
| Year 3 (2012) Monitoring Document  | November 2012                   | November 2012                 |
| Replanting Entire Site             | --                              | November 2013                 |
| Structure Removal                  | --                              | November 2013                 |
| Year 4 (2014) Monitoring Document  | September 2014                  | November 2014                 |

**Table 3. Project Contacts Table  
Irwin Creek Restoration Site/EEP Project Number 192**

|  |   |
|--|---|
| <b>Designer</b>  | HDR Engineering of the Carolinas, Inc.<br>3733 National Drive<br>Raleigh, NC 27612<br>919-785-1118        |
| <b>Construction and Seeding and Matting Contractor</b> | Blythe Development Company<br>1415 E. Westinghouse<br>Charlotte, NC 28273                                 |
| <b>Planting Contractor</b>                             | North State Environmental, Inc.<br>2889 Lowery Street, Suite B<br>Winston Salem, NC 27101<br>336-725-2010 |
| <b>Monitoring Performer</b>                            | Axiom Environmental, Inc.<br>218 Snow Avenue<br>Raleigh, NC 27603<br>919-215-1693                         |

**Table 4. Project Baseline Information and Attributes  
Irwin Creek Restoration Site/EEP Project Number 192**

| <b>Project Information</b>                   |                                    |
|--|------------------------------------|
| Project Name                                 | Irwin Creek Restoration Site       |
| Project County                               | Mecklenburg County, North Carolina |
| Project Area                                 | 5.7 acres                          |
| Project Coordinates                          | 35.199345°N, 80.900418°W           |
| <b>Project Watershed Summary Information</b> |                                    |
| Physiographic Region                         | Piedmont                           |
| Ecoregion                                    | Southern Outer Piedmont            |
| Project River Basin                          | Catawba                            |
| USGS 8-digit HUC                             | 03050103                           |
| USGS 14-digit HUC                            | 03050103020020                     |
| NCDWQ Subbasin                               | 03-08-34                           |
| Project Drainage Area                        | 20,000 acres                       |
| Project Drainage Area Impervious Surface     | >30%                               |
| CGIS Land Use Classification                 |                                    |
| <b>Reach Summary Information</b>             |                                    |
| Enhanced length                              | 980 linear feet                    |
| Drainage Area                                | 31 square miles                    |
| NCDWQ Index Number                           | 11-137-1                           |
| NCDWQ Classification                         | C                                  |
| Dominant Soil Series                         | Monacan                            |
| Drainage Class                               | Moderately well-somewhat poorly    |
| Soil Hydric Status                           | Contains 5% hydric Wehadkee soils  |
| <b>Wetland Summary Information</b>           |                                    |
| Size of Wetland                              | 0.5 acres                          |
| Wetland Type                                 | Riparian riverine                  |
| Mapped Soil Series                           | Monacan                            |
| Drainage Class                               | Moderately well-somewhat poorly    |
| Soil Hydric Status                           | Contains 5% hydric Wehadkee soils  |
| Source of Hydrology                          | Stormwater, stream overbank        |
| <b>Regulatory Considerations</b>             |                                    |
| <b>Regulation</b>                            | <b>Applicable</b>                  |
| Waters of the U.S. –Sections 404 and 401     | No                                 |
| Endangered Species Act                       | No                                 |
| Historic Preservation Act                    | No                                 |
| CZMA/CAMA                                    | No                                 |
| FEMA Floodplain Compliance                   | No                                 |
| Essential Fisheries Habitat                  | No                                 |

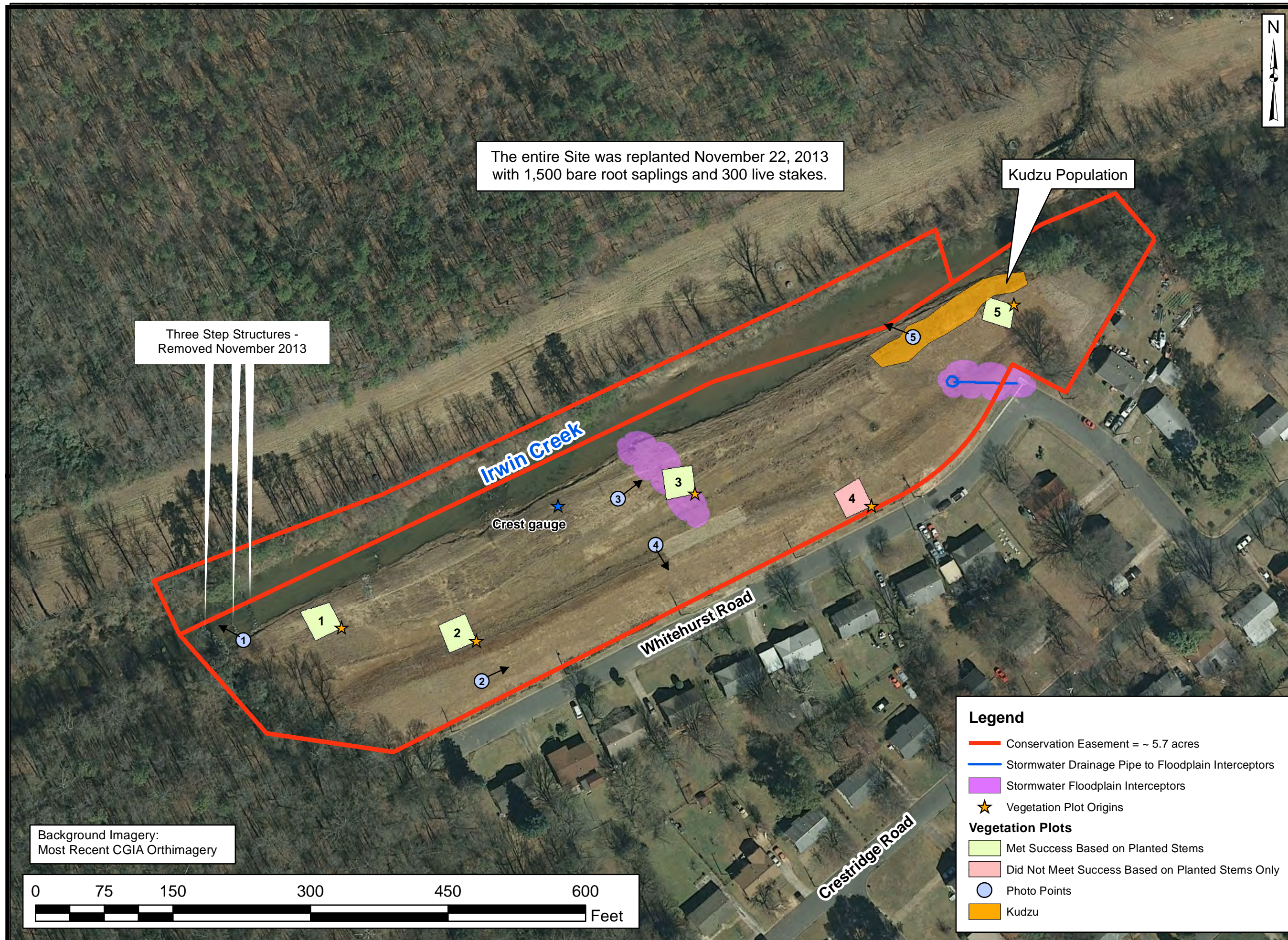
APPENDIX B

VISUAL ASSESSMENT DATA

Figure 2. Current Conditions Plan View

Table 5. Vegetation Condition Assessment Table

Vegetation Monitoring Plot Photos



Project:

**IRWIN CREEK RESTORATION SITE**

EEP Project Number 192  
Mecklenburg County, NC

Title:

**CURRENT CONDITIONS PLAN VIEW**

Drawn by: CLF/KRJ

Date: November 2014

Scale: 1:1200

Project No.: 12-004.02

**FIGURE 2**

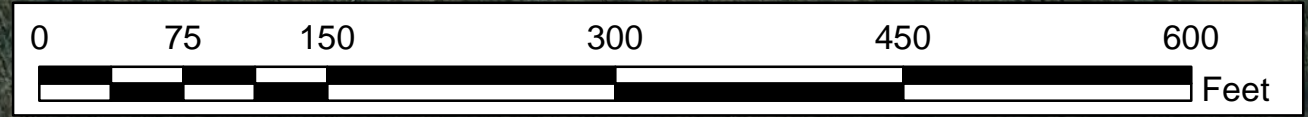
**Legend**

- Conservation Easement = ~ 5.7 acres
- Stormwater Drainage Pipe to Floodplain Interceptors
- Stormwater Floodplain Interceptors
- ★ Vegetation Plot Origins

**Vegetation Plots**

- Met Success Based on Planted Stems
- Did Not Meet Success Based on Planted Stems Only
- Photo Points
- Kudzu

Background Imagery:  
Most Recent CGIA Orthimagery



**Table 5** **Vegetation Condition Assessment**  
**Irwin Creek Restoration Site/EEP Project Number 192**

Planted Acreage<sup>1</sup> 3.2

| Vegetation Category                    | Definitions   | Mapping Threshold | CCPV Depiction | Number of Polygons      | Combined Acreage | % of Planted Acreage |
|--|---|-------------------|----------------|-------------------------|------------------|----------------------|
| 1. Bare Areas                          | NA  | NA                | NA             | NA                      | NA               | NA                   |
| 2. Low Stem Density Areas              | The entire site was replanted with 1500 bare-root trees in tree tubes and 300 live stakes in November 2013. Mowing activities to curb herbaceous competition continued after the replanting. During these mowing activities, several stems were destroyed causing several small areas throughout the Site to have reduced stem density. | NA                | NA             | NA                      | 0.10             | NA                   |
|  |   |                   |                | <b>Total</b>            | 0                | 0.10                 |
| 3. Areas of Poor Growth Rates or Vigor | NA  | NA                | NA             | NA                      | NA               | NA                   |
|  |   |                   |                | <b>Cumulative Total</b> | 0                | 0.10                 |

Easement Acreage<sup>2</sup> 14

| Vegetation Category                         | Definitions   | Mapping Threshold | CCPV Depiction | Number of Polygons | Combined Acreage | % of Easement Acreage |
|---|---|-------------------|----------------|--------------------|------------------|-----------------------|
| 4. Invasive Areas of Concern <sup>4</sup>   | Small patch of kudzu on the left bank of Irwin Creek in the upstream portion of the Site. | NA                | Orange polygon | 1                  | 0.11             | 0.8%                  |
| 5. Easement Encroachment Areas <sup>3</sup> | NA  | NA                | NA             | NA                 | NA               | NA                    |

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

<sup>2</sup> = The acreage within the easement boundaries.

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

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

**Vegetation Monitoring Photographs**  
**Taken July 2014**



## APPENDIX C

### VEGETATION PLOT DATA

Table 6. Vegetation Plot Criteria Attainment

Table 7. CVS Vegetation Plot Metadata

Table 8. Total and Planted Stems by Plot and Species



**Table 6. Vegetation Plot Criteria Attainment  
Irwin Creek Restoration Site (EEP Project Number 192)**

| <b>Vegetation Plot ID</b> | <b>Vegetation Survival Threshold Met?</b> | <b>Tract Mean</b> |
|---------------------------|---|-------------------|
| 1                         | Yes                                       | 80%               |
| 2                         | Yes                                       |                   |
| 3                         | Yes                                       |                   |
| 4                         | No  |                   |
| 5                         | Yes                                       |                   |

**Table 7. CVS Vegetation Plot Metadata  
Irwin Creek Restoration Site (EEP Project Number 192)**

|  |   |
|--|---|
| <b>Report Prepared By</b>                              | Corri Faquin  |
| <b>Date Prepared</b>                                   | 3/5/2014 9:27   |
| <b>database name</b>                                   | Axiom-EEP-pre2014-A-v2.3.1.mdb  |
| <b>database location</b>                               | C:\Axiom\Business\CVS   |
| <b>computer name</b>                                   | CORRI-PC  |
| <b>file size</b>                                       | 41537536  |
| <b>DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----</b> |   |
| <b>Metadata</b>  | Description of database file, the report worksheets, and a summary of project(s) and project data.  |
| <b>Proj, planted</b>                                   | Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.   |
| <b>Proj, total stems</b>                               | Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems. |
| <b>Plots</b>   | List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).  |
| <b>Vigor</b>   | Frequency distribution of vigor classes for stems for all plots.  |
| <b>Vigor by Spp</b>                                    | Frequency distribution of vigor classes listed by species.  |
| <b>Damage</b>  | List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.  |
| <b>Damage by Spp</b>                                   | Damage values tallied by type for each species.   |
| <b>Damage by Plot</b>                                  | Damage values tallied by type for each plot.  |
| <b>ALL Stems by Plot and spp</b>                       | A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.                                   |
| <b>PROJECT SUMMARY-----</b>                            |   |
| <b>Project Code</b>                                    | 192   |
| <b>project Name</b>                                    | Irwin Creek Whitehurst Road   |
| <b>Description</b>                                     | Stream and Wetland Restoration  |
| <b>River Basin</b>                                     | Catawba   |
| <b>length(ft)</b>                                      | 980   |
| <b>stream-to-edge width (ft)</b>                       | 150   |
| <b>area (sq m)</b>                                     | 13650   |
| <b>Required Plots (calculated)</b>                     | NA  |
| <b>Sampled Plots</b>                                   | 5   |

**Table 8. Total and Planted Stems by Plot and Species**  
**EEP Project Code 192. Project Name: Irwin Creek Whitehurst Road**

| Scientific Name           | Common Name        | Species Type  | Current Plot Data (MY4 2014) |       |      |             |       |       |             |       |     |             |       |       |             |       |       | Annual Means |       |       |                 |       |       |
|---------------------------|--------------------|---------------|------------------------------|-------|------|-------------|-------|-------|-------------|-------|-----|-------------|-------|-------|-------------|-------|-------|--------------|-------|-------|-----------------|-------|-------|
|                           |                    |               | 192-01-0001                  |       |      | 192-01-0002 |       |       | 192-01-0003 |       |     | 192-01-0004 |       |       | 192-01-0005 |       |       | MY4 (2014)   |       |       | Baseline (2014) |       |       |
|                           |                    |               | PnoLS                        | P-all | T    | PnoLS       | P-all | T     | PnoLS       | P-all | T   | PnoLS       | P-all | T     | PnoLS       | P-all | T     | PnoLS        | P-all | T     | PnoLS           | P-all | T     |
| Acer rubrum               | red maple          | Tree          |                              |       |      | 2           | 2     | 2     | 2           | 2     | 2   |             |       |       | 1           | 1     | 1     | 5            | 5     | 5     | 1               | 1     | 13    |
| Alnus serrulata           | hazel alder        | Shrub         | 1                            | 1     | 1    |             |       |       |             |       |     |             |       |       |             |       |       | 1            | 1     | 1     | 1               | 1     | 1     |
| Aronia arbutifolia        | Red Chokeberry     | Shrub         |                              |       |      |             |       |       |             |       |     |             |       |       |             |       |       |              |       |       | 2               | 2     | 2     |
| Betula nigra              | river birch        | Tree          | 12                           | 12    | 12   | 2           | 2     | 2     | 1           | 1     | 1   |             |       |       | 1           | 1     | 1     | 16           | 16    | 16    | 26              | 26    | 26    |
| Carpinus caroliniana      | American hornbeam  | Tree          |                              |       |      |             |       |       | 1           | 1     | 1   |             |       |       | 1           | 1     | 1     | 2            | 2     | 2     | 10              | 10    | 10    |
| Carya                     | hickory            | Tree          |                              |       |      |             |       |       |             |       | 1   |             |       |       |             |       |       |              |       | 1     |                 |       |       |
| Cephalanthus occidentalis | common buttonbush  | Shrub         |                              |       |      |             |       |       |             |       |     |             |       |       |             |       |       |              |       |       | 1               | 1     | 1     |
| Cercis canadensis         | eastern redbud     | Tree          |                              |       |      | 1           | 1     | 1     | 2           | 2     | 2   | 1           | 1     | 1     | 1           | 1     | 1     | 5            | 5     | 5     | 2               | 2     | 2     |
| Cornus amomum             | silky dogwood      | Shrub         | 1                            | 1     | 1    | 1           | 1     | 1     | 1           | 1     | 1   | 2           | 2     | 2     | 1           | 1     | 1     | 6            | 6     | 6     | 11              | 13    | 13    |
| Diospyros virginiana      | common persimmon   | Tree          |                              |       |      |             |       |       |             |       |     |             |       |       |             |       |       |              |       |       | 1               | 1     | 1     |
| Fraxinus americana        | white ash          | Tree          |                              |       |      |             |       |       |             |       |     |             |       |       |             |       |       |              |       |       | 1               | 1     | 1     |
| Fraxinus pennsylvanica    | green ash          | Tree          |                              |       |      |             |       |       |             |       | 1   |             |       |       |             |       |       |              |       | 1     | 13              | 13    | 18    |
| Ilex verticillata         | common winterberry | Shrub         |                              |       |      | 2           | 2     | 2     | 4           | 4     | 4   | 1           | 1     | 1     |             |       |       | 7            | 7     | 7     | 5               | 5     | 5     |
| Liquidambar styraciflua   | sweetgum           | Tree          |                              |       | 5    |             |       |       |             |       |     |             |       |       |             |       |       |              |       | 5     |                 |       |       |
| Morus rubra               | red mulberry       | Tree          |                              |       |      |             |       |       |             |       |     |             |       |       |             |       |       |              |       |       | 1               | 1     | 1     |
| Pinus taeda               | loblolly pine      | Tree          |                              |       |      |             |       |       |             |       |     |             |       |       |             |       |       |              |       |       |                 |       | 3     |
| Platanus occidentalis     | American sycamore  | Tree          | 4                            | 4     | 4    |             |       |       |             |       |     |             |       |       | 1           | 1     | 1     | 5            | 5     | 5     | 4               | 4     | 4     |
| Prunus serotina           | black cherry       | Tree          |                              |       |      |             |       |       |             |       |     |             |       |       |             |       |       |              |       |       | 3               | 3     | 3     |
| Quercus michauxii         | swamp chestnut oak | Tree          | 1                            | 1     | 1    | 2           | 2     | 2     |             |       |     |             |       |       | 2           | 2     | 2     | 5            | 5     | 5     | 5               | 5     | 5     |
| Salix sericea             | silky willow       | Shrub         |                              |       |      |             |       |       |             |       |     |             |       |       |             |       |       |              |       |       |                 | 1     | 1     |
| Unknown                   |                    | Shrub or Tree |                              |       |      |             |       |       | 1           | 1     | 1   |             |       |       | 1           | 1     | 1     | 2            | 2     | 2     | 4               | 4     | 4     |
| Viburnum dentatum         | southern arrowwood | Shrub         | 1                            | 1     | 1    |             |       |       | 1           | 1     | 1   | 1           | 1     | 1     | 5           | 5     | 5     | 8            | 8     | 8     | 1               | 1     | 1     |
| <b>Stem count</b>         |                    |               | 20                           | 20    | 25   | 10          | 10    | 10    | 13          | 13    | 15  | 5           | 5     | 5     | 14          | 14    | 14    | 62           | 62    | 69    | 92              | 95    | 115   |
| <b>size (ares)</b>        |                    |               | 1                            |       |      | 1           |       |       | 1           |       |     | 1           |       |       | 1           |       |       | 5            |       |       | 5               |       |       |
| <b>size (ACRES)</b>       |                    |               | 0.02                         |       |      | 0.02        |       |       | 0.02        |       |     | 0.02        |       |       | 0.02        |       |       | 0.12         |       |       | 0.12            |       |       |
| <b>Species count</b>      |                    |               | 6                            | 6     | 7    | 6           | 6     | 6     | 8           | 8     | 10  | 4           | 4     | 4     | 9           | 9     | 9     | 11           | 11    | 14    | 18              | 19    | 20    |
| <b>Stems per ACRE</b>     |                    |               | 809.4                        | 809.4 | 1012 | 404.7       | 404.7 | 404.7 | 526.1       | 526.1 | 607 | 202.3       | 202.3 | 202.3 | 566.6       | 566.6 | 566.6 | 501.8        | 501.8 | 558.5 | 744.6           | 768.9 | 930.8 |

**Color for Density**

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

- PnoLS = Planted excluding livestakes
- P-all = Planting including livestakes
- T = All planted and natural recruits including livestakes
- T includes natural recruits

APPENDIX D  
STREAM SURVEY DATA  
Fixed-Station Photos

**Irwin Creek  
Taken September 2014**

Photo Point 1:  
Removed Structures  
downstream of Site



Photo Point 2:  
Levee Area

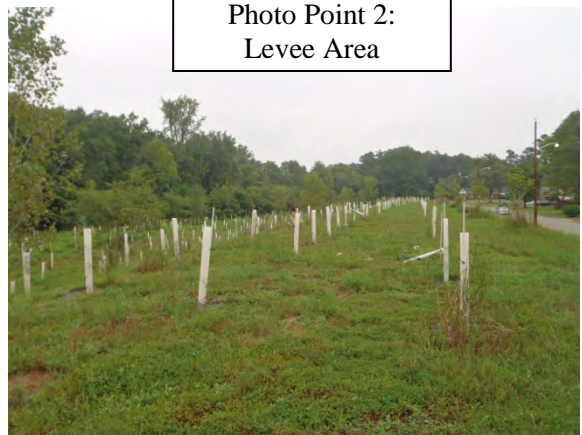


Photo Point 3:  
Excavated bench area



Photo Point 4:  
Topo break looking from the  
excavated bench up to the levee



Photo Point 5:  
Stream-side assemblage



APPENDIX E  
HYDROLOGY DATA

Table 9. Verification of Bankfull Events

**Table 9. Verification of Bankfull Events****Irwin Creek Restoration Site (EEP Project Number 192)**

| <b>Date of Data Collection</b> | <b>Date of Occurrence</b> | <b>Method</b>   | <b>Photo (if available)</b> |
|--------------------------------|---------------------------|---|-----------------------------|
| September 23, 2010             | July 12, 2010             | Bankfull event likely occurred after a total of 2.14 inches* of rain reported to fall over 2 days (July 11-12, 2010) as well as a brief spike in groundwater at groundwater gauge 2   | --                          |
| September 23, 2010             | August 19, 2010           | Bankfull event likely occurred after a total of 1.1 inches* of rain reported to fall over 2 days (August 18-19, 2010) after a total of 4.43 inches* of rain the preceding 4 weeks as well as brief spike in groundwater at groundwater gauges 1 and 2 | --                          |
| October 18, 2010               | September 29, 2010        | Bankfull event likely occurred after a total of 4.04 inches* of rain reported to fall over 6 days (September 25-30, 2010) as well as a brief spike in groundwater at groundwater gauge 2  | --                          |
| October 21, 2011               | August 5, 2011            | Bankfull event documented after a total of 2.50 inches* of rain reported to fall on August 5, 2011 as well as a brief spike in groundwater at groundwater gauge 2   | 1                           |
| August 6, 2012                 | May 8, 2012               | Bankfull event likely occurred after a total of 2.77 inches* of rain reported to fall on May 8-9, 2012.   | --                          |
| August 6, 2012                 | May 16, 2012              | Bankfull event likely occurred after a total of 2.71 inches* of rain reported to fall on May 13-16, 2012.   | --                          |
| May 12, 2014                   | April 28, 2013            | Bankfull event likely occurred after a total of 2.23 inches** of rain reported to fall on April 28, 2013.   | --                          |
| May 12, 2014                   | June 3, 2013              | Bankfull event likely occurred after a total of 2.33 inches** of rain reported to fall on June 3, 2013.   | --                          |
| May 12, 2014                   | September 21, 2013        | Bankfull event likely occurred after a total of 2.74 inches** of rain reported to fall on September 21, 2013.   | --                          |
| May 12, 2014                   | November 26, 2013         | Bankfull event likely occurred after a total of 2.36 inches** of rain reported to fall on November 26, 2013.  | --                          |
| May 12, 2014                   | December 23, 2013         | Bankfull event likely occurred after a total of 3.37 inches** of rain reported to fall over two days (December 22-23, 2013).  | --                          |
| May 12, 2014                   | January 19, 2014          | Bankfull event likely occurred after a total of 2.80 inches** of rain reported to fall over two days (January 18-19, 2014).   | --                          |
| September 17, 2014             | August, 1 2014            | Bankfull event documented after a total of 3.85 inches* of rain reported to fall over two days (July 31-August 1 2014).   | 2, 3                        |

\* Reported at KCLT Weather Station at the Charlotte Airport (Weatherunderground 2012).

\*\* Reported at KNCCHARL48 Weather Station at Midtown Charlotte (Weatherunderground 2014).

