Baseline Monitoring Document and As-Built Baseline Report - Final

Suther (Dutch Buffalo Creek)
Stream and Wetland Restoration Project
Cabarrus County, North Carolina
Yadkin-Pee Dee River Basin Cataloging Unit 03040105
EEP Project No. 370
SCO Project No. 06-06752-01

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Ecosystem Enhancement PROGRAM

NCDENR

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EXECUTIVE SUMMARY

Dutch Buffalo Creek is located in Cabarrus County, North Carolina, northeast of the City of Concord. The project is located within the Yadkin-Peedee River Basin (USGS HUC 03040105). The primary objectives of the project were to stabilize and protect degraded or vulnerable stream banks along the main channel of Dutch Buffalo Creek, restore a natural, stable dimension, pattern, and profile along an unnamed tributary (UT) to Dutch Buffalo Creek, improve habitat, restore and/or enhance the natural hydrology, vegetation, and soil composition in adjacent wetlands, and provide alternate cattle water sources and trails across the streams. These objectives were achieved by enhancing 3,004 linear feet (lf), preserving 3,583 lf, and restoring 608 lf of stream, preserving 1.67 acres (ac), enhancing 4.26 ac, and restoring 7.29 ac of wetland area.

Pre-Construction Site Conditions

Dutch Buffalo Creek is located in the Piedmont Ecoregion with a watershed land use dominated by rural pasture land and forest. The surrounding land use of the project site is primarily agricultural with activities ranging from cattle grazing to row crops. Dutch Buffalo Creek is a third order stream with an approximate drainage area of 23 square miles at the farthest downstream point of the project. The UT to Dutch Buffalo Creek is a first order stream with an approximate drainage area of 0.3 square miles. Prior to restoration, the site had been disturbed due to past and current management for cattle grazing and rearing. Past site land use includes livestock grazing, removal of riparian vegetation, dredging and straightening of drainage channels to Dutch Buffalo Creek and its tributary, and ditching of wetlands to drain them for conversion to crop fields.

The main reach of Dutch Buffalo Creek was slightly incised and classified as a C5e. Bedrock outcroppings throughout the existing stream bed provide grade control and have prevented the stream from further incision. Areas of mass wasting, bank slumping, and sediment deposition was evident throughout the upstream project reach. The substrate in the upper reach of the project appeared to be dominated by fine sand. Further downstream, the banks appeared to be more stable and vegetated, resulting in a cobble dominated substrate. The UT to Dutch Buffalo Creek was deeply incised and appeared to have been modified or straightened in the past. The channel was classified as a G5c, which are considered entrenched, have a moderate gradient, deeply incised with highly erosive banks, and a sandy substrate (Rosgen, 1996). Approximately 65% of the existing stream banks were eroding. The stream banks were typically over-widened and highly erosive with little to no vegetation. As a result of poor stream bank protection, the majority of the channel's substrate was fine sand.

Field studies identified the presence of six wetlands within the easement areas. The wetlands were classified as palustrine forested, palustrine forested-emergent, or palustrine scrub-shrub systems. However, only three (Wetland Areas B-1, B-2, and C) of the six originally identified wetlands were restored or enhanced for this project. Wetland area B-1 was classified as a palustrine forested system with a saturated to seasonally flooded hydrologic regime. Indicators

of wetland hydrology included saturated soils within the upper 12 inches, areas of inundation, oxidized rhizospheres, drift lines, sediment deposition, and water-stained vegetation. Wetland areas B-2 was classified as a palustrine forested system with a saturated to temporarily flooded hydrologic regime. Indicators of wetland hydrology included saturated soils within the upper 12 inches, drift lines, sediment deposition, and water-stained vegetation. Wetland C was classified as a palustrine forested-emergent system with a saturated to seasonally flooded hydrologic regime. The area was managed for a number of years as a pasture planted in switch grass. An existing drainage ditch cut through the southern edge of the switch grass field and drained to Dutch Buffalo Creek. Similarly, there were also several side ditches off of this ditch. These channelized ditches effectively drained surface water and shallow groundwater from the switch grass area by providing a drainage way at an elevation lower than potential groundwater levels.

Restoration Approach and Implementation

Stream

The stream restoration effort consisted of Enhancement Level II along the main reach of Dutch Buffalo Creek and Restoration Priority Level 1 and 2 along the UT. The restoration plan also included wetland restoration and enhancement, the re-establishment of native riparian areas, and preservation of native vegetation, wetlands, and reaches of Dutch Buffalo Creek.

Enhancement Level II practices along the upstream section of Dutch Buffalo Creek's main channel (station 17+61 – 53+72) consisted of fencing the stream and associated wetland areas to prevent livestock grazing and trampling and vegetating vulnerable stream banks and riparian areas where necessary. An alternative water source and livestock exclusion fencing were installed. The downstream section of the main channel (station 53+72 – 100+50) was placed in preservation. An electric fence was installed along the easement boundary to prevent cattle access. Two permanent stream crossings were installed along the main channel and cattle stock trails were built to provide Mr. Suther and his cattle access to all necessary fields.

The UT to Dutch Buffalo Creek was restored using a Priority Level 1 and 2 approach as a C/E channel. Stream dimension, pattern, and profile were re-established to maintain stability and establish riffle/pool sequences. The channel was relocated onto the floodplain and transitioned to meet up with the main channel of Dutch Buffalo Creek. Adjacent stream banks and riparian zones were replanted using native species appropriate to the area. Brush mattresses of native plant material were installed on the outside meander bends to provide bank protection and habitat. A cross-vane was installed at the beginning of the project above the channel plug to provide grade control, habitat, and bank protection while vegetation is established. A series of log vane step-pools were installed to transition the UT from its elevation to the elevation of the main channel. All structures were installed to provide grade-control and habitat and protect the stream banks while vegetation establishes.

The majority of the wetland areas are located along the upstream half of the project. One wetland area is located at the downstream terminus of the project. The project included both riparian wetland restoration and enhancement. The primary wetland restoration area is within the field at the western end of the project that is currently planted in switch grass. Ditches draining this field were plugged, and the areas were planted with native tree and shrub species.

Other wetland restoration opportunities included plugging/filling ditches in existing forested wetlands and returning hydrology to the wetland adjacent to the stream restoration reach.

Vegetation

The wetland restoration area and the areas of disturbance associated with the ditch filling will be planted with species similar to those found in reference wetlands (Wetlands B-1 and C-1) to achieve a Piedmont/Mountain Bottomland Forest as described in Schafale and Weakely (1990). The reference wetlands, surrounding forest, and Schafale and Weakley's species descriptions were used to develop a species list. The stream banks and immediately adjacent riparian areas associated with disturbance due to bank stabilization will be planted with species similar to those currently found there to maintain a Piedmont/Low Mountain Alluvial Forest (Schafale and Weakely 1990). Species selected for live staking are based on on-site inventories, past experience, and results of field trials reported by Calabria *et al.* (2006).

Hydrology

Wetland Restoration Area C

The area adjacent to Wetland Restoration Area C (Wetland C-1) has been managed for a number of years as a pasture planted in switch grass. An existing agricultural drainage ditch is cut through the southern edge of the switch grass field and drains to Dutch Buffalo Creek. Several side ditches drain to this ditch. These channelized ditches effectively drain surface water and shallow groundwater from the switch grass area by providing a drainage way at an elevation lower than potential groundwater levels. The first 100 feet of this channel (from convergence with Dutch Buffalo Creek and up-channel) will be partially filled and then restored with shallow log vane step-pools. The step-pools will facilitate some drainage from the wetlands and provide a step-down change in elevation to Dutch Buffalo Creek. The remainder of these channelized ditches will be "plugged" with earth material to restore the ditches to current grade and restore groundwater to its "pre-ditched" level. Construction materials will consist of clay plug material, native fill material (from grading the stream bank), and natural fiber erosion control fabric.

Wetland Enhancement Area B-1

Similar to Wetland Restoration Area C, the area adjacent to Wetland Enhancement Area B (Reference Wetland B-1) has been altered by an existing drainage ditch cut through the southeastern edge of Wetland B-1 and drains to Dutch Buffalo Creek. Several side ditches drain to this ditch. Over time, the ditches have incised due to the elevation of Dutch Buffalo Creek and cattle activity, which has resulted in reduced vegetation and increased runoff. These stresses have likely exacerbated the incision of the streams. These channelized ditches effectively drain surface water and shallow groundwater from the surrounding area by providing a drainage way at an elevation lower than potential groundwater levels. Two approaches will be used in these areas. The more incised portions of these channels will be partially filled and then restored with shallow log vane step-pools. These restored shallow drainage swales will enhance the surrounding wetland habitat and provide good amphibian habitat in wetter seasons of the year. Also, these swales will facilitate drainage from the wetland. The fill will consist of compacted earth material. Construction materials will consist of clay plug material, native fill material (from grading the stream bank), and natural fiber erosion control fabric. Filling the ditch shall be accomplished in similarity to dike construction to prevent seepage and erosion. Similar to an unaltered wetland area, inundation and saturation levels will vary with seasonal and climatological variability. In droughts, groundwater

will be at a lower elevation; therefore, groundwater in these areas will be at a lower elevation and may not inundate or saturate proposed restoration areas.

Wetland Enhancement Area B-2
The area surrounding the tributary proposed for restoration is proposed for wetland enhancement. Currently, two small wetland areas surround the existing tributary. The tributary is incised and drains its surrounding floodplain and groundwater sources due to its vertical instability and incision. The existing stream may have been previously channelized and straightened for drainage which increased its slope resulting in an increase in velocity and vertical incision. By relocating the channel to the east at a higher elevation, the channel will be reconnected with its floodplain, reducing drainage of the floodplain and increasing the elevation of the groundwater table. By increasing the sinuosity of the channel, the slope is decreased, resulting in a lower velocity. However, the elevation of the floodplain surrounding the relocated channel is approximately 647 ft which is one foot lower than the elevation of floodplain area (approximately 648 ft) surrounding the existing channel. As a result, the relocated channel is designed to flood more frequently as well as raise the surrounding groundwater.

Restoration Approach and Implementation – As-Built Condition

Between the project design and the as-built condition, there was no significant deviation in terms of channel morphology. There was, however, a change in the proposed planting plan. During construction, it was decided that bare roots would not be planted in Wetland B-1 and Wetland B-2 because of the well-established, existing mature canopy, which could have threatened the survival of the bare roots because of a lack of sunlight. It was further determined that the bare roots were not needed because of the abundant, mature existing vegetation in these areas. In Wetlands B-1 and C, the locations of the log vanes were modified slightly during construction.

Monitoring

Monitoring will consist of collecting the morphological, vegetative, and hydrological data on an annual basis to assess the project success based on the restoration goals and objectives. Specifically, the success of the site will be assessed using measurements of the stream channel's dimension, pattern, profile, and substrate composition, permanent photographs, and vegetation sampling. Also included in the annual monitoring will be surface and groundwater gauge data collection to document both high flow events and ground water hydrology. The first annual monitoring survey will be conducted following the first full growing season in 2010.

Potential problem areas, such as streambank instability, aggradation/degradation, or unsuccessful vegetation establishment will be evaluated during the annual monitoring. If, during the annual review of the stream reach, a failure is noted, the areas will be evaluated and discussed with EEP staff to determine if remedial maintenance measures are required to resolve the problem. If remediation of an area is required, a proposal will be submitted for the needed work. If vegetative success criteria is not achieved, supplemental plantings will be performed with native species.

1.0 PROJECT GOALS, BACKGROUND, AND ATTRIBUTES

1.1 Project Location

Dutch Buffalo Creek and its UT are located in Cabarrus County, North Carolina approximately 9 miles northeast of the City of Concord. The project is located in the Yadkin-Pee Dee River Basin, Catalog Unit 03040105, DWQ Subbasin 30712 with a watershed land use dominated by rural pasture land and forest. The surrounding land use of the project site is primarily agricultural with activities ranging from cattle grazing to row crops. Dutch Buffalo Creek is a third order stream with an approximate drainage area of 23 square miles at the farthest downstream point of the project. The unnamed tributary to Dutch Buffalo Creek is a first order stream with an approximate drainage area of 0.3 square miles. Dutch Buffalo Creek drains into the Pee Dee River and is listed as WS-II class waters.

The project area is generally oriented east to west. The downstream end of the project begins southeast of an existing wetland. The project area extends upstream for approximately 10,050 feet along Dutch Buffalo Creek and terminates adjacent to a former wetland area currently planted in switch grass (*Panicum virgatum*). The majority of the wetland areas are located along the upstream half of the project. One wetland area is located at the downstream terminus of the project. Existing soils within the proposed wetland restoration and enhancement areas consisted of Chewacla soils which are naturally fertile and well-suited for planting (USDA, 1988).

To access the site from Interstate 85, take exit 63 (Lane Road) and turn east off the exit. Take Lane Road for approximately 0.8 miles to Old Salisbury-Concord Road and turn left. Take Old Salisbury-Concord Road for 0.5 miles and turn right onto Irish Potato Road (heading east). Follow Irish Potato Road for 5.0 miles, and where it intersects with Gold Hill Road, turn left (heading north-east). Take this to 6200 Gold Hill Road (approximately 2 miles), home of L. Suther. Refer to Figure 1.1 for a location map of the project site.

1.2 Project Goals and Objectives

The following goals have been established for the Dutch Buffalo Creek Stream and Wetland Restoration project.

- Stabilize and protect degraded or vulnerable stream banks along the main reach of Dutch Buffalo Creek.
- Enhance the upper project reach of Dutch Buffalo Creek by fencing out the livestock and vegetating streambanks where necessary.
- Restore a natural, stable dimension, pattern, and profile along one unnamed tributary using natural channel design techniques.
- Improve riffle and pool habitats supportive of macrobenthos and fish communities.
- Restore and/or enhance the natural hydrology, vegetation, and soil characteristics in adjacent wetlands.
- Provide alternate cattle watering sources and road access across Dutch Buffalo Creek to support exclusion of cattle from the channel.
- Improve the aesthetics of the stream.

To meet these goals, the following objectives have been established for the Dutch Buffalo Creek Stream and Wetland Restoration project.

- Enhancing approximately 3,004 linear feet in the main channel's upper reach.
- Preserving approximately 3,583 linear feet in the main channel's lower and upper reaches.
- Restoring 608 linear feet of an unnamed tributary into a Rosgen C/E stream type.
- Preserving approximately 1.67 acres, enhancing approximately 4.26 acres, and restoring approximately 7.29 acres of riparian riverine[1] wetland area.
- Constructing access crossings across the main channel and the unnamed tributary of Dutch Buffalo Creek.
- Creating an alternative livestock watering source and install livestock exclusion fencing.

2.0 PROJECT STRUCTURE, RESTORATION TYPE AND APPROACH

2.1 Project Structure

Please refer to Figure 1.2 for a map delineating the restoration and enhancement reaches for Dutch Buffalo Creek, the UT, and their adjacent wetland areas.

2.2 Restoration Type and Approach

Prior to restoration, the site had been disturbed due to past and current management for cattle grazing and rearing. Past site land use included livestock grazing, removal of riparian vegetation, dredging and straightening of drainage channels to Dutch Buffalo Creek and its tributary, and ditching of wetlands to drain them for conversion to crop fields. The stream restoration effort consisted of Enhancement Level II along the main reach of Dutch Buffalo Creek and Restoration Priority Level 1 and 2 along the UT to Dutch Buffalo Creek. The project also included wetland restoration and enhancement, the re-establishment of native riparian areas, and preservation of native vegetation, wetlands, and reaches of Dutch Buffalo Creek.

The wetland restoration and enhancement area and the areas of disturbance associated with the ditch filling were planted with species similar to those found in reference wetlands to achieve a Piedmont/Mountain Bottomland Forest as described in Schafale and Weakely (1990). Similarly, the stream banks and immediately adjacent riparian areas associated with disturbance due to bank stabilization were also planted with species similar to those currently found there to maintain a Piedmont/Low Mountain Alluvial Forest (Schafale and Weakely 1990). With the exception of the drainage ditches, minimal grading (fill or cut) occurred for the wetland restoration and enhancement areas. Top soil taken from cut areas along the stream was reserved for the top soil dressing utilized for ditch filling. The soil along the stream banks was naturally fertile due to its alluvial nature, so this top soil was well suited for planting. In addition, disking was completed to ensure adequate drainage and beneficial microtopography for planting and drainage.

[1] The primary source hydrology appears to be groundwater, based on site observations. However, due to adjacency to Dutch Buffalo Creek and based on overbank flooding from Dutch Buffalo Creek at an apparent frequency of greater than once every 5 years, the wetlands appear to be riverine.

Dutch Buffalo Creek-Main Reach

Enhancement Level II practices along the upstream section of the main reach (station 17+61 – 53+72) consisted of fencing the stream and associated wetland areas to prevent livestock grazing and trampling and vegetating vulnerable stream banks and riparian areas where necessary. An alternative water source was developed to prevent the livestock from accessing the stream. The alternative livestock watering system consisted of two 4-hole water tanks supplied by 2,670 feet of pipe from a new 365-foot deep well. Through a task order contract, the Cabarrus County Soil and Water Conservation District oversaw the installation of the alternative watering system and 8,200 linear feet of cattle exclusion fencing.

The downstream section of the main reach (station 53+72 – 100+50) was placed in preservation. An electric fence was installed along the easement boundary to prevent cattle access. Two permanent stream crossings were installed along the main channel, and a cattle stock trail was built to provide Mr. Suther and his cattle access to all necessary fields.

Dutch Buffalo Creek-Unnamed Tributary

The UT was restored using a Priority Level 1 and 2 approach as a C/E channel. Stream dimension, pattern and profile were re-established to maintain stability and establish riffle/pool sequences. The channel was relocated onto the floodplain and transitioned to meet up with the main channel of Dutch Buffalo Creek. Adjacent stream banks and riparian zones were replanted using native species appropriate to the area. Brush mattresses of native plant material were installed on the outside meander bends to provide bank protection and habitat. A cross-vane was installed at the beginning of the project above the channel plug to provide grade control, habitat, and bank protection while vegetation is established. A series of log vane step-pools were installed to transition the UT from its elevation to the elevation of the main channel. All structures installed will provide grade-control and habitat and protect the stream banks while vegetation is established.

The farm pond upstream of the Suther property will regulate stream flow to the UT and keep stream flow rather constant during normal rainfall events. During droughts, the flow available for the stream will be minimal because the pond will store most of the runoff until it reaches the outlet elevation. In summary, the pond will likely dampen stream flow rate variations.

Wetland Area C

Wetland area C consisted of both restoration and enhancement efforts. The area adjacent to Wetland C was managed for a number of years as a pasture planted in switch grass. An existing drainage ditch was located along the southern edge of the switch grass field and drained to Dutch Buffalo Creek. This channel draining Wetland C was filled and compacted with native fill material as noted in the plans. Four log sills were installed sequentially downstream of the ditch fill to prevent the formation of a headcut, increase inundation levels in the floodplain/wetland areas, and provide a stable transition zone for wetland drainage as it merges with the main channel's elevation along Dutch Buffalo Creek. Constructed riffle material was installed on the upstream side of each log sill. Currently, the elevation of the ditch is 648 feet above mean sea level (ft), whereas the stream is at 644 ft. Similar to an unaltered wetland area, inundation and saturation levels will vary

with seasonal and climatological variability. During periods of drought, groundwater will be at a lower elevation; therefore, groundwater in these areas will be more shallow than in periods of normal precipitation and may not inundate or saturate the proposed restoration areas. The lower 90 feet of the drainage ditch (moving upstream from the confluence with Dutch Buffalo Creek) was stabilized by partially filling with a 50/50 mix of soil and #57 stone, filter fabric and riprap to protect the roots of nearby trees.

Bare roots and live stakes were used to replant the riparian zone using native vegetation, such as silky dogwood *(Cornus amomum)*, willow (*Salix sp.)*, elderberry *(Sambucus sp.)*, and ninebark *(Physocarpus sp.)*. Indigenous plant species were planted at elevations according to their ability to be saturated.

Wetland Area B-1

Wetland area B-1 consisted of both restoration and enhancement efforts. Similar to Wetland Area C, Wetland Area B-1 has been altered by an existing drainage ditch cut through the southeastern edge of Wetland B-1 and drains to Dutch Buffalo Creek, with several side ditches. Two approaches were used in this wetland area. Drainage ditches were filled and compacted with native fill material. Three log sills were installed sequentially downstream of the ditch fill to prevent the formation of a headcut, increase inundation levels in the floodplain/wetland areas, and provide a stable transition zone for wetland drainage as it merges with the main channel's elevation along Dutch Buffalo Creek. Constructed riffle material and filter fabric were installed upstream of each log sill. Currently, the elevation of the ditch is 643 ft whereas the stream is at 641 ft. Similar to an unaltered wetland area, inundation and saturation levels will vary with seasonal and climatological variability. In droughts, groundwater will be at a lower elevation; therefore, groundwater in these areas will be at a lower elevation and may not inundate or saturate proposed restoration areas.

Bare roots and live stakes were used to replant the riparian zone using native vegetation, such as silky dogwood *(Cornus amomum)*, willow (*Salix sp.)*, elderberry *(Sambucus sp.)*, and ninebark *(Physocarpus sp.)*. Indigenous plant species were planted at elevations according to their ability to be saturated.

Wetland Area B-2

Wetland area B-2 consisted of both restoration and enhancement efforts. The old UT previously drained areas in the vicinity of wetland area B-2. However, due to the relocation of the UT using a Priority 1 approach, the majority of the previous channel was filled with backfill. An oxbow/vernal pool was constructed approximately halfway along the former UT channel to allow for stormwater and runoff to accumulate in this area during storm events. By filling the previous UT channel and raising the new restored UT, the hydrology should be enhanced in the Wetland B-2 area and potentially restore wetland fringe areas.

Bare roots and live stakes were used to replant the riparian zone using native vegetation, such as silky dogwood *(Cornus amomum)*, willow (*Salix sp.)*, elderberry *(Sambucus sp.)*, and ninebark *(Physocarpus sp.)*. Indigenous plant species were planted at elevations according to their ability to be saturated.

2.3 Project History, Contacts, and Attribute Data

Dutch Buffalo Creek drains approximately 23 square miles at the farthest downstream point of the NCEEP project easement. The upper portion of the Dutch Buffalo Creek drainage basin is situated in Rowan County, NC and the lower portion lies within Cabarrus County, NC. In general, Dutch Buffalo Creek flows north to south through its watershed. The watershed land use is dominated by rural pasture land and forest. The surrounding land use of the project site is primarily agricultural with activities ranging from cattle grazing to row crops. The majority of the site has been historically disturbed due to past and current management for cattle grazing and rearing. Past site land use includes livestock grazing, removal of riparian vegetation, dredging and straightening of drainage channels to Dutch Buffalo Creek and its tributary, and ditching of wetlands to drain them for conversion to crop fields. The Cabarrus County GIS land use coverage has the entire drainage area of the project reach characterized as Open Space. The County zoning ordinance defines Open Space as primarily agricultural with some undeveloped or forested areas. Residences and businesses are typically related to or support agriculture. Please refer to Appendix 1 for project history, contact, and attribute data.

3.0 SUCCESS CRITERIA

The following success criteria are provided from the NCEEP Mitigation Plan Document Guidance (2008) and the US Army Corps of Engineers (ACOE) Stream Mitigation Guidelines (2003).

3.1 Morphological Parameters and Channel Stability

Restored or enhanced streams should demonstrate morphologic stability to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction and some change/variation subsequent to that is also to be expected. However, the observed change should not be unidirectional such that it represents a robust trend. If some trend is evident, it should be very modest or indicate migration to another stable form. Annual variation is to be expected, but over time this should demonstrate maintenance around some acceptable baseline with maintenance of or even a reduction in the amplitude of variation. Lastly, all of this must be evaluated in the context of hydrologic events to which the system is exposed.

3.1.1 Dimension

Cross-section measurements should indicate little change from the as-built cross-sections; however, some change is natural and expected. Any changes that occur will be evaluated to determine whether the adjustments are indicative of movement toward an unstable condition or whether it is natural and of something to be expected. The following thresholds will be considered indicators of instability if 1) W/D ratio increases by more than 10 to 15 percent, or 2) change in stream classification (for example a change from a C/E to an F/G).

3.1.2 Pattern and Profile

The channel's profile should not demonstrate any trends in thalweg aggradation or degradation over any significant continuous portion of its length. The thalweg should maintain bed variation and distinctiveness with maintenance of the intended bedform distributions (e.g. significant run expansion should not occur). Pools should be deeper with lesser slopes and riffles shallow with steeper slopes in keeping with design targets, and robust trends should not be evident in mean facet slopes. Although a pool cross-section may experience periodic infilling due to watershed activity and the timing of events relative to monitoring, the majority of the pool cross-sections need to be maintained over time and the rates of lateral migration need to be minimal. The following thresholds will be considered indicators of instability if 1) Facet slopes increase by 50 percent, and 2) the longitudinal profile water surface slope increases by more than 30 percent.

3.1.3 Substrate

Substrate measurements should indicate the progression towards, or the maintenance of the known distributions from the design phase. The D50 and D84 should coarsen over the five year monitoring period. Generally riffles will contain coarser material and the fines will deposit in the pools. Fluctuations in the substrate composition may occur over the five year monitoring period. Any change should be evaluated as to whether is a localized change or something larger out of the project area. The following threshold will be considered a concern 1) the D50 increases by 30 percent and 2) the substrate composition has an increase of silt and/or sand by more than 50 percent.

3.2 Vegetation

Planted vegetation will be monitored for five years in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2006). To achieve vegetative success criteria the average number of planted stems per acre must exceed or meet 320 stems/acre after the third year of monitoring, 288 stems/acre after four years, and 260 stems/acre after the fifth year of project monitoring. High threat invasive species as defined in Version 1.3 of the EEP Monitoring Template should be limited in their spatial extent and density such that survival and diversity of native woody trees and shrubs is not compromised.

3.3 Hydrology

Stream and wetland hydrology attainment will be monitored in accordance to the ACOE (2003) standards. At the end of the five year monitoring period, two or more bankfull events must occur in separate years within the restoration reach. The target wetland hydrological success criterion is saturation or inundation for at least 8 percent of the growing season in the lower landscape (floodplain) positions. To achieve the above hydrologic success criterion, groundwater levels must be within 12-inches of the ground surface for 18 consecutive days, which is 8 percent of the March 23 to November 7 (229 days) growing season.

4.0 MONITORING PLAN

Methods employed for the project were a combination of those established the NCEEP Mitigation Plan Document Guidance (2008) and the U.S. Army Corps of Engineers (USACE) Stream Mitigation Guidelines for Stream Mitigation (2003) (Monitoring Level 1 for restoration and enhancement areas and Monitoring Level 3 for all preservation areas). Vegetation assessments will be performed following the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2006). The *Flora of the Carolinas, Virginia, Georgia, and surrounding areas* by Alan S. Weakley was used as the taxonomic standard for all vegetation nomenclature for this report. Please refer to Appendix 2 for the as-built monitoring data.

Monitoring shall be conducted for a minimum of five years or until success criteria are met, as required in the guidelines. The initial baseline assessment was conducted in December 2009 and in January and April of 2010.

4.1 Hydrology Attainment and Bankfull Verification

Stream flow will be monitored to determine the occurrence of bankfull events on Dutch Buffalo Creek's main channel and its UT restored reach. A manual crest gauge has been installed along the main channel of Dutch Buffalo and an automated continuously recording gauge has been installed on the UT restoration reach. Both gauges should be monitored on a monthly basis to capture stream flow data and carry out necessary maintenance. Each field visit will involve recording the high water mark on the manual gauge and/or electronically downloading the automatic gauge with compatible handheld software, resetting of the devices or download of any data, and carry out necessary maintenance or replacement of gauges. Should gauge malfunction occur, observations of wrack and deposition may serve to augment gauge observations.

Monitored groundwater gauges will be used to determine the success of the wetland areas. Ten groundwater monitoring gauges were installed in Wetland Areas B-1, B-2, and C to document water table hydrology in the required wetland restoration and enhancement locations. The monitoring gauges are programmed to download groundwater levels daily and need to be downloaded monthly from March to November in order to capture hydrological data during the growing season and carry out necessary maintenance.

4.2 Stream Channel Stability and Geomorphology

In order to ensure the Site meets regulatory stream and wetland enhancement success criteria, each feature on-site will be monitored annually for five years. Dutch Buffalo Creek's main channel will be visually monitored for stability and vegetation establishment along the entire stream reach. Stream monitoring will be conducted on the UT to evaluate the stability and function of the restoration reach. Geomorphic and stream assessments should be performed following guidelines outlined in the Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (Harrelson et al., 1994), methodologies utilized in the Rosgen stream assessment and classification document (Rosgen, 1994 and 1996), and in the Stream Restoration a Natural Channel Design Handbook (Doll et al, 2003).

4.2.1 Dimension

Permanent cross-sections were installed to represent the restored reach stream type and capture the variability in the dimensional features along the UT. Four cross-sections were established approximately 20 bankfull width lengths apart (three riffles and 1 pool). Permanent monuments have been established that are recoverable either through field identification or with the use of a GPS unit. Each assessment following the initial as-built survey should include re-surveying the same permanent cross-sections. Cross-section surveys will detail the stream, bank, and floodplain topography of the channel including, but not limited to top of bank, bankfull, at all breaks in slope, water's edge, and the channel thalweg. Subsequently, each cross-section's Bankfull Area, W/D, ER, and Bank Height Ratios (BHR) will be calculated to meet the requirements as described in the EEP monitoring and mitigation protocols. Reference photographs looking upstream and downstream at each cross-section were taken with the as-built. Subsequently, assessments following the initial as-built survey should capture the same reference photograph.

4.2.2 Profile

One longitudinal profile will be conducted along the UT covering the entire length of 608 feet. The beginning of the longitudinal profile will begin at the invert of the cross-vane and end at the confluence with the main channel of Dutch Buffalo Creek. Each assessment following the initial as-built survey should include re-surveying the same longitudinal profile. Calculated values for riffle and pool facet slopes, riffle length, pool-to-pool spacing, and pool depth will be done annually to evaluate changes in the bedform.

4.2.3 Pattern

Evaluation of the UT stream pattern was assessed and ranges were defined. Stream pattern will only need to be conducted in year five and only if the dimension or profile measurements indicate pattern measurements might be necessary. Calculated sinuosity, meander width ratio, radius of curvature/bankfull width ratio, and meander length/bankfull width ratio will be used to evaluate channel migration/changes over the five year monitoring period.

4.2.4 Visual Assessment

Visual assessments will be conducted along the main channel of the Dutch Buffalo Creek enhancement reach (3,004 lf) and the restoration reach (608 lf), which is the UT. Assessments will follow the latest monitoring format document on the EEP website.

4.2.5 Bank Stability Assessments

Stream bed and bank composition will provide indicators for changes in channel form, hydraulics, erosion rate, and sediment supply (Doll et al., 2003) on the restoration reach (the UT). Two prediction methodologies will be used to determine the stream's potential for bank erosion: Bank Erodibility Hazard Index (BEHI) and Near-Bank Stress (NBS). The EEP visual assessment will also be performed annually to catalog the percentage of active bank erosion. The BEHI analysis will be used to assess the physical properties of the stream bank and to

determine the possible sources of bank instability. The NBS will be used to assess the bank with respect to the stress associated with the velocity in that portion of the channel. Using these methodologies, the expected annual sediment load produced from a stream system will be estimated and compared to pre-construction conditions. BEHI and NBS assessments will only be conducted in year five.

4.3 Vegetation Monitoring

Planted woody vegetation will be monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2008) to monitor and assess the planted woody vegetation in the wetland areas and along the UT stream reach. Seven vegetation plots were established within the project easement area: three standard (10x10 meter (m)) and four non-standard (5x20 m) vegetation monitoring plots. Plots were randomly established within planted portions of the wetland and stream restoration and enhancement areas to capture the heterogeneity of the designed vegetative communities. The plot corners have been marked and are recoverable either through field identification or with the use of a GPS unit. Reference photographs at the origin looking diagonally across the plot to the opposite corner were taken with the as-built. Subsequently, assessments following the initial as-built survey should capture the same reference photograph.

4.4 Photograph Reference Points

Permanent photographic reference points established along the wetland and channels will be used to support the qualitative visual assessments for the annual monitoring and subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and effectiveness of erosion control measures. Photographs will indicate the absence of developing bars within the channel, excessive bank erosion, changes in channel depth over time, and maturation of riparian vegetation. Reference photographs looking upstream and downstream at each photo point were taken with the as-built. Subsequently, assessments following the initial as-built survey should capture the same reference photograph.

4.5 Wetland Monitoring

As described by the USACE Wilmington District, success criteria must be SMART (specific, measurable, attainable, reasonable, and trackable). Wetland restoration success criteria are normally addressed in terms of the three parameters (vegetation, soils, and hydrology) (USACE, 2007).

4.5.1 Hydrology

Wetland restoration success is largely dictated by the hydrology of the site. Factors considered in establishing wetlands hydrologic success criteria include knowledge of existing and/or relic hydric soil types and target wetland systems, as well as relevant scientific literature. Hydrology will be monitored through the use of Ecotone Water Level Loggers during each growing season for the first five years of monitoring, or until the success criteria have been met, whichever occurs later. The monitoring gauge is programmed to download groundwater levels daily and will be downloaded monthly from March to November in order to capture hydrological data

during the growing season. The target wetland hydrological success criterion is saturation or inundation for at least 8 percent of the growing season in the lower landscape (floodplain) positions. To achieve the above hydrologic success criterion, groundwater levels must be within 12-inches of the ground surface for 18 consecutive days, which is 8 percent of the March 23 to November 7 (229 days) growing season.

Ten groundwater monitoring wells were installed in representative wetland restoration areas. Groundwater monitoring well installation followed the USACE standard methods found in Technical Notes ERDC TNWRAP- 00-02 (July 2000). Precipitation data collected by the State Climate Office of North Carolina for Concord, NC will be used to determine "normal/average" precipitation for months within the growing season. In the event that there are years of "normal/average" precipitation during the monitoring period and the data for those years does not show that the site has been inundated or saturated for the appropriate hydroperiod during the normal precipitation year, the review agencies may require remedial action.

5.0 MAINTENANCE AND CONTINGENCY PLANS

Potential problem areas, such as stream bank instability, aggradation/degradation, or unsuccessful vegetation establishment will be evaluated during the annual monitoring. If, during the annual review of the stream reach, a failure is noted, the areas will be evaluated and discussed with EEP staff to determine if remedial maintenance measures are required to resolve the problem. If remediation of an area is required, a proposal will be submitted for the needed work. If vegetative success criteria is not achieved, supplemental plantings will be performed with native species approved by the appropriate regulatory agencies.

6.0 AS-BUILT

The Dutch Buffalo Creek Stream and Wetland construction was completed in November 2009 and the As-Built survey was completed in December 2009. The survey included locating the channel boundaries, location of structures, cross-sections, monitoring features such as photo points, vegetation plots, and groundwater gauges. All permanent monitoring markers were located in the survey as well. A half size As-Built plan is located in Appendix 3 with the pre-construction, design and post-construction locations and alignments for the project.

7.0 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.

EcoScience. 2003. Unnamed Tributary to Dutch Buffalo Creek Detailed Stream Mitigation Plan. Raleigh, NC.

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.

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.

USACOE (1987) *Corps of Engineers Wetlands Delineation Manual*. Tech report Y-87-1. AD/A176.

USACOE (2003) *Stream Mitigation Guidelines.* USACOE, NCDENR-DWQ, USEPA, NCWRC.

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.

APPENDIX 1
GENERAL TABLES AND FIGURES

Figure 1.1 Vicinity Map

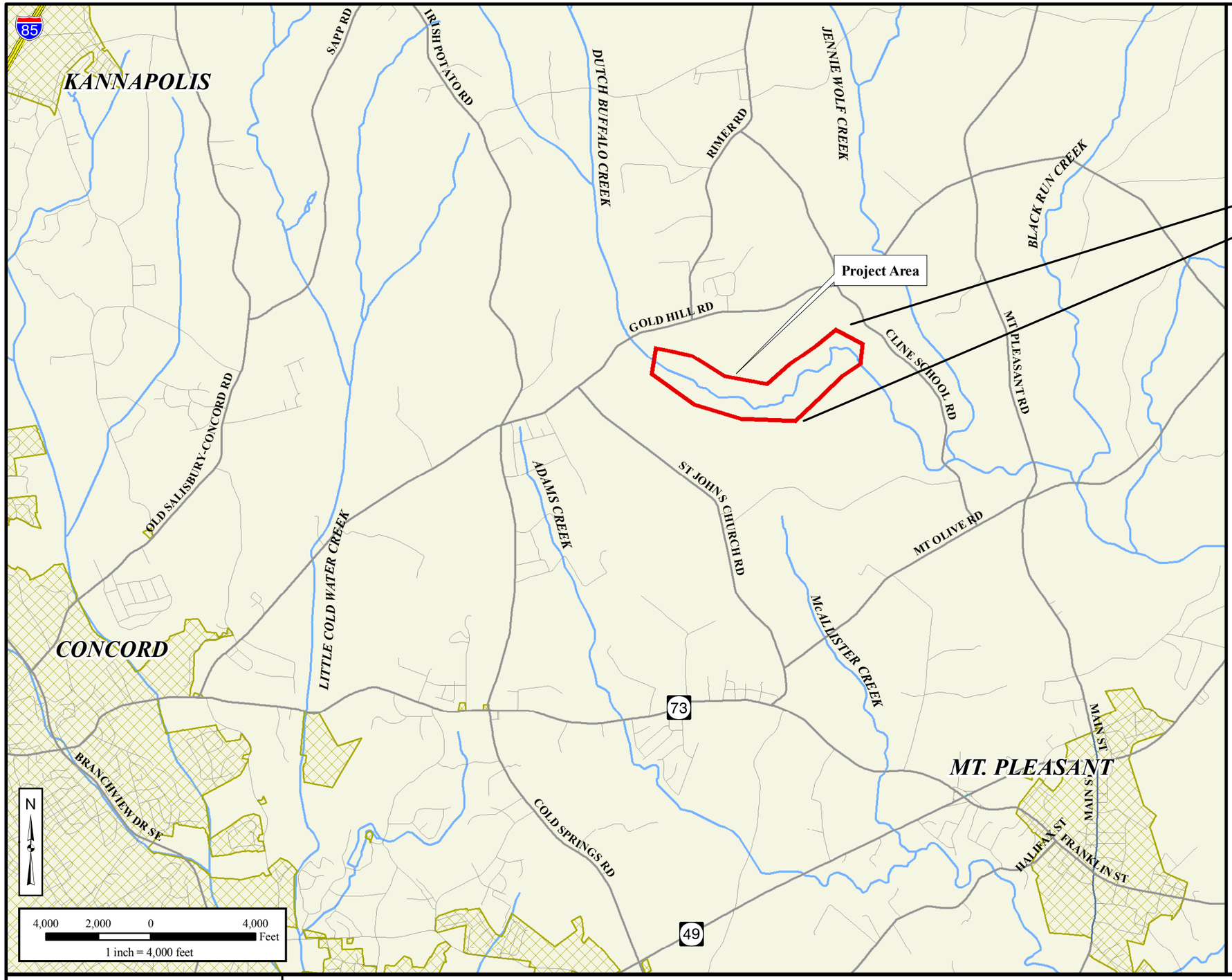
Figure 1.2 Project Component Map

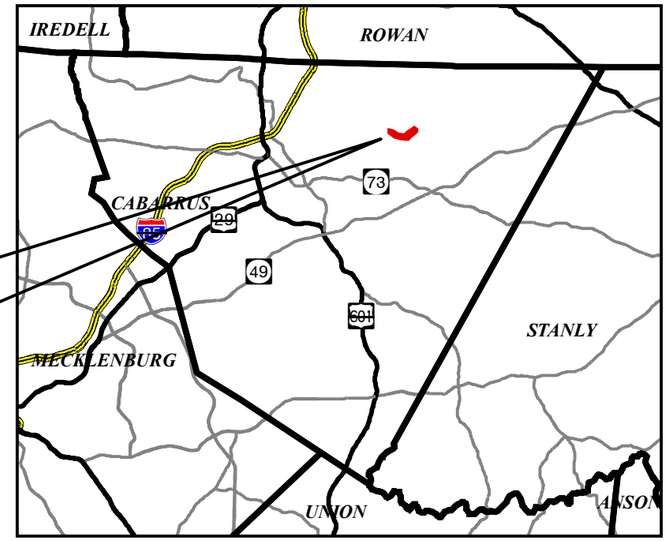
Table 1.1 Project Components

Table 1.2 Project Activity and Reporting History

Table 1.3 Project Contact Table

Table 1.4 Project Background



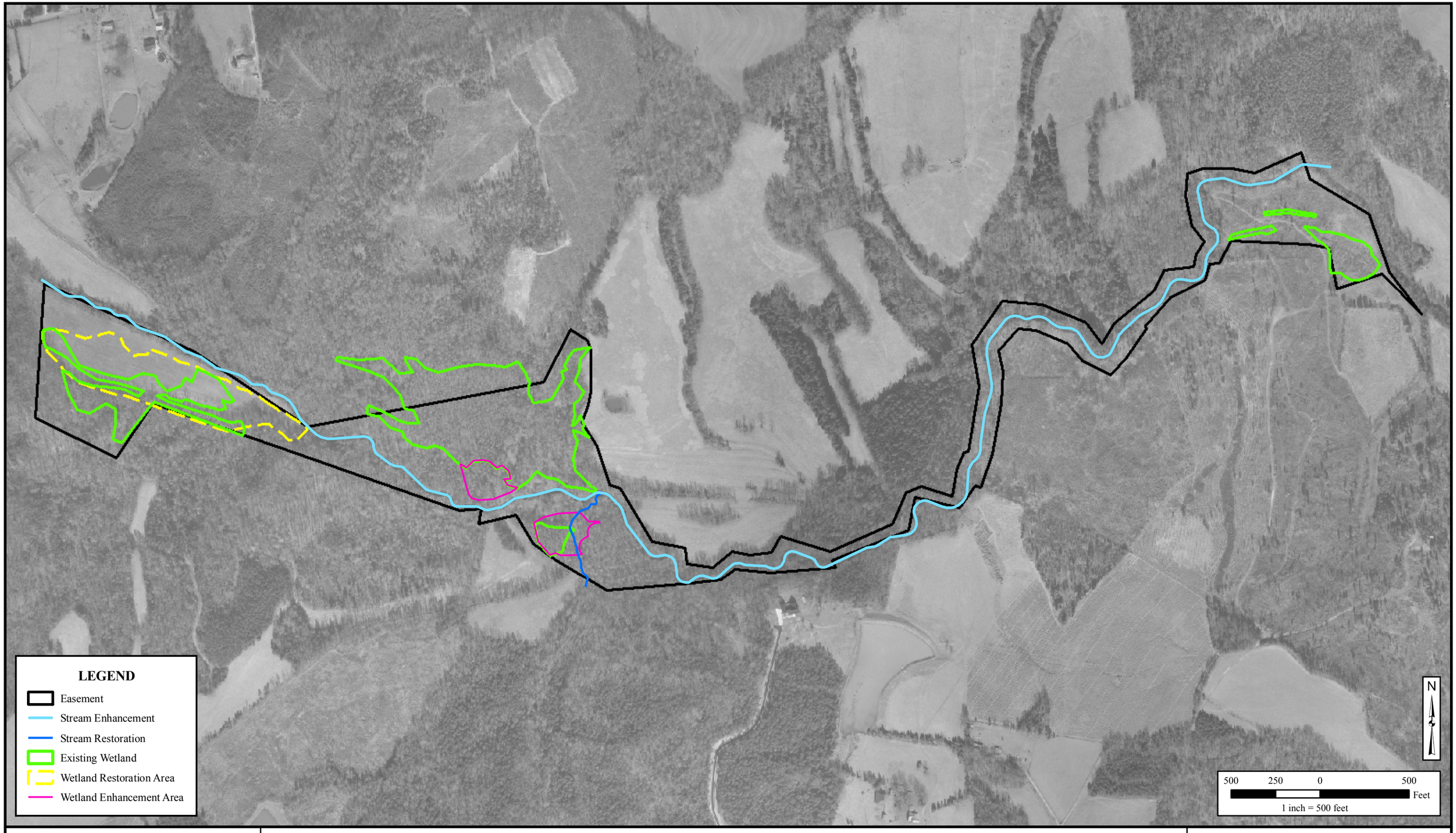


Directions from Charlotte, NC to Project Site:

From Interstate 85 North, take exit 63 (Lane Road) and turn east off the exit. Take Lane Road for approximately 0.8 miles to Old Salisbury-Concord Road and turn left. Take Old Salisbury-Concord Road for 0.5 miles and turn right onto Irish Potato Road (heading east). Follow Irish Potato Road for 5.0 miles, and where it intersects with Gold Hill Road, turn left (heading north-east). Take this to 6200 Gold Hill Road (approximately 2 miles), home of L. Suther.

Dutch Buffalo Creek Stream and Wetland Restoration Project
Vicinity Map
Cabarrus County, NC

Figure 1.1
April 2011
Project No: 3060002



Dutch Buffalo Creek Stream and Wetland Restoration Project
Project Component Map
Cabarrus County, NC

Figure 1.2
April 2011
Project No: 3060002

Table 1.1 Project Components Dutch Buffalo Creek Stream and Wetland Restoration Project SCO# 06-06752-01						
Segment/Reach	**Existing Feet/Acres**	**Mitigation Type**	**Approach**	**Linear Footage or Acres**	**Stationing (ft)**	**Comments**
Dutch Buffalo Creek-Upper Reach	N/A	N/A	N/A	N/A	0+00 – 17+61	Fencing one side of stream in conservation easement.
	3,611 lf	Enhancement II	N/A	3,004 lf	17+61 - 53+72	Replanting of native vegetation.* Easement will be fencend.
Dutch Buffalo Creek-Lower Reach	4,678 ft	Preservation	N/A	3,583 lf	53+72 – 100+50	Fencing of conservation easement.
Unnamed Tributary	527 ft	Restoration	P1,2	608 lf	0+00 – 6+08	Channel restoration with use of grade control and bank protection structures.
Wetland Area A	1.67 ac	Preservation	N/A	N/A	NA	Fencing of conservation easement.
Wetland Area B	9.93 ac	Enhancement	NA	2.47 ac	NA	Plugging/filling ditches, replanting vegetation.
		Restoration	NA	1.97 ac		
Wetland Area C	4.64 ac	Enhancement	NA	1.79 ac	NA	Plugging/filling ditches, replanting vegetation.
		Restoration	NA	5.32 ac		

Component Summations						
		Wetland (ac)				
Restoration Level	**Stream (lf)**	**Riparian**	**Non-Riparian**	**Upland (ac)**	**Buffer (ac)**	**BMP**
Restoration (R)	608	7.29	N/A	N/A	N/A	N/A
Enhancement (E)	N/A	4.26	N/A	N/A	N/A	N/A
Enahncement I (E)	N/A	N/A	N/A	N/A	N/A	N/A
Enhancement II (E)	3,004	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	**3,612**	**11.55**	**N/A**	**N/A**	**N/A**	**N/A**

*Efforts will consist of enhancing degraded sections along the right and left banks.

Table 1.2 Project Activity and Reporting History Dutch Buffalo Creek Stream and Wetland Restoration Project SCO# 06-06752-01		
Activity or Report	**Data Collection Completed**	**Actual Completion or Delivery**
Restoration Plan	Jan-06	Sep-07
Final Design-90%	Nov-08	Nov-08
Construction	Nov-09	Dec-09
Temporary S&E mix applied to entire project area*	Nov-09	Nov-09
Permanent seed mix applied to reach	Nov-09	Nov-09
Bare root and livestake plantings for reach	Dec-09	Dec-09
Mitigation Plan/ As-Built (Year 0 Monitoring)	Dec-09	Jan-09
Section 404 Permit	Jan-08	March 27, 2008
Year 1 Monitoring	2010	2010
Year 2 Monitoring	2011	2011
Year 3 Monitoring	2012	2012
Year 4 Monitoring	2013	2013
Year 5 Monitoring	2014	2014

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

Table 1.3 Project Contact Table Dutch Buffalo Creek Stream and Wetland Restoration Project SCO #06-06752-01	
Designer Matthew Clabaugh, PE	Jordan, Jones and Goulding, Inc. 309 E. Morehead Street, Suite 110 Charlotte, NC 28202 704-527-4106
Construction Will Pedersen	River Works, Inc. 8000 Regency Parkway, Suite 200 Cary, NC 27511 919-459-9001
Planting Contractor	River Works, Inc.
Seeding Contractor	River Works, Inc.
Monitoring Performers: **Baseline Year 0**	Jordan, Jones and Goulding, Inc. 309 E. Morehead Street, Suite 110 Charlotte, NC 28202
Stream Monitoring, POC	Alison Nichols, 704-247-9065
Vegetation Monitoring, POC	
Wetland Monitoring, POC	

Table 1.4 Project Attribute Table Dutch Buffalo Creek Stream and Wetland Restoration Project SCO #06-06752-01			
Project County	Cabarrus County, NC		
Physiographic Region	Piedmont		
Ecoregion	Southern Outer Piedmont		
Project River Basin	Yadkin PeeDee		
USGS HUC for Project (14 digit)	03040105020060		
NCDWQ Sub-basin for Project and Reference	03-07-12		
Within extent of EEP Watershed Plan?	No*		
WRC Class (Warm, Cool, Cold)	U		
% of project easement fenced or demarcated?	100%		
Beaver activity observed during design phase?	Yes**		
Restoration Component Attribute Table			
	Main Channel	**UT**	**WL C-1**
Drainage Area (sq.mi.)	21.3	0.31	N/A
Stream Order	3rd	1st	N/A
Restored Length (ft)	N/A	608	N/A
Acres	N/A	N/A	7.29
Perennial or Intermittent	Perennial	Intermittent	N/A
Watershed type (Rural, Urban, Developing)	Rural		
Watershed LULC Distribution			
Agriculture***	61.98%		
Commercial	0.95%		
Public/Institutional	0.05%		
Residential	34.50%		
Transportation	2.53%		
Watershed Impervious Cover (%)	3		
NCDWQ AU/Index number	13-17-11-(4.5)		N/A
NCDWQ classification	WS-II; HQW,CA		N/A
303d listed?	No		N/A
Upstream of a 303d listed sedment?	N/A		
Reasons for 303d listing or stressor	N/A		
Total acreage of easement	66 acres		
Total vegetated acreage within the easement	14.8 acres		
Total planted acreage as part of the restoration	14.8 acres		
Rosgen classification of the pre-existing	C5e	G5c	N/A
Rosgen classification of the As-Built	N/A	E4	N/A
Valley Type	VIII		N/A
Valley slope	0.0011	0.0093	N/A
Valley side slope range	U		N/A
Valley toe slope range	U		N/A
Cowardin classification	N/A		PFO1B/E PEM1B/E
Trout waters designation	No		N/A
Species of concern, endangered, etc? (Y/N)	N/A		N/A
Dominant soil series and characteristics	Aab, CcB2, CcD2, Ch, CuD2, EnD, PaF, MeB, MeD		
Series	Altavista, Cecil, Chewacala, Cullen, Enon, Pacolet, Mecklenburg		
Depth	Very Deep		
Clay %	-		
K	moderate - slow		N/A
T	-		N/A

*This site is not within an EEP planning area but is in a Targeted Local Watershed

**Beaver activity was observed along the main channel of Dutch Buffalo Creek during the early stages of the design phase and has not impacted the UT.

*** The forested lands classification includes areas within Cabarrus County only, because data was not available for specific forested areas within Rowan County. The Cabarrus County data is more detailed than the Rowan County data, so we were able to process the agricultural and forested areas within Cabarrus County into separate classifications of Cleared and Forested land uses. However, the Agriculture classification for Rowan County includes both cleared lands and any extent forested lands within the drainage basin, as there was no information available for processing these land uses separately.

"N/A": items do not apply / "-": items are unavailable / "U": items are unknown

APPENDIX 2
SUMMARY DATA AND PLOTS

Table 2.1 Stem Counts for Planted Species

Table 2.2 Baseline Stream Data Summary

Table 2.3 Morphological and Hydraulic Monitoring Summary

Figure 2.1 Longitudinal Plot

Figure 2.2 Cross-Section Plots

Figure 2.3 Pebble Count Plots

Reference Photograph Points

Table 2.1 Stem Counts for Planted Species
Dutch Buffalo Creek Stream and Wetland Restoration Project
SCO #06-06752-01

			Current Data (MY0-2010)														Annual Means	
			Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6		Plot 7		Current Mean	
Species	**Common Name**	**Type**	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Alnus serrulata	hazel alder	T/S	7	7	5	5	6	6	3	3	3	3			3	3	**4**	**4**
Aimina triloba	pawpaw	T/S			2	2			1	1	3	3			1	1	**2**	**2**
Betula nigra	river birch	T	1	1			1	1									**1**	**1**
Carpinus caroliniana	american hornbeam	T/S	2	2			1	1							1	1	**1**	**1**
Celtis laevigata	sugarberry	T/S	1	1													**1**	**1**
Cornus amomum	silky dogwood	S	5	5	6	6											**6**	**6**
Fraxinus pennsylvanica	green ash	T							6	6	3	3	4	4			**4**	**4**
Lindera benzoin	northern spicebush	T/S	2	2	1	1	3	3			1	1	1	1			**2**	**2**
Liriodendron tulipifera	tuliptree	T			2	2			1	1	2	2			2	2	**2**	**2**
Nyssa sylvatica	blackgum	T			1	1							1	1			**1**	**1**
Platanus occidentalis	american sycamore	T											7	7			**7**	**7**
Quercus michauxii	swamp chestnut oak	T	1	1													**1**	**1**
Quercus phellos	willow oak	T													2	2	**2**	**2**
Ulmus americana	american elm	T	1	1	3	3	3	3			5	5	1	1	5	5	**3**	**3**
Viburnum dentatum	southern arrowwood	T/S	1	1	5	5											**3**	**3**
	Plot Area (acres)		**0.024**		**0.024**		**0.057**		**0.024**		**0.057**		**0.024**		**0.024**			
	Species Count		**9**	**9**	**8**	**8**	**5**	**5**	**4**	**4**	**6**	**6**	**5**	**5**	**6**	**6**	**6**	**6**
	Stem Count		**21**	**21**	**25**	**25**	**14**	**14**	**11**	**11**	**17**	**17**	**14**	**14**	**14**	**14**	**16**	**16**
	Stems per Acre		**875**	**875**	**1042**	**1042**	**583**	**583**	**458**	**458**	**708**	**708**	**583**	**583**	**583**	**583**	**677**	**677**

Type=**S**hrub or **T**ree
P = Planted
T = Total

Table 2.2 Baseline Stream Data Summary								
Dutch Buffalo Creek Stream and Wetland Restoration Project/SCO #06-06752-01								
Unnammed Tributary to Dutch Buffalo (608 linear feet)								
Parameter	Pre-Existing Condition		Reference Reach Data		Design		As-built-MY0	
Dimension - Riffle	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	8.68		8.30		9.00		8.60	
Floodprone Width (ft)	9.80		130.00		150.00		150.00	
Bankfull Mean Depth (ft)	1.17		1.30		1.00		1.02	
Bankfull Max Depth (ft)	1.49		1.90		1.50		1.74	
Bankfull Cross-Sectional Area (ft^2)	10.17		10.95		9.00		8.77	
Width/Depth Ratio	7.42		6.40		9.00		8.60	
Entrenchment Ratio	1.13		15.66		16.67		16.67	
Bank Height Ratio	2.53		1.20		1.00		1.00	
Bankfull Velocity (fps)	3.80		3.50		3.65		3.65	
Pattern								
Channel Beltwidth (ft)	2.50	19.40	33.00	69.00	33.30	81.00	33.30	81.00
Radius of Curvature (ft)	10.38	37.99	12.00	19.00	22.50	27.00	22.50	27.00
Rc:Bankfull width (ft/ft)	1.20	4.38	1.40	2.30	2.50	3.00	2.50	3.00
Meander Wavelength (ft)	43.00	109.00	60.00	69.00	57.60	126.00	57.60	126.00
Meander Width Ratio	0.29	2.24	4.00	8.30	3.70	9.00	3.70	9.00
Profile								
Riffle Length (ft)	6.76	41.57	5.40	23.00	10.00	41.20	13.76	19.36
Riffle Slope (ft/ft)	0.0031	0.0386	0.0160	0.0240	0.0140	0.0240	0.0014	0.0111
Pool Length (ft)	5.89	37.56	7.80	35.00	21.10	54.10	10.32	31.40
Pool Spacing (ft)	17.35	125.66	40.30	60.00	34.60	67.90	10.32	52.04
Substrate and Transport Parameters								
SC% / Sa% / G% / C% / B% / Be%	-		-		-		-	
d16 / d35 / d50 / d84 / d95 (mm)	0.12/0.83/2.36/11.03/22.6				-		1.45/5.85/8.29/25.06/47.52	
Reach Shear Stress (competency) lb/ft^2	-		-		-		0.95	
Additional Reach Parameters								
Channel length (ft)	527		-		608		608	
Drainage Area (mi^2)	0.31		0.3		0.31		0.31	
Rosgen Classification	G5c		E4		C/E4		C/E4	
Bankfull Discharge (cfs)	39.04*		38		39.04*		39.04*	
Sinuosity	1.24		1.8		1.13		1.13	
Water Surface Slope (ft/ft)	0.008		0.005		0.006		0.008	
Eroding Banks	0.650		N/A		N/A		N/A	
BF slope (ft/ft)	0.008		0.005		0.006		0.008	
*Calculated using Flowmaster								

Table 2.3 Morphologic and Hydraulic Monitoring Summary

Dutch Buffalo Creek Stream and Wetland Restoration Project/SCO #06-06752-01

Unnammed Tributary to Dutch Buffalo (608 linear feet)

PARAMETER	Cross-Section 1-Riffle						Cross-Section 2-Riffle						Cross-Section 3-Pool						Cross-Section 4-Riffle					
DIMENSION	**MY0-2009**	**MY1-2010**	**MY2-2011**	**MY3-2012**	**MY4-2013**	**MY5-2014**	**MY0-2009**	**MY1-2010**	**MY2-2011**	**MY3-2012**	**MY4-2013**	**MY5-2014**	**MY0-2009**	**MY1-2010**	**MY2-2011**	**MY3-2012**	**MY4-2013**	**MY5-2014**	**MY0-2009**	**MY1-2010**	**MY2-2011**	**MY3-2012**	**MY4-2013**	**MY5-2014**
Bankfull Width (ft)	8.9						9.6						11.0						8.3					
Floodprone Width (ft)	55.6						53.3						59.0						52.5					
Bankfull Cross-sectional Area	9.2						10.2						9.3						8.3					
Bankfull Mean Depth	1.0						1.1						0.8						1.0					
Bankfull Max Depth	1.8						1.7						1.9						1.7					
Width/Depth Ratio	8.5						9.1						13.1						8.3					
Entrenchment Ratio	6.3						5.6						5.4						6.3					
Wetted Perimeter (ft)	9.9						10.6						12.1						9.2					
Hydraulic Radius (ft)	0.9						1.0						0.8						0.9					
Bank Height Ratio	1.0						1.0						1.0						1.0					
SUBSTRATE	**MY0-2009**	**MY1-2008**	**MY2-2009**	**MY3-2010**	**MY4-2011**	**MY5-2012**	**MY0-2009**	**MY1-2008**	**MY2-2009**	**MY3-2010**	**MY4-2011**	**MY5-2012**	**MY0-2009**	**MY1-2008**	**MY2-2009**	**MY3-2010**	**MY4-2011**	**MY5-2012**	**MY0-2009**	**MY1-2008**	**MY2-2009**	**MY3-2010**	**MY4-2011**	**MY5-2012**
D50 (mm)	13.65						0.13						0.14						11.08					
D84 (mm)	46.90						0.45						0.85						27.82					

PROFILE	MY0-2009			MY1-2010			MY2-2011			MY3-2012			MY4-2013			MY5-2014		
Main Channel	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Riffle Length (ft)	13.76	28.82	19.36															
Riffle Slope (ft/ft)	0.00142	0.01856	0.01113															
Pool Length (ft)	10.32	53.33	31.4															
Pool to Pool Spacing (ft)	10.32	75.27	52.04															

ADDITIONAL REACH PARAMETERS	MY0-2009	MY1-2010	MY2-2011	MY3-2012	MY4-2013	MY5-2014
Valley Length (ft)	0.0093					
Channel Length (ft)	608					
Sinuosity	1.16					
Water Surface Slope (ft/ft)	0.008					
Bankfull Slope (ft/ft)	0.008					
Rosgen Classification	E4					

Figure 2.1 Longitudinal Plot
Dutch Buffalo Creek (Unnamed Tributary)
Longitudinal Profile
MY-0 (2009) As-Built

Right Bankfull/Top of Bank = -0.008*STA+649.54
Left Bankfull/Top of Bank = -0.0075*STA+649.45
Water Surface = -0.008*STA+647.89

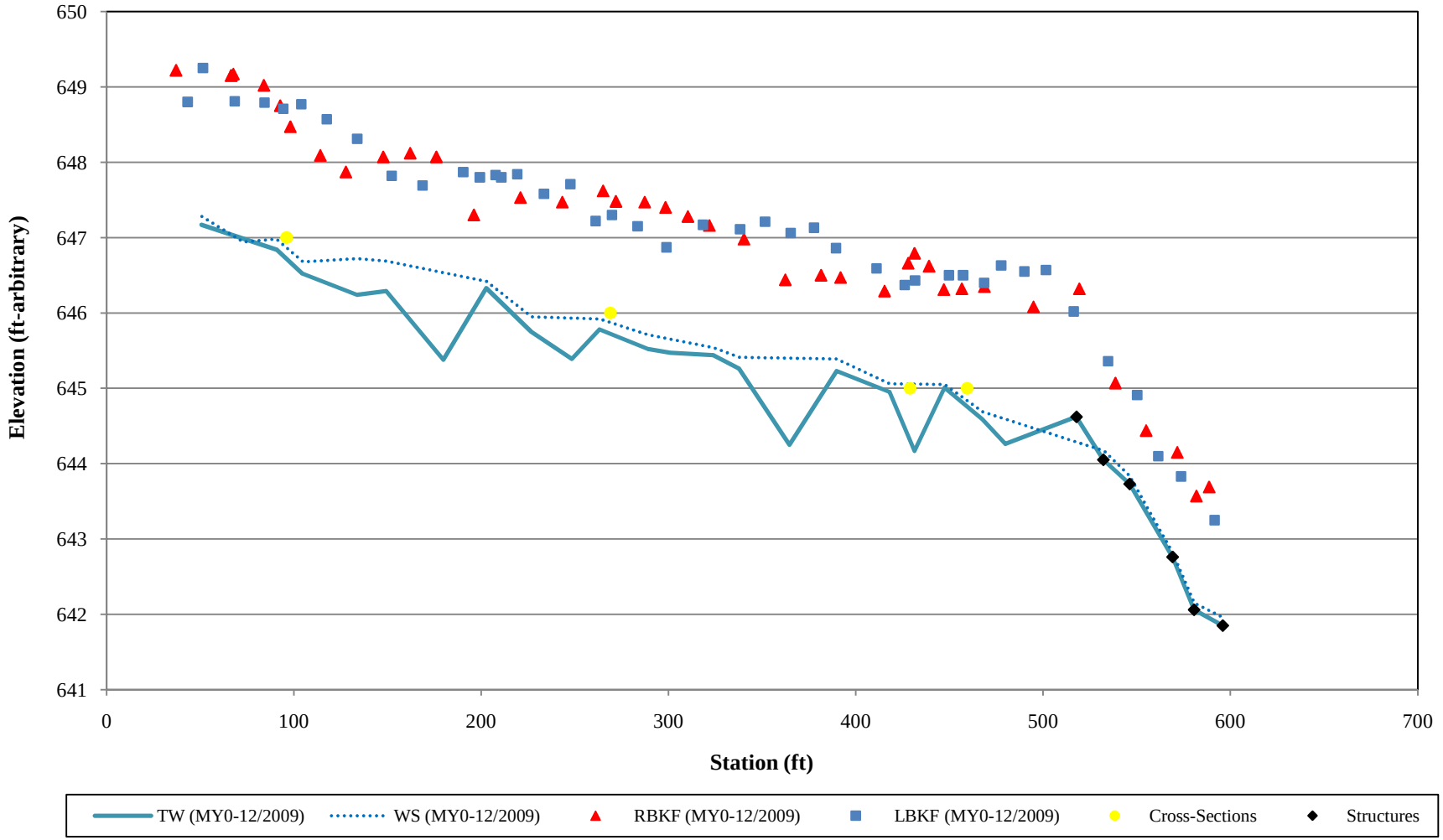


Figure 2.2a Cross-Section Plots

Project Name: Dutch Buffalo Creek (Unnamed Tributary)		
Cross-Section: 1		
Feature: Riffle		
MY0-4/2010		
Station	**Elevation**	**Notes**
0.00	650.15	
27.36	648.66	
29.43	647.74	
30.35	647.01	
31.01	646.80	LEW
31.91	646.70	
32.54	646.70	
32.62	646.80	REW
33.51	646.79	
34.60	647.76	
36.55	648.51	BKF
55.57	648.52	
55.54	648.52	

Summary Data	
Bankfull Cross-sectional Area (ft^2)	9.24
Bankfull Width (ft)	8.85
Bankfull Mean Depth (ft)	1.04
Bankfull Max Depth (ft)	1.81
Width/Depth Ratio	8.51
Entrenchment Ratio	6.28

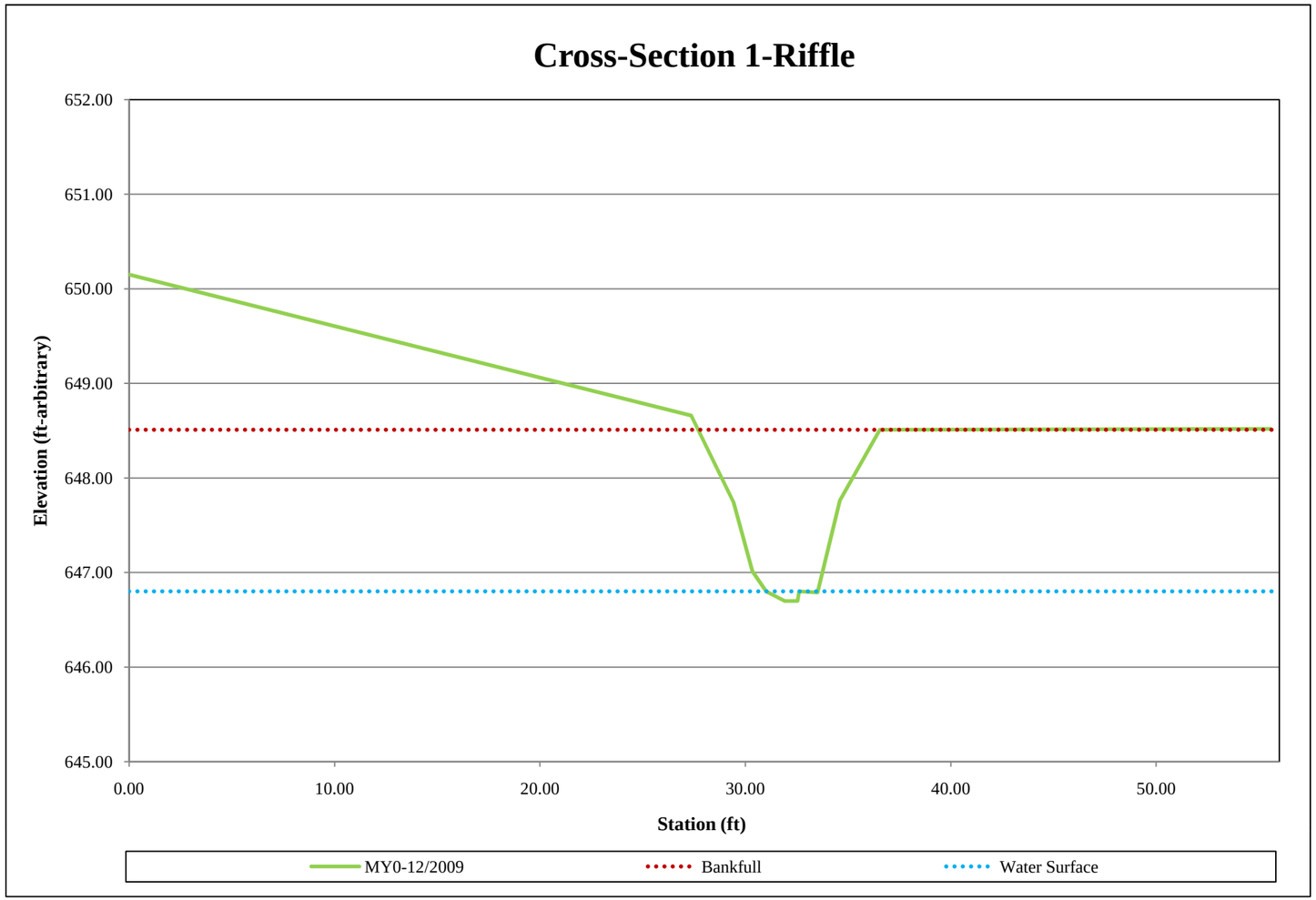


Figure 2.2b Cross-Section Plots

Project Name: Dutch Buffalo Creek (Unnamed Tributary)		
Cross-Section: 2		
Feature: Pool		
MY0-4/2010		
Station	**Elevation**	**Notes**
0.00	647.47	
20.82	647.41	BKF
22.77	646.66	
23.38	645.81	W
24.19	645.69	
25.19	645.79	
25.63	645.81	W
27.55	645.85	
28.66	646.65	
30.59	647.49	
53.32	647.64	

Summary Data	
Bankfull Cross-sectional Area (ft^2)	10.16
Bankfull Width (ft)	9.59
Bankfull Mean Depth (ft)	1.06
Bankfull Max Depth (ft)	1.72
Width/Depth Ratio	9.05
Entrenchment Ratio	N/A

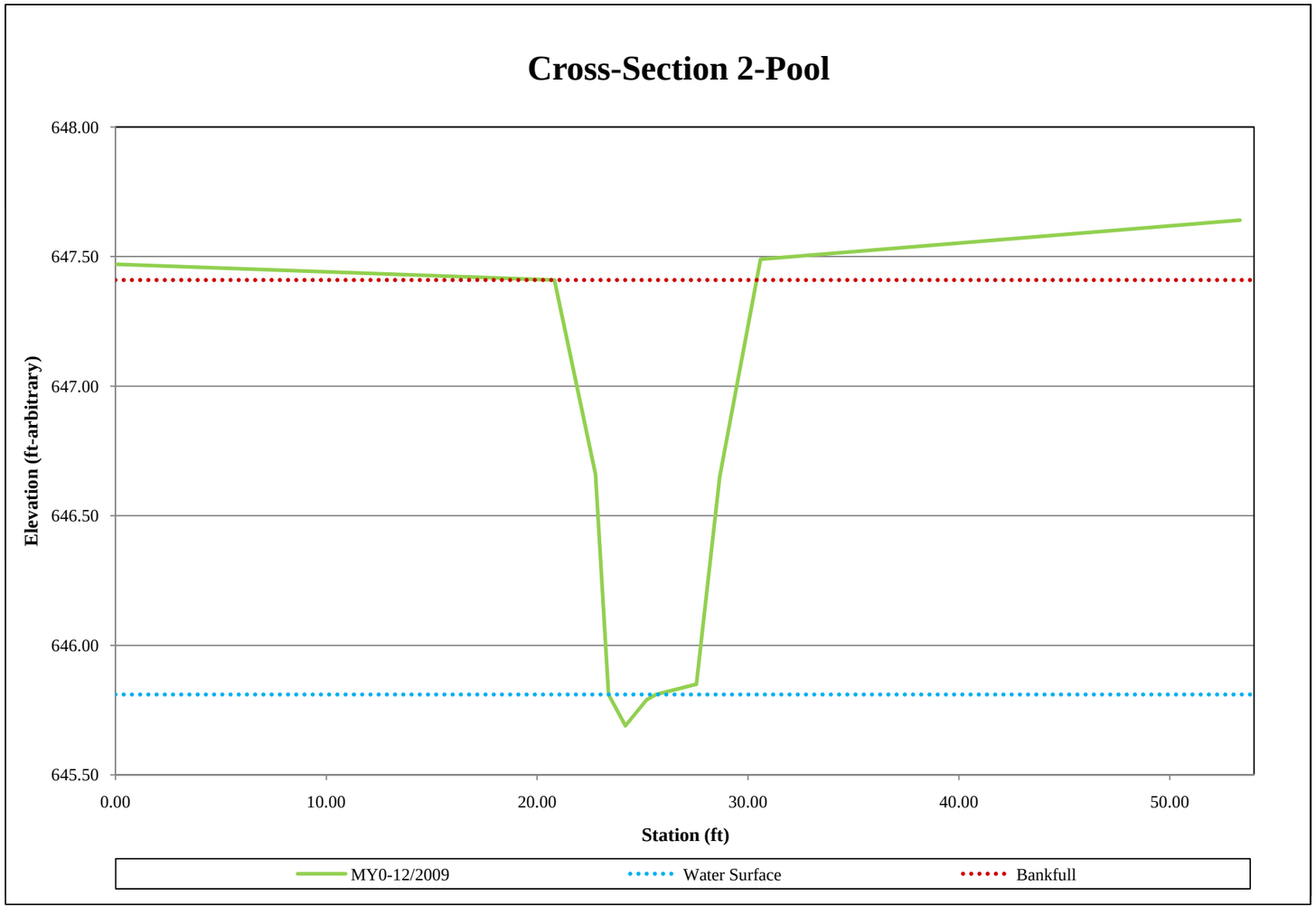


Figure 2.2c Cross-Section Plots

Project Name: Dutch Buffalo Creek (Unnamed Tributary)		
Cross-Section: 3		
Feature: Pool		
MY0-4/2010		
Station	**Elevation**	**Notes**
0.00	647.38	
28.66	645.96	BKF
30.76	645.58	
32.56	645.20	
34.03	644.96	
35.82	644.55	
36.65	644.34	
37.40	644.05	
37.86	644.97	
38.46	645.01	WS
39.60	645.91	
40.92	646.82	
58.96	647.68	
58.94	647.68	

Summary Data	
Bankfull Cross-sectional Area (ft^2)	9.28
Bankfull Width (ft)	11.01
Bankfull Mean Depth (ft)	0.84
Bankfull Max Depth (ft)	1.91
Width/Depth Ratio	13.11
Entrenchment Ratio	N/A

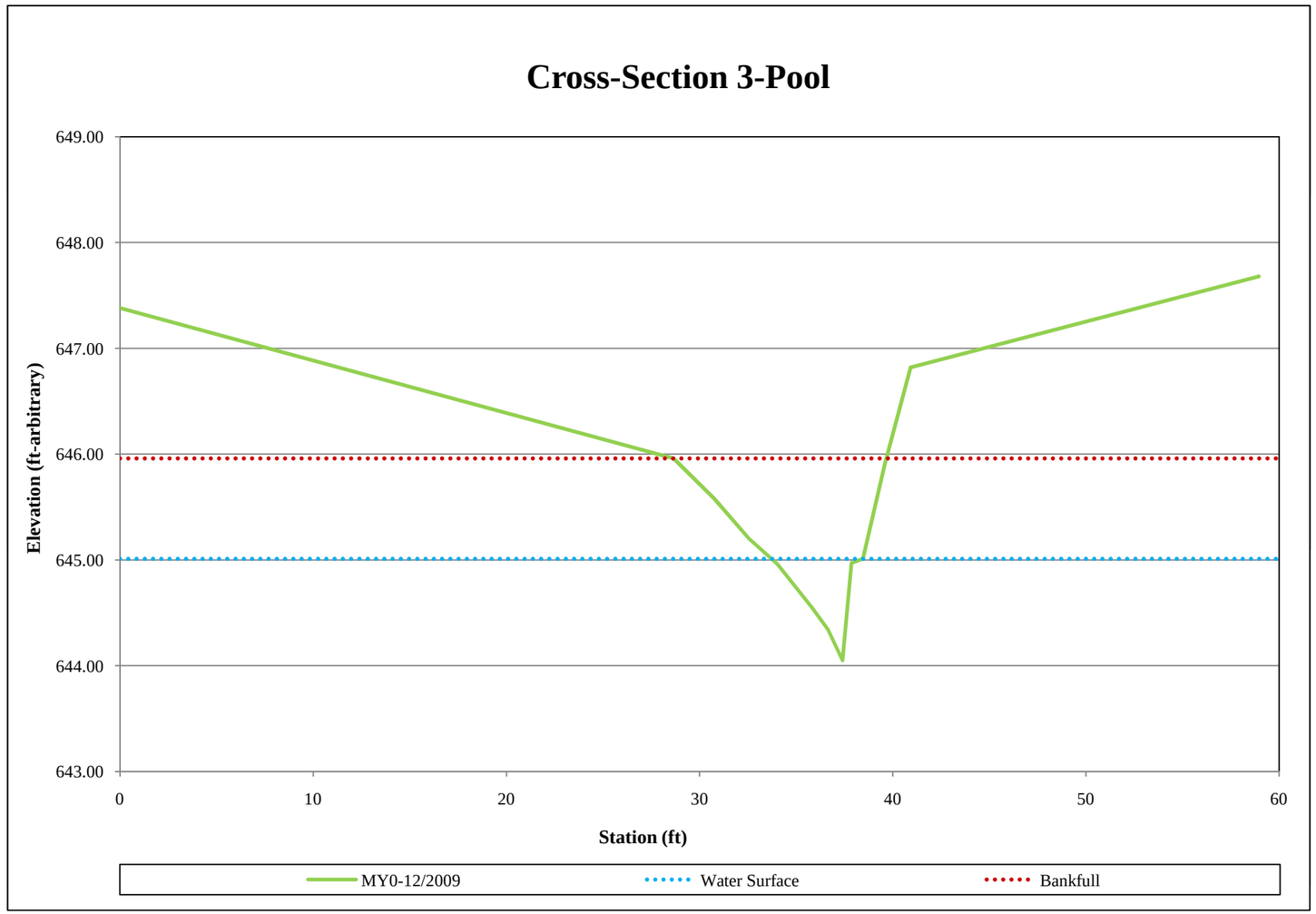


Figure 2.2d Cross-Section Plots

Project Name: Dutch Buffalo Creek (Unnamed Tributary)		
Cross-Section: 4		
Feature: Riffle		
MY0-4/2010		
Station	**Elevation**	**Notes**
0.00	647.35	
24.01	646.49	
25.22	645.86	
26.29	645.01	
26.50	644.97	
27.19	644.86	
27.92	644.91	
28.66	644.71	
29.34	644.83	
29.90	644.92	WS
31.15	645.91	
32.56	646.38	BKF
52.50	647.15	
52.52	647.15	

Summary Data	
Bankfull Cross-sectional Area (ft^2)	8.30
Bankfull Width (ft)	8.34
Bankfull Mean Depth (ft)	1.00
Bankfull Max Depth (ft)	1.67
Width/Depth Ratio	8.34
Entrenchment Ratio	6.30

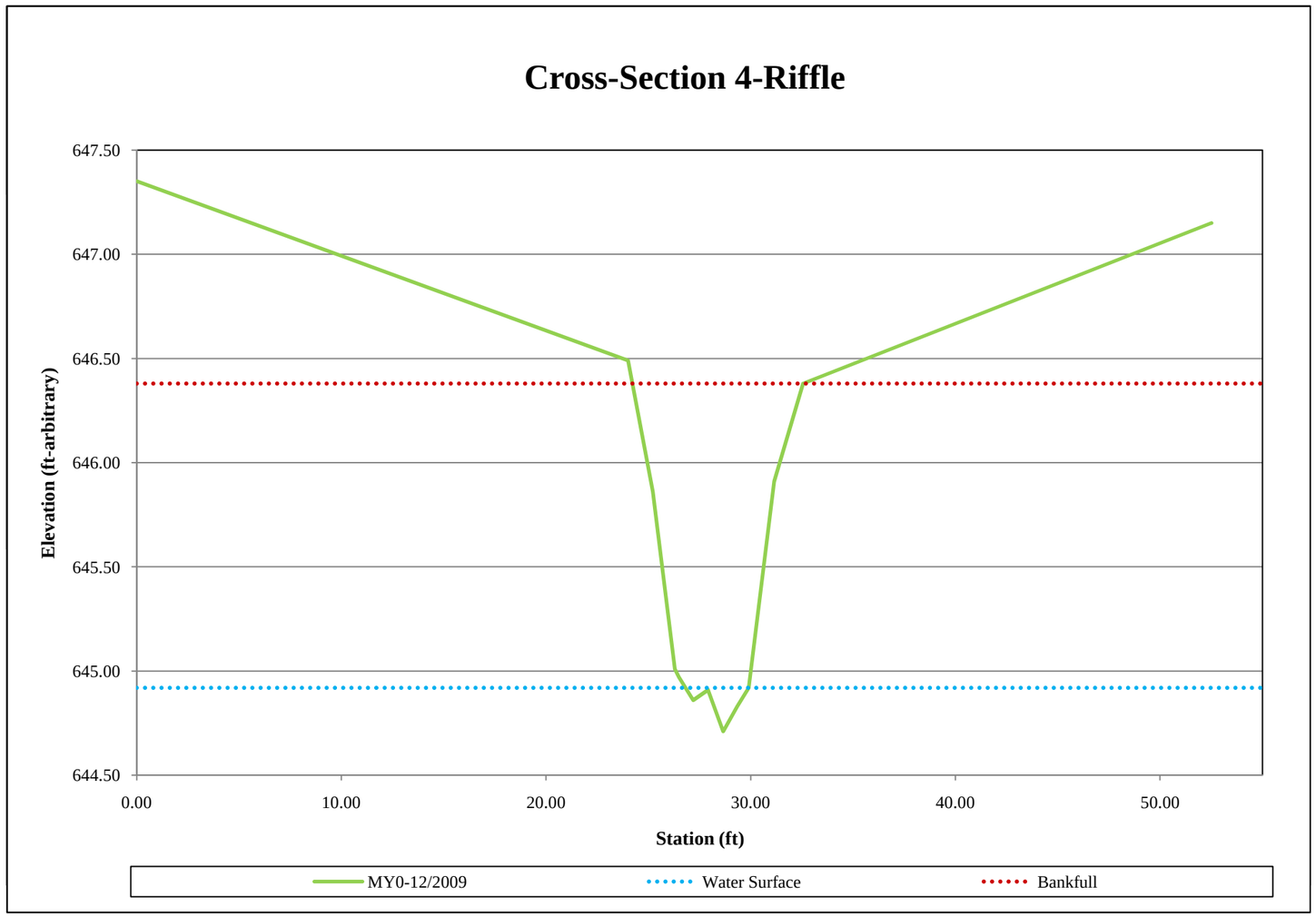
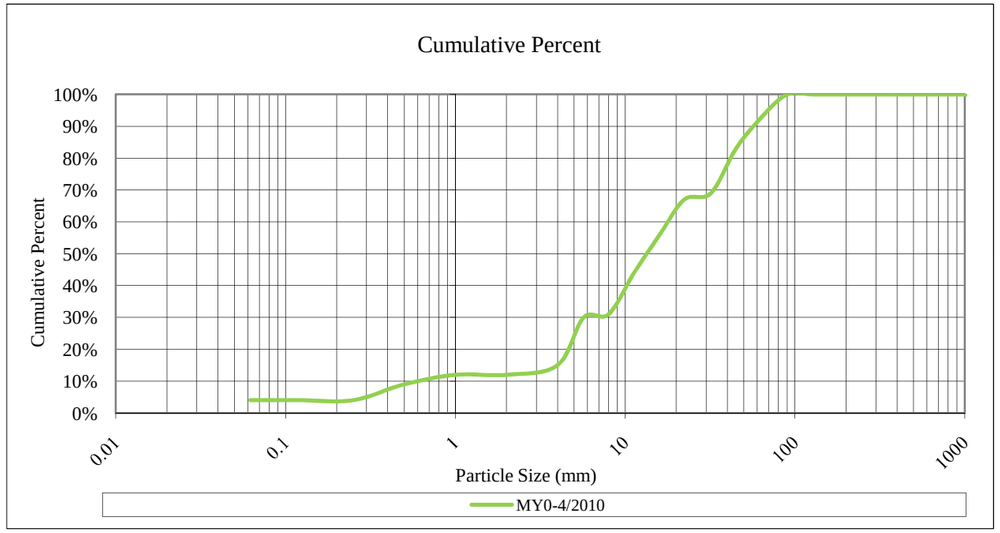


Figure 2.3a Pebble Count Plots

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section: 1					
Feature: Riffle					
			MY0-4/2010		
Description	**Material**	**Size (mm)**	**Total #**	**Item %**	**Cum %**
Silt/Clay	silt/clay	0.062	4	4%	4%
Sand	very fine sand	0.125	0	0%	4%
	fine sand	0.250	0	0%	4%
	medium sand	0.50	5	5%	9%
	coarse sand	1.00	3	3%	12%
	very coarse sand	2.0	0	0%	12%
Gravel	very fine gravel	4.0	3	3%	15%
	fine gravel	5.7	15	15%	30%
	fine gravel	8.0	1	1%	31%
	medium gravel	11.3	13	13%	44%
	medium gravel	16.0	12	12%	56%
	course gravel	22.3	11	11%	67%
	course gravel	32.0	2	2%	69%
	very coarse gravel	45	14	14%	83%
	very coarse gravel	64	10	10%	93%
Cobble	small cobble	90	7	7%	100%
	medium cobble	128	0	0%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count			100	100%	100%

Summary Data	
D50	13.65
D84	46.90
D95	71.43



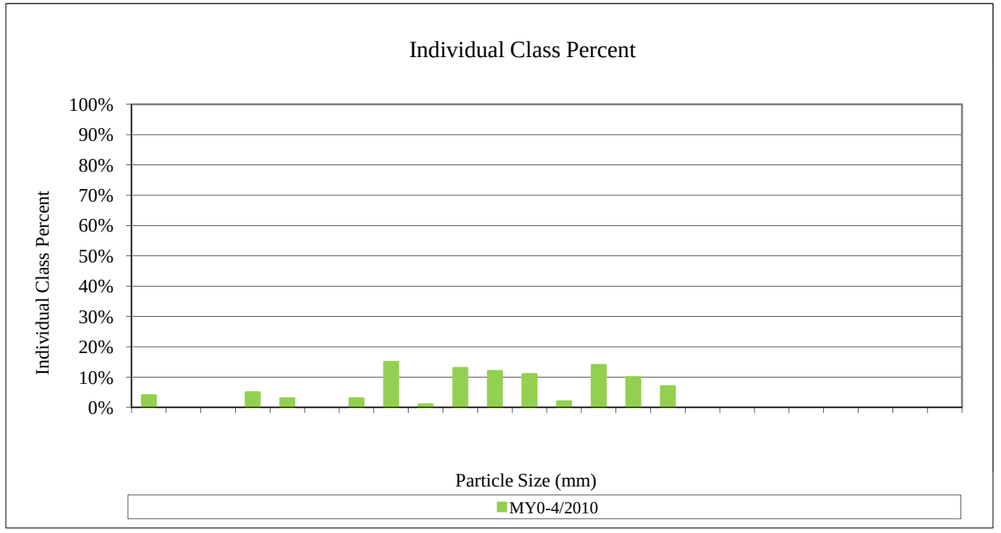
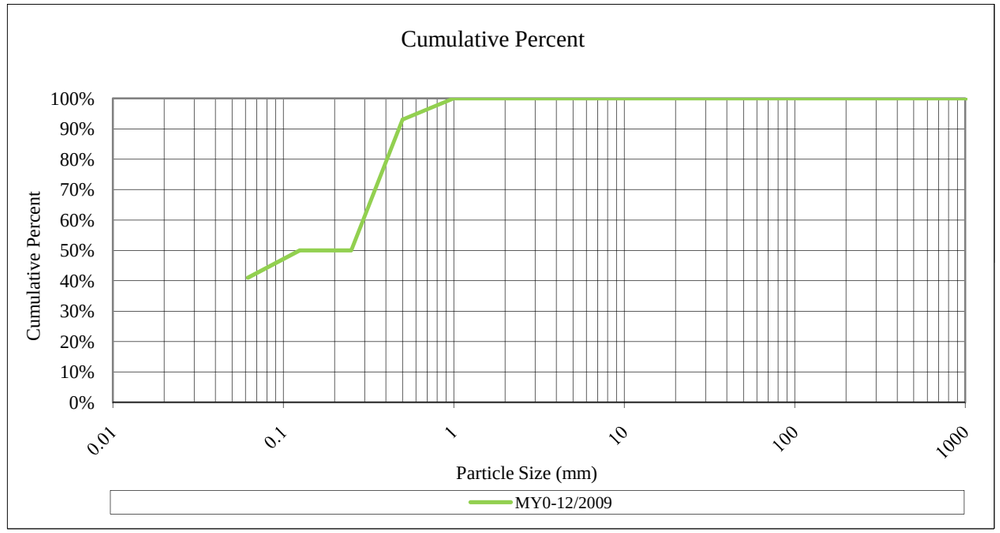


Figure 2.3b Pebble Count Plots

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section: 2					
Feature: Pool					
			MY0-4/2010		
Description	**Material**	**Size (mm)**	**Total #**	**Item %**	**Cum %**
Silt/Clay	silt/clay	0.062	41	41%	41%
Sand	very fine sand	0.125	9	9%	9%
	fine sand	0.250	0	0%	0%
	medium sand	0.50	43	43%	43%
	coarse sand	1.00	7	7%	7%
	very coarse sand	2.0	0	0%	0%
Gravel	very fine gravel	4.0	0	0%	0%
	fine gravel	5.7	0	0%	0%
	fine gravel	8.0	0	0%	0%
	medium gravel	11.3	0	0%	0%
	medium gravel	16.0	0	0%	0%
	course gravel	22.3	0	0%	0%
	course gravel	32.0	0	0%	0%
	very coarse gravel	45	0	0%	0%
	very coarse gravel	64	0	0%	0%
Cobble	small cobble	90	0	0%	0%
	medium cobble	128	0	0%	0%
	large cobble	180	0	0%	0%
	very large cobble	256	0	0%	0%
Boulder	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
Bedrock	bedrock	40096	0	0%	0%
TOTAL % of whole count			100	100%	100%

Summary Data	
D50	0.13
D84	0.45
D95	0.64



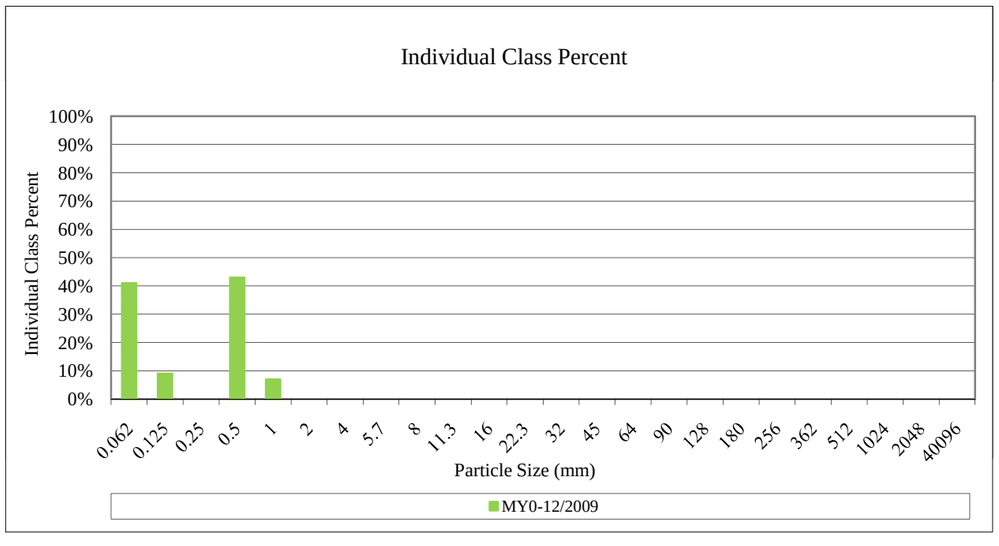
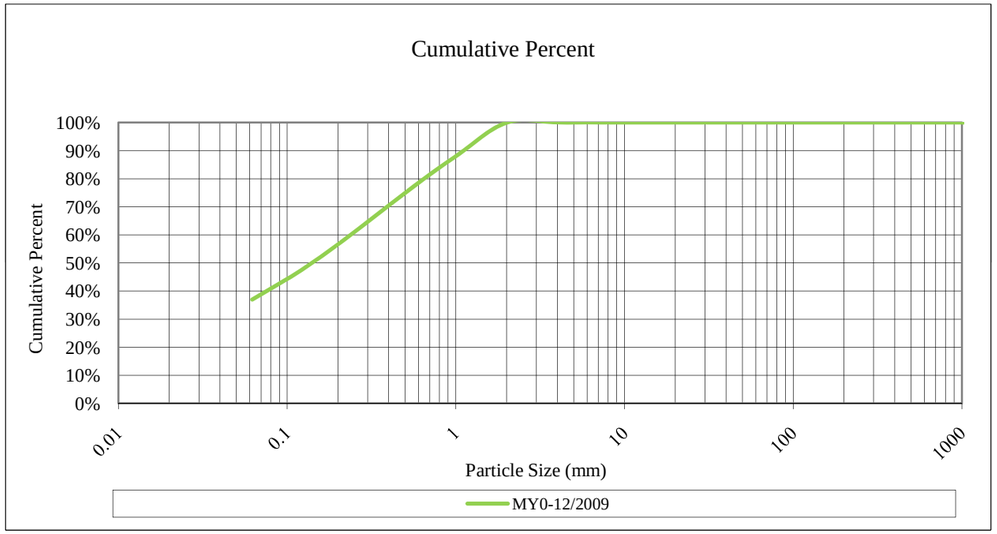


Figure 2.3c Pebble Count Plots

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section: 3					
Feature: Pool					
			MY0-4/2010		
Description	**Material**	**Size (mm)**	**Total #**	**Item %**	**Cum %**
Silt/Clay	silt/clay	0.062	37	37%	37%
Sand	very fine sand	0.125	11	11%	11%
	fine sand	0.250	13	13%	13%
	medium sand	0.50	14	14%	14%
	coarse sand	1.00	13	13%	13%
	very coarse sand	2.0	12	12%	12%
Gravel	very fine gravel	4.0	0	0%	0%
	fine gravel	5.7	0	0%	0%
	fine gravel	8.0	0	0%	0%
	medium gravel	11.3	0	0%	0%
	medium gravel	16.0	0	0%	0%
	course gravel	22.3	0	0%	0%
	course gravel	32.0	0	0%	0%
	very coarse gravel	45	0	0%	0%
	very coarse gravel	64	0	0%	0%
Cobble	small cobble	90	0	0%	0%
	medium cobble	128	0	0%	0%
	large cobble	180	0	0%	0%
	very large cobble	256	0	0%	0%
Boulder	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
Bedrock	bedrock	40096	0	0%	0%
TOTAL % of whole count			100	100%	100%

Summary Data	
D50	0.14
D84	0.85
D95	1.58



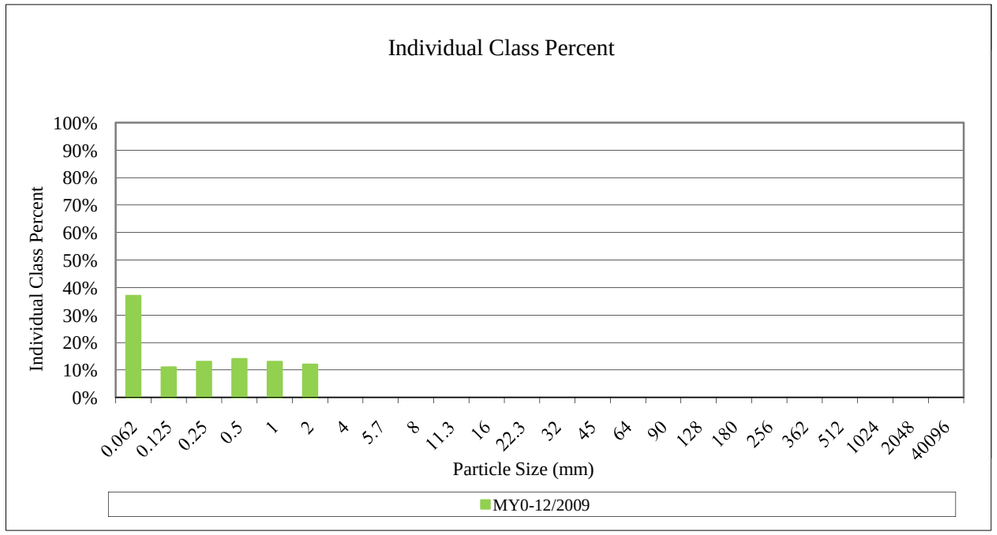
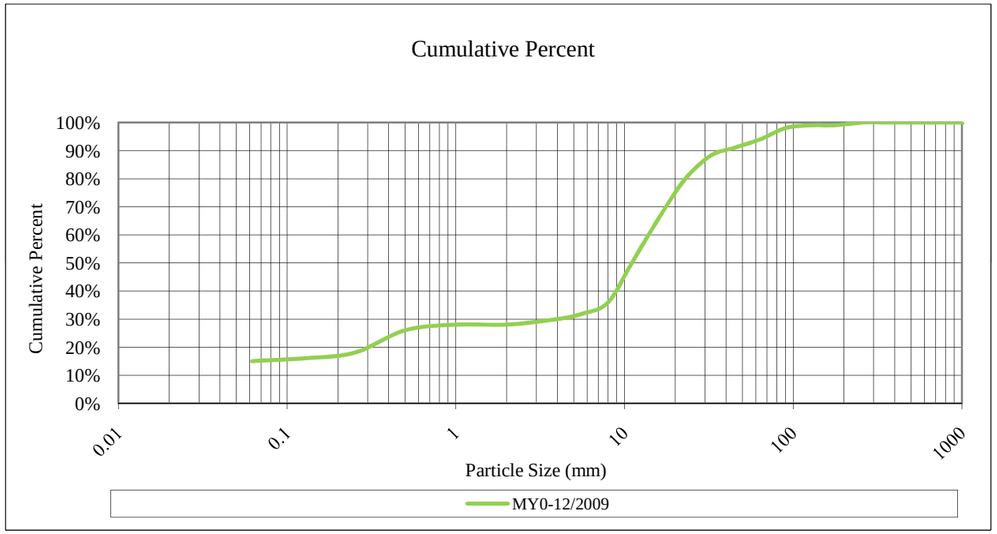


Figure 2.3d Pebble Count Plots

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section: 4					
Feature: Riffle					
			MY0-4/2010		
Description	**Material**	**Size (mm)**	**Total #**	**Item %**	**Cum %**
Silt/Clay	silt/clay	0.062	15	15%	15%
Sand	very fine sand	0.125	1	1%	1%
	fine sand	0.250	2	2%	2%
	medium sand	0.50	8	8%	8%
	coarse sand	1.00	2	2%	2%
	very coarse sand	2.0	0	0%	0%
Gravel	very fine gravel	4.0	2	2%	2%
	fine gravel	5.7	2	2%	2%
	fine gravel	8.0	4	4%	4%
	medium gravel	11.3	15	15%	15%
	medium gravel	16.0	15	15%	15%
	course gravel	22.3	13	13%	13%
	course gravel	32.0	9	9%	9%
	very coarse gravel	45	3	3%	3%
	very coarse gravel	64	3	3%	3%
Cobble	small cobble	90	4	4%	4%
	medium cobble	128	1	1%	1%
	large cobble	180	0	0%	0%
	very large cobble	256	1	1%	1%
Boulder	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
Bedrock	bedrock	40096	0	0%	0%
TOTAL % of whole count			100	100%	100%

Summary Data	
D50	11.08
D84	27.82
D95	70.5



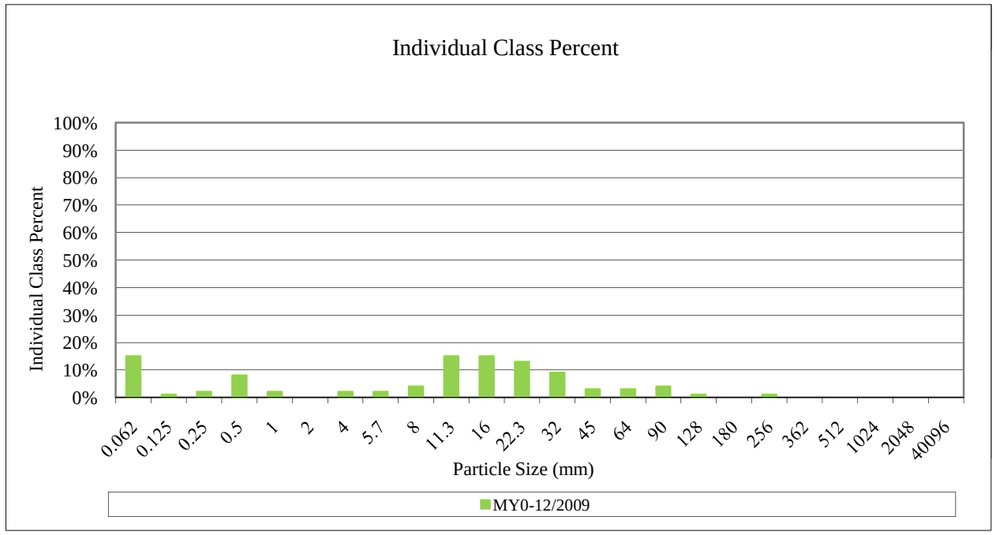


Photo Point 1-View Northeast
Wetland Area C (4/2010)

Photo Point 1-View Northwest
Wetland Area C (4/2010)

Photo Point 1-View Southeast
Wetland Area C (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 2-View Upstream
Wetland Area C (4/2010)

Photo Point 2-View Downstream
Wetland Area C (4/2010)

Photo Point 3-View Upstream
Wetland Area C (4/2010)

Photo Point 3-View Downstream
Wetland Area C (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 4-View Upstream
DBC Main Channel (4/2010)

Photo Point 4-View Downstream
DBC Main Channel (4/2010)

Photo Point 5-View Upstream
DBC Main Channel (4/2010)

Photo Point 5-View Downstream
DBC Main Channel (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 6-View Upstream
DBC Main Channel (4/2010)

Photo Point 6-View Downstream
DBC Main Channel (4/2010)

Photo Point 7-View Upstream
DBC Main Channel (4/2010)

Photo Point 7-View Downstream
DBC Main Channel (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 8-View Upstream
DBC Main Channel (4/2010)

Photo Point 8-View Downstream
DBC Main Channel (4/2010)

Photo Point 9-View Upstream
DBC Main Channel (4/2010)

Photo Point 9-View Downstream
DBC Main Channel (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 10-View Upstream
DBC Main Channel (4/2010)

Photo Point 10-View Downstream
DBC Main Channel (4/2010)

Photo Point 11-View Upstream
DBC Main Channel (4/2010)

Photo Point 11-View Downstream
DBC Main Channel (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 12-View Upstream
DBC Main Channel (4/2010)

Photo Point 12-View Downstream
DBC Main Channel (4/2010)

Photo Point 13-View Upstream
DBC Main Channel (4/2010)

Photo Point 13-View Downstream
DBC Main Channel (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 14-View Upstream
DBC Main Channel (9/2010)

Photo Point 14-View Downstream
DBC Main Channel (9/2010)

Photo Point 15-View Upstream
DBC Main Channel (9/2010)

Photo Point 15-View Downstream
DBC Main Channel (9/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 17-View Upstream
DBC Main Channel (4/2010)

Photo Point 17-View Downstream
DBC Main Channel (4/2010)

Photo Point 18-View Upstream
DBC Main Channel (9/2010)

Photo Point 18-View Downstream
DBC Main Channel (9/2010)

Photo Point 19-View Upstream
DBC Main Channel (9/2010)

Photo Point 19-View Downstream
DBC Main Channel (9/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 20-View Upstream
DBC Main Channel (4/2010)

Photo Point 20-View Downstream
DBC Main Channel (4/2010)

Photo Point 21-View Upstream
DBC Main Channel (4/2010)

Photo Point 21-View Downstream
DBC Main Channel (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 22-View Upstream
DBC Main Channel (4/2010)

Photo Point 22-View Downstream
DBC Main Channel (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 24-View Upstream
Unnamed Tributary (9/2010)

Photo Point 24-View Downstream
Unnamed Tributary (9/2010)

Photo Point 25-View Upstream
Unnamed Tributary (9/2010)

Photo Point 25-View Downstream
Unnamed Tributary (9/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 26-View Upstream
Unnamed Tributary (9/2010)

Photo Point 26-View Downstream
Unnamed Tributary (9/2010)

Photo Point 27-View Upstream
Unnamed Tributary (9/2010)

Photo Point 27-View Downstream
Unnamed Tributary (9/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 28-View Upstream
Unnamed Tributary (9/2010)

Photo Point 28-View Downstream
Unnamed Tributary (9/2010)

Photo Point 29-View Upstream
Unnamed Tributary (9/2010)

Photo Point 29-View Downstream
Unnamed Tributary (9/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Photo Point 30-View Upstream
Unnamed Tributary (9/2010)

Photo Point 30-View Downstream
Unnamed Tributary (9/2010)

Photo Point 31-View Upstream
Unnamed Tributary (9/2010)

Photo Point 31-View Downstream
Unnamed Tributary (9/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 SCO Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Cross-Section 1-View Upstream
Unnamed Tributary (4/2010)

Cross-Section 1-View Downstream
Unnamed Tributary (4/2010)

Cross-Section 2-View Upstream
Unnamed Tributary (4/2010)

Cross-Section 2-View Downstream
Unnamed Tributary (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Cross-Section 3-View Upstream
Unnamed Tributary (4/2010)

Cross-Section 3-View Downstream
Unnamed Tributary (4/2010)

Cross-Section 4-View Upstream
Unnamed Tributary (4/2010)

Cross-Section 4-View Downstream
Unnamed Tributary (4/2010)

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Vegetation Plot 1 (12/2009)
Wetland C

Vegetation Plot 2 (12/2009)
Wetland C

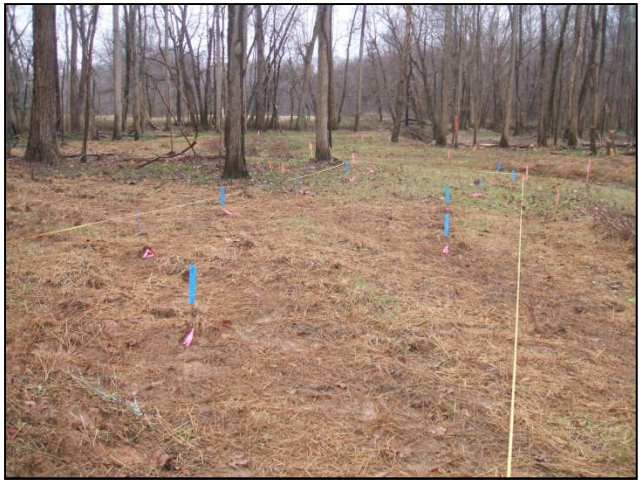
Vegetation Plot 3 (12/2009)
Main Channel

Vegetation Plot 4 (12/2009)
Main Channel

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

Vegetation Plot 5 (12/2009)
Main Channel

Vegetation Plot 6 (12/2009)
Tributary



Vegetation Plot 7 (12/2009)
Tributary

Prepared For:	Dutch Buffalo Creek Stream and Wetland Restoration Year 0 of 5	Date: April 2011 Project No.: 06-06752-01
	Appendix 2 - Summary Data and Plots **Reference Photograph Points**	

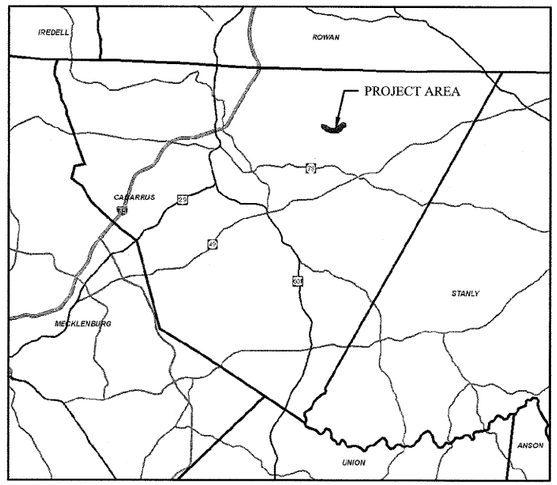
APPENDIX 3
AS-BUILT PLANS

CHRIS AVERETTE

CABARRUS COUNTY

SC0 # 06-06752-01
DUTCH BUFFALO CREEK
EEP STREAM AND WETLAND RESTORATION PROJECT
(AS-BUILTS)

LOCATION: SOUTHEAST OF GOLD HILL ROAD AND WEST OF CLINE SCHOOL ROAD, EAST OF THE CITIES CONCORD AND KANNAPOLIS, AND NORTHWEST OF THE CITY OF MT. PLEASANT, NORTH CAROLINA



VICINITY MAP
NOT TO SCALE

PROJECT DISTURBED AREA : 8.29 AC

LOCATION MAP
NOT TO SCALE

INDEX OF SHEETS

SHEET NUMBER	SHEET
CVR	COVER SHEET
AB-0 THRU AB-6	STREAM & WETLAND RESTORATION AS-BUILT SHEETS

DAVID A. WEINERT L-2648 LAND SURVEYOR 10/20/10 For As-Built Purposes Only

nce002COVR-AB.dwg
10.07.10

PLANS PREPARED FOR

Ecosystem Enhancement PROGRAM

PROJECT MANAGER
ROBIN DOLIN

REVIEW COORDINATOR
LIN XU

PROJECT ENGINEER
MATTHEW CLABAUGH, PE
(704) 527-4106
matt.clabaugh@jjg.com

NO.	DATE	DESCRIPTION OF REVISION
AB	09-14-10	AS-BUILTS
0	10-28-08	INITIAL ISSUE

JORDAN JONES & GOULDING

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

NORTH CAROLINA PROFESSIONAL SEAL 030950 ENGINEER MATTHEW M. CLABAUGH 10-25

DUTCH BUFFALO CREEK
STREAM AND WETLAND RESTORATION PROJECT

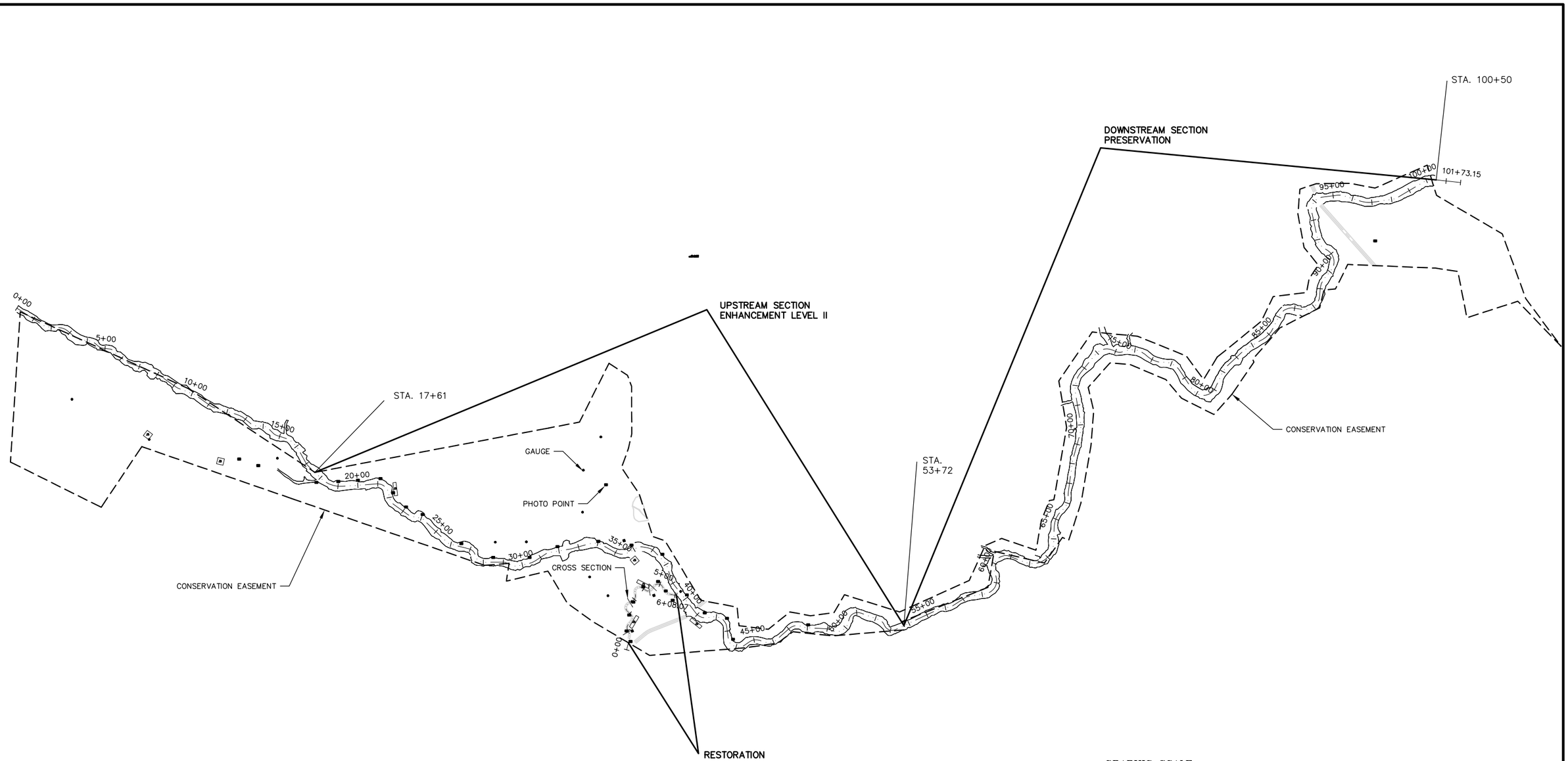
TITLE SHEET

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	CVR SHEET	AB REV
DRAWN: TBM	JOB NO. 03060-002	SCALE:		

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

CHRIS.AVERETTE



GRAPHIC SCALE

250 0 125 250 500 1000

(IN FEET)
1 inch = 250 ft.

nce002CS12-AB0.dwg
10.28.10

THIS LINE ——— IS ONE INCH LONG WHEN PLOTTED FULL SCALE

PLANS PREPARED FOR

Ecosystem Enhancement PROGRAM

PROJECT MANAGER
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REVIEW COORDINATOR
LIN XU

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NO.	DATE	DESCRIPTION OF REVISION
AB	09-14-10	AS-BUILTS
0	10-28-08	INITIAL ISSUE

JORDAN JONES & GOULDING

NORTH CAROLINA
ECOSYSTEM ENHANCEMENT
PROGRAM

NORTH CAROLINA PROFESSIONAL SEAL 030950 ENGINEER MATTHEW M. CLABAUGH 10-15

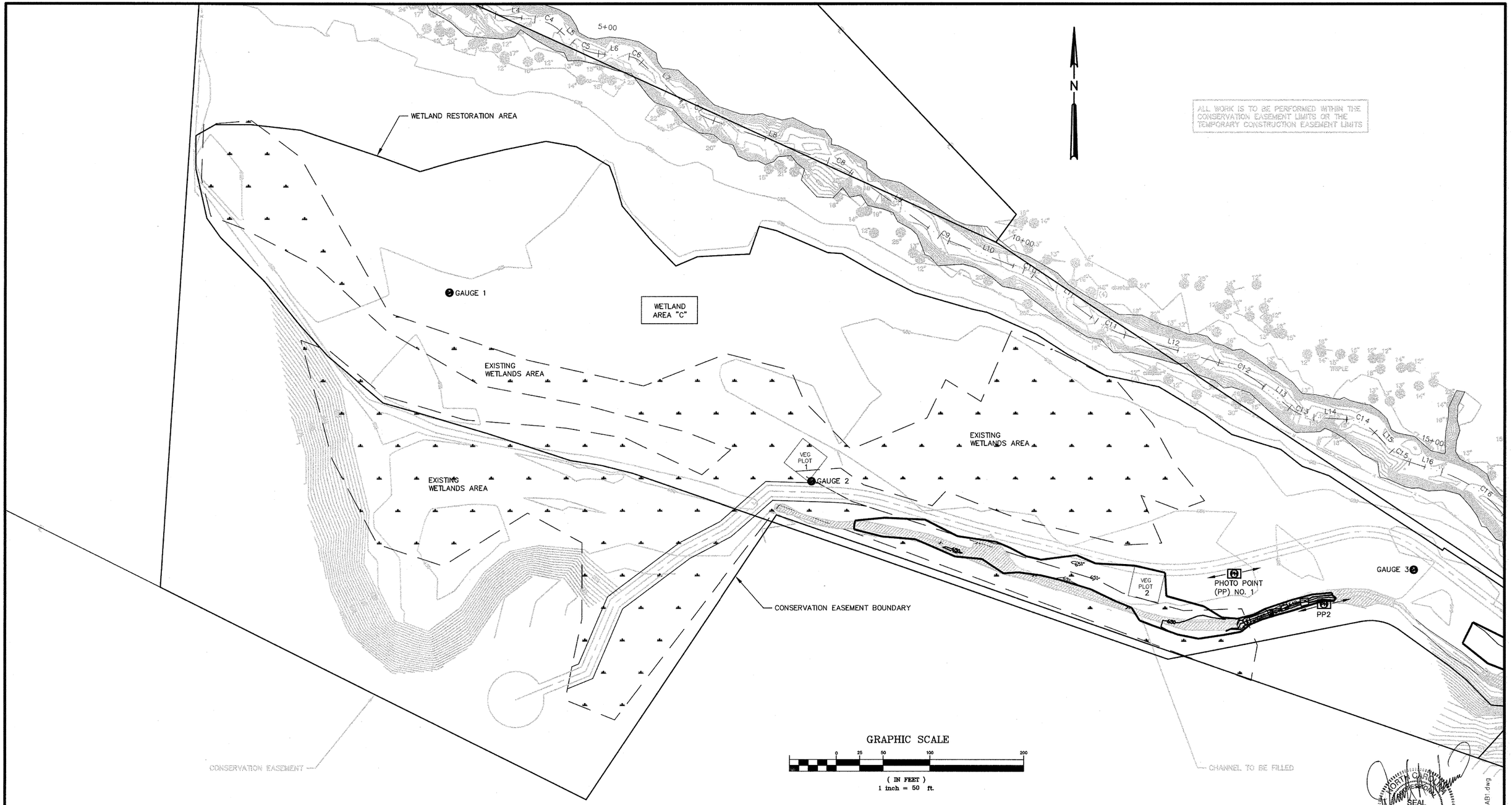
DUTCH BUFFALO CREEK
STREAM AND WETLAND RESTORATION PROJECT

LOCATION OF RESTORATION ACTIVITIES

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	AB-0	AB
DRAWN: TBM	JOB NO. 03060-002	SCALE: 1"=250'	SHEET	REV

CHRIS AVERETTE



GRAPHIC SCALE

0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

SEAL L-3846 LAND SURVEYOR DAVID A. WETHERLY 10/20/10
For As-built Purposes Only

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10.07.10

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PLANS PREPARED FOR

Ecosystem Enhancement PROGRAM

PROJECT MANAGER
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JORDAN JONES & GOULDING

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 030859 MATTHEW M. CLABAUGH

DUTCH BUFFALO CREEK STREAM AND WETLAND RESTORATION PROJECT

AS-BUILT PLAN

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	AB-1 SHEET	AB REV
DRAWN: TBM	JOB NO. 03060-002	SCALE:		

CHRIS.AVERETTE

MATCH TO SHEET AB-1
DBC STA. 15+00

ALL WORK IS TO BE PERFORMED WITHIN THE CONSERVATION EASEMENT LIMITS OR THE TEMPORARY CONSTRUCTION EASEMENT LIMITS

CONSERVATION EASEMENT BOUNDARY

TEMPORARY ROCK STREAM CROSSING

EXISTING WETLANDS AREA

WETLAND ENHANCEMENT AREA

PROPOSED GRAVEL ACCESS ROAD (LOCATION TO BE COORDINATED WITH PROPERTY OWNER)

GAUGE 3

GAUGE 4

PP3 PP4 PP5 PP6 PP7 PP8 PP9 PP10 PP11

VEG PLOT 5

C16 C17 C18 C19 C20 C21 C22 C23 C24 C25 C26 C27

L17 L21 L22 L23 L24 L25 L26 L27

25+00

WETLAND ENHANCEMENT AREA SEE SHEET PLT-04

CONSERVATION EASEMENT

FENCE TO BE INSTALLED 1' INSIDE OF CONSERVATION EASEMENT

FENCING TO BE INSTALLED BY SOIL AND WATER CONSERVATION DISTRICT

MATCH TO SHEET AB-3
DBC STA. 30+00

N

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

SEAL L-3846 LAND SURVEYOR DAVID A. WEIRICH 10/20/10
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nce002CS02-AB2.dwg
10.07.10

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PLANS PREPARED FOR

Ecosystem Enhancement PROGRAM

PROJECT MANAGER
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NO.	DATE	DESCRIPTION OF REVISION
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JORDAN JONES & GOULDING

NORTH CAROLINA
ECOSYSTEM ENHANCEMENT
PROGRAM

NORTH CAROLINA PROFESSIONAL SEAL 030950 ENGINEER MATTHEW M. CLABAUGH 10-25-10

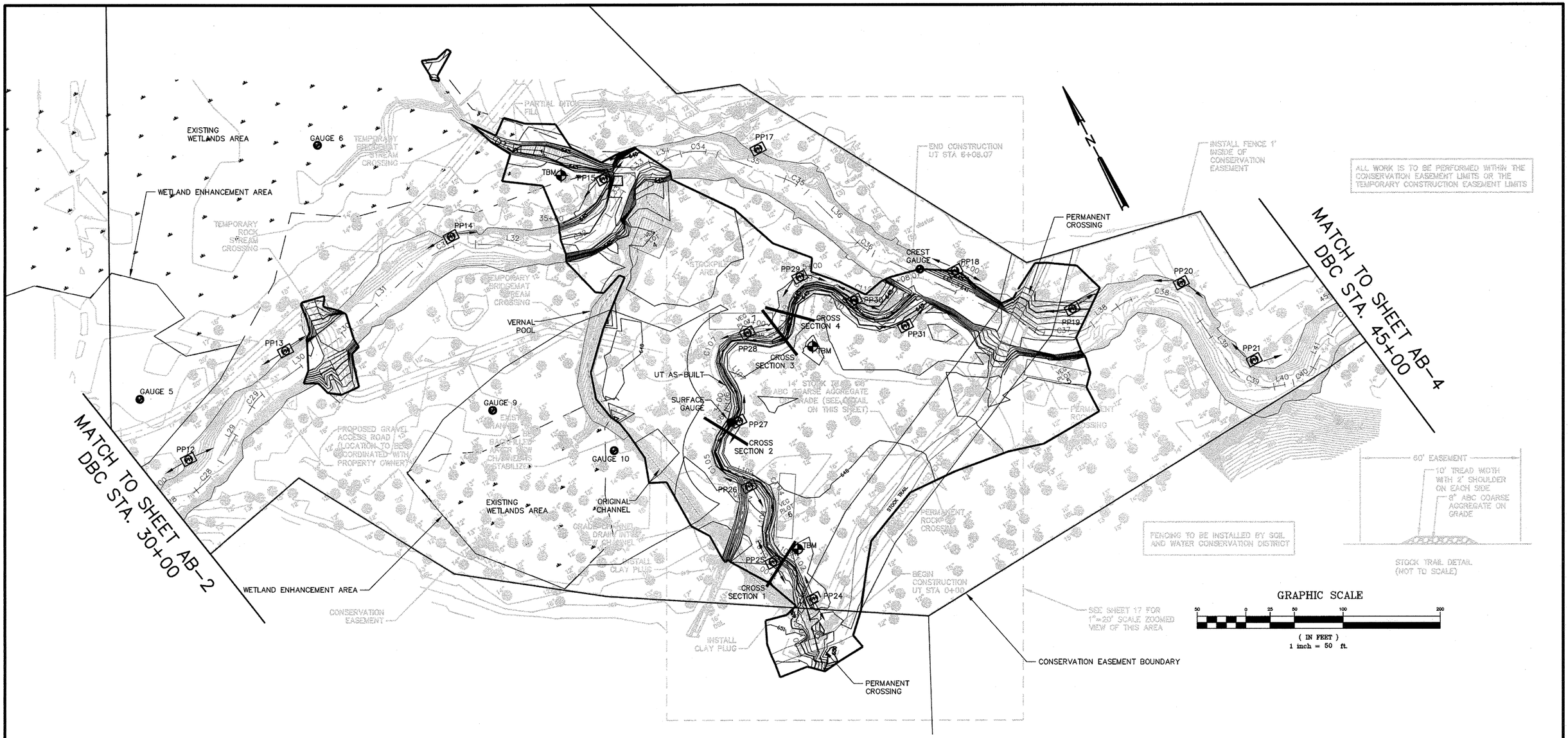
DUTCH BUFFALO CREEK
STREAM AND WETLAND RESTORATION PROJECT

AS-BUILT PLAN

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	AB-2	AB
DRAWN: TBM	JOB NO. 03060-002	SCALE:	SHEET	REV

CHRIS.AVERETTE



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SEAL L-3846 DAVID A. WEIRICH LAND SURVEYOR 10/10/10
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PLANS PREPARED FOR

Ecosystem Enhancement PROGRAM

PROJECT MANAGER
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JORDAN JONES & GOULDING

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

NORTH CAROLINA PROFESSIONAL SEAL 030959 ENGINEER MATTHEW M. CLABAUGH 10-28-08

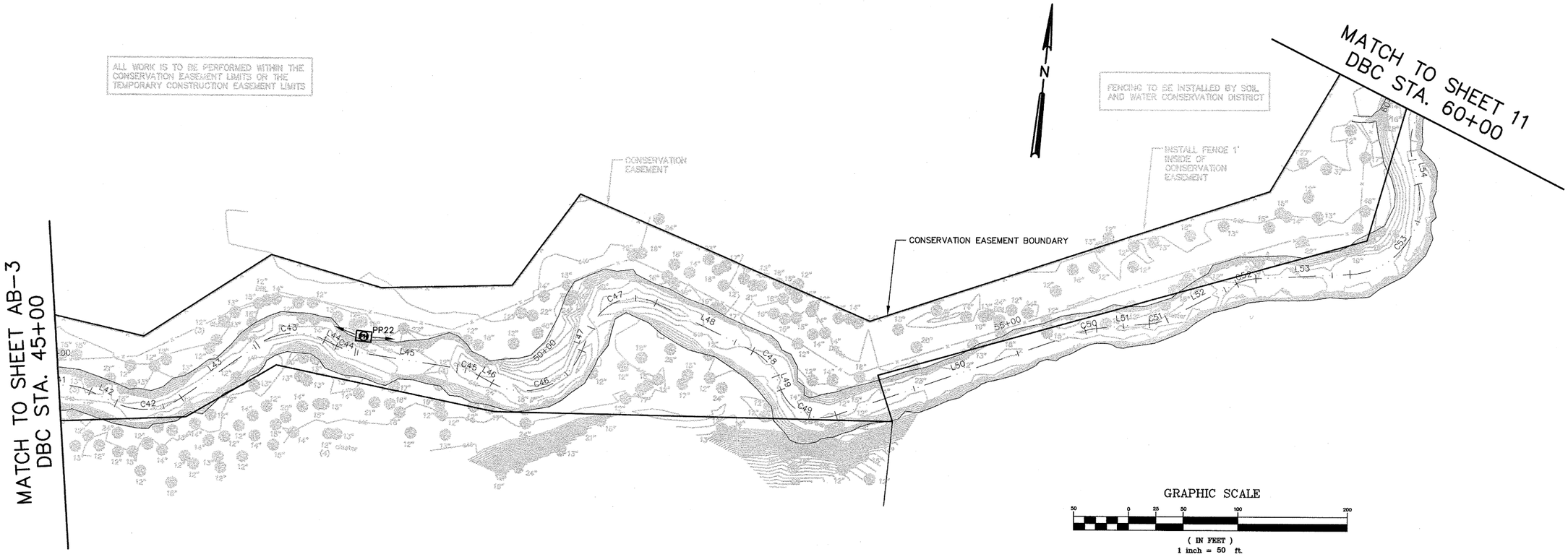
DUTCH BUFFALO CREEK STREAM AND WETLAND RESTORATION PROJECT

AS-BUILT PLAN

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	AB-3 SHEET	AB REV
DRAWN: TBM	JOB NO. 03060-002	SCALE:		

CHRIS.AVERETTE



GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

SEAL L-3846 LAND SURVEYOR DAVID A. WEIRICH 10/20/10
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nce0020CS04-AB4.dwg
10.07.10

PLANS PREPARED FOR

Ecosystem Enhancement PROGRAM

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JORDAN JONES & GOULDING

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

NORTH CAROLINA PROFESSIONAL SEAL 030959 ENGINEER MATTHEW M. CLABAUGH

DUTCH BUFFALO CREEK STREAM AND WETLAND RESTORATION PROJECT

AS-BUILT PLAN

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	AB-4 SHEET	AB REV
DRAWN: TBM	JOB NO. 03060-002	SCALE:		

THIS LINE ——— IS ONE INCH LONG WHEN PLOTTED FULL SCALE

CHRIS AVERETTE

ALL WORK IS TO BE PERFORMED WITHIN THE CONSERVATION EASEMENT LIMITS OR THE TEMPORARY CONSTRUCTION EASEMENT LIMITS

FENCING TO BE INSTALLED BY SOIL AND WATER CONSERVATION DISTRICT

INSTALL FENCE 1' INSIDE OF CONSERVATION EASEMENT

REFER TO SHEET 16 FOR PROFILE (STA 90+00 TO END)

20' ACCESS EASEMENT

PERMANENT CROSSING

PERMANENT ROCK CROSSING

95+00

100+00

101+73.15

L81 C80 L80 C79 L79 C78 L78 C77 L77 C76 L76 C75 L75 C74 L74

14' STOCK TRAIL @8" ABC COARSE AGGREGATE ON GRADE (SEE DETAIL ON THIS SHEET)

60' ACCESS EASEMENT

CONSERVATION EASEMENT

EXISTING WETLANDS AREA

PP23

EXISTING WETLANDS AREA

EXISTING WETLANDS AREA

CONSERVATION EASEMENT BOUNDARY

MATCH TO SHEET 12 DBC STA. 90+00

N

60' EASEMENT
10' TREAD WIDTH WITH 2' SHOULDER ON EACH SIDE
8" ABC COARSE AGGREGATE ON GRADE

STOCK TRAIL DETAIL (NOT TO SCALE)

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

NORTH CAROLINA SEAL L-3846 LAND SURVEYOR DAVID A. WEIRICH 10/20/10 For As-Built Purposes Only

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PLANS PREPARED FOR

Ecosystem Enhancement PROGRAM

PROJECT MANAGER
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JORDAN JONES & GOULDING

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 030959 MATTHEW M. CLABAUGH

DUTCH BUFFALO CREEK
STREAM AND WETLAND RESTORATION PROJECT

AS-BUILT PLAN

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	AB-5 SHEET	AB REV
DRAWN: TBM	JOB NO. 03060-002	SCALE:		

CHRIS.AVERETTE

GRAPHIC SCALE

0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

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FENCING TO BE INSTALLED BY SOIL AND WATER CONSERVATION DISTRICT

N

CONSERVATION EASEMENT

WETLAND AREA "B-1"

EXISTING WETLANDS AREA

GAUGE 8

GAUGE 7

GAUGE 6

PP16

CONSERVATION EASEMENT BOUNDARY

PARTIAL DITCH FILL

GRADE BANK SIDESLOPES BACKWARD 3:1

VEG PLOT

L19 L20 L21 L22 L23

C19 C20 C21 C22 C23 C31

25+00

SEAL L-3646 LAND SURVEYOR DAVID A. WEIRICH 10/20/10
For As-built Purposes Only

nc8002009-AB6.dwg
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PLANS PREPARED FOR

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NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 030959 MATTHEW M. CLABAUGH 10-25-10

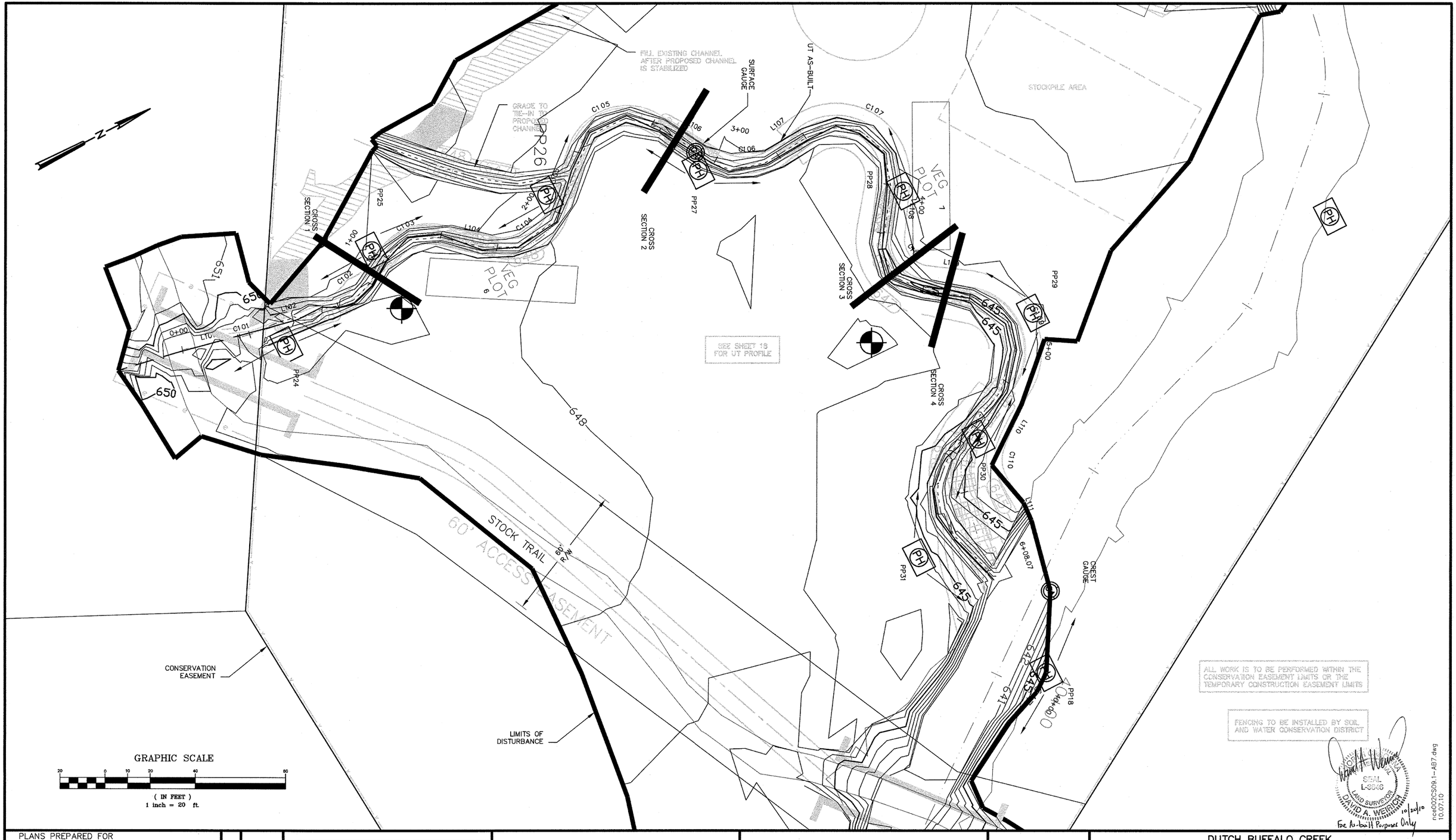
DUTCH BUFFALO CREEK STREAM AND WETLAND RESTORATION PROJECT

AS-BUILT PLAN

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	AB-6 SHEET	AB REV
DRAWN: TBM	JOB NO. 03060-002	SCALE:		

CHRIS AVERETTE



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JORDAN JONES & GOULDING

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

SEAL 030939 NORTH CAROLINA PROFESSIONAL ENGINEER MATTHEW M. CLABAUGH

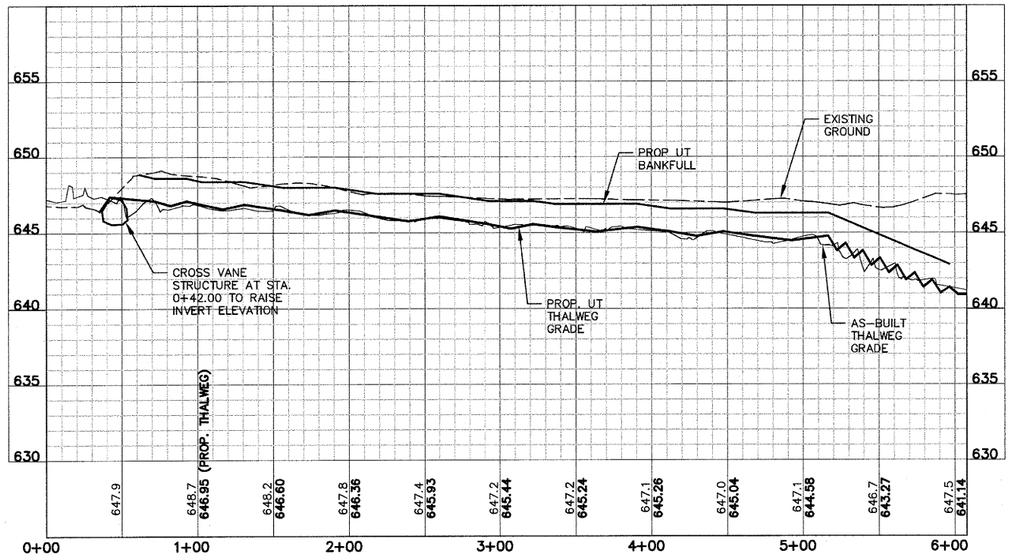
DUTCH BUFFALO CREEK STREAM AND WETLAND RESTORATION PROJECT

ZOOMED VIEW OF PROP. TRIB

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	AB-7 SHEET	AB REV
DRAWN: TBM	JOB NO. 03060-002	SCALE: 1"=20'		

nce002CS09.1-AB7.dwg
10.07.10



UT PROFILE

HOR. SCALE 1"=50'
VER. SCALE 1"=5'

nce002CS10-AB8.dwg
10.07.10

THIS LINE ——— IS ONE INCH LONG WHEN PLOTTED FULL SCALE

PLANS PREPARED FOR

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NORTH CAROLINA
ECOSYSTEM ENHANCEMENT
PROGRAM

NORTH CAROLINA PROFESSIONAL SEAL 030950 ENGINEER MATTHEW M. CLABAUGH

DUTCH BUFFALO CREEK
STREAM AND WETLAND RESTORATION PROJECT

PROFILE

SCO NO: 06-06752-01

DESIGNED: MMC	CHECKED: MMC	DATE: NOVEMBER, 2007	AB-8 SHEET	AB REV
DRAWN: TBM	JOB NO. 03060-002	SCALE:		