MUDDY RUN STREAM RESTORATION PROJECT
DRAFT FINAL MITIGATION PLAN

DUPLIN COUNTY, NORTH CAROLINA, PROJECT # 95018

Prepared for:

North Carolina Ecosystem Enhancement Program

North Carolina Department of Environment and Natural Resources
1652 Mail Service Center
Raleigh, NC 27699-1652

August 2012

DRAFT FINAL MITIGATION PLAN
August 2012

Muddy Run
Duplin County, North Carolina
EEP Project ID 95018

Cape Fear River Basin
HUC 0030007060010

Prepared for:

NC Department of Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Prepared by:

Environmental Banc & Exchange
909 Capability Drive, Suite 3100
Raleigh, NC 27606
919-829-9909

WK Dickson & Co., Inc.
720 Corporate Center Drive
Raleigh, NC 27607
919-782-0495

EXECUTIVE SUMMARY

The Muddy Run Stream Restoration Project is located within an agricultural watershed in Duplin County, North Carolina, approximately six miles south of Beulaville. The stream channels have been heavily impacted by channelization and agricultural practices. The project will involve the restoration and protection of streams in the Muddy Creek watershed. The purpose of this restoration project is to restore and enhance a stream/wetland complex located within the Cape Fear River Basin.

The project lies within USGS Hydrologic Unit Code 03030007060010 (USGS, 1998) and within the North Carolina Division of Water Quality (NCDWQ) Cape Fear River Subbasin 03-06-22 (NCDENR, 2002). The project consists of three unnamed tributaries to Muddy Creek, but the project has been divided into five distinct reaches for design purposes. Reach 1A is the upstream-most portion of Reach 1; it begins approximately 50 feet below an agricultural road crossing, and extends to STA17+25. Reach 1B is the middle reach of the main stem; it begins at STA17+25, and runs through a clear-cut area to STA33+67. Reach 1C is the downstream section of Reach 1; it begins at a culvert crossing (STA33+67) and flows westward to STA47+08. Reach 2 starts on the south side of eight hog houses and flows northwest around two hog lagoons before entering Reach 1C. Reach 3 runs north to south, and flows directly into Reach 1C.

The proposed Muddy Run II Mitigation Project will be located on stream reaches upstream of Reach 3 and downstream of Reach 1C. Muddy Run II will also include riparian wetland restoration areas directly adjacent to the Muddy Run Easement on Reach 1B, Reach 1C, Reach 2, and Reach 3. The design of Muddy Run includes considerations for this future mitigation project.

The site consists of farmland, concentrated animal feeding operations (CAFO), and wooded areas. The total easement area is 19.1 acres, 1.6 acres of which are wooded. The remaining area is agricultural or clear-cut. The wooded areas along the corridor designated for restoration are classified as disturbed deciduous forest, and invasive species are prevalent throughout. Several ditches exist throughout the project and flow into the main channel. Each ditch contributes to the overall design discharge of the channel. All existing channels are degraded to a point where they no longer access their floodplain, water quality is poor, and aquatic life is not supported. Little habitat is available to support aquatic life, and the channels are not maximizing their potential to filter nutrients because they are entrenched.

The goal for the Muddy Run project is to restore the channelized streams based on reference reach conditions, enrich the aquatic ecosystem through stream restoration and riparian buffer habitat improvements, and provide ecological uplift within the Cape Fear River Basin. The design will be based on reference conditions, USACE guidance (USACE, 2005), and criteria that are developed during this project to achieve success.

The objective for this restoration project is to design a natural waterway through a stream/wetland complex with appropriate cross-sectional dimension and slope that will provide function and meet the appropriate success criteria for the existing streams. Accomplishing this objective entails the restoration of natural stream characteristics, such as stable cross sections, planform, and in-stream habitat. The floodplain areas will be hydrologically reconnected to the channel to provide natural exchange and storage during flooding events. Additional project objectives, such as restoring the riparian buffer with native vegetation, ensuring hydraulic stability, and eradicating invasive species, are listed in Section 6 along with several other project objectives.

The design approach for Muddy Run is to combine the analog method of natural channel design with analytical methods to evaluate stream flows and hydraulic performance of the channel and floodplain. The analog method involves the use of a “template” stream adjacent to, nearby, or previously in the same

location as the design reach. The template parameters of the analog reach are replicated to create the features of the design reach. The analog approach is useful when watershed and boundary conditions are similar between the design and analog reaches (Skidmore, et al., 2001). Hydraulic geometry was developed using analytical methods in an effort to identify the design discharge.

The headwater valley restoration approach is proposed along Reach 1A and continues down to Reach 1B. The existing channel adjacent to the hog houses will be backfilled to the extent possible such that cut and fill is balanced along the reach. The upper reach will not be completely filled to prevent hydrologic trespass upstream of the road at STA 0+25. Priority Level I restoration is proposed on Reach 1B. For the majority of the reach, the channel will be rerouted to the south of its current location. Relocating the channel will not impact any forested areas because most of the buffer was clear-cut in the fall of 2010. However, there is a small wooded area along the upstream portion of the reach. The elevated road bed along the north side of the existing channel will be removed to maintain a continuous connection between the proposed channel and its floodplain. The downstream section of the proposed Reach 1B has been relocated to avoid impacts to two existing wetland areas adjacent to the channel. Priority Level I restoration is proposed on Reach 1C. The restoration approach on this reach includes relocating the channel to the north of its current location within the adjacent agricultural field. The existing channel will be plugged and filled to prevent continued flow within the ditch. By rerouting and raising the channel, the design will allow the channel frequent access to its floodplain and the opportunity for creating small depressional areas within the buffer to enhance habitat for wildlife and aquatic organisms. Priority Level I restoration is proposed on Reach 2. The channel will flow northwest to the confluence with Reach 1C. The majority of Reach 2 is proposed to be moved north and east of its current location into an area of fill material adjacent to two hog waste lagoons. The proposed design will allow the channel to access its floodplain regularly. Priority Level I restoration is proposed on Reach 3. Restoration will involve relocating the channel east of the existing ditch into the adjacent spray field. The reach will reconnect with the primary channel (Reach 1) approximately 146 feet downstream of the confluence with Reach 1C at STA 5+72. A temporary log ramp will be installed at the downstream end to tie the proposed channel into the existing ditch. This structure will be removed when the proposed Muddy Run II Mitigation Project is constructed.

After completion of all construction and planting activities, the site will be monitored on a regular basis, and a physical inspection of the site will be conducted a minimum of twice per year throughout the five year post-construction monitoring period, or until performance standards are met. These site inspections will identify site components and features that require routine maintenance. Success criteria on the headwater valley reach will include documented surface flow and vegetative success. The measure of stream restoration success will be documented bankfull flows and no change in stream channel classification. Sand bed channels are dynamic, and minor adjustments to dimension and profile are expected. The measure of vegetative success for the site will be the survival of at least 260 5-year old planted trees per acre at the end of year five of the monitoring period. Annual monitoring data will be reported using the EEP monitoring template.

Upon approval for closeout by the Interagency Review Team (IRT), the site will be transferred to the State of North Carolina (State). The State shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party.

This mitigation plan has been written in conformance with the requirements of the following:

- Federal rule for compensatory mitigation project sites as described in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.8 paragraphs (c)(2) through (c)(14).
- NCDENR Ecosystem Enhancement Program In-Lieu Fee Instrument signed and dated July 28, 2010

These documents govern NCEEP operations and procedures for the delivery of compensatory mitigation.

TABLE OF CONTENTS

List of Tables

List of Figures

Appendices

1 PROJECT SITE IDENTIFICATION AND LOCATION

1.1 Directions to the Project Site

The Muddy Run Stream Site is located in Duplin County approximately 1.4 miles east of Chinquapin, NC (**Figure 1**). To access the Site from the town of Chinquapin, travel east on Highway 50, take the first left onto Pickett Bay Road (SR 1819), go 1.1 miles, then turn left onto Kenney Crawley Road. This private road is gravel and will split just past the residential house on the right. Keeping to the left will take you to the downstream portion of Reach 1 and Reaches 2 and 3. Going to the right at the split will take you to the upstream limits of Reach 1 at the Headwater Valley restoration portion.

1.2 USGS Hydrologic Unit Code and NC DWQ River Basin

The project is located within the Cape Fear River Basin (8-digit USGS HUC 03030007, 14-digit USGS HUC 0303007060010) (USGS, 1998) and the NCDWQ Cape Fear 03-06-22 sub-basin (NCDWQ, 2002) (**Figure 2**).

1.3 Project Components and Structure

Table 1. Muddy Run Project Components

Reach	Mitigation Type	Stationing	Existing Length	Proposed Length	Mitigation Ratio	SMUs
Reach 1A	Headwater Valley	0+66 to 17+25	1,659	1,659	1:1	1,659
Reach 1B	P1 Restoration	17+25 to 33+67	1,597	1,642	1:1	1,642
Reach 1C	P1 Restoration	33+67 to 47+08	1,317	1,341	1:1	1,341
Reach 2	P1 Restoration	0+50 to 17+20	1,448	1,670	1:1	1,670
Reach 3	P1 Restoration	0+94 to 7+18	464	624	1:1	624
		Total	**6,485**	**6,936**		**6,936**

2 SITE PROTECTION INSTRUMENT

The land required for the construction, management, and stewardship of this mitigation project includes portions of the following parcels. A copy of the land protection instrument(s) is included in **Appendix 5**.

PIN	Landowner	County	Acreage
336900251179	Brown, Danny Clark	Duplin	1.96
336900147555	Brown, Danny Clark	Duplin	8.41
336900335816	Brown, Marion Dean, Jr. & Wife Vivian Battelle Brown	Duplin	2.78
336900352864	Futreal, Johnny Adrian	Duplin	4.81
336900445188	Hatcher, Danny Guy & Etals	Duplin	1.74

3 WATERSHED CHARACTERIZATION

3.1 Drainage Area

The easement totals 19.1 acres and is broken into five reaches. Reach 1A has a drainage area of 0.23 square miles (145 acres); it begins at the start of the restoration project (sta. 0+62) and extends north and west to STA17+25. Reach 1B has a drainage area of 0.28 square miles (177 acres); it begins at STA17+25 and extends to STA33+67. Reach 1C is the downstream section (Sta. 33+67 to 47+08) of Reach 1 and has a drainage area of 0.37 square miles (238 acres). Reach 2 has a drainage area of 0.1 square miles (60 acres) and flows northwest directly into Reach 1. Reach 3 has a drainage area of 0.13 square miles (85 acres) extending north to south (**Figure 2**). The land use in the project watershed is approximately 49 percent cultivated, 33 percent southern yellow pine, 9 percent bottomland forest/hardwood swamp, 7 percent wooded and shrubland, and 2 percent managed herbaceous cover.

3.2 Surface Water Classification

The current State classification for the Muddy Run restoration reaches is unclassified. Reach 1 is the main stem of the project which runs directly into Muddy Creek. Muddy Creek is defined as Class C S*w* (NCDWQ, 2005). Class C waters are suitable for aquatic life, secondary recreation, and agricultural usage. The *Sw* is a designation for swamp waters—waters that have low velocities and other natural characteristics that are different from adjacent streams.

3.3 Physiography, Geology, and Soils

The Muddy Run Site is located in the Coastal Plain Physiographic Province. The watershed is underlain by the Castle Hayne aquifer. The Castle Hayne aquifer is composed of limestone, sandy limestone, and sand. It is the most productive aquifer in North Carolina. The topography of the area is generally flat with elevations ranging from 39 feet to 60 feet.

The Duplin County Soil Survey depicts a limited number of soil types as present within the project area (**Figure 3**). The three series present are Foreston loamy fine sand, 0 to 2 percent slopes, Goldsboro loamy sand, 0 to 2 percent slopes, and Rains fine sandy loam, 0 to 1 percent slopes. Of the three mapped soil series that occur throughout the project, the majority consists of two series—Goldsboro loamy sand and Rains fine sandy loam. These soils formed in loamy and sandy marine deposits or fluvial sediments. The Goldsboro soils are moderately well drained, and have moderate permeability. Runoff is negligible to medium. The seasonal high water table ranges from 24 to 36 inches. Theses soils are located on the hill slope summit and shoulder. This soil unit is typically cultivated. The Rains soils are poorly drained and have moderate permeability. Runoff is negligible. The seasonal high water table ranges from 0 to 12 inches. Theses soils occur across flats, depressions, and Carolina bays. The Foreston soils are moderately well drained and have moderately rapid permeability. Runoff is naturally slow. The seasonal high water table ranges from 24 to 42 inches. Theses soils are located on high ridges and slight rises within broad, flat inter-stream divides. None of these soils are subject to ponding, and only Rains may experience flooding. The Natural Resources Conservation Service (NRCS) considers Rains soils to be hydric when undrained. The remaining soils mapped on the site contain small inclusions of hydric soil.

3.4 Historical Land Use and Development Trends

Aerial imagery and information provided by the property owners indicate that the subject site has been used extensively for agricultural purposes and that the location of the stream has not changed in over 50 years (**Figure 4 and Figure 5**). From 1949 to 1987, the land was primarily used for agriculture crop production. A network of drainage ditches made it possible to farm these flat, sandy

fields. Between 1987 and 1993, two CAFOs (hog farms) were added to the Brown parcels. These hog operations consisted of four hog houses and one waste lagoon per site. The 1998 aerial photography shows that these CAFOs were expanded between 1993 and 1998. The western hog farm operation added four additional hog houses and one waste lagoon. The eastern hog farm had grown to a total of six hog houses and two waste lagoons. Little has changed since 1998 in regards to the development of the project site and nearby surrounding property. The area remains in an agricultural community with some neighboring forested property. All of the facts in Section 3.4 support the notion that several watershed characteristics, such as groundwater, vegetation, surface drainage, and potentially soil parameters, have been modified. Soil structure and surface texture have been altered from intensive agricultural operations, and, although most of the soils characterized on the site are classified as poorly drained, the ditching system has caused these soils to be effectively drained.

Table 2. Historical Land Use and Development Trends

Date	Land Use and Development Observations*
1949	Conditions consist of ditched agricultural fields throughout the project area except where Reach 1A is proposed. This area is forested.
1965	Land use conditions have changed very little; however, there is a noticeable reduction in the drainage ditch network.
1987	The forested corridor where Reach1A is proposed has been logged and converted into agricultural fields.
1993	Two CAFOs (hog farm operations) have been added to the project vicinity. These operations consist of four houses and one waste lagoon per site.
1998	On the western hog farm operation, four additional hog houses and one waste lagoon have been added. The eastern hog farm operation has also added two hog houses and one additional waste lagoon.
2010	Depicts current site conditions.

* Observations based on aerial imagery

3.5 Endangered/Threatened Species

Plants and animals with a federal classification of endangered or threatened are protected under provisions of Sections 7 and 9 of the Endangered Species Act of 1973, as amended. Rare and protected species listed for Duplin County, and any likely impacts to the species as a result of the project construction, are discussed in the following sections.

The US Fish and Wildlife Service (USFWS) database (updated 22 September 2010) lists one endangered species for Duplin County, North Carolina: red-cockaded woodpecker (*Picoides borealis*). The American alligator (*Alligator mississippiensis*) is listed as Threatened due to similarity of appearance, but is not protected. No protected species or potential habitat for protected species was observed during preliminary site evaluations.

In addition to the USFWS database, the NC Natural Heritage Program (NHP) GIS database was consulted to determine whether previously cataloged occurrences of protected species were mapped within one mile of the project site. Results from NHP indicate that there are no known occurrences within a one-mile radius of the project area. Based on initial site investigations, no impacts to federally protected species are anticipated as a result of the proposed project.

WK Dickson submitted a request to USFWS for review and comments on the proposed Muddy Run Stream Restoration Project on December 15, 2011 in regards to any potential impacts to threatened and endangered species. No response was received within a 30-day period; therefore, it is assumed that the initial determination of no effect to endangered and threatened species will result from the proposed project.

The proposed project offers some potential to improve or create suitable habitat for several Federal Species of Concern. Habitat may be improved or created for species that require riverine habitat by improving water quality, in-stream and near-stream forage, and providing stable conditions not subject to regular maintenance. Improved stream habitat may benefit American eel (*Anguilla rostrata*) and broadtail madtom (*Noturus* sp. cf. *leptacanthus*).

3.6 Cultural Resources

Cultural resources include historic and archeological resources located in or near the project area. WK Dickson completed a preliminary survey of cultural resources to determine potential project impacts. No architectural structures or archeological artifacts have been observed or noted during surveys of the site for restoration purposes. In addition, the majority of the site has historically been disturbed due to agricultural practices and channel modifications.

WK Dickson submitted a request to the NC State Historic Preservation Office (SHPO) to search records to determine the presence of any areas of architectural, historic, or archaeological significance that may be affected by the Muddy Run Stream Restoration Project on July 1, 2011. In a letter dated July 19, 2011 (**Appendix 3**), the SHPO stated that they had "conducted a review of the project and are aware of no historic resources which would be affected by the project."

3.7 Potential Constraints

3.7.1 Property Ownership, Boundary, and Utilities

There are several constraints at the Muddy Run Mitigation site. Due to multiple landowners and scattered agricultural operations, numerous crossings are required (**Figure 6)**. A number of smaller drainage culverts beneath the farm paths will be removed. The existing spray configuration of the land-applied animal waste will need to be adjusted to prevent spray occurring within the stream buffer. Overhead utilities (service electrical lines) that provide power to the CAFO houses are located near the upstream end of Reach 2 and will have to be relocated. Underground pipe distribution from the lagoons to the spray areas is located near the animal houses, and two aerial stream crossings were observed. Existing aerial distribution lines will be buried during construction where there are channel crossings, and access corridors will be left in the easement to facilitate maintenance. The Muddy Run site is not located within five miles an air transport facility.

3.7.2 Site Access

There are no access constraints to the Muddy Run site. To access the Site from the town of Chinquapin, travel east on Highway 50. Take the first left onto Pickett Bay Road and go 1.1 miles. Turn left onto Kenney Crawley Road. This road is gravel and will split just past the residential house on the right. Keeping to the left will take you to the downstream portion of Reach 1 and also Reaches 2 and 3. Going to the right at the split will take you to the upstream limits of Reach 1 at the Headwater Valley restoration potion.

3.7.3 FEMA/ Hydrologic Trespass

Hydrologic trespass is a not a major concern for this project. The Muddy Run Restoration Site is outside of any FEMA floodway area (**Figure 7**). The Site is mapped as Zone X, which indicates that there is 0.2 percent annual chance of flooding. While designing the Muddy Run project, appropriate measures were taken to reduce the chances of hydrologic trespass of the adjacent agricultural fields and animal operations. No detrimental impacts are expected beyond the easement limits. Landowner communication indicates Reach 1C is subject to flooding due to backwater from the downstream Muddy Creek.

4 PROJECT SITE STREAMS AND WETLANDS (EXISTING CONDITIONS)

The principal drainage feature (Reach 1) generally flows northwest to west across the site. It is divided into three reaches (Reach 1A, Reach 1B, and Reach 1C) based on slope, drainage area, and surrounding landscape. Reach 1A flows in a northerly direction adjacent to several hog houses and two large lagoons. The planform of this G-type channel is generally straight and is deeply incised throughout. No large woody debris was observed in the channel. A maintained access path built upon spoil material runs along the channel bank. The channel scored 24 points on the NCDWQ Stream Identification Form (Version 4.11). The natural drainage of this channel is bypassed through a deep, excavated ditch through uplands that connects to Reach 2.

The middle section (Reach 1B) of this reach is mostly excavated through a forested area. The surrounding riparian forest contains jurisdictional wetlands that are adjacent to Reach 1B. This channel has been dredged to nearly four feet in depth. A farm road that is elevated 0.85 feet above the flood plain is located along the right bank. The planform of this F-type channel is generally straight with occasional bends. The channel is entrenched throughout. The banks are nearly vertical in many locations and have almost no vegetation. No large woody debris was observed in the channel. The channel scored 29 points on the NCDWQ Stream Identification Form (Version 4.11).

The downstream section of Reach 1 (Reach 1C) is located within a cleared hay field. This reach appears to have been straightened and has been dredged. A farm road that is elevated 0.5 to 1.1 feet above bankfull is located along the right bank. Reach 1C is an F-type channel with a planform that is generally straight with a few minor bends throughout. The entire reach is moderately to severely incised with steep banks due to repeated dredging by the landowner. The dominant bed materials are fine sand and silt. The banks are nearly vertical with sparse vegetation. The channel scored 33 points on the NCDWQ Stream Identification Form (Version 4.11).

Flowing into Reach 1C are two smaller tributary reaches (Reach 2 and Reach 3). Reach 2 begins south of Reach 1C at a wetland, and follows a shallow drainage feature to the confluence with Reach 1C. It receives flow through a ditch from Reach 1A. This F-type channel is actively maintained and has been dredged to nearly four feet in depth. The banks are nearly vertical in many locations and have almost no vegetation. No large woody debris was observed in the channel. The channel scored 26.5 points on the NCDWQ Stream Identification Form (Version 4.11).

Reach 3, an F-type stream channel, begins north of Reach 1C at a wetland ditch and follows a shallow drainage feature to Reach 1C. A hay field is located on the east side, and a scrub community lies to the west. This channel has been dredged and the dominant bed material is fine sand. The banks are nearly vertical in many locations and have almost no vegetation. No large woody debris was observed in the channel. The channel scored 24.5 points on the NCDWQ Stream Identification Form (Version 4.11).

In general, the streams do not typically function to their full potential. Having been channelized in the past and ditched to drain nearby wetlands for row crops, the streams do not access their floodplains as often as they naturally would have prior to the farm operations. In some cases, the streams are not hydraulically stable, causing erosion and undercutting of the banks. Habitat along the restoration reaches is poor in that there is no debris in the upper portions of the reach for fish cover or protection for other aquatic species. Vegetative diversity and habitat diversity is poor along the reaches, as well, and offers little benefit to the wildlife in the area. Site photographs are located in **Appendix 1** and morphological parameters are in **Appendix 4**.

4.1 Channel Classification

The streams have been classified as intermittent and perennial streams using the NCDWQ Stream Identification Form version 4.11 (**Appendix 2**) and are predominantly F5 stream types using the Rosgen stream classification system (Rosgen, 1994). The design reaches have been separated into five distinct sections that are described in Section 4.3. Channel characteristics are summarized in **Table 3**.

4.2 Discharge

Estimating flows (discharge) for Muddy Run is difficult due to the existing network of ditches and low, depressional areas located throughout the site. Several models, regression equations, and the Coastal Plain regional curves were used to develop existing discharges. Land use and slope were considered when the discharge calculations were developed. All hydraulic and hydrologic analyses are discussed in Section 6.3. Data and analysis of the hydrologic and hydraulic models are included as **Appendix 4**.

4.3 Channel Morphology

4.3.1 Reach 1

Reach 1 is subdivided into three segments, Reaches 1A, 1B, and 1C. Reach 1A has a drainage area of 0.23 square miles (145 acres), and flows in a northerly direction adjacent to several hog houses and two large waste lagoons. The planform of this G-type channel is generally straight (sinuosity = 1.0) and is entrenched throughout. The current cross sectional area is 23.1 square feet with approximate dimensions of 11.5 feet wide and 3.4 feet deep. The existing length of Reach 1A is 1,638 linear feet, and the dominant bed material is fine sand. The gradient of the reach is approximately 0.0016 ft/ft, and bed forms are generally absent. No large woody debris was observed in the channel. The natural drainage of this channel is bypassed through a deep excavated ditch through uplands that connect to Reach 2.

Headwater reach R-1A. Waste storage lagoon to right.

The middle section of Reach 1 (Reach 1B) is mostly excavated through a recent clear-cut area. This channel has been dredged to nearly four feet in depth and is approximately 20 feet wide. A farm road that is elevated 0.85 feet above the flood plain is located along the right bank. The drainage area of Reach 1B is approximately 0.28 square miles (177 acres) and begins at existing STA16+89. The planform of this F-type channel is generally straight (sinuosity = 1.0) with occasional bends. Reach

1B has an approximate length of 1,597 linear feet, and the bed is comprised of fine sand. The existing cross sectional area of Reach 1B is 38.8 square feet, and the slope of the reach is approximately 0.0033 ft/ft and bed forms are absent. The banks are nearly vertical in many locations and have almost no vegetation. No large woody debris was observed in the channel.

Reach 1C begins just downstream of an existing farm crossing at STA 32+86 and runs along the north side of eight hog houses and two waste lagoons. This F-type stream reach flows east to west and has a drainage area of 0.37 square miles (238 acres). The existing length of Reach 1C is 1,317 linear feet. This section is currently very straight (sinuosity = 1.0) and has a low gradient (0.0035 ft/ft). This portion of the stream has a cross-sectional area of approximately 54.8 square feet. The bed material found in this section is fine sand.

4.3.2 Reach 2

Reach 2 begins at existing STA 0+50 and flows from southeast to northwest adjacent to an agricultural field on the western side. Reach 2 is approximately 1,448 linear feet and flows directly into Reach 1C. It has a drainage area of 0.10 square miles (60 acres). Reach 2, an F-type channel, is typically 21.9 feet wide and 2.7 feet deep and is entrenched. This indicates that during channelization, the stream was dug exceedingly deep to aid in draining the adjacent fields. The average cross sectional area is approximately 34 square feet. The existing slope of Reach 2 is 0.0032 ft/ft, and the dominant bed material is fine sand.

Facing Downstream on restoration Reach-3.

4.3.3 Reach 3

Reach 3 begins at existing STA 0+63, and flows north to south before emptying into Reach 1C at STA 5+27. Reach 3 has a drainage area of 0.61 square miles (391 acres) and has a width and depth of 21.9 feet and 4.7 feet, respectively. The existing cross-sectional area is approximately 59.2 square feet. The existing slope is 0.0029 ft/ft and has little to no buffer on either side of the channel. This reach is classified as a F5 stream type and has an existing length of 464 linear feet.

Table 3. Summary of Existing Channel Characteristics

Reach	Drainage Area (Ac)	CSA[1] (ft^2)	Width (ft)	Max Depth (ft)	Width:Depth Ratio	Sinuosity	Slope (ft/ft)
1A	145	23.1	11.5	3.4	5.8	1.0	0.0016
1B	177	38.8	17.9	3.8	8.3	1.0	0.0033
1C	238	54.8	18.3	5.2	6.1	1.0	0.0035
2	60	34.1	16.2	4.0	7.7	1.0	0.0032
3	391	59.2	21.9	4.7	6.4	1.0	0.0029

[1]CSA= cross-sectional area (measured from top of bank)

4.4 Channel Stability Assessment

A modified version of the channel stability assessment method (CSA) provided in "Assessing Stream Channel Stability at Bridges in Physiographic Regions" by Johnson (2006) was used to assess channel stability for the Muddy Run existing channels and reference reach. This method may be

applied on a variety of stream types in different physiographic regions having a range of bed and bank materials. Additionally, this method was selected as it provides a rapid assessment of channel stability that may be easily applied for a comparison of stability between stream reaches.

The original CSA method was designed to evaluate thirteen stability indicators in the field. These parameters are: watershed characteristics, flow habit, channel pattern, entrenchment/channel confinement, bed material, bar development, presence of obstructions/debris jams, bank soil texture and coherence, average bank angle, bank vegetation/protection, bank cutting, mass wasting/bank failure, and upstream distance to bridge. As this method was initially developed to assess stability at bridges, a few minor adjustments were made to remove indicators that contradict stability characteristics of natural channels in favor of providing hydraulic efficiency at bridges. First, the "channel pattern" indicator was altered such that naturally meandering channels scored low as opposed to straightened/engineered channels that are favorable for stability near bridges. Secondly, the last indicator, "upstream distance to bridge," was removed from the assessment as bridges are not a focus of channel stability for this project. Lastly, the "bed material" indicator was removed since all project streams are sand bed channels and would subsequently score high (poorly), as this indicator focuses on coarse substrate. The eleven indicators were then scored in the field, and a rating of excellent, good, fair, or poor was assigned to each project reach based on the total score. (See **Appendix 2** for the CSA field form.)

The CSA results (scores and ratings) for the Muddy Run project and reference reaches are provided in **Table 4**. Project Reaches 1A, 2, and 3 all received "Fair" ratings, while Reaches 1B and 1C received "Good" ratings. Overall, the existing project streams appear to be physically stable as there is little active erosion present; however, all channels have been straightened and entrenched, and are actively maintained. These characteristics are reflected in the poor CSA scores for channel pattern and bank vegetation/protection. Each reach also scored poorly for watershed characteristics since the surrounding land use is dominated by agriculture activities or recent clear cutting (**Figure 4**).

Table 4. Channel Stability Assessment Results

		Reach 1A	Reach 1B	Reach 1C	Reach 2	Reach 3	Reference Reach
1	**Watershed characteristics**	10	10	10	10	10	4
2	**Flow habit**	4	3	3	3	3	1
3	**Channel pattern**	12	12	12	12	12	2
4	**Entrenchment/channel confinement**	10	10	10	10	10	1
5	**Bed material**	NA	NA	NA	NA	NA	NA
6	**Bar development**	1	1	1	1	1	1
7	**Obstructions/debris jams**	10	3	3	5	5	5
8	**Bank soil texture and coherence**	5	5	5	5	5	3
9	**Average bank angle**	10	3	3	6	6	4
10	**Bank vegetation/protection**	11	12	12	11	11	4
11	**Bank cutting**	3	2	2	2	2	2
12	**Mass wasting/bank failure**	3	2	2	4	4	3
13	**Upstream distance to bridge**	NA	NA	NA	NA	NA	NA
	Score	**79**	**63**	**63**	**69**	**69**	**30**
	Rating*	**Fair**	**Good**	**Good**	**Fair**	**Fair**	**Excellent**

***** Excellent (0 < Score <= 33), Good (33 < Score <= 66), Fair (66 < Score <= 99), Poor (99 < Score <= 132)

4.5 Bankfull Verification

Bankfull is difficult and often times impossible to accurately identify on actively maintained channels and agricultural ditches. The usual and preferred indicators rarely exist, and other factors may be taken into consideration in order to approximate a bankfull stage. Other factors that may be used are wrack lines, vegetation lines, scour lines, or top of a bankfull bench; however, complete confidence should not be placed on these indicators. Throughout the entire project, the channel is generally entrenched and actively maintained, which means bankfull indicators were very limited or non-existent. Therefore, bankfull stage was estimated by using Coastal Plain Regional Curves and other hydrologic analyses, existing cross-sections, and in-house spreadsheets to estimate bankfull area and bankfull discharge.

4.6 Vegetation

Current land use around the project is primarily agriculture and forestry. Land use immediately surrounding the project consists of concentrated animal feeding operations (CAFO), row crop production, animal waste spray area, and forestry. The CAFOs consist of 14 active hog houses and four active chicken houses. There are four lagoons storing waste that is sprayed on fields adjacent to proposed restoration reaches. The remaining channels are adjacent to cultivated fields or disturbed forested areas. The landscape appears to have been contoured to increase surface runoff and eliminate surface ponding. Natural channels and valleys have been excavated to promote further drainage.

The actively managed fields appear to be Bermuda or similar perennial warm season grass over-seeded with a cool season grass. The cultivated fields were fallow, but corn and soybeans appear to have been routinely planted. Soil investigations show that much of the low-lying landscape exhibits hydric characteristics and a shallow seasonal high water table. The forested community is young, mixed pine hardwood forest. Prior to being awarded a contract and closing on the easement, the forests surrounding Reach 2B were harvested due to a timber sale contract the landowner had previously executed. Areas at higher elevations are typically dominated by loblolly pine (*Pinus taeda*) and have a dense understory. Lower and wetter landscapes have a mix of loblolly pine and hardwoods or are predominately hardwoods. The hardwood species include willow oak (*Quercus phellos*), laurel oak (*Quercus laurifolia*), tulip poplar (*Liriodendron tulipifera*) and sweet gum (*Liquidambar styraciflua*). A mid-story layer is comprised of water oak (*Quercus nigra*), tulip poplar, red maple (*Acer rubrum*), and swamp chestnut oak (*Quercus michauxii*). Shrubs and woody vines are locally dense and include sweet bay (*Magnolia virginiana*), redbay (*Persea borbonia*), American holly (*Ilex opaca*), large gallberry (*Ilex coriacea*), wax myrtle (*Morella cerifera*), and swamp greenbriar (*Smilax laurifolia*). Some exotics were noted, including Chinese privet (*Ligustrum sinense*) and Japanese honeysuckle (*Lonicera sempervirens*). The only common herbaceous plant observed is giant cane (*Arundinaria gigantea*). All naturally vegetated areas were classified by their community type, and their boundaries were approximately located on field maps (**Figure 8**). Detailed observations of vegetation species, soils, and hydrology were recorded in each community type. **Table 5** describes each natural community.

Table 5. Natural Community Summary

Natural Community	Percent of Study Area	Schafale and Weakley Community
Agriculture – Pasture/Hayfields	61	NA
Agriculture – Row Crops	11	NA
Bottomland Hardwood Forest	3	NA
Concentrated Animal Feeding Operation	7	NA

Natural Community	Percent of Study Area	Schafale and Weakley Community
Clear-Cut	15	NA
Mixed Pines/Hardwoods	3	Mesic Mixed Hardwood Forest-Coastal Plain

4.7 Existing Wetlands

The US Fish and Wildlife Service National Wetland Inventory Map (NWI) does not depict any wetlands within the project site (**Figure 9**). A wetland delineation was performed in November 2011. Wetland boundaries were delineated using current methodology outlined in the 1987 Army Corps of Engineers Wetland Delineation Manual (DOA 1987) and Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0) (U.S. Army Corps of Engineers 2010). Soils were characterized and classified using the Field Indicators of Hydric Soils in the United States, Version 7.0 (USDA-NRCS 2010). Wetland boundaries were marked with sequentially numbered wetland survey tape (pink/black striped). Flag locations were surveyed under the direction of a Professional Licensed Surveyor (PLS) with GPS and conventional survey (**Figure 9**).

A jurisdictional determination of the wetlands has not been made by the US Army Corps of Engineers (USACE), but the USACE has visited the restoration site. Wetland forms are included in **Appendix 2**. Onsite wetlands include riparian wetlands along both sides of Reach 1B and outside of the proposed easement just upstream from Reach 2.

The existing wetland areas on-site are riparian. The wetlands are immediately adjacent to Reach 1B and have relatively high groundwater elevations. Based on vegetation, soil, and hydrology indicators, it appears that these areas are inundated or saturated for most of the growing season in a typical year. The wetlands are depressional or topographic low areas. They are impacted by the spoil material along the channel and the access path, creating an artificial barrier between the wetland and channel. Field indicators of wetland hydrology include water stained leaves, saturated soil within one foot of the surface, crayfish burrows, and mapped hydric soils. An extensive ditch network and agricultural surface modifications have significantly affected wetland hydrology.

The wetland areas identified within the floodplain along the north and south sides of Reach 1B were located approximately 550 feet downstream of a farm crossing. Potential impacts associated with restoration efforts occurring adjacent to the existing wetlands (Wetlands A, B, and C) along Reach 1B have been minimized by placing the proposed channel in a non-wetland area. **Table 6** summarizes the sizes of each existing wetland and its location.

Table 6. Existing Wetlands Parameter and Characteristics

Parameters	Wetland A/B	Wetland C
Size of Wetland within Easement (Acres)	0.37	0.02
Wetland Type	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Goldsboro	Rains
Drainage Class	Moderately well	Poorly
Hydric Soil Status	Yes	Yes
Source of Hydrology	Groundwater / overbank flows	Groundwater / overbank flows
Hydrological Impairment	Ditched/Incised channel	Ditched/Incised channel
Native Vegetation Community	Clear-cut	Clear-cut
Percent composition of exotic/invasive species	5% Chinese Privet	5% Chinese Privet

The existing wetlands have been historically disturbed and lack the typical vegetation of hardwood wetlands. The wetland areas are seasonally saturated, and approximately five percent of the areas contain invasive species [e.g., Chinese privet]. Creating a new channel that will only impact them slightly will provide an overall increase in wetland function with the addition of native trees and shrubs used along the stream banks. Restoration in these areas will also remove the invasive species in connection with the building of the new channel.

The Goldsboro soils are moderately well drained, and have moderate permeability. Runoff is negligible to medium. The seasonal high water table ranges from 24 to 36 inches. Theses soils are located on the hill slope summit and shoulder. This soil unit is typically cultivated. The Rains soils are poorly drained and have moderate permeability. Runoff is negligible. The seasonal high water table ranges from 0 to 12 inches. Theses soils occur across flats, depressions and Carolina bays. The Natural Resources Conservation Service (NRCS) considers Rains soils to be hydric when undrained. Soil series descriptions are discussed in Section 3.3. Soil profiles are listed on the wetland forms (**Appendix 2**). Soils found in the wetland areas along Reach 1B can be described as Goldsboro and Rains soils.

4.8 Quantitative Habitat Assessment

A quantitative habitat assessment was performed in November 2011 on the reference reach and existing Muddy Run Reach 1 and Reach 2 to measure the volume of woody debris and fish cover. These data were used to establish a baseline for measuring functional uplift and as a tool to determine the placement and volume of woody debris in the design reaches. The total available woody debris (not buried) in the design reaches exceeds the reference reach on a per linear foot basis. In addition, surveys conducted pre- and post-construction in the restoration reach will enable EBX to quantify habitat deficiencies and habitat gains over time.

The length of each sample reach was thirty to forty times the base-flow wetted width of the channel with a minimum reach size of 150 feet. The sample reach was divided into ten transects spaced evenly over the entire reach. Transect length was five feet upstream and five feet downstream of the transect midpoint, and extend the full width of the channel. Parameters measured at each transect were small woody debris (SWD), fish cover, substrate material, and riparian composition. At each transect, the channel bed form was noted and an average width and depth recorded. The following is an analysis of the habitat assessment data.

Reach 3 was not included in the habitat assessment due to its short overall length and similarity to Reach 1C.

4.8.1 Small Woody Debris Methods and Results

Small woody debris, generally comprised of small sticks and or branches, was measured at the reference reach in order to design SWD habitat structures similar to those found in the reference reach (**Appendix 2**). SWD greater than 0.2 inches in diameter were measured in each reference reach transect. Large woody debris (fallen trees, logs, stumps, snags, etc.) was eliminated from analysis since these are analogous to structures such as log vanes and log toes currently applied to most restoration designs.

Transects were identified as either shallow or pool bed form types resulting in three pools and ten shallows measured at the reference reach. Measurements of SWD were summed for each bed form type and divided by the number of corresponding transects to get the average volume of SWD per pool or shallow. The average volume was then divided by the average transect area to get the volume of SWD per square foot. The average design reach bed form area was calculated by assuming a length of ten feet (based on reference transects) and multiplying that by the average bottom cross section width. The average volume was multiplied by the ratio of average reference reach transect area to the average area in the design reach to obtain the volume of SWD to be installed at each fixed pool and at select locations along the design shallows.

WK Dickson currently uses wattles, dead brush, and woody debris bundles in the design of restoration channels. Based on the reference reach SWD analysis, these SWD structures will be concentrated in pool habitats and throughout shallows in volumes and size classes similar to those found in the reference reach. Wattles are woody branch structures tied together and embedded into the bank so that the free ends stick out into the wetted channel. Dead brush structures are shrub or tree tops that are anchored to the bottom of the channel. Woody debris bundles are bundles of sticks one to four inches in diameter and one to four feet long that are anchored to the streambed. Although root wads serve as bank stability structures, they also provide a significant amount of SWD volume to the restoration reach. The average volume of each SWD structure is presented in **Table 8**. A combination of structures listed in **Table 7** will be used in the design to attempt to achieve the calculated average volume per bed form type listed in **Table 8**.

Table 7. Average volume (cubic inches) of SWD structures used in the design reach.

SWD	Average Volume
Woody Debris Bundle	509
Dead Brush	589
Wattle	42
Root Wad	562
Leaf Pack	120

Table 8. Small Woody Debris calculations for the reference and design reach.

Channel bed form	Number of transects	Total volume (in^3)	Average volume in reference reach (in^3)	Percent of WD	Average volume to be applied to design Reach 1 per 10 LF of channel (in^3)	Average volume to be applied to design Reach 2 per 10 LF of channel (in^3)
Shallow	7	3219	460	39%	605	230
Pool	3	5115	1705	61%	1904	944
Total	10	8334	2165	100%	2508	1174

In addition to the habitat assessment conducted at the reference site, Reaches 1 and 2 of the project site were assessed in order to measure representative habitat gains over time post-construction. Based on these assessments, there is a large disparity of SWD volume between the reference reach and the design reaches (**Chart 1**).

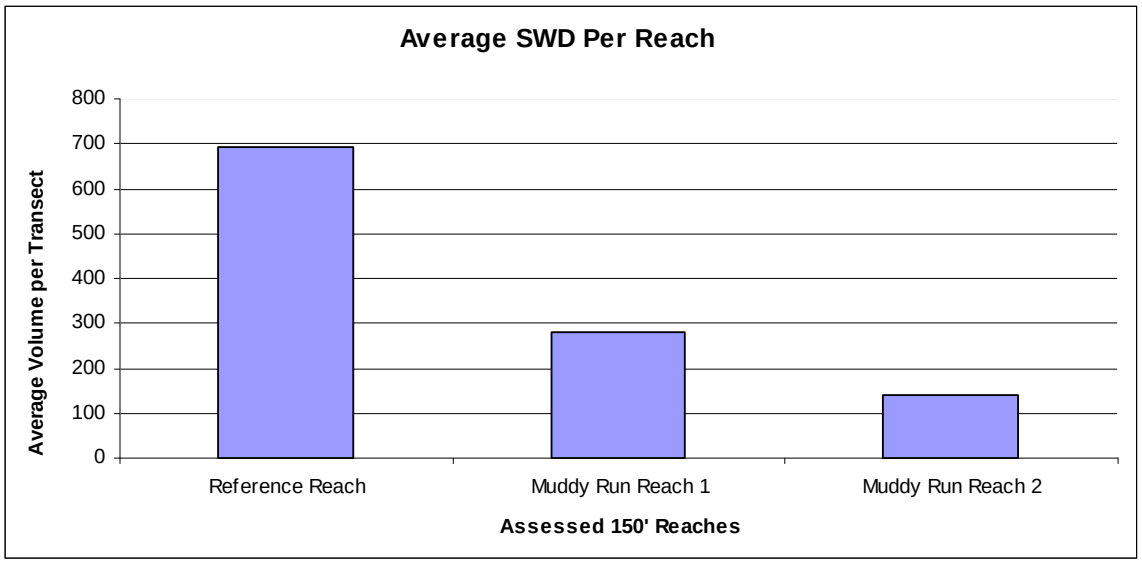


Chart 1. Average volume (cubic inches) of SWD per assessed reach. This chart represents existing conditions in all assessed reaches.

Woody debris collected in streams provides habitat for macroinvertebrates, fish, and amphibians, and increases stream productivity by retaining carbon in the channel. While it would be difficult to replicate the volume and spatial distribution of SWD found in the reference channel, this quantitative habitat assessment provides guidance for improving habitat conditions through specifically placed and sized SWD structures, and provides a means for assessing functional gains over time. WKD has included these structures in the design plans (**Appendix 6**).

4.8.2 Fish Cover Methods and Results

Fish cover measurements were taken at each transect along the reference reach and Muddy Run Reaches 1 and 2. Fish cover area was visually calculated within the ten-foot transect length. Fish cover types include small woody debris and brush, aquatic macrophytes, overhanging vegetation, undercut banks, and boulders. For each transect, a percentage of total fish cover and individual cover type areas were calculated (**Chart 2**). Location and general habitat data was recorded for each fish cover measurement to assess spatial distribution.

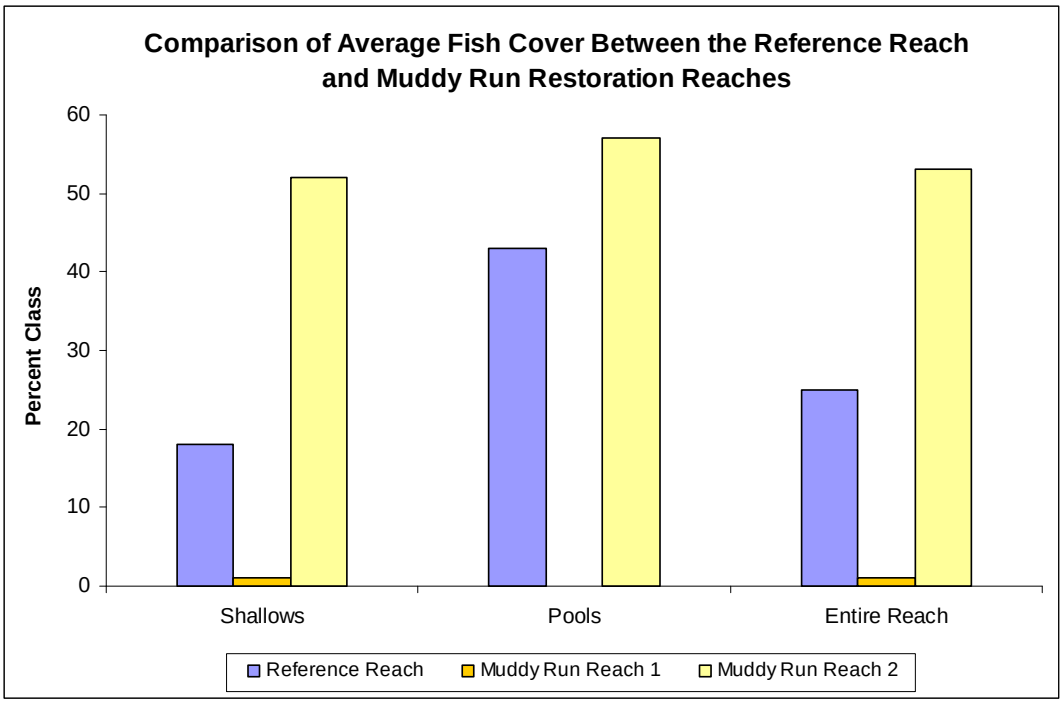


Chart 2. Average percent of fish cover per channel bed form type in the reference reach

The fish cover analysis revealed that the average area of fish cover is almost twice as high in Muddy Run Reach 2 as in the reference reach. This is because the Reach 2 streambed is mostly covered by macrophytic vegetation along the majority of the assessed reach. Muddy Run Reach 2 also had shrubby overhanging bank vegetation, whereas the reference reach ran through a mature forested buffer with few shrubs and overhanging bank vegetation. Muddy Run Reach 1 was devoid of pool bed forms and had very little fish cover habitat due to recent clear cutting of its adjacent buffer. Fish cover from low growing brush will increase in the restoration reaches after the riparian planting occurs. Woody debris structures will also provide additional fish cover habitat and resting areas for fish swimming upstream.

4.8.3 Substrate Composition

Substrates were divided into eight classes as follows: coarse/fine particulate organic matter, silt/clay/muck, fine sand, coarse sand, gravel, cobble, boulder, and bedrock (**Chart 3**). Channel width and water depth were measured at each transect in four equally spaced intervals from bank to bank. Substrate coverage was visually determined between widths measured at each major change in substrate type.

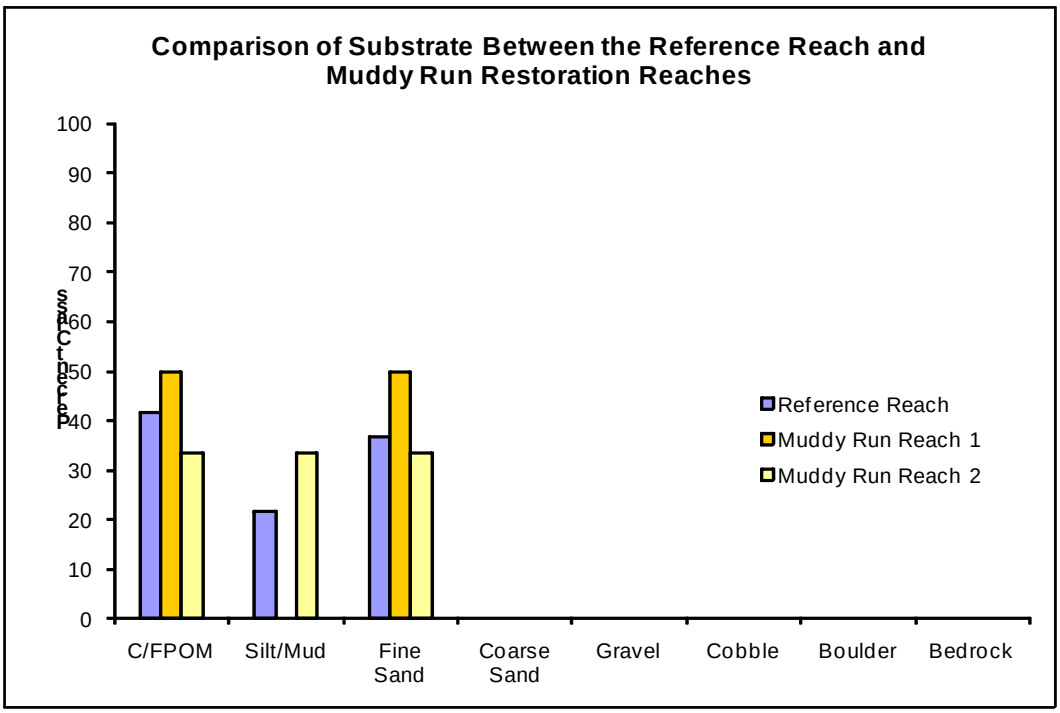


Chart 3. Comparison of substrate composition between the reference reach and the restoration reaches.

The substrate composition analysis revealed that the reference reach has slightly more organic matter substrate (C/FPOM) than Reach 2, and slightly less than Reach 1. These differences may be attributed to a couple of factors, including the maturity and close proximity of riparian plants to the reference reach and Reach 1 (prior to clear cutting), and channelization and incision of Reach 2 which typically results in flushing of organic matter and a lack of carbon retention. Macroinvertebrate abundance and diversity has been tied to the ability of a channel to retain carbon. Several design structures and vegetation plantings can be used to increase organic substrate composition. Constructed leaf packs (approximate 2ft X 3ft area of leaf debris attached to the stream bed with stakes and coir matting) will be installed in select locations for immediate macroinvertebrate colonization. SWD bundles will serve to collect organic matter flowing downstream increasing carbon retention. By adding sinuosity and creating a better floodplain connection, adding SWD in select locations, and creating pool habitats, substrate composition will more closely resemble reference reach conditions.

5 REFERENCE STREAMS

5.1 Target Reference Conditions

The restoration site is characterized by agricultural and forestry practices. Several ditches and underdrains exist in the watershed and contribute to the project site. Physical parameters of the site were used, as well as other reference materials, to determine the target stream type. An iterative process was used to develop the final information for the site design.

To develop the target reference conditions, physical site parameters were reviewed. This included the drainage area, land use, soils mapping units from the Duplin County Soil Survey for the watershed and site, typical woody debris and habitat available and for the area, as well as general topography. The "Classification of the Natural Communities of North Carolina" was also used to narrow the potential community types that would have existed at the site (Shafale and Weakley, 2003).

Targeted reference conditions included the following:

- Located within the Physiographic Region – Outer Coastal Plain,
- Similar drainage area,
- Similar land use onsite and in the watershed,
- Similar watershed soil types,
- Similar site soil types,
- Ideal, undisturbed habitat – several types of woody debris present,
- Similar topography,
- Similar slope,
- Pattern common among coastal plain streams, and
- Minimal presence of invasive species.

5.2 Reference Site Search Methodology

All the parameters used in Section 5.1 were used to find appropriate reference stream sites. Obtaining property owner information and owner authorization for access was another factor in locating suitable reference sites for the project. For this project, there was no predetermined amount of reference sites needed as long as the site was suitable and met nearly all the parameters. Eight potential reference sites were visited, and their characteristics were noted. It is difficult to find reference sites on the coastal plain because many have been disturbed by farming or urban development. Most streams tend to be modified ditches and may have some of the characteristics that are sought in a reference, but too few to make it an ideal reference for the project site. One reference stream site that proves to be ideal in both geomorphology and habitat is located approximately six miles southeast of the restoration site in a wooded corridor.

A GIS-based search was initially conducted for the identification of reference stream sites in the outer coastal plain. The GIS process was based on a search through quadrangle maps, aerial photography, and topography. Drainage areas for each reference site were delineated. Soils and land use were considered for each site, as well as accessibility and location in comparison to the restoration reach. Once sites were identified, all eight sites were visited and assessed. Many of the references were affected by farming practices, dense invasive species, and disturbed or altered floodplains along the streams. This was the case for a few of the sites visited, and, therefore, the sites were not considered. One site was identified for use as a reference site.

5.3 Reference Watershed Characterization

The reference stream flows northwest and drains into Cypress Creek (**Figure 10**). The reach that was surveyed and analyzed is approximately 300 feet long. The drainage area for the unnamed tributary to Cypress Creek (UT) is 0.47 square miles (300 acres). The land use in the watershed is characterized by mostly southern yellow pine (86 percent), bottomland hardwood forest/hardwood swamps (6 percent), broadleaf evergreen forest (3 percent), managed herbaceous cover (3 percent), and cultivation (2 percent). Site photographs of the reference stream are located in **Appendix 1**.

The current State classification for the UT to Cypress Creek is undefined. However, Cypress Creek is defined as Class C *Sw* (NCDWQ, 2005). Class C waters are suitable for aquatic life, secondary recreation, and agricultural usage. The *Sw* is a designation for swamp waters—waters that have low velocities and other natural characteristics that are different from adjacent streams. Using Rosgen stream classification, the stream is classified as a E5 stream type.

5.4 Reference Soils Characterization

The soils found in and around the reference reach are mapped as Muckalee, Blanton, and Murville, all of which are hydric soils. Muckalee is a Hydric B, loam soil, typically found on slopes ranging from 0 to 1 percent slopes. Blanton is a Hydric B sandy soil, found on flats, marines, and terraces with slopes from 1 to 6 percent. Murville soils are mucky fine sand generally found in depressions with slopes of 0 to 2 percent. The soils immediately adjacent to the reference reach have similar characteristics and properties to the soils found at the Muddy Run Restoration Site.

5.5 Reference Discharge

Several hydrologic models/methods were used to develop a bankfull discharge for the reference site. Existing drainage area, land use, slope, roughness, and cross-sectional area were all factors considered when performing the calculations. Using a combination of Coastal Plain Regional Curves, in-house spreadsheet tools, and a project specific regional flood frequency analysis, the existing discharge was found to be around 11 cubic feet per second (ft^3/s). See Section 6.3 for a more detailed description of the hydrologic analyses performed for this project.

5.6 Reference Channel Morphology

In comparison to the restoration reaches, the reference reach is smaller when comparing pattern, dimension and profile, which is the reason for using a scaling factor for the design. The scaling factor is based on the smaller bankfull area of the reference channel. Since the reference stream was smaller, it was necessary to scale up the analog reach in order to use it for design. The new reach would then have the necessary dimensions of that of a bigger stream similar in size to the existing channel that would correspond to the larger drainage area. The stream was typically five to eight feet wide and one to two feet deep. The cross sectional area was typically around 6.7 square feet with a width to depth ratio close to 9.0.

5.7 Reference Channel Stability Assessment

The reference reach was stable and showed no evidence of incision or erosion in the portion that was surveyed and analyzed. The stream appeared to maintain its slope and had sufficient amounts of vegetation to secure its banks. Riparian buffer widths exceeded fifty feet on each side. The CSA results (scores and ratings) for the reference reach is provided above in **Table 4 (**Section 4.4). The reference reach received an "Excellent" rating as the channel demonstrates a stable meandering pattern and a well vegetated riparian buffer.

5.8 Reference Bankfull Verification

Typical indicators of bankfull include vegetation at the bankfull elevation, scour lines, wrack lines, vegetation lines, benches/inner berm, and point bars. Throughout the entire length of the reference reach, bankfull is located at the top of bank elevation. The accuracy of this bankfull stage is verified by the Coastal Plain Regional Curves using existing cross sections to calculate area and discharge. Evidence that can further support the location of bankfull is the lack of any bench or berm features within the channel, and wrack lines present within the floodplain.

5.9 Reference Vegetation

The reference reach riparian community is characteristic of a coastal plain small stream swamp community. This community is approximately 15 to 20 years old, as evidenced by the representative diameter at breast height (DBH) measurements. The following table lists the coverage estimates and species encountered. The right bank is denoted as RB and the left bank is denoted as LB.

Table 9. Tree Communities at the Reference Reach for Muddy Run.

Transect	Location	Percent Coverage	Percent Evergreen	Percent Deciduous	Representative DBH (")	Species
1	LB	80	15	85	8	*Nyssa biflora, Magnolia virginiana, Ilex opaca, Acer rubrum, Liriodendron tulipifera*
	RB	90	15	85	12.5	*Liriodendron tulipifera, Liquidambar styraciflua, Nyssa biflora, Ilex opaca,*
2	LB	65	10	90	9	*Liriodendron tulipifera, Ilex opaca, Liquidambar styraciflua*
	RB	80	10	90	15	*Liquidambar styraciflua, Nyssa biflora, Liriodendron tulipifera*
3	LB	90	10	90	10	*Nyssa biflora, Acer rubrum, Liriodendron tulipifera, Ilex opaca, Magnolia virginiana*
	RB	60	30	70	7	*Ilex opaca, Magnolia virginiana, Nyssa biflora, Liquidambar styraciflua*
4	LB	85	10	90	10	*Liquidambar styraciflua, Liriodendron tulipifera, Ilex opaca*
	RB	35	50	50	3	*Ilex opaca, Magnolia virginiana, Liquidambar styraciflua*
5	LB	90	10	90	8	*Liriodendron tulipifera, Magnolia virginiana, Acer rubrum, Fagus grandifolia, Nyssa biflora, Liquidambar styraciflua*
	RB	60	25	75	9	*Nyssa biflora, Liquidambar styraciflua, Ilex opaca, Liriodendron tulipifera*
6	LB	90	10	90	8	*Liriodendron tulipifera, Magnolia virginiana, Acer rubrum, Fagus grandifolia, Nyssa biflora, Liquidambar styraciflua*
	RB	70	50	50	6	*Magnolia virginiana, Ilex opaca, Nyssa biflora*
7	LB	75	10	90	10	*Liriodendron tulipifera, Acer rubrum, Ilex opaca, Q. michauxii*
	RB	60	40	60	8	*Ilex opaca, Liriodendron tulipifera, Liquidambar styraciflua*
8	LB	55	20	80	7	*Liriodendron tulipifera, Acer rubrum, Pinus taeda, Ilex opaca, Ligustrum japonicum*
	RB	80	40	60	6	*Quercus nigra, Liriodendron tulipifera, Ilex opac, Acer rubrum*
9	LB	70	25	75	10	*Nyssa biflora,Ilex opaca, Liriodendron tulipifera, Pinus taeda*
	RB	80	20	80	6	*Liriodendron tulipifera , Ilex opaca, Quercus nigra, Acer ruburm*
10	LB	60	25	75	11.5	*Nyssa biflora,Ilex opaca, Liriodendron tulipifera, Pinus taeda*

Transect	Location	Percent Coverage	Percent Evergreen	Percent Deciduous	Representative DBH (")	Species
	RB	80	15	85	11	*Pinus taeda, Quercus michauxii,Ilex opaca, Acer rubrum, Liquidambar styraciflua, Liriodendron tulipifera, Ligustrum japonicum*

5.10 Habitat Assessment – Woody Debris

The habitat assessment for the reference stream channel is included in the habitat assessment discussion for Muddy Run within Section 4.8.

6 PROJECT SITE RESTORATION PLAN

6.1 Restoration Project Goals and Objectives

The proposed Muddy Run stream mitigation project will provide numerous ecological and water quality benefits within the Cape Fear River Basin. While many of these benefits are limited to the project area, others, such as pollutant removal and improved aquatic and terrestrial habitat, have more far-reaching effects. Expected improvements to water quality, hydrology, and habitat are outlined in **Table 10**.

Table 10. Design Goals and Objectives

Benefits Related to Water Quality	
Nutrient removal	Benefit will be achieved through filtering of runoff from adjacent CAFOs through buffer areas, the conversion of active farm fields to forested buffers, improved denitrification and nutrient uptake through buffer zones, and installation of BMPs at the headwaters of selected reaches and ditch outlets.
Sediment removal	Benefit will be achieved through the stabilization of eroding stream banks and reduction of sediment loss from field areas due to lack of vegetative cover. Channel velocities will also be decreased through a reduction in slope, therefore decreasing erosive forces.
Increase dissolved oxygen concentration	Benefit will be achieved through the construction of instream structures to increase turbulence and dissolved oxygen concentrations and lower water temperature to increase dissolved oxygen capacity.
Runoff filtration	Benefit will be achieved through the restoration of buffer areas that will receive and filter runoff, thereby reducing nutrients and sediment concentrations reaching water bodies downstream.
Benefits to Flood Attenuation	
Water storage	Benefit will be achieved through the restoration of buffer areas which will infiltrate more water during precipitation events than under current site conditions.
Improved groundwater recharge	Benefit will be achieved through the increased storage of precipitation in buffer areas, ephemeral depressions, and reconnection of existing floodplain. Greater storage of water will lead to improved infiltration and groundwater recharge.
Improved/restored hydrologic connections	Benefit will be achieved by restoring the stream to a natural meandering pattern with an appropriately sized channel, such that the channel's floodplain will be flooded more frequently at flows greater than the bankfull stage.
Benefits Related to Ecological Processes	
Restoration of habitats	Benefit will be achieved by restoring riparian buffer habitat to appropriate bottomland hardwood ecosystem.
Improved substrate and instream cover	Benefit will be achieved through the construction of instream structures designed to improve bedform diversity and to trap detritus. Substrate will become more coarse as a result of the stabilization of stream banks and an overall decrease in the amount of fine materials deposited in the stream.

Addition of large woody debris	Benefit will be achieved through the addition of wood structures as part of the restoration design. Such structures may include log vanes, root wads, and log weirs.
Reduced temperature of water due to shading	Benefit will be achieved through the restoration of canopy tree species to the stream buffer areas.
Restoration of terrestrial habitat	Benefit will be achieved through the restoration of riparian buffer bottomland hardwood habitats.

6.2 Restoration Approach

Stream buffers throughout the project site will be restored and protected in perpetuity. Proposed mitigation for the Muddy Run site involves headwater valley restoration and Priority Level I stream restoration. The proposed mitigation design divides the site into three distinct drainage features consisting of five design reaches (**Figure 11**). Priority Level I restoration is proposed on four reaches and headwater valley restoration is proposed on one reach.

Priority I restoration reaches will typically include a meandering stream pattern constructed to mimic the natural planform of low-gradient, sand bed channels. The proposed sinuosity is 1.1, which is based on local reference reach conditions, existing site constraints, and hydraulic modeling. As a result of the restoration of planform and dimension, frequent overbank flows and a restored riparian buffer will provide the appropriate hydrology and sediment transport throughout this coastal plain watershed.

Headwater valley restoration will follow current regulatory guidance and published research. This restoration approach will result in a fully vegetated valley bottom following natural existing contours. Any ditches or channels present will be backfilled and stabilized. Vegetation will be restored across the entire headwater valley.

Muddy Run has been broken into the following design reaches:

- **Reach 1A (STA 0+66 to STA 17+25)** – Eastern most reach along the primary drainage feature totaling approximately 1,629 linear feet of headwater valley restoration. This reach is flat with agricultural fields to the east and west and waste lagoons to the east. The reach begins approximately 30 feet downstream from a farm road crossing.

- **Reach 1B (STA 17+25 to STA 33+67)** – Middle reach along the primary drainage feature totaling approximately 1,630 linear feet of Priority 1 restoration. Reach 1B has a farm path along the north bank, wetlands to the north and south, and a culvert crossing at STA 21+01.

- **Reach 1C (STA 33+67 to STA 47+08)** – Western most reach along the primary drainage feature totaling approximately 1,293 linear feet of Priority 1 restoration. Reach 1C is flat and flows through an active agricultural field. Reach 2 flows into this reach near STA 45+26.

- **Reach 2 (STA 0+50 to STA 17+20)** – Southwestern reach totaling approximately 1,670 linear feet of Priority 1 restoration. Reach 1B flows through an agricultural field and is adjacent to hog houses and two waste lagoons located to the east.

- **Reach 3 (STA 0+94 to STA 7+18)** – Western-most reach totaling approximately 624 linear feet of Priority 1 restoration. This reach is flat with agricultural fields to the east and west. Reach 1C flows into this reach near STA 5+72.

Reach 1A
Headwater valley restoration is proposed along Reach 1A and continues down to Reach 1B. The existing channel adjacent to the hog houses will be backfilled to the extent possible such that cut and fill is balanced along the reach. The existing 18-inch corrugated plastic pipe located under the gravel road at STA 0+25 will be removed and replaced with three 12-inch CMPs at a slightly higher elevation. A sediment trapping pool and level spreader BMP immediately downstream of the road crossing will be constructed to provide diffuse flow into the valley and collect sediment from the farm access road. The BMP will be located outside the conservation easement to allow for maintenance. The reach will not be completely filled so as to prevent hydrologic trespass upstream of the road at STA 0+25. Grade control structures will be placed along portions of the reach that will be filled to provide additional vertical stability.

A forested buffer approximately 115 feet wide will be planted throughout this reach. Where the channel is currently redirected towards Reach 2 near STA 11+31, a channel plug will be constructed, and flow will be directed back in a northerly direction. A channel plug and grade control structure will also be installed where an existing ditch enters the buffer from the east. Flow will be directed along the reach such that it follows along the natural valley from STA 11+31 down to Reach 1B. An existing 30-inch CMP culvert located at STA 11+12 will be removed and replaced with three 12-inch CMPs to allow the landowner access to all areas of his property, as the proposed restoration will bisect his land. The terminus of the headwater valley at STA 17+25 will include a grade control structure at the transition to a stable channel for Reach 1B.

Reach 1B
Priority Level I restoration is proposed on Reach 1B. For the majority of the reach, the channel will be rerouted to the south of its current location. Relocating the channel will not impact any forested areas because most of the buffer was clear cut in the fall of 2011. However, there is a small, wooded area along the upstream portion of the reach. The proposed channel from STA 17+25 to 20+78 meanders along the existing channel footprint in order to minimize impacts to the established buffer to the south. The elevated road bed along the north side of the existing channel will be removed in order to maintain a continuous connection between the proposed channel and its floodplain. A channel plug and grade control structure will also be installed where an existing ditch enters the buffer from the north near STA 18+08. An existing 42-inch CMP culvert crossing will be removed and replaced with two 36-inch CMPs at STA 20+93 to maintain access to all portions of the landowner's property. Structures along this reach will include log grade controls, root wads, and various woody debris structures to enrich habitat and ensure bank stability and channel integrity.

The downstream section of the proposed reach has been relocated to avoid impacts to two existing wetland areas adjacent to the channel. There are two existing ditches within the proposed easement that cross the wetland to the south. These ditches will be plugged to provide diffuse flow through the wetland and into the restored channel.

Reach 1C
Priority Level I restoration is proposed on Reach 1C. The restoration approach on this reach includes relocating the channel to the north of its current location within the adjacent agricultural field. The relocation also includes moving the confluence with Reach 2 to STA 45+27. The existing channel will be plugged and filled to prevent continued flow within the ditch. An existing 36-inch CMP culvert crossing located at the upstream end of the reach will be removed and relocated to STA 33+67. The proposed twin 42-inch culverts will be placed in-line with the proposed restoration to maintain access to all portions of the landowner's property.

By rerouting and raising the channel, the design will allow the channel frequent access to its floodplain and the opportunity for creating small depressional areas within the buffer to enhance habitat for wildlife and aquatic organisms. Structures along this reach will include log grade controls, root wads, leaf packs, and various woody debris structures that will improve in-stream habitat and bank stability.

The downstream end of Reach 1C terminates at a temporary grade drop structure. The restoration will be continued in a subsequent phase of the project, Muddy Run II.

Reach 2
Priority Level I restoration is proposed on Reach 2. The bed elevation at the top of the reach is controlled by a 42-inch CMP culvert. This culvert and the associated farm road will be moved approximately 100 feet upstream of its current location. The culvert will be replaced with a 36-inch CMP to maintain access to the adjacent hog houses and lagoons located just north of the upstream end of the reach. The channel will flow in a northwesterly direction to the confluence with Reach 1C.

The majority of the channel is proposed to be relocated north and east of the existing ditch towards the lagoons. The lower end will meander through a large spoil area constructed during installation of the lagoons. Before constructing the channel, this area will be graded down to match pre-disturbance elevations, and the cut will be used to fill abandoned ditches throughout the project. The proposed design will allow the channel to access its floodplain regularly. Typical in-stream structures along this reach will include log grade controls, root wads, leaf packs, and various woody debris structures that will improve habitat and bank stability. All areas within the proposed easement will be planted with native shrub and tree species.

Reach 3
Priority Level I restoration is proposed on Reach 3. Its bed elevation is controlled at the top of the reach by a 24-inch CMP culvert. This culvert will be removed and replaced with two 42-inch CMPs at a higher elevation to maintain access across the property. The culvert will be raised a minimal amount to prevent hydrologic trespass upstream of the project. Restoration will begin just south of the culvert crossing, and will involve relocating the channel to the east of the existing ditch into the adjacent spray field. The reach will reconnect with the primary channel (Reach 1) approximately 146 feet downstream of the confluence with Reach 1C at STA 5+72. A temporary log ramp will be installed at the downstream end to tie the proposed channel into the existing ditch. This structure will be removed when the Muddy Run II Mitigation Project is constructed.

By relocating the channel, the design will allow the channel regular access to its floodplain and the opportunity for enhanced wetland habitat throughout the buffer. In-stream structures along this reach will include log grade controls, root wads, leaf packs, and various woody debris structures that will provide bed diversity and subsequently improve habitat and bank stability. All areas within the proposed easement will be planted with native shrub and tree species.

The current design of Reach 3 reflects a proposed drainage area of 391 acres as opposed to the existing area of 85 acres. This significant increase in watershed size incorporates a drainage area that borders Reach 3 to the north and east, which currently directs flows away from the project site. It appears that the drainage features within this additional area were historically diverted north across a natural divide to promote drainage for agricultural production. The proposed Muddy Run II Stream and Wetland Mitigation Project will reconnect this drainage to the Muddy Run project site.

6.3 Stream Hydrologic Analysis

Hydrologic evaluations were performed for the design reaches using multiple methods to determine and validate the design bankfull discharge and channel geometry required to provide regular floodplain inundation. The use of various methods allows for comparison of results and eliminates reliance on a single model. Peak flows (**Table 11**) and corresponding channel cross-sectional areas were determined for comparison to design parameters using the following methods:

- Regional Flood Frequency Analysis,
- Intellisolve's Hydraflow Express Hydrographs,
- NC and VA/MD Regional Curves for the Coastal Plain, and
- USGS regional regression equations for rural conditions in the Coastal Plain.

Regional Flood Frequency Analysis

A flood frequency analysis was completed for the study region using historic gauge data on all nearby USGS gauges with drainage areas less than 6,400 acres (10 mi^2) which passed the Dalrymple homogeneity test (Dalrymple, 1960). This is a subset of gauges used for USGS regression equations. Regional flood frequency equations were developed for the 1.1-, 1.5-, and 2-year peak discharges based on the gauge data. Discharges were then computed for the design reach. These discharges were compared to those predicted by the discharge regional curve and USGS regional regression 2-year discharge equations.

Intellisolve's Hydraflow Hydrographs

Hydraflow Hydrographs was used to simulate the rainfall-runoff process and establish peak flows for the watersheds. This model was chosen over the U.S. Army Corps of Engineers model HEC-1 because it allows the user to adjust the peak shape factor for the Coastal Plain conditions. Using a standard Type III distribution in HEC-1, the model will use a 284 peak shape factor, which is the outdated standard for a coastal environment. This results in conservatively high peak flows that may not be appropriate for a stream restoration design. NRCS staff has recommended using peak shape factors between 60 and 100 for the Coastal Plain. Hydraflow Hydrographs allows the user to make this adjustment to the peak shape factor.

Regional Curve Regression Equations

The North Carolina Coastal Plain regional curves by Doll et al (2003) and Sweet and Geratz (2003) and the Virginia/Maryland (Krstolic et al., 2007) Coastal Plain regional curves for discharge were used to predict the bankfull discharge for the site. The NC regional curves predicted flows that are similar to those predicted by the 1.1-year flood frequency, while the VA/MD curves are comparable to flows predicted by the 1.5-year flood frequency equation. The regional curve equations for NC discharges by Doll et al. (2003) (1) and Sweet and Geratz (2003) (2) and VA/MD (3) discharges are:

(1)	$Q_{bkf}=16.56*(DA)^{0.72}$	(Doll et al., 2003)
(2)	$Q_{bkf}=8.49*(DA)^{0.76}$	(Sweet and Geratz, 2003)
(3)	$Q_{bkf}= 28.3076*(DA)^{0.59834}$	(Krstolic et al., 2007)

Where Q_{bkf}=bankfull discharge (ft^3/s) and DA=drainage area (mi^2).

USGS Regional Regression Equations

USGS regression equations estimate the magnitude and frequency of flood-peak discharges (Gotvald, et al., 2009). The regression equations were developed from gauge data in different physiographic regions of the Southeastern United States. For this analysis, there was only concern for the 2-year return interval. The equation for the rural Coastal Plain (Hydrologic Region 4) is:

(4) $$Q_2=60.3*(DA)^{0.649}$$

Where Q_2=2-year peak discharge (ft^3/s) and DA=drainage area (mi^2).

Table 11. Peak Flow Comparison

Reach	Drainage Area (Ac)	Hydraflow Hydrographs Q_1	FFQ $Q_{1.1}$	FFQ $Q_{1.5}$	NC Regional Curve Q (1)	NC Regional Curve Q (2)	VA/MD Regional Curve Q (3)	Regional Regression Eqns. Q_2	Design/ Calculated Q
Analog	285	---	11	23	9	5	18	36	13
1B	177	11	7	16	7	3	13	26	9
1C	238	14	9	20	8	4	16	32	13
2	60	8	2	7	3	1	7	13	4
3	391	29	15	29	12	6	21	44	19

The NC regional curve (Doll et al., 2003) predicts flows similar to the 1.1-year flood frequency analysis which indicates that the bankfull flows occur in the region with a frequency of approximately once a year. This also corresponds to the NC Coastal Plain regional curve (Doll et al., 2003) where the developers report an average recurrence interval of 1.12 years for the gauged streams included in their study. Additionally, the calculated bankfull discharge based on field measured geometry at the reference (analog) site closely matches flows generated 1.1-year flood frequency analysis.

6.4 Design Discharge

Based upon the hydrologic analysis described above, design discharges were selected that fall on the low end of flows between the results of the 1.1 and 1.5-year flood frequency analysis for each reach. The selected flows are 9 ft^3/s, 12 ft^3/s, 4 ft^3/s, and 19 ft^3/s for Reaches 1B, 1C, 2, and 3 respectively. These discharges will provide frequent inundation of the adjacent floodplain.

The design discharges were selected based on the following rationale:

- The calculated bankfull discharge for the analog/reference reach closely matches the results of the 1.1-year flood frequency analysis,
- The results of the Hydraflow Hydrographs for the 1-year storm fell between the results of the 1.1 and 1.5-year flood frequency analysis,
- The results of the 1.1-year flood frequency analysis matched well with the NC regional curve (Doll et al., 2003), and
- Selecting design discharges between the 1.1 and 1.5-year storm events allows frequent inundation of the floodplain, while also preventing adjacent active agriculture land from flooding at a high frequency.

6.5 Design Methods

There are three primary methods that have demonstrated success in stream restoration: analog, empirical, and analytical. All three methods have advantages and limitations, and it is often best to utilize more than one method to address site-specific conditions or to verify the applicability of design elements. This is particularly true in developed watersheds where existing conditions do not always reflect current inputs and events, and sediment and hydrologic inputs may remain unstable for some time. Combinations of analytical and analog methods were used to develop the stream designs for Muddy Run.

Analytical Approach
Analytical design is based on principles and processes considered universal to all streams, and can entail many traditional engineering techniques. The analytical approach utilizes continuity, roughness equations, hydrologic and hydraulic models, and sediment transport functions to derive equilibrium conditions. Since the project is located within a rural watershed, restoration designs are based on hydrologic and hydraulic analyses, including rainfall-runoff models to determine design discharges coupled with reference reach techniques.

Analog Approach
The analog method of natural channel design involves the use of a "template" or reference stream located near the design reach, and is particularly useful when watershed and boundary conditions are similar between the design and analog reaches (Skidmore et al., 2001). In an analog approach, the planform pattern, cross-sectional shape, longitudinal profile, and frequency and locations of woody debris along the analog reaches are mimicked when developing the design parameters for the subject stream. A scaling factor was calculated from the survey data in order to correctly size the planform design parameters for the project site. The scaling factors for each design reach were derived from the design cross-sectional area and topwidth of each reach as follows:

1. The appropriate bankfull cross-sectional area (CSA) of each design reach was calculated using an in-house spreadsheet based on Manning's Equation. The input parameters included the design discharge as determined by the hydrologic analysis described above, and proposed slope based on site conditions and the sinuosity measured for the analog reach.

2. The cross-sectional shape was adjusted within the spreadsheet to replicate the width-depth ratios and side slopes surveyed along the analog reach, while also maintaining the CSA necessary to convey the design discharge.

3. The scaling factor is determined from the ratio of the design topwidth to the analog topwidth (**Table 12**). For this project, several sections and planform geometry were obtained at the analog site, resulting in an average width of 7.6 feet.

4. Pool cross-sectional areas were calculated using both typical reference reach techniques and the analog approach. Design CSA areas were determined using the measured analog ratios of shallow/ripple CSA to pool CSA as applied to the design CSAs. The pool cross-sectional shape was adjusted within the in-house spreadsheet as described above in step 2.

Table 12. Scaling Factors for Sizing Planform Design Parameters

Reach	Drainage Area (ac)	Proposed Bankfull CSA (ft^2)	Design Topwidth (ft)	Analog Reach Topwidth (ft)	Scaling Factor
MR1B	177	6.6	8.2	7.6	1.1
MR1C	238	8.9	9.5	7.6	1.3
MR2	60	3.1	5.6	7.6	0.7
MR3	391	13.1	11.4	7.6	1.5

6.5.1 Typical Design Sections

Typical cross sections for shallows and pools are shown on the design plan sheets in **Appendix 6**. The cross-section dimensions were developed for the three design reaches by using a WK Dickson in-house spreadsheet described in Section 5.3 of this report. The cross-sections were altered slightly to

facilitate constructability; however, the cross-sectional area, width to depth ratio, and side slopes were preserved. Typical pool sections include pools located on straight reaches and pools on meander bends.

6.5.2 Typical Meander Pattern

The design plans showing the proposed channel alignment are provided in **Appendix 6**. The meander pattern was derived directly from the analog reach and sized using the scaling factors described in **Table 12**. The analog meander pattern was altered in some locations to provide variability in pattern, to avoid onsite constraints, to follow the valley pattern, and to make the channel more constructible. The morphologic parameters summarized in **Table 12** and **Appendix 6** were applied wherever these deviations occurred.

6.5.3 Longitudinal Profiles

The design profiles are presented in **Appendix 6**. These profiles extend throughout the entire project for the proposed channel alignment. The profiles were designed using the analog reach bed features that were sized with the scaling factors. The bed slopes and bankfull energy gradients were determined for each design reach based on the existing valley slope and the sinuosity of the design reach. Log structures will be utilized in the design to control grade, divert flows, and provide additional habitat diversity and stability.

6.5.4 In-Stream Structures


Sod mats blanket the top of bank of this stream in Bertie County.

Structures will be incorporated into the channel design to provide additional stability and improve aquatic habitat. Native materials and vegetation will be used for revetments and grade control structures where applicable. Additionally, woody debris will be placed throughout the channel at locations and at a frequency that is similar to those mapped in the analog reaches. The analog reach has woody debris throughout the length of the channel, providing grade control for shallows and forcing scour pools. Woody habitat features installed will include leaf packs, dead brush, woody debris bundles, root wads, and wattles. Sod mats harvested onsite will be installed along stream banks during construction if and when feasible. Sod mats (see photo above) are natural sections of vegetation taken from the banks when they were cut during construction, and are about nine inches thick. Before installation, proposed banks are graded lower than specified to accommodate the thickness of the mat. The mats are placed on top of the bank to act as a natural stabilizer of native species, and they grow much faster than the combination of coir fiber matting and seeding (see detail **Appendix 6**). Other bank stability measures include the installation of cuttings bundles at three to five foot intervals along the tops of banks, root wads, and log toes. Typical details for proposed in-stream structures and revetments are in **Appendix 6**.

6.6 Sediment Transport Analysis

An erosion and sedimentation analysis was performed to confirm that the restoration design creates a stable sand bed channel that neither aggrades nor degrades over time. Typically, sediment transport is assessed to determine a stream's ability to move a specific grain size at specified flows. Various sediment transport equations may be easily applied when estimating entrainment for gravel bed streams; however, these equations are not as effectively applied to sand bed channels where the entire bed becomes mobile during geomorphically significant flows. Therefore, more sophisticated

modeling techniques were used to analyze the stream design for this project. The following methods and functions were utilized during the sediment transport analysis:

- Stable Channel Design Function – Copeland Method (HEC-RAS),
- Shear Stress, and
- Velocity.

Stable Channel Design

Design cross-section dimensions as determined from the analog approach were evaluated using the stable channel design functions within HEC-RAS. These functions are based upon the methods presented in the SAM Hydraulic Design Package for Channels developed by the USACE Waterways Experiment Station. The Copeland Method was developed specifically for sand bed channels (median grain size restriction of 0.0625 mm to 2 mm) and was selected for application at Muddy Run. The method sizes stable dimensions as a function of slope, discharge, roughness, side slope, bed material gradation, and the inflowing sediment discharge. Results are presented as a range of widths and slopes, and their unique solution for depth, making it easy to adjust channel dimensions to achieve stable channel configurations. The stable design output parameters are listed in **Table 13**. The results are acceptable and match closely with the design reach parameters.

Table 13. Stable Channel Design Output

Reach	Q (ft/s^3)	Bottom Width (ft)	Depth (ft)	Energy Slope (ft/ft)	Composite n value	Velocity (ft/s)	Shear Stress (lbs/ft^2)
MR-1B	9	4	1.2	0.0021	0.033	1.81	0.15
MR-1C	13	4	1.5	0.0020	0.038	1.71	0.18
MR-2	4	3	0.8	0.0021	0.033	1.39	0.10
MR-3	19	6	1.7	0.0013	0.039	1.57	0.14

Shear Stress Approach

Shear stress is a commonly used tool for assessing channel stability. Allowable channel shear stresses are a function of bed slope, channel shape, flows, bed material (shape, size, and gradation), cohesiveness of bank materials, and vegetative cover. The shear stress approach compares calculated shear stresses to those found in the literature. Shear stress is the force exerted on a boundary during the resistance of motion as calculated using the following formula:

(1) $\tau = \gamma RS$

τ = shear stress (lb/ft2)
γ = specific gravity of water (62.4 lb/ft3)
R = hydraulic radius (ft)
S = average channel slope (ft/ft)

Table 14. Comparison of Allowable and Proposed Shear Stresses

Reach	Proposed Shear Stress at Bankfull Stage (lbs/ft^2)	Critical Shear Stress (lbs/ft^2)	Allowable Shear Stress[1]	
			Sand/Silt/Clay (lbs/ft^2)	Vegetation (lbs/ft^2)
MR-1B	0.11	0.003	0.4 to 2.5	0.2 to 0.95
MR-1C	0.11	0.003	0.4 to 2.5	0.2 to 0.95

Reach	Proposed Shear Stress at Bankfull Stage (lbs/ft^2)	Critical Shear Stress (lbs/ft^2)	Allowable Shear Stress[1]	
			Sand/Silt/Clay (lbs/ft^2)	Vegetation (lbs/ft^2)
MR-2	0.10	0.003	0.4 to 2.5	0.2 to 0.95
MR-3	0.11	0.003	0.4 to 2.5	0.2 to 0.95

[1](Fischenich, 2001)

Review of the above table shows that the proposed shear stresses for the Muddy Run design reaches fall between the critical shear stress (shear stress required to initiate motion) and the allowable limits. Therefore, the proposed channel should remain stable.

Velocity Approach

Published data are readily available that provide entrainment velocities for different bed and bank materials. A comparison of calculated velocities to these permissible velocities is a simple method to aid in the verification of channel stability. **Table 15** compares the proposed velocities calculated using Manning's equation with the permissible velocities presented in the Stream Restoration Design Handbook (NRCS, 2007).

Table 15. Comparison of Allowable and Proposed Velocities

Reach	Design Velocity (ft/s)	Allowable Velocity[1] (ft/s)	
		Fine Sand	Coarse Sand
MR-1B	1.5	2.0	4.0
MR-1C	1.5	2.0	4.0
MR-2	1.3	2.0	4.0
MR-3	1.4	2.0	4.0

[1](NRCS, 2007)

6.7 HEC-RAS Analysis

A hydraulic analysis was performed to confirm that the restoration design results in a channel that will convey the design discharge and provide for frequent flooding of the adjacent riparian floodplain and wetlands. Channel characteristics including cross-sectional dimension, slope, and roughness, were used to analyze and adjust design parameters calculated by the analog/reference reach approach.

HEC-RAS was used to perform the hydraulic analysis. This model is a hydraulic model developed by the US Army Corps of Engineers' Hydrologic Engineering Center to perform one-dimensional (1-D) steady and unsteady flow calculations. The model uses representative geometric data (cross-sections) and hydraulic computation routines.

Design cross-sectional dimensions determined through the analog/reference reach approach were evaluated using the 1-D steady flow analysis component and the channel design functions within the HEC-RAS Model (Version 4.0.0). The cross-sectional dimensions for reaches 1B, 1C, 2, and 3 were iteratively adjusted based on the model results to produce a channel design that will regularly flood the adjacent riparian areas. Model results are presented in **Appendix 4.** The results are organized by reach, discharge, and STA number and include water surface elevation, velocity, flow area, stream power, and shear stress.

6.8 Best Management Practices

Due to the rural nature of this project, individual stormwater best management practices (BMPs) will not be required. However, agricultural BMPs will be applied at locations where ditches or other forms of concentrated flow enter the conservation easement. These BMPs will consist of a pool (forebay) that will attenuate runoff coupled with a level spreader that will diffuse flow before entering the buffer.

Stormwater management issues resulting from future development of adjacent properties will be governed by the applicable state and local ordinances and regulations. It is recommended that any future stormwater entering the site maintain pre-development peak flow. Any future stormwater diverted into the project should be done in a manner as to prevent erosion, adverse conditions, or degradation of the project in any way.

6.9 Soil Restoration

After construction activities, the subsoil will be scarified and any compaction will be deep tilled before the topsoil is placed back over the site. Any topsoil that is removed during construction will be stockpiled and placed over the site during final soil preparation. This process should provide favorable soil conditions for plant growth.

6.10 Natural Plant Community Restoration

6.10.1 Plant Community Restoration

The restoration of the plant communities is an important aspect to the restoration of the site. The selection of plants is based on what was observed at the reference reach and the forest surrounding the restoration site and what is typically native to the area. Several sources of information were used to determine the most appropriate species for the restoration project. The reference stream is located within a disturbed Coastal Plain Small Stream Swamp – Blackwater subtype. Dominant species included sweetgum (*Liquidambar styraciflua*), tulip poplar (*Liriodendron tulipifera*), swamp tupelo (*Nyssa biflora*), and red maple (*Acer ruburm*) in the canopy. Shrubs included sweetbay (*Magnolia virginiana*) and American holly (*Ilex opaca*). The absence of bald cypress (*Taxodium distichum*) likely indicates past logging with poor regeneration at the site. The mitigation site also supports many species typical of this community type. Timber management is likely responsible for the absence of cypress, also. Typically, a Coastal Plain Small Stream Swamp would be located along the stream banks and adjacent floodplain.

The restoration site has a relatively uniform topography. Based on observations of the reference community and the communities surrounding the mitigation site, a single community is appropriate. Therefore, Coastal Plain Small Stream Swamp will be the target community type and will be used for all areas within the project, as well as for buffer around the site. A plant species list has been developed and can be found in **Table 16**. Species with high dispersal rates are not included because of local occurrence and the high potential for natural regeneration. The high dispersal species found locally in the surrounding communities include red maple, tulip poplar, and sweetgum.

The restoration of plant communities along Muddy Run will provide a planting plan that will provide stabilization and diversity. For rapid stabilization, silky dogwood, silky willow, and black willow were chosen for live stakes along the restored channel because of their rapid growth patterns and high success rates. Willows will also be quicker to contribute organic matter to the channel. Willows grow at a faster rate than the species planted around them and stabilize the stream banks. When the other species are bigger, the black willow and silky willows will slowly stop growing or die out because the

other species would outgrow them and create shade that the willows do not tolerate. The live stake species will be planted along the outside of the meander bends three feet from the top of bank, creating a three-foot section along the top of bank. The willows would be spaced every three feet with alternate spacing. See **Appendix 6** for a detailed planting plan.

Table 16. Proposed Plant List

Bare Root Planting Tree Species			
Common Name	**Scientific Name**	**Wetland Indicator**	**Percent Composition**
River birch	*Betula nigra*	FACW	10%
Green ash	*Fraxinus pennsylvanica*	FACW+	10%
Laurel oak	*Quercus laurifolia*	FACW+	20%
Overcup oak	*Quercus lyrata*	OBL	20%
Swamp chestnut oak	*Quercus michauxii*	FACW+	10%
Water oak	*Quercus nigra*	FACW	10%
American sycamore	*Platanus occidentalis*	FACW-	10%
Bald cypress	*Taxodium distichum*	OBL	10%

*Planting density approximately 680 stems per acre

Live Staking and Live Cuttings Bundle Tree Species			
Common Name	**Scientific Name**	**Wetland Indicator**	**Percent Composition**
Silky dogwood	*Cornus amomum*	FACW+	45%
Silky willow	*Salix sericea*	OBL	45%
Black willow	*Salix nigra*	OBL	10%

6.10.2 On-Site Invasive Species Management

Some invasive species have been noted on the site. They include Chinese privet (*Ligustrum sinense*) and Japanese honeysuckle (*Lonicera sempervirens*). These invasive species are common but not limited to any confined location. The movement of topsoil will also stir up weed seeds, but most will be inhibited by the raising of the water table on the site. It will be important during monitoring site visits to check for any significant encroachment of invasive species and to develop a plan of action to control any such problem.

6.11 Restoration Summary

Natural channel design techniques have been used to develop the restoration designs described in this document. The combination of the analog and analytical design methods was determined to be appropriate for this project because the watershed is rural, the causes of disturbance are known and have been abated, and there are minimal infrastructure constraints. The original design parameters were developed from the measured analog/reference reach data and applied to the subject stream. The parameters were then analyzed and adjusted through an iterative process using analytical tools and numerical simulations of fluvial processes. The designs presented in this report provide for the restoration of natural Coastal Plain sand-bed channel features and stream bed diversity to improve benthic habitat. The proposed design will allow flows that exceed the design bankfull stage to spread out over the floodplain, restoring a portion of the hydrology for the existing wetlands.

A large portion of the existing stream will be filled using material excavated from the restoration channel and from a large spoil area adjacent to the western hog lagoons. However, many segments

will be left partially filled to provide habitat diversity and flood storage. Native woody material will be installed throughout the restored reach to reduce bank stress, provide grade control, and increase habitat diversity.

Forested riparian buffers of at least fifty feet on both sides of the channel will be established along the project reach. An appropriate riparian plant community, a Coastal Plain Small Stream Swamp – Blackwater subtype community, will be established to include a diverse mix of species. Replanting of native species will occur where the existing buffer is impacted during construction.

Reductions in nutrients and other pollutants will be achieved with the buffer restoration work, providing substantial benefits to the watershed. Incidental to the stream restoration, existing riparian wetlands will be enhanced by allowing a more natural flood occurrence interval, as seen in the reference.

7 MAINTENANCE PLAN

NCEEP shall monitor the site on a regular basis and shall conduct a physical inspection of the site a minimum of once per year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and may include the following:

Component/Feature	Maintenance through project close-out
Stream	Routine channel maintenance and repair activities may include chinking of in-stream structures to prevent piping, securing of loose coir matting, and supplemental installations of live stakes and other target vegetation along the channel. Areas where stormwater and floodplain flows intercept the channel may also require maintenance to prevent bank failures and head-cutting.
Wetland	Routine wetland maintenance and repair activities may include securing of loose coir matting and supplemental installations of live stakes and other target vegetation within the wetland. Areas where stormwater and floodplain flows intercept the wetland may also require maintenance to prevent scour.
Vegetation	Vegetation shall be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Exotic invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
Site Boundary	Site boundaries shall be identified in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, tree-blazing, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as-needed basis.
Utility Right-of-Way	Utility rights-of-way within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.

Component/Feature	Maintenance through project close-out
Ford Crossing	Ford crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Road Crossing	Road crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Stormwater Management Device	Stormwater management devices will be monitored and maintained per the protocols and procedures defined by the NC Division of Water Quality Storm Water Best Management Practices Manual.

8 PERFORMANCE CRITERIA

The success criteria for the Muddy Run Site stream restoration will follow accepted and approved success criteria presented in the USACE Stream Mitigation Guidelines and subsequent NCEEP and agency guidance. Specific success criteria components are presented below.

8.1 Stream Restoration Success Criteria

8.1.1 Bankfull Events

Two bankfull flow events must be documented within the five-year monitoring period. The two bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years.

8.1.1 Cross Sections

There should be little change in as-built cross-sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion), or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen stream classification method, and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

8.1.2 Digital Image Stations

Digital images will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal images should not indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

8.2 Vegetation Success Criteria

Specific and measurable success criteria for plant density within the riparian buffers on the site will follow NCEEP Guidance. Vegetation monitoring plots will be a minimum of 0.02 acres in size, and cover a minimum of two percent of the planted area. Vegetation monitoring will occur annually in the fall of each year. The interim measures of vegetative success for the site will be the survival of at least 320 three-year-old trees per acre at the end of Year 3, and the final vegetative success criteria will be 260 trees per acre at the end of Year 5.

8.3 Scheduling/Reporting

A mitigation plan and as-built drawings documenting stream restoration activities will be developed within 60 days of the planting completion on the mitigation site. The report will include all information required by NCEEP mitigation plan guidelines, including elevations, photographs and sampling plot locations, gauge locations, and a description of initial species composition by community type. The report will also include a list of the species planted and the associated densities. Baseline vegetation monitoring will follow CVS-NCEEP Protocol for Recording Vegetation Version 4.0. Level 1 and Level 2 monitoring will be conducted. The baseline report will follow Baseline Monitoring Report Template and Guidance version 2.0 (10/14/10).

The monitoring program will be implemented to document system development and progress toward achieving the success criteria. The restored stream morphology will be assessed to determine the success of the mitigation. The monitoring program will be undertaken for five years or until the final success criteria are achieved, whichever is longer.

Monitoring reports will be prepared in the fall of each year of monitoring and submitted to NCEEP. The monitoring reports will include all information, and will be in the format required by NCEEP in Version 2.0 of the NCEEP Monitoring Report Template.

9 MONITORING

The success criteria for the Muddy Run Site stream mitigation will follow current accepted and approved success criteria presented in the USACE Stream Mitigation Guidelines, NCEEP requirements, and subsequent agency guidance. Specific success criteria components are presented below. Monitoring reports will be prepared annually and submitted to EEP.

9.1 As-Built Survey

An as-built survey will be conducted following construction to document channel size, condition, and location. The survey will include a complete profile of thalweg, water surface, bankfull, and top of bank to compare with future geomorphic data. Longitudinal profiles will not be required in annual monitoring reports unless requested by NCEEP or USACE. Stream channel stationing will be marked with stakes placed near the top of bank every 100 feet.

9.2 Visual Monitoring

Visual monitoring of all mitigation areas will be conducted a minimum of twice per monitoring year by qualified individuals. The visual assessments will include vegetation density, vigor, invasive species, and easement encroachments. Visual assessments of stream stability will include a complete stream walk and structure inspection. Digital images will be taken at fixed representative locations to record each monitoring event as well as any noted problem areas or areas of concern. Results of visual monitoring will be presented in a plan view exhibit with a brief description of problem areas and digital images. Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal photos should indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral photos should not indicate excessive erosion or continuing degradation of the banks over time. A series of photos over time should indicate successional maturation of riparian vegetation.

9.3 Cross Sections

Permanent cross-sections will be installed at a minimum of one per 20 bankfull widths with half in pools and half in shallows. All cross-section measurements will include bank height ratio and entrenchment ratio. Cross-sections will be monitored annually. There should be little change in as-built cross-sections. If changes do take place, they should be evaluated to determine if they represent movement toward a less stable condition (for example down-cutting or erosion), or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Bank height ratio shall not exceed 1.2, and the entrenchment ratio shall be no less than 2.2 within restored reaches. Channel stability should be demonstrated through a minimum of two bankfull events documented in the five-year monitoring period.

9.4 Bank Pin Arrays

At each cross section located on a meander, a bank pin array will be installed along the outer bend and upstream third and downstream third of the meander. Bank pins will be a minimum of three feet long, and will be installed just above the water surface and every two feet above the lowest pin. Bank pin exposure will be recorded at each monitoring event, and the exposed pin will be driven flush with the bank.

9.5 Surface Flow

Headwater valley restoration areas will be monitored to document intermittent or seasonal surface flow. This will be accomplished through direct observation, photo documentation of dye tests, and surface flow gauges.

9.6 Vegetative Success Criteria

Vegetative monitoring success criteria for plant density within the riparian buffers on the site will follow NCEEP Guidance dated 7 November 2011. Vegetation monitoring plots will be a minimum of 0.02 acres in size, and cover a minimum of two percent of the planted area. The following data will be recorded for all trees in the plots: species, height, planting date (or volunteer), and grid location. Monitoring will occur each year during the monitoring period. The interim measures of vegetative success for the site will be the survival of at least 320 3-year-old trees per acre at the end of Year 3. The final vegetative success criteria will be the survival of 260 trees per acre at the end of Year 5 of the monitoring period.

Invasive and noxious species will be monitored and controlled so that none become dominant or alter the desired community structure of the site. If necessary, EBX will develop a species-specific control plan.

9.7 Remedial Actions

The Mitigation Plan will include a detailed adaptive management plan that will address how potential problems are resolved. In the event that the site, or a specific component of the site, fails to achieve the defined success criteria, EBX will develop necessary adaptive management plans and/or implement appropriate remedial actions for the site in coordination with NCEEP and the review agencies. Remedial action required will be designed to achieve the success criteria specified previously, and will include identification of the causes of failure, remedial design approach, work schedule, and monitoring criteria that will take into account physical and climatic conditions.

10 LONG-TERM MANAGEMENT PLAN

Upon approval for closeout by the Interagency Review Team (IRT), the site will be transferred to the State of North Carolina (State). The State shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party.

11 ADAPTIVE MANAGEMENT PLAN

Upon completion of site construction, EEP will implement the post-construction monitoring protocols previously defined in this document. Project maintenance will be performed as described previously in this document. If, during the course of annual monitoring, it is determined that the site's ability to achieve site performance standards are jeopardized, EEP will notify the USACE of the need to develop a Plan of Corrective Action. The Plan of Corrective Action may be prepared using in-house technical staff or may require engineering and consulting services. Once the Corrective Action Plan is prepared and finalized EEP will:

1. Notify the USACE as required by the Nationwide 27 permit general conditions.
2. Revise performance standards, maintenance requirements, and monitoring requirements as necessary and/or required by the USACE.
3. Obtain other permits as necessary.
4. Implement the Corrective Action Plan.
5. Provide the USACE a Record Drawing of Corrective Actions. This document shall depict the extent and nature of the work performed.

12 FINANCIAL ASSURANCES

Pursuant to Section IV H and Appendix III of the Ecosystem Enhancement Program's In-Lieu Fee Instrument dated July 28, 2010, the North Carolina Department of Environment and Natural Resources has provided the U.S. Army Corps of Engineers Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by EEP. This commitment provides financial assurance for all mitigation projects implemented by the program.

13 REFERENCES

Duplin County, North Carolina. Available online at http://www.fws.gov/raleigh/. [Accessed 25 October 2011.]

Amoroso, J.L. ed. 1999. Natural Heritage Program List of the Rare Plant Species of North Carolina. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Carolina Department of Environment and Natural Resources. Raleigh, North Carolina.

Chow, Ven Te. 1959. Open-Channel Hydraulics, McGraw-Hill, New York.

Cowardin, L.M., V. Carter, F.C. Golet and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service, Office of Biological Services, FWS/OBS-79/31. U.S. Department of the Interior, Washington, DC.

Environmental Laboratory. 1987. *U.S. Army Corps of Engineers Wetlands Delineation Manual, Technical Report* Y-87-1. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Fischenich, C. 2001. ‘‘Stability thresholds for stream restoration materials.’’ ERDC Technical Note No. EMRRP-SR-29, U.S. Army Engineer Research and Development Center, Vicksburg, Miss.

Griffith, G., Omernik, J. and J. Comstock. 2002. Ecoregions of North Carolina. United States Environmental Protection Agency. Research and Development. NHEERL. Western Ecology Division. Corvallis, OR.

Horton, J. Wright Jr. and Victor A. Zullo. 1991. The Geology of the Carolinas, Carolina Geological Society Fiftieth Anniversary Volume. The University of Tennessee Press. Knoxville, TN.

Johnson PA. 2006. Assessing stream channel stability at bridges in physiographic regions. U.S. Department of Transportation. Federal Highway Administration. Report Number FHWA-HRT-05-072.

Krstolic, J.L., and Chaplin, J.J. 2007. Bankfull regional curves for streams in the non-urban, non-tidal Coastal Plain Physiographic Province, Virginia and Maryland: U.S. Geological Survey Scientific Investigations Report 2007-5162, 48 p.

LeGrand, H.E., Jr. and S.P. Hall, eds. 1999. Natural Heritage Program List of the Rare Animal Species of North Carolina. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Carolina Department of Environment and Natural Resources. Raleigh, North Carolina.

Natural Resources Conservation Service (NRCS). 2007. Stream Restoration Design Handbook (NEH 654), USDA

NCDENR. “Water Quality Stream Classifications for Streams in North Carolina.” Water Quality Section. http://h2o.enr.state.nc.us/wqhome/html (June 2005).

Radford, A.E., H.E. Ahles and F.R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. The University of North Carolina Press, Chapel Hill, North Carolina.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina, Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, NCDENR, Raleigh, NC.

Sweet, William V. and Jens W. Geratz. 2003. Bankfull Hydraulic Geometry Relationships and Recurrence Intervals for North Carolina’s Coastal Plain. J. of the American Water Resources Association (JAWRA) 39(4):861-871.

Tweedy, K. A Methodology for Predicting Channel Form in Coastal Plain Headwater Systems. Stream Restoration in the Southeast: Advancing the Science and Practice, November 2008, Asheville, NC. Unpublished Conference Paper, 2008.
http://www.bae.ncsu.edu/programs/extension/wqg/srp/2008conference/tweedy_paper.pdf

US Army Corps of Engineers (USACE). 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1, January 1987.

US Army Corps of Engineers (USACE). 2002. Regulatory Guidance Letter. RGL No. 02-2, December 24, 2002.

US Army Corps of Engineers (USACE). 2003. April 2003 Stream Mitigation Guidelines.
United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), 1959. *Soil Survey of Duplin County, North Carolina.*

U.S. Army Corps of Engineers (USACE). 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0), ed. J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-10-20. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Web Soil Survey; http://websoilsurvey.nrcs.usda.gov (Decemeber 2011).

United States Department of Agriculture, Natural Resources Conservation Service. 2010. Field Indicators of Hydric Soils in the United States, Version 7.0. L.M. Vasilas, G.W. Hurt, and C.V. Noble (eds.). USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils.

United States Environmental Protection Agency, (USEPA, 1999) 1999. *EPA Manual. Quantifying Physical Habitat in Wadeable Streams.*

United States Fish and Wildlife Service. "Threatened and Endangered Species in North Carolina." North Carolina Ecological Services.
http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=37061. (November 2011).

List of Figures

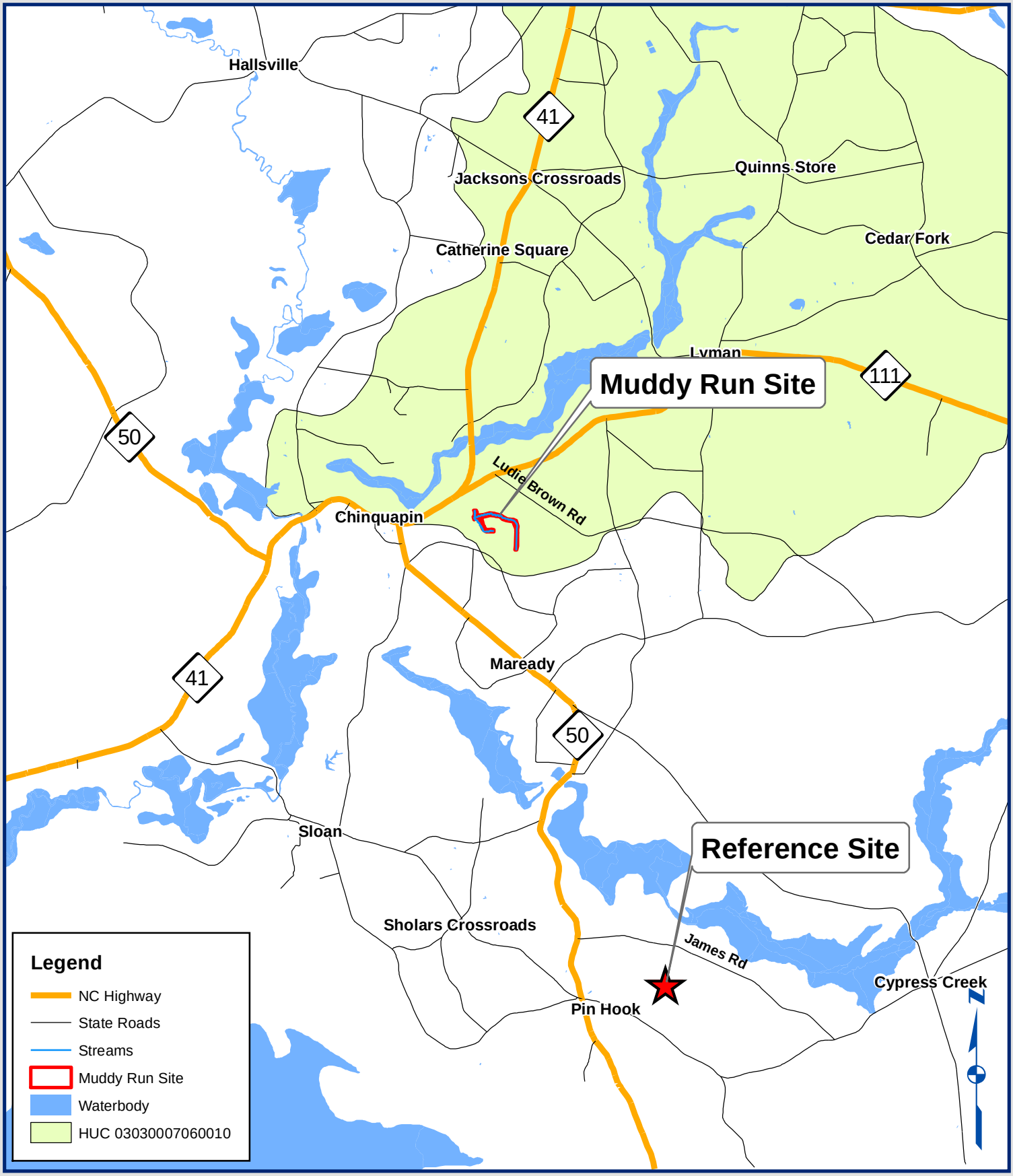
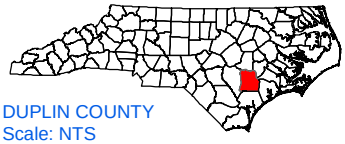


Figure 1.
Project Vicinity Map
Muddy Run Site

0 0.75 1.5 3 Miles

1 inch = 1.5 miles



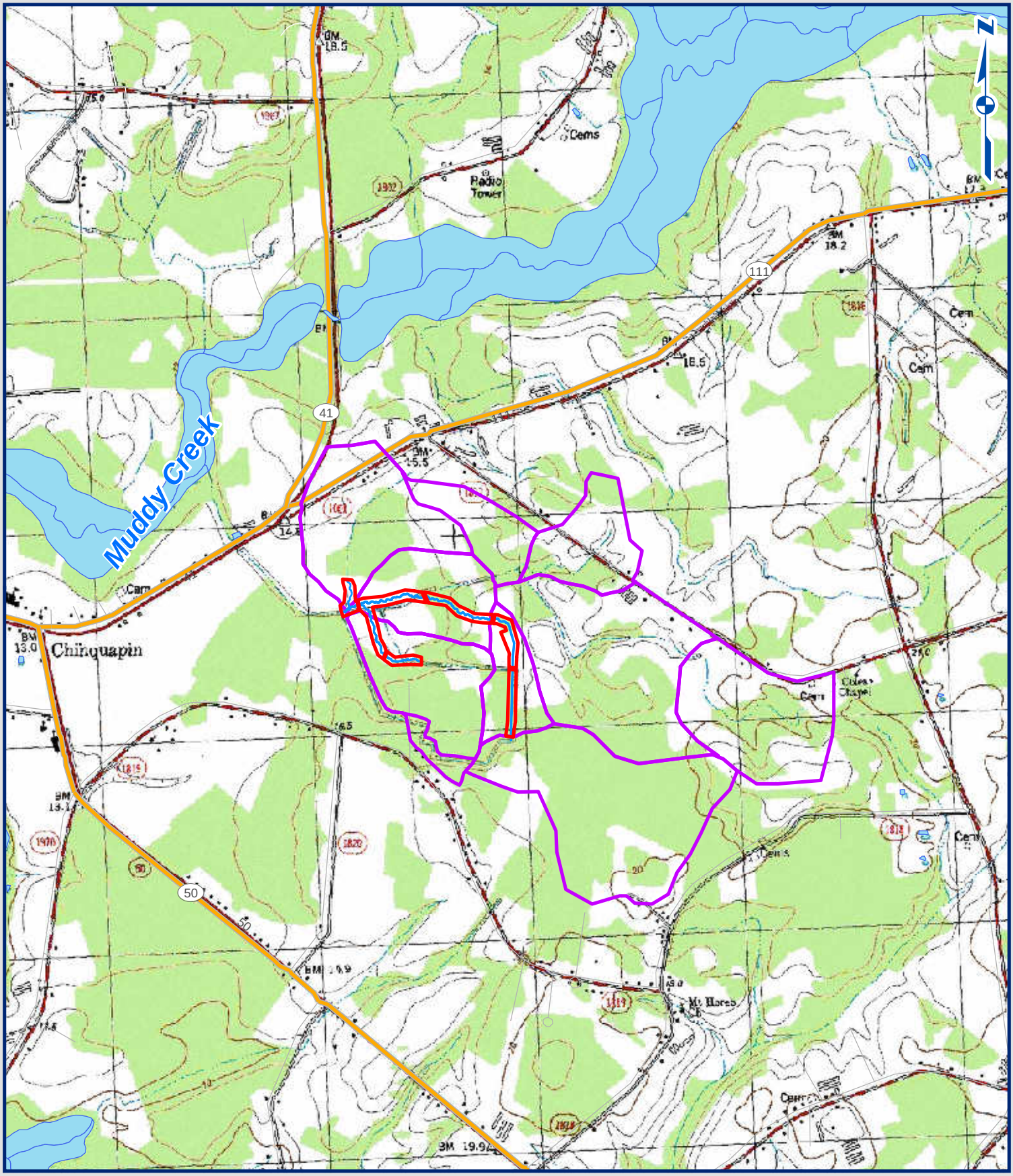


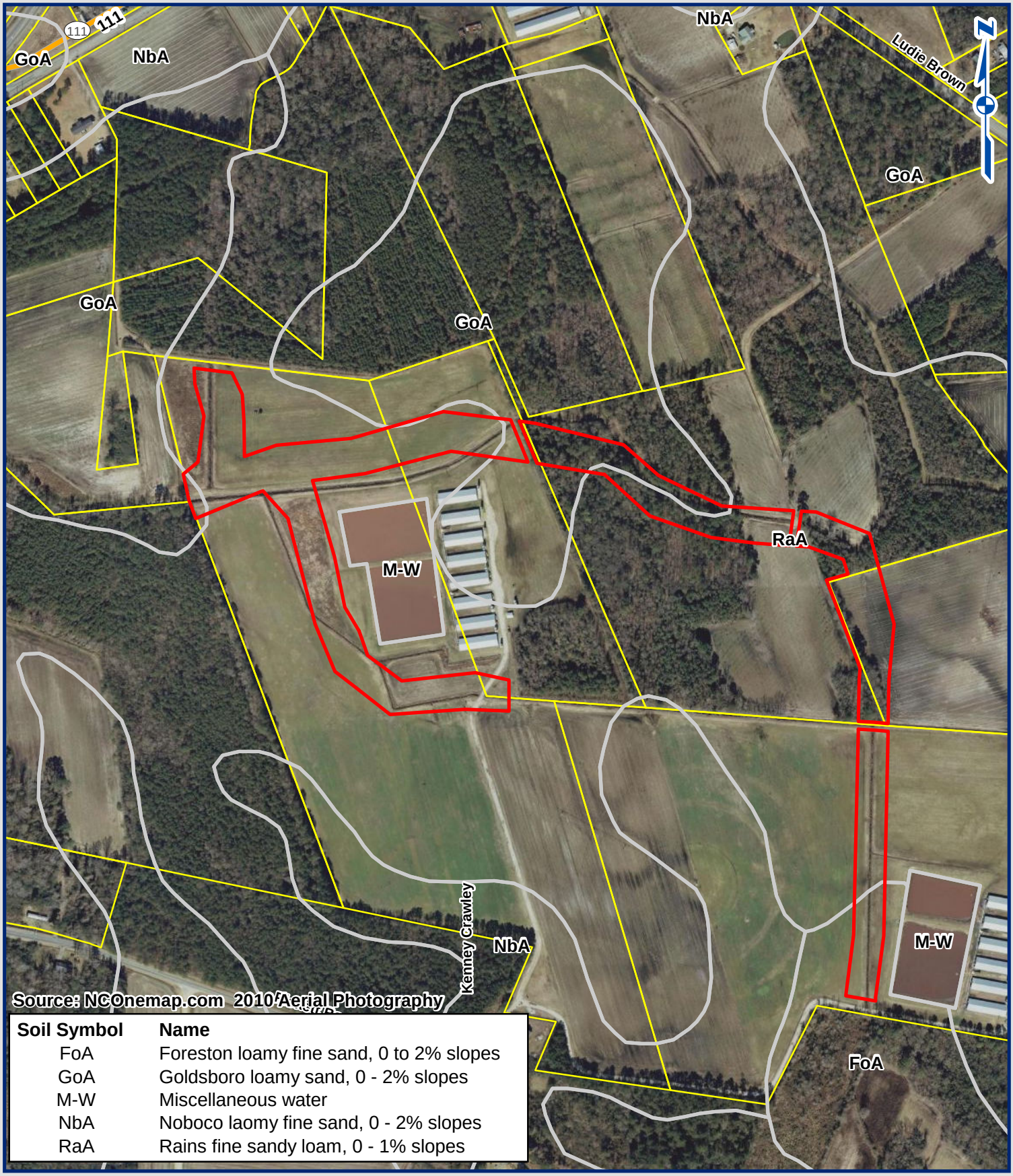
Figure 2.
USGS/Watershed Map
Muddy Run Site

0 1,000 2,000 4,000 Feet

1 inch = 2,000 feet

Legend

- Muddy Run Streams
- Drainage Areas
- Muddy Run Easement
- Waterbodies



Soil Symbol	Name
FoA	Foreston loamy fine sand, 0 to 2% slopes
GoA	Goldsboro loamy sand, 0 - 2% slopes
M-W	Miscellaneous water
NbA	Noboco laomy fine sand, 0 - 2% slopes
RaA	Rains fine sandy loam, 0 - 1% slopes

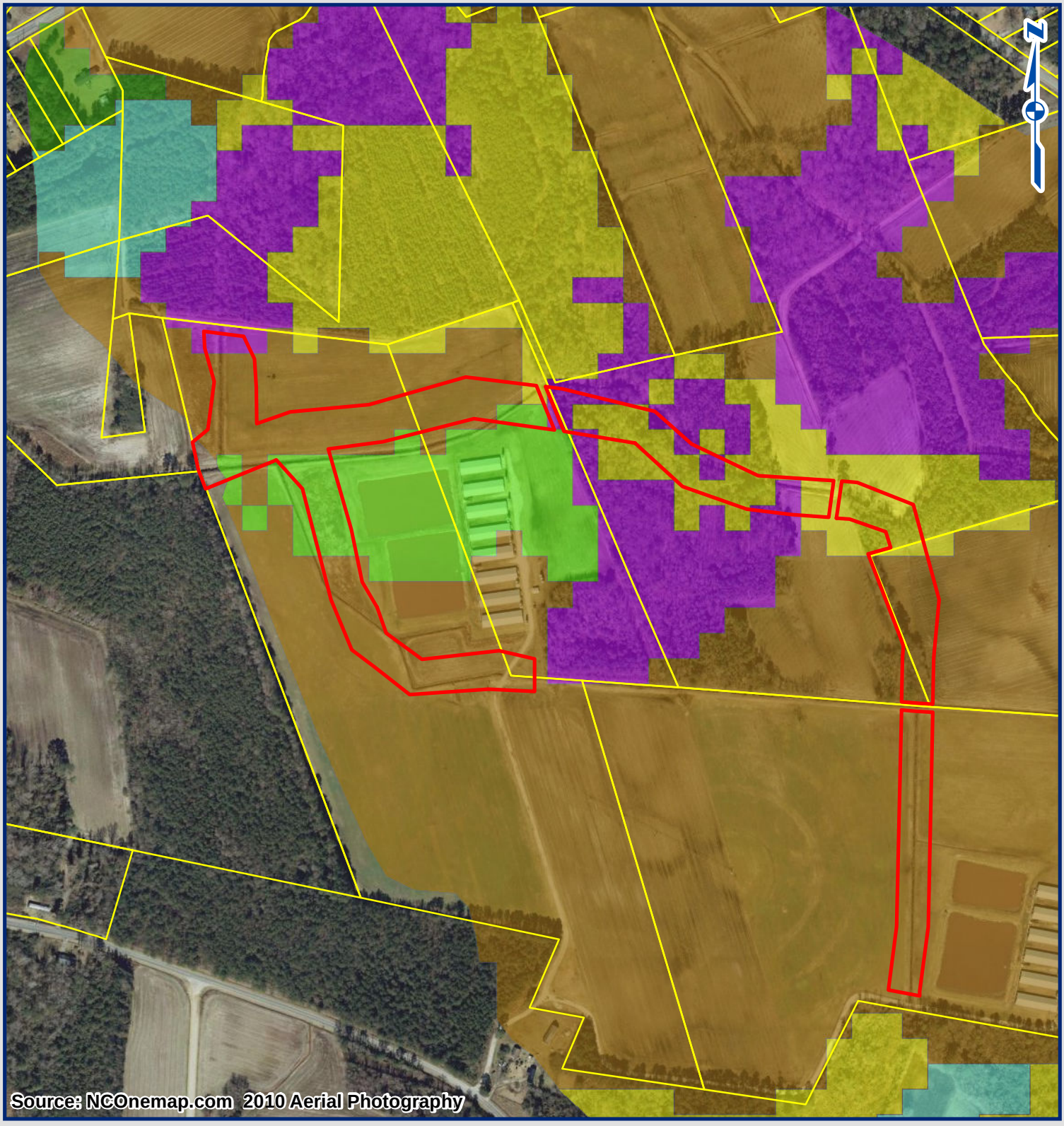
EBX

Figure 3.
NRCS Soils Map
Muddy Run Site

0 250 500 1,000 Feet

1 inch = 500 feet

Muddy Run Easement
Duplin County Soils
Parcel Boundaries



Bottomland Forest/Hardwood Swamps
Mixed Shrubland
Southern Yellow Pine
Managed Herbaceous Cover
Cultivated
Mixed Upland Hardwoods

EBX

Figure 4.
Landuse Map
Muddy Run Site

0 250 500 1,000 Feet

1 inch = 500 feet

Parcel Boundaries
Muddy Run Easement

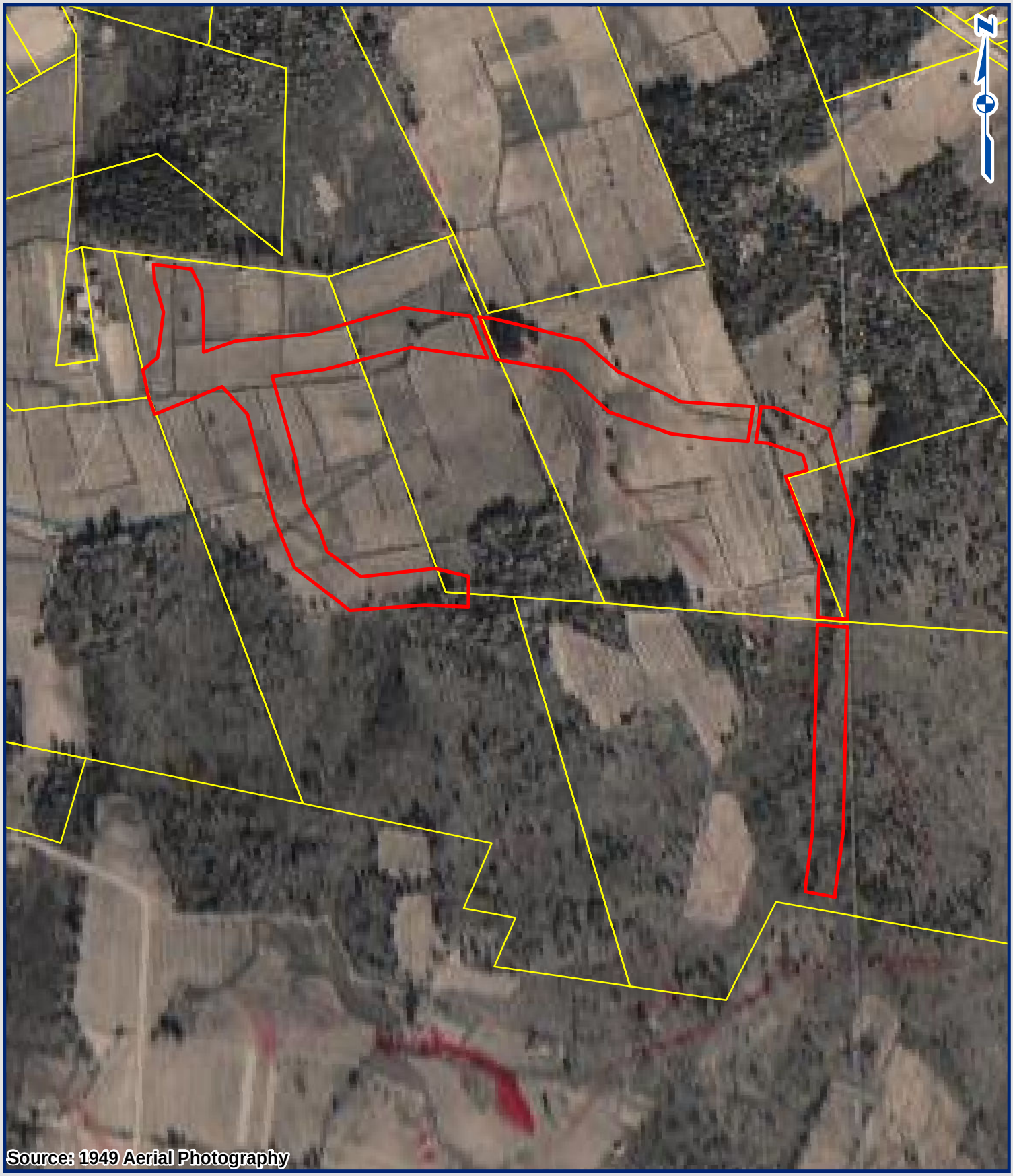
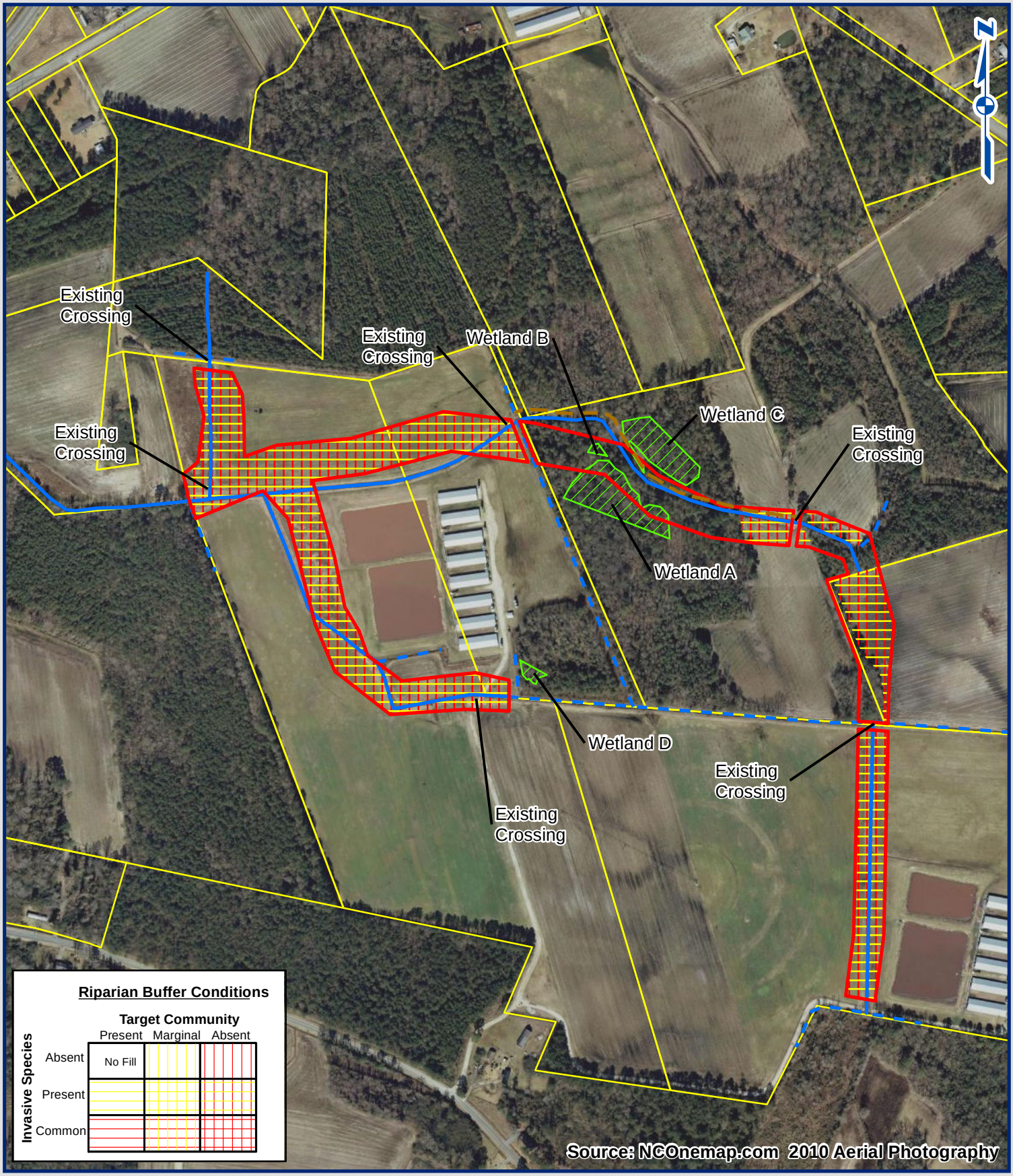


Figure 5.
Historical Conditions
Muddy Run Site

0 250 500 1,000 Feet

1 inch = 500 feet

Muddy Run Easement
Parcel Boundaries



EBX

Figure 6.
Current Conditions Map
Muddy Run Site

0 250 500 1,000 Feet

1 inch = 500 feet

- Existing Farm Path
- Proposed Easement
- Streams
- Ditches
- Delineated Wetlands
- Parcel Boundaries

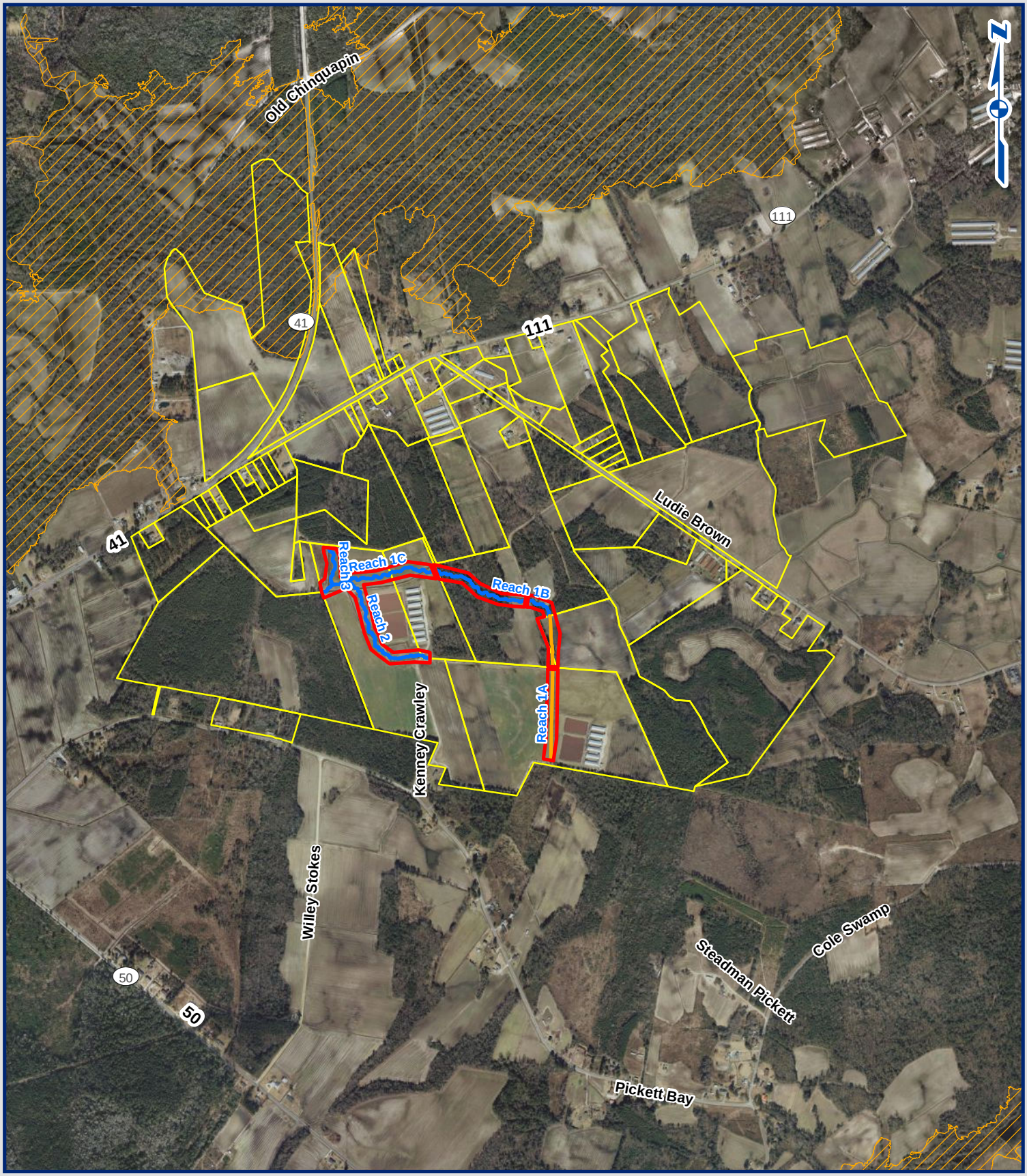


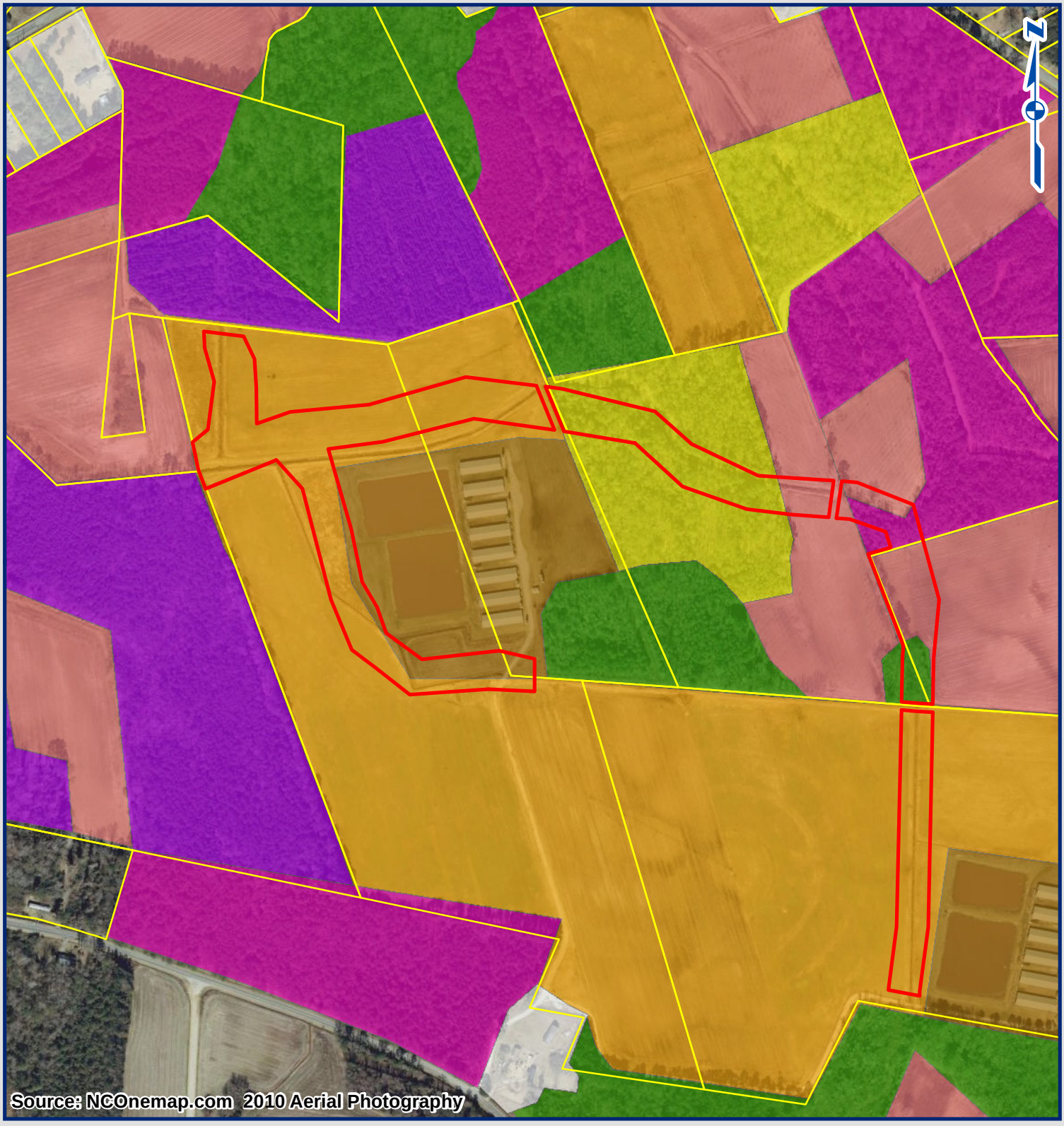
Figure 7.
FEMA Map
Muddy Run Site

0 750 1,500 3,000 Feet

1 inch = 1,500 feet

Legend

- Proposed Streams
- Muddy Run Site
- Target Parcels
- FEMA Zone AE - Detailed 100yr. Floodplain



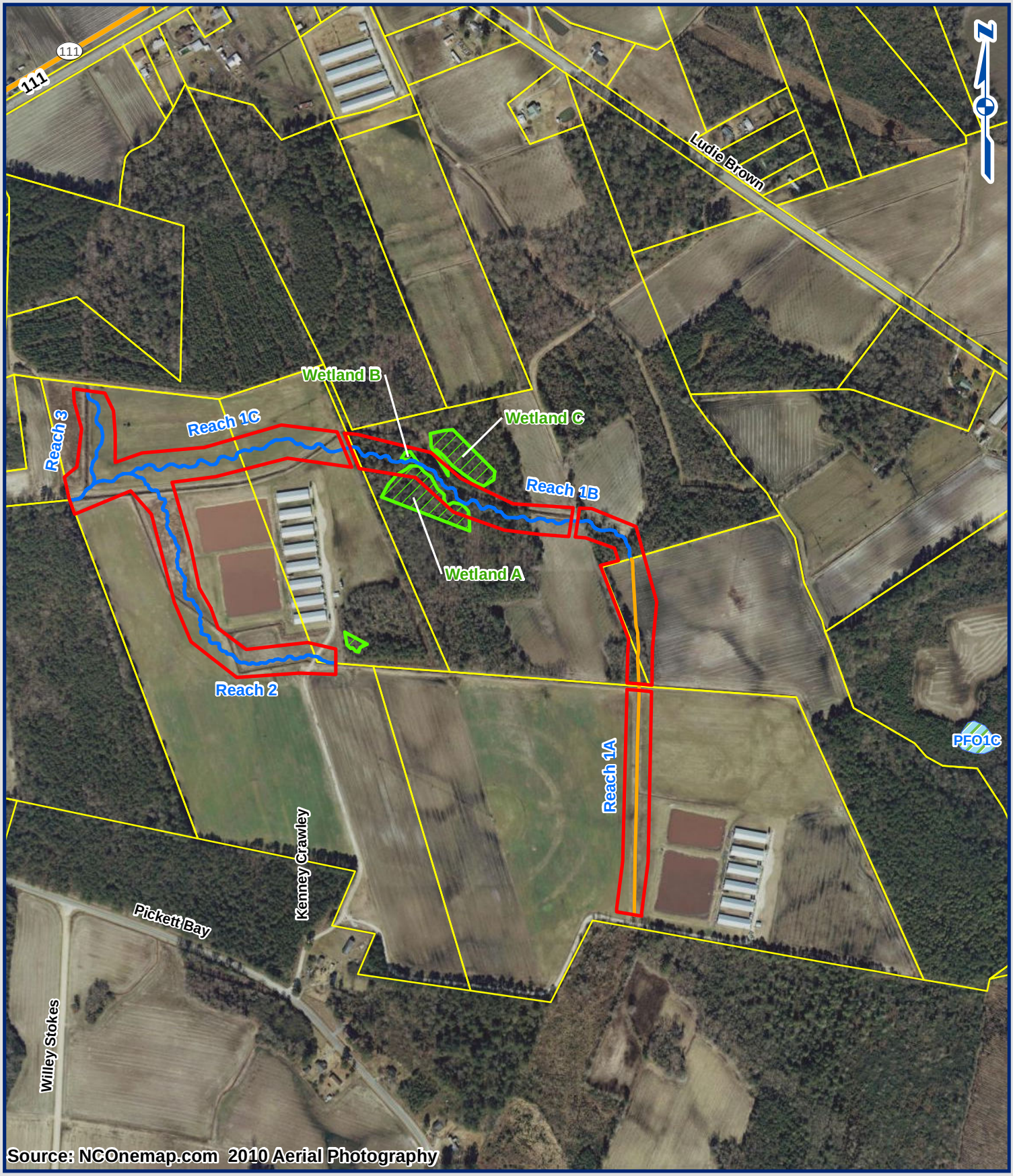
Agricultural - Pasture/Hay
Bottomland Hardwoods
Mixed Pines/Hardwoods
Residential
Agricultural - Row Crops
Concentrated Animal Feeding Operation
Clear-Cut
Pine Plantation

EBX

Figure 8.
Natural Communities Map
Muddy Run Site

0 250 500 1,000 Feet
1 inch = 500 feet

Parcel Boundaries
Muddy Run Easement



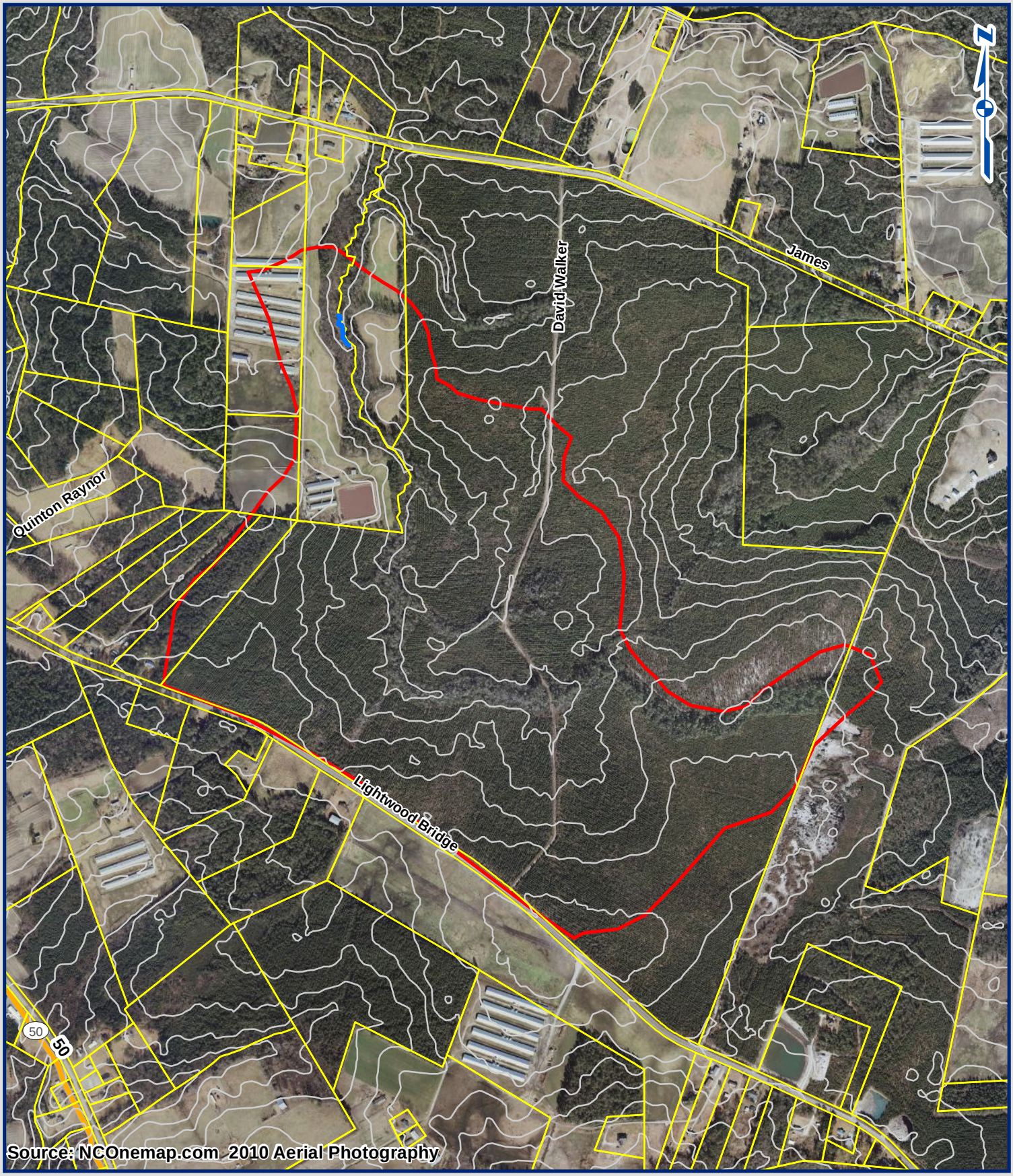
EBX

Figure 9.
NWI Wetlands Map
Muddy Run Site

0 300 600 1,200 Feet

1 inch = 600 feet

- Headwater Valley Restoration
- Priority 1 Restoration
- Proposed Easement
- NWI Wetlands
- Delineated Wetlands
- Parcel Boundaries



EBX

Figure 10.
Muddy Run Refence Reach
Muddy Run Site

0 500 1,000 2,000 Feet

1 inch = 1,000 feet

Muddy Run Reference Reach
Duplin County Parcels
2 ft. Contours
Drainage Area = 300.0 Ac

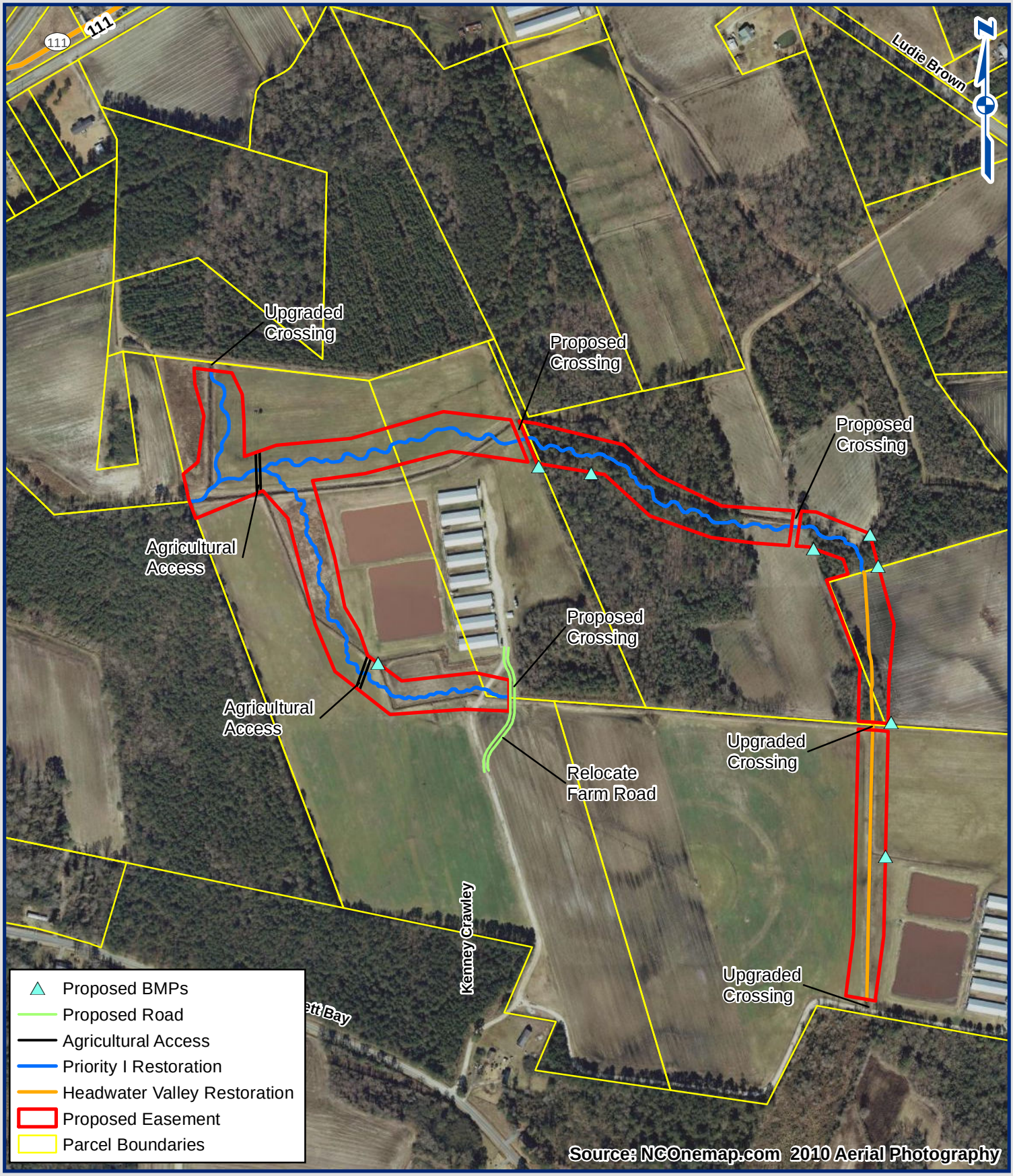


Figure 11.
Conceptual Plan
Muddy Run Site

0 250 500 1,000 Feet

1 inch = 500 feet

APPENDIX 1

Project Site and Reference Site Photographs

Muddy Run I Site Photographs

Headwater Reach 1A. Waste storage lagoon to right. 1/24/2011

Facing upstream on Reach 1B. 1/24/2011

Facing upstream on Reach 1C. 1/24/2011

Facing downstream on headwater Reach 2. 1/24/2011

Facing downstream on headwater Reach 3. 1/24/2011

Facing downstream on Reach 1B after logging activities 12/01/2011

Reference Reach Site Photographs

Facing upstream on Reference Reach at typical run cross section. 12/02/2011

Facing downstream on Reference Reach at typical run cross section. 12/02/2011

Facing upstream on Reference Reach at typical shallow. 12/02/2011

Facing downstream on Reference Reach at typical shallow cross section. 12/02/2011

Facing upstream on Reference Reach at typical pool cross section. 12/02/2011

Facing downstream on Reference Reach at typical pool cross section. 12/02/2011

APPENDIX 2

Baseline Information Data

Muddy Run USACE Routine Wetland Data Forms
Muddy Run NCDWQ Stream Determination Data Forms
Reference Reach NCDWQ Stream Determination Data Forms
Reference Reach Aquatic Habitat Assessment
Channel Stability Assessment Form

Print Form

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Muddy Run City/County: Duplin Sampling Date: Nov 29, 2011

Applicant/Owner: EBX State: NC Sampling Point: AB-wet

Investigator(s): G Lankford Section, Township, Range:

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 34.83033 Long: -77.79163 Datum:

Soil Map Unit Name: Rains fine sandy loam, 0 to 1 percent slopes NWI classification:

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☒, Soil ☒, or Hydrology ☒ significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	**Is the Sampled Area within a Wetland?** Yes ☒ No ☐
Hydric Soil Present?	Yes ☒ No ☐	
Wetland Hydrology Present?	Yes ☒ No ☐	

Remarks:

Site recently clear-cut. Vegetation is mostly absent. Previous site visits prior to clear-cutting indicated canopy vegetation as dominantly hydrophytic. Dredged channel and shallow ditches drain surface waters and lower groundwater elevation near drainage features.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☒ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches):

Water Table Present? Yes ☒ No ☐ Depth (inches): 6 inches

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): 6 inches

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appears to have retained sufficient hydrology due to shallow ditches, clayey subsoil, and nearly level topography.

VEGETATION – Use scientific names of plants. Sampling Point: SB 1

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Sapling Stratum (Plot size:)			
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Shrub Stratum (Plot size:)			
1. Ligustrum sinense	1%	☒	FAC
2. Platanus occidentalis	1%	☒	FACW-
3. Acer rubrum	1%	☒	FAC
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Herb Stratum (Plot size:)			
1. Eupatorium capillifolium	1%	☒	FACU
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
8.		☐	
9.		☐	
10.		☐	
11.		☐	
12.		☐	
	= Total Cover		
Woody Vine Stratum (Plot size:)			
1. Toxicodendron radicans	1%	☒	FAC
2. Smilax smallii	1%	☒	FACU
3.		☐	
4.		☐	
5.		☐	
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size. Includes woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks: (If observed, list morphological adaptations below).

Site is recent clear-cut. Recent forest vegetation was forested. Site is currently slash and windrows. A few stumps are sprouting.

SOIL

Sampling Point: SB 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	7.5YR 2.5/2						SL	
8-17	10YR 4/1	85%	10 YR 4/3	10%	C	M	SCL	
--	--	--	10 YR 4/6	5%	C	M	--	
17-22	7.5YR 5/1	90%	7.5 YR 5/6	10%	C	M	SL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12) **(LRR T, U)**
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ☒ **No** ☐

Remarks:

Print Form

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Muddy Run City/County: Duplin Sampling Date: Nov 29, 2011

Applicant/Owner: EBX State: NC Sampling Point: A/B upland

Investigator(s): G Lankford Section, Township, Range:

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 34.83033 Long: -77.79163 Datum:

Soil Map Unit Name: Rains fine sandy loam, 0 to 1 percent slopes NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☒, Soil ☒, or Hydrology ☒ significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ☒	**Is the Sampled Area within a Wetland?** Yes ☐ No ☒
Hydric Soil Present?	Yes ☒	No ☐	
Wetland Hydrology Present?	Yes ☒	No ☐	

Remarks:

Site recently clear-cut. Vegetation is mostly absent. Previous site visits prior to clear-cutting indicated canopy vegetation as dominantly hydrophytic. Dredged channel and shallow ditches drain surface waters and lower groundwater elevation near drainage features.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (inches):
Water Table Present?	Yes ☒	No ☐	Depth (inches): 19 inches
Saturation Present? (includes capillary fringe)	Yes ☒	No ☐	Depth (inches): 14 inches

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appears to have slightly higher topography and sandy textured soils.

VEGETATION – Use scientific names of plants.

Sampling Point: A/B upland

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Sapling Stratum (Plot size:)			
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Shrub Stratum (Plot size: 20 ft radius)			
1. Ligustrum sinense	1%	☒	FAC
2. Ulmus alata	1%	☒	FACU+
3. Quercus michauxii	1%	☒	FACW
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	3% = Total Cover		
Herb Stratum (Plot size: 20 ft radius)			
1. Eupatorium capillifolium	1%	☒	FACU
2. Centella asiatica	1%	☒	FACW
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
8.		☐	
9.		☐	
10.		☐	
11.		☐	
12.		☐	
	2% = Total Cover		
Woody Vine Stratum (Plot size: 20 ft radius)			
1. Toxicodendron radicans	1%	☒	FAC
2. Smilax smallii	1%	☒	FACU
3.		☐	
4.		☐	
5.		☐	
	2% = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 75% (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 57% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size. Includes woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks: (If observed, list morphological adaptations below).

Site is recent clear-cut. Recent forest vegetation was forested. Site is currently slash and windrows. A few stumps are sprouting.

SOIL

Sampling Point: A/B upland

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	10 YR 4/2		10 YR 5/2	4%	C	M	SL	
14-21	10YR 4/2	85%	7.5 YR 2.5/2	2%	C	M	SL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12) **(LRR T, U)**
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ☒ **No** ☐

Remarks:

Print Form

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Muddy Run City/County: Duplin Sampling Date: Nov 29, 2011

Applicant/Owner: EBX State: NC Sampling Point: C wet

Investigator(s): G Lankford Section, Township, Range:

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 34.83068 Long: -77.79105 Datum:

Soil Map Unit Name: Goldsboro loamy sand, 0 to 2 percent slopes NWI classification:

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☒, Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐ No ☐	**Is the Sampled Area within a Wetland?** Yes ☒ No ☐
Hydric Soil Present?	Yes ☒ No ☐	
Wetland Hydrology Present?	Yes ☒ No ☐	

Remarks:

Site recently clear-cut. Vegetation is mostly absent. Site visits prior to clear-cutting indicated canopy vegetation as dominantly hydrophytic. Dredged channel and shallow ditches drain surface waters and lower groundwater elevation near drainage features.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☒ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (inches):
Water Table Present?	Yes ☒	No ☐	Depth (inches): -2 inches
Saturation Present? (includes capillary fringe)	Yes ☒	No ☐	Depth (inches): -1 inch

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appears to have retained sufficient hydrology due to shallow ditches, clayey subsoil, and nearly level topography.

VEGETATION – Use scientific names of plants.

Sampling Point: C wet

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Sapling Stratum (Plot size:)			
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Shrub Stratum (Plot size:)			
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Herb Stratum (Plot size:)			
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
8.		☐	
9.		☐	
10.		☐	
11.		☐	
12.		☐	
	= Total Cover		
Woody Vine Stratum (Plot size:)			
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: _____ (A)

Total Number of Dominant Species Across All Strata: _____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: _____ (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size. Includes woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** ☐ **No** ☐

Remarks: (If observed, list morphological adaptations below).

Site is recent clear-cut. Recent forest vegetation was forested. Site is currently slash and windrows.

SOIL

Sampling Point: C wet

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0- 7	10 YR 3/3	85%	10 YR 5/2	15%	D	M/PL	fSL	
7-14	10YR 6/2	80%	10 YR 4/6	20%	C	M/PL	fSL/LS	
14-20	10 YR 5/2	90%	10 YR 5/4	10%	C	M	SL	
20-23	10 YR 5/1	85%	10 YR 4/6	15%	C	M	SCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☒ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12) **(LRR T, U)**
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ☒ **No** ☐

Remarks:

Print Form

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Muddy Run City/County: Duplin Sampling Date: Nov 29, 2011

Applicant/Owner: EBX State: NC Sampling Point: C upland

Investigator(s): G Lankford Section, Township, Range:

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR or MLRA): LRR T/MLRA 153A Lat: 34.83068 Long: -77.79105 Datum:

Soil Map Unit Name: Goldsboro loamy sand, 0 to 2 percent slopes NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☒, Soil ☒, or Hydrology ☒ significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒	No ☐	**Is the Sampled Area within a Wetland?** Yes ☐ No ☒
Hydric Soil Present?	Yes ☐	No ☒	
Wetland Hydrology Present?	Yes ☐	No ☒	

Remarks:

Site recently clear-cut. Vegetation is mostly absent. Previous site visits prior to clear-cutting indicated canopy vegetation as dominantly hydrophytic. Dredged channel and shallow ditches drain surface waters and lower groundwater elevation near drainage features.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches):

Water Table Present? Yes ☐ No ☒ Depth (inches):

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches):

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appears to have slightly higher topography and sandy textured soils.

VEGETATION – Use scientific names of plants.

Sampling Point: C upland

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Sapling Stratum (Plot size:)			
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Shrub Stratum (Plot size:)			
1.		☐	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
	= Total Cover		
Herb Stratum (Plot size: 20 ft radius)			
1. Carex sp.	<1%	☒	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
6.		☐	
7.		☐	
8.		☐	
9.		☐	
10.		☐	
11.		☐	
12.		☐	
	<1% = Total Cover		
Woody Vine Stratum (Plot size:)			
1.		☒	
2.		☐	
3.		☐	
4.		☐	
5.		☐	
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 75% (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 57% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size. Includes woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks: (If observed, list morphological adaptations below).

Site is recent clear-cut. Recent vegetation was forested. Site is currently slash and windrows. No vegetation was observed.

SOIL

Sampling Point: C upland

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 3/3	100%					fSL	
3-10	10YR 4/2	100%					fSL	
10-18	10 YR 6/4	85%	10 YR 4/6	15%	C	M/PCL	SL	
18-24	10 YR 6/1	70%	10 YR 5/6	30%	C	M/PL	SC	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12) **(LRR T, U)**
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ☐ **No** ☒

Remarks:

Mapped Soil Series

Reach	Map Unit	Series Name	Drainage Class	Representative Percent Composition
ER-1	GoA	Goldsboro loamy sand	moderately well	1% undrained Muckalee 5% undrained Rains
	RaA	Rains fine sandy loam	Poorly	10% undrained Rains 80% drained Rains
ER-2	GoA	Goldsboro loamy sand	moderately well	1% undrained Muckalee 5% undrained Rains
	RaA	Rains fine sandy loam	Poorly	10% undrained Rains 80% drained Rains
WR-1	FoA	Foreston loamy fine sand	moderately well	5% undrained Woodington
	GoA	Goldsboro loamy sand	moderately well	1% undrained Muckalee 5% undrained Rains
	RaA	Rains fine sandy loam	Poorly	10% undrained Rains 80% drained Rains
WR-2	GoA	Goldsboro loamy sand	moderately well	1% undrained Muckalee 5% undrained Rains
	RaA	Rains fine sandy loam	Poorly	10% undrained Rains 80% drained Rains
WR-3	GoA	Goldsboro loamy sand	moderately well	1% undrained Muckalee 5% undrained Rains
	RaA	Rains fine sandy loam	Poorly	10% undrained Rains 80% drained Rains

Soil Series Descriptions

Foreston loamy fine sand (FoA), 0 to 2 percent slopes. This unit is a moderately well drained soil found on high ridges and slight rises within broad flat interstream. The seasonal high water table ranges from 24 to 42 inches below the surface. It has typically has sandy subsoil. This soil is considered to have hydric inclusions by the NRCS.

Goldsboro loamy sand (GoA), to 2 percent slopes. This unit is a moderately well drained soil found on hillslope summits and shoulders. They have moderate permeability and runoff is negligible to medium. The seasonal high water table ranges from 24 to 36 inches below the surface. It has often has clayey subsoil. This soil unit is typically cultivated. This soil is considered to have hydric inclusions by the NRCS.

Rains fine sandy loam (RaA), 0 to 1 percent slopes. This unit is a poorly drained soil found across flats, depressions and Carolina bays. They have moderate permeability and runoff is negligible. This soil may experience flooding. The seasonal high water table ranges from 0 to 12 inches below the surface. It has often has clayey subsoil. This soil is considered hydric when undrained by the NRCS.

Soils Information

Soil Boring Log

SB-1	Reach WR-2		Mapped as Rains	
Depth	**Matrix Colors**	**Mottle Color**	**Mottle Percentage**	**Texture**
0-10	7.5 YR 2.5/3	---	---	Sandy loam
10-13	7.5 YR 6/1	7.5 YR 4/6	45%	Sandy clay
13-25	7.5 YR 2.5/1	5 YR 3/4	7%	fine Sandy loam

SB-2	Reach WR-1		Mapped as Goldsboro	
Depth	**Matrix Color**	**Mottle Colors**	**Mottle Percentage**	**Texture**
0-9	7.5 YR 2.5/2	---	---	fine Sandy loam
9-13	7.5 YR 4/1	7.5 YR 2.5/3 7.5 YR 4/6	10% 5%	Sandy loam
13-15	7.5 YR 5/1	7.5 YR 4/6	4%	Sandy loam
Water table at 9 inches				

SB-3	Reach WE-2		Mapped as Goldsboro	
Depth	**Matrix Color**	**Mottle Color**	**Mottle Percentage**	**Texture**
0-6	7.5 YR 2.5/1	---	---	fine Sandy loam
6-13	7.5 YR 7/3	---	---	fine Sandy loam
13-22	7.5 YR 7/1	5 YR 5/8	30%	Sandy clay loam
Plow pan at ~8 to 12 inches				

NC DWQ Stream Identification Form Version 4.11

Date: Jan. 24, 2011	**Project/Site:** Muddy Run ER2A	**Latitude:**
Evaluator: DP1	**County:** Duplin	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 27	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 9.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	(2)	3
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	(1)	2	3
5. Active/relict floodplain	0	(1)	2	3
6. Depositional bars or benches	0	(1)	2	3
7. Recent alluvial deposits	(0)	1	2	3
8. Headcuts	(0)	1	2	3
9. Grade control	0	0.5	1	(1.5)
10. Natural valley	0	0.5	(1)	1.5
11. Second or greater order channel	(No = 0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6.5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	1.5	1	(0.5)	0
15. Sediment on plants or debris	(0)	0.5	1	1.5
16. Organic debris lines or piles	(0)	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		(Yes = 3)	

C. Biology (Subtotal = 11)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	(1)	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	0	(0.5)	1	1.5
23. Crayfish	0	0.5	(1)	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	0	(0.5)	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5; (Other = 0)			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: Jan. 24, 2011	**Project/Site:** Muddy Run WR1A	**Latitude:**
Evaluator: DP1	**County:** Duplin	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 24	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 7)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	(2)	3
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	(0)	1	2	3
4. Particle size of stream substrate	0	1	(2)	3
5. Active/relict floodplain	(0)	1	2	3
6. Depositional bars or benches	(0)	1	2	3
7. Recent alluvial deposits	(0)	1	2	3
8. Headcuts	(0)	1	2	3
9. Grade control	0	0.5	(1)	1.5
10. Natural valley	0	0.5	(1)	1.5
11. Second or greater order channel	(No = 0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
12. Presence of Baseflow	0	1	(2)	3
13. Iron oxidizing bacteria	0	(1)	2	3
14. Leaf litter	(1.5)	1	0.5	0
15. Sediment on plants or debris	(0)	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	(1)	1.5
17. Soil-based evidence of high water table?	No = 0		(Yes = 3)	

C. Biology (Subtotal = 8.5)				
18. Fibrous roots in streambed	3	2	(1)	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	(1)	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	0	(0.5)	1	1.5
23. Crayfish	0	0.5	(1)	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	0	0.5	(1)	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5; (Other = 0)			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: Jan. 24, 2011	Project/Site: Muddy Run WR1C	Latitude:
Evaluator: DPI	County: Duplin	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 33	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other *e.g. Quad Name:*

A. Geomorphology (Subtotal = 12)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	1	(2)	3
5. Active/relict floodplain	0	(1)	2	3
6. Depositional bars or benches	(0)	1	2	3
7. Recent alluvial deposits	(0)	1	2	3
8. Headcuts	(0)	1	2	3
9. Grade control	(0)	0.5	1	1.5
10. Natural valley	0	0.5	(1)	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	(1.5)	1	0.5	0
15. Sediment on plants or debris	(0)	0.5	1	1.5
16. Organic debris lines or piles	0	(0.5)	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 13)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	(2)	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	0	0.5	(1)	1.5
23. Crayfish	0	0.5	(1)	1.5
24. Amphibians	0	0.5	(1)	1.5
25. Algae	0	(0.5)	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5		Other = 0	

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: Jan. 24 2011	Project/Site: Muddy Run WR2	Latitude:
Evaluator: DPI	County: Duplin	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 26.5	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other *e.g. Quad Name:*

A. Geomorphology (Subtotal = 7.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	(2)	3
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	(0)	1	2	3
4. Particle size of stream substrate	0	(1)	2	3
5. Active/relict floodplain	0	1	(2)	3
6. Depositional bars or benches	(0)	1	2	3
7. Recent alluvial deposits	(0)	1	2	3
8. Headcuts	(0)	1	2	3
9. Grade control	0	(0.5)	1	1.5
10. Natural valley	0	0.5	(1)	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtota = 9)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	0	1	(2)	3
14. Leaf litter	1.5	(1)	0.5	0
15. Sediment on plants or debris	(0)	0.5	1	1.5
16. Organic debris lines or piles	(0)	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		(Yes = 3)	

C. Biology (Subtotal =)				
18. Fibrous roots in streambed	3	(2)	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	(1)	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	0	(0.5)	1	1.5
23. Crayfish	0	0.5	(1)	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	0	(0.5)	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5		Other = 0	

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: Jan. 24, 2011	**Project/Site:** Muddy Run WR3	**Latitude:**
Evaluator: DPI	**County:** Duplin	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 24.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 7.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	(2)	3
2. Sinuosity of channel along thalweg	(0)	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	(0)	1	2	3
4. Particle size of stream substrate	0	1	(2)	3
5. Active/relict floodplain	0	(1)	2	3
6. Depositional bars or benches	(0)	1	2	3
7. Recent alluvial deposits	(0)	1	2	3
8. Headcuts	(0)	1	2	3
9. Grade control	0	0.5	1	(1.5)
10. Natural valley	0	0.5	(1)	1.5
11. Second or greater order channel	(No = 0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6)				
12. Presence of Baseflow	0	1	(2)	3
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	1.5	(1)	0.5	0
15. Sediment on plants or debris	(0)	0.5	1	1.5
16. Organic debris lines or piles	(0)	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		(Yes = 3)	

C. Biology (Subtotal = 11)				
18. Fibrous roots in streambed	3	(2)	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	(2)	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	0	(0.5)	1	1.5
23. Crayfish	0	(0.5)	1	1.5
24. Amphibians	0	0.5	(1)	1.5
25. Algae	0	(0.5)	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 (Other = 0)			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 12/02/2011	**Project/Site:** MR Reference Site	**Latitude:**
Evaluator: AFM, BSH	**County:** Duplin County, NC	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 40	**Stream Determination (circle one)** Ephemeral Intermittent **Perennial**	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 21.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	1	(2)	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	(3)
4. Particle size of stream substrate	0	1	(2)	3
5. Active/relict floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	(2)	3
7. Recent alluvial deposits	0	1	(2)	3
8. Headcuts	0	1	(2)	3
9. Grade control	0	0.5	(1)	1.5
10. Natural valley	0	0.5	1	(1.5)
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 11)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	0	(1)	2	3
14. Leaf litter	(1.5)	1	0.5	0
15. Sediment on plants or debris	0	0.5	(1)	1.5
16. Organic debris lines or piles	0	0.5	1	(1.5)
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 7.5)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	(1)	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	(0.5)	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

Muddy Run Reference Reach Aquatic Habitat Assessment

Transect	Habitat	Location	Position	Diameter (ft)	length (ft)	Diameter (in)	Radius (in)	length (in)	Volume (in)
1	shal	mid	sub	0.08	0.65	0.96	0.48	7.8	5.64
1	shal	mid	sub	0.1	0.70	1.2	0.6	8.4	9.50
1	shal	mid	sub	0.03	2.00	0.36	0.18	24	2.44
2	shal	rb	sub	0.02	0.70	0.24	0.12	8.4	0.38
2	shal	mid	sub	0.03	0.30	0.36	0.18	3.6	0.37
2	shal	mid	sub	0.05	0.70	0.6	0.3	8.4	2.37
2	shal	mid	sub	0.02	0.90	0.24	0.12	10.8	0.49
2	shal	lb	par sub	0.02	1.50	0.24	0.12	18	0.81
2	shal	mid	sub	0.03	1.00	0.36	0.18	12	1.22
2	shal	lb	sub	0.04	1.10	0.48	0.24	13.2	2.39
2	shal	mid	sub	0.05	0.90	0.6	0.3	10.8	3.05
2	shal	rb	sub	0.05	1.30	0.6	0.3	15.6	4.41
2	shal	mid	sub	0.05	1.30	0.6	0.3	15.6	4.41
2	shal	mid	par emb	0.05	1.50	0.6	0.3	18	5.09
2	shal	lb	emb	0.1	1.30	1.2	0.6	15.6	17.63
2	shal	mid	sub	0.2	1.00	2.4	1.2	12	54.26
2	shal	mid	sub	0.03	2.10	0.36	0.18	25.2	2.56
2	shal	lb	sus/sub	0.03	3.20	0.36	0.18	38.4	3.91
2	shal	lb	sub	0.04	1.80	0.48	0.24	21.6	3.91
2	shal	mid	sub	0.05	1.90	0.6	0.3	22.8	6.44
2	shal	rb	sus/sub	0.05	2.70	0.6	0.3	32.4	9.16
2	shal	across	sus/sub	0.1	1.80	1.2	0.6	21.6	24.42
2	shal	lb	sus/sub	0.1	2.00	1.2	0.6	24	27.13
2	shal	across	sus/sub	0.1	3.00	1.2	0.6	36	40.69
2	shal	rb	sus/sub	0.15	2.00	1.8	0.9	24	61.04
2	shal	lb	sus	0.02	4.00	0.24	0.12	48	2.17
3	pool	lb	sub	0.02	0.80	0.24	0.12	9.6	0.43
3	pool	mid	sub	0.03	0.60	0.36	0.18	7.2	0.73
3	pool	lb	par sub	0.02	1.20	0.24	0.12	14.4	0.65
3	pool	rb	sub	0.15	1.30	1.8	0.9	15.6	39.68
3	pool	rb	emb	0.25	1.60	3	1.5	19.2	135.65
3	pool	rb	sus	0.03	3.00	0.36	0.18	36	3.66
3	pool	mid	emb	0.10	3.00	1.2	0.6	36	40.69
3	pool	lb	emb	0.15	2.00	1.8	0.9	24	61.04
3	pool	rb	sus	0.30	2.00	3.6	1.8	24	244.17
3	pool	lb	sus/sub	0.30	3.00	3.6	1.8	36	366.25
3	pool	rb	sus	0.05	6.00	0.6	0.3	72	20.35
4	shal	mid	sub	0.03	0.45	0.36	0.18	5.4	0.55
4	shal	mid	sub	0.05	0.25	0.6	0.3	3	0.85
4	shal	mid	sub	0.10	0.45	1.2	0.6	5.4	6.10
4	shal	mid	sub	0.02	0.90	0.24	0.12	10.8	0.49
4	shal	mid	sub	0.02	0.90	0.24	0.12	10.8	0.49
4	shal	mid	sub	0.05	1.25	0.6	0.3	15	4.24
4	shal	mid	sub	0.03	3.00	0.36	0.18	36	3.66
5	pool	lb	par	0.03	0.80	0.36	0.18	9.6	0.98

Transect	Habitat	Location	Position	Diameter (ft)	length (ft)	Diameter (in)	Radius (in)	length (in)	Volume (in)
5	pool	mid	sub	0.10	0.50	1.2	0.6	6	6.78
5	pool	mid	sub	0.03	0.90	0.36	0.18	10.8	1.10
5	pool	mid	sub	0.03	1.60	0.36	0.18	19.2	1.95
5	pool	mid	sub	0.02	2.00	0.24	0.12	24	1.09
5	pool	mid	sub	0.04	2.00	0.48	0.24	24	4.34
5	pool	mid	sub	0.07	2.60	0.84	0.42	31.2	17.28
5	pool	mid	sub	0.10	2.00	1.2	0.6	24	27.13
5	pool	mid	sub	0.10	2.70	1.2	0.6	32.4	36.62
5	pool	mid	sub	0.20	2.30	2.4	1.2	27.6	124.80
5	pool	rb	sus	0.30	2.00	3.6	1.8	24	244.17
5	pool	rb	sus/sub	0.35	3.00	4.2	2.1	36	498.51
5	pool	lb	sus/sub	0.40	2.20	4.8	2.4	26.4	477.48
5	pool	lb	par sub	0.40	2.80	4.8	2.4	33.6	607.70
5	pool	rb-mid	sus-emb	1.80	3.00	21.6	10.8	36	1318.50
5	pool	mid	float	0.02	3.70	0.24	0.12	44.4	2.01
5	pool	mid-rt	par sub	0.05	4.00	0.6	0.3	48	13.56
5	pool	mid-rt	sub	0.08	3.50	0.96	0.48	42	30.39
5	pool	rb	sus	0.40	3.60	4.8	2.4	43.2	781.33
6	shal	mid	sub	0.03	0.40	0.36	0.18	4.8	0.49
6	shal	rb	sub	0.03	0.83	0.36	0.18	9.96	1.01
6	shal	mid	sub	0.05	0.35	0.6	0.3	4.2	1.19
6	shal	lb	sus/emb	0.07	0.60	0.84	0.42	7.2	3.99
6	shal	mid	sub	0.10	0.50	1.2	0.6	6	6.78
6	shal	mid	emb/sub	0.13	0.60	1.56	0.78	7.2	13.75
6	shal	mid	sub	0.03	1.30	0.36	0.18	15.6	1.59
6	shal	mid	sub	0.05	1.50	0.6	0.3	18	5.09
6	shal	mid	sub	0.08	0.90	0.96	0.48	10.8	7.81
6	shal	mid	sub	0.10	1.00	1.2	0.6	12	13.56
6	shal	mid	sub	0.15	0.95	1.8	0.9	11.4	28.99
6	shal	lb	sus	0.15	1.40	1.8	0.9	16.8	42.73
6	shal	rb	float	0.25	1.60	3	1.5	19.2	135.65
6	shal	lb	emb	0.40	1.00	4.8	2.4	12	217.04
6	shal	mid	sub	0.03	1.75	0.36	0.18	21	2.14
6	shal	rb	sus	0.03	1.80	0.36	0.18	21.6	2.20
6	shal	rb	sub	0.03	1.85	0.36	0.18	22.2	2.26
6	shal	mid	sub	0.05	2.20	0.6	0.3	26.4	7.46
6	shal	mid	sub	0.05	2.60	0.6	0.3	31.2	8.82
6	shal	across	sus	0.35	3.00	4.2	2.1	36	498.51
7	shal	mid	sub	0.03	0.50	0.36	0.18	6	0.61
7	shal	mid	sub	0.05	0.80	0.6	0.3	9.6	2.71
7	shal	mid	sub	0.10	0.50	1.2	0.6	6	6.78
7	shal	mid	sub	0.02	1.00	0.24	0.12	12	0.54
7	shal	mid	sub	0.03	1.00	0.36	0.18	12	1.22
7	shal	lb	sus	0.25	1.00	3	1.5	12	84.78
7	shal	mid	par	0.02	3.00	0.24	0.12	36	1.63

Transect	Habitat	Location	Position	Diameter (ft)	length (ft)	Diameter (in)	Radius (in)	length (in)	Volume (in)
7	shal	mid	sub	0.03	2.00	0.36	0.18	24	2.44
7	shal	lb	sus	0.30	2.00	3.6	1.8	24	244.17
8	pool	mid	sub	0.04	0.70	0.48	0.24	8.4	1.52
8	pool	rb	sub	0.03	1.60	0.36	0.18	19.2	1.95
8	pool	rb	sub	0.03	2.10	0.36	0.18	25.2	2.56
9	shal	mid	sub	0.05	0.40	0.6	0.3	4.8	1.36
9	shal	rb	sub	0.05	0.60	0.6	0.3	7.2	2.03
9	shal	mid	emb	0.05	0.60	0.6	0.3	7.2	2.03
9	shal	mid	sub	0.05	0.80	0.6	0.3	9.6	2.71
9	shal	mid	sub	0.10	0.75	1.2	0.6	9	10.17
9	shal	mid	sub	0.12	0.60	1.44	0.72	7.2	11.72
9	shal	lb	par	0.19	0.40	2.28	1.14	4.8	19.59
9	shal	mid	sub	0.20	0.40	2.4	1.2	4.8	21.70
9	shal	lb	par	0.25	0.70	3	1.5	8.4	59.35
9	shal	mid	sub	0.03	1.10	0.36	0.18	13.2	1.34
9	shal	mid	par	0.06	1.60	0.72	0.36	19.2	7.81
9	shal	mid	sub	0.04	2.00	0.48	0.24	24	4.34
9	shal	rb	sub	0.06	2.50	0.72	0.36	30	12.21
9	shal	rb	emb	0.50	2.10	6	3	25.2	712.15
10	shal	rb	emb	0.10	0.50	1.2	0.6	6	6.78
10	shal	lb	sub	0.10	0.60	1.2	0.6	7.2	8.14
10	shal	mid	sub	0.10	0.70	1.2	0.6	8.4	9.50
10	shal	lb	par	0.15	0.80	1.8	0.9	9.6	24.42
10	shal	mid	sub	0.20	0.65	2.4	1.2	7.8	35.27
10	shal	mid	sub	0.15	2.50	1.8	0.9	30	76.30
10	shal	across	emb	0.22	2.90	2.64	1.32	34.8	190.40
10	shal	across	emb	0.30	2.80	3.6	1.8	33.6	341.83

Muddy Run Reach 1B Aquatic Habitat Assessment

Transect	Habitat	Location	Position	Diameter	length	Notes	Diameter (in	Radius (in)	length (in)	Volume (in)
7	Run	LB	sub	0.02	0.60	stick	0.24	0.12	7.2	0.33
5	Run	mid	sub	0.03	0.20	stick	0.36	0.18	2.4	0.24
1	Run	mid	sub	0.03	0.80	stick	0.36	0.18	9.6	0.98
5	Run	mid	sub	0.05	0.40	stick	0.6	0.3	4.8	1.36
2	Run	mid	sub	0.05	0.50	stick	0.6	0.3	6	1.70
3	Run	mid	sub	0.05	0.60	stick	0.6	0.3	7.2	2.03
5	Run	RB	sub	0.05	0.70	stick	0.6	0.3	8.4	2.37
5	Run	mid	sub	0.05	0.80	stick	0.6	0.3	9.6	2.71
9	Run	RB	sub	0.08	0.80	stick	0.96	0.48	9.6	6.95
4	Run	mid	Emb	0.10	0.25	stick	1.2	0.6	3	3.39
4	Run	LB	sub	0.10	0.30	stick	1.2	0.6	3.6	4.07
7	Run	mid	sub	0.10	0.30	stick	1.2	0.6	3.6	4.07
7	Run	mid	sub	0.10	0.30	stick	1.2	0.6	3.6	4.07
7	Run	mid	sub	0.10	0.30	stick	1.2	0.6	3.6	4.07
7	Run	mid	sub	0.10	0.35	stick	1.2	0.6	4.2	4.75
7	Run	mid	sub	0.10	0.35	stick	1.2	0.6	4.2	4.75
7	Run	mid	sub	0.10	0.40	stick	1.2	0.6	4.8	5.43
6	Run	mid	sub	0.10	0.60	stick	1.2	0.6	7.2	8.14
7	Run	mid	sub	0.10	0.60	stick	1.2	0.6	7.2	8.14
7	Run	mid	sub	0.10	0.70	stick	1.2	0.6	8.4	9.50
7	Run	mid	sub	0.15	0.20	stick	1.8	0.9	2.4	6.10
4	Run	mid	sub	0.15	0.30	stick (floating)	1.8	0.9	3.6	9.16
3	Run	mid	sub	0.02	1.20	stick	0.24	0.12	14.4	0.65
7	Run	mid	sub	0.02	1.30	stick	0.24	0.12	15.6	0.71
10	Run	mid	sub	0.02	1.30	stick	0.24	0.12	15.6	0.71
3	Run	mid	sub	0.02	1.40	stick	0.24	0.12	16.8	0.76
2	Run	mid	sub	0.02	1.50	stick	0.24	0.12	18	0.81
2	Run	RB	sub	0.02	1.50	stick	0.24	0.12	18	0.81
4	Run	mid	sub	0.03	1.00	stick	0.36	0.18	12	1.22
9	Run	mid	sub	0.03	1.00	stick	0.36	0.18	12	1.22
2	Run	mid	sub	0.03	1.20	stick	0.36	0.18	14.4	1.46
6	Run	mid	sub	0.03	1.20	stick	0.36	0.18	14.4	1.46
8	Run	mid	sub	0.03	1.40	stick	0.36	0.18	16.8	1.71
8	Run	mid	sub	0.03	1.50	stick	0.36	0.18	18	1.83
10	Run	LB	sub	0.03	1.50	stick	0.36	0.18	18	1.83
2	Run	mid	sub	0.04	1.00	stick	0.48	0.24	12	2.17
6	Run	LB	sub	0.05	1.20	stick	0.6	0.3	14.4	4.07
2	Run	mid	sub	0.05	1.40	stick	0.6	0.3	16.8	4.75
4	Run	mid	sub	0.05	1.60	stick	0.6	0.3	19.2	5.43
7	Run	mid	sub	0.05	1.60	stick	0.6	0.3	19.2	5.43
8	Run	mid	sub	0.05	1.60	stick	0.6	0.3	19.2	5.43
7	Run	mid	sub	0.06	1.40	stick	0.72	0.36	16.8	6.84
9	Run	mid	sub	0.09	1.60	stick	1.08	0.54	19.2	17.58
6	Run	mid	sub	0.02	1.80	stick	0.24	0.12	21.6	0.98
2	Run	mid	sub	0.02	2.00	stick	0.24	0.12	24	1.09
2	Run	mid	sub	0.02	2.00	stick	0.24	0.12	24	1.09
3	Run	mid	sub	0.02	2.00	stick	0.24	0.12	24	1.09
10	Run	mid	sub	0.02	2.00	stick	0.24	0.12	24	1.09
2	Run	mid	sub	0.02	2.20	stick	0.24	0.12	26.4	1.19
4	Run	mid	sub	0.02	2.50	stick	0.24	0.12	30	1.36
2	Run	LB	Emb	0.03	1.80	stick	0.36	0.18	21.6	2.20
2	Run	mid	sub	0.03	2.00	stick	0.36	0.18	24	2.44
2	Run	RB	sub	0.03	2.00	stick	0.36	0.18	24	2.44
4	Run	LB	sub	0.03	2.00	stick	0.36	0.18	24	2.44

Muddy Run Reach 1B Aquatic Habitat Assessment

Transect	Habitat	Location	Position	Diameter	length	Notes	Diameter (in	Radius (in)	length (in)	Volume (in)
4	Run	mid	sub	0.03	2.00	stick	0.36	0.18	24	2.44
7	Run	mid	sub	0.03	2.00	stick	0.36	0.18	24	2.44
10	Run	mid	sub	0.03	2.00	stick	0.36	0.18	24	2.44
10	Run	RB	sub	0.03	2.00	stick	0.36	0.18	24	2.44
4	Run	LB	sub	0.03	2.10	stick	0.36	0.18	25.2	2.56
9	Run	mid	sub	0.03	2.50	stick	0.36	0.18	30	3.05
8	Run	LB	sub	0.04	2.00	stick	0.48	0.24	24	4.34
9	Run	RB	sub	0.04	2.10	stick	0.48	0.24	25.2	4.56
7	Run	mid	sub	0.04	2.90	stick	0.48	0.24	34.8	6.29
7	Run	mid	sub	0.04	3.00	stick	0.48	0.24	36	6.51
3	Run	LB	sub	0.04	3.20	stick	0.48	0.24	38.4	6.95
1	Run	LB	sub	0.05	1.90	stick	0.6	0.3	22.8	6.44
1	Run	mid	sub	0.05	2.00	stick	0.6	0.3	24	6.78
7	Run	LB	sub	0.05	2.00	stick	0.6	0.3	24	6.78
1	Run	RB	sub	0.05	2.50	stick	0.6	0.3	30	8.48
4	Run	LB+	sub	0.05	2.50	stick	0.6	0.3	30	8.48
7	Run	RB-mid	sub	0.05	2.50	stick	0.6	0.3	30	8.48
8	Run	LB	sub	0.05	2.80	stick	0.6	0.3	33.6	9.50
10	Run	RB	sub	0.05	2.80	stick	0.6	0.3	33.6	9.50
8	Run	LB	sub	0.05	3.00	stick	0.6	0.3	36	10.17
7	Run	RB-mid	sub	0.05	3.20	stick	0.6	0.3	38.4	10.85
10	Run	LB	sus	0.05	3.20	stick (mostly submerged)	0.6	0.3	38.4	10.85
10	Run	RB-mid	sub	0.05	3.20	stick	0.6	0.3	38.4	10.85
9	Run	mid	sub	0.06	1.80	stick	0.72	0.36	21.6	8.79
2	Run	RB	sub	0.08	3.00	stick (mostly submerged)	0.96	0.48	36	26.04
9	Run	mid	sub	0.09	2.00	stick	1.08	0.54	24	21.97
1	Run	mid	sub	0.10	2.30	stick	1.2	0.6	27.6	31.20
3	Run	RB	sub	0.10	2.40	stick	1.2	0.6	28.8	32.56
10	Run	LB	sus	0.1	3.00	stick	1.2	0.6	36	40.69
9	Run	RB	sus	0.10	3.10	stick (mostly submerged)	1.2	0.6	37.2	42.05
8	Run	RB	sub	0.13	2.30	stick	1.56	0.78	27.6	52.73
2	Run	+	Emb	0.14	3.20	stick	1.68	0.84	38.4	85.08
2	Run	LB	Emb	0.20	2.00	stick	2.4	1.2	24	108.52
2	Run	RB	Emb	0.20	3.00	stick	2.4	1.2	36	162.78
3	Run	RB-mid	Emb	0.30	2.00	stick	3.6	1.8	24	244.17
8	Run	LB-mid	sub	0.05	3.80	stick	0.6	0.3	45.6	12.89
8	Run	RB	sus	0.05	4.00	stick	0.6	0.3	48	13.56
2	Run	mid	sub	0.05	7.00	stick	0.6	0.3	84	23.74
9	Run	RB-mid	sus	0.07	4.00	stick (par. sub)	0.84	0.42	48	26.59
8	Run	mid	sub	0.08	4.50	stick	0.96	0.48	54	39.07
8	Run	LB	sus	0.10	4.00	stick	1.2	0.6	48	54.26
8	Run	RB	Par-sub	0.10	4.50	stick	1.2	0.6	54	61.04
7	Run	RB	sub-par	0.10	7.00	stick (3 ft. in water)	1.2	0.6	84	94.95
7	Run	t	sus	0.15	5.00	stick	1.8	0.9	60	152.60
1	Run	mid	Par Emb	0.15	6.50	log	1.8	0.9	78	198.39
4	Run	+	sub	0.15	7.00	stick	1.8	0.9	84	213.65
1	Run	+	Par Emb	0.30	6.00	log	3.6	1.8	72	732.50

Muddy Run Reach 2 Aquatic Habitat Assessment

Transect	Habitat	Location	Position	Diameter	length	Notes	Diameter (in)	Radius (in)	length (in)	Volume (in)
10	run	mid	sub	0.03	0.60	stick	0.36	0.18	7.2	0.73
8	run	mid	sub	0.04	0.70	stick	0.48	0.24	8.4	1.52
9	run	mid	sub	0.04	0.80	stick	0.48	0.24	9.6	1.74
9	run	RB	sub	0.05	0.35	stick	0.6	0.3	4.2	1.19
8	run	mid	sub	0.05	0.70	stick	0.6	0.3	8.4	2.37
8	run	mid	sub	0.06	0.50	stick	0.72	0.36	6	2.44
5	pool	mid	sub	0.25	0.80	stick	3	1.5	9.6	67.82
5	pool	mid	sub	0.02	1.20	stick	0.24	0.12	14.4	0.65
5	pool	mid	sub	0.02	1.20	stick	0.24	0.12	14.4	0.65
5	pool	mid	sub	0.03	1.30	stick	0.36	0.18	15.6	1.59
10	run	mid	sub	0.03	0.90	stick	0.36	0.18	10.8	1.10
8	run	mid	sub	0.05	1.10	stick	0.6	0.3	13.2	3.73
8	run	mid	sub	0.05	1.10	stick	0.6	0.3	13.2	3.73
8	run	mid	sub	0.05	1.10	stick	0.6	0.3	13.2	3.73
8	run	mid	Par-sub	0.05	1.20	stick	0.6	0.3	14.4	4.07
8	run	mid	sub	0.07	1.50	stick	0.84	0.42	18	9.97
6	run	RB	sus	0.10	1.50	stick	1.2	0.6	18	20.35
5	pool	mid	sub	0.02	2.00	stick	0.24	0.12	24	1.09
5	pool	mid	sub	0.03	1.70	stick	0.36	0.18	20.4	2.08
5	pool	mid	sub	0.03	1.80	stick	0.36	0.18	21.6	2.20
5	pool	LB	sus	0.03	2.40	stick	0.36	0.18	28.8	2.93
5	pool	LB	sus	0.03	3.00	stick	0.36	0.18	36	3.66
5	pool	mid	sub	0.03	3.00	stick	0.36	0.18	36	3.66
10	run	mid	sub	0.02	1.70	stick	0.24	0.12	20.4	0.92
8	run	RB	sus	0.03	2.30	stick (0.60 in water)	0.36	0.18	27.6	2.81
7	run	RB	sus	0.03	2.50	stick (0.50 in water)	0.36	0.18	30	3.05
10	run	RB-mid	sub	0.03	2.70	stick	0.36	0.18	32.4	3.30
6	run	RB	sus	0.03	3.00	stick	0.36	0.18	36	3.66
9	run	mid	sub	0.04	3.30	stick	0.48	0.24	39.6	7.16
8	run	LB	sus	0.05	2.00	stick (0.60 in water)	0.6	0.3	24	6.78
8	run	RB	sus	0.05	2.50	stick (1.0 in water)	0.6	0.3	30	8.48
8	run	mid	sub	0.05	2.50	stick	0.6	0.3	30	8.48
8	run	mid	sub	0.08	1.80	stick	0.96	0.48	21.6	15.63
8	run	RB	sus	0.08	2.70	stick	0.96	0.48	32.4	23.44
8	run	mid	sub	0.10	1.70	stick	1.2	0.6	20.4	23.06
8	run	Rb	sus	0.10	2.50	stick	1.2	0.6	30	33.91
7	run	LB	sus	0.10	3.00	stick	1.2	0.6	36	40.69
7	run	RB	sus	0.20	3.00	stick (0.50 in water)	2.4	1.2	36	162.78
10	run	RB-mid	sub	0.40	1.80	stick	4.8	2.4	21.6	390.67
5	pool	LB	sus	0.03	4.20	stick	0.36	0.18	50.4	5.13
5	pool	LB	sus	0.05	6.00	stick (0.40 in water)	0.6	0.3	72	20.35
5	pool	mid	sub	0.05	6.00	stick	0.6	0.3	72	20.35
5	pool	RB-mid	sub	0.05	8.00	stick	0.6	0.3	96	27.13
9	run	mid	sub	0.02	5.00	stick	0.24	0.12	60	2.71
8	run	mid	sub	0.03	3.40	stick	0.36	0.18	40.8	4.15
9	run	mid	sub	0.03	3.80	stick	0.36	0.18	45.6	4.64
8	run	mid	sub	0.03	4.10	stick	0.36	0.18	49.2	5.01
9	run	mid	sub	0.03	6.00	stick	0.36	0.18	72	7.32
7	run	RB	sub	0.05	6.00	stick	0.6	0.3	72	20.35
10	run	LB	sus	0.05	6.00	stick (1.0 in water)	0.6	0.3	72	20.35

8	run	RB	sus	0.06	3.50	stick (1.0 in water)	0.72	0.36	42	17.09
8	run	RB-mid	sub	0.07	5.50	stick	0.84	0.42	66	36.56
10	run	mid	sub	0.10	6.50	stick	1.2	0.6	78	88.17
8	run	mid	sub	0.10	7.00	stick	1.2	0.6	84	94.95

Muddy Run Reference Reach Riparian Buffer

Transect	Location	Coverage	%E	%D	DBH	Species
1	LB	80	15	85	8	bay sp?, black gum?, Am. Holly, RM, TP
1	RB	90	15	85	12.5	TP, SG, Am holly, black gum?
2	LB	65	10	90	9	TP, Am holly, SG
2	RB	80	10	90	15	SG, black gum?, TP
3	LB	90	10	90	10	black gum, RM, TP, Am holly
3	RB	60	30	70	7	SG, Am holly, bay?, black gum?
4	LB	85	10	90	10	SG, TP, Am holly
4	RB	35	50	50	3	Am holly, green briar, cane, bay?, SG
5	LB	90	10	90	8	TP, bay sp?, RM, beech, sw. gum, black gum
5	RB	60	25	75	9	black gum?, SG, Am holly, TP
6	LB	90	10	90	8	TP, bay sp?, RM, beech, sw. gum, black gum
6	RB	70	50	50	4-6	bay?, holly, black gum?
7	LB	75	10	90	10	TP, RM, Am. Holly, swamp chestnut oak
7	RB	60	40	60	8	Am holly, TP, SG
8	LB	55	20	80	7	TP, red maple, loblolly, Am. Holly, privet
8	RB	80	40	60	6	water oak, TP, Am holly, RM
9	LB	70	25	75	10	Luael oak, Am. Holly, tulip poplar, loblolly
9	RB	80	20	80	6	TP, Am holly, water oak, RM
10	LB	60	20/25	75	11.5	Luael oak, Am. Holly, tulip poplar, loblolly
10	RB	80	15	85	11	loblolly, Sw. ches. Oak, Am holly, RM, SG, TP, privet

Muddy Run Reach 1B Riparian Buffer

Transect 1-10; RB buffer clearcut and farm road along top of bank
LB buffer clearcut, few single young trees along top of bank

Muddy Run Reach 2 Riparian Buffer

Riparian buffer shrubby (thin)
few willows, syc, & privet

Muddy Run Reference Reach Fish Cover

Transect	Width	Length	Cover Type	Location	Notes	Area (ft^2)
1	0.6	9	under cut	LB		5.4
1	0.4	1	root	RB		0.4
2	0.3	1.5	under cut	LB		0.45
2	3	3	overhang/dead brush	RB		9
3	1.5	3	overhang veg	RB		4.5
3	0.5	4.4	root overhang	RB		2.2
3	0.4	1	under cut	RB		0.4
3	0.4	0.5	root overhang	LB		0.2
4	1	3	overhang veg	RB		3
5	0.7	10	root overhang/cut	LB		7
5	0.4	6.5	root overhang/cut	RB		2.6
5	2	2	overhang veg	RB		4
5	4	3	overhang veg	RB		12
5	1	4	overhang veg	LB		4
5	2	2	overhang veg	LB		4
6	0.5	1	root overhang	RB	(in water)	0.5
7	0.6	0.8	log overhang	LB	(in water)	0.48
7	0.3	2	log overhang	LB	(in water)	0.6
8	4.6	3.9	overhang veg	RB		17.94
8	0.25	4	under cut bank	RB		1
9	0.3	0.5	stick overhang	LB		0.15
9	0.3	0.5	stick overhang	LB		0.15
9	0.3	1	under cut	LB		0.3
9	3	3.7	veg/brush overhang	RB		11.1
10	1	1.2	veg overhang	RB		1.2
10	0.2	1.5	under cut	RB		0.3
10	0.4	1.5	under cut	RB		0.6
10	2	2	veg overhang	RB		4

Muddy Run Reach 1B Fish Cover

no buffer and no overhanging veg or undercut banks, fish cover non-existent

Muddy Run Reach 2 Fish Cover

Transect	Width	Lenth	Cover Type	Location	Notes	Area (ft^2)
2	3	2	overhang veg	RB		6
2	1	1	overhang veg	RB		1
5	2.6	5.8	overhang veg	LB	syc	15.08
8	3.8	3.5	overhang veg	RB	willow	13.3
8	1.6	4	overhang veg	LB	willow	6.4
8	1.4	3.5	overhang veg	RB	willow	4.9
9	1.8	3	overhang veg	RB		5.4
9	3.2	2	overhang veg	LB		6.4
10	1.7	4.5	overhang veg	RB		7.65
10	2	1	overhang veg	LB		2

CHANNEL STABILITY ASSESSMENT FORM

Stability Indicator	Excellent (1 -3)	Good (4 - 6)	Fair (7 - 9)	Poor (10 - 12)	Score
1. Watershed and flood plain activity and characteristics	Stable, forested, undisturbed watershed	Occasional minor disturbances in the watershed, including cattle activity (grazing and/or access to stream), construction, logging, or other minor deforestation. Limited agricultural activities	Frequent disturbances in the watershed, including cattle activity, landslides, channel sand or gravel mining, logging, farming, or construction of buildings, roads, or other infrastructure. Urbanization over significant portion of watershed	Continual disturbances in the watershed. Significant cattle activity, landslides, channel sand or gravel mining, logging, farming, or construction of buildings, roads, or other infrastructure. Highly urbanized or rapidly urbanizing watershed	
2. Flow habit	Perennial stream with no flashy behavior	Perennial stream or ephemeral first-order stream with slightly increased rate of flooding	Perennial or intermittent stream with flashy behavior	Extremely flashy; flash floods prevalent mode of discharge; ephemeral stream other than first-order stream	
3. Channel pattern	Straight to meandering with low radius of curvature; primarily suspended load	Meandering, moderate radius of curvature; mix of suspended and bed loads; well-maintained engineered channel	Meandering with some braiding; tortuous meandering; primarily bed load; poorly maintained engineered channel	Braided; primarily bed load; engineered channel that is maintained	
3. Channel pattern (revised)	No evidence of channelization. Meandering, stable channel or straight (step-pool system, narrow valley), stable channel.	Appears to have previously been channelized. Stream is relatively stable. Channel has some meanders due to previous channel adjustment.	Appears to have previously been channelized. Stream is actively adjusting (meandering); localized areas of instability and/or erosion around bends. Straightened, stable channel.	Appears to have previously been channelized. Stream is actively adjusting (laterally and/or vertically) with few bends. Straight, unstable reach.	
4. Entrenchment/ channel confinement	Active flood plain exists at top of banks; no sign of undercutting infrastructure; no levees	Active flood plain abandoned, but is currently rebuilding; minimal channel confinement; infrastructure not exposed; levees are low and set well back from the river	Moderate confinement in valley or channel walls; some exposure of infrastructure; terraces exist; flood plain abandoned; levees are moderate in size and have minimal setback from the river	Knickpoints visible downstream; exposed water lines or other infrastructure; channel-width-to-top-of-banks ration small; deeply confined; no active flood plain; levees are high and along the channel edge	
5. Bed materia Fs = approximate portion of sand in the bed	Assorted sized tightly packed, overlapping, and possibly imbricated. Most material > 4 mm. Fs < 20%	Moderately packed with some overlapping. Very small amounts of material < 4 mm. 20 < Fs < 50%	Loose assortment with no apparent overlap. Small to medium amounts of material < 4 mm. 50 < Fs < 70%	Very loose assortment with no packing. Large amounts of material < 4 mm. Fs > 70%	
6. Bar development	For S < 0.02 and w/y > 12, bars are mature, narrow relative to stream width at low flow, well-vegetated, and composed of coarse gravel to cobbles. For S > 0.02 and w/y are < 12, no bars are evident	For S < 0.02 and w/y > 12, bars may have vegetation and/or be composed of coarse gravel to cobbles, but minimal recent growth of bar evident by lack of vegetation on portions of the bar. For S > 0.02 and w/y <12, no bars are evident	For S < 0.02 and w/y > 12, bar widths tend to be wide and composed of newly deposited coarse sand to small cobbles and/or may be sparsely vegetated. Bars forming for S > 0.02 and w/y < 12	Bar widths are generally greater than 1/2 the stream width at low flow. Bars are composed of extensive deposits of fine particles up to coarse gravel with little to no vegetation. No bars for S < 0.02 and w/y > 12	
7. Obstructions, including bedrock outcrops, armor layer, LWD jams, grade control, bridge bed paving, revetments, dikes or vanes, riprap	Rare or not present	Occasional, causing cross currents and minor bank and bottom erosion	Moderately frequent and occasionally unstable obstructions, cause noticeable erosion of the channel. Considerable sediment accumulation behind obstructions	Frequent and often unstable, causing a continual shift of sediment and flow. Traps are easily filled, causing channel to migrate and/or widen	
8. Bank soil texture and coherence	Clay and silty clay; cohesive material	Clay loam to sandy clay loam; minor amounts of noncohesive or unconsolidated mixtures; layers may exist, but are cohesive materials	Sandy clay to sandy loam; unconsolidated mixtures of glacial or other materials; small layers and lenses of noncohesive or unconsolidated mixtures	Loamy sand to sand; noncohesive material; unconsolidated mixtures of glacial or other materials; layers of lenses that include noncohesive sands and gravels	
9. Average bank slope angle (where 90° is a vertical bank)	Bank slopes < 3H:1V (18°) for noncohesive or unconsolidated materials to < 1:1 (45°) in clays on both sides	Bank slopes up to 2H:1V (27°) in noncohesive or unconsolidated materials to 0.8:1 (50°) in clays on one or occasionally both banks	Bank slopes to 1H:1V (45°) in noncohesive or unconsolidated materials to 0.6:1 (60°) in clays common on one or both banks	Bank slopes over 45° in noncohesive or unconsolidated materials or over 60° in clays common on one or both banks	
10. Vegetative or engineered bank protection	Wide band of woody vegetation with at least 90% density and cover. Primarily hard wood, leafy, deciduous trees with mature, healthy, and diverse vegetation located on the bank. Woody vegetation oriented vertically. In absence of vegetation, both banks are lined or heavily armored	Medium band of woody vegetation with 70-90% plant density and cover. A majority of hard wood, leafy, deciduous trees with maturing, diverse vegetation located on the bank. Wood vegetation oriented 80-90% from horizontal with minimal root exposure. Partial lining or armoring of one or both banks	Small band of woody vegetation with 50-70% plant density and cover. A majority of soft wood, piney, coniferous trees with young or old vegetation lacking in diversity located on or near the top of bank. Woody vegetation oriented at 70-80% from horizontal, often with evident root exposure. No lining of banks, but some armoring may be in place on one bank	Woody vegetation band may vary depending on age and health with less than 50% plant density and cover. Primarily soft wood, piney, coniferous trees with very young, old and dying, and/or monostand vegetation located off of the bank. Woody vegetation oriented at less than 70% from horizontal with extensive root exposure. No lining or armoring of banks	
11. Bank cutting	Little or none evident. Infrequent raw banks, insignificant percentage of total bank	Some intermittently along channel bends and at prominent constrictions. Raw banks comprise minor portion of bank in vertical direction	Significant and frequent on both banks. Raw banks comprise large portion of bank in vertical direction. Root mat overhangs	Almost continuous cuts on both banks, some extending over most of the banks. Undercutting and sod-root overhangs	
12. Mass wasting or bank failure	No or little evidence of potential or very small amounts of mass wasting. Uniform channel width over the entire reach	Evidence of infrequent and/or minor mass wasting. Mostly healed over with vegetation. Relatively constant channel width and minimal scalloping of banks	Evidence of frequent and/or significant occurrences of mass wasting that can be aggravated by higher flows, which may cause undercutting and mass wasting of unstable banks. Channel width quite irregular, and scalloping of banks is evident	Frequent and extensive mass wasting. The potential for bank failure, as evidenced by tension cracks, massive undercuttings, and bank slumping is considerable. Channel width is highly irregular, and banks are scalloped	
13. Upstream distance to bridge from meander impact point and alignment	More than 35 m; bridge is well-aligned with river flow	20-35 m; bridge is aligned with flow	10-20 m; bridge is skewed to flow, or flow alignment is otherwise not centered beneath bridge	Less than 10 m; bridge is poorly aligned with flow	

H = horizontal, V = vertical, Fs = fraction of sand, S = slope, w/y = width-to-depth ratio

Total Score _____

APPENDIX 3

Environmental Screening and Resource Agency Correspondence

Muddy Run CE
Farmland Conversion Impact Rating (Form AD 1006)
FEMA Floodplain Checklist
Muddy Run Correspondence - SHPO
Muddy Run Correspondence - FWS

RECEIVED
NOV 28 2011
NC ECOSYSTEM
ENHANCEMENT PROGRAM

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	Muddy Run Mitigation Project
County Name:	Duplin
EEP Number:	
Project Sponsor:	Environmental Banc & Exchange, LLC
Project Contact Name:	Norton Webster
Project Contact Address:	909 Capability Drive, Suite 3100, Raleigh, NC 27606
Project Contact E-mail:	Norton@EBXUSA.com
EEP Project Manager:	

Project Description

The mitigation project at the Muddy Run Site will involve restoration of the historic condition of coastal plain small stream swamps. Stream buffers throughout the project area will be restored and protected in perpetuity. Priority Level I restoration is proposed on six reaches, headwater valley restoration is proposed on two reaches, and preservation is proposed on one reach. This will result in ecological improvements, including habitat restoration and a decrease in non-point source pollution from agricultural practices. [1]

For Official Use Only

Reviewed By:

12/19/2011
Date

for Kristin Miguez
EEP Project Manager

Conditional Approved By:

Date

For Division Administrator
FHWA

☐ **Check this box if there are outstanding issues**

Final Approval By:

12-16-11
Date

For Division Administrator
FHWA

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☑ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☑ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☑ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☑ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☑ Yes ☐ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☑ No ☐ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☑ No ☐ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☑ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☑ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☑ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☑ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☑ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☑ Yes ☐ No
2. Does the project require the acquisition of real estate?	☑ Yes ☐ No ☐ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☑ No ☐ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☑ Yes ☐ No ☐ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☐ Yes ☑ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☑ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☑ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☑ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☑ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☑ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☑ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☐ Yes ☑ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
4. Is the project "likely to adversely affect" the species and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☑ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☑ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☑ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☑ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☑ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☑ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☑ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☑ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☑ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☑ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☑ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☑ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☑ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☑ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☑ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☑ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☑ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☑ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☑ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☑ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☑ N/A

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 7/15/11
Name Of Project Muddy Run EEP Stream Mitigation Site	Federal Agency Involved FHWA-EEP
Proposed Land Use Stream mitigation	County And State Duplin, NC
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 7/19/11

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply -- do not complete additional parts of this form).*	Yes ☑	No ☐	Acres Irrigated None	Average Farm Size 153

Major Crop(s) Corn	Farmable Land In Govt. Jurisdiction Acres: 440587 % 84	Amount Of Farmland As Defined in FPPA Acres: 305682 % 59
Name Of Land Evaluation System Used Duplin LE	Name Of Local Site Assessment System None	Date Land Evaluation Returned By NRCS 9/1/11

PART III *(To be completed by Federal Agency)*	Alternative Site Rating Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly	16.0			
B. Total Acres To Be Converted Indirectly	4.4			
C. Total Acres In Site	20.4	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information				
A. Total Acres Prime And Unique Farmland	20.4			
B. Total Acres Statewide And Local Important Farmland	0.0			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted	0.0			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value	55.6			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*	90	0	0	0

PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use	15	15			
2. Perimeter In Nonurban Use	10	10			
3. Percent Of Site Being Farmed	20	17			
4. Protection Provided By State And Local Government	20	0			
5. Distance From Urban Builtup Area	15	15			
6. Distance To Urban Support Services	15	15			
7. Size Of Present Farm Unit Compared To Average	10	0			
8. Creation Of Nonfarmable Farmland	10	0			
9. Availability Of Farm Support Services	5	5			
10. On-Farm Investments	20	20			
11. Effects Of Conversion On Farm Support Services	10	0			
12. Compatibility With Existing Agricultural Use	10	0			
TOTAL SITE ASSESSMENT POINTS	160	97	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	90	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	97	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	187	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? Yes ☐ No ☐

Reason For Selection:

This form was electronically produced by National Production Services Staff

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. Edward Curtis), NC Floodplain Mapping Unit (attn. John Gerber) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Muddy Run I Stream Restoration Project
Name if streams or features:	Unnamed Tributaries to Muddy Creek
County:	Duplin County, NC
Name of river basin:	Cape Fear River Basin
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Duplin County
DFIRM panel number for entire site:	Firm Panel 3368 Map Number: 3720336800J Effective Date: Febuary 16, 2006
Consultant name:	Wk Dickson & Co., Inc. Daniel Ingram – Project Manager
Phone number:	(919)782-0495
Address:	720 Corporate Center Drive Raleigh, NC 27607

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500".

Wk Dickson is designing Muddy Run I Stream Restoration Project in Duplin County, NC to provide stream mitigation units (SMUs) in the Cape Fear River Basin for the NC Ecosystem Enhancement Program (NCEEP). Stream restoration activities include channel and floodplain grading of approximately 6, 800 linear feet of unnamed tributaries to Muddy Creek.

Summarize stream reaches or wetland areas according to their restoration priority.

Stream Reach	Mitigation Type	Total LF	Priority
Reach 1A	Valley Restoration	1,952	HWV
Reach 1B	Restoration	1,335	P1
Reach 1C	Restoration	1,398	P1
Reach 2	Restoration	1,626	P1
Reach 3	Restoration	486	P1
	Total:	6,797	

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

☐ Yes ☒ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation:

Check if applies:

☐ AE Zone

☒ Floodway

☒ Non-Encroachment

☉ None

☐ A Zone

☐ Local Setbacks Required

☐ No Local Setbacks Required

If local setbacks are required, list how many feet:

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

☐ Yes ☉ No

Land Acquisition (Check)

☐ State owned (fee simple)

☐ Conservation easment (Design Bid Build)

☑ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

☉ Yes ☐ No

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: Edward Curtis, (919) 715-8000 x369)

Name of Local Floodplain Administrator: Randall Tyndall
Phone Number: (910) 296-2102
Email: randallt@duplincountync.com

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☑ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision

☐ Other Requirements

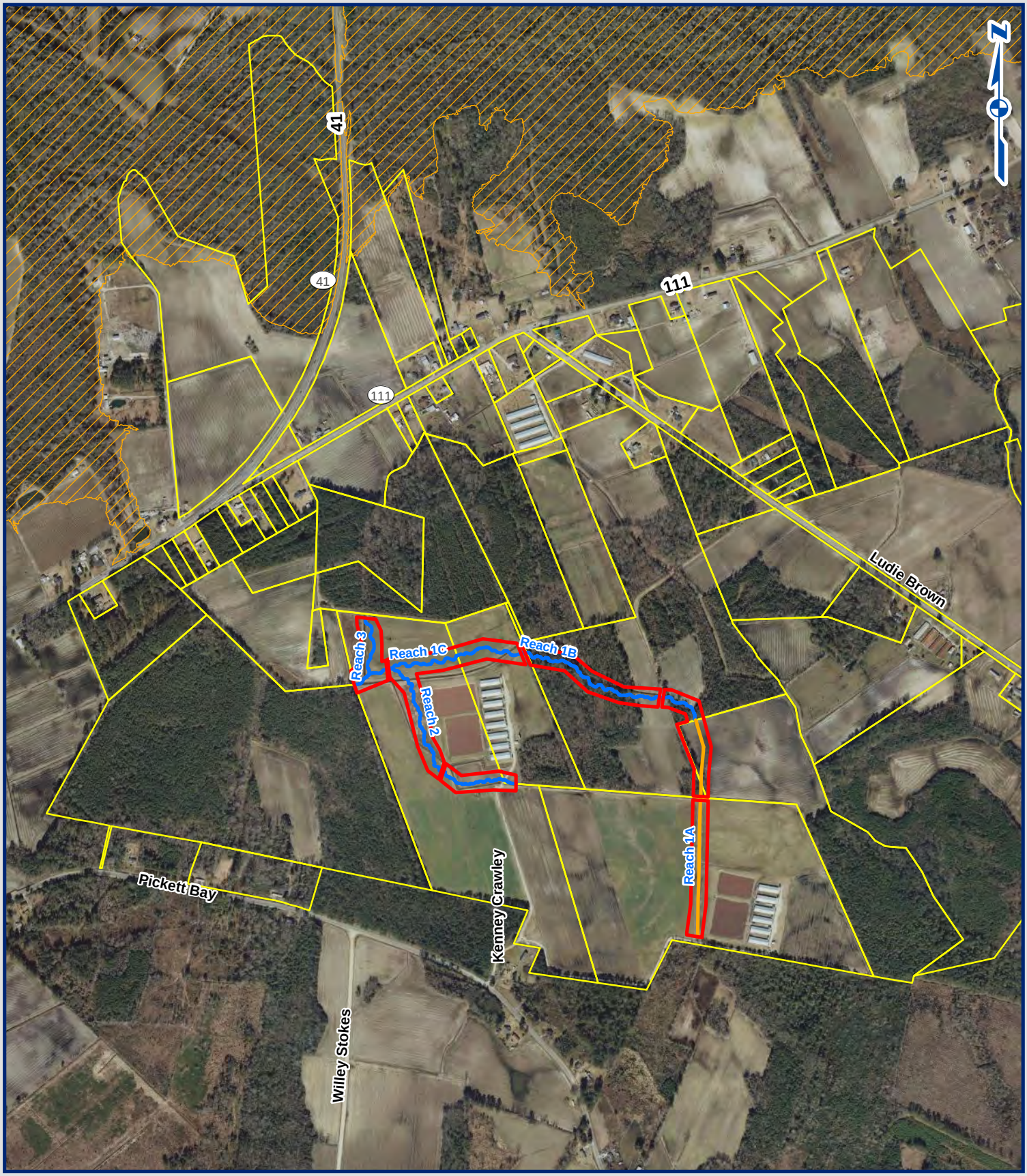
List other requirements:

Comments:

This project has been discussed with the local Soil and Water Conservation District. It is requested that coordination be made with that office at (910) 296-2120 X 3 (Attn: Donna Rouse).

Name: Randall G. Tyndall Signature: Randall G. Tyndall

Title: Section Mgr/County Planner Date: July 20, 2012
Duplin Alternate Floodplain Mgr



EBX

Figure 1.
FEMA Map
Muddy Run Site

0 500 1,000 2,000 Feet

1 inch = 1,000 feet

Legend

- Proposed Streams
- Muddy Run Site
- Target Parcels
- FEMA Zone AE - Detailed 100yr. Floodplain

RECEIVED
JUL 25 2011

North Carolina Department of Cultural Resources

State Historic Preservation Office

Claudia Brown, Acting Administrator

Beverly Eaves Perdue, Governor
Linda A. Carlisle, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

July 19, 2011

Daniel Ingram
W.K. Dickson & Company, Inc.
720 Corporate Center Drive
Raleigh, NC 27607

Re: Muddy Run Wetland and Stream Mitigation Project, Duplin County, ER 11-1383

Dear Mr. Ingram:

Thank you for your letter of July 1, 2011, concerning the above project.

We have conducted a review of the project and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the project as proposed.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Claudia Brown

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

RECEIVED
AUG 1 2011
BY:.....

July 26, 2011

Daniel Ingram
W.K. Dickson & Co., Inc.
720 Corporate Center Drive
Raleigh, NC 27607

Re: Muddy Run EEP Wetland and Stream Mitigation Project

Dear Mr. Ingram:

This letter is to inform you that a list of all federally-protected endangered and threatened species with known occurrences in North Carolina is now available on the U.S. Fish and Wildlife Service's (Service) web page at http://www.fws.gov/raleigh. Therefore, if you have projects that occur within the Raleigh Field Office's area of responsibility (see attached county list), you no longer need to contact the Raleigh Field Office for a list of federally-protected species.

Our web page contains a complete and frequently updated list of all endangered and threatened species protected by the provisions of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)(Act), and a list of federal species of concern[1] that are known to occur in each county in North Carolina.

Section 7 of the Act requires that all federal agencies (or their designated non-federal representative), in consultation with the Service, insure that any action federally authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of any federally-listed endangered or threatened species. A biological assessment or evaluation may be prepared to fulfill that requirement and in determining whether additional consultation with the Service is necessary. In addition to the federally-protected species list, information on the species' life histories and habitats and information on completing a biological assessment or evaluation and can be found on our web page at http://www.fws.gov/raleigh. Please check the web site often for updated information or changes.

---

[1] The term "federal species of concern" refers to those species which the Service believes might be in need of concentrated conservation actions. Federal species of concern receive no legal protection and their designation does not necessarily imply that the species will eventually be proposed for listing as a federally endangered or threatened species. However, we recommend that all practicable measures be taken to avoid or minimize adverse impacts to federal species of concern.

If your project contains suitable habitat for any of the federally-listed species known to be present within the county where your project occurs, the proposed action has the potential to adversely affect those species. As such, we recommend that surveys be conducted to determine the species' presence or absence within the project area. The use of North Carolina Natural Heritage program data should not be substituted for actual field surveys.

If you determine that the proposed action may affect (i.e., likely to adversely affect or not likely to adversely affect) a federally-protected species, you should notify this office with your determination, the results of your surveys, survey methodologies, and an analysis of the effects of the action on listed species, including consideration of direct, indirect, and cumulative effects, before conducting any activities that might affect the species. If you determine that the proposed action will have no effect (i.e., no beneficial or adverse, direct or indirect effect) on federally listed species, then you are not required to contact our office for concurrence (unless an Environmental Impact Statement is prepared). However, you should maintain a complete record of the assessment, including steps leading to your determination of effect, the qualified personnel conducting the assessment, habitat conditions, site photographs, and any other related articles.

With regard to the above-referenced project, we offer the following remarks. Our comments are submitted pursuant to, and in accordance with, provisions of the Endangered Species Act.

Based on the information provided and other information available, it appears that the proposed action is not likely to adversely affect any federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Act at these sites. We believe that the requirements of section 7(a)(2) of the Act have been satisfied for your project. Please remember that obligations under section 7 consultation must be reconsidered if: (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is subsequently modified in a manner that was not considered in this review; or, (3) a new species is listed or critical habitat determined that may be affected by the identified action.

However, the Service is concerned about the potential impacts the proposed action might have on aquatic species. Aquatic resources are highly susceptible to sedimentation. Therefore, we recommend that all practicable measures be taken to avoid adverse impacts to aquatic species, including implementing directional boring methods and stringent sediment and erosion control measures. An erosion and sedimentation control plan should be submitted to and approved by the North Carolina Division of Land Resources, Land Quality Section prior to construction. Erosion and sedimentation controls should be installed and maintained between the construction site and any nearby down-gradient surface waters. In addition, we recommend maintaining natural, vegetated buffers on all streams and creeks adjacent to the project site.

The North Carolina Wildlife Resources Commission has developed a Guidance Memorandum (a copy can be found on our website at (http://www.fws.gov/raleigh) to address and mitigate secondary and cumulative impacts to aquatic and terrestrial wildlife resources and water quality. We recommend that you consider this document in the development of your projects and in completing an initiation package for consultation (if necessary).

We hope you find our web page useful and informative and that following the process described above will reduce the time required, and eliminate the need, for general correspondence for species' lists. If you have any questions or comments, please contact John Ellis of this office at (919) 856-4520 ext. 26.

Sincerely,

Pete Benjamin
Field Supervisor

List of Counties in the Service's Raleigh Field Office Area of Responsibility

Alamance
Beaufort
Bertie
Bladen
Brunswick
Camden
Carteret
Caswell
Chatham
Chowan
Columbus
Craven
Cumberland
Currituck
Dare
Duplin
Durham
Edgecombe
Franklin
Gates
Granville
Greene
Guilford
Halifax
Harnett
Hertford
Hoke
Hyde
Johnston
Jones
Lee
Lenoir
Martin
Montgomery
Moore
Nash
New Hanover
Northampton
Onslow
Orange
Pamlico
Pasquotank
Pender
Perquimans
Person
Pitt
Randolph
Richmond
Robeson
Rockingham
Sampson
Scotland
Tyrrell
Vance
Wake
Warren
Washington
Wayne
Wilson

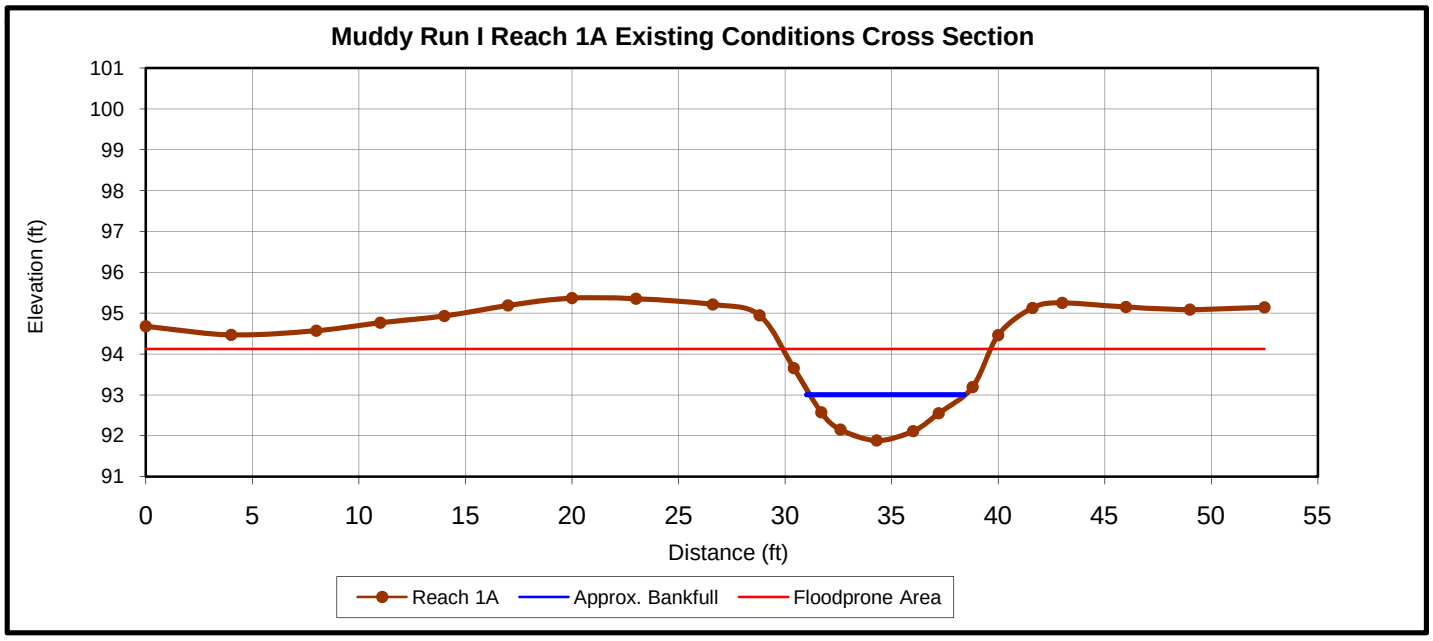
APPENDIX 4

Morphological Parameters and Analyses

Muddy Run Existing Morphological Parameters and Profile Charts
Reference Reach Existing Morphological Parameters and Profile Charts
Muddy Run Stable Channel Design Output
Stream Design Modeling Data (HEC-RAS)

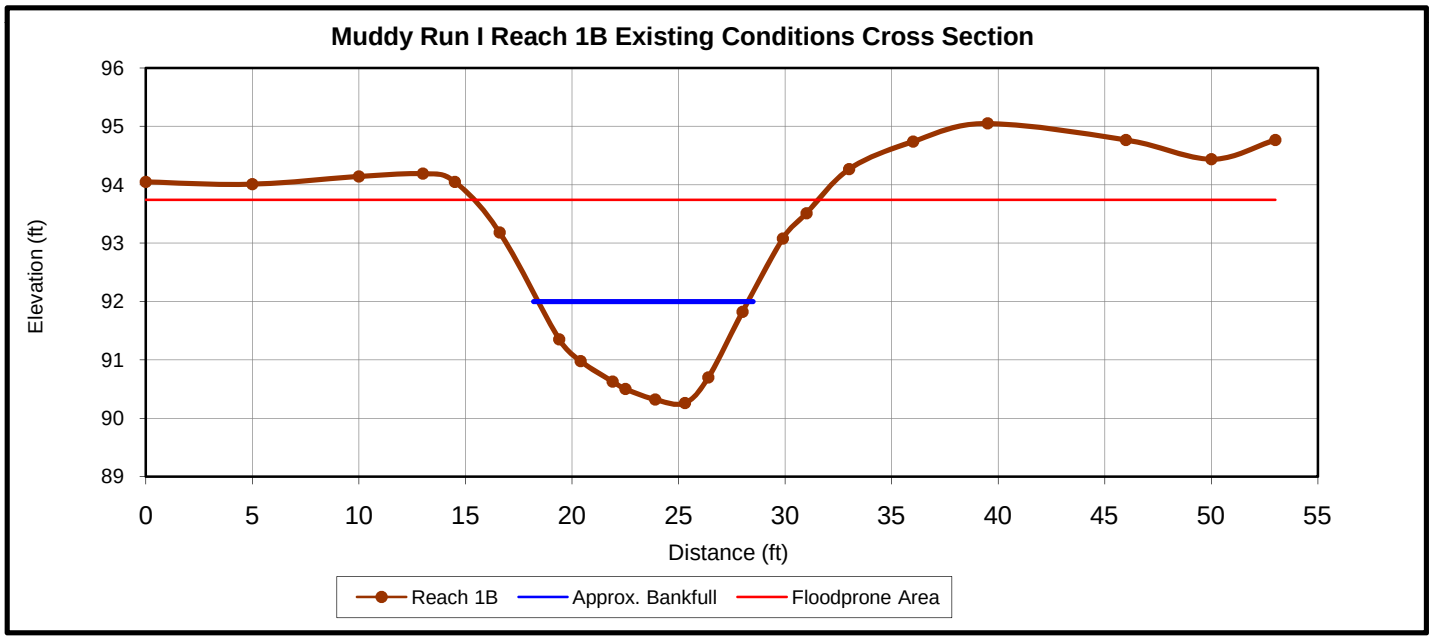
Upstream

Downstream



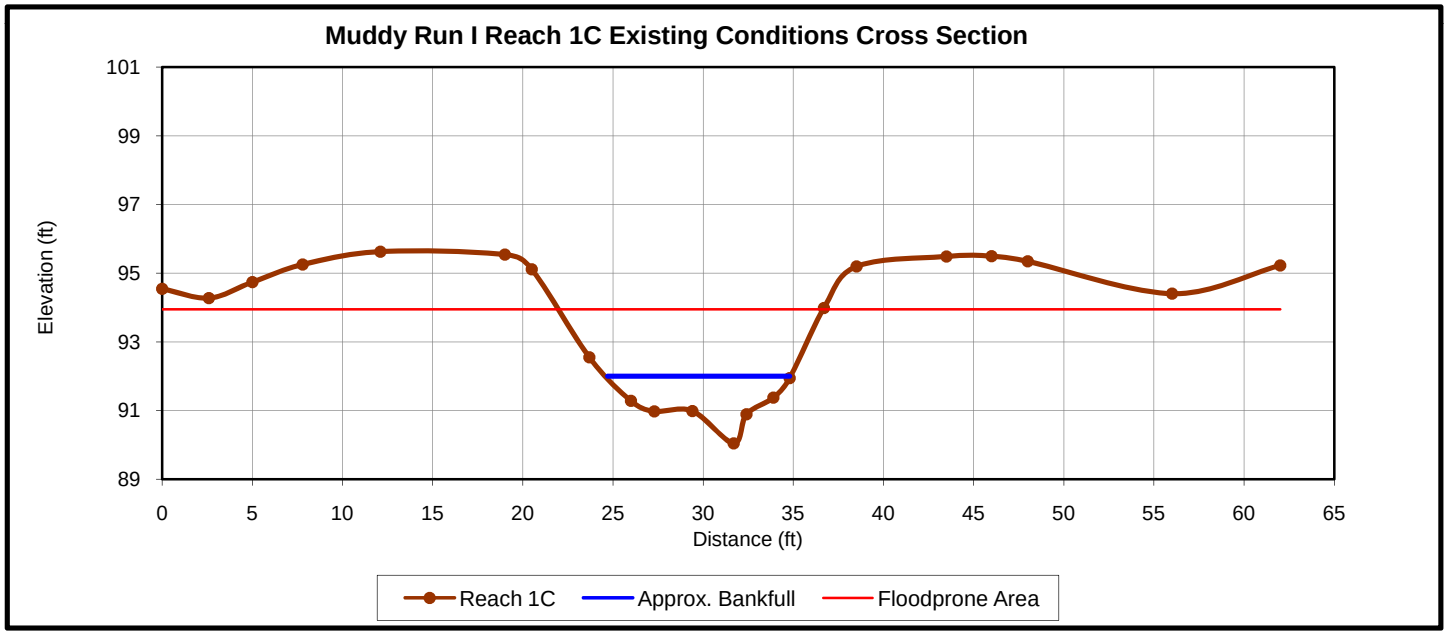
Upstream

Downstream



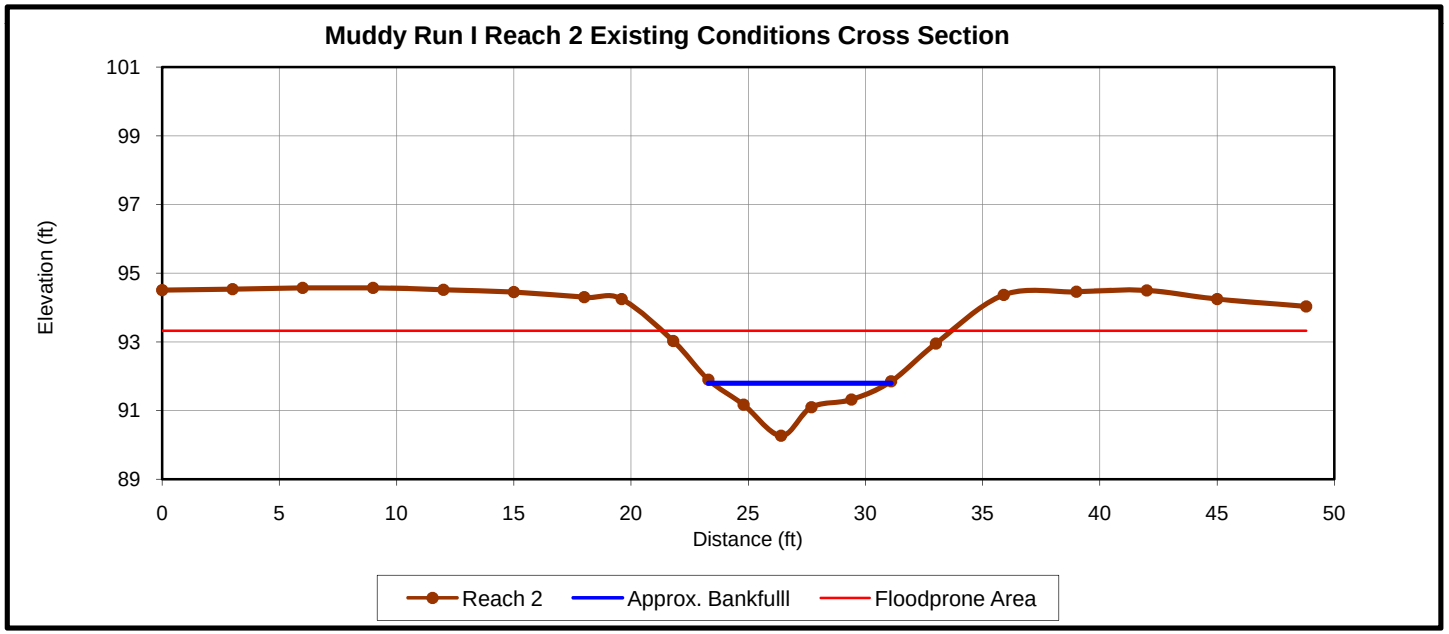
Upstream

Downstream



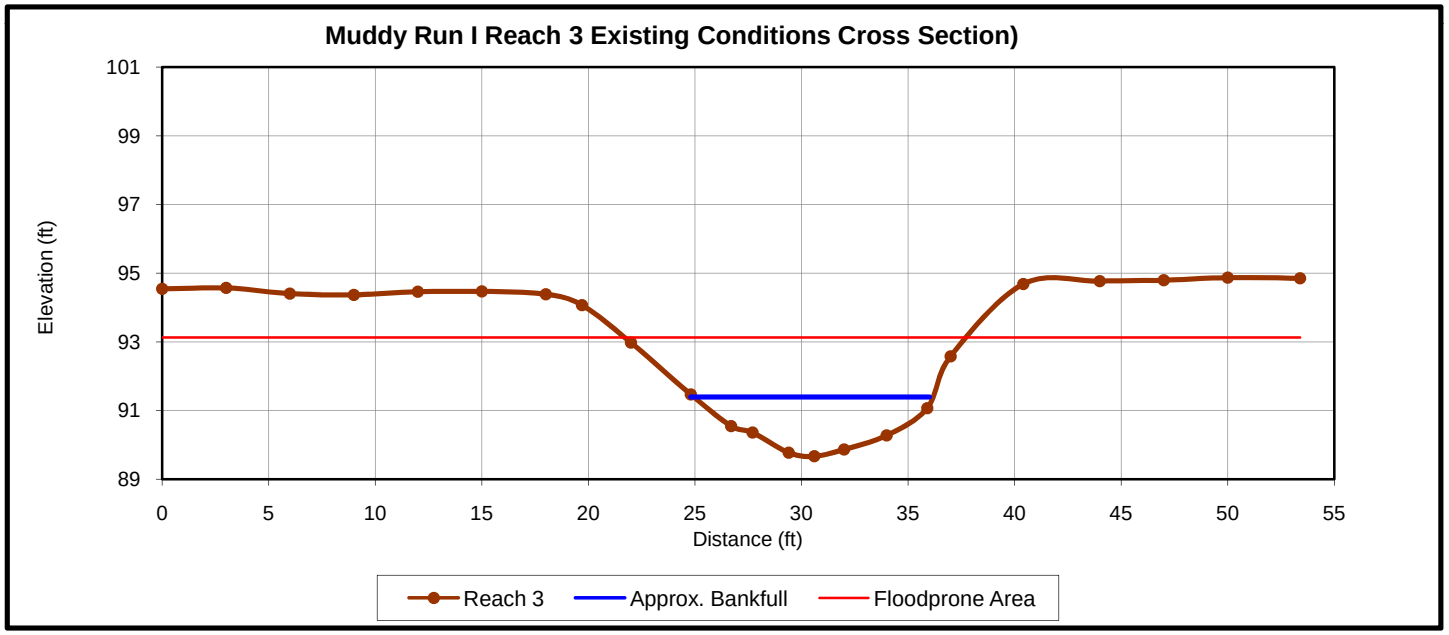
Upstream

Downstream



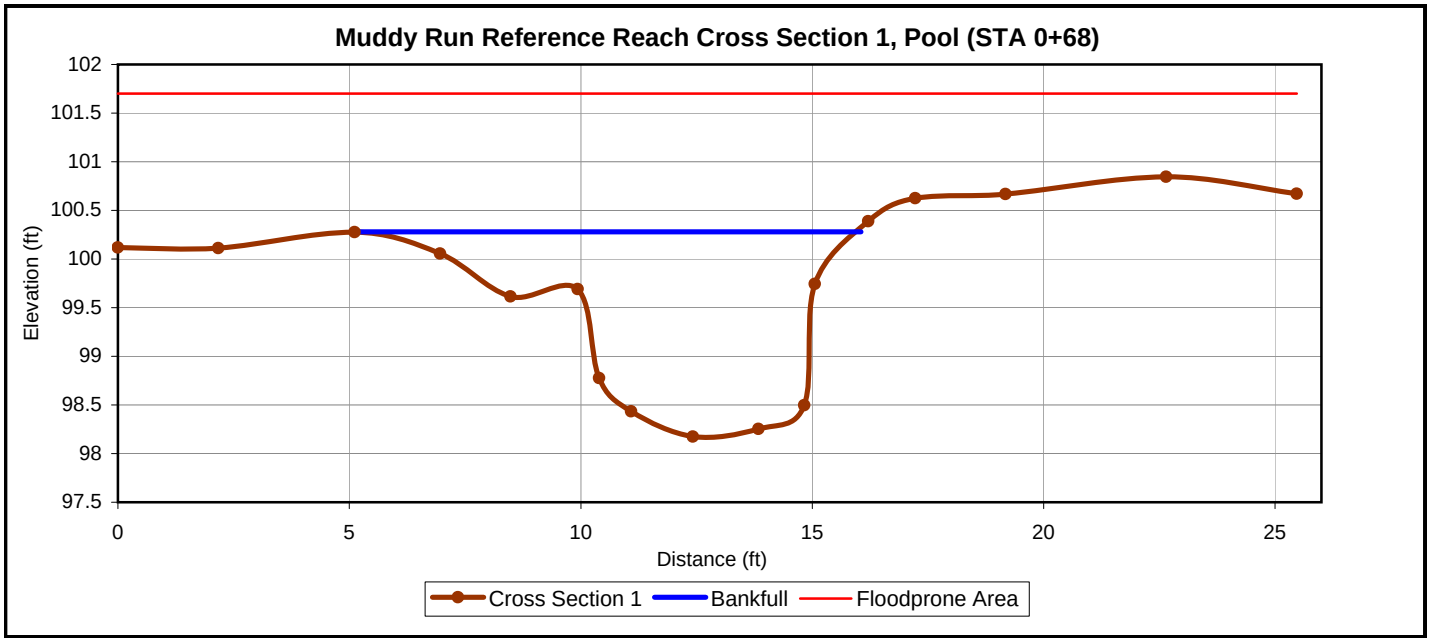
Upstream

Downstream



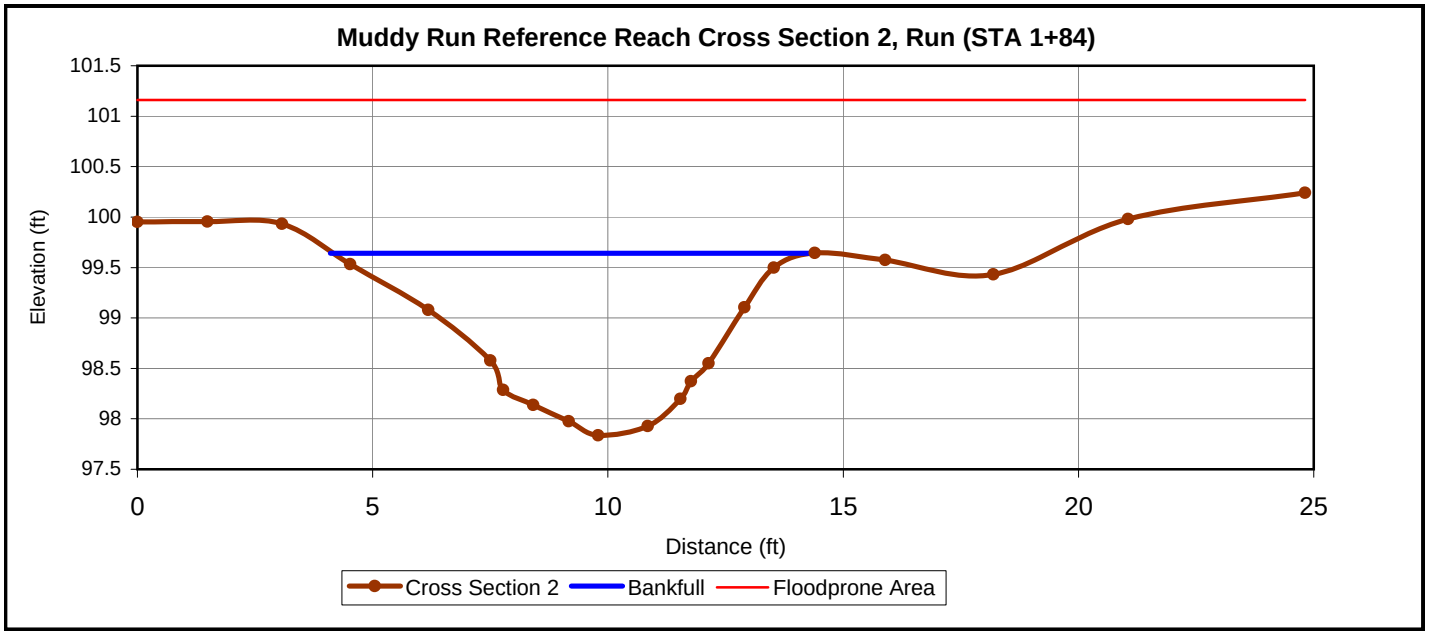
Upstream

Downstream



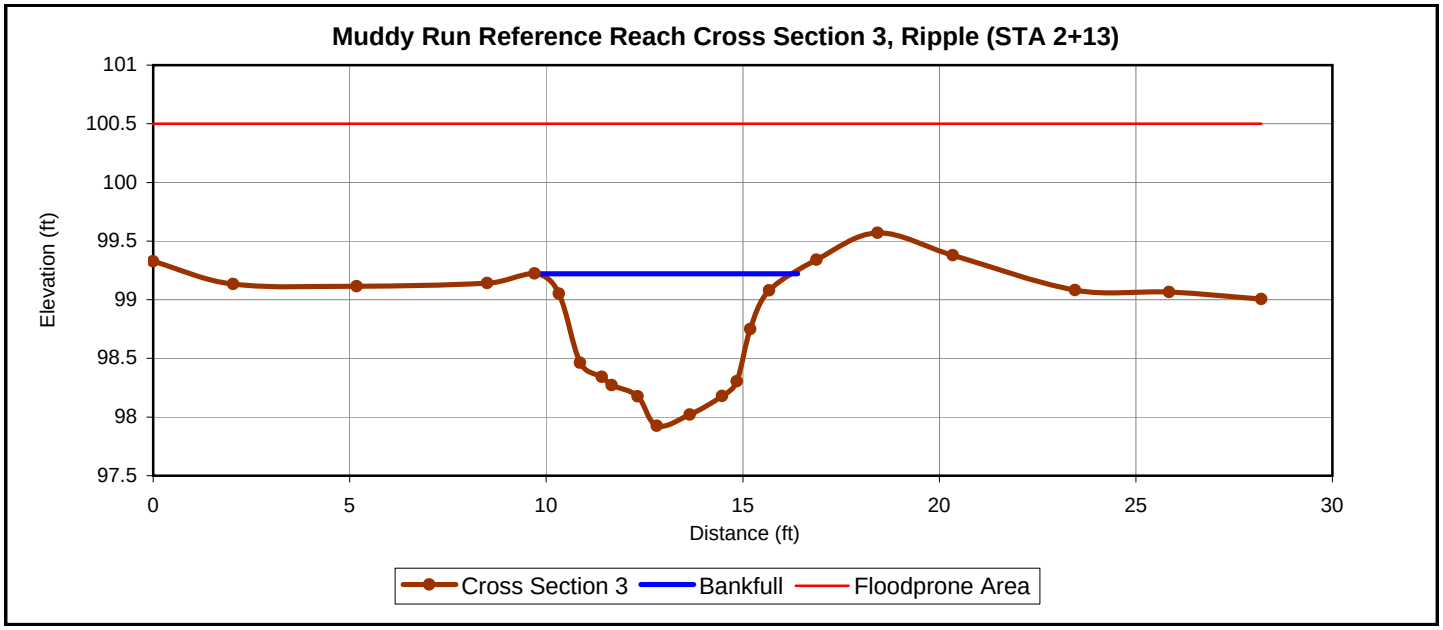
Upstream

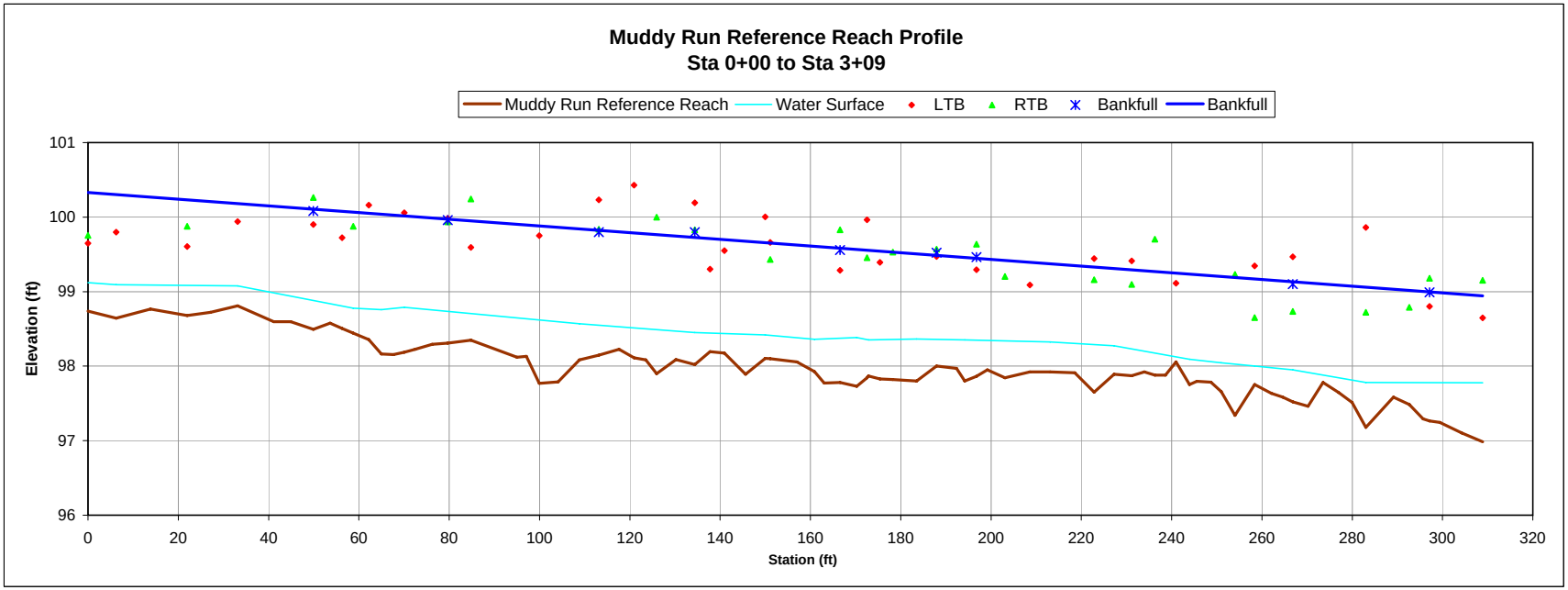
Downstream



Upstream

Downstream




Muddy Run Reference Profile
Sta 0+00 to Sta 3+09
Muddy Run Reference Reach
Water Surface
LTB
RTB
Bankfull
Bankfull
Elevation (ft)
101
100
99
98
97
96
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
Station (ft)

Muddy Run Morphological Parameters

	Reference Reach			Existing[1]					Design							
				MR1A	MR1B	MR1C	MR2	MR3	MR1B		MR1C		MR2		MR3	
Feature	Pool	Run	Ripple	Run	Run	Run	Run	Run	Ripple		Ripple		Ripple		Ripple	
Drainage Area (ac)	286	286	286	145	177	238	60	85	177		238		60		391	
NC Regional Curve Discharge (cfs)			9.3	6	7	8	3	4	7		8		3		12	
Design/Calculated Discharge (cfs)	---	---	13	---	---	---	---	---	9		13		4		19	
Dimension																
BF Width (ft)	10.9	8.9	7.0	6.6	7.3	9.7	6.9	7.2	8.2		9.5		5.6		11.4	
Floodprone Width (ft)	100	100	100	9.9	10.3	15.3	10.3	10.7	> 50		> 50		> 50		> 50	
BF Cross Sectional Area (ft^2)	11.4	8.4	5	5	4.4	5.6	3.6	3.3	6.6		8.9		3.1		13.1	
BF Mean Depth (ft)	1.0	0.9	0.8	0.8	0.6	0.6	0.5	0.5	0.8		0.9		0.6		1.1	
BF Max Depth (ft)	2.1	1.7	1.3	1.1	0.9	1.3	1.0	0.8	1.3		1.5		0.9		1.8	
Width/Depth Ratio	10.4	9.5	8.8	8.7	12.2	17.1	13.2	15.8	10		10		10		10	
Entrenchment Ratio	9.2	11.2	15.1	1.5	1.4	1.5	1.5	10.5	> 2.2		> 2.2		> 2.2		> 2.2	
Wetted Perimeter (ft)	12.8	9.7	7.4	6.9	7.7	10.3	7.2	7.4	8.7		10.1		5.9		12.1	
Hydraulic Radius (ft)	0.9	0.9	0.7	0.7	0.6	0.5	0.5	0.4	0.8		0.9		0.5		1.1	
Substrate																
	Fine Sand			Fine Sand					Fine Sand		Fine Sand		Fine Sand		Fine Sand	
Pattern																
	Min	**Max**	**Med**	---	---	---	---	---	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Channel Beltwidth (ft)	13.6	31.8	23.1	---	---	---	---	---	13.3	40.0	18.0	37.2	10.2	26.8	20.6	40.3
Radius of Curvature (ft)	11.0	27.6	17.6	---	---	---	---	---	11.4	40.4	14.8	40.8	8.9	21.7	22.8	46.5
Radius of Curvature Ratio	1.5	3.7	2.3						1.4	4.9	1.6	3.5	1.6	3.4	2.0	4.1
Meander Wavelength (ft)	34.9	68.3	54.5	---	---	---	---	---	23.2	89.9	33.2	71.2	16.2	48.6	56.5	144
Meander Width Ratio	1.8	4.2	3.1	---	---	---	---	---	1.6	4.9	1.9	3.9	1.8	4.8	1.8	3.5
Profile																
Ripple Length (ft)	3.1	30.7	12.6	---	---	---	---	---	5	72	10	72	4	62	25.9	39.9
Run Length (ft)	2.2	33.2	11.3	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Length (ft)	4.2	9.5	5.8	---	---	---	---	---	17	36	20	34	9	20	18.2	49.0
Pool -to-Pool Spacing (ft)	17.5	59.8	36.3	---	---	---	---	---	23	95	25	97	16	78	37.0	90.0
Additional Reach Parameters																
Valley Length (ft)	274			---	---	---	---	---	1485		1194		1560		554	
Channel Length (ft)	309			1638	1590	1324	1448	464	1642		1341		1670		624	
Sinuosity	1.1			1.0	1.0	1.0	1.0	1.0	1.1		1.1		1.1		1.1	
Water Surface Slope (ft/ft)	0.004			---	---	---	---	---	---		---		---		---	
Channel Slope (ft/ft)	0.003			0.0016	0.0033	0.0035	0.0032	0.0055	0.0022		0.0019		0.0023		0.0010	
Rosgen Classification	E5			G5c	F5	F5	F5	F5	E5		E5		E5		E5	
*Habitat Index																

[1] Bankfull stage was estimated using NC Regional Curve equations and existing conditions data

Muddy Run I Reach 1B

Hydraulic Design Data

Stable Channel Design Results - Copeland Method

d84(mm) = .50, D50(mm) = .20, D16(mm) = .062

Temperature (F)	55
Specific Gravity of Sediments	2.65
Unit Weight of Water (lb/cu ft)	62.385
Viscosity (sq ft/s)	1.32E-05
Discharge (cfs)	9

Upstream Channel

Sediment Concentration (ppm)	489.89	
Base Width (ft)	3.6	
Channel Slope (ft/ft)	0.0022	
	Left	Right
Side Slope	2.19	2.19
Roughness Eq	Manning	Manning
Roughness Value	0.048	0.048

Stable Channel

Median Channel Width (ft)	8.2	
Valley Slope(ft/ft)	0.0069	
	Left	Right
Side Slope	2.19	2.19
Roughness Eq	Manning	Manning
Roughness Value	0.048	0.048

Computed Stable Channels

Bottom Width	Depth	Energy Slope	Comp n-Value	Hyd Radius	Velocity	Froude Number	Shear Stress	Regime
1	1.4	0.004026	0.0454	0.72	1.66	0.25	0.34	Lower*
2	1.3	0.002849	0.0431	0.74	1.52	0.24	0.22	Lower
2	2.3	0.002864	0.0428	0.74	1.52	0.18	0.4	Lower
3	1.1	0.002388	0.0404	0.73	1.45	0.24	0.17	Lower
4	1	0.002136	0.0383	0.71	1.42	0.25	0.14	Lower
5	0.9	0.001975	0.0364	0.68	1.4	0.26	0.11	Lower
6	0.8	0.001875	0.0346	0.65	1.39	0.27	0.1	Lower
7	0.8	0.001789	0.0333	0.62	1.38	0.28	0.08	Lower
7	1.8	0.001807	0.0332	0.61	1.38	0.18	0.2	Lower
8	0.7	0.001763	0.0316	0.58	1.37	0.29	0.08	Lower
9	0.6	0.001743	0.0307	0.55	1.36	0.3	0.07	Lower
10	0.6	0.001733	0.0297	0.52	1.34	0.31	0.06	Lower
11	0.6	0.001736	0.029	0.49	1.33	0.32	0.06	Lower
11	1.6	0.001735	0.029	0.49	1.33	0.19	0.17	Lower
12	0.5	0.001738	0.0284	0.47	1.32	0.32	0.06	Lower
13	0.5	0.001748	0.0276	0.45	1.31	0.33	0.05	Lower
14	0.5	0.001775	0.0273	0.43	1.3	0.34	0.05	Lower
15	0.4	0.001783	0.0271	0.41	1.29	0.34	0.05	Lower
16	0.4	0.001815	0.0265	0.39	1.28	0.35	0.05	Lower
16	1.4	0.001813	0.0265	0.39	1.28	0.19	0.16	Lower
*******Solution for Minimum Stream Power*******								
10.3	0.6	0.00173	0.0294	0.51	1.34	0.31	0.06	Lower

Muddy Run I Reach 1C

Hydraulic Design Data

Stable Channel Design Results - Copeland Method

d84(mm) = .50, D50(mm) = .20, D16(mm) = .062

Temperature (F)	55	
Specific Gravity of Sediments	2.65	
Unit Weight of Water (lb/cu ft)	62.385	
Viscosity (sq ft/s)	1.32E-05	
Discharge (cfs)	12	

Upstream Channel

Sediment Concentration (ppm)	326.14	
Base Width (ft)	4.3	
Channel Slope (ft/ft)	0.0019	
	Left	Right
Side Slope	2.17	2.17
Roughness Eq	Manning	Manning
Roughness Value	0.05	0.05

Stable Channel

Median Channel Width (ft)	9.5	
Valley Slope(ft/ft)	0.0027	
	Left	Right
Side Slope	2.17	2.17
Roughness Eq	Manning	Manning
Roughness Value	0.05	0.05

Computed Stable Channels

Bottom Width	Depth	Energy Slope	Comp n-Value	Hyd Radius	Velocity	Froude Number	Shear Stress	Regime
1	1.7	0.002995	0.0467	0.86	1.57	0.22	0.31	Upper*
2	1.5	0.00267	0.0456	0.86	1.54	0.22	0.25	Lower
3	1.4	0.002213	0.0431	0.86	1.47	0.22	0.19	Lower
4	1.2	0.001959	0.041	0.84	1.44	0.23	0.15	Lower
5	1.1	0.001803	0.039	0.82	1.42	0.23	0.13	Lower
6	1	0.001698	0.0373	0.78	1.41	0.24	0.11	Lower
7	1	0.001623	0.0357	0.75	1.39	0.25	0.1	Lower
8	0.9	0.001577	0.0344	0.72	1.38	0.26	0.09	Lower
9	0.8	0.001537	0.0328	0.68	1.37	0.27	0.08	Lower
10	0.8	0.001506	0.0319	0.65	1.37	0.28	0.07	Lower
10	1.8	0.00152	0.0317	0.65	1.37	0.18	0.17	Lower
11	0.7	0.001507	0.0307	0.61	1.36	0.28	0.07	Lower
12	0.7	0.001499	0.0299	0.59	1.35	0.29	0.06	Lower
13	0.6	0.001503	0.0293	0.56	1.34	0.3	0.06	Lower
14	0.6	0.001508	0.0287	0.54	1.33	0.3	0.06	Lower
15	0.6	0.001515	0.0281	0.51	1.32	0.31	0.05	Lower
16	0.5	0.001526	0.0275	0.49	1.31	0.32	0.05	Lower
17	0.5	0.001543	0.0273	0.47	1.3	0.32	0.05	Lower
18	0.5	0.001552	0.0271	0.46	1.29	0.33	0.05	Lower
19	0.5	0.001581	0.0263	0.44	1.28	0.33	0.05	Lower
*******Solution for Minimum Stream Power*******								
12.2	0.7	0.0015	0.0297	0.58	1.35	0.29	0.06	Lower

Muddy Run I Reach 2

Hydraulic Design Data

Stable Channel Design Results - Copeland Method

d84(mm) = .50, D50(mm) = .20, D16(mm) = .062

Temperature (F)	55
Specific Gravity of Sediments	2.65
Unit Weight of Water (lb/cu ft)	62.385
Viscosity (sq ft/s)	1.32E-05
Discharge (cfs)	4

Upstream Channel

Sediment Concentration (ppm)	291.03	
Base Width (ft)	2.6	
Channel Slope (ft/ft)	0.0021	
	Left	Right
Side Slope	2.14	2.14
Roughness Eq	Manning	Manning
Roughness Value	0.04	0.04

Stable Channel

Median Channel Width (ft)	6	
Valley Slope(ft/ft)	0.0035	
	Left	Right
Side Slope	2.14	2.14
Roughness Eq	Manning	Manning
Roughness Value	0.04	0.04

Computed Stable Channels

Bottom Width	Depth	Energy Slope	Comp n-Value	Hyd Radius	Velocity	Froude Number	Shear Stress	Regime
1	0.9	0.003148	0.0374	0.52	1.44	0.26	0.18	Lower
1	1.9	0.003153	0.0374	0.52	1.44	0.18	0.38	Lower
2	0.8	0.002311	0.0351	0.52	1.33	0.26	0.12	Lower
2	1.8	0.002334	0.0349	0.52	1.32	0.17	0.26	Lower
3	0.7	0.002021	0.0327	0.5	1.28	0.27	0.09	Lower
4	0.6	0.001841	0.031	0.47	1.26	0.28	0.07	Lower
4	1.6	0.001855	0.0307	0.47	1.25	0.17	0.19	Lower
5	0.5	0.00179	0.029	0.43	1.23	0.3	0.06	Lower
5	1.5	0.001782	0.0292	0.43	1.23	0.18	0.17	Lower
6	0.5	0.001761	0.0283	0.4	1.21	0.31	0.05	Lower
7	0.4	0.001764	0.0271	0.37	1.19	0.32	0.05	Lower
7	1.4	0.001767	0.0271	0.37	1.19	0.18	0.16	Lower
8	0.4	0.001782	0.0263	0.35	1.18	0.33	0.04	Lower
8	1.4	0.001789	0.0265	0.35	1.18	0.18	0.15	Lower
9	0.4	0.001815	0.0257	0.32	1.16	0.34	0.04	Lower
10	0.3	0.00186	0.025	0.3	1.14	0.35	0.04	Lower
10	1.3	0.001843	0.0251	0.3	1.14	0.17	0.15	Lower
11	0.3	0.001888	0.0248	0.29	1.13	0.36	0.04	Lower
11	1.3	0.001887	0.0248	0.29	1.13	0.17	0.15	Lower
12	0.3	0.001935	0.0243	0.27	1.11	0.37	0.03	Lower
*******Solution for Minimum Stream Power*******								
6.4	0.5	0.001771	0.0275	0.39	1.2	0.32	0.05	Lower

Muddy Run I Reach 3

Hydraulic Design Data

Stable Channel Design Results - Copeland Method

d84(mm) = .50, D50(mm) = .20, D16(mm) = .062

Temperature (F)	55
Specific Gravity of Sediments	2.65
Unit Weight of Water (lb/cu ft)	62.385
Viscosity (sq ft/s)	1.32E-05
Discharge (cfs)	19

Upstream Channel

Sediment Concentration (ppm)	152.12	
Base Width (ft)	5.2	
Channel Slope (ft/ft)	0.0011	
	Left	Right
Side Slope	2.13	2.13
Roughness Eq	Manning	Manning
Roughness Value	0.048	0.048

Stable Channel

Median Channel Width (ft)	11.4	
Valley Slope(ft/ft)	0.0041	
	Left	Right
Side Slope	2.13	2.13
Roughness Eq	Manning	Manning
Roughness Value	0.048	0.048

Computed Stable Channels

Bottom Width	Depth	Energy Slope	Comp n-Value	Hyd Radius	Velocity	Froude Number	Shear Stress	Regime
1	2.1	0.002365	0.0458	1.06	1.62	0.2	0.31	Lower
2	2	0.001675	0.0441	1.11	1.47	0.18	0.21	Lower
3	1.9	0.001374	0.0428	1.13	1.4	0.18	0.16	Lower
5	1.7	0.001105	0.0395	1.11	1.34	0.18	0.11	Lower
6	1.5	0.001028	0.0381	1.08	1.32	0.19	0.1	Lower
7	1.4	0.000977	0.0368	1.05	1.31	0.19	0.09	Lower
8	1.3	0.000939	0.0355	1.02	1.3	0.2	0.08	Lower
9	1.3	0.00091	0.0344	0.99	1.29	0.2	0.07	Lower
10	1.2	0.00089	0.0334	0.95	1.29	0.21	0.07	Lower
11	1.1	0.000869	0.0321	0.91	1.28	0.21	0.06	Lower
13	1	0.00085	0.0305	0.85	1.27	0.22	0.05	Lower
14	0.9	0.000843	0.03	0.82	1.26	0.23	0.05	Lower
15	0.9	0.000842	0.0293	0.79	1.26	0.23	0.05	Lower
16	0.9	0.000843	0.029	0.76	1.25	0.24	0.04	Lower
17	0.8	0.000842	0.0285	0.74	1.25	0.24	0.04	Lower
18	0.8	0.000847	0.028	0.71	1.24	0.25	0.04	Lower
19	0.8	0.00085	0.0276	0.69	1.23	0.25	0.04	Lower
21	0.7	0.000868	0.0268	0.64	1.22	0.26	0.04	Lower
22	0.7	0.000868	0.0267	0.63	1.21	0.26	0.04	Lower
23	0.6	0.000878	0.0263	0.61	1.2	0.26	0.04	Lower
*******Solution for Minimum Stream Power*******								
15	0.9	0.000846	0.0292	0.78	1.25	0.23	0.05	Lower

Muddy Run I Reach 1B

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Power Total	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	(lb/ft s)	(lb/sq ft)
MR1B	1610	BKF Q	9	46.92	48.15		48.19	0.0026	1.47	6.10	7.90	0.18	0.12
MR1B	1610	Q5yr	57	46.92	49.58		49.68	0.0022	2.67	35.20	42.70	0.18	0.28
MR1B	1610	Q10yr	85	46.92	49.98		50.08	0.0022	2.96	55.17	58.49	0.19	0.33
MR1B	1610	Q25yr	131	46.92	50.44		50.55	0.0021	3.29	86.61	77.05	0.22	0.38
MR1B	1591	BKF Q	9	46.88	48.10		48.13	0.0028	1.50	6.00	7.85	0.19	0.12
MR1B	1591	Q5yr	57	46.88	49.54		49.63	0.0022	2.67	35.13	42.64	0.18	0.28
MR1B	1591	Q10yr	85	46.88	49.94		50.04	0.0022	2.96	55.11	58.45	0.19	0.33
MR1B	1591	Q25yr	131	46.88	50.40		50.51	0.0021	3.29	86.57	77.03	0.22	0.38
MR1B	1582	BKF Q	9	46.26	48.11		48.12	0.0006	0.87	10.32	9.30	0.03	0.04
MR1B	1582	Q5yr	57	46.26	49.55		49.61	0.0011	2.07	42.44	45.16	0.09	0.16
MR1B	1582	Q10yr	85	46.26	49.94		50.01	0.0012	2.41	63.15	60.80	0.11	0.21
MR1B	1582	Q25yr	131	46.26	50.40		50.49	0.0014	2.81	95.22	79.13	0.14	0.27
MR1B	1573	BKF Q	9	46.24	48.10		48.11	0.0006	0.86	10.46	9.35	0.03	0.04
MR1B	1573	Q5yr	57	46.24	49.54		49.60	0.0011	2.05	42.92	45.58	0.08	0.16
MR1B	1573	Q10yr	85	46.24	49.93		50.00	0.0012	2.40	63.70	61.16	0.10	0.21
MR1B	1573	Q25yr	131	46.24	50.39		50.47	0.0014	2.79	95.83	79.44	0.14	0.27
MR1B	1563	BKF Q	9	46.82	48.07		48.10	0.0025	1.45	6.22	7.97	0.17	0.12
MR1B	1563	Q5yr	57	46.82	49.49		49.58	0.0021	2.65	35.49	42.98	0.18	0.28
MR1B	1563	Q10yr	85	46.82	49.88		49.98	0.0021	2.95	55.57	58.76	0.19	0.32
MR1B	1563	Q25yr	131	46.82	50.35		50.46	0.0021	3.28	87.13	77.32	0.22	0.38
MR1B	1552	BKF Q	9	46.79	48.04		48.07	0.0025	1.44	6.24	7.98	0.17	0.11
MR1B	1552	Q5yr	57	46.79	49.47		49.56	0.0021	2.64	35.78	43.25	0.17	0.27
MR1B	1552	Q10yr	85	46.79	49.86		49.96	0.0021	2.93	55.97	59.04	0.19	0.32
MR1B	1552	Q25yr	131	46.79	50.33		50.43	0.0021	3.26	87.69	77.60	0.22	0.37
MR1B	1545	BKF Q	9	46.08	48.05		48.06	0.0006	0.84	10.67	9.38	0.03	0.04
MR1B	1545	Q5yr	57	46.08	49.48		49.54	0.0011	2.04	42.93	45.46	0.08	0.16
MR1B	1545	Q10yr	85	46.08	49.87		49.94	0.0013	2.38	63.74	61.09	0.11	0.21
MR1B	1545	Q25yr	131	46.08	50.33		50.41	0.0014	2.77	95.98	79.44	0.14	0.26
MR1B	1535	BKF Q	9	46.06	48.04		48.05	0.0005	0.83	10.80	9.43	0.03	0.03
MR1B	1535	Q5yr	57	46.06	49.47		49.52	0.0011	2.03	43.34	45.82	0.08	0.16
MR1B	1535	Q10yr	85	46.06	49.86		49.93	0.0012	2.37	64.21	61.39	0.10	0.20
MR1B	1535	Q25yr	131	46.06	50.31		50.40	0.0014	2.76	96.47	79.69	0.14	0.26
MR1B	1525	BKF Q	9	46.73	48.01		48.04	0.0022	1.39	6.49	8.12	0.15	0.11
MR1B	1525	Q5yr	57	46.73	49.42		49.51	0.0021	2.61	36.31	43.73	0.17	0.27
MR1B	1525	Q10yr	85	46.73	49.81		49.91	0.0021	2.91	56.58	59.45	0.18	0.31
MR1B	1525	Q25yr	131	46.73	50.27		50.38	0.0020	3.24	88.43	77.99	0.21	0.37
MR1B	1510	BKF Q	9	46.70	47.98		48.01	0.0023	1.39	6.46	8.10	0.15	0.11
MR1B	1510	Q5yr	57	46.70	49.39		49.48	0.0021	2.62	36.26	43.69	0.17	0.27
MR1B	1510	Q10yr	85	46.70	49.78		49.88	0.0021	2.91	56.53	59.42	0.18	0.31
MR1B	1510	Q25yr	131	46.70	50.24		50.35	0.0020	3.24	88.38	77.96	0.21	0.37
MR1B	1504	BKF Q	9	46.09	47.98		48.00	0.0005	0.83	10.78	9.48	0.03	0.03
MR1B	1504	Q5yr	57	46.09	49.40		49.46	0.0011	2.04	43.32	45.93	0.08	0.16
MR1B	1504	Q10yr	85	46.09	49.79		49.86	0.0012	2.38	64.23	61.50	0.10	0.20
MR1B	1504	Q25yr	131	46.09	50.25		50.33	0.0014	2.78	96.60	79.83	0.14	0.26
MR1B	1496	BKF Q	9	46.07	47.98		47.99	0.0005	0.82	10.94	9.65	0.03	0.03
MR1B	1496	Q5yr	57	46.07	49.39		49.45	0.0010	2.03	43.88	46.41	0.08	0.15
MR1B	1496	Q10yr	85	46.07	49.78		49.85	0.0012	2.37	64.91	61.94	0.10	0.20
MR1B	1496	Q25yr	131	46.07	50.24		50.32	0.0013	2.76	97.35	80.20	0.13	0.26
MR1B	1485	BKF Q	9	46.65	47.95		47.98	0.0021	1.35	6.66	8.22	0.13	0.10
MR1B	1485	Q5yr	57	46.65	49.34		49.43	0.0020	2.61	36.48	43.89	0.16	0.27
MR1B	1485	Q10yr	85	46.65	49.73		49.83	0.0020	2.90	56.76	59.57	0.18	0.31
MR1B	1485	Q25yr	131	46.65	50.20		50.30	0.0020	3.24	88.61	78.08	0.21	0.37
MR1B	1470	BKF Q	9	46.61	47.92	47.29	47.95	0.0020	1.34	6.74	8.35	0.13	0.10
MR1B	1470	Q5yr	57	46.61	49.31	48.27	49.40	0.0020	2.59	36.95	44.31	0.16	0.26
MR1B	1470	Q10yr	85	46.61	49.70	48.63	49.80	0.0020	2.88	57.35	59.97	0.18	0.31
MR1B	1470	Q25yr	131	46.61	50.17	49.19	50.27	0.0020	3.21	89.39	78.48	0.21	0.36

Muddy Run I Reach 1C

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Power Total	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	(lb/ft s)	(lb/sq ft)
MR1C	1300	BKF Q	12	42.51	43.97		44.00	0.0019	1.41	8.53	9.32	0.15	0.10
MR1C	1300	Q5yr	69	42.51	45.46		45.55	0.0018	2.56	43.48	47.70	0.16	0.25
MR1C	1300	Q10yr	102	42.51	45.89		45.99	0.0018	2.85	67.37	64.70	0.17	0.29
MR1C	1300	Q25yr	156	42.51	46.39		46.49	0.0018	3.18	104.46	84.58	0.20	0.35
MR1C	1225	BKF Q	12	42.39	43.81		43.84	0.0021	1.46	8.19	9.16	0.17	0.11
MR1C	1225	Q5yr	69	42.39	45.33		45.42	0.0018	2.59	42.66	47.00	0.16	0.26
MR1C	1225	Q10yr	102	42.39	45.75		45.85	0.0018	2.88	66.32	64.04	0.18	0.30
MR1C	1225	Q25yr	156	42.39	46.25		46.36	0.0018	3.21	103.04	83.90	0.21	0.35
MR1C	1213	BKF Q	12	41.67	43.82		43.83	0.0005	0.85	14.04	10.80	0.03	0.03
MR1C	1213	Q5yr	69	41.67	45.34		45.39	0.0009	2.00	50.45	45.54	0.08	0.15
MR1C	1213	Q10yr	102	41.67	45.76		45.83	0.0010	2.36	72.61	59.95	0.11	0.19
MR1C	1213	Q25yr	156	41.67	46.24		46.33	0.0012	2.80	105.93	76.67	0.15	0.26
MR1C	1203	BKF Q	12	41.65	43.81		43.82	0.0004	0.84	14.21	10.86	0.03	0.03
MR1C	1203	Q5yr	69	41.65	45.33		45.38	0.0009	1.99	50.97	45.94	0.08	0.14
MR1C	1203	Q10yr	102	41.65	45.75		45.82	0.0010	2.35	73.19	60.28	0.11	0.19
MR1C	1203	Q25yr	156	41.65	46.23		46.32	0.0012	2.79	106.54	76.95	0.15	0.26
MR1C	1190	BKF Q	12	42.33	43.78		43.81	0.0020	1.42	8.45	9.28	0.15	0.11
MR1C	1190	Q5yr	69	42.33	45.28		45.36	0.0018	2.58	43.02	47.31	0.16	0.25
MR1C	1190	Q10yr	102	42.33	45.70		45.80	0.0018	2.87	66.67	64.27	0.18	0.30
MR1C	1190	Q25yr	156	42.33	46.20		46.30	0.0018	3.20	103.48	84.11	0.21	0.35
MR1C	1180	BKF Q	12	42.32	43.76		43.79	0.0020	1.44	8.35	9.23	0.16	0.11
MR1C	1180	Q5yr	69	42.32	45.26		45.35	0.0018	2.59	42.61	46.96	0.17	0.26
MR1C	1180	Q10yr	102	42.32	45.68		45.78	0.0018	2.89	66.11	63.92	0.18	0.30
MR1C	1180	Q25yr	156	42.32	46.18		46.28	0.0018	3.22	102.72	83.75	0.21	0.35
MR1C	1170	BKF Q	12	41.50	43.76		43.78	0.0005	0.85	14.19	10.86	0.03	0.03
MR1C	1170	Q5yr	69	41.50	45.27		45.32	0.0009	1.98	51.97	49.72	0.08	0.14
MR1C	1170	Q10yr	102	41.50	45.69		45.76	0.0011	2.31	76.39	66.53	0.10	0.19
MR1C	1170	Q25yr	156	41.50	46.18		46.26	0.0012	2.70	113.92	86.19	0.13	0.24
MR1C	1159	BKF Q	12	41.48	43.76		43.77	0.0005	0.84	14.35	10.92	0.03	0.03
MR1C	1159	Q5yr	69	41.48	45.26		45.31	0.0009	1.97	52.46	50.12	0.08	0.14
MR1C	1159	Q10yr	102	41.48	45.68		45.74	0.0010	2.30	76.97	66.87	0.10	0.19
MR1C	1159	Q25yr	156	41.48	46.17		46.25	0.0012	2.69	114.53	86.47	0.13	0.24
MR1C	1150	BKF Q	12	42.27	43.73		43.76	0.0019	1.40	8.55	9.33	0.14	0.10
MR1C	1150	Q5yr	69	42.27	45.21		45.30	0.0018	2.59	42.66	47.00	0.16	0.26
MR1C	1150	Q10yr	102	42.27	45.63		45.73	0.0018	2.89	66.03	63.86	0.18	0.30
MR1C	1150	Q25yr	156	42.27	46.13		46.23	0.0018	3.22	102.65	83.72	0.21	0.35
MR1C	1110	BKF Q	12	42.21	43.65		43.68	0.0020	1.44	8.36	9.24	0.16	0.11
MR1C	1110	Q5yr	69	42.21	45.13		45.22	0.0019	2.62	41.89	46.34	0.17	0.26
MR1C	1110	Q10yr	102	42.21	45.55		45.65	0.0019	2.92	64.99	63.21	0.19	0.31
MR1C	1110	Q25yr	156	42.21	46.05		46.16	0.0019	3.26	101.28	83.06	0.22	0.36
MR1C	1099	BKF Q	12	41.49	43.66		43.67	0.0004	0.84	14.25	10.87	0.03	0.03
MR1C	1099	Q5yr	69	41.49	45.14		45.20	0.0009	2.01	49.78	45.04	0.09	0.15
MR1C	1099	Q10yr	102	41.49	45.56		45.63	0.0011	2.38	71.48	59.30	0.11	0.20
MR1C	1099	Q25yr	156	41.49	46.04		46.14	0.0013	2.82	104.46	76.01	0.16	0.27
MR1C	1088	BKF Q	12	41.47	43.65		43.66	0.0004	0.83	14.41	10.93	0.03	0.03
MR1C	1088	Q5yr	69	41.47	45.13		45.19	0.0009	2.00	50.15	45.32	0.08	0.15
MR1C	1088	Q10yr	102	41.47	45.54		45.62	0.0011	2.37	71.84	59.51	0.11	0.20
MR1C	1088	Q25yr	156	41.47	46.03		46.12	0.0012	2.82	104.75	76.14	0.16	0.26
MR1C	1075	BKF Q	12	42.15	43.62		43.65	0.0019	1.39	8.63	9.36	0.14	0.10
MR1C	1075	Q5yr	69	42.15	45.07		45.17	0.0019	2.61	42.07	46.50	0.17	0.26
MR1C	1075	Q10yr	102	42.15	45.49		45.60	0.0019	2.92	65.06	63.26	0.19	0.31
MR1C	1075	Q25yr	156	42.15	45.99		46.10	0.0019	3.25	101.33	83.08	0.22	0.36
MR1C	1045	BKF Q	12	42.10	43.56	42.85	43.59	0.0019	1.40	8.56	9.33	0.14	0.10
MR1C	1045	Q5yr	69	42.10	45.02	43.86	45.11	0.0019	2.63	41.69	46.17	0.17	0.26
MR1C	1045	Q10yr	102	42.10	45.44	44.25	45.54	0.0019	2.93	64.59	62.95	0.19	0.31
MR1C	1045	Q25yr	156	42.10	45.93	44.82	46.04	0.0019	3.27	100.70	82.78	0.22	0.37

Muddy Run I Reach 2

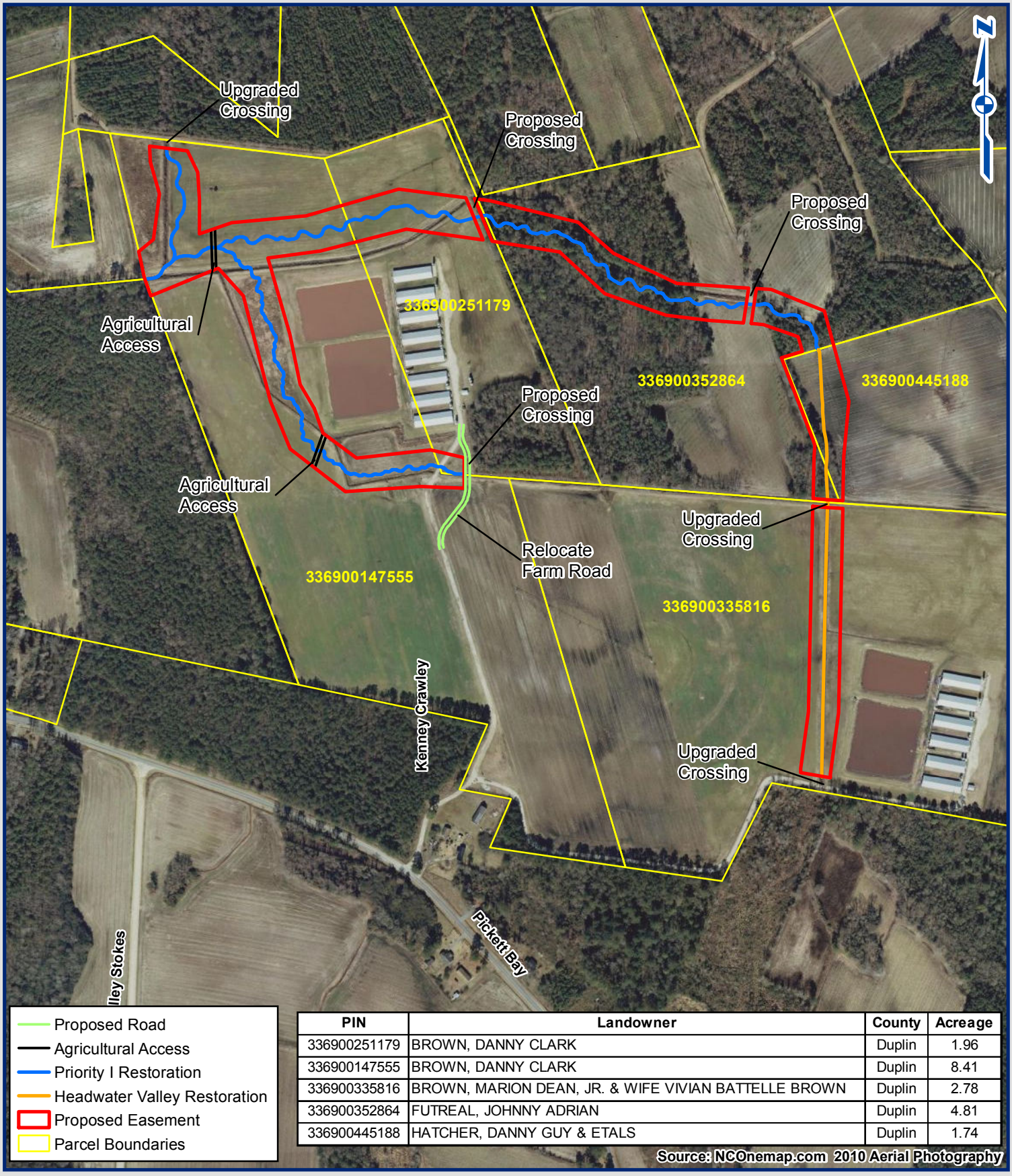
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Power Total	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	(lb/ft s)	(lb/sq ft)
MR2	2050	BKF Q	4	41.92	42.83		42.85	0.0024	1.25	3.19	5.74	0.10	0.08
MR2	2050	Q5yr	29	41.92	43.99		44.06	0.0020	2.44	21.08	32.30	0.11	0.21
MR2	2050	Q10yr	44	41.92	44.31		44.40	0.0020	2.73	33.73	45.34	0.12	0.24
MR2	2050	Q25yr	69	41.92	44.69		44.79	0.0020	3.06	53.92	60.58	0.14	0.29
MR2	2032	BKF Q	4	41.88	42.79		42.81	0.0024	1.26	3.17	5.70	0.10	0.08
MR2	2032	Q5yr	29	41.88	43.95		44.03	0.0020	2.43	21.20	32.45	0.11	0.21
MR2	2032	Q10yr	44	41.88	44.28		44.36	0.0020	2.72	33.91	45.49	0.12	0.24
MR2	2032	Q25yr	69	41.88	44.66		44.75	0.0020	3.05	54.15	60.74	0.14	0.29
MR2	2025	BKF Q	4	41.47	42.79		42.80	0.0006	0.78	5.15	6.67	0.02	0.03
MR2	2025	Q5yr	29	41.47	43.96		44.01	0.0011	1.96	24.58	33.91	0.06	0.13
MR2	2025	Q10yr	44	41.47	44.28		44.34	0.0013	2.29	37.61	46.82	0.07	0.17
MR2	2025	Q25yr	69	41.47	44.66		44.73	0.0014	2.67	58.06	61.87	0.10	0.22
MR2	2018	BKF Q	4	41.46	42.79		42.80	0.0006	0.77	5.19	6.75	0.02	0.03
MR2	2018	Q5yr	29	41.46	43.95		44.00	0.0011	1.95	24.65	33.99	0.06	0.13
MR2	2018	Q10yr	44	41.46	44.27		44.33	0.0013	2.29	37.65	46.86	0.07	0.17
MR2	2018	Q25yr	69	41.46	44.65		44.72	0.0014	2.67	58.05	61.87	0.10	0.22
MR2	2012	BKF Q	4	41.84	42.77		42.79	0.0022	1.22	3.27	5.93	0.09	0.07
MR2	2012	Q5yr	29	41.84	43.92		43.99	0.0020	2.42	21.34	32.63	0.11	0.20
MR2	2012	Q10yr	44	41.84	44.24		44.32	0.0020	2.71	34.07	45.64	0.12	0.24
MR2	2012	Q25yr	69	41.84	44.62		44.71	0.0020	3.04	54.35	60.87	0.14	0.29
MR2	1988	BKF Q	4	41.80	42.71		42.73	0.0024	1.26	3.18	5.72	0.10	0.08
MR2	1988	Q5yr	29	41.80	43.87		43.94	0.0020	2.44	21.05	32.27	0.11	0.21
MR2	1988	Q10yr	44	41.80	44.19		44.28	0.0020	2.74	33.67	45.28	0.12	0.25
MR2	1988	Q25yr	69	41.80	44.57		44.66	0.0020	3.06	53.81	60.51	0.14	0.29
MR2	1982	BKF Q	4	41.33	42.71		42.72	0.0006	0.77	5.18	6.84	0.02	0.03
MR2	1982	Q5yr	29	41.33	43.88		43.93	0.0012	1.95	24.79	34.22	0.06	0.13
MR2	1982	Q10yr	44	41.33	44.20		44.26	0.0013	2.27	37.92	47.13	0.07	0.17
MR2	1982	Q25yr	69	41.33	44.57		44.65	0.0014	2.64	58.51	62.20	0.10	0.21
MR2	1975	BKF Q	4	41.32	42.71		42.72	0.0006	0.77	5.22	6.92	0.02	0.03
MR2	1975	Q5yr	29	41.32	43.87		43.92	0.0012	1.94	24.85	34.30	0.06	0.13
MR2	1975	Q10yr	44	41.32	44.19		44.25	0.0013	2.27	37.95	47.16	0.07	0.17
MR2	1975	Q25yr	69	41.32	44.56		44.64	0.0014	2.64	58.49	62.18	0.10	0.21
MR2	1970	BKF Q	4	41.76	42.69		42.71	0.0021	1.22	3.29	5.98	0.08	0.07
MR2	1970	Q5yr	29	41.76	43.83		43.91	0.0020	2.43	21.26	32.53	0.11	0.20
MR2	1970	Q10yr	44	41.76	44.16		44.24	0.0020	2.72	33.92	45.51	0.12	0.24
MR2	1970	Q25yr	69	41.76	44.54		44.63	0.0020	3.05	54.11	60.71	0.14	0.29
MR2	1959	BKF Q	4	41.74	42.66		42.69	0.0024	1.26	3.17	5.79	0.10	0.08
MR2	1959	Q5yr	29	41.74	43.81		43.89	0.0021	2.48	20.90	32.24	0.12	0.21
MR2	1959	Q10yr	44	41.74	44.13		44.22	0.0021	2.77	33.50	45.26	0.13	0.25
MR2	1959	Q25yr	69	41.74	44.51		44.61	0.0021	3.09	53.64	60.52	0.15	0.30
MR2	1956	BKF Q	4	41.33	42.67		42.68	0.0005	0.76	5.29	6.93	0.02	0.03
MR2	1956	Q5yr	29	41.33	43.82		43.87	0.0011	1.95	24.74	34.10	0.06	0.13
MR2	1956	Q10yr	44	41.33	44.14		44.21	0.0013	2.28	37.80	46.98	0.07	0.17
MR2	1956	Q25yr	69	41.33	44.52		44.60	0.0014	2.66	58.30	62.03	0.10	0.21
MR2	1950	BKF Q	4	41.32	42.67		42.68	0.0005	0.75	5.33	7.02	0.02	0.03
MR2	1950	Q5yr	29	41.32	43.82		43.87	0.0011	1.95	24.86	34.23	0.06	0.13
MR2	1950	Q10yr	44	41.32	44.14		44.20	0.0013	2.28	37.92	47.08	0.07	0.17
MR2	1950	Q25yr	69	41.32	44.51		44.59	0.0014	2.66	58.40	62.09	0.10	0.21
MR2	1945	BKF Q	4	41.71	42.65		42.67	0.0020	1.20	3.35	6.10	0.08	0.07
MR2	1945	Q5yr	29	41.71	43.78		43.86	0.0020	2.43	21.22	32.48	0.11	0.20
MR2	1945	Q10yr	44	41.71	44.11		44.19	0.0020	2.72	33.87	45.46	0.12	0.24
MR2	1945	Q25yr	69	41.71	44.49		44.58	0.0020	3.05	54.08	60.69	0.14	0.29
MR2	1911	BKF Q	4	41.64	42.58	42.14	42.60	0.0020	1.19	3.36	6.12	0.08	0.07
MR2	1911	Q5yr	29	41.64	43.71	42.95	43.79	0.0020	2.43	21.28	32.54	0.11	0.20
MR2	1911	Q10yr	44	41.64	44.04	43.23	44.12	0.0020	2.72	33.96	45.54	0.12	0.24
MR2	1911	Q25yr	69	41.64	44.42	43.68	44.51	0.0020	3.05	54.20	60.77	0.14	0.29

Muddy Run I Reach 3

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Power Total (lb/ft s)	Shear Chan (lb/sq ft)
MR3	2850	BKF Q	18	39.74	41.53		41.56	0.0011	1.39	12.96	11.36	0.11	0.08
MR3	2850	Q5yr	94	39.74	43.24		43.32	0.0011	2.46	63.59	59.31	0.10	0.18
MR3	2850	Q10yr	139	39.74	43.74		43.83	0.0011	2.75	98.81	79.59	0.12	0.21
MR3	2850	Q25yr	210	39.74	44.33		44.43	0.0011	3.06	152.30	103.03	0.14	0.25
MR3	2832	BKF Q	18	39.72	41.51		41.54	0.0012	1.39	12.92	11.35	0.11	0.08
MR3	2832	Q5yr	94	39.72	43.22		43.30	0.0011	2.46	63.52	59.26	0.10	0.18
MR3	2832	Q10yr	139	39.72	43.73		43.82	0.0011	2.75	98.71	79.54	0.12	0.21
MR3	2832	Q25yr	210	39.72	44.31		44.41	0.0011	3.07	152.17	102.97	0.14	0.25
MR3	2826	BKF Q	18	38.92	41.52		41.53	0.0003	0.87	20.80	13.26	0.02	0.03
MR3	2826	Q5yr	94	38.92	43.23		43.29	0.0006	1.92	75.62	61.94	0.05	0.10
MR3	2826	Q10yr	139	38.92	43.74		43.80	0.0006	2.24	111.96	82.12	0.06	0.14
MR3	2826	Q25yr	210	38.92	44.32		44.40	0.0007	2.61	166.48	105.38	0.09	0.17
MR3	2814	BKF Q	18	38.90	41.52		41.53	0.0003	0.86	20.92	13.38	0.02	0.03
MR3	2814	Q5yr	94	38.90	43.23		43.28	0.0005	1.92	75.96	62.16	0.05	0.10
MR3	2814	Q10yr	139	38.90	43.73		43.80	0.0006	2.24	112.34	82.30	0.06	0.13
MR3	2814	Q25yr	210	38.90	44.31		44.39	0.0007	2.60	166.87	105.53	0.08	0.17
MR3	2806	BKF Q	18	39.70	41.49		41.52	0.0011	1.38	13.02	11.39	0.11	0.08
MR3	2806	Q5yr	94	39.70	43.19		43.27	0.0011	2.47	63.29	59.10	0.11	0.18
MR3	2806	Q10yr	139	39.70	43.70		43.79	0.0011	2.76	98.44	79.40	0.12	0.21
MR3	2806	Q25yr	210	39.70	44.28		44.38	0.0011	3.07	151.85	102.85	0.14	0.25
MR3	2762	BKF Q	18	39.65	41.44		41.47	0.0012	1.39	12.94	11.36	0.11	0.08
MR3	2762	Q5yr	94	39.65	43.14		43.22	0.0011	2.48	63.08	58.96	0.11	0.18
MR3	2762	Q10yr	139	39.65	43.65		43.74	0.0011	2.76	98.15	79.26	0.12	0.21
MR3	2762	Q25yr	210	39.65	44.23		44.33	0.0011	3.08	151.48	102.71	0.14	0.25
MR3	2753	BKF Q	18	38.74	41.45		41.46	0.0003	0.87	20.79	13.30	0.02	0.03
MR3	2753	Q5yr	94	38.74	43.16		43.21	0.0006	1.92	75.17	61.68	0.05	0.11
MR3	2753	Q10yr	139	38.74	43.66		43.72	0.0006	2.24	111.41	81.88	0.07	0.14
MR3	2753	Q25yr	210	38.74	44.24		44.32	0.0007	2.60	165.84	105.16	0.09	0.18
MR3	2735	BKF Q	18	38.73	41.44		41.46	0.0003	0.86	20.96	13.47	0.02	0.03
MR3	2735	Q5yr	94	38.73	43.14		43.20	0.0006	1.92	75.65	61.99	0.05	0.10
MR3	2735	Q10yr	139	38.73	43.65		43.71	0.0006	2.24	111.94	82.13	0.07	0.14
MR3	2735	Q25yr	210	38.73	44.23		44.31	0.0007	2.60	166.38	105.36	0.09	0.17
MR3	2721	BKF Q	18	39.61	41.42		41.45	0.0011	1.37	13.13	11.50	0.10	0.07
MR3	2721	Q5yr	94	39.61	43.10		43.18	0.0011	2.47	63.13	58.99	0.11	0.18
MR3	2721	Q10yr	139	39.61	43.61		43.70	0.0011	2.76	98.10	79.23	0.12	0.21
MR3	2721	Q25yr	210	39.61	44.19		44.29	0.0011	3.08	151.33	102.65	0.14	0.25
MR3	2673	BKF Q	18	39.56	41.36		41.39	0.0011	1.38	13.07	11.42	0.10	0.08
MR3	2673	Q5yr	94	39.56	43.05		43.13	0.0011	2.48	62.88	58.82	0.11	0.18
MR3	2673	Q10yr	139	39.56	43.55		43.65	0.0011	2.77	97.76	79.06	0.12	0.21
MR3	2673	Q25yr	210	39.56	44.14		44.24	0.0011	3.09	150.88	102.47	0.14	0.25
MR3	2667	BKF Q	18	38.76	41.37		41.39	0.0003	0.86	20.96	13.42	0.02	0.03
MR3	2667	Q5yr	94	38.76	43.06		43.12	0.0006	1.93	74.97	61.52	0.05	0.11
MR3	2667	Q10yr	139	38.76	43.57		43.63	0.0006	2.26	111.00	81.65	0.07	0.14
MR3	2667	Q25yr	210	38.76	44.15		44.23	0.0007	2.62	165.18	104.89	0.09	0.18
MR3	2655	BKF Q	18	38.75	41.37		41.38	0.0003	0.85	21.08	13.54	0.02	0.03
MR3	2655	Q5yr	94	38.75	43.06		43.11	0.0006	1.92	75.30	61.73	0.05	0.10
MR3	2655	Q10yr	139	38.75	43.56		43.63	0.0006	2.25	111.37	81.83	0.07	0.14
MR3	2655	Q25yr	210	38.75	44.14		44.22	0.0007	2.62	165.56	105.03	0.09	0.18
MR3	2646	BKF Q	18	39.54	41.35		41.38	0.0011	1.37	13.17	11.54	0.10	0.07
MR3	2646	Q5yr	94	39.54	43.02		43.10	0.0011	2.49	62.64	58.66	0.11	0.18
MR3	2646	Q10yr	139	39.54	43.52		43.62	0.0011	2.78	97.46	78.91	0.12	0.21
MR3	2646	Q25yr	210	39.54	44.11		44.21	0.0011	3.09	150.52	102.33	0.14	0.25
MR3	2620	BKF Q	18	39.51	41.32	40.36	41.35	0.0011	1.37	13.14	11.50	0.10	0.07
MR3	2620	Q5yr	94	39.51	42.99	41.45	43.07	0.0011	2.49	62.46	58.54	0.11	0.18
MR3	2620	Q10yr	139	39.51	43.49	41.89	43.59	0.0011	2.78	97.23	78.79	0.12	0.22
MR3	2620	Q25yr	210	39.51	44.08	42.50	44.18	0.0011	3.10	150.23	102.22	0.14	0.25

APPENDIX 5

Site Protection Instrument



PIN	Landowner	County	Acreage
336900251179	BROWN, DANNY CLARK	Duplin	1.96
336900147555	BROWN, DANNY CLARK	Duplin	8.41
336900335816	BROWN, MARION DEAN, JR. & WIFE VIVIAN BATTELLE BROWN	Duplin	2.78
336900352864	FUTREAL, JOHNNY ADRIAN	Duplin	4.81
336900445188	HATCHER, DANNY GUY & ETALS	Duplin	1.74

Source: NCOnemap.com 2010 Aerial Photography

EBX

Site Protection Instrument
Muddy Run Site

0 250 500 1,000 Feet

1 inch = 500 feet

STATE OF NORTH CAROLINA

DUPLIN COUNTY

CONSERVATION EASEMENT PROVIDED PURSUANT TO FULL DELIVERY MITIGATION CONTRACT

SPO File Number: 31-I
Prepared by: Office of the Attorney General
Property Control Section
Return to: NC Department of Administration
State Property Office
1321 Mail Service Center
Raleigh, NC 27699-1321

THIS CONSERVATION EASEMENT DEED, made this 15th day of May, 2012, by DANNY GUY HATCHER and wife, MELISSA H. HATCHER whose mailing address is 257 Willie Hatcher Road, Chinquapin, NC, JAMES ALLEN HATCHER and wife, CONNIE M. HATCHER, whose address is 605 Willie Hatcher Road, Chinquapin, NC, CARLTON RYAN HATCHER and wife, RHONDA HATCHER whose mailing address is 501 Willie Hatcher Road, China, FORREST CRAIG HATCHER and wife, NORMA J. HATCHER, whose mailing address is 545 Willie Hatcher RD Chinquapin, NC, and JENNIFER JILL KOPANSKI and husband, DAVID KOPANSKI, whose mailing address is 404 Panther Creek Road, Pink Hill, NC, (**"Grantor"**), to the STATE OF NORTH CAROLINA, ("**Grantee**"), whose mailing address is State of North Carolina, Department of Administration, State Property Office, 1321 Mail Service Center, Raleigh, NC 27699-1321. The designations of Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine, or neuter as required by context.

WITNESSETH:

WHEREAS, pursuant to the provisions of N.C. Gen. Stat. § 143-214.8 et seq., the State of North Carolina has established the Ecosystem Enhancement Program (formerly known as the Wetlands Restoration Program) within the Department of Environment and Natural Resources for the purposes of acquiring, maintaining, restoring, enhancing, creating and preserving wetland and riparian resources that contribute to the

DRAFT

protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; and

WHEREAS, this Conservation Easement from Grantor to Grantee has been negotiated, arranged and provided for as a condition of a full delivery contract between **EBX NEUSE I, LLC, 10055 Red Run Boulevard, Owing Mills, MD 21117,** and the North Carolina Department of Environment and Natural Resources, to provide stream, wetland and/or buffer mitigation pursuant to the North Carolina Department of Environment and Natural Resources Purchase and Services Contract Number 003981 and dated June 27, 2011.

WHEREAS, The State of North Carolina is qualified to be the Grantee of a Conservation Easement pursuant to N.C. Gen. Stat. § 121-35; and

WHEREAS, the Department of Environment and Natural Resources, the North Carolina Department of Transportation and the United States Army Corps of Engineers, Wilmington District entered into a Memorandum of Agreement, (MOA) duly executed by all parties in Greensboro, NC on July 22, 2003, which recognizes that the Ecosystem Enhancement Program is to provide for compensatory mitigation by effective protection of the land, water and natural resources of the State by restoring, enhancing and preserving ecosystem functions; and

WHEREAS, the acceptance of this instrument for and on behalf of the State of North Carolina was granted to the Department of Administration by resolution as approved by the Governor and Council of State adopted at a meeting held in the City of Raleigh, North Carolina, on the 8th day of February 2000; and

WHEREAS, the Ecosystem Enhancement Program in the Department of Environment and Natural Resources, which has been delegated the authority authorized by the Governor and Council of State to the Department of Administration, has approved acceptance of this instrument; and

WHEREAS, Grantor owns in fee simple certain real property situated, lying, and being in Cedar Grove Township, Duplin County, North Carolina (the "**Property**"), and being more particularly described as:

Tax Parcel Identification Number 336900445188:

Being all of that certain parcel of land containing approximately 32.4 acres and being conveyed to Grantor by deed as recorded in **Deed Book 1530 at Page 728** of the Duplin County Registry, North Carolina.

WHEREAS, Grantor is willing to grant a Conservation Easement over the herein described areas of the Property, thereby restricting and limiting the use of the included areas of the Property to the terms and conditions and purposes hereinafter set forth, and

DRAFT

Grantee is willing to accept such Conservation Easement. This Conservation Easement shall be for the protection and benefit of **Muddy Run, NCEEP Project # 95018.**

NOW, THEREFORE, in consideration of the mutual covenants, terms, conditions, and restrictions hereinafter set forth, Grantor unconditionally and irrevocably hereby grants and conveys unto Grantee, its successors and assigns, forever and in perpetuity, a Conservation Easement along with a general Right of Access.

The Easement Area consists of the following:

That area of land containing **1.918 acres** as shown on the plats of survey entitled "The Hatcher Property For the State of North Carolina, S.P.O. File #31-1, NCEEP Project #95018, NCEEP Project Name: Muddy Run" dated April 25th, 2012, by Christopher K. Paderick, PLS Number 4189 and recorded in the Duplin County, North Carolina Register of Deeds at **Plat Book _____, Page _____.**

See attached "**Exhibit A**", Legal Description of area of the Property hereinafter referred to as the "Easement Area"

The purposes of this Conservation Easement are to maintain, restore, enhance, create and preserve wetland and/or riparian resources in the Easement Area that contribute to the protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; to maintain permanently the Easement Area in its natural condition, consistent with these purposes; and to prevent any use of the Easement Area that will significantly impair or interfere with these purposes. To achieve these purposes, the following conditions and restrictions are set forth:

I. DURATION OF EASEMENT

Pursuant to law, including the above referenced statutes, this Conservation Easement and Right of Access shall be perpetual and it shall run with, and be a continuing restriction upon the use of, the Property, and it shall be enforceable by the Grantee against the Grantor and against Grantor's heirs, successors and assigns, personal representatives, agents, lessees, and licensees.

II. GRANTOR RESERVED USES AND RESTRICTED ACTIVITES

The Easement Area shall be restricted from any development or usage that would impair or interfere with the purposes of this Conservation Easement. Unless expressly reserved as a compatible use herein, any activity in, or use of, the Easement Area by the Grantor is prohibited as inconsistent with the purposes of this Conservation Easement. Any rights not expressly reserved hereunder by the Grantor have been acquired by the Grantee. Any rights not expressly reserved hereunder by the Grantor, including the rights to all mitigation credits, including, but not limited to, stream, wetland, and riparian buffer mitigation units, derived from each site within the area of the Conservation Easement, are

DRAFT

conveyed to and belong to the Grantee. Without limiting the generality of the foregoing, the following specific uses are prohibited, restricted, or reserved as indicated:

A. Recreational Uses. Grantor expressly reserves the right to undeveloped recreational uses, including hiking, bird watching, hunting and fishing, and access to the Easement Area for the purposes thereof.

B. Motorized Vehicle Use. Motorized vehicle use in the Easement Area is prohibited.

C. Educational Uses. The Grantor reserves the right to engage in and permit others to engage in educational uses in the Easement Area not inconsistent with this Conservation Easement, and the right of access to the Easement Area for such purposes including organized educational activities such as site visits and observations. Educational uses of the property shall not alter vegetation, hydrology or topography of the site.

D. Vegetative Cutting. Except as related to the removal of non-native plants, diseased or damaged trees, or vegetation that destabilizes or renders unsafe the Easement Area to persons or natural habitat, all cutting, removal, mowing, harming, or destruction of any trees and vegetation in the Easement Area is prohibited.

E. Industrial, Residential and Commercial Uses. All industrial, residential and commercial uses are prohibited in the Easement Area.

F. Agricultural Use. All agricultural uses are prohibited within the Easement Area including any use for cropland, waste lagoons, or pastureland.

G. New Construction. There shall be no building, facility, mobile home, antenna, utility pole, tower, or other structure constructed or placed in the Easement Area.

H. Roads and Trails. There shall be no construction of roads, trails, walkways, or paving in the Easement Area.

I. Signs. No signs shall be permitted in the Easement Area except interpretive signs describing restoration activities and the conservation values of the Easement Area, signs identifying the owner of the Property and the holder of the Conservation Easement, signs giving directions, or signs prescribing rules and regulations for the use of the Easement Area.

J. Dumping or Storing. Dumping or storage of soil, trash, ashes, garbage, waste, abandoned vehicles, appliances, machinery, or any other material in the Easement Area is prohibited.

DRAFT

K. Grading, Mineral Use, Excavation, Dredging. There shall be no grading, filling, excavation, dredging, mining, drilling; removal of topsoil, sand, gravel, rock, peat, minerals, or other materials.

L. Water Quality and Drainage Patterns. There shall be no diking, draining, dredging, channeling, filling, leveling, pumping, impounding or diverting, causing, allowing or permitting the diversion of surface or underground water in the Easement Area. No altering or tampering with water control structures or devices, or disruption or alteration of the restored, enhanced, or created drainage patterns is allowed. All removal of wetlands, polluting or discharging into waters, springs, seeps, or wetlands, or use of pesticide or biocides in the Easement Area is prohibited. In the event of an emergency interruption or shortage of all other water sources, water from within the Easement Area may temporarily be used for good cause shown as needed for the survival of livestock and agricultural production on the Property.

M. Subdivision and Conveyance. Grantor voluntarily agrees that no subdivision, partitioning, or dividing of the underlying Property owned by the Grantor in fee simple ("fee") that is subject to this Easement is allowed. Unless agreed to by the Grantee in writing, any future conveyance of the underlying fee and the rights conveyed herein shall be as a single block of property. Any future transfer of the fee simple shall be subject to this Conservation Easement. Any transfer of the fee is subject to the Grantee's right of unlimited and repeated ingress and egress over and across the Property to the Easement Area for the purposes set forth herein.

N. Development Rights. All development rights are permanently removed from the Easement Area and are non-transferrable.

O. Disturbance of Natural Features. Any change, disturbance, alteration or impairment of the natural features of the Easement Area or any intentional introduction of non-native plants, trees and/or animal species by Grantor is prohibited.

The Grantor may request permission to vary from the above restrictions for good cause shown, provided that any such request is not inconsistent with the purposes of this Conservation Easement, and the Grantor obtains advance written approval from the N.C. Ecosystem Enhancement Program, whose mailing address is 1652 Mail Services Center, Raleigh, NC 27699-1652.

III. GRANTEE RESERVED USES

A. Right of Access, Construction, and Inspection. The Grantee, its employees and agents, successors and assigns, receive a perpetual Right of Access to the Easement Area over the Property at reasonable times to undertake any activities to restore, construct, manage, maintain, enhance, and monitor the stream, wetland and any other riparian resources in the Easement Area, in accordance with restoration activities or a long-term management plan. Unless otherwise specifically set forth in this Conservation Easement, the rights granted herein do not include or establish for the public any access rights.

DRAFT

B. Restoration Activities. These activities include planting of trees, shrubs and herbaceous vegetation, installation of monitoring wells, utilization of heavy equipment to grade, fill, and prepare the soil, modification of the hydrology of the site, and installation of natural and manmade materials as needed to direct in-stream, above ground, and subterraneous water flow.

C. Signs. The Grantee, its employees and agents, successors or assigns, shall be permitted to place signs and witness posts on the Property to include any or all of the following: describe the project, prohibited activities within the Conservation Easement, or identify the project boundaries and the holder of the Conservation Easement.

D. Fences. The Grantee, its employees and agents, successors or assigns, shall be permitted to place fencing on the Property to restrict livestock access. Although the Grantee is not responsible for fence maintenance, the Grantee reserves the right to repair the fence, at its sole discretion.

IV. ENFORCEMENT AND REMEDIES

A. Enforcement. To accomplish the purposes of this Conservation Easement, Grantee is allowed to prevent any activity within the Easement Area that is inconsistent with the purposes of this Easement and to require the restoration of such areas or features in the Easement Area that may have been damaged by such unauthorized activity or use. Upon any breach of the terms of this Conservation Easement by Grantor, the Grantee shall, except as provided below, notify the Grantor in writing of such breach and the Grantor shall have ninety (90) days after receipt of such notice to correct the damage caused by such breach. If the breach and damage remains uncured after ninety (90) days, the Grantee may enforce this Conservation Easement by bringing appropriate legal proceedings including an action to recover damages, as well as injunctive and other relief. The Grantee shall also have the power and authority, consistent with its statutory authority: (a) to prevent any impairment of the Easement Area by acts which may be unlawful or in violation of this Conservation Easement; (b) to otherwise preserve or protect its interest in the Property; or (c) to seek damages from any appropriate person or entity. Notwithstanding the foregoing, the Grantee reserves the immediate right, without notice, to obtain a temporary restraining order, injunctive or other appropriate relief, if the breach is or would irreversibly or otherwise materially impair the benefits to be derived from this Conservation Easement, and the Grantor and Grantee acknowledge that the damage would be irreparable and remedies at law inadequate. The rights and remedies of the Grantee provided hereunder shall be in addition to, and not in lieu of, all other rights and remedies available to Grantee in connection with this Conservation Easement.

B. Inspection. The Grantee, its employees and agents, successors and assigns, have the right, with reasonable notice, to enter the Easement Area over the Property at reasonable times for the purpose of inspection to determine whether the Grantor is complying with the terms, conditions and restrictions of this Conservation Easement.

DRAFT

C. Acts Beyond Grantor's Control. Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury or change in the Easement Area caused by third parties, resulting from causes beyond the Grantor's control, including, without limitation, fire, flood, storm, and earth movement, or from any prudent action taken in good faith by the Grantor under emergency conditions to prevent, abate, or mitigate significant injury to life or damage to the Property resulting from such causes.

D. Costs of Enforcement. Beyond regular and typical monitoring expenses, any costs incurred by Grantee in enforcing the terms of this Conservation Easement against Grantor, including, without limitation, any costs of restoration necessitated by Grantor's acts or omissions in violation of the terms of this Conservation Easement, shall be borne by Grantor.

E. No Waiver. Enforcement of this Easement shall be at the discretion of the Grantee and any forbearance, delay or omission by Grantee to exercise its rights hereunder in the event of any breach of any term set forth herein shall not be construed to be a waiver by Grantee.

V. MISCELLANEOUS

A. This instrument sets forth the entire agreement of the parties with respect to the Conservation Easement and supersedes all prior discussions, negotiations, understandings or agreements relating to the Conservation Easement. If any provision is found to be invalid, the remainder of the provisions of the Conservation Easement, and the application of such provision to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby.

B. Grantor is responsible for any real estate taxes, assessments, fees, or charges levied upon the Property. Grantee shall not be responsible for any costs or liability of any kind related to the ownership, operation, insurance, upkeep, or maintenance of the Property, except as expressly provided herein. Upkeep of any constructed bridges, fences, or other amenities on the Property are the sole responsibility of the Grantor. Nothing herein shall relieve the Grantor of the obligation to comply with federal, state or local laws, regulations and permits that may apply to the exercise of the Reserved Rights.

C. Any notices shall be sent by registered or certified mail, return receipt requested to the parties at their addresses shown herein or to other addresses as either party establishes in writing upon notification to the other.

D. Grantor shall notify Grantee in writing of the name and address and any party to whom the Property or any part thereof is to be transferred at or prior to the time said transfer is made. Grantor further agrees that any subsequent lease, deed, or other legal instrument by which any interest in the Property is conveyed subject to the Conservation Easement herein created.

DRAFT

E. The Grantor and Grantee agree that the terms of this Conservation Easement shall survive any merger of the fee and easement interests in the Property or any portion thereof.

F. This Conservation Easement and Right of Access may be amended, but only in writing signed by all parties hereto, or their successors or assigns, if such amendment does not affect the qualification of this Conservation Easement or the status of the Grantee under any applicable laws, and is consistent with the purposes of the Conservation Easement. The owner of the Property shall notify the U.S. Army Corps of Engineers in writing sixty (60) days prior to the initiation of any transfer of all or any part of the Property. Such notification shall be addressed to: Justin McCorkle, General Counsel, US Army Corps of Engineers, 69 Darlington Avenue, Wilmington, NC 28403

G. The parties recognize and agree that the benefits of this Conservation Easement are in gross and assignable provided, however, that the Grantee hereby covenants and agrees, that in the event it transfers or assigns this Conservation Easement, the organization receiving the interest will be a qualified holder under N.C. Gen. Stat. § 121-34 et seq. and § 170(h) of the Internal Revenue Code, and the Grantee further covenants and agrees that the terms of the transfer or assignment will be such that the transferee or assignee will be required to continue in perpetuity the conservation purposes described in this document.

VI. QUIET ENJOYMENT

Grantor reserves all remaining rights accruing from ownership of the Property, including the right to engage in or permit or invite others to engage in only those uses of the Easement Area that are expressly reserved herein, not prohibited or restricted herein, and are not inconsistent with the purposes of this Conservation Easement. Without limiting the generality of the foregoing, the Grantor expressly reserves to the Grantor, and the Grantor's invitees and licensees, the right of access to the Easement Area, and the right of quiet enjoyment of the Easement Area

TO HAVE AND TO HOLD, the said rights and easements perpetually unto the State of North Carolina for the aforesaid purposes.

AND Grantor covenants that Grantor is seized of said premises in fee and has the right to convey the permanent Conservation Easement herein granted; that the same is free from encumbrances and that Grantor will warrant and defend title to the same against the claims of all persons whomsoever.

DRAFT

IN TESTIMONY WHEREOF, the Grantor has hereunto set Grantor's hand and seal, the day and year first above written.

_____ (SEAL)
Danny Guy Hatcher

_____ (SEAL)
Melissa H. Hatcher

_____ (SEAL)
James Allen Hatcher

_____ (SEAL)
Connie M. Hatcher

_____ (SEAL)
Carlton Ryan Hatcher

_____ (SEAL)
Rhonda Hatcher

_____ (SEAL)
Forrest Craig Hatcher

_____ (SEAL)
Norma J. Hatcher

_____ (SEAL)
Jennifer Jill Kopanski

_____ (SEAL)
David Kopanski

DRAFT

NORTH CAROLINA

COUNTY OF _____

I, _____, a Notary Public in and for the County and State aforesaid, do hereby certify that DANNY GUY HATCHER and wife, MELISSA H. HATCHER, Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the _____ day of _____, 2012.

_____
Notary Public

My commission expires:

_____

NORTH CAROLINA

COUNTY OF _____

I, _____, a Notary Public in and for the County and State aforesaid, do hereby certify that JAMES ALLEN HATCHER and wife, CONNIE M. HATCHER, Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the _____ day of _____, 2012.

_____
Notary Public

My commission expires:

_____

DRAFT

NORTH CAROLINA

COUNTY OF _____

I, _____, a Notary Public in and for the County and State aforesaid, do hereby certify that CARLTON RYAN HATCHER and wife, RHONDA HATCHER, Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the _____ day of _____, 2012.

_____
Notary Public

My commission expires:

_____

NORTH CAROLINA

COUNTY OF _____

I, _____, a Notary Public in and for the County and State aforesaid, do hereby certify that FORREST CRAIG HATCHER and wife, NORMA J. HATCHER, Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the _____ day of _____, 2012.

_____
Notary Public

My commission expires:

_____

DRAFT

NORTH CAROLINA

COUNTY OF _____

I, _____, a Notary Public in and for the County and State aforesaid, do hereby certify that JENNIFER JILL KOPANSKI and husband, DAVID KOPANSKI, Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the _____ day of _____, 2012.

_____

Notary Public

My commission expires:

_____

DRAFT

EXHIBIT A

TO CONSERVATION EASEMENT DEED BETWEEN DANNY GUY HATCHER and wife, MELISSA H. HATCHER, JAMES ALLEN HATCHER and wife, CONNIE M. HATCHER, CARLTON RYAN HATCHER and wife, RHONDA HATCHER, FORREST CRAIG HATCHER and wife, NORMA J. HATCHER, and JENNIFER JILL KOPANSKI and husband, DAVID KOPANSKI, Grantor, AND the STATE OF NORTH CAROLINA, Grantee, dated May 15th, 2012.

Located in Cypress Creek Township, Duplin County, North Carolina and being more particularly described as follows: BEGINNING at a corner located on an old chopped gum tree and also located N 82 degrees 37' 30" 2.61 feet from an existing iron pipe as indicated on map referenced below, thence from that corner N 18 degrees 38' 24" W 249.30 feet; thence N 21 degrees 14' 35" W 338.39 feet to a ditch; thence along the ditch N 74 degrees 09' 03" E 208.55 feet; thence S 15 degrees 10' 48" E 233.92 feet; thence S 05 degrees 04' 22" W 216.49 feet; thence S 01 degree 11' 22" W 169.99 feet; thence N 85 degrees 42' 13" W 37.02 feet to the point of the beginning, containing 1.918 Acres, more or less, and being that same property recorded in Map Book ___, Page___, entitled "The Hatcher Property for the State of North Carolina," by Christopher K. Paderick, P.L.S. No. 4189, and dated April 25th, 2012. Reference to said map is made for a more perfect and accurate description.

DRAFT

NC GEODETIC SURVEY MONUMENT REFERENCE TABLE	
FROM: "BROWN 1974"	TO: "HATCHER 1974"
N=395,131.0634' E=2,357,379.5569'	N=398,054.6107' E=2,362,255.4002'
GRID BEARING 59°-03'-11"	GRID DISTANCE 5,685.1541' (GRID) 5,685.86' (MEASURED)

FLOOD STATEMENT

THIS PROPERTY IS LOCATED IN ZONE "X" AND IS NOT WITHIN A SPECIAL FLOOD HAZARD AREA, AS DETERMINED BY NFIP RATE MAP DATED FEBRUARY 16, 2006 : COMMUNITY PANEL NUMBER 370083-3368-J .

LEGEND

- ● = NEW IRON STAKE
- CPP = CORRUGATED PLASTIC PIPE
- PP = POWER POLE
- CMP = CORRUGATED METAL PIPE
- (TL) = TIE LINE
- (CC) = CONTROL CORNER
- NCGSM = NC GRID SURVEY MONUMENT
- ZZ = NOT TO SCALE
- = ADJOINING PROPERTY LINE
- = EASEMENT LINE
- E = ELECTRICAL LINE

NOTES:

1. COMBINED FACTOR IS 0.99989904.
2. ALL DISTANCES ARE HORIZONTAL GROUND MEASUREMENTS IN FEET & DECIMALS THEREOF, UNLESS OTHERWISE NOTED.

"PRELIMINARY PLAT"
NOT FOR SALES, CONVEYANCES, OR RECORDATION.

CONSERVATION EASEMENT
SURVEY OF

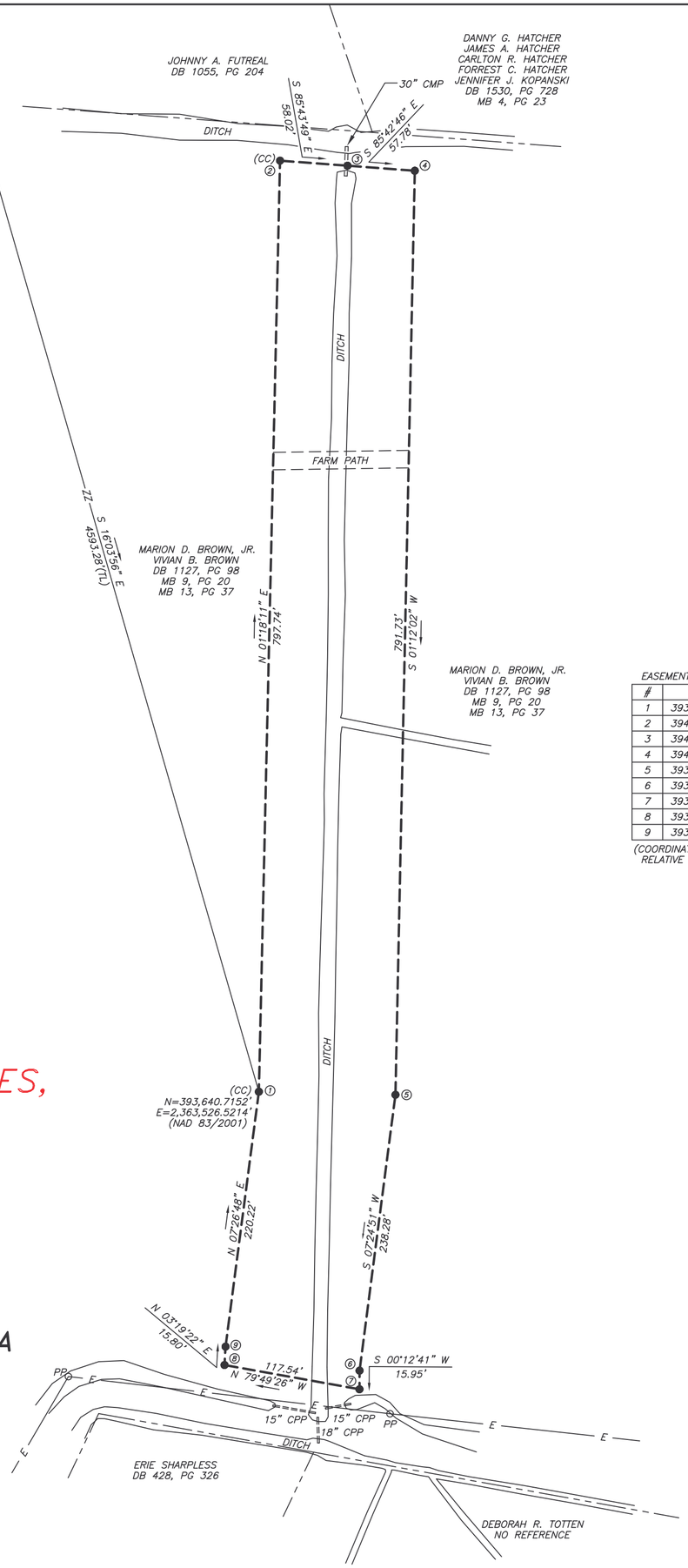
THE MARION D. BROWN PROPERTY FOR THE STATE OF NORTH CAROLINA

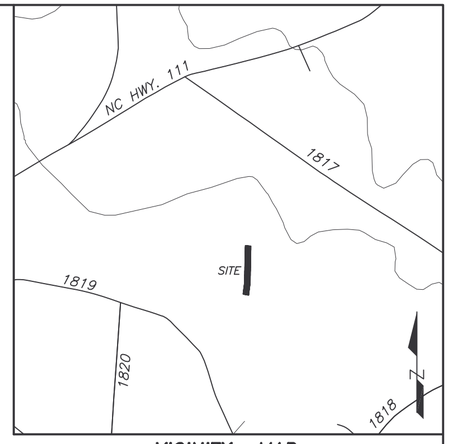
S.P.O. FILE #31-I
NCEEP RFP #16-003575
NCEEP PROJECT #95018
NCEEP PROJECT NAME: MUDDY RUN

CYPRESS CREEK TOWNSHIP
DUPLIN COUNTY, NC

MAY 7, 2012
1" = 80'

80' 40' 0 80' 160'
GRAPHIC SCALE





VICINITY MAP
(NOT TO SCALE)

EASEMENT CORNER COORDINATE TABLE

#	NORTHING	EASTING
1	393,640.7152'	2,363,526.5214'
2	394,438.2476'	2,363,544.6642'
3	394,433.9280'	2,363,602.5232'
4	394,429.6081'	2,363,660.1461'
5	393,638.0527'	2,363,643.5587'
6	393,401.7634'	2,363,612.8102'
7	393,385.8162'	2,363,612.7514'
8	393,406.5821'	2,363,497.0643'
9	393,422.3533'	2,363,497.9799'

(COORDINATES ARE GROUND COORDINATES RELATIVE TO NCGSM "HATCHER 1974")

I, _____, REVIEW OFFICER OF DUPLIN COUNTY, CERTIFY THAT THE MAP OR PLAT TO WHICH THIS CERTIFICATION IS AFFIXED MEETS ALL STATUTORY REQUIREMENTS FOR RECORDING.

_____
REVIEW OFFICER

_____
DATE

FILED FOR REGISTRATION _____,
2012. ____:____ __M
PLAT CABINET _____, PAGE _____.

_____
REGISTER OF DEEDS
DUPLIN COUNTY

I, CHRISTOPHER K. PADERICK, PROFESSIONAL LAND SURVEYOR NO. 4189, CERTIFY THAT THIS SURVEY IS OF ANOTHER CATEGORY. TO WIT; AN EASEMENT SURVEY.

_____
L-4189

STATE OF NORTH CAROLINA DUPLIN COUNTY

I, CHRISTOPHER K. PADERICK, CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION; (DEED DESCRIPTION RECORDED IN MAP & DEED BOOKS NOTED); THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED AS DRAWN FROM INFORMATION REFERENCED HEREON; THAT THE RATIO OF PRECISION AS CALCULATED IS 1: 10,000+; THAT THIS PLAT WAS PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS 7TH DAY OF MAY, A.D., 2012.

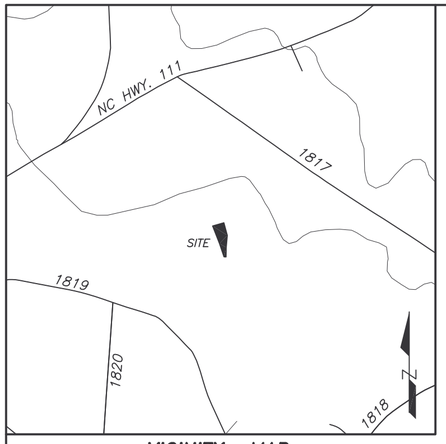
_____
L-4189

SOURCE OF TITLE
DB 1127, PG 98
MB 9, PG 20
MB 13, PG 37

ACREAGE DATA
(BY COMPUTER)
2.778 AC±

MATRIX EAST, PLLC
PROFESSIONAL LAND SURVEYORS
906 N. QUEEN ST., SUITE A KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747

FIRM LIC. # P-0221	EMAIL: surveyor@matrixeast.net
DRAWN BY: CKP	PROJECT NO.: 20110047
SURVEYED BY: LDL/CCK	DATE: 5/7/2012
SCALE: 1" = 80'	DRAWING NAME: M. BROWN



VICINITY MAP
(NOT TO SCALE)

EASEMENT CORNER COORDINATE TABLE

#	NORTHING	EASTING
1	395,070.9927'	2,363,622.1918'
2	394,845.2312'	2,363,683.4455'
3	394,629.5937'	2,363,664.3037'
4	394,459.6451'	2,363,660.7751'
5	394,462.4183'	2,363,623.8624'
6	394,698.6449'	2,363,544.1793'
7	395,014.0373'	2,363,421.5739'

(COORDINATES ARE GROUND COORDINATES RELATIVE TO NCGSM "HATCHER 1974")

NOTES:

1. COMBINED FACTOR IS 0.99989904.
2. ALL DISTANCES ARE HORIZONTAL GROUND MEASUREMENTS IN FEET & DECIMALS THEREOF, UNLESS OTHERWISE NOTED.

FLOOD STATEMENT

THIS PROPERTY IS LOCATED IN ZONE "X" AND IS NOT WITHIN A SPECIAL FLOOD HAZARD AREA, AS DETERMINED BY NFIP RATE MAP DATED FEBRUARY 16, 2006 : COMMUNITY PANEL NUMBER 370083-3368-J .

I, _____, REVIEW OFFICER OF DUPLIN COUNTY, CERTIFY THAT THE MAP OR PLAT TO WHICH THIS CERTIFICATION IS AFFIXED MEETS ALL STATUTORY REQUIREMENTS FOR RECORDING.

_____
REVIEW OFFICER

_____
DATE

FILED FOR REGISTRATION _____, 2012. _____ __M
PLAT CABINET _____, PAGE _____ .

_____
REGISTER OF DEEDS
DUPLIN COUNTY

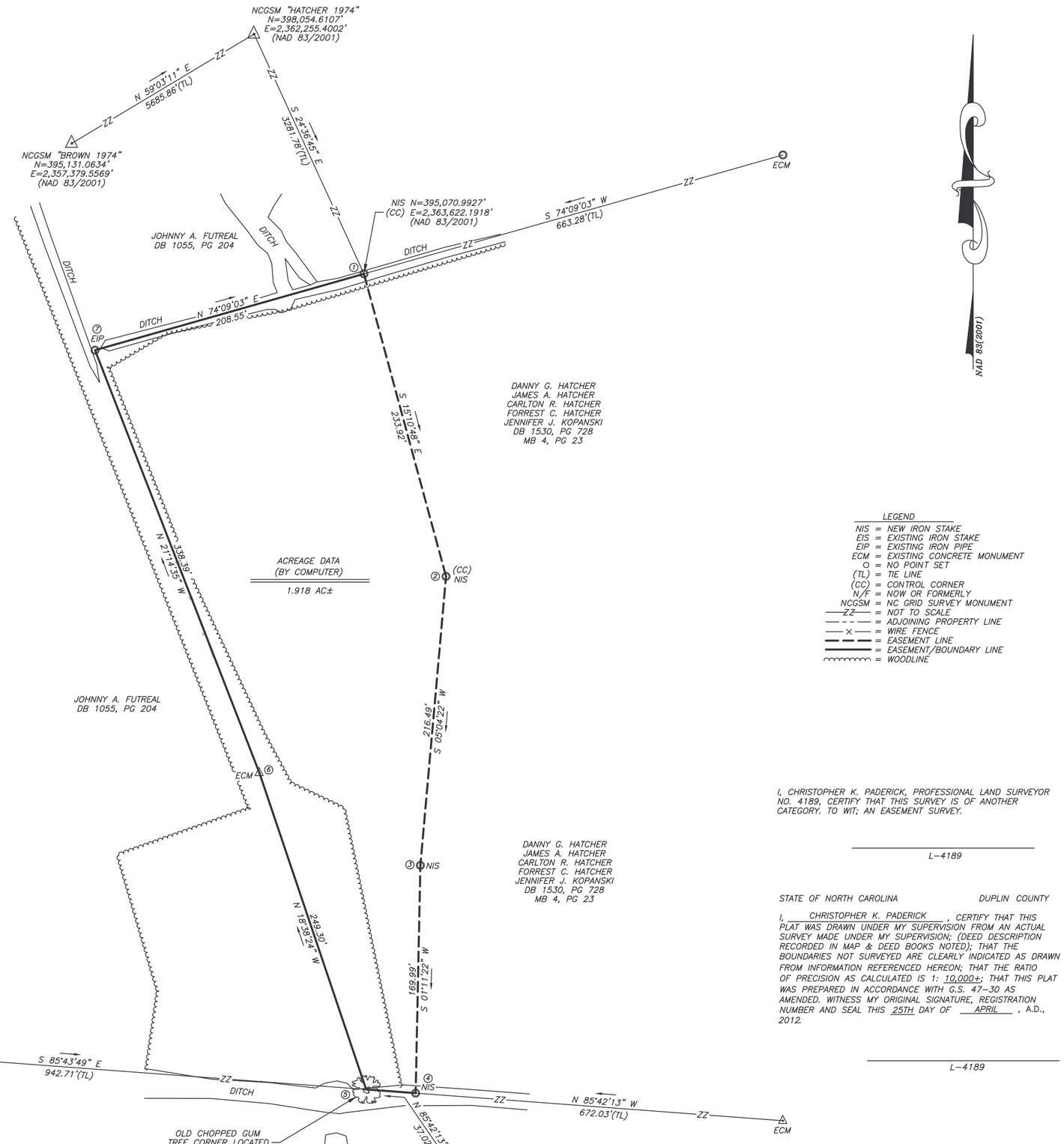
CONSERVATION EASEMENT
SURVEY OF

THE HATCHER PROPERTY
FOR THE STATE OF NORTH CAROLINA
S.P.O. FILE #31-I
NCEEP RFP #16-003575
NCEEP PROJECT #95018
NCEEP PROJECT NAME: MUDDY RUN

CYPRESS CREEK TOWNSHIP
DUPLIN COUNTY, NC

APRIL 25, 2012
1" = 60'

60' 30' 0 60' 120'
GRAPHIC SCALE



ACREAGE DATA
(BY COMPUTER)
1.918 AC±

LEGEND

- NIS = NEW IRON STAKE
- EIS = EXISTING IRON STAKE
- EIP = EXISTING IRON PIPE
- ECM = EXISTING CONCRETE MONUMENT
- O = NO POINT SET
- (TL) = TIE LINE
- (CC) = CONTROL CORNER
- N/F = NOW OR FORMERLY
- NCGSM = NC GRID SURVEY MONUMENT
- ZZ = NOT TO SCALE
- — - — = ADJOINING PROPERTY LINE
- —×— = WIRE FENCE
- = EASEMENT LINE
- = EASEMENT/BOUNDARY LINE
- = WOODLINE

I, CHRISTOPHER K. PADERICK, PROFESSIONAL LAND SURVEYOR NO. 4189, CERTIFY THAT THIS SURVEY IS OF ANOTHER CATEGORY. TO WIT; AN EASEMENT SURVEY.

_____
L-4189

STATE OF NORTH CAROLINA DUPLIN COUNTY

I, CHRISTOPHER K. PADERICK , CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION; (DEED DESCRIPTION RECORDED IN MAP & DEED BOOKS NOTED); THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED AS DRAWN FROM INFORMATION REFERENCED HEREON; THAT THE RATIO OF PRECISION AS CALCULATED IS 1: 10,000+; THAT THIS PLAT WAS PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS 25TH DAY OF APRIL , A.D., 2012.

_____
L-4189

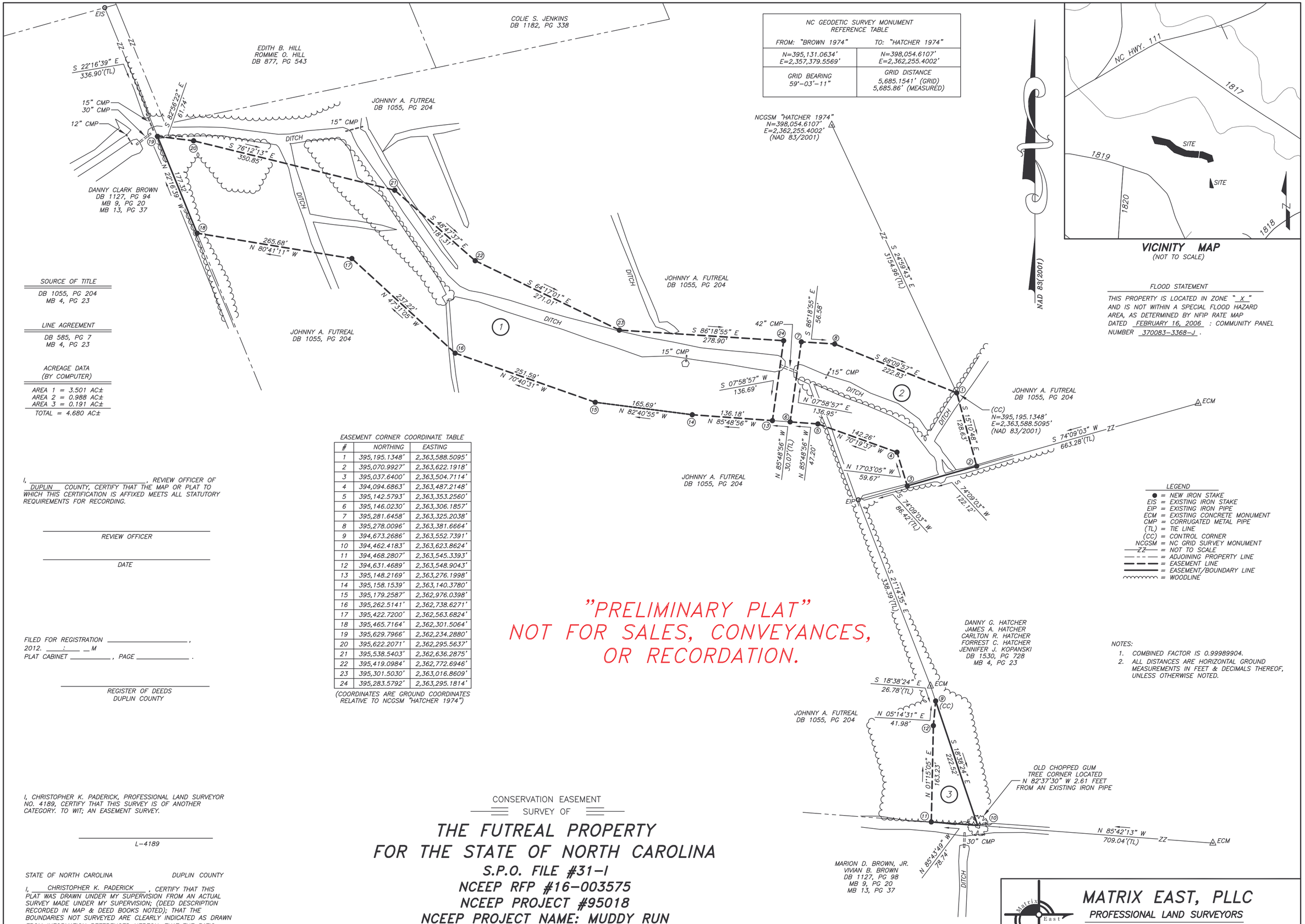
"PRELIMINARY PLAT"
NOT FOR SALES, CONVEYANCES, OR RECORDATION.

SOURCE OF TITLE
DB 1530, PG 728
MB 4, PG 23

LINE AGREEMENT
DB 585, PG 7
MB 4, PG 23

MATRIX EAST, PLLC
PROFESSIONAL LAND SURVEYORS
906 N. QUEEN ST., SUITE A KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747

FIRM LIC. # P-0221	EMAIL: surveyor@matrixeast.net
DRAWN BY: CKP/INM	PROJECT NO.: 20110047
SURVEYED BY: LDL/CCK	DATE: APRIL 25, 2012
SCALE: 1" = 60'	DRAWING NAME: HATCHER ESMT.



VICINITY MAP
(NOT TO SCALE)

NC GEODETIC SURVEY MONUMENT REFERENCE TABLE	
FROM: "BROWN 1974"	TO: "HATCHER 1974"
N=395,131.0634' E=2,357,379.5569'	N=398,054.6107' E=2,362,255.4002'
GRID BEARING 59°-03'-11"	GRID DISTANCE 5,685.1541' (GRID) 5,685.86' (MEASURED)

SOURCE OF TITLE
DB 1055, PG 204
MB 4, PG 23

LINE AGREEMENT
DB 585, PG 7
MB 4, PG 23

ACREAGE DATA (BY COMPUTER)
AREA 1 = 3.501 AC±
AREA 2 = 0.988 AC±
AREA 3 = 0.191 AC±
TOTAL = 4.680 AC±

FLOOD STATEMENT
THIS PROPERTY IS LOCATED IN ZONE " X " AND IS NOT WITHIN A SPECIAL FLOOD HAZARD AREA, AS DETERMINED BY NFIP RATE MAP DATED FEBRUARY 16, 2006 : COMMUNITY PANEL NUMBER 370083-3368-J .

EASEMENT CORNER COORDINATE TABLE

#	NORTHING	EASTING
1	395,195.1348'	2,363,588.5095'
2	395,070.9927'	2,363,622.1918'
3	395,037.6400'	2,363,504.7114'
4	394,094.6863'	2,363,487.2148'
5	395,142.5793'	2,363,353.2560'
6	395,146.0230'	2,363,306.1857'
7	395,281.6458'	2,363,325.2038'
8	395,278.0096'	2,363,381.6664'
9	394,673.2686'	2,363,552.7391'
10	394,462.4183'	2,363,623.8624'
11	394,468.2807'	2,363,545.3393'
12	394,631.4689'	2,363,548.9043'
13	395,148.2169'	2,363,276.1998'
14	395,158.1539'	2,363,140.3780'
15	395,179.2587'	2,362,976.0398'
16	395,262.5141'	2,362,738.6271'
17	395,422.7200'	2,362,563.6824'
18	395,465.7164'	2,362,301.5064'
19	395,629.7966'	2,362,234.2880'
20	395,622.2071'	2,362,295.5637'
21	395,538.5403'	2,362,636.2875'
22	395,419.0984'	2,362,772.6946'
23	395,301.5030'	2,363,016.8609'
24	395,283.5792'	2,363,295.1814'

(COORDINATES ARE GROUND COORDINATES RELATIVE TO NCGSM "HATCHER 1974")

LEGEND
● = NEW IRON STAKE
EIS = EXISTING IRON STAKE
EIP = EXISTING IRON PIPE
ECM = EXISTING CONCRETE MONUMENT
CMP = CORRUGATED METAL PIPE
(TL) = TIE LINE
(CC) = CONTROL CORNER
NCGSM = NC GRID SURVEY MONUMENT
ZZ = NOT TO SCALE
= ADJOINING PROPERTY LINE
= EASEMENT LINE
= EASEMENT/BOUNDARY LINE
= WOODLINE

NOTES:
1. COMBINED FACTOR IS 0.99989904.
2. ALL DISTANCES ARE HORIZONTAL GROUND MEASUREMENTS IN FEET & DECIMALS THEREOF, UNLESS OTHERWISE NOTED.

I, _____, REVIEW OFFICER OF DUPLIN COUNTY, CERTIFY THAT THE MAP OR PLAT TO WHICH THIS CERTIFICATION IS AFFIXED MEETS ALL STATUTORY REQUIREMENTS FOR RECORDING.

REVIEW OFFICER

DATE

FILED FOR REGISTRATION _____, 2012. ____:____ __M
PLAT CABINET _____, PAGE _____ .

REGISTER OF DEEDS
DUPLIN COUNTY

I, CHRISTOPHER K. PADERICK, PROFESSIONAL LAND SURVEYOR NO. 4189, CERTIFY THAT THIS SURVEY IS OF ANOTHER CATEGORY. TO WIT; AN EASEMENT SURVEY.

L-4189

STATE OF NORTH CAROLINA DUPLIN COUNTY

I, CHRISTOPHER K. PADERICK , CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION; (DEED DESCRIPTION RECORDED IN MAP & DEED BOOKS NOTED); THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED AS DRAWN FROM INFORMATION REFERENCED HEREON; THAT THE RATIO OF PRECISION AS CALCULATED IS 1: 10,000+; THAT THIS PLAT WAS PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS 7TH DAY OF MAY , A.D., 2012.

L-4189

"PRELIMINARY PLAT"
NOT FOR SALES, CONVEYANCES, OR RECORDATION.

CONSERVATION EASEMENT
SURVEY OF

THE FUTREAL PROPERTY
FOR THE STATE OF NORTH CAROLINA
S.P.O. FILE #31-I
NCEEP RFP #16-003575
NCEEP PROJECT #95018
NCEEP PROJECT NAME: MUDDY RUN

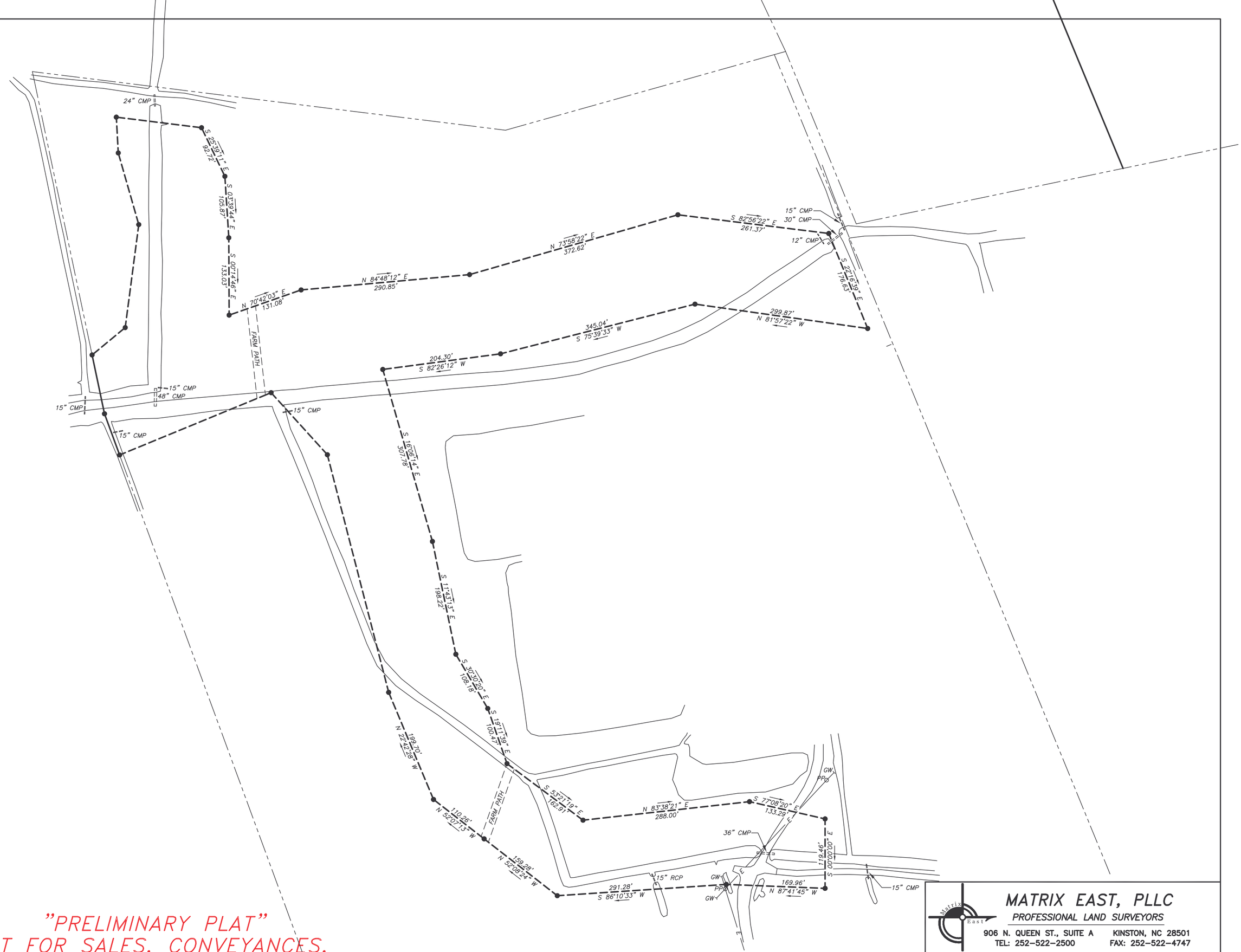
CYPRESS CREEK TOWNSHIP
DUPLIN COUNTY, NC

MAY 7, 2012
1" = 100'

100' 50' 0 100' 200'
GRAPHIC SCALE

MATRIX EAST, PLLC
PROFESSIONAL LAND SURVEYORS
906 N. QUEEN ST., SUITE A KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747

FIRM LIC. # P-0221	EMAIL: surveyor@matrixeast.net
DRAWN BY: CKP	PROJECT NO.: 20110047
SURVEYED BY: LDL/CCK	DATE: 5/7/2012
SCALE: 1" = 100'	DRAWING NAME: FUTREAL 1



"PRELIMINARY PLAT"
NOT FOR SALES, CONVEYANCES,
OR RECORDATION.

MATRIX EAST, PLLC
PROFESSIONAL LAND SURVEYORS
906 N. QUEEN ST., SUITE A KINSTON, NC 28501
TEL: 252-522-2500 FAX: 252-522-4747

FIRM LIC. # P-0221	EMAIL: surveyor@matrixeast.net
DRAWN BY:	PROJECT NO.:
SURVEYED BY:	DATE:
SCALE: 1" = 0'	DRAWING NAME: _

APPENDIX 6

Muddy Run Design Plan Sheets

MUDDY RUN MITIGATION PROJECT

NCEEP PROJECT ID 95018

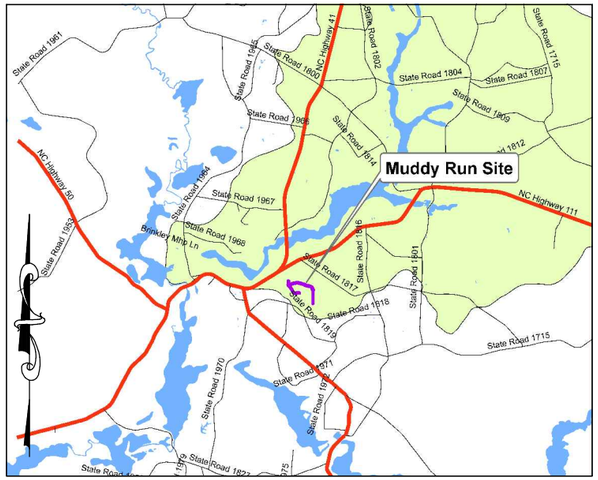
AUGUST 2012

LOCATION: DUPLIN COUNTY, NORTH CAROLINA

ENVIRONMENTAL BANC & EXCHANGE, LLC

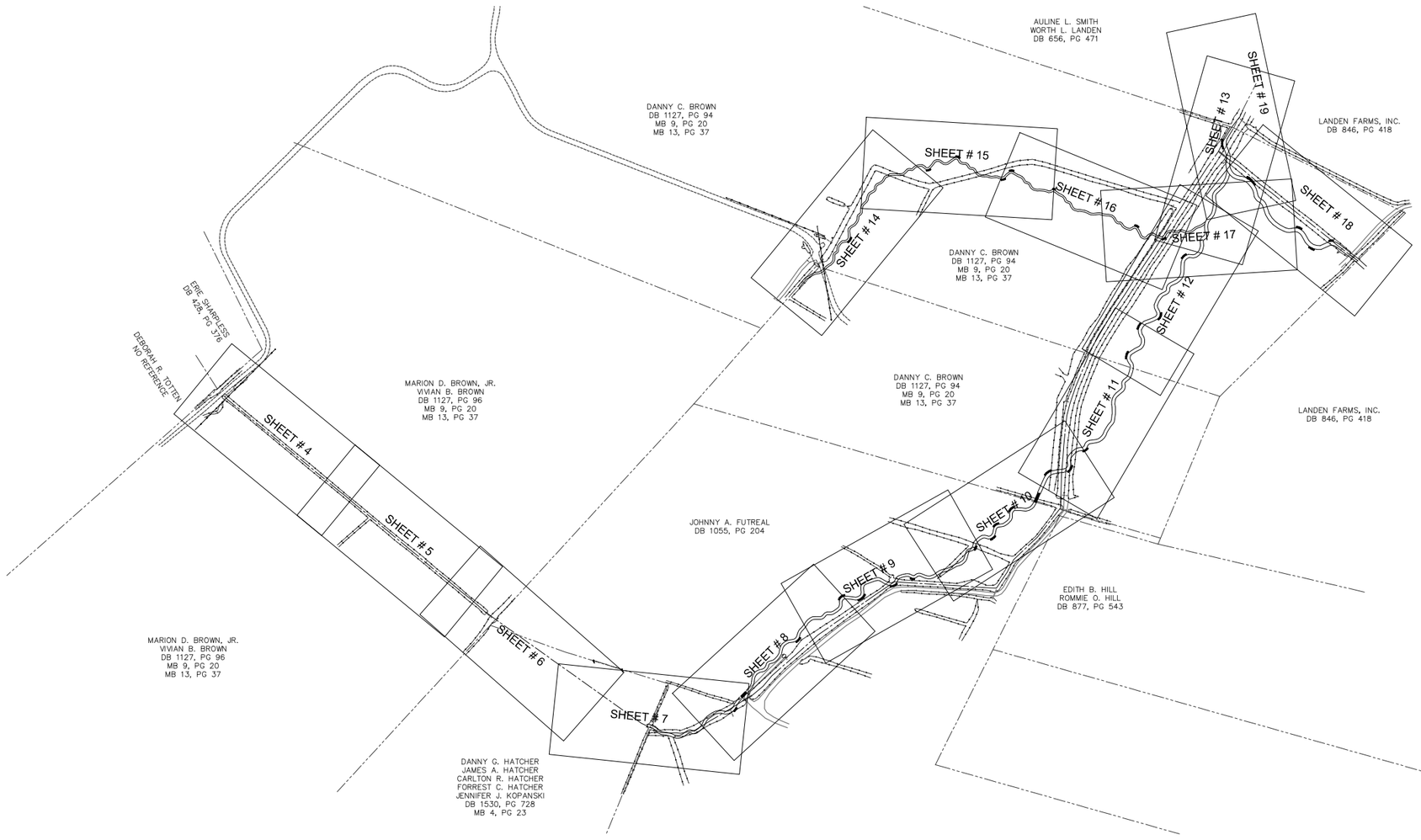
909 CAPABILITY DRIVE, SUITE 3100

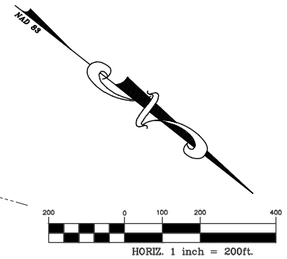
RALEIGH, NC 27606



VICINITY MAP
NTS

DRAWING LIST	
DRAWING NUMBER	DRAWING TITLE
1	COVER
2	EXISTING CONDITIONS
3	EXISTING CONDITIONS
4	REACH 1 PLAN & PROFILE STA 0+00–5+00
5	REACH 1 PLAN & PROFILE STA 5+00–10+00
6	REACH 1 PLAN & PROFILE STA 10+00–15+00
7	REACH 1 PLAN & PROFILE STA 15+00–20+00
8	REACH 1 PLAN & PROFILE STA 20+00–25+00
9	REACH 1 PLAN & PROFILE STA 25+00 TO 30+00
10	REACH 1 PLAN & PROFILE STA 30+00 TO 35+00
11	REACH 1 PLAN & PROFILE STA 35+00 TO 40+00
12	REACH 1 PLAN & PROFILE STA 40+00 TO 45+00
13	REACH 1 PLAN & PROFILE STA 45+00 TO 47+20.77
14	REACH 2 PLAN & PROFILE STA 0+00 TO 10+00
15	REACH 2 PLAN & PROFILE STA 5+00 TO 10+00
16	REACH 2 PLAN & PROFILE STA 10+00 TO 15+00
17	REACH 2 PLAN & PROFILE STA 15+00 TO 16+79
18	REACH 3 PLAN & PROFILE STA 0+00 TO STA 4+00
19	REACH 3 PLAN &PROFILE STA 4+00 TO 7+18.02
20	REACH 1 XSECTIONS
21	PLANTING PLAN
22	DETAILS
23	DETAILS
24	DETAILS
25	DETAILS





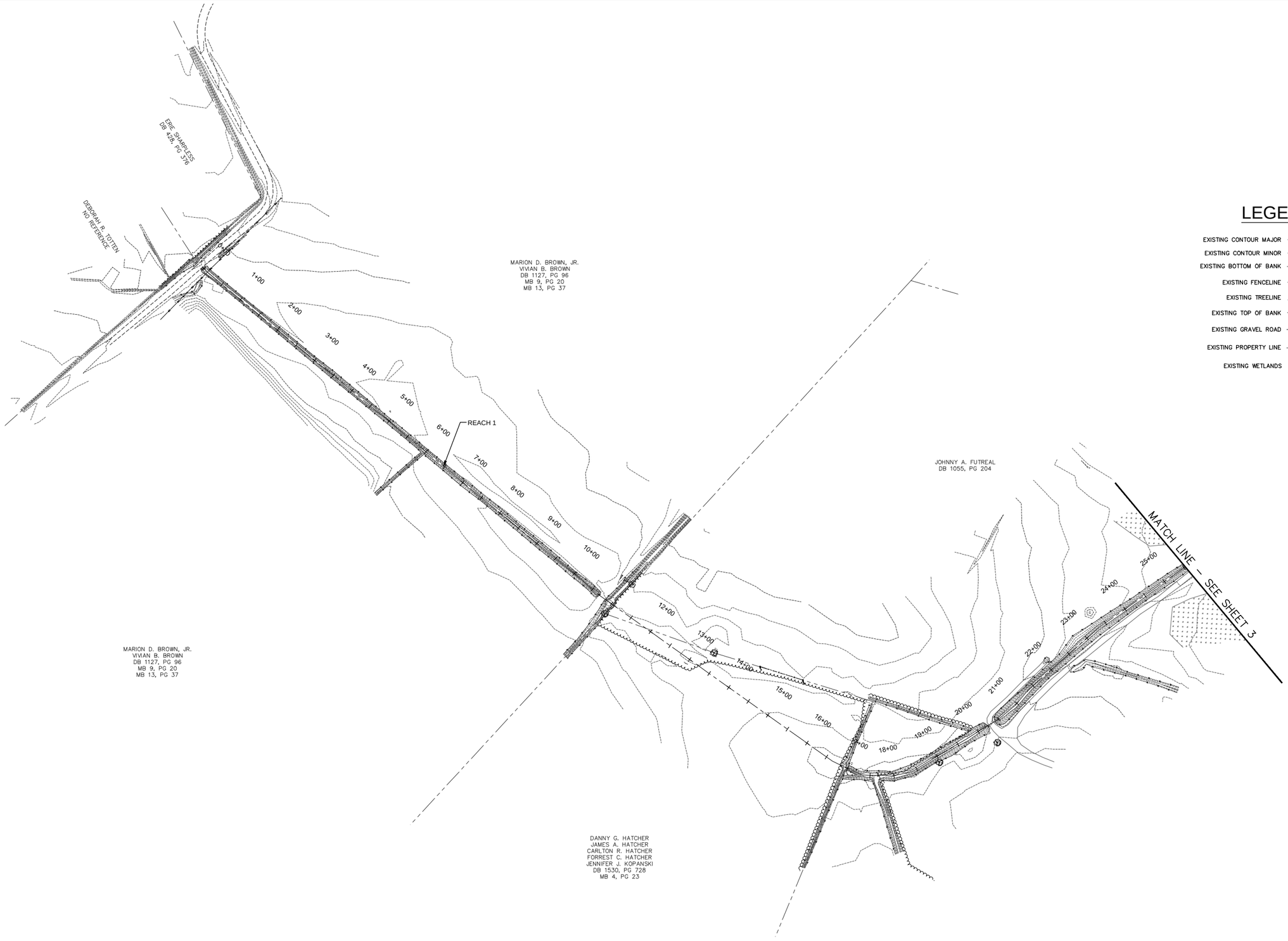
PRELIMINARY
NOT FOR CONSTRUCTION

DESIGN CONSULTANT

WK DICKSON
community infrastructure consultants

720 CORPORATE CENTER DR
RALEIGH, NC 27607
(919) 782–0495

NC LICENSE NO. F–0374



LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- EXISTING BOTTOM OF BANK
- EXISTING FENCELINE
- EXISTING TREELINE
- EXISTING TOP OF BANK
- EXISTING GRAVEL ROAD
- EXISTING PROPERTY LINE
- EXISTING WETLANDS

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 100
0 100 200
2" = FULL SCALE
1" = HALF SCALE

MARK	DATE	DESCRIPTION
---	---	---
---	---	---
---	---	---

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PLOT DATE:
5/2/12

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
EXISTING CONDITIONS

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

DRAWING NUMBER:
2

PROJ. N0.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- EXISTING BOTTOM OF BANK
- EXISTING FENCELINE
- EXISTING TREELINE
- EXISTING TOP OF BANK
- EXISTING GRAVEL ROAD
- EXISTING PROPERTY LINE
- EXISTING WETLANDS

FULL SCALE: 1"= 100

0 100 200

2" = FULL SCALE
1" = HALF SCALE

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

PLOT DATE: 12/14/11

MARK	DATE	DESCRIPTION
---	---	---
---	---	---
---	---	---

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
EXISTING CONDITIONS

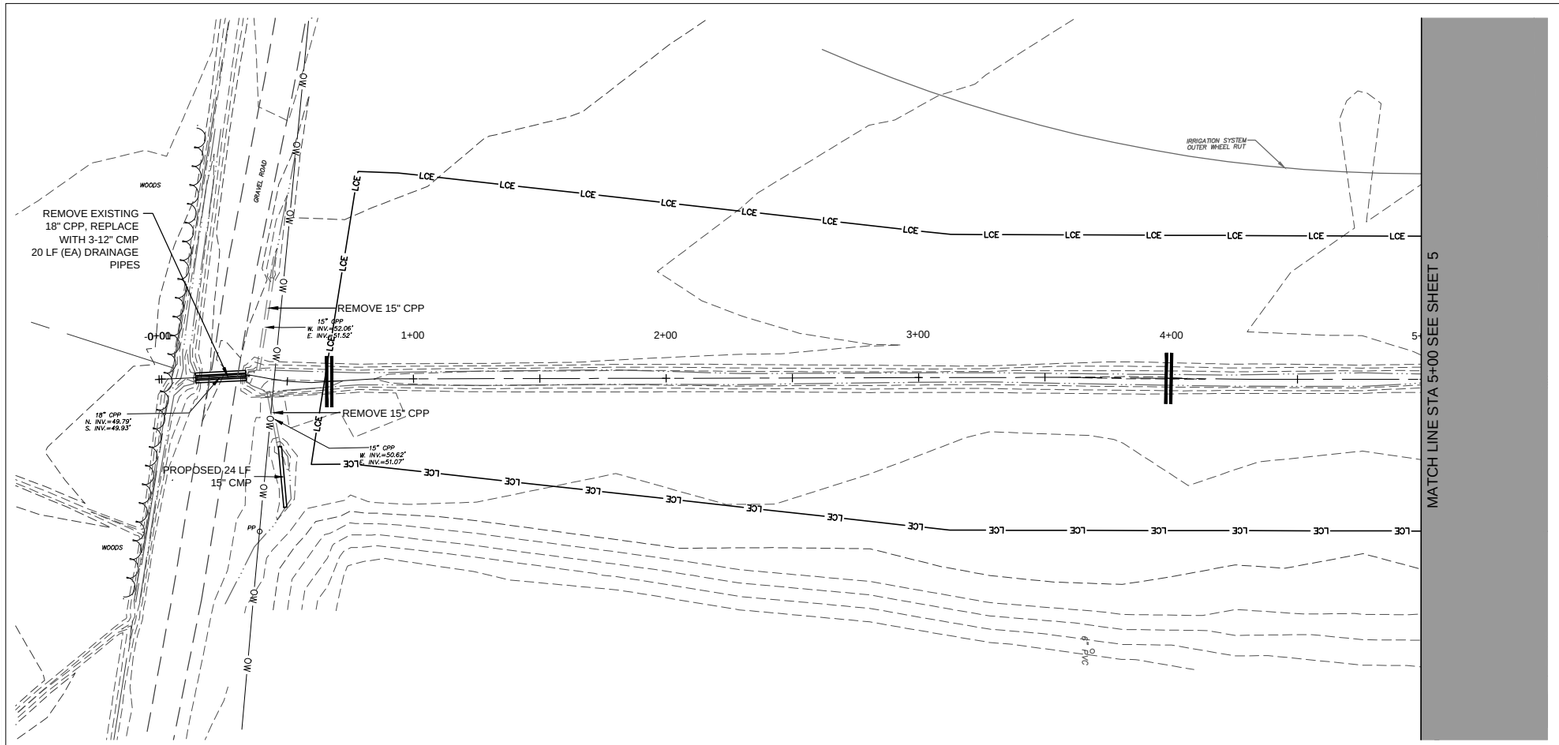
OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

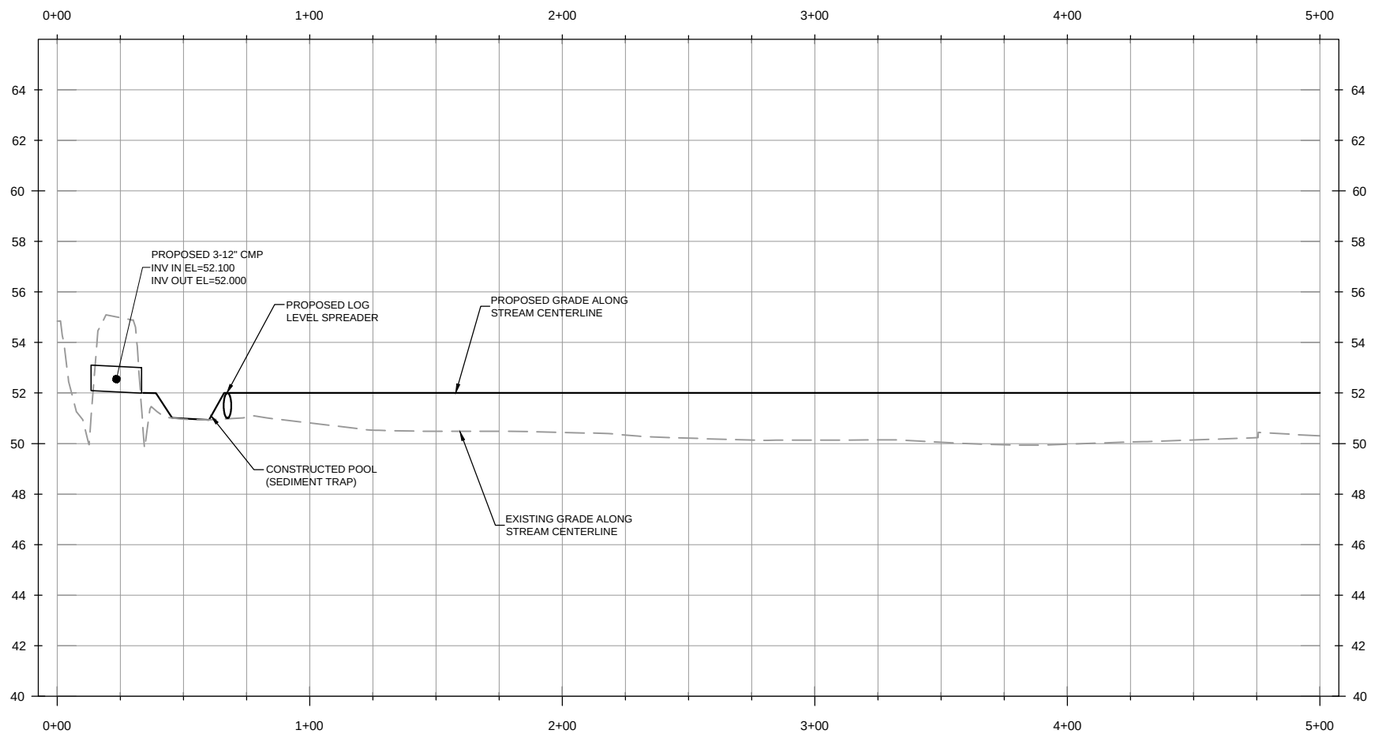
PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

DRAWING NUMBER:
3

PROJ. NO.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.





1:30

1:30

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT — LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE — LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS (W)
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE — OW — OW

*SEE SHEET 20 FOR PROPOSED CROSS SECTIONS

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PLOT DATE: 7/10/2012

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 PLAN & PROFILE STA 0+00-5+00

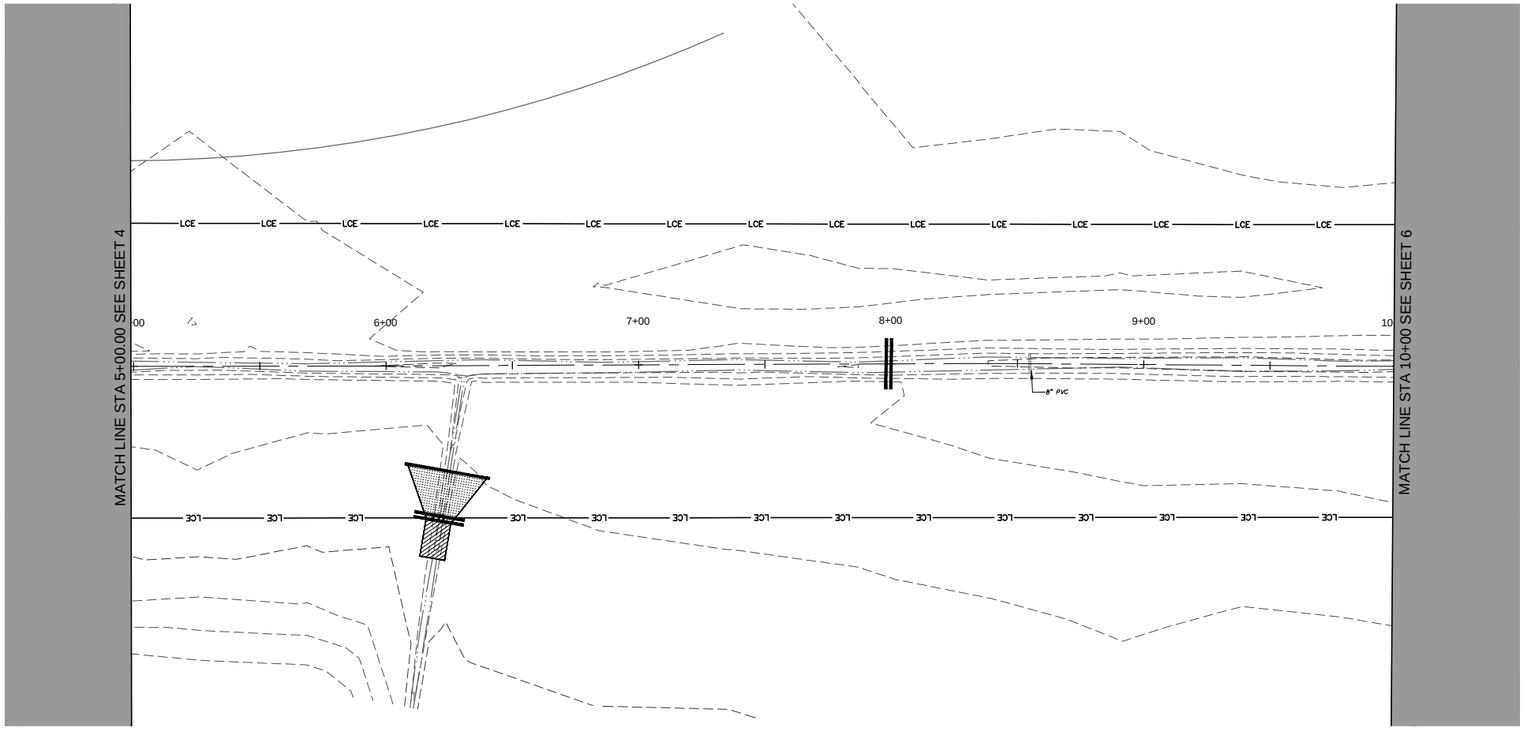
OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

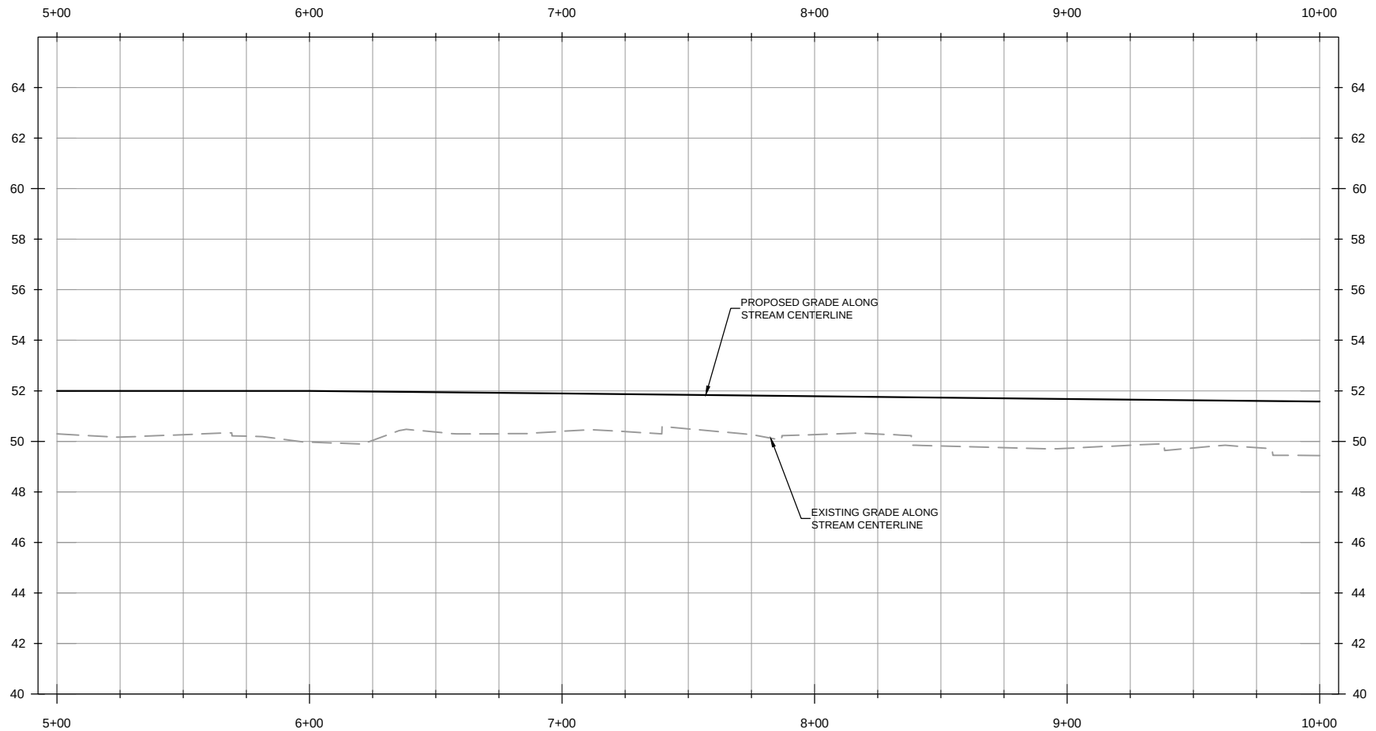
PROJ. DATE: DEC 2011
Q.C.: FM
Q.C. DATE: DEC 2011

DRAWING NUMBER:
4

PROJ. NO.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy





1:30

1:30

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT (LCE)
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE (LOD)
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS (W)
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE (S)
- WETLANDS
- OVERHEAD UTILITY LINE (OW)

*SEE SHEET 20 FOR PROPOSED CROSS SECTIONS

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 12/14/11

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 PLAN & PROFILE STA 5+00-10+00

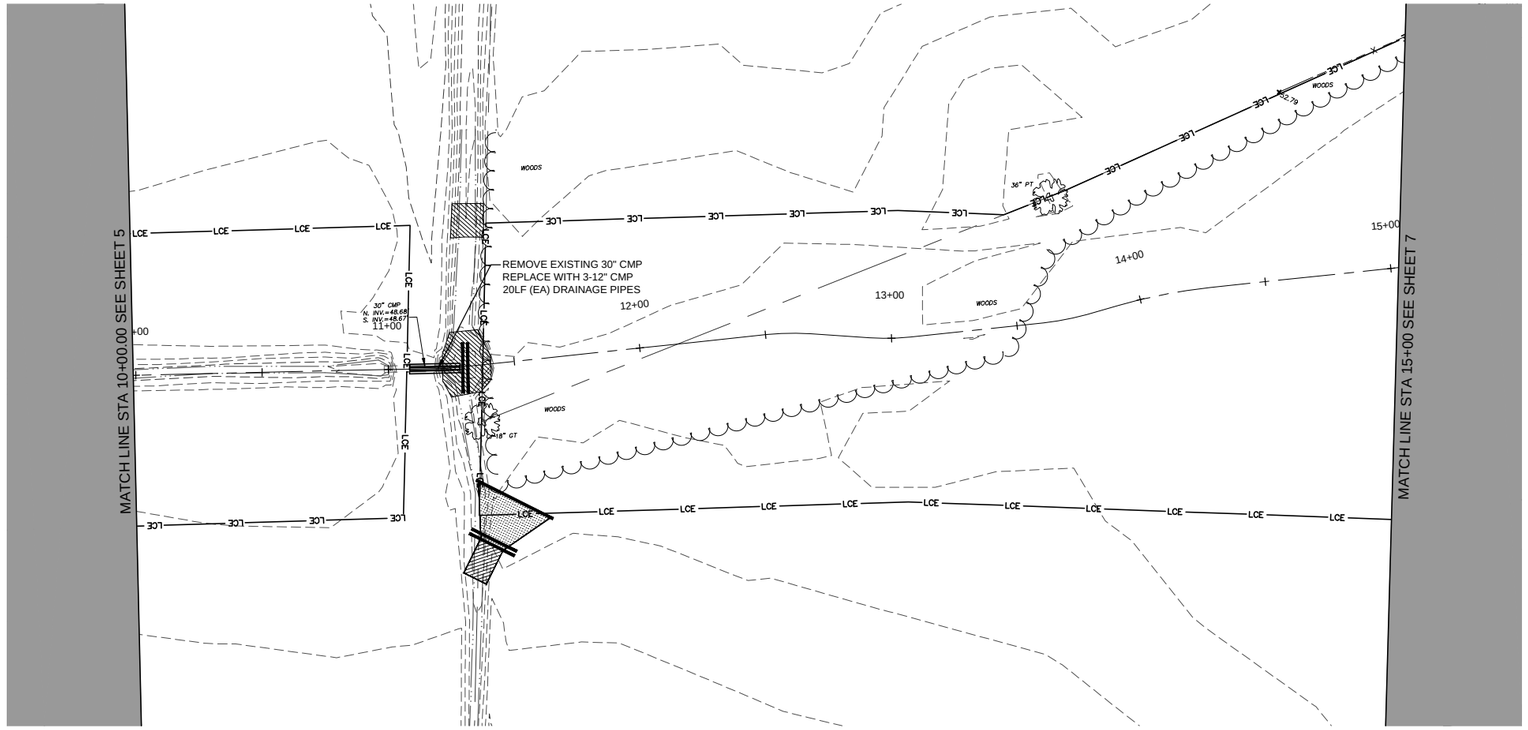
OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

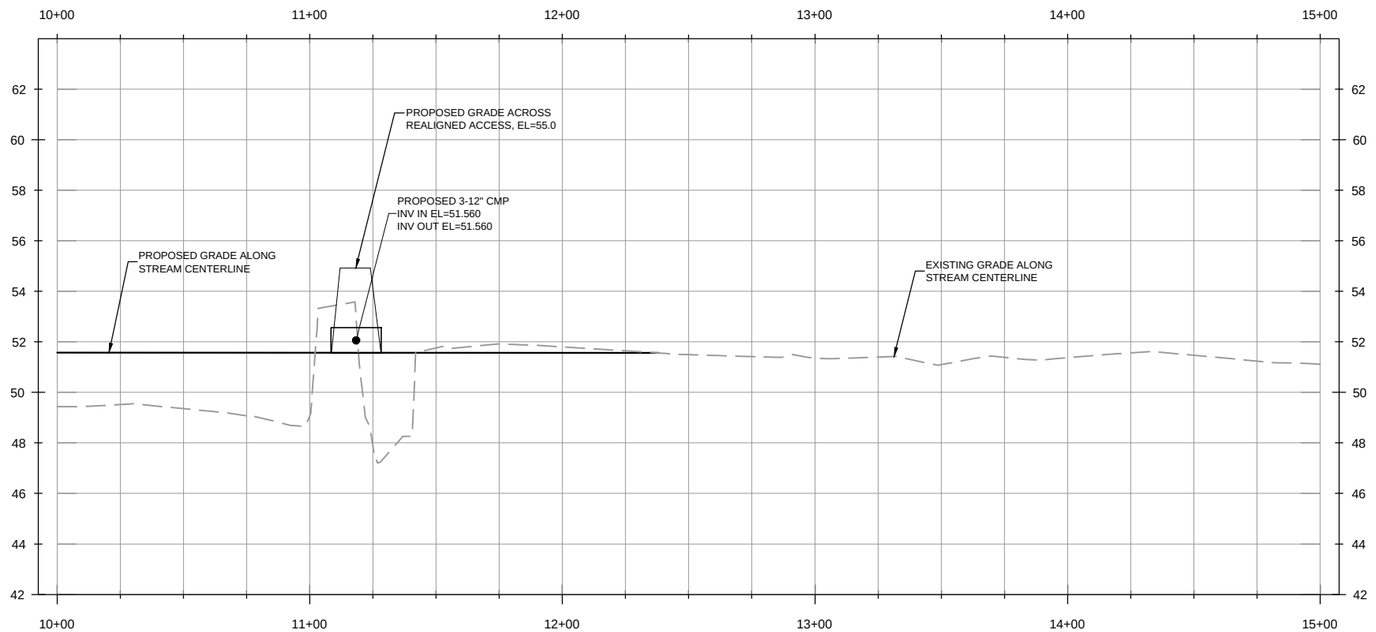
PROJ. DATE: DEC 2011
Q.C.: FM
Q.C. DATE: DEC 2011

DRAWING NUMBER:
5

PROJ. NO.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy





1:30

1:30

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT (LCE)
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE (LOD)
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS (W)
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE (OW)

*SEE SHEET 20 FOR PROPOSED CROSS SECTIONS

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PLOT DATE: 7/10/2012

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 PLAN & PROFILE STA 10+00-15+00

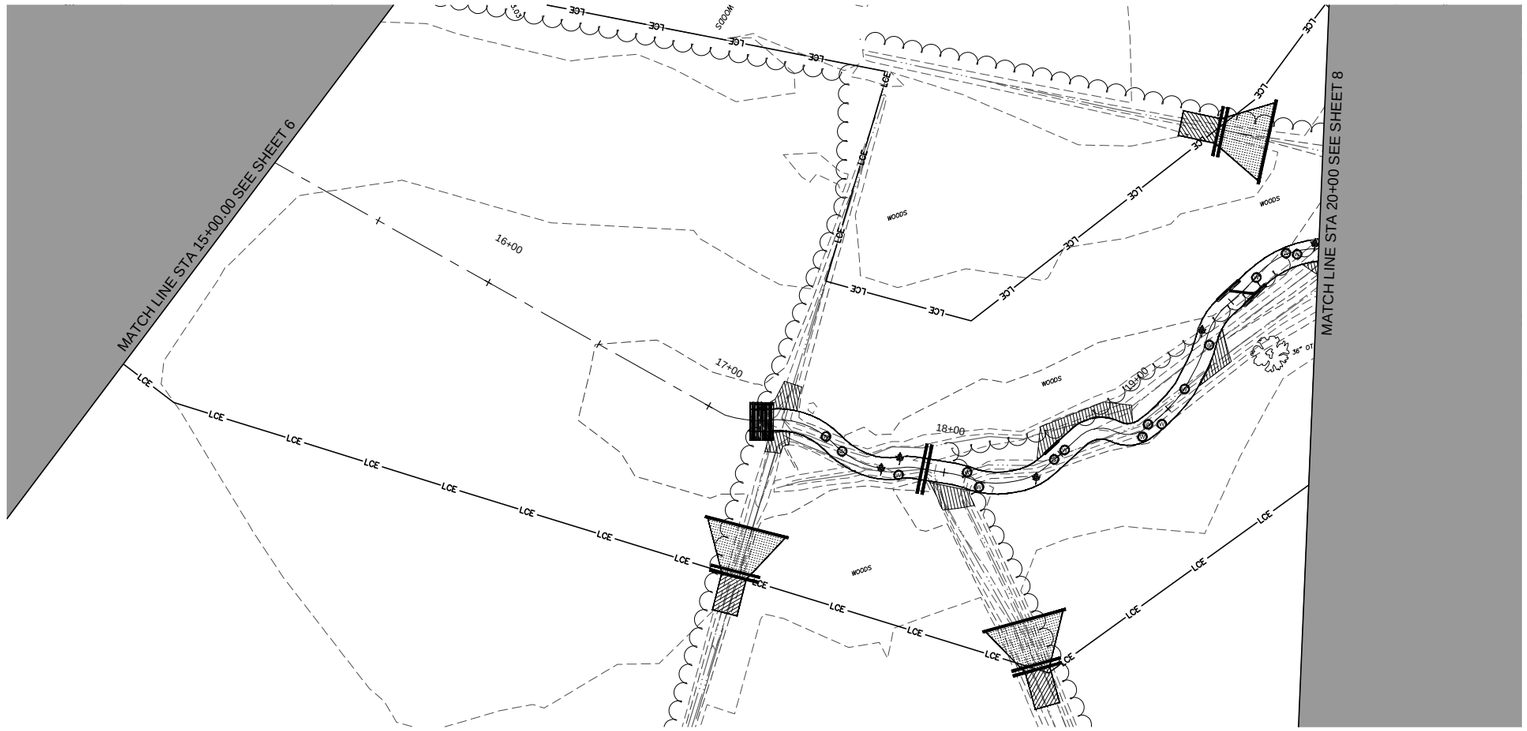
OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE: DEC 2011
Q.C.: FM
Q.C. DATE: DEC 2011

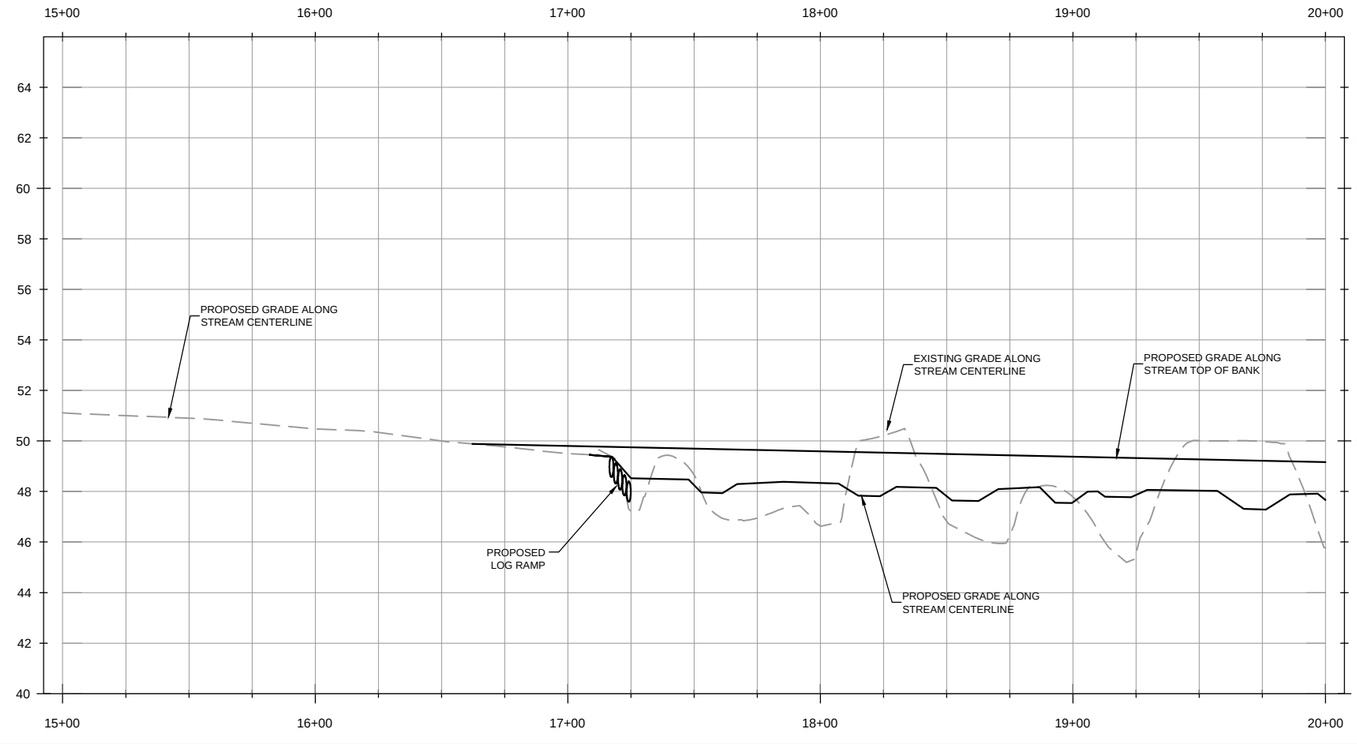
DRAWING NUMBER:
6

PROJ. NO.:
2011017600RA

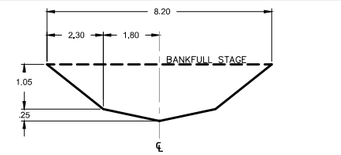
COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



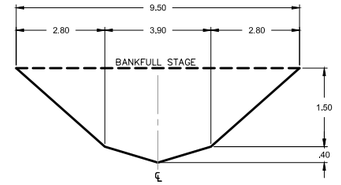
1:30



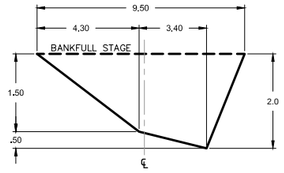
1:30



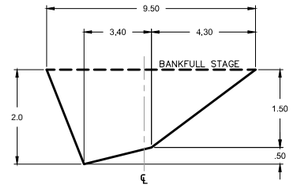
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT — LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE — LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE — OW — OW —

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
---	---	---
---	---	---
---	---	---

REVISIONS:

RELEASED FOR: PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO. NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 PLAN & PROFILE STA 15+00-20+00

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

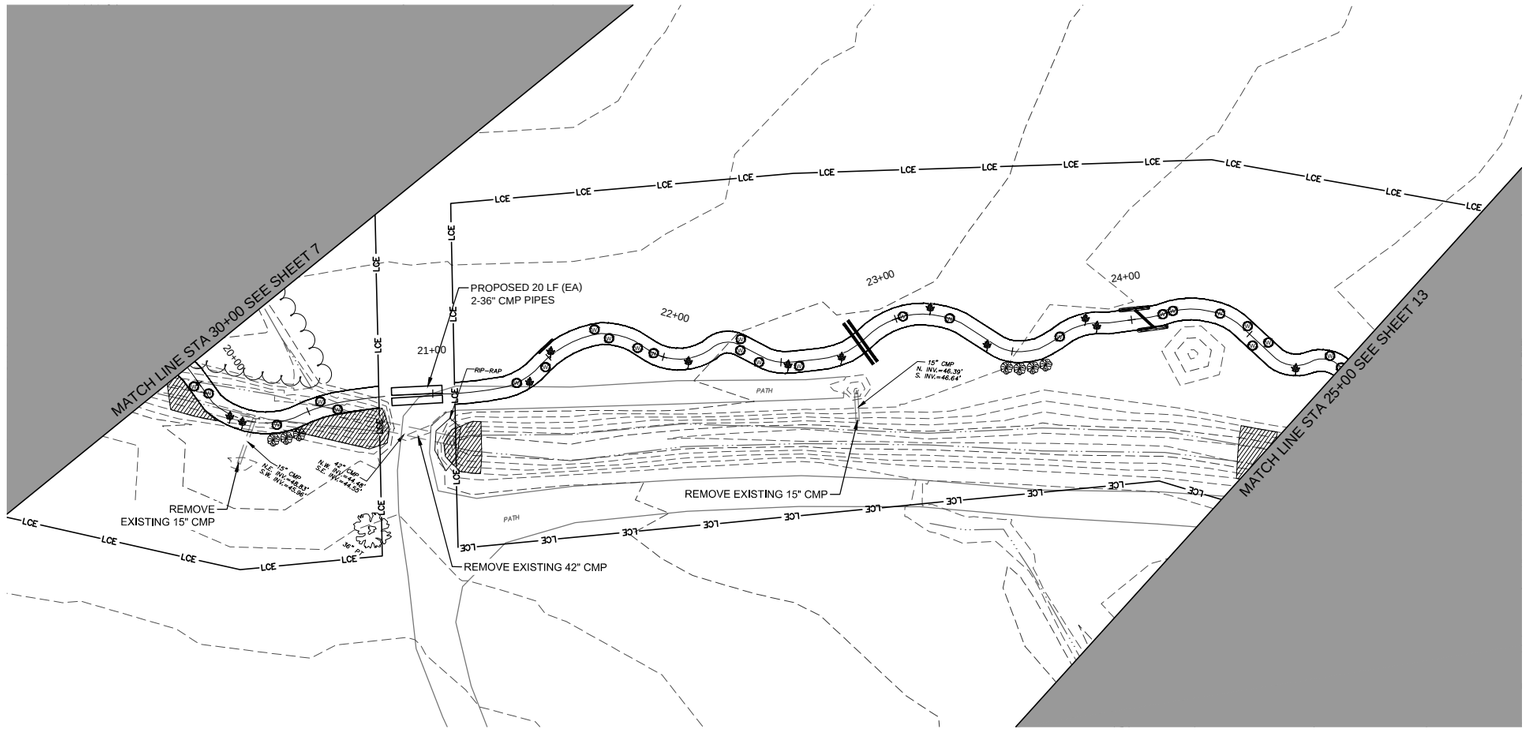
PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

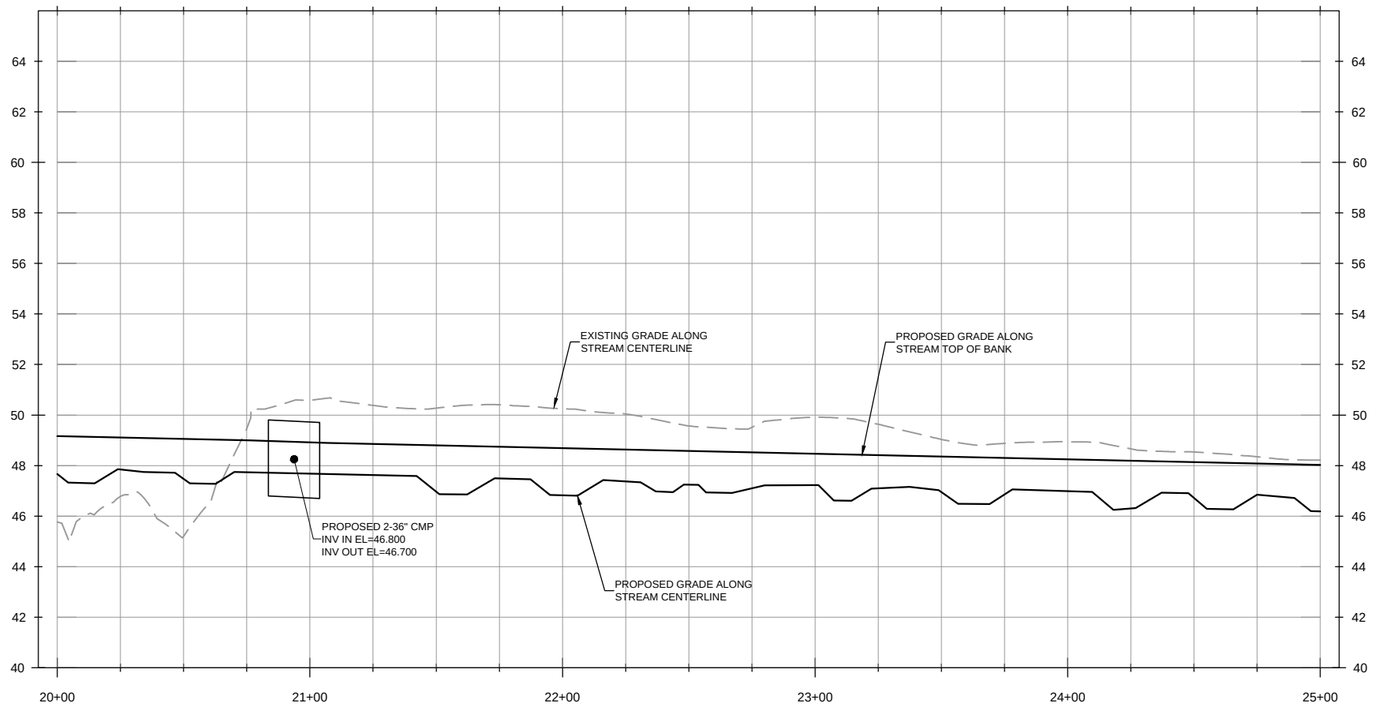
DRAWING NUMBER: 7

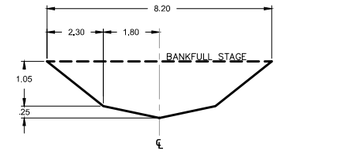
PROJ. NO.: 2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

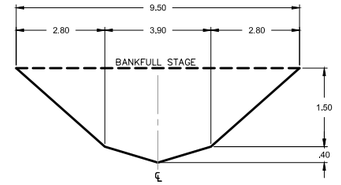
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



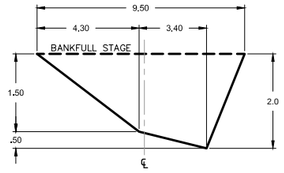




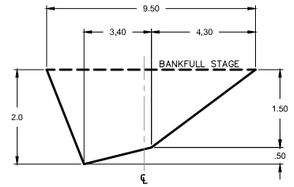
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT — LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE — LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE — OW — OW —

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
---	---	---
---	---	---
---	---	---

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO. NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 PLAN & PROFILE STA 20+00-25+00

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

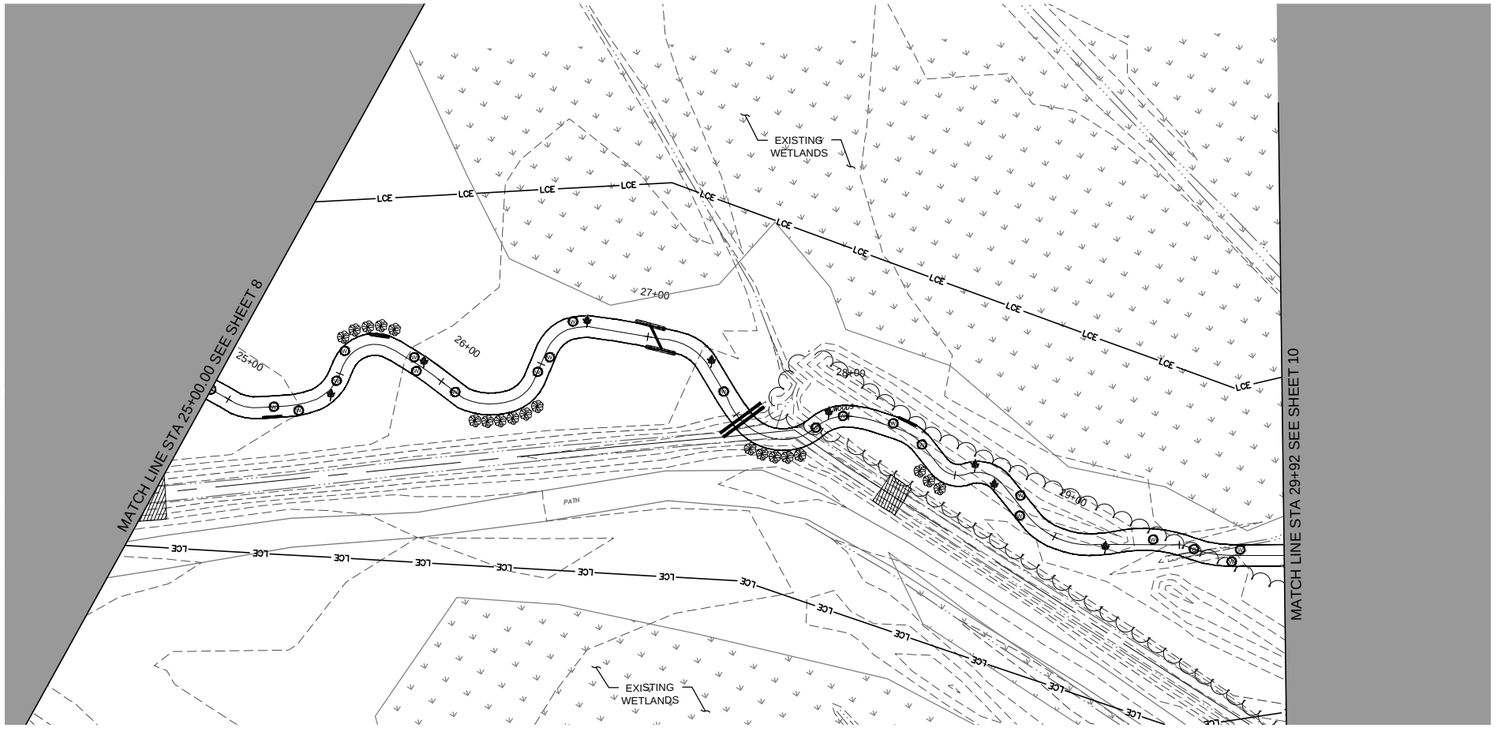
DRAWING NUMBER:
8

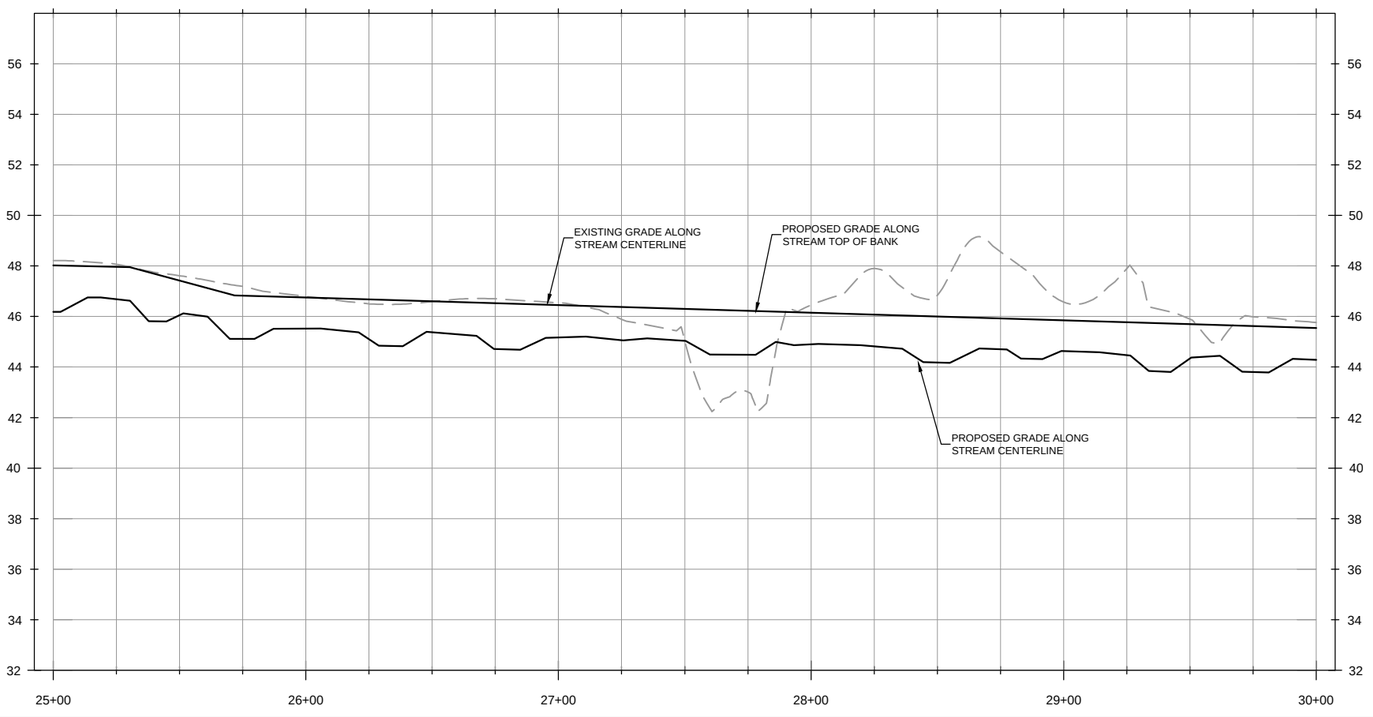
PROJ. NO.:
2011017600RA

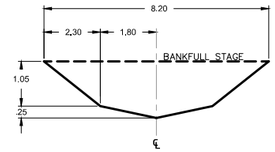
1:30

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

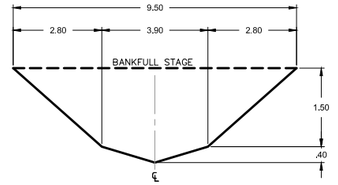
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



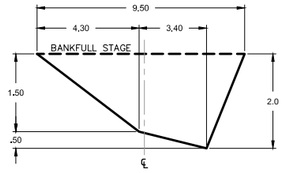




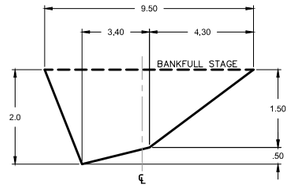
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT — LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE — LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE — OW — OW —

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
---	---	---
---	---	---
---	---	---

REVISIONS:

RELEASED FOR: PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME: MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO. NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE: REACH 1 PLAN & PROFILE STA 25+00 TO 30+00

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

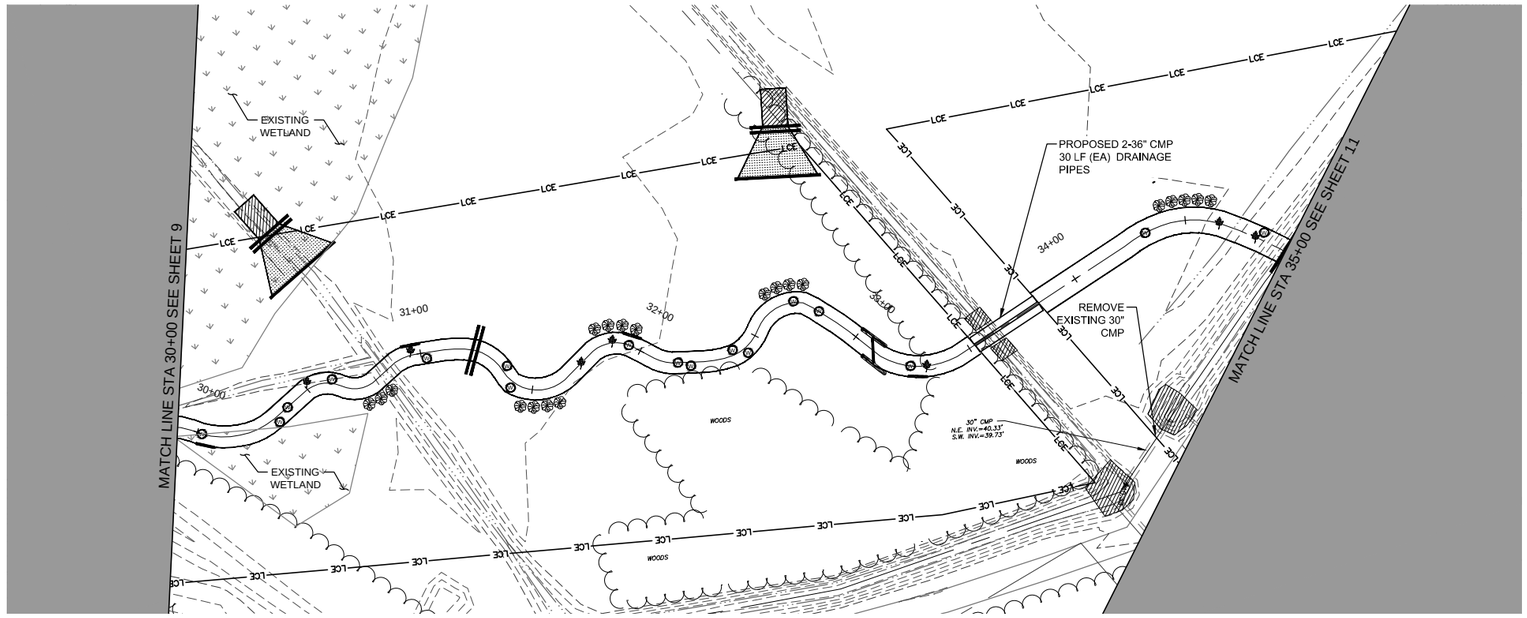
PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

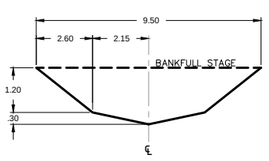
DRAWING NUMBER: 9

PROJ. NO.: 2011017600RA

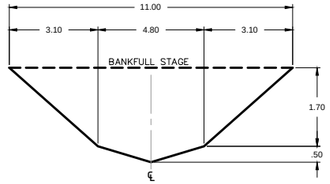
1:30

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy

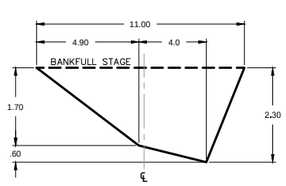




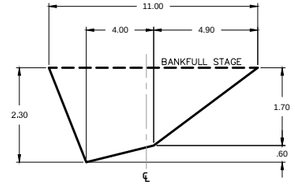
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH

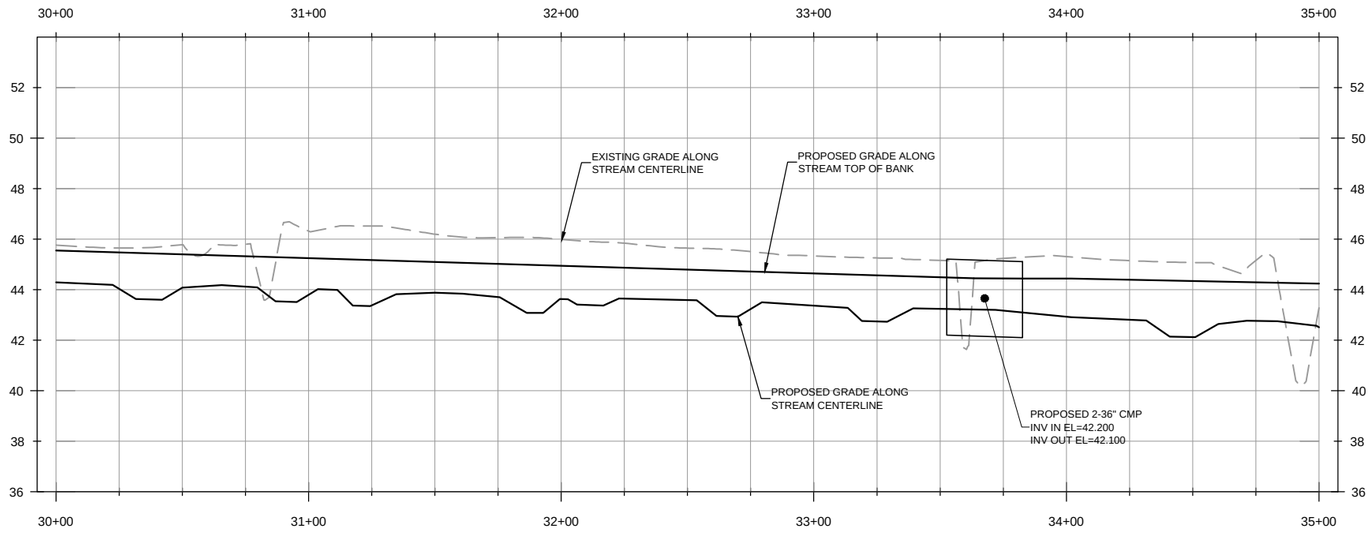


TYPICAL RIGHT MEANDER CROSS SECTION



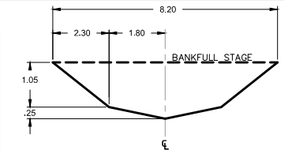
TYPICAL LEFT MEANDER CROSS SECTION

TYPICAL SECTIONS STA 33+67 TO 35+00

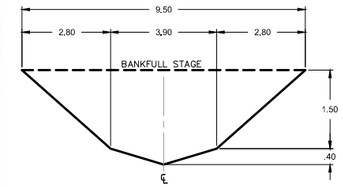


1:30

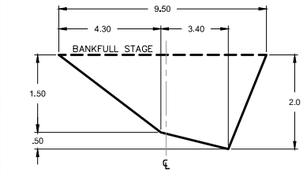
1:30



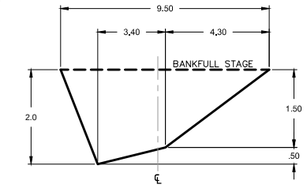
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

TYPICAL SECTIONS STA 30+00 TO 33+67

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT — LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE — LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE — OW — OW

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 PLAN & PROFILE STA 30+00 TO 35+00

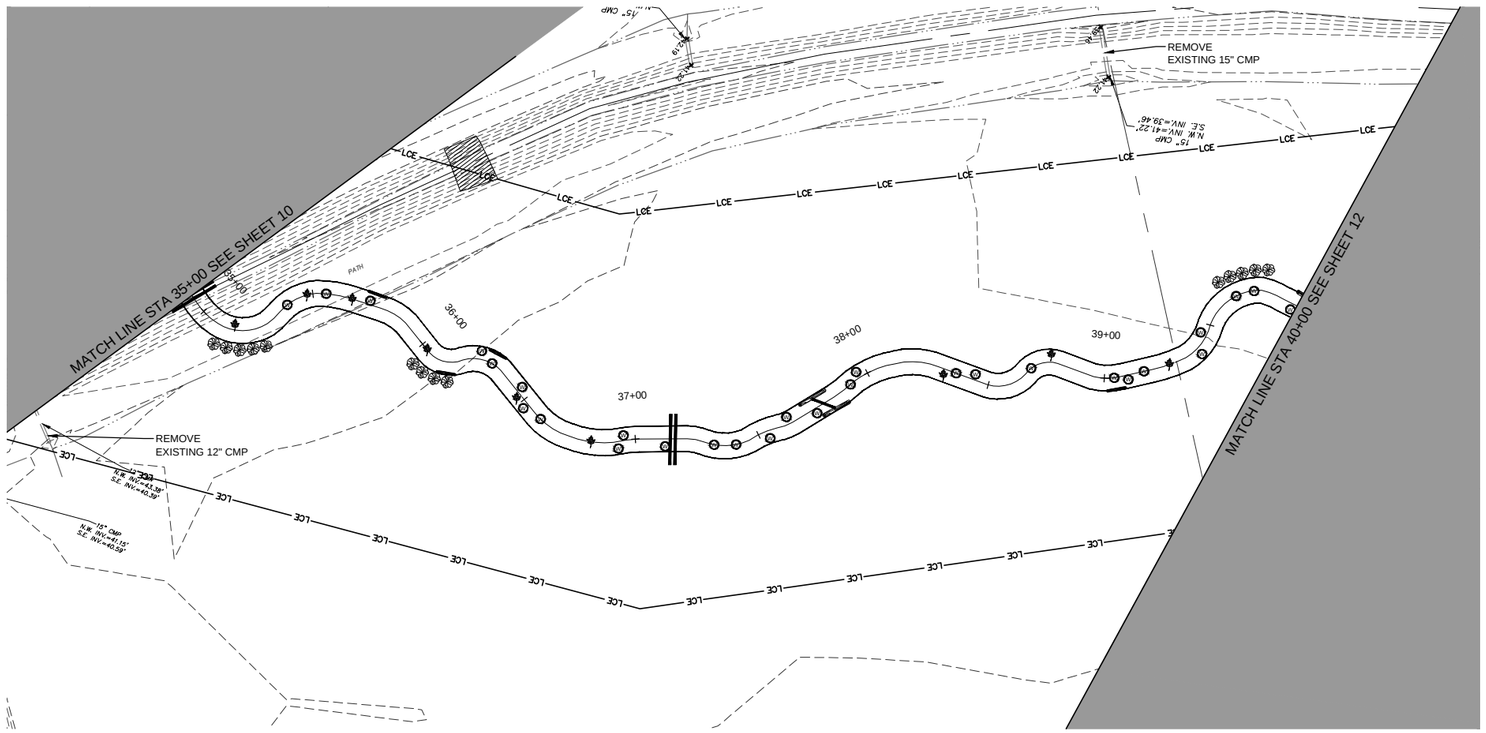
OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

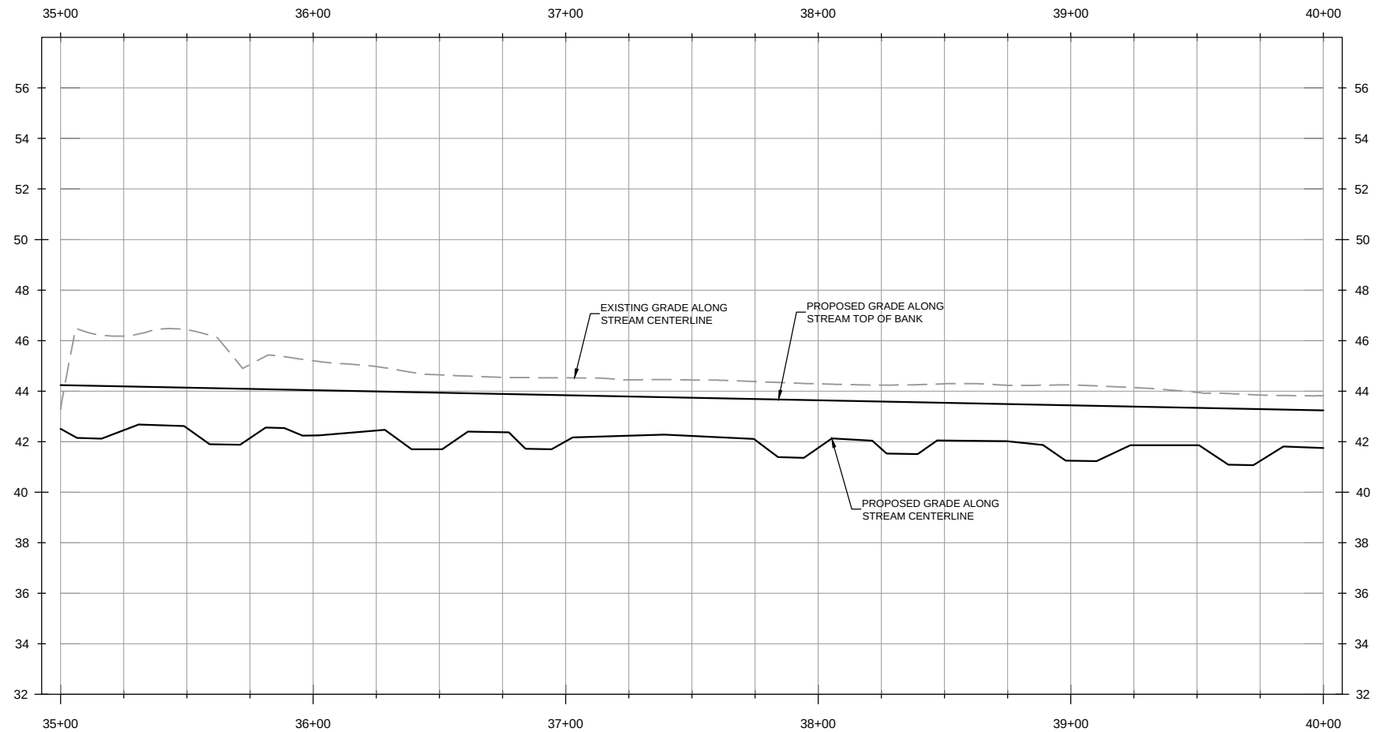
PROJ. DATE: DEC 2011
Q.C.: FM
Q.C. DATE: DEC 2011

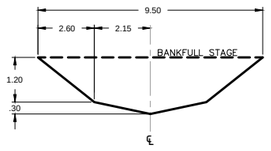
DRAWING NUMBER:
10

PROJ. NO.:
2011017600RA

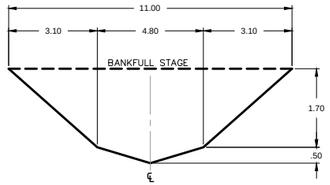
COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.
FILE NAME: I:\Projects\EBX\201101760RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



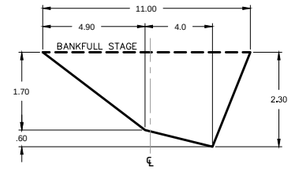




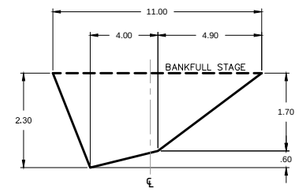
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT — LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE — LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE — OW — OW

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 PLAN & PROFILE STA 35+00 TO 40+00

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

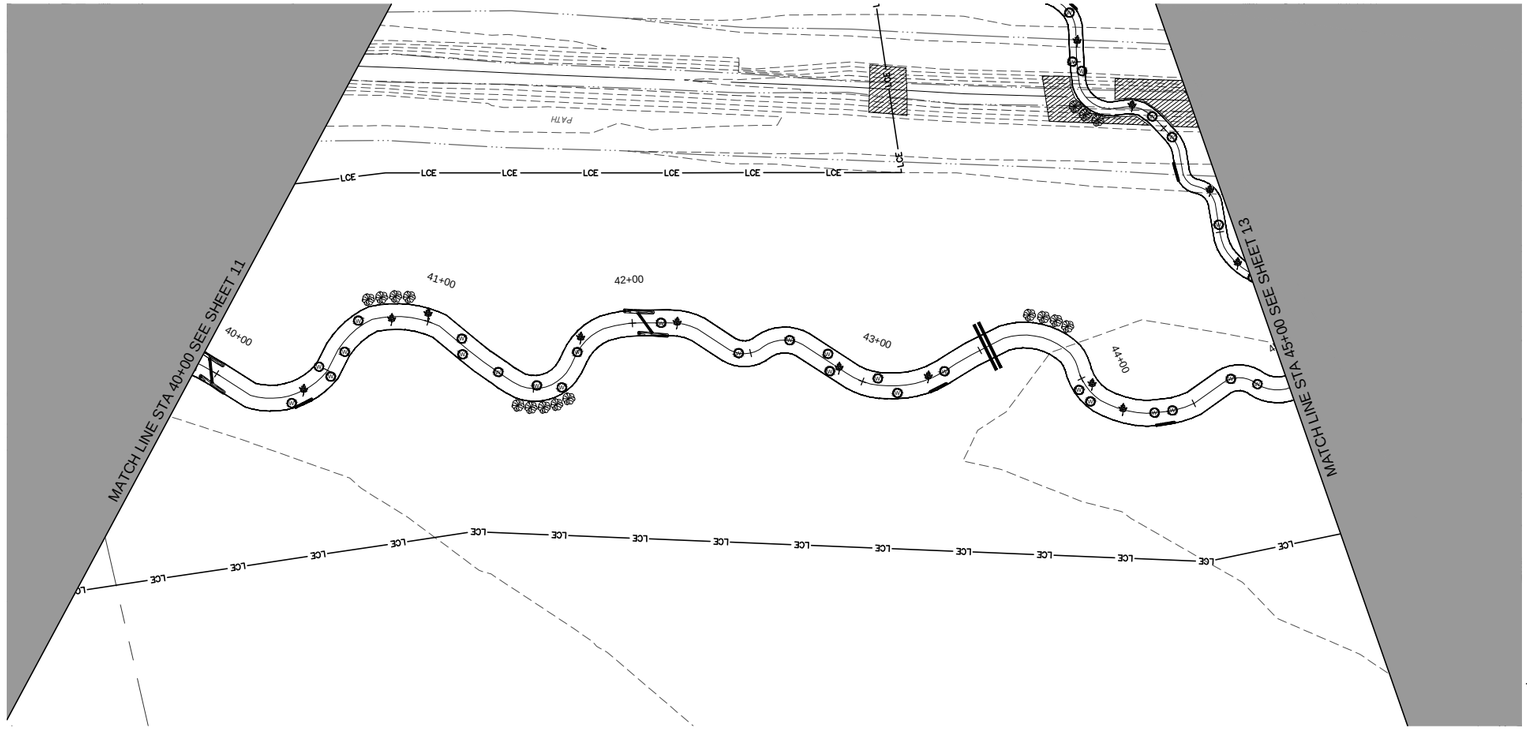
PROJ. DATE: DEC 2011
Q.C.: FM
Q.C. DATE: DEC 2011

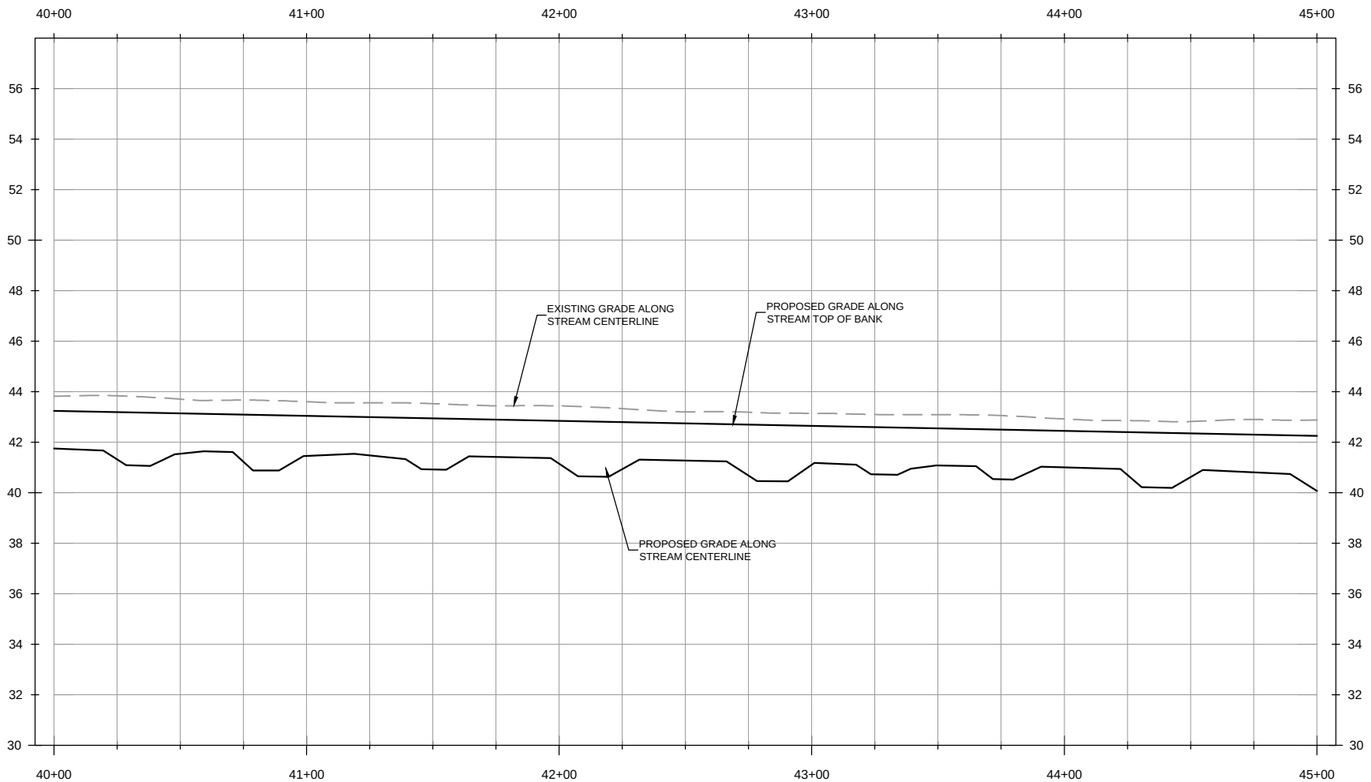
DRAWING NUMBER:
11

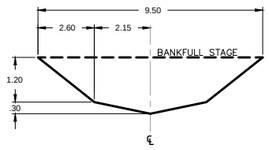
PROJ. NO.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

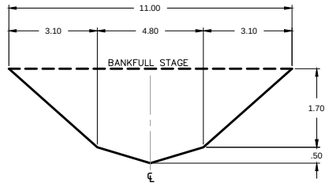
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



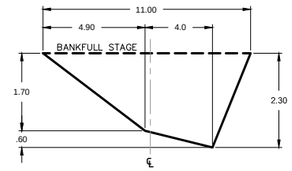




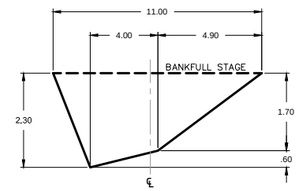
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT — LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE — LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE — OW — OW

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 PLAN & PROFILE STA 40+00 TO 45+00

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

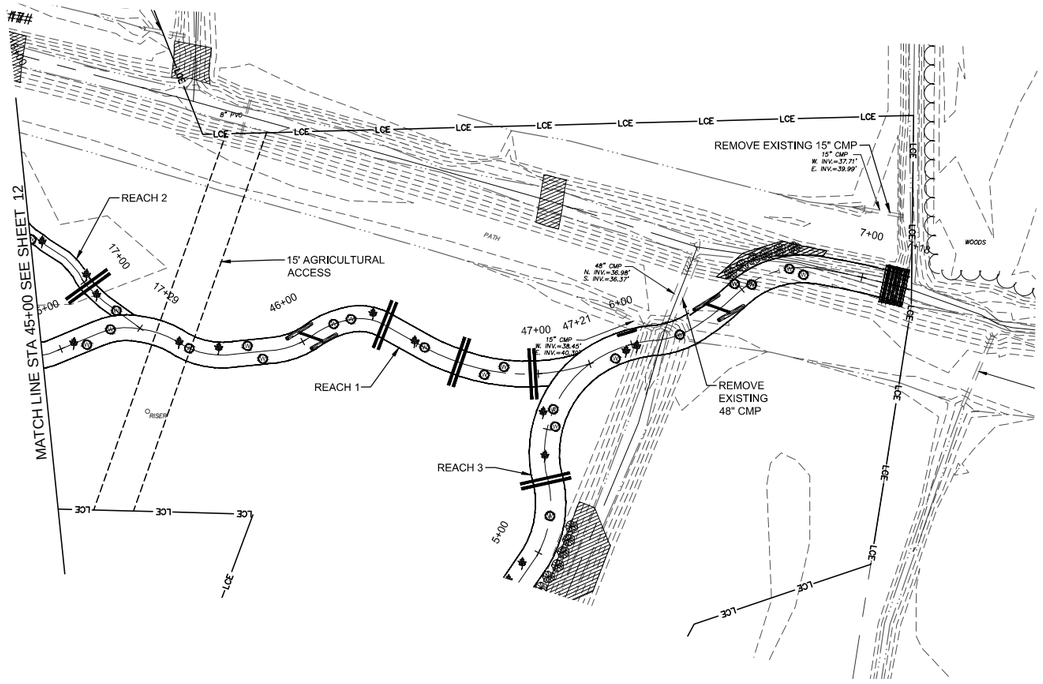
PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

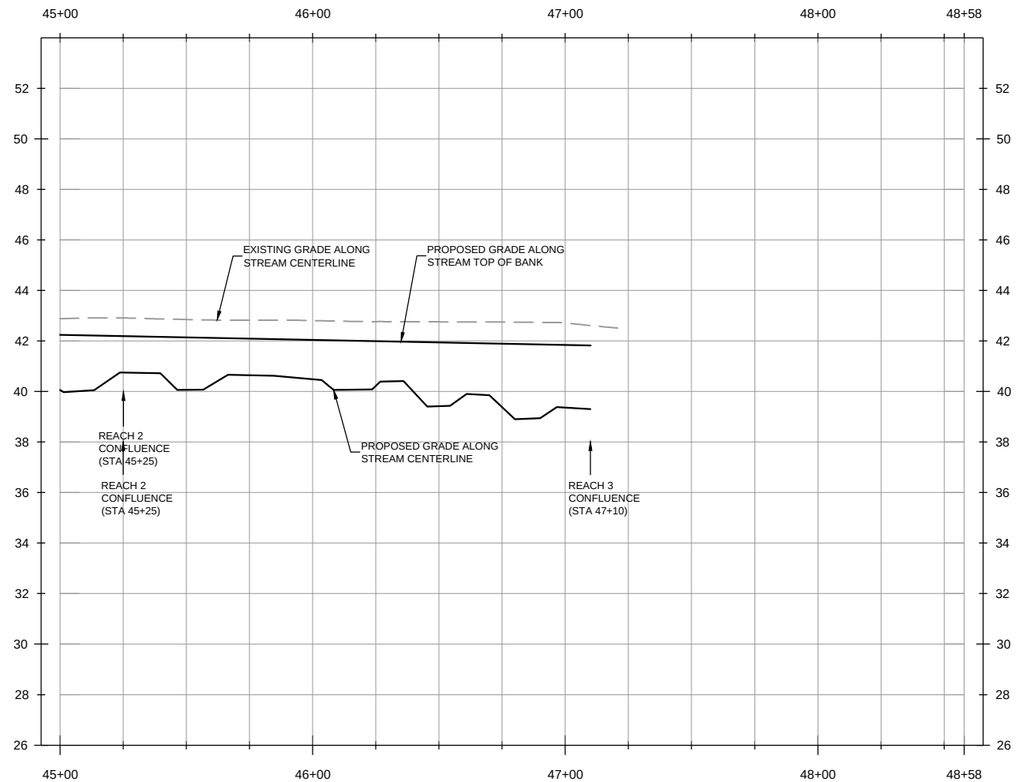
DRAWING NUMBER:
12

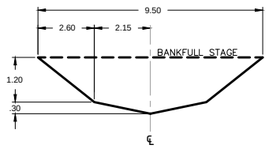
PROJ. NO.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

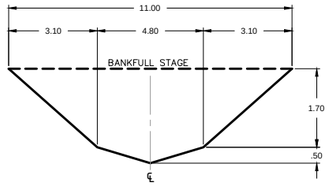
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



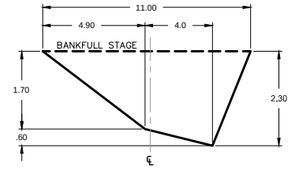




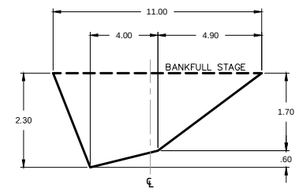
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10.70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT (LCE)
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE (LOD)
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS (W)
- LEAF PACK (LP)
- LIVE CUTTINGS BUNDLE (LC)
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE (OW)

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 12/14/11

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 PLAN & PROFILE STA 45+00 TO 47+20.77

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

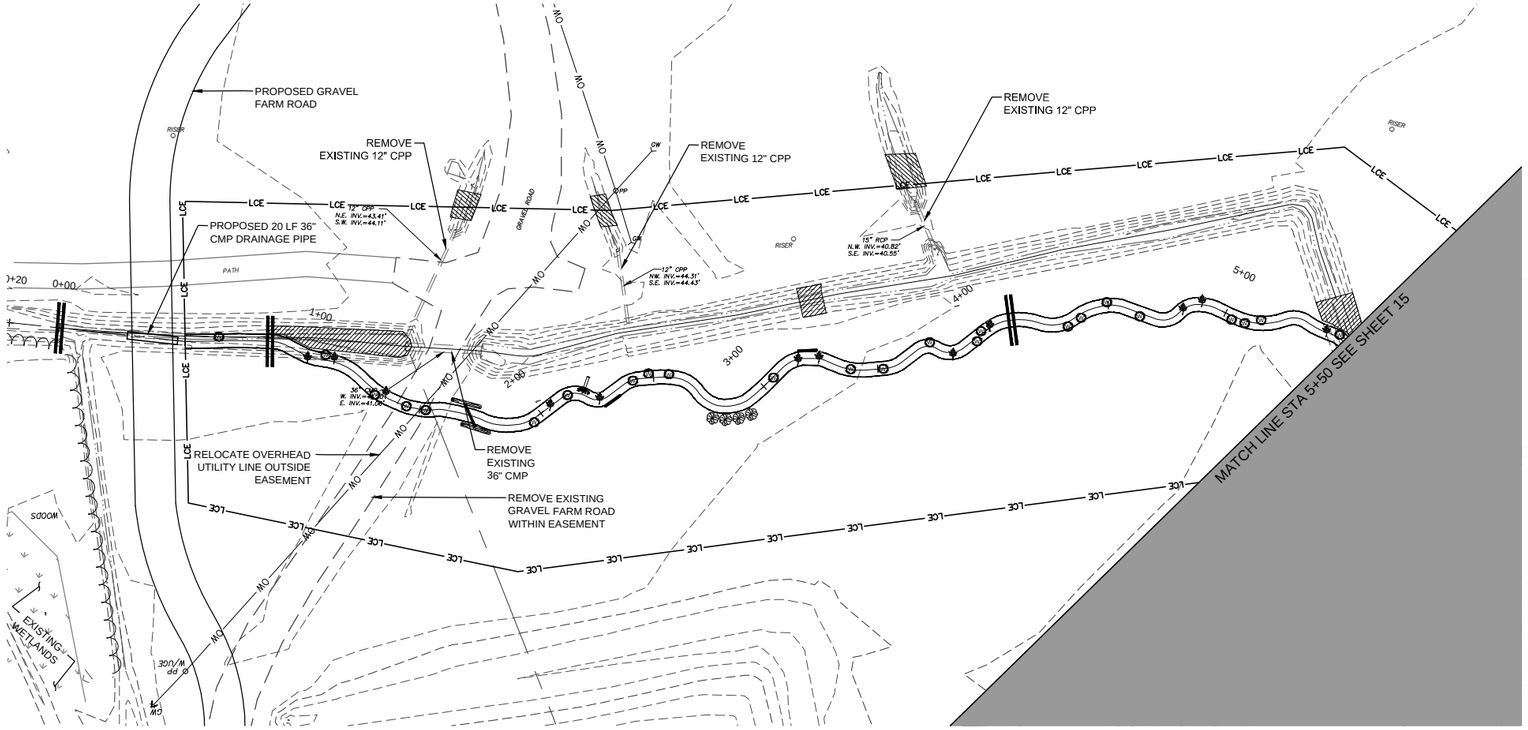
DRAWING NUMBER:
13

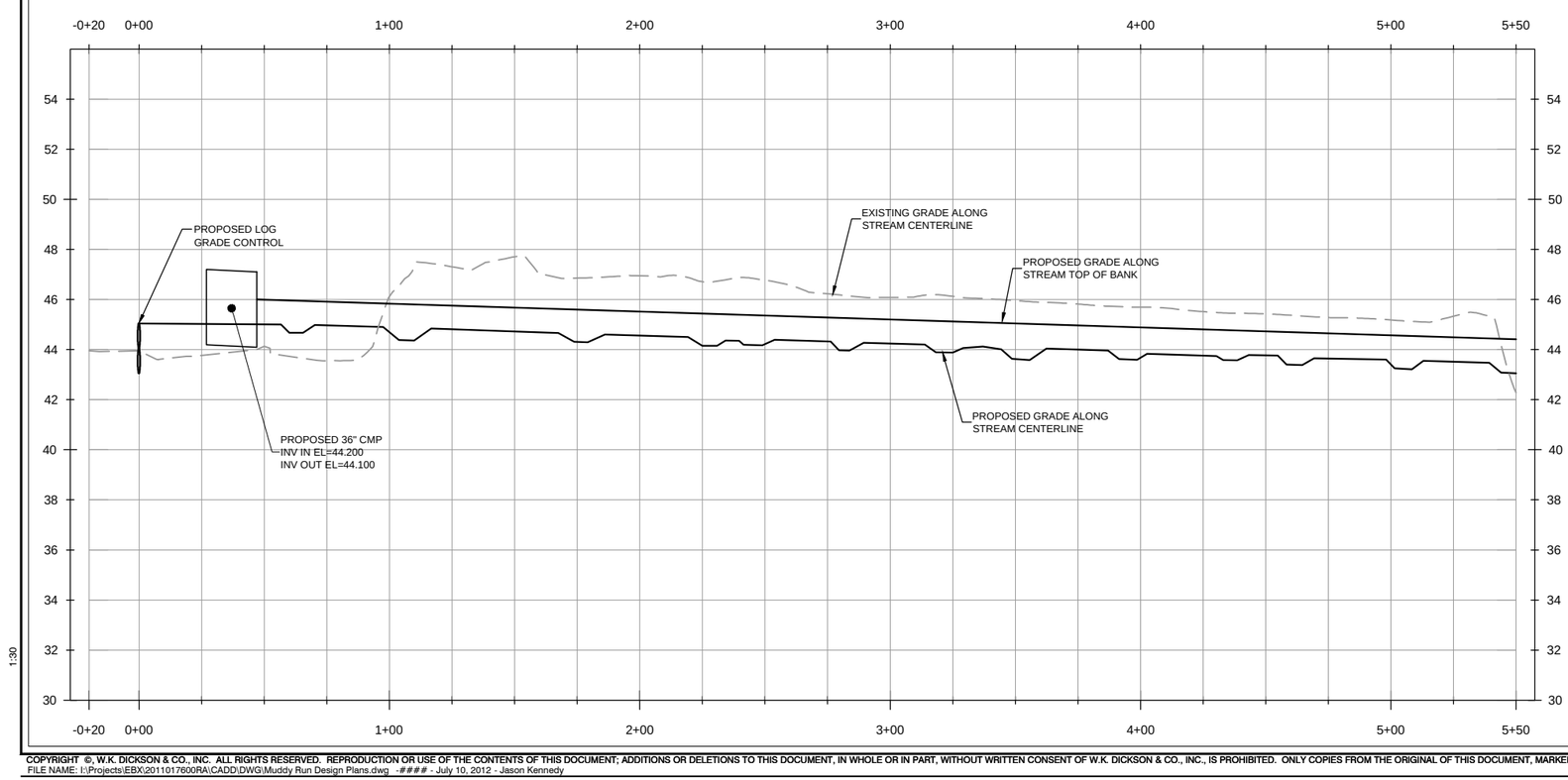
PROJ. NO.:
2011017600RA

1:30

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

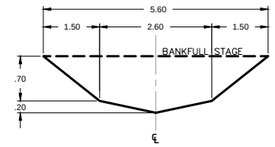
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



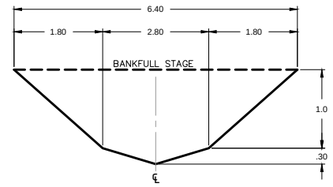


1:30

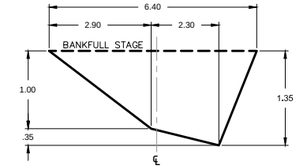
1:30



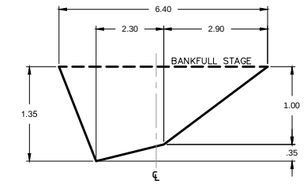
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT — LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE — LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE — OW — OW

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR: PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 2 PLAN & PROFILE STA 0+00 TO 10+00

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

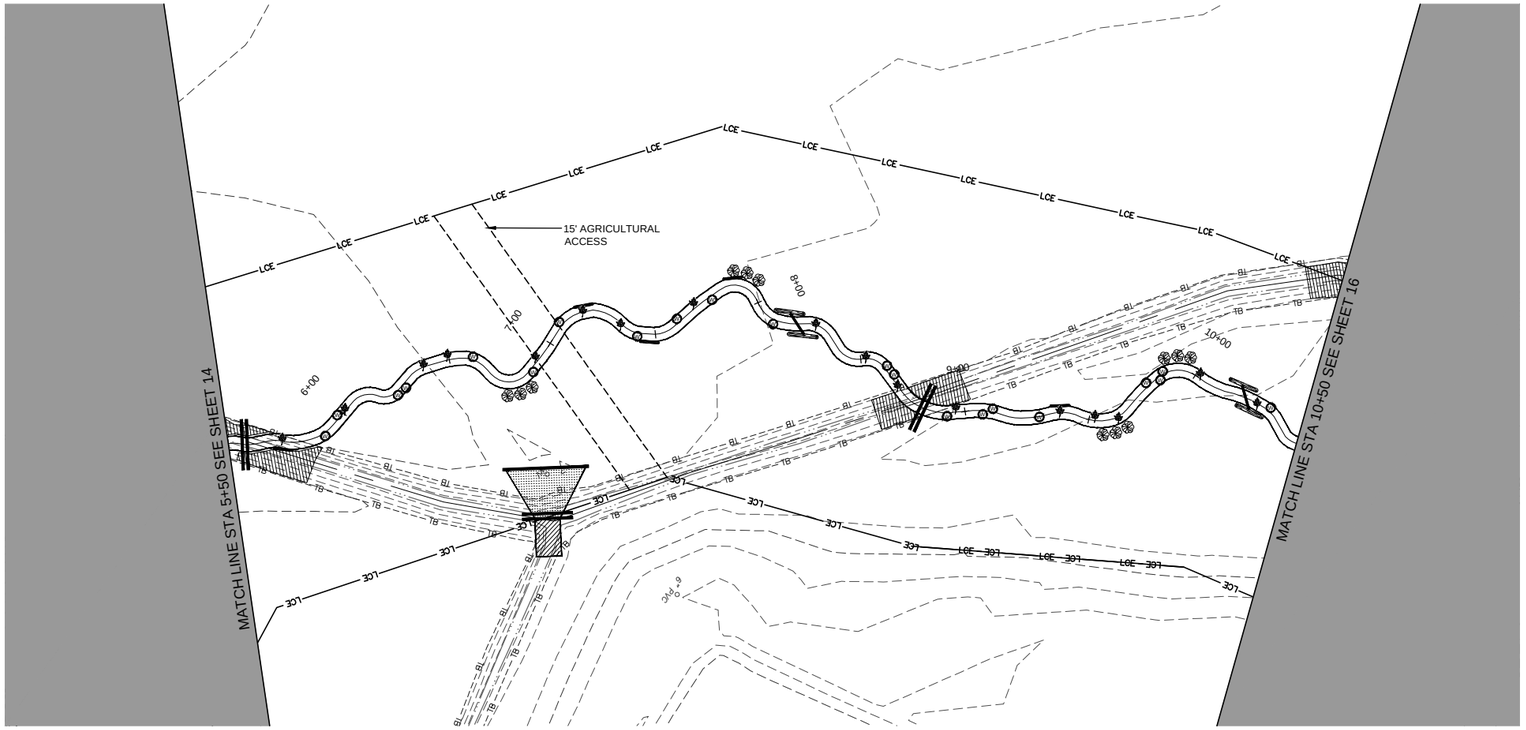
PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

DRAWING NUMBER:
14

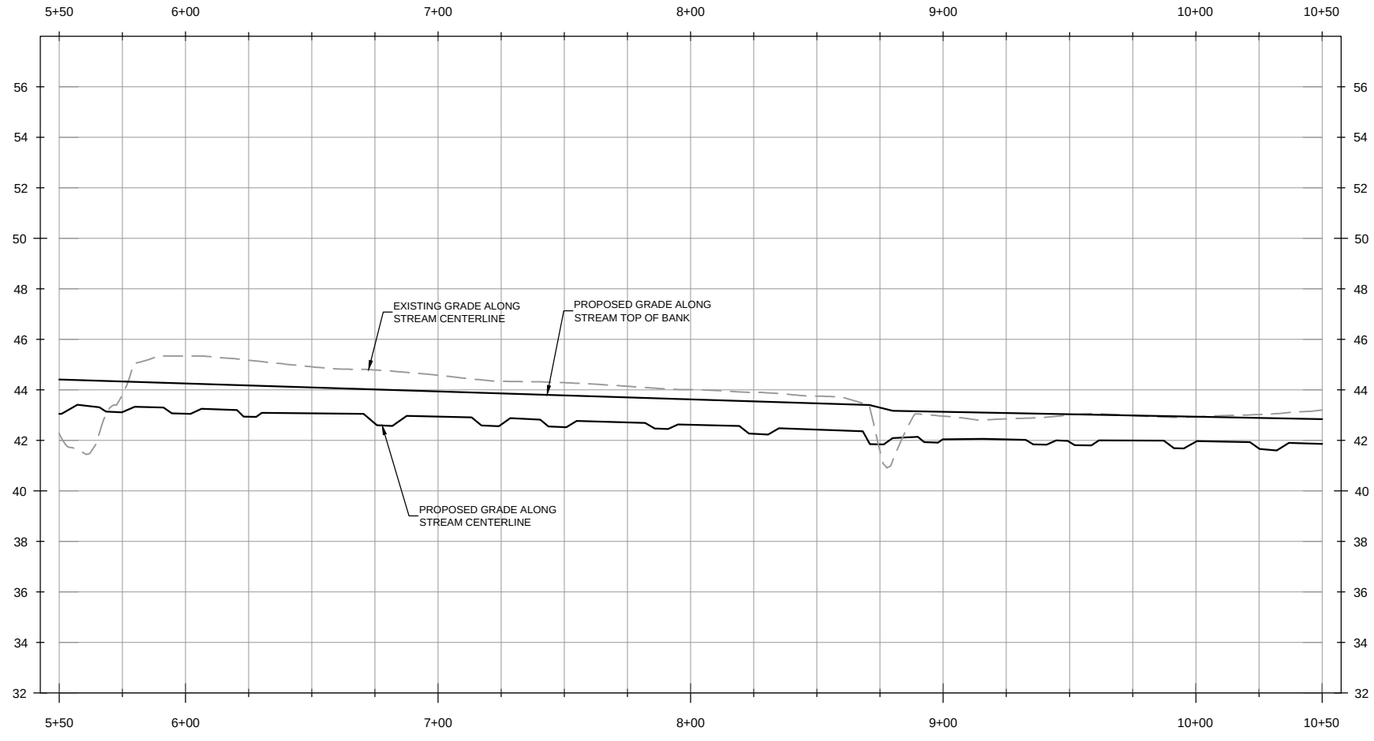
PROJ. NO.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

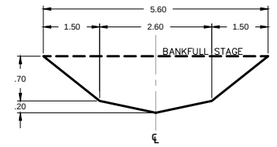
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



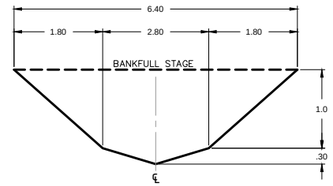
1:30



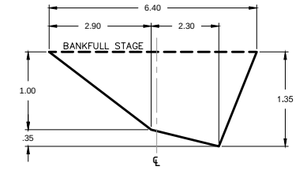
1:30



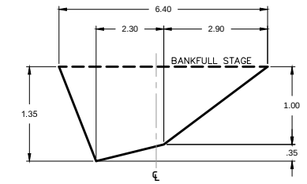
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED CENTERLINE OF CHANNEL
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE OW

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO. NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 2 PLAN & PROFILE STA 5+00 TO 10+00

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

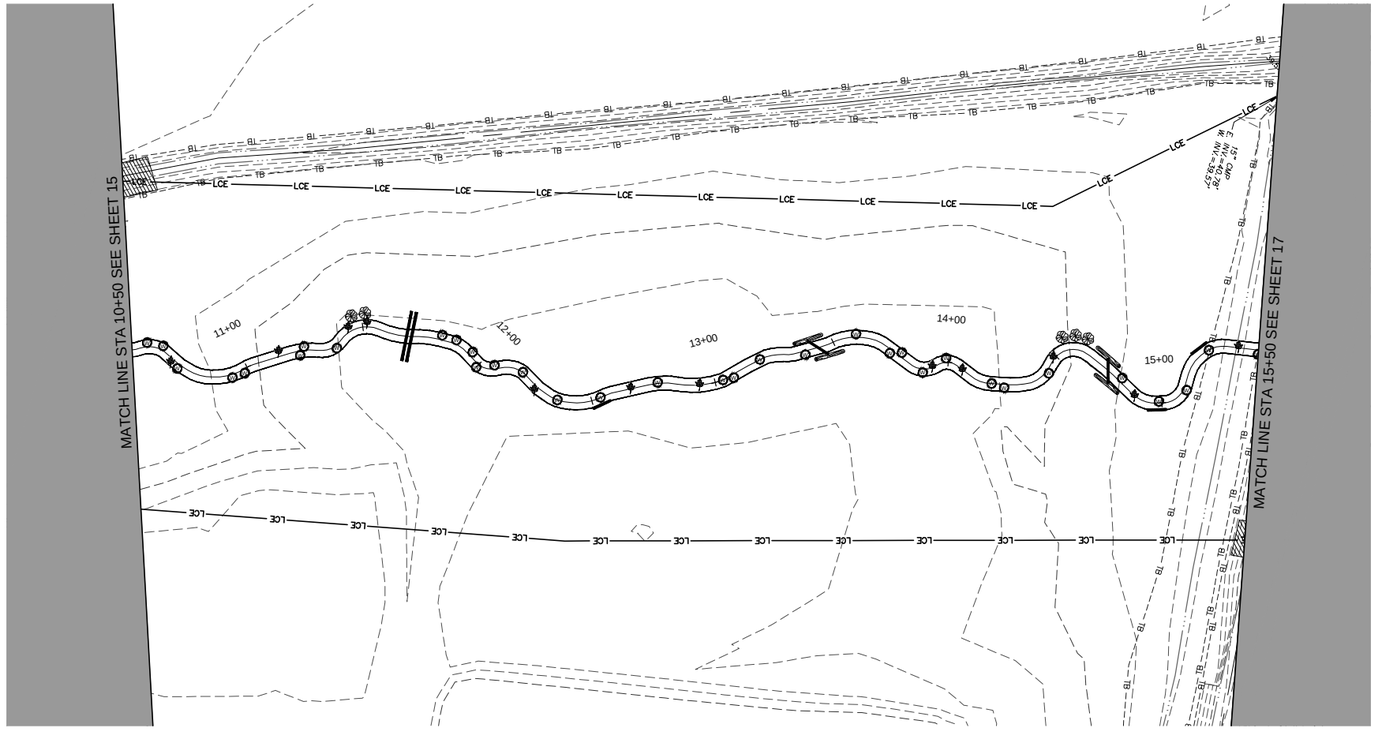
PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

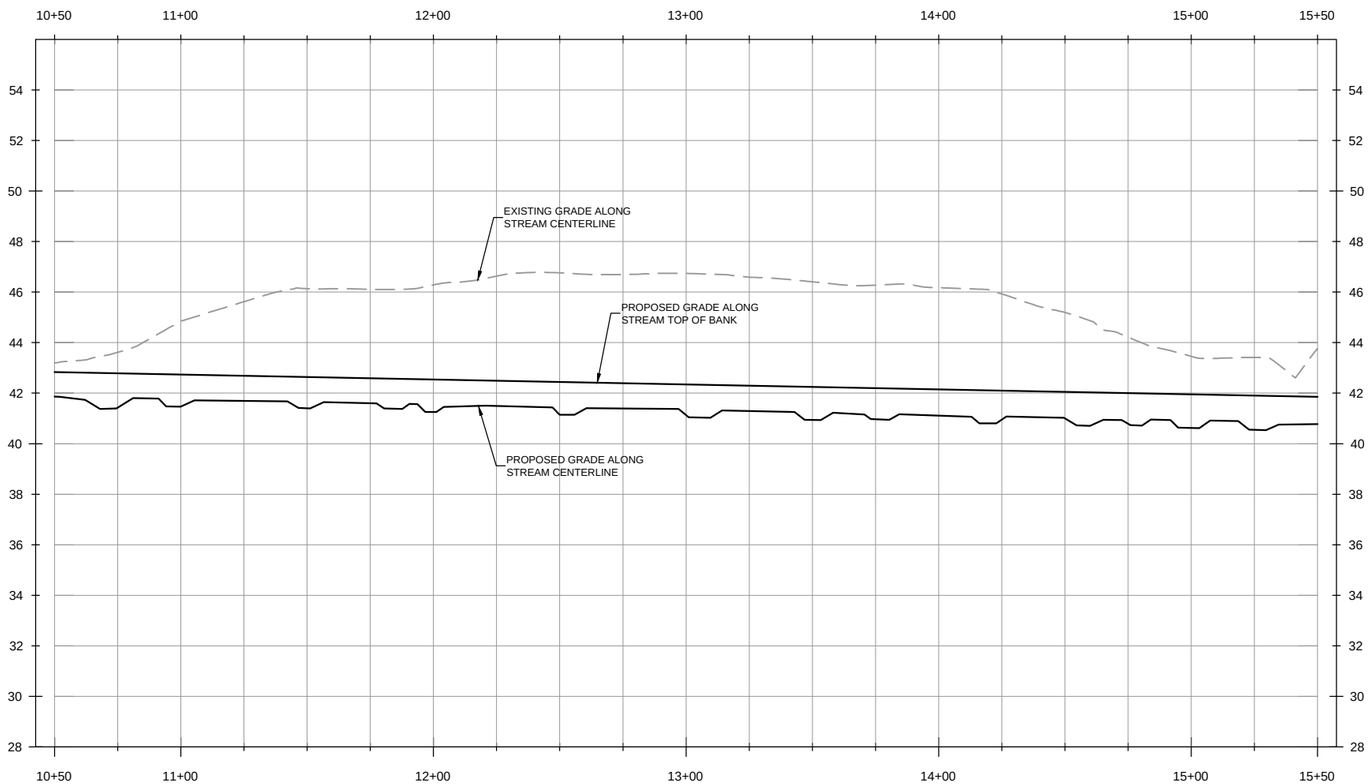
DRAWING NUMBER:
15

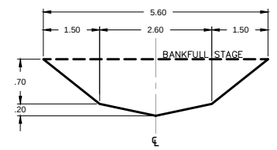
PROJ. NO.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

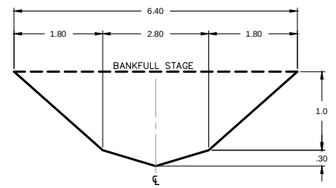
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



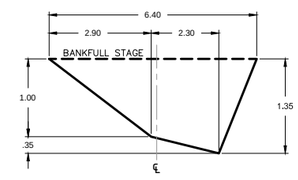




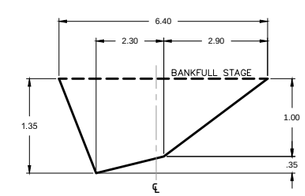
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT — LCE
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE — LOD
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE — OW — OW

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 2 PLAN & PROFILE STA 10+00 TO 15+00

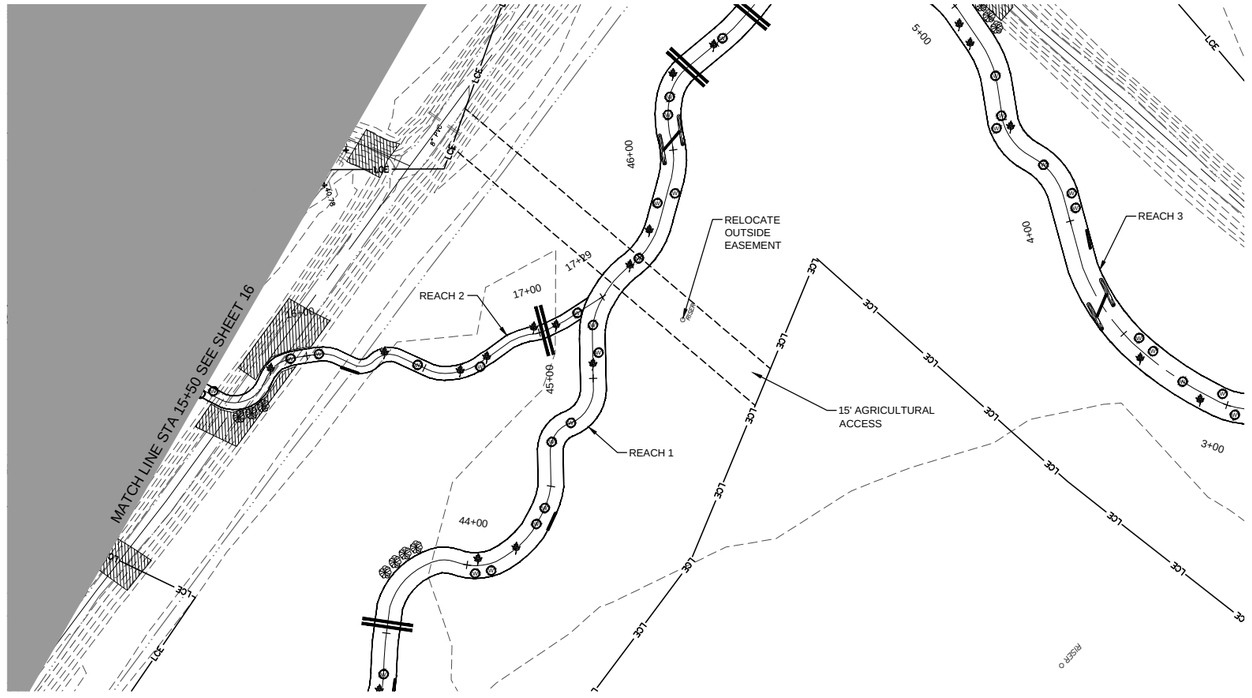
OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

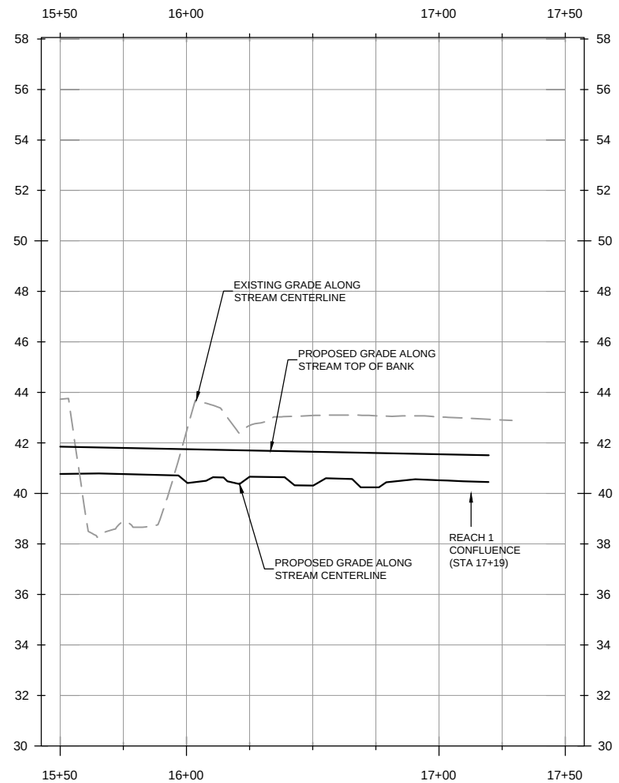
PROJ. DATE: DEC 2011
Q.C.: FM
Q.C. DATE: DEC 2011

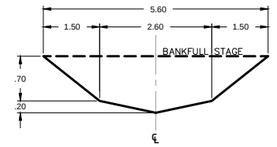
DRAWING NUMBER:
16

PROJ. NO.:
2011017600RA

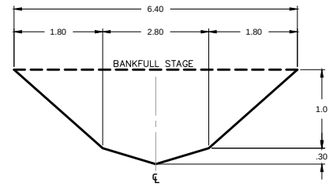
COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



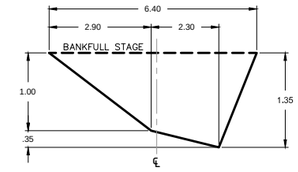




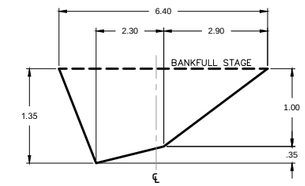
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10.70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT (LCE)
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE (LOD)
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE (OW)

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
---	---	---
---	---	---
---	---	---

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 2 PLAN & PROFILE STA 15+00 TO 16+79

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

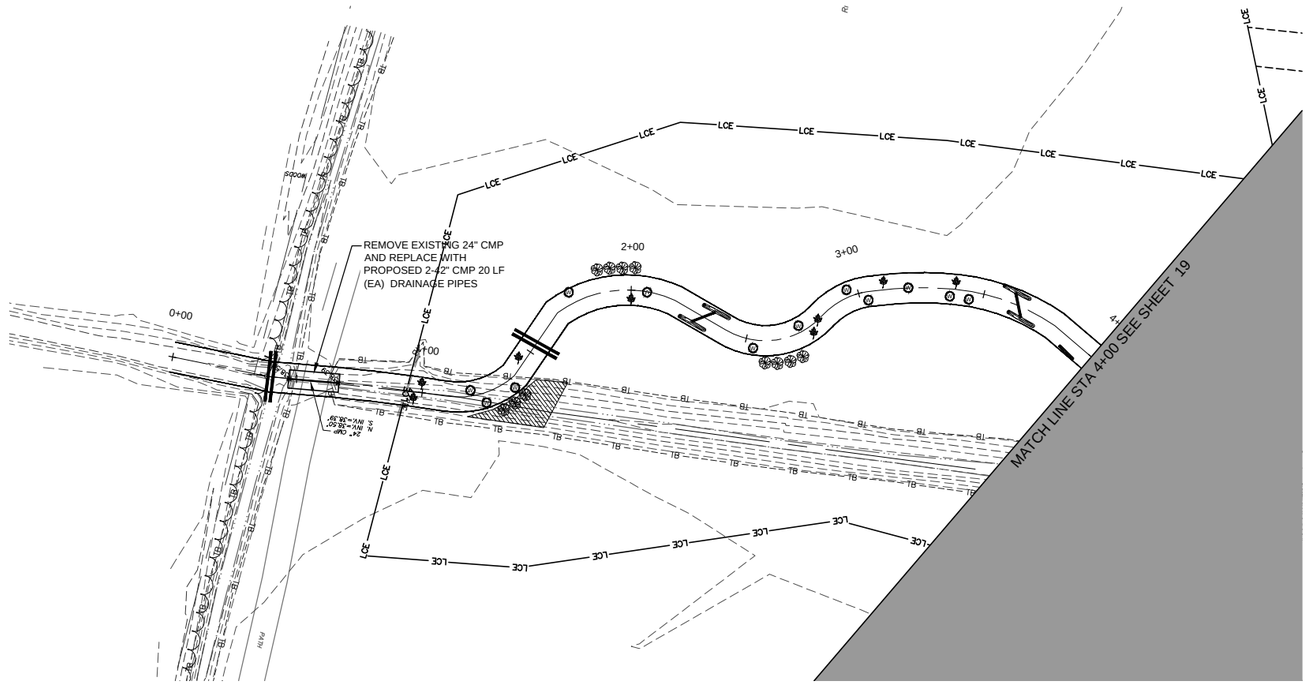
DRAWING NUMBER:
17

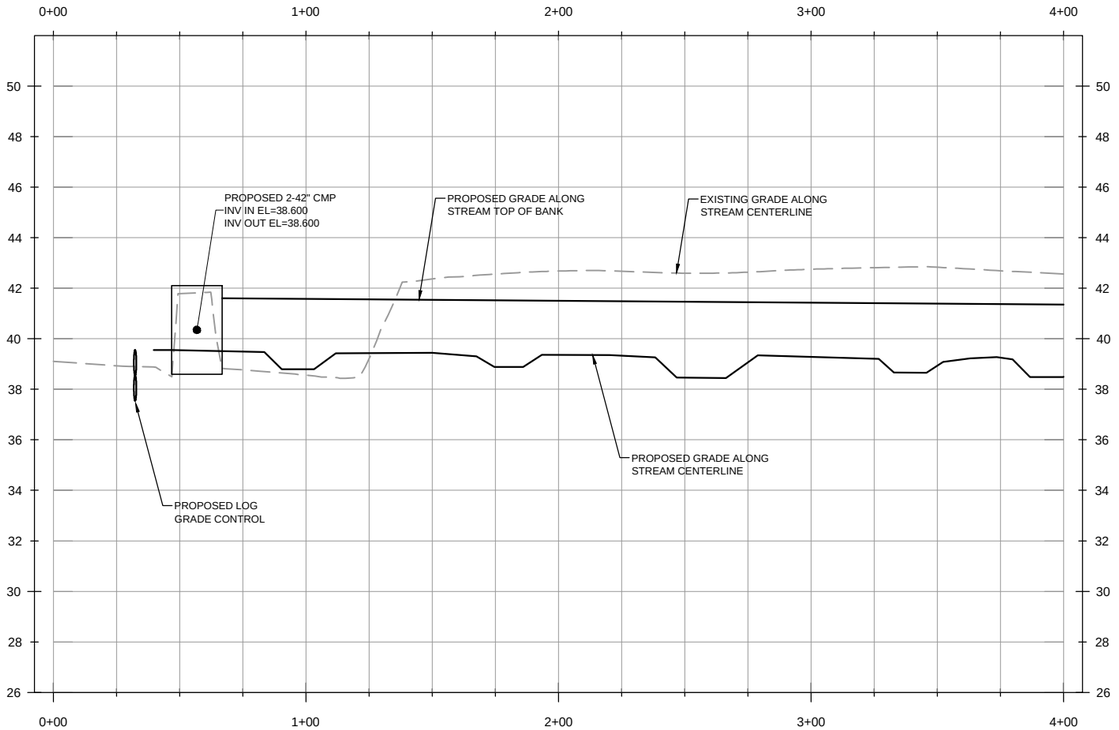
PROJ. NO.:
2011017600RA

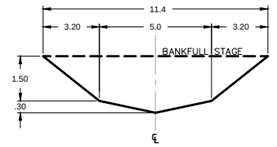
1:30

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

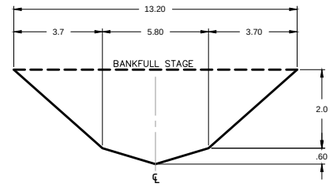
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



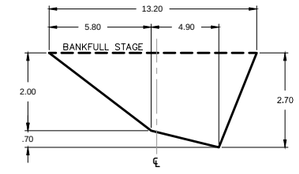




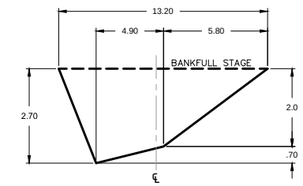
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT (LCE)
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE (LOD)
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE (OW)

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
----	----	----
----	----	----

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME: MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 3 PLAN & PROFILE STA 0+00 TO STA 4+00

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

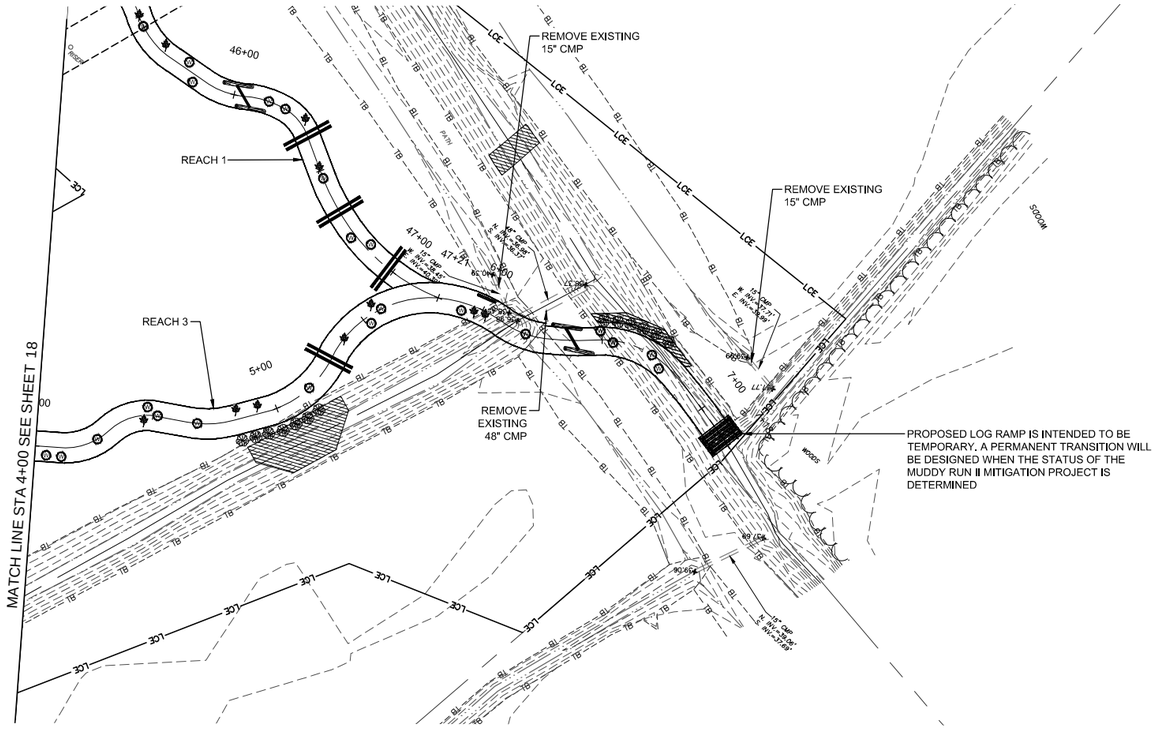
PROJ. DATE: DEC 2011
Q.C.: FM
Q.C. DATE: DEC 2011

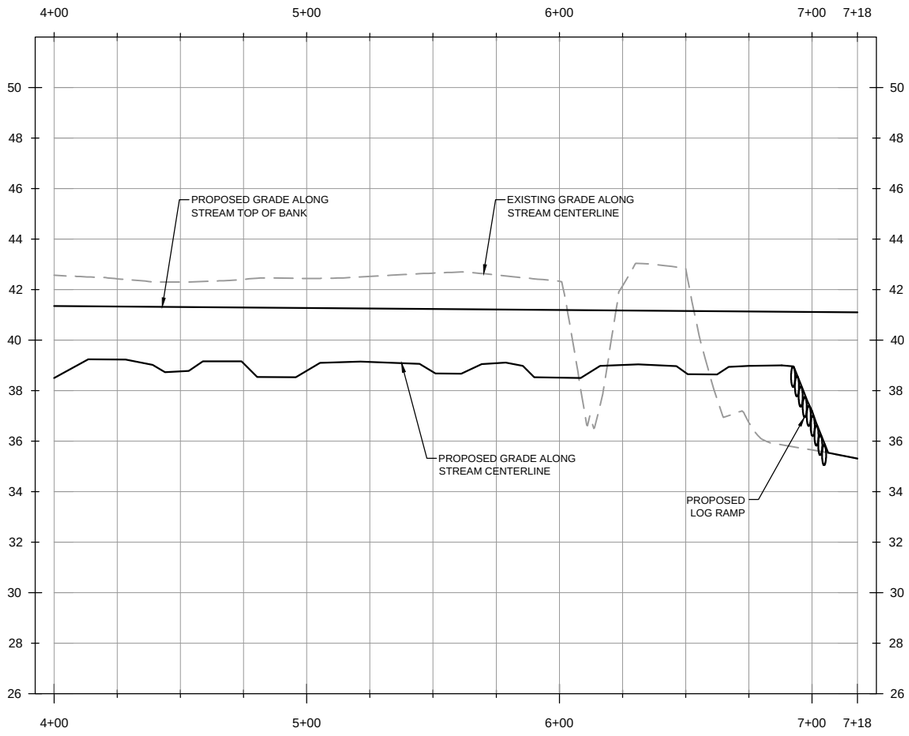
DRAWING NUMBER:
18

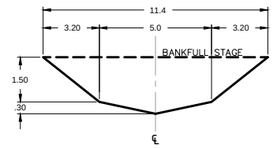
PROJ. N0.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

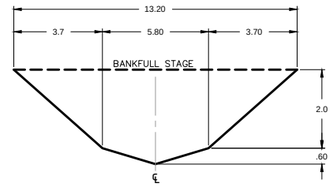
FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy



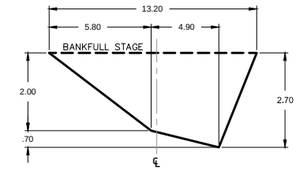




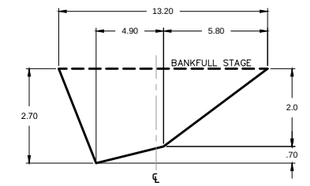
TYPICAL SHALLOW CROSS SECTION



TYPICAL POOL CROSS SECTION
STRAIGHT REACH



TYPICAL RIGHT MEANDER CROSS SECTION



TYPICAL LEFT MEANDER CROSS SECTION

NOTES:

1. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.
2. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.
3. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.
4. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.
5. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.
6. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.
7. FILL ALL ABANDONED DITCHES WITHIN THE PROPOSED EASEMENT PER CHANNEL BACKFILL DETAIL ON SHT 23 UNLESS DIRECTED OTHERWISE BY ENGINEER.

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10^70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT (LCE)
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE (LOD)
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS (W)
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE (OW)

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30
0 30 60
2" = FULL SCALE
1" = HALF SCALE

MARK	DATE	DESCRIPTION
----	----	----
----	----	----
----	----	----

REVISIONS:
RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION
PLOT DATE: 7/10/2012

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 3 PLAN &PROFILE STA 4+00 TO 7+18.02

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

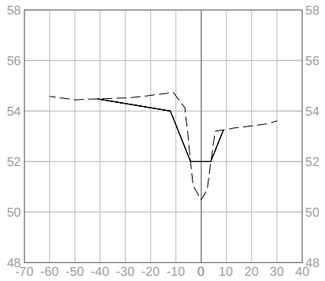
DRAWING NUMBER:
19

PROJ. N0.:
2011017600RA

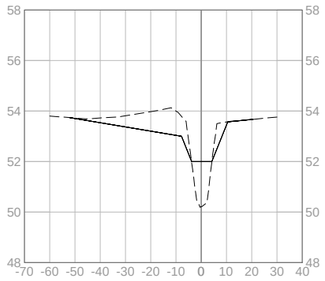
COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy

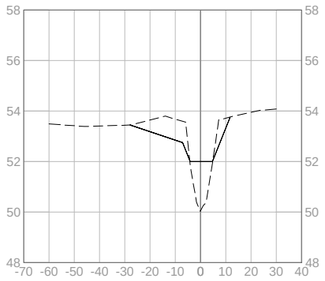
1+50



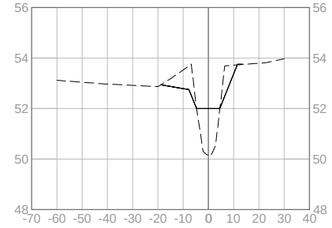
2+50



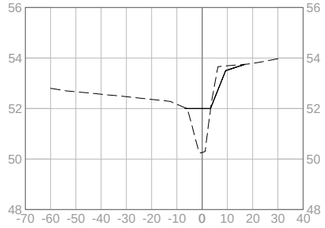
3+50



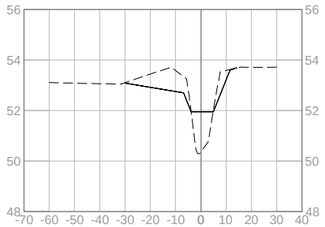
4+50



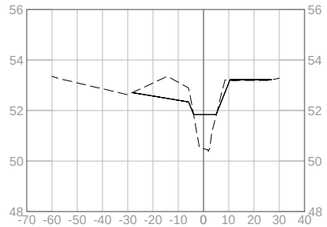
5+50



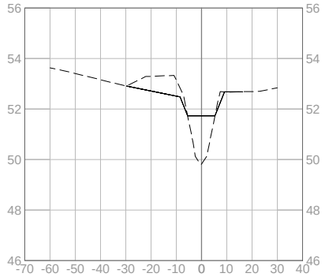
6+50



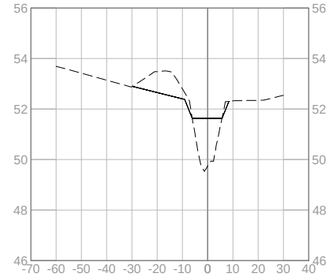
7+50



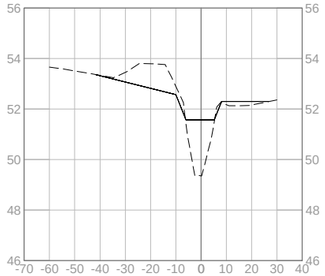
8+50



9+50



10+50



LEGEND

EXISTING GRADE - - - - - - - -

PROPOSED GRADE ————————

SCALE

1"=30' HORIZ

1"=3' VERT

WK DICKSON

community infrastructure consultants

Transportation + Water Resources

Urban Development + Geomatics

720 Corporate Drive

Raleigh, NC 27607

(v) 919.782.0495

(f) 919.782.9672

www.wkdickson.com

NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 30

0 30 60

2" = FULL SCALE

1" = HALF SCALE

MARK	DATE	DESCRIPTION
----	----	----

REVISIONS:

RELEASED FOR:

PRELIMINARY-NOT FOR CONSTRUCTION

PLOT DATE: 7/10/2012

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO. NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
REACH 1 XSECTIONS

OWNER / 24 HR CONTACT:

ADDRESS:
PHONE:
MOBILE:

PROJ. DATE: DEC 2011

Q.C.:

Q.C. DATE: DEC 2011

DRAWING NUMBER:

20

PROJ. N0.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

FILE NAME: I:\Projects\EBX\2011017600RA\CADD\DWG\Muddy Run Design Plans.dwg -#### - July 10, 2012 - Jason Kennedy

####

1:30

LEGEND

- EXISTING CONTOUR MAJOR
- EXISTING CONTOUR MINOR
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PROPOSED SPOT SHOT +10.70
- EXISTING CENTERLINE OF CHANNEL
- PROPOSED CENTERLINE OF CHANNEL
- EXISTING FENCELINE
- PROPOSED TOP OF BANK
- LIMITS OF PROPOSED CONSERVATION EASEMENT (LCE)
- TEMPORARY SILT FENCE
- EXISTING TREELINE
- LIMITS OF DISTURBANCE (LOD)
- TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- BMP LEVEL SPREADER
- LOG TOE PROTECTION
- LOG VANE
- BEDDED LOG STRUCTURE
- LOG GRADE CONTROL
- LOG RAMP
- ROOT WAD
- CHANNEL PLUG
- SMALL WOODY DEBRIS
- LEAF PACK
- LIVE CUTTINGS BUNDLE
- EXISTING TREE
- WETLANDS
- OVERHEAD UTILITY LINE (OW)

PLANTING TABLE

Bare Root Planting Tree Species

Common Name	Scientific Name	Wetland Indicator	Percent Composition
River birch	*Betula nigra*	FACW	10%
Green ash	*Fraxinus pennsylvanica*	FACW+	10%
Laurel oak	*Quercus laurifolia*	FACW+	20%
Overcup oak	*Quercus lyrata*	OBL	20%
Swamp chestnut oak	*Quercus michauxii*	FACW+	10%
Water oak	*Quercus nigra*	FACW	10%
American sycamore	*Platanus occidentalis*	FACW-	10%
Bald cypress	*Taxodium distichum*	OBL	10%

NOTES:
1. Bare root planting is proposed for all areas within the easement not designated for live staking or live cuttings bundles.
2. Planting density is approximately 680 stems per acre.

Live Staking and Live Cuttings Bundle Tree Species

Common Name	Scientific Name	Wetland Indicator	Percent Composition
Silky dogwood	*Cornus amomum*	FACW+	45%
Silky willow	*Salix sericea*	OBL	45%
Black willow	*Salix nigra*	OBL	10%

NOTES:
1. Live cuttings bundles are proposed along the outside of all meander bends.
2. Live cuttings bundle species shall include silky willows or black willows.
3. Live stakes are proposed along both banks of straight reaches adjacent to pools.

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

FULL SCALE: 1"= 200
0 200 400
2" = FULL SCALE
1" = HALF SCALE

MARK	DATE	DESCRIPTION
---	---	---
---	---	---

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PLOT DATE: 7/10/2012

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
PLANTING PLAN

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

DRAWING NUMBER:
21

PROJ. NO.:
2011017600RA

COPYRIGHT ©, W.K. DICKSON & CO., INC. ALL RIGHTS RESERVED. REPRODUCTION OR USE OF THE CONTENTS OF THIS DOCUMENT; ADDITIONS OR DELETIONS TO THIS DOCUMENT, IN WHOLE OR IN PART, WITHOUT WRITTEN CONSENT OF W.K. DICKSON & CO., INC., IS PROHIBITED. ONLY COPIES FROM THE ORIGINAL OF THIS DOCUMENT, MARKED WITH AN ORIGINAL SIGNATURE AND SEAL SHALL BE CONSIDERED TO BE VALID, TRUE COPIES.

WHEN AND WHERE TO USE IT
SILT FENCE IS APPLICABLE IN AREAS:

WHERE THE MAXIMUM SHEET OR OVERLAND FLOW PATH LENGTH TO THE FENCE IS 100-FEET. WHERE THE MAXIMUM SLOPE STEEPNESS (NORMAL [PERPENDICULAR] TO FENCE LINE) IS 2H:1V.
THAT DO NOT RECEIVE CONCENTRATED FLOWS GREATER THAN 0.5 CFS.

DO NOT PLACE SILT FENCE ACROSS CHANNELS OR USE IT AS A VELOCITY CONTROL BMP.

CONSTRUCTION SPECIFICATIONS:

1. USE A SYNTHETIC FILTER FABRIC OF AT LEAST 95% BY WEIGHT OF POLYOLEFINS OR POLYESTER, WHICH IS CERTIFIED BY THE MANUFACTURER OR SUPPLIER AS CONFORMING TO THE REQUIREMENTS IN ASTM D 6461. SYNTHETIC FILTER FABRIC SHOULD CONTAIN ULTRAVIOLET RAY INHIBITORS AND STABILIZERS TO PROVIDE A MINIMUM OF 6 MONTHS OF EXPECTED USABLE CONSTRUCTION LIFE AT A TEMPERATURE RANGE OF 0° TO 120° F.
2. ENSURE THAT POSTS FOR SEDIMENT FENCES ARE 1.33 LB/LINEAR FT STEEL WITH A MINIMUM LENGTH OF 5 FEET. MAKE SURE THAT STEEL POSTS HAVE PROJECTIONS TO FACILITATE FASTENING THE FABRIC.

CONSTRUCTION:

1. CONSTRUCT THE SEDIMENT BARRIER OF EXTRA STRENGTH SYNTHETIC FILTER FABRICS.
2. ENSURE THAT THE HEIGHT OF THE SEDIMENT FENCE DOES NOT EXCEED 24 INCHES ABOVE THE GROUND SURFACE. (HIGHER FENCES MAY IMPOUND VOLUMES OF WATER SUFFICIENT TO CAUSE FAILURE OF THE STRUCTURE.)
3. CONSTRUCT THE FILTER FABRIC FROM A CONTINUOUS ROLL CUT TO THE LENGTH OF THE BARRIER TO AVOID JOINTS. WHEN JOINTS ARE NECESSARY, SECURELY FASTEN THE FILTER CLOTH ONLY AT A SUPPORT POST WITH 4 FEET MINIMUM OVERLAP TO THE NEXT POST.
4. EXTRA STRENGTH FILTER FABRIC WITH 6 FEET POST SPACING DOES NOT REQUIRE WIRE MESH SUPPORT FENCE. SECURELY FASTEN THE FILTER FABRIC DIRECTLY TO POSTS. WIRE OR PLASTIC ZIP TIES SHOULD HAVE MINIMUM 50 POUND TENSILE STRENGTH.
5. EXCAVATE A TRENCH APPROXIMATELY 4 INCHES WIDE AND 8 INCHES DEEP ALONG THE PROPOSED LINE OF POSTS AND UPSLOPE FROM THE BARRIER.
6. PLACE 12 INCHES OF THE FABRIC ALONG THE BOTTOM AND SIDE OF THE TRENCH.
7. BACKFILL THE TRENCH WITH SOIL PLACED OVER THE FILTER FABRIC AND COMPACT; THOROUGH COMPACTION OF THE BACKFILL IS CRITICAL TO SILT FENCE PERFORMANCE.
8. DO NOT ATTACH FILTER FABRIC TO EXISTING TREES.

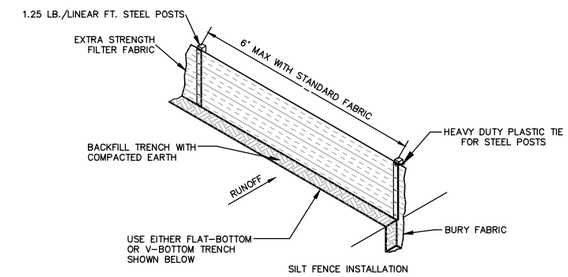
MAINTENANCE:

INSPECT SEDIMENT FENCES AT LEAST ONCE A WEEK AND AFTER EACH RAINFALL. MAKE ANY REQUIRED REPAIRS IMMEDIATELY.

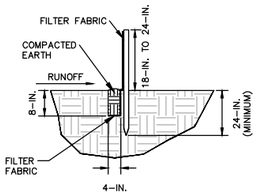
SHOULD THE FABRIC OF A SEDIMENT FENCE COLLAPSE, TEAR, DECOMPOSE OR BECOME INEFFECTIVE, REPLACE IT PROMPTLY.

REMOVE SEDIMENT DEPOSITS AS NECESSARY TO PROVIDE ADEQUATE STORAGE VOLUME FOR THE NEXT RAIN AND TO REDUCE PRESSURE ON THE FENCE. TAKE CARE TO AVOID UNDERMINING THE FENCE DURING CLEANOUT.

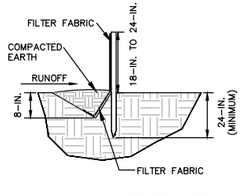
REMOVE ALL FENCING MATERIALS AND UNSTABLE SEDIMENT DEPOSITS AND BRING THE AREA TO GRADE AND STABILIZE IT AFTER THE CONTRIBUTING DRAINAGE AREA HAS BEEN PROPERLY STABILIZED.



SILT FENCE INSTALLATION



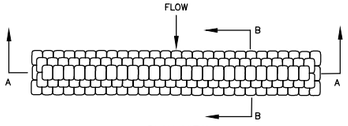
FLAT-BOTTOM TRENCH DETAIL



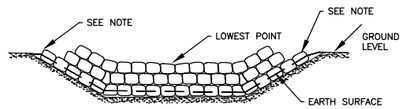
V-SHAPED TRENCH DETAIL

TEMPORARY SILT FENCE

NTS



PLAN VIEW



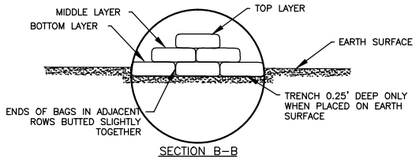
SECTION A-A

NOTE: END OF DIKE AT GROUND LEVEL TO BE HIGHER THAN THE LOWEST POINT OF FLOW CHECK. SUFFICIENT SANDBAGS ARE TO BE PLACED TO PREVENT SCOURING.

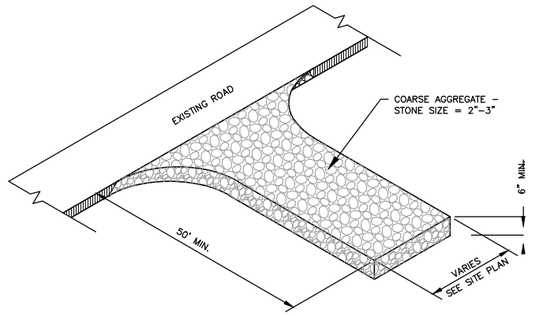
SANDBAG BARRIERS SHALL BE CONSTRUCTED OF THREE LAYERS OF SANDBAGS. THE BOTTOM LAYER SHALL CONSIST OF 3 ROWS OF BAGS, THE MIDDLE LAYER SHALL CONSIST OF 2 ROWS OF BAGS AND THE TOP LAYER SHALL CONSIST OF 1 ROW OF BAGS. THE RECOMMENDED DIMENSION OF A FILLED SANDBAG SHALL BE APPROXIMATELY 0.5 FT X 0.5 FT X 1.5 FT.

SANDBAG IMPERVIOUS DIKE

NTS



SECTION B-B



PURPOSE:

STABILIZED CONSTRUCTION ENTRANCES SHOULD BE USED AT ALL POINTS WHERE TRAFFIC WILL BE LEAVING A CONSTRUCTION SITE AND MOVING DIRECTLY ONTO A PUBLIC ROAD.

CONSTRUCTION SPECIFICATIONS:

1. CLEAR THE ENTRANCE AND EXIT AREA OF ALL VEGETATION, ROOTS, AND OTHER OBJECTIONABLE MATERIAL AND PROPERLY GRADE IT.
2. PLACE THE GRAVEL TO THE SPECIFIC GRADE AND DIMENSIONS SHOWN ON THE DETAIL, AND SMOOTH IT.
3. PROVIDE DRAINAGE TO CARRY WATER TO A SEDIMENT TRAP OR OTHER SUITABLE OUTLET.
4. USE GEOTEXTILE FABRICS BECAUSE THEY IMPROVE STABILITY OF THE FOUNDATION IN LOCATIONS SUBJECT TO SEEPAGE OR HIGH WATER TABLE.

MAINTENANCE:

MAINTAIN THE GRAVEL PAD IN A CONDITION TO PREVENT MUD OR SEDIMENT FROM LEAVING THE CONSTRUCTION SITE. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH 2-INCH STONE. AFTER EACH RAINFALL, INSPECT ANY STRUCTURE USED TO TRAP SEDIMENT AND CLEAN IT OUT AS NECESSARY. IMMEDIATELY REMOVE ALL OBJECTIONABLE MATERIALS SPILLED, WASHED, OR TRACKED ONTO PUBLIC ROADWAYS, OR AIRFIELD PAVEMENTS.

TEMPORARY GRAVEL CONSTRUCTION ENTRANCE

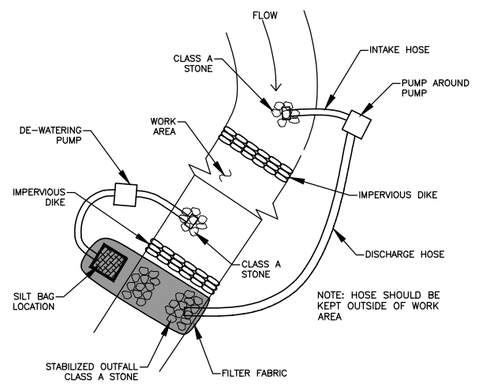
NTS

NOTES:

1. EXCAVATION SHALL BE PERFORMED ONLY IN DRY AND/OR ISOLATED SECTIONS OF CHANNEL.
2. IMPERVIOUS DIKES SHOULD BE USED TO ISOLATE WORK AREAS FROM STREAM FLOW.
3. THE CONTRACTOR SHALL NOT DISTURB MORE AREA THAN CAN BE STABILIZED IN ONE WORKING DAY. A MAXIMUM OF 200 FEET MAY BE DISTURBED AT ANY ONE TIME.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING PUMP SIZE SUFFICIENT TO PUMP BASE FLOW.
5. DIKE MUST BE CONSTRUCTED OF NON-ERODIBLE MATERIALS SUCH AS SANDBAGS.

SEQUENCE OF CONSTRUCTION FOR TYPICAL PUMP AROUND

1. INSTALL STILLING BASIN AND STABILIZED OUTFALL USING CLASS A RIP RAP AT THE DOWNSTREAM END OF THE DESIGNATED PROJECT WORKING AREA.
2. THE CONTRACTOR SHALL INSTALL THE PUMP AROUND PUMP AND THE TEMPORARY PIPING THAT WILL CONVEY THE BASE FLOW FROM UPSTREAM OF THE WORK AREA TO THE STABILIZED OUTFALL.
3. INSTALL UPSTREAM IMPERVIOUS DIKE AND BEGIN PUMPING OPERATIONS FOR STREAM DIVERSION.
4. INSTALL THE DOWNSTREAM IMPERVIOUS DIKE AND DEWATERING PUMPING APPARATUS IF NEEDED TO DEWATER THE ENTRAPPED AREA. THE PUMP AND HOSE FOR THIS PURPOSE SHALL BE OF SUFFICIENT SIZE TO DEWATER THE WORK AREA. THIS WATER WILL ALSO BE PUMPED TO AN OUTFALL STABILIZED WITH CLASS A RIP RAP.
5. THE CONTRACTOR SHALL EXCAVATE ANY ACCUMULATED SILT AND DEWATER BEFORE REMOVAL OF THE IMPERVIOUS DIKE. WHEN DEWATERING AREA, ALL DIRTY WATER MUST BE PUMPED THROUGH A SILT BAG. REMOVE IMPERVIOUS DIKES, PUMPS, AND TEMPORARY FLEXIBLE HOSE/PIPING STARTING WITH THE DOWNSTREAM DIKE FIRST.
6. ONCE THE WORKING AREA IS COMPLETED, REMOVE ALL RIP RAP AND IMPERVIOUS DIKES AND STABILIZE DISTURBED AREAS WITH SEED AND MULCH.
7. ALL WORK IN CHANNEL MUST BE COMPLETED BEFORE REMOVING IMPERVIOUS DIKE.



PUMP AROUND & DEWATERING DETAIL

NTS

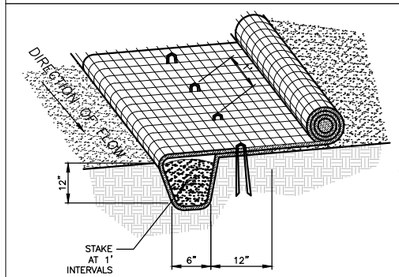


FIGURE 1
TOE SLOPE ANCHOR TRENCH

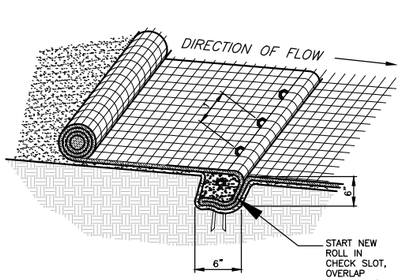


FIGURE 2
INTERMITTENT CHECK SLOT / BEGINNING OF NEW ROLL

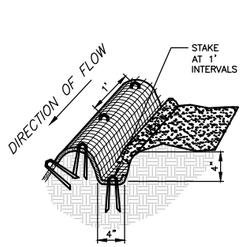


FIGURE 3
TOP OF EMBANKMENT/BANK TERMINATION

INSTALLATION NOTES:

SITE PREPARATION

GRADE AND COMPACT AREA.

REMOVE ALL ROCKS, CLODS, VEGETATION, AND OBSTRUCTIONS SO THAT MATTING WILL HAVE DIRECT CONTACT WITH THE SOIL.

PREPARE SEEDBED BY LOOSENING 3 TO 4 INCHES OF TOPSOIL ABOVE FINAL GRADE.

TEST SOILS FOR ANY NUTRIENT DEFICIENCIES AND SUBMIT SOIL TEST RESULTS TO THE ENGINEER. APPLY ANY TREATMENT SUCH AS LIME OR FERTILIZERS TO THE SOIL IF NEEDED.

DO NOT MULCH AREAS WHERE MAT IS TO BE INSTALLED.

SEEDING

SEE SHEET 24 FOR SEEDING REQUIREMENTS.

APPLY SEED TO SOIL BEFORE PLACING MATTING.

INSTALLATION - STREAM BANK

SEE GRADING NOTES ON SHEET XX FOR INFORMATION REGARDING WHAT AREAS ARE TO RECEIVE EROSION CONTROL MATTING.

OVERLAP ADJACENT MATS 3" AND ANCHOR EVERY 12" ACROSS THE OVERLAP. THE HIGHER ELEVATION MAT SHOULD BE PLACED OVER THE LOWER ELEVATION MAT.

EDGES SHOULD BE SHINGLED AWAY FROM THE FLOW OF WATER.

LAY MAT LOOSE TO ALLOW CONTACT WITH SOIL.
DO NOT STRETCH TIGHT.

ANCHOR MAT USING BIODEGRADABLE STAKES OR PINS.

EXCAVATE INITIAL ANCHOR TRENCH 12"X6" ACROSS TOE OF BANK AT THE LOWER END OF EACH AREA TO RECEIVE EROSION CONTROL MATTING. ANCHOR TRENCH TO BE A MINIMUM OF 1' OFF OF TOE OF BANK. SEE FIGURE 1 FOR TOE SLOPE ANCHOR TRENCH.

PLACE 6" x 6" CHECK SLOTS AT 30' INTERVALS ALONG THE BANK. SEE FIGURE 2.

CUT 4" x 4" TRENCH ALONG TOP OF BANK FOR MAT TERMINATION AS SHOWN IN FIGURE 3. EXTEND MAT 3 FEET PAST TOP OF BANK.

BEGINNING AT THE DOWNSTREAM END OF THE AREA TO BE LINED, PLACE THE END OF THE ROLL IN TOE SLOPE ANCHOR TRENCH AND SECURE WITH BIODEGRADABLE STAKES OR PINS. SEE FIGURE 1.

PLACE ADJACENT ROLLS IN THE ANCHOR TRENCH WITH A MINIMUM OF 3" OVERLAP. SECURE WITH BIODEGRADABLE STAKES OR PINES, BACKFILL ANCHOR TRENCH, AND COMPACT SOIL.

UNROLL MAT OVER COMPACTED ANCHOR TRENCH, STOP AT NEXT CHECK SLOT OR TERMINAL ANCHOR.

UNROLL ADJACENT ROLLS IN SAME MANNER, WITH A MINIMUM OF 3" OF OVERLAP.

STAPLE AT 12" INTERVALS ALONG OVERLAP.

FOLD AND SECURE MAT ROLLS TIGHTLY INTO CHECK SLOTS. LAY MAT IN CHECK SLOT, FOLD BACK AGAINST ITSELF, ANCHOR THROUGH BOTH LAYERS, BACKFILL AND COMPACT SOIL, CONTINUE ROLLING MAT UPSTREAM. SEE FIGURE 2.

BEGIN NEW ROLLS IN CHECK SLOT, AND OVERLAP ENDS MINIMUM OF 1'.

STREAM BANK MATTING TO BE INSTALLED FROM TOE OF BANK TO TOP OF BANK. SEE FIGURE 3 FOR TERMINATION AT TOP OF BANK AND FIGURE 1 FOR INITIAL ANCHOR TRENCH AT TOE OF BANK.

SEE FIGURE 3 FOR TERMINATION AT UPSTREAM END.

EROSION CONTROL MATTING MUST MEET OR EXCEED THE FOLLOWING REQUIREMENTS:

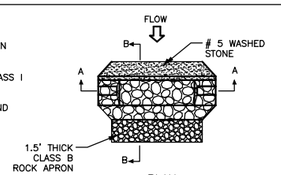
- 100 % COCONUT FIBER (COIR) TWINE WOVEN INTO A HIGH STRENGTH MATRIX.
- THICKNESS - 0.35 IN. MINIMUM.
- TENSILE STRENGTH - 1740 LB/FT MINIMUM
- SHEAR STRESS 4.5 LBS/SQFT
- FLOW VELOCITY- OBSERVED 12 FT/SEC
- WEIGHT - 23 OZ/SY
- SIZE 9.84FT X 165 FT (180 SY)
- COFACTOR - 0.002
- OPEN AREA (MEASURED) - 48%
- SLOPES UP TO A MAXIMUM OF 1:1

EROSION CONTROL MATTING

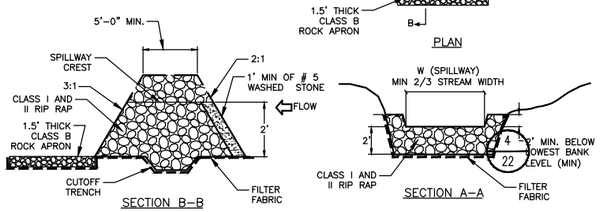
NTS

GENERAL NOTES:

1. CONSTRUCT DAM ACCORDING TO NCDENR EROSION CONTROL MANUAL.
2. ROCK DAM RIPRAP SHALL BE 50/50 MIX OF CLASS I AND II.
3. PLACE ROCK DAM AS SHOWN ON PLANS. EXTEND CLASS B RIP RAP ROCK APRON 5 FEET DOWNSTREAM FROM TOE OF ROCK DAM.



PLAN

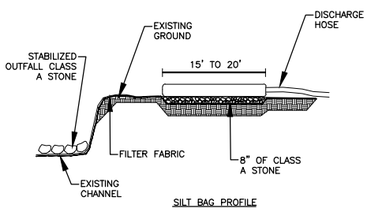


SECTION B-B

SECTION A-A

TEMPORARY ROCK CHECK DAM

NTS



SILT BAG PROFILE

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

MARK	DATE	DESCRIPTION
----	----	----

REVISIONS:
RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PLOT DATE: 7/10/2012

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
DETAILS

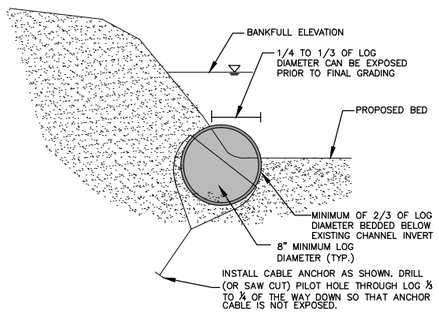
OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE: DEC 2011
Q.C.: FM
Q.C. DATE: DEC 2011

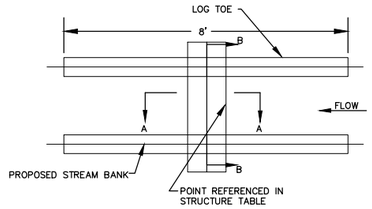
DRAWING NUMBER:
22

PROJ. NO.:
2011017600RA

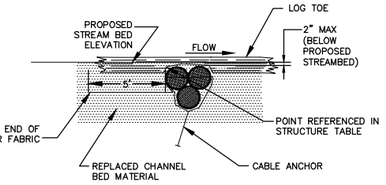
NOTES:
1. LOGS SHOULD BE AT LEAST 8 INCHES IN DIAMETER, 6–10 FEET LONG, RELATIVELY STRAIGHT, AND HARDWOOD.
2. CABLE ANCHORS SHOULD BE PLACED 1' TO 3' FROM EACH END OF LOG. REBAR (5/8" MINIMUM DIAMETER 3' MIN. LENGTH TYPICAL) MAY BE USED AS A SUBSTITUTION FOR CABLE ANCHORS PER DIRECTION OF ENGINEER.
3. IF REBAR IS USED, PRE–DRILL HOLES WITH 5/8" DRILL BIT.



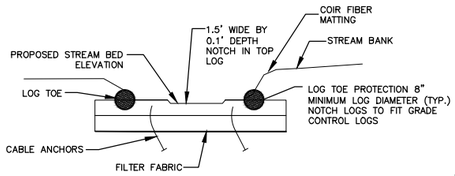
LOG TOE PROTECTION
NTS



PLAN VIEW



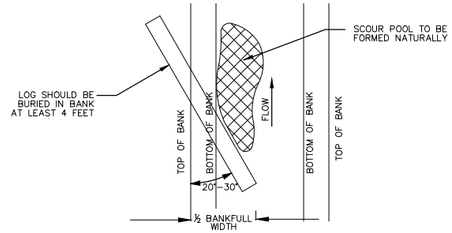
SECTION A–A



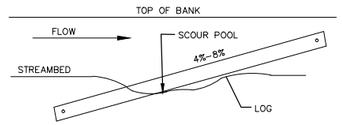
GRADE CONTROL STRUCTURE
SECTION B–B

1. LOGS SHOULD BE AT LEAST 8 INCHES IN DIAMETER, A MINIMUM OF 15 FEET IN LENGTH (UNLESS OTHERWISE NOTED), AND RELATIVELY STRAIGHT.
2. NAIL FILTER FABRIC USING 3" 10D GALVANIZED COMMON NAIL EVERY 2' ALONG THE LOG.
3. FILTER FABRIC USED SHALL BE NCDOT TYPE 2 ENGINEERING FABRIC OR EQUIVALENT.

LOG GRADE CONTROL
NTS



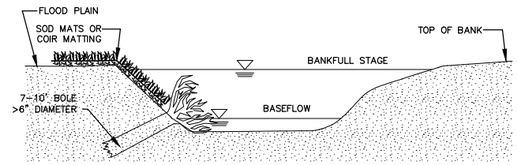
PLAN VIEW



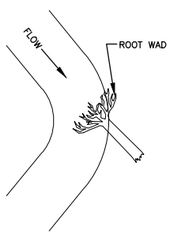
PROFILE VIEW

NOTES:
1. LOGS SHOULD BE AT LEAST 8 INCHES IN DIAMETER, 20 FEET LONG, RELATIVELY STRAIGHT, AND HARDWOOD.
2. VANE LOG ARMS SHOULD BE BURIED INTO THE BANK AND BED A MINIMUM OF 4 FEET.
3. SET ELEVATION OF TOP OF LOG CROSS PIECES TO DESIRED ELEVATION OF STREAMBED.
4. REBAR (5/8" MINIMUM DIAMETER 3' MIN. LENGTH TYPICAL) SHOULD BE PLACED 1' TO 3' FROM END OF LOG. ADDITIONAL REBAR TO BE PLACED AT 5' OFFSETS. LAST REBAR SHOULD BE PLACED 1' TO 3' FROM END OF LOG. DUCK BILL ANCHORS MAY BE USED AS A SUBSTITUTION FOR REBAR.
5. PRE–DRILL HOLES FOR REBAR WITH 5/8" DRILL BIT.
6. DRIVE REBAR THROUGH LOGS AND BEND ENDS AS SHOWN.

LOG VANE
NTS



CROSS SECTION VIEW



PLAN VIEW

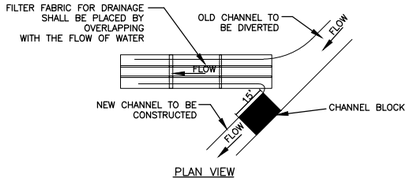
DRIVE POINT METHOD:

SHARPEN THE END OF THE LOG WITH A CHAINSAW BEFORE "DRIVING" IT INTO THE BANK. ORIENT ROOT WADS UPSTREAM SO THAT THE STREAM FLOW MEETS THE ROOT WAD AT A 90–DEGREE ANGLE, DEFLECTING THE WATER AWAY FROM THE BANK.

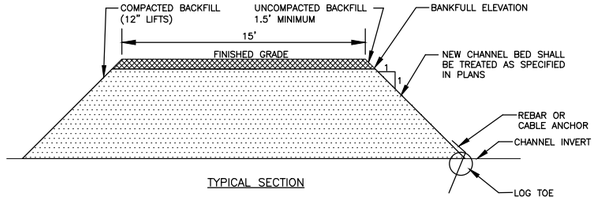
TRENCHING METHOD:

IF THE ROOT WAD CANNOT BE DRIVEN INTO THE BANK OR THE BANK NEEDS TO BE RECONSTRUCTED, THE TRENCHING METHOD SHOULD BE USED. THIS METHOD REQUIRES THAT A TRENCH BE EXCAVATED PARALLEL TO THE BANK AND WELL BELOW THE STREAMBED FOR THE LOG PORTION OF THE ROOT WAD. ONE–THIRD OF THE ROOT WAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

ROOT WAD REVETMENT
NTS

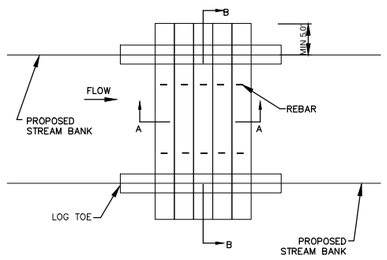


PLAN VIEW

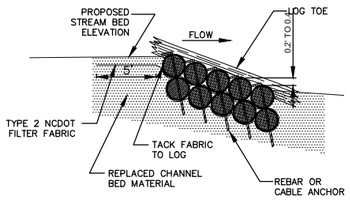


TYPICAL SECTION

CHANNEL PLUG
NTS

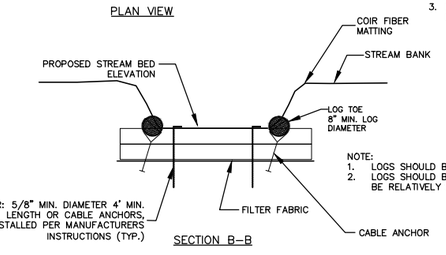


PLAN VIEW



NOTE:
1. LOGS SHOULD BE AT LEAST 8 INCHES IN DIAMETER AND RELATIVELY STRAIGHT.
2. NAIL FILTER FABRIC USING 3" 10D GALVANIZED COMMON NAIL EVERY 2' ALONG THE LOG.
3. FILTER FABRIC USED SHALL BE NCDOT TYPE 2 ENGINEERING FABRIC OR EQUIVALENT.

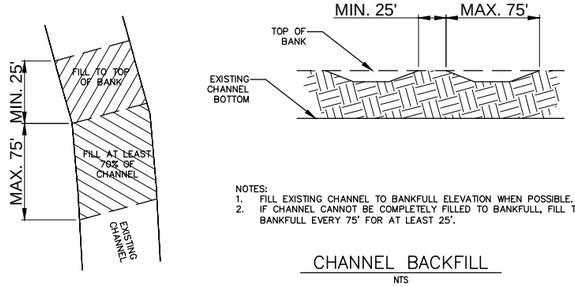
SECTION A–A



SECTION B–B

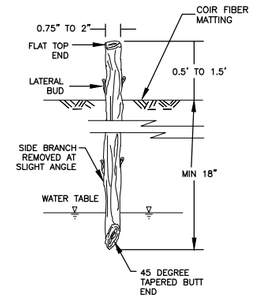
NOTE:
1. LOGS SHOULD BE OF HARDWOOD SPECIES ONLY.
2. LOGS SHOULD BE A MINIMUM OF 15 FEET IN LENGTH AND BE RELATIVELY STRAIGHT.

LOG RAMP
NTS

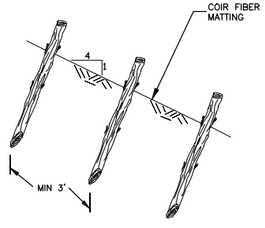


NOTES:
1. FILL EXISTING CHANNEL TO BANKFULL ELEVATION WHEN POSSIBLE.
2. IF CHANNEL CANNOT BE COMPLETELY FILLED TO BANKFULL, FILL TO BANKFULL EVERY 75' FOR AT LEAST 25'.

CHANNEL BACKFILL
NTS



DETAIL
LIVE STAKES SHOULD BE LONG ENOUGH TO REACH BELOW THE GROUNDWATER TABLE. (GENERALLY, A LENGTH OF 2 TO 3 FEET IS SUFFICIENT.) ADDITIONALLY, THE STAKES SHOULD HAVE A DIAMETER IN THE RANGE OF 0.75 TO 2 INCHES.



SECTION VIEW
LIVE STAKES SHALL BE SPACED 3 FEET APART, ALTERNATE SPACING.

NOTE:
1. ACCEPTABLE SPECIES INCLUDE BLACK WILLOW (SALIX NIGRA), SILKY WILLOW (SALIX SERICEA) AND SILKY DOGWOOD (CORNUS AMMOMUM).
2. LIVE STAKES SHALL BE PLANTED IN AN AREA EXTENDING 3 FEET OUT FROM TOP OF BANK TO JUST BELOW BANKFULL.

LIVE STAKE
NTS

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

MARK	DATE	DESCRIPTION
---	---	---
---	---	---
---	---	---

REVISIONS:
RELEASED FOR: PRELIMINARY-NOT FOR CONSTRUCTION
PLOT DATE: 7/10/2012

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

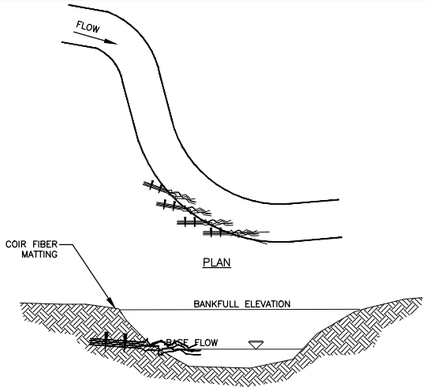
DRAWING TITLE:
DETAILS

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE: DEC 2011
Q.C.: FM
Q.C. DATE: DEC 2011

DRAWING NUMBER:
23

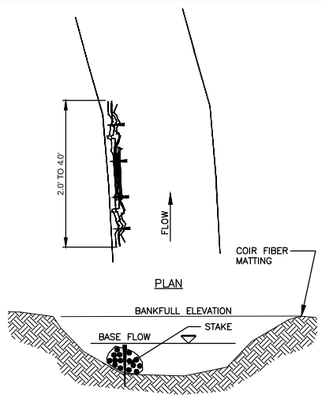
PROJ. NO.:
2011017600RA



TYPICAL SECTION

NOTE:
WATTLES ARE TO BE INSTALLED 4' O.C. BY CUTTING AN APPROXIMATELY 4" WIDE TRENCH PERPENDICULAR TO THE STREAM BANK JUST ABOVE BASEFLOW ELEVATION. INSERT THE WATTLES, ANCHORING WITH STAKES, AND TIGHTLY BACKFILL WITH TOPSOIL. WATTLES SHALL CONSIST OF 5 TO 10 STEMS, 0.25" TO 0.5" IN DIAMETER. MINIMUM LENGTH IS 4.5 FEET. AT LEAST 3.0 FEET SHALL BE INSTALLED WITHIN THE BANK. WATTLES SHOULD BE INSTALLED AT AN ANGLE OF 20° TO 30° TO THE STREAM BANK AND SHOULD POINT DOWNSTREAM.

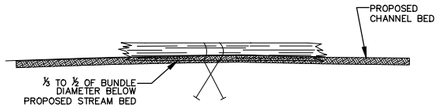
WATTLE



TYPICAL SECTION

NOTE: USE DEAD BRUSH AND TOPS 0.5 TO 2.0 INCHES IN DIAMETER. TIE BUNDLES WITH TWINE AND STAKE TO THE CHANNEL BED.

DEAD BRUSH



USE STICKS AND LOGS OF VARYING SIZES 1"–4" DIAMETER AND 1'–4' LONG. WOODY DEBRIS SHALL BE HELD IN PLACE USING TWINE AND WOODEN STAKES AND SHALL BE PLACED ACCORDING TO DESIGN PLANS AND AS DIRECTED BY ENGINEER.

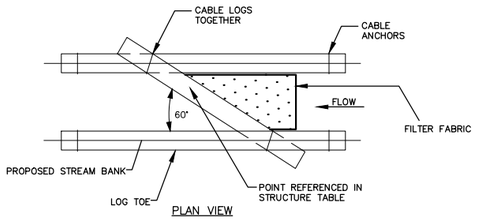
WOODY DEBRIS BUNDLE

NOTE:
WHEN INSTALLING SMALL WOODY DEBRIS STRUCTURES AS LOCATED ON THE PLAN SHEETS, CONTRACTOR SHALL ALTERNATE BETWEEN WATTLE, SMALL LOG, AND DEAD BRUSH STRUCTURES BASED ON READILY AVAILABLE MATERIALS AND PER DIRECTION OF THE ENGINEER.

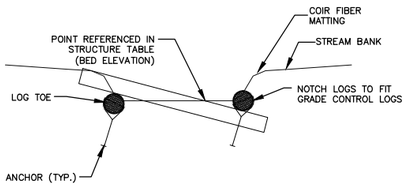
SMALL WOODY DEBRIS & HABITAT STRUCTURES
NTS

NOTES:

1. CROSS LOGS SHOULD BE AT LEAST 6 INCHES IN DIAMETER AND A MINIMUM OF 20 FEET IN LENGTH.
2. LOG TOES SHOULD BE AT LEAST 8 INCHES IN DIAMETER AND A MINIMUM OF 8 FEET IN LENGTH.
3. ALL LOGS SHOULD BE RELATIVELY STRAIGHT.
4. NAIL FILTER FABRIC USING 3" 10D GALVANIZED COMMON NAIL EVERY 2' ALONG THE LOG.
5. FILTER FABRIC USED SHALL BE NCDOT TYPE 2 ENGINEERING FABRIC OR EQUIVALENT.

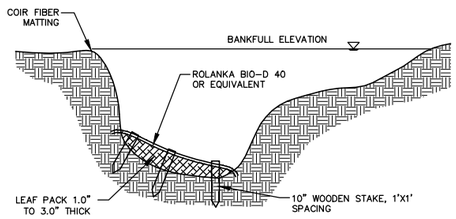


PLAN VIEW

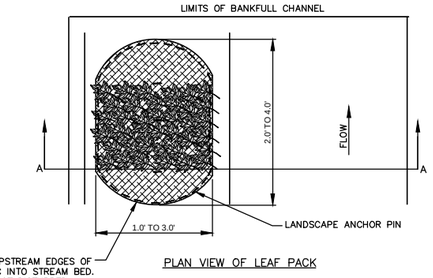


PROFILE VIEW

BEDDED LOG STRUCTURE
NTS

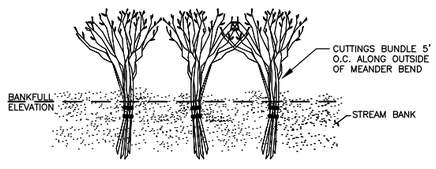


SECTION A–A

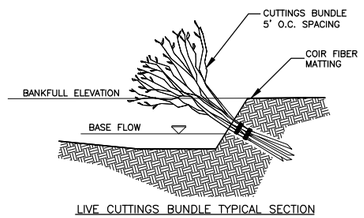


PLAN VIEW OF LEAF PACK

LEAF PACK
NTS



LIVE CUTTINGS BUNDLE TYPICAL PROFILE

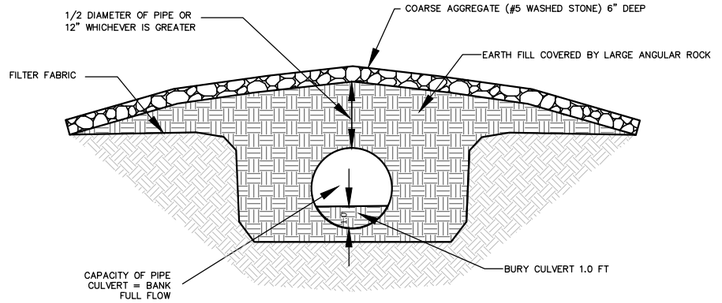


LIVE CUTTINGS BUNDLE TYPICAL SECTION

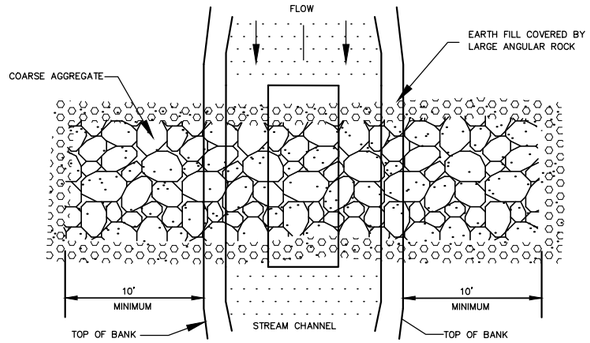
NOTE: ACCEPTABLE SPECIES INCLUDE BLACK WILLOW (SALIX NIGRA) AND SILKY WILLOW (SALIX SERICEA). CUTTINGS BUNDLES ARE TO BE INSTALLED (AFTER SOD MAT HAS BEEN PLACED) BY DRILLING AN APPROXIMATE 4" DIAMETER HOLE INTO THE STREAM BANK FROM AN ELEVATION SLIGHTLY ABOVE BANKFULL ELEVATION, INSERTING THE CUTTINGS AND TIGHTLY BACKFILLING WITH TOPSOIL. WILLOW CUTTINGS SHOULD BE RINSED AT CUTTING POINT TO ALLOW BETTER ROOTING. ALDER TRANSPLANTS CAN BE SUBSTITUTED FOR CUTTINGS BUNDLES WITH APPROVAL OF ENGINEER

LIVE CUTTINGS BUNDLE
NTS

ELEVATION



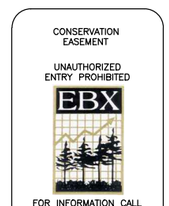
PLAN



NOTES:

1. CONSTRUCT STREAM CROSSING WHEN FLOW IS LOW.
2. INSTALL STREAM CROSSING PERPENDICULAR TO FLOW.
3. CONTRACTOR TO COORDINATE APPROPRIATE BEDDING MATERIAL WITH MANUFACTURER.
4. FILTER FABRIC USED SHALL BE NCDOT TYPE 2 ENGINEERING FABRIC OR EQUIVALENT.
5. WIDTH OF THE CROSSING SHALL BE SUFFICIENT (12' MIN.) TO ACCOMMODATE THE LARGEST VEHICLE CROSSING THE CHANNEL.

PROPOSED CULVERT CROSSING
NTS



CONSERVATION EASEMENT SIGN
NTS

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

PLOT DATE: 7/10/2012

MARK	DATE	DESCRIPTION
---	---	---
---	---	---
---	---	---

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

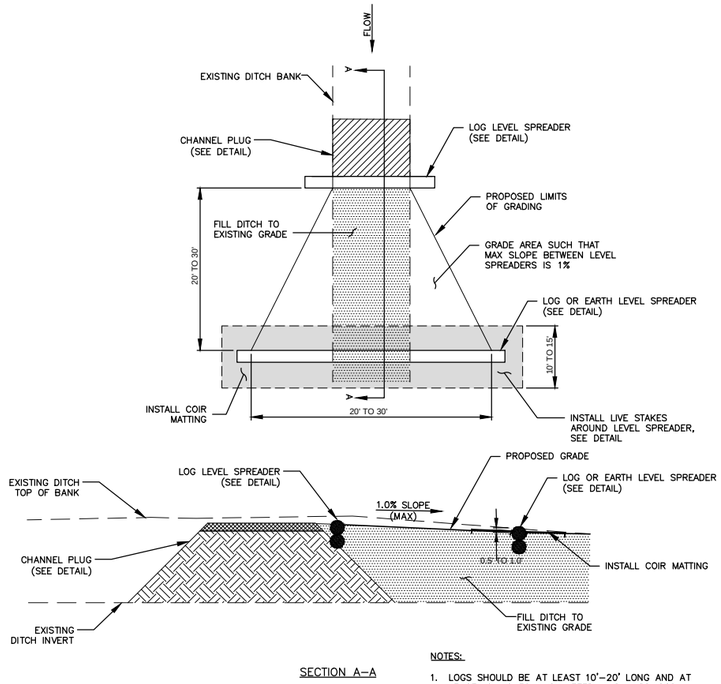
DRAWING TITLE:
DETAILS

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE: DEC 2011
Q.C.:
Q.C. DATE: DEC 2011

DRAWING NUMBER:
24

PROJ. NO.:
2011017600RA



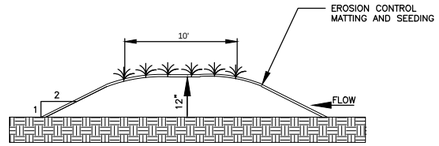
SECTION A–A

NOTES:

1. LOGS SHOULD BE AT LEAST 10'–20' LONG AND AT LEAST 10 INCHES IN DIAMETER, AND HARDWOOD.

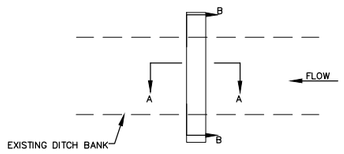
BMP LEVEL SPREADER

NTS

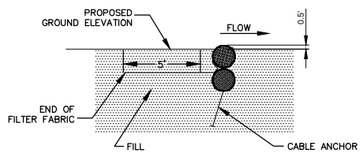


LEVEL SPREADER

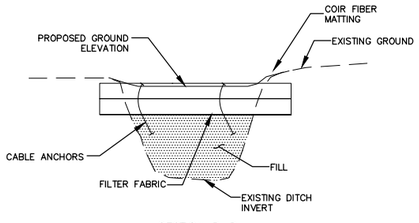
NTS



PLAN VIEW



SECTION A–A



SECTION B–B

1. LOGS SHOULD BE AT LEAST 8 INCHES IN DIAMETER, A MINIMUM OF 10 TO 20 FEET IN LENGTH (UNLESS OTHERWISE NOTED), AND RELATIVELY STRAIGHT.
2. NAIL FILTER FABRIC USING 3" 10D GALVANIZED COMMON NAIL EVERY 3' ALONG THE LOG.
3. FILTER FABRIC USED SHALL BE NCDOT TYPE 2 ENGINEERING FABRIC OR EQUIVALENT.

LOG LEVEL SPREADER

NTS

WK DICKSON
community infrastructure consultants
Transportation + Water Resources
Urban Development + Geomatics
720 Corporate Drive
Raleigh, NC 27607
(v) 919.782.0495
(f) 919.782.9672
www.wkdickson.com
NC. LICENSE NO. F-0374

EBX

MARK	DATE	DESCRIPTION
---	---	---
---	---	---
---	---	---

REVISIONS:

RELEASED FOR:
PRELIMINARY-NOT FOR CONSTRUCTION

PLOT DATE:
7/10/2012

PROJECT NAME:
MUDDY RUN STREAM MITIGATION PROJECT
DUPLIN CO, NORTH CAROLINA
ENVIRONMENTAL BANC & EXCHANGE, LLC

DRAWING TITLE:
DETAILS

OWNER / 24 HR CONTACT:
ADDRESS:
PHONE:
MOBILE:

PROJ. DATE:	DEC 2011
Q.C.:	FM
Q.C. DATE:	DEC 2011

DRAWING NUMBER:
25

PROJ. NO.:
2011017600RA