RESTORATION PLAN

ADKIN BRANCH STREAM RESTORATION PROJECT

Lenoir County, North Carolina
Project ID No. 050656101

Prepared for:

NCDENR-Ecosystem Enhancement Program
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EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) is currently developing stream restoration plans for the Adkin Branch Stream Restoration Project (Project) located on the southeast side of the City of Kinston, in Lenoir County. The Project begins at North Carolina Highways 11 and 55 and ends at Lincoln Street. The Project is located in United States Geological Survey (USGS) Hydrologic Unit (HU) and Targeted Local Watershed 03020202060030 (North Carolina Division of Water Quality [NCDWQ] Subbasin 03-04-05) of the Neuse River Basin and will service the USGS 8-digit HU 03020202.

This document details planned stream restoration activities on the Project. A 46-acre conservation easement will be placed on the Project to incorporate all restoration activities. The Project contains Adkin Branch, an unnamed tributary (UT) to Adkin Branch, riparian buffer, floodplain, and upland slopes. The Project watershed, including the Project, is characterized primarily by urban development associated with the City of Kinston, agriculture, disturbed forest, former neighborhoods, a former landfill, and a former wastewater treatment plant. Adjacent urban land uses, which include the maintenance and removal of riparian vegetation, impervious surfaces, and straightening and rerouting of stream channels, has resulted in degraded water quality and unstable channel characteristics (stream entrenchment, erosion, and bank collapse).

The primary goals and objects of this project include:

- Reducing sediment input to Adkin Branch by restoring a stable dimension, pattern, and profile, and establishing a vegetated stream bank, floodplain and terrace forest. Forest vegetation species were selected by studying a Reference Forest Ecosystem located directly upstream of the Project and reviewing species listed in <u>Classification of the Natural Communities of North Carolina: Third Approximation</u> (Schafale and Weakley 1990). These species will mimic a Coastal Plain Forest.
- Promote floodwater attenuation and decrease floodwater levels by excavating a gently sloping floodplain bench that begins at the bankfull discharge elevation and slopes up to the terrace elevation, and increasing roughness in the floodplain by establishing a vegetated riparian buffer.
- Improving aquatic habitat by enhancing stream bed variability (riffle-pool sequence), and introducing woody debris in the form of rootwads, log vanes, and log sills. A riffle-pool sequence and woody debris structures provide places for forage, cover and reproduction for aquatic fauna and in some instances flora.
- Improve terrestrial habitat by restoring a forested riparian corridor through a highly urbanized environment which has historically experienced vegetation maintenance and forest segmentation. This corridor will provide a diversity of habitats such as mature forest, early successional forest, riparian wetlands and uplands.
- Reduce nonpoint source pollution associated with urban land uses (i.e. maintained ball fields, roadways, residential communities) by providing a vegetative buffer adjacent to

streams to treat surface runoff. Virtually all research that has been conducted on vegetated riparian buffer strips shows a substantial decrease in pollutants such as nitrate-nitrogen, phosphorous, chloride, ammonium, and sedimentation.

- Improve water quality by creating riparian stormwater wetlands adjacent to the UT, implementing BMPs along Adkin Branch for stormwater runoff that will retain sediments and nutrients, and removing creosote timber retaining walls throughout the project.

Project restoration efforts will result in the following:

- Restoration efforts will increase the stream length of Adkin Branch from an existing length of 7,982 linear feet to 8,521 linear feet. Restoration efforts will increase the stream length of the UT from an existing length of 1,263 linear feet to 1,616 linear feet.
- Creation of approximately 0.45 acres of riverine stormwater wetlands adjacent to the UT.
- There are currently 22.4 acres of buffers within the 50 foot riparian corridor of Adkin Branch and the UT. Of the 22.4 acres there are 7.6 acres of forest which meet vegetation requirements of Neuse River Buffers. The remaining area of 13.5 acres of grass, 0.7 acres of impervious surface, and 0.6 acres of maintained sewer easement, do not meet vegetation requirements of Neuse River Buffers. These buffers will be impacted by the relocation of Adkin Branch and the UT.
- The relocation and reforestation of Adkin Branch's riparian corridor will result in a total of 22.63 acres of riparian corridor within 50 feet of Adkin Branch. Of the 22.63 acres there are 21.55 acres of forest vegetation which will be considered Neuse River Buffers. The remaining area of 0.65 acres of maintained grass, 0.31 acres of maintained sewer easement, and 0.12 acres of impervious surface, will not meet vegetation requirements of Neuse River Buffers.
- A total of 41.74 acres of stream banks, floodplains, upland slopes and BMPs will be reforested within the project limits

This document represents a detailed restoration plan summarizing activities proposed within the Site. The plan includes 1) descriptions of existing conditions, 2) reference stream and forest studies, 3) restoration plans, and 4) Project monitoring and success criteria. Upon approval of this plan by EEP, engineering construction plans will be prepared and activities implemented as outlined. Proposed restoration activities may be modified during the civil design stage due to constraints such as access issues, sediment-erosion control measures, drainage needs (floodway constraints), or other design considerations.

Many properties adjacent to Adkin Branch, a landfill, and a wastewater treatment plant were purchased by the City of Kinston with Federal Emergency Management Agency (FEMA) funds following Hurricanes Fran and Floyd. The City of Kinston is in the process of developing a plan for reuse of these properties, which will include the establishment of a greenway and trail, educational nature park and facilities, and an arboretum.

1.0 **PROJECT SITE LOCATION**: The project site is located on the southeast side of the City of Kinston, in Lenoir County, North Carolina and includes Adkin Branch and an unnamed tributary (UT) to Adkin Branch (Figure 1).

Approximately 10,137 linear feet of stream are to be restored at the Site. Table 1 describes the Project restoration structures and objectives.

Table 1. Project Restoration Structures and Objectives
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Restoration Segment/ Reach ID	Station Range	Restoration Type	Priority Approach	Existing Linear Footage/ Acreage	Designed Linear Footage/ Acreage	Comment
Adkin Branch	10+00 – 35+26	Restoration	II	2,488	2,526	NC11/55 to Washington Avenue
	35+26 – 35+96	---	---	70	----	Existing Box Culvert
	35+96 – 53+46	Restoration	II	1,680	1,750	Washington Avenue to Gordon Street
	53+46 – 54+03	---	---	57	----	Existing Box Culvert
	54+03 – 60+27	Restoration	II	636	624	Gordon Street to Caswell Street
	60+27 – 60+68	---	---	41	----	Existing Box Culvert
	60+68 – 96+90	Restoration	II	3588	3,622	Caswell Street to Lincoln Street
UT to Adkin Branch	10+00 – 26+15	Restoration	I & II	1,200	1,615	---
Neuse River Buffers	Forest (> 100 trees per acre)	Restoration	---	7.58	21.55	Trees and shrubs will be planted in all areas located within the project's easement area.
	Grass / Forest (< 100 trees per acre)	---	---	13.58	0.65	The 0.65 acres is located outside of the proposed easement, therefore could not be reforested.
	Sewer	---	---	0.55	0.31	---
	Impervious Area	---	---	0.69	0.12	The impervious areas inside of the easement area cannot be reforested.

1.1 **Directions to Project Site**: From Raleigh, North Carolina take I-40 east for approximately 6.5 miles to US Highway 70 east. Take US 70 east for approximately 68.5 miles to NC Highways 11 and 55. Take a left turn and travel northeast on NC 11/55 through Kinston for 2.6 miles to the intersection with Adkin Branch. The project study area is southeast of NC 11/55.

1.2 **USGS Hydrologic Unit Code and NCDWQ River Basin Designation**: The Adkin Branch Project is located in Lenoir County, North Carolina within United

States Geological Survey (USGS) Hydrologic Unit (HU) and Targeted Local Watershed 03020202060030 (North Carolina Division of Water Quality (NCDWQ) Subbasin 03-04-05) of the Neuse River Basin and will service the USGS 8-digit HU 03020202 (USGS 1974, NCWRP 2003).

NCDWQ Subbasin 03-04-05 of the Neuse River Basin includes most of Lenoir County, the southeast corner of Wayne County, and small portions of Craven, Jones, and Greene Counties. This subbasin includes the Neuse River from the mouth of Stoney Creek to the mouth of Contentnea Creek (NCDWQ 2006a).

1.3 **Project Vicinity Map**: The Project is located on the southeast side of the City of Kinston, in Lenoir County, North Carolina. The Project begins at NC 11/55 and ends at Lincoln Street. The project vicinity is depicted on Figure 1.

2.0 WATERSHED CHARACTERIZATION

2.1 Drainage Area: Adkin Branch has a watershed area of approximately 3495 acres (5.46 square miles) at its downstream most point of the Project (Table 2 and Figure 2). The UT to Adkin Branch has a watershed area of 78 acres (0.12 square miles) at its confluence with Adkin Branch. Onsite elevations range from a high of 42 feet National Geodetic Vertical Datum (NGVD) at the upstream extent of the Project to a low of approximately 14 feet NGVD at the downstream extent of the Project, as obtained from field surveys.

Table 2. Drainage Areas
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Reach	Drainage Area	
	Acres	Square Mile(s)
Adkin Branch (at Washington Avenue)	2495	4.60
Adkin Branch (at Gordon Street)	3220	5.03
Adkin Branch (at Caswell Street)	3260	5.09
Adkin Branch (at Project outfall – Lincoln Street)	3495	5.46
UT to Adkin Branch (at confluence with Adkin Branch)	78	0.12

2.2 Surface Water Classification/Water Quality: Adkin Branch and its tributaries have been assigned Stream Index Number 27-79, a Best Usage Classification of **C Sw NSW**, and are supporting their intended uses (NCDWQ 2002, NCDWQ 2006b). Class C waters are suitable for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner. Sw (swamp waters) is a supplemental classification intended to recognize those waters that generally have naturally occurring very low velocities, low pH, and low dissolved oxygen. NSW (nutrient sensitive waters) is a supplemental classification intended for waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation.

2.3 Physiography, Geology, and Soils: The Project is divided by two ecoregions within the Southeastern Plains of North Carolina: 1) Rolling Coastal Plains and 2) Southeastern Floodplains and Low Terrace. The Rolling Coastal Plain ecoregion, located at the upstream/northern half of the Project, is characterized by dissected, irregular plains and smooth plains on broad interstream divides with gentle to steep side slopes dissected by numerous small, low to moderate gradient sandy bottomed streams. The Southeastern Floodplains and Low Terrace ecoregion, located at the downstream/southern half of the Project, is characterized by major river floodplains and associated low terraces containing low gradient streams with sandy and silty substrates, oxbow lakes, ponds, and/or swamps (Griffith 2002).

Soils that occur within the Site, according to the *Soil Survey of Lenoir County, North Carolina* are depicted in Figure 3 and described in Table 3 (USDA 1992).

Table 3. USDA Soils Mapped within the Project
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Soil Series	Hydric Status*	Family	Description
Bibb (BB)	Class A	*Typic Fluvaquents*	This series consists of frequently flooded, poorly drained, moderately permeable, nearly level soils on floodplains. Slopes are generally less than 1 percent. The seasonal high water table generally occurs at the soil surface. Marl occurs at a depth of 4 to 7 feet.
Kalmia (Ka)	Class B	*Typic Hapludults*	This series consists of well-drained, moderately permeable, nearly level soils on stream terraces. Slopes are generally between 0 and 2 percent. Depth to the seasonal high water table occurs at 5 feet.
Kenansville (Ke)	Class B	*Arenic Hapludults*	This series consists of well-drained, moderately rapid permeable, nearly level soils on stream terraces. Depth to the seasonal high water table occurs at 5 feet.

* Class A = hydric soils; Class B = nonhydric soils, which may contain hydric soil inclusions

2.4 **<u>Historical Land Use and Development Trends</u>**: Land use within the Project watershed is characterized primarily as urban development, which is associated with the City of Kinston. Land uses include agriculture, disturbed forest, parks, former neighborhoods, a former landfill, and a former wastewater treatment plant (Table 4 and Figure 2). The removal of riparian vegetation, impervious surfaces, and straightening and rerouting of stream channels, has resulted in degraded water quality and unstable channel characteristics (stream entrenchment, erosion, and bank collapse).

Many of the former neighborhoods, landfill, and wastewater treatment plant were purchased by the City of Kinston with Federal Emergency Management Agency (FEMA) funds following flooding from Hurricanes Fran and Floyd. The City of Kinston is in the process of developing a plan for reuse of these properties including the establishment of a greenway, educational facilities, and parks.

Table 4. Land Use of Watershed
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Land Use	Acreage	Percentage
Urban Land	2655	76
Agricultural Land	450	13
Mixed Forest/Disturbed Forest	260	7
Evergreen Forest	130	4
TOTAL	**3495**	**100**

2.5 Threatened and Endangered Species: Species with a Federal classification of Endangered or Threatened are protected under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). The term "Endangered species" is defined as "any species which is in danger of extinction throughout all or a significant portion of its range," and the term "Threatened species" is defined as "any species which is likely to become an Endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. 1532).

Based on the most recently updated county-by-county database of federally listed species in North Carolina as posted by the United States Fish and Wildlife Service (USFWS) at http://nc-es.fws.gov/es/countyfr.html, three federally protected species are listed for Lenoir County. Table 5 lists the federally protected species for Lenoir County and indicates if potential habitat exists within the Project for each.

Table 5. Federally Protected Species for Lenoir County
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Common Name	Scientific Name	Status*	Habitat Present Within Project	Biological Conclusion
Vertebrates				
Bald eagle	*Haliaeetus leucocephalus*	Threatened	No	No Effect
Red-cockaded woodpecker	*Picoides borealis*	Endangered	No	No Effect
Vascular Plants				
Sensitive joint-vetch	*Aeschynomene virginica*	Threatened	No	No Effect

*Endangered = a taxon "in danger of extinction throughout all or a significant portion of its range"; Threatened = a taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range".

Potential habitat may occur for the bald eagle approximately one mile south of the Project along the Neuse River. The Project may serve as a fly over corridor for the bald eagle; however, the urban nature of the Project indicates that the proposed project will have no effect on the bald eagle.

The Project is almost entirely composed of urban/disturbed vegetative communities and contains no open stands of pine suitable for red-cockaded woodpecker foraging (30 years or older) or roosting/nesting (60 years or older) habitat; therefore, no habitat for red-cockaded woodpecker occurs within the Project and the proposed project will have no effect on red-cockaded woodpecker.

In addition, the Project is not tidally influenced and therefore, contains no suitable habitat for sensitive joint-vetch and this project will have no effect on sensitive joint-vetch. A NCWRC response letter can be found in Appendix C.

No designated units of Critical Habitat are listed as occurring in Lenoir County.

2.6 **Cultural Resources:** Pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for compliance with Section 106 (36 CFR Part 800) comments were received for the Project from the North Carolina State Historic Preservation Office (NCSHPO) (Appendix C).

No known archaeological sites are present within the proposed project area. NCSHPO indicated that it is unlikely that any archaeological resources that may be eligible for inclusion in the National Register of Historic Places will be affected by the project; therefore, NCSHPO recommends no archaeological investigations be conducted in connection with the project.

One structure of historical or architectural importance is documented in the general area of the Site, (LR 465) Queen Gordon Streets Historic District, which is listed in the National Register of Historic Places. However, this stream restoration project will not affect any structures associated with the Historic District listed above and will therefore not affect any known structures of historical or architectural importance.

2.7 **Potential Constraints:** The presence of conditions or characteristics that have the potential to hinder restoration activities at the Project was evaluated. The evaluation focused primarily on the presence of hazardous materials, utilities and restrictive easements, rare/threatened/endangered species or critical habitats, and the potential for hydrologic trespass. Existing information regarding constraints was acquired and reviewed. In addition, any Project conditions that have the potential to restrict the restoration design and implementation were documented during the field investigation.

One potential offsite environmental concern was identified during a Phase I Environmental Site Assessment. EI, Inc. recommended obtaining any additional information regarding the potential underground storage tank near the Adkins Branch project corridor, south of NC 11/55. Depending on the findings of an additional file review, further investigations of soils and groundwater may be necessary to assess potential impacts to the subject project area.

Table 6 Design Constraints
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Location	Design Constraint	Number of Constraints in Project Area
First Section of Project **NC11/55 to Washington Avenue**	Existing Building along right side	1
	Sanitary sewer line and easement along left side	1
	Kinston Housing Authority along right side	1
	Storm system outfalls	8
	Drainage swales or channels	5
	Residential properties with structures along left side	4
	Charter school property along right side	1
Second Section of Project **Washington Avenue to Gordon Street**	Adkin Alumni Building along right side	1
	Water line crossing	1
	Sanitary sewer line and easement along left side	1
	Rochelle Middle School Park along left side	1
	Residential properties with structures	10
	Properties with no structures	19
	Storm system outfalls	8
Third Section of Project **Gordon Street to Caswell Street**	Properties with structures	1
	Properties with no structures	7
	Storm system outfalls	2
Fourth Section of Project **Caswell Street to Lincoln Street**	Water line crossing	2
	Sanitary sewer line and easement along left side	1
	Sanitary sewer line and easement crossing	1
	Sanitary sewer line and easement along right side	1
	City of Kinston well	1
	City of Kinston swimming pool	1
	Properties with structures	10
	Properties with no structures	45
	Storm system outfalls	12
	Drainage swales or channels	3
	City of Kinston baseball/football field	2
	Baseball/football field lights	4

2.7.1 Property Ownership and Boundary

The Project contains parcels owned by the City of Kinston and private individuals. The City of Kinston purchased many properties using FEMA hurricane relief funds. Other City owned properties are existing parks and public housing. The City of Kinston is donating permanent conservation easements on these properties for areas associated with this Project. Easements on the privately owned properties were obtained in a joint effort between the City of Kinston and the EEP.

The Project requires that a permanent conservation easement be placed along the riparian corridor of Adkin Branch and the UT. A 50 foot from top of each bank easement was the goal for the easement bounds. However, because the Project traverses numerous private and public properties with structures on many properties, a minimum 50 foot easement was not able to be placed along the entire riparian corridor through the Project. Some areas of the project required less than a 50 foot easement because of constraints, however there is an easement that spans the entire Project.

The permanent conservation easements will total approximately 46 acres. Approximately 41.3 acres of the permanent easements will result in a reforested riparian buffer.

2.7.2 Project Access

The Project is located in the City of Kinston; many points of access to the restoration areas are available. A transportation plan, including the location of access routes and staging areas will be designed to minimize Project disturbance to the maximum extent feasible. The number of transportation access points into the floodplain will be maximized to avoid traversing long distances through the Project interior.

2.7.3 Utilities

Sanitary sewer and water lines are present within the Site; however, coordination with the City of Kinston has been made so that disturbance to the sewer and water lines will be minimized as a result of restoration activities.

2.7.4 FEMA/Hydrologic Trespass

The HEC-RAS analysis indicates that the restoration design will result in a no-rise in the 100-year floodplain water surface elevations outside of the project area. The results of this analysis affirm that hydrologic trespass to adjacent properties will not occur. The HEC-RAS is discussed in more detail in Section 5.3 (HEC-RAS Analysis).

3.0 PROJECT SITE STREAMS (EXISTING CONDITIONS):

Project streams proposed for restoration include Adkin Branch and an UT to Adkin Branch (Figure 4 and Sheets 1 through 1B).

3.1 Channel Classification:

Stream geometry and substrate data have been evaluated to classify existing stream conditions, utilizing fluvial geomorphic principles (Rosgen 1996). Tables 7A and 7B provide a summary of measured stream geometry attributes under existing conditions (considered to be unstable) in addition to stable stream attributes (reference and proposed).

Adkin Branch – Rochelle Middle School Park

Data collected during a Rosgen Level II survey, near Rochelle Middle School Park, were used to classify Adkin Branch as a G5-type channel for the large majority of the Project. G-type channels typically display low entrenchment ratios, low width-to-depth ratios, and a low sinuosity. The second descriptor, 5, indicates that channel materials are dominated by sand. These conditions, as shown on Adkin Branch, lead to higher shear stresses on channel banks and bed and typically an over abundance of stream power, which leads to channel degradation. Evidence of channel degradation can be seen in the existing photographs (Appendix A). The primary cause of degradation stems from historic channelization, urbanization of the watershed, and routine maintenance of channel banks.

Adkin Branch – Pilot Site

Data was also taken at a Pilot Site to study its design concept. The Pilot Site is located between Caswell Street and Lincoln Street near Holloway Park (Sheet 1B). The Pilot Site was constructed in 2002 by the North Carolina Department of Transportation (DOT). The DOT had planned to restore the entire length of Adkin Branch within the current Project Area, but decided to construct the Pilot Site to determine potential problems that may arise from a design and construction aspect.

Existing conditions of the Pilot Site revealed that the channel has become somewhat incised and shows signs of degradation. The existing stream type here is an incised and degraded C/E5. C/E type channels display characteristics of both C and E type stream types. C/E streams typically display moderate width ratios ranging between 10 and 12, with entrenchment ratios higher than 2.2. C/E channel types also typically display steep point bars, where as E type channels typically have little to no point bars and C type channels typically display gently sloping point bars.

It was determined that the pilot site is unstable for numerous reasons. However, the primary reason seems to be because the bankfull discharge elevation is below the top of existing bank (i.e. an incised channel was constructed). This means that high flows (above bankfull discharge) are contained within the channel banks, which consequently leads to excess stress within the channel.

A designed incised channel is understandable because bankfull indicators are hard to identify within the Project Area. Additionally, at the time the channel was designed and constructed information within the stream restoration industry seemed to indicate that bankfull discharge may be substantially higher in urban watersheds compared with rural watersheds within the same physiographic region. Many, including Ko & Associates, now agree that the bankfull discharge remains constant for a channel regardless of impervious area within a watershed. The bankfull discharge return interval may increase as the watershed becomes more urbanized, but the bankfull discharge should remain constant. The theory during the time that the Pilot Site was designed and constructed that urbanized watersheds tend to display higher bankfull discharges led to the channel being constructed to a bankfull discharge that is larger than the actual bankfull discharge because the Project's watershed is located in a highly urbanized watershed.. After reviewing features in the Pilot Site and finding other indicators through the Project Area, the bankfull discharge was determined to be much lower than the Pilot Site design.

Other "lessons learned" from the Pilot Site are a) that immediate vegetation cover of the channel banks will be required for a stable channel, b) very fine sands are located within the soils throughout the Project which will slow construction of structures and side slopes, and c) overland flow on the floodplain can scour inside meander bends where overland flow reenters the channel.

UT – Holloway Park

Data collected during a Rosgen Level II survey was used to classify the UT to Adkin Branch as an E5-type channel. Survey data was collected in the most stable reach of the UT to help determine bankfull discharge. However, classification of the UT ranges from F5- to G5- to E5-type channels. The reasons for multiple channel classifications vary and are outlined below. Some reaches of the channel, classified as an F-type channel, have not formed a bankfull channel due to emergent vegetation that has "choked" the channel flow, not allowing a low flow or bankfull channel to form. Other reaches are incised; therefore, the channel in these areas contains the bankfull flow and resembles a G-type ("gully") channel. Some reaches, such as the surveyed reach, have begun to form a bankfull bench, but still display evidence of scour resulting from a lack of rooted woody vegetation stemming from ongoing channel maintenance. Evidence of historic channelization and continual maintenance of the UT can be seen in the existing photographs (Appendix A).

The UT has a watershed area of 78 acres (0.12 square miles), which raised the question of if the channel was a perennial or intermittent stream. Mr. Garcy Ward of the NCDWQ, Mr. William Wescott of the United States Army Corps of Engineers (ACOE), and Mr. Ryan Smith of Ko & Associates, P.C. met on June 20, 2006 to discuss the perenniallity of the UT. A NCDWQ Stream Identification Form was completed on two sections of the UT by Mr. Smith during this meeting. Mr. Smith's two forms scored a 22.25 and 25.25 respectively. Mr. Ward and Mr. Wescott revisited the site on August 8, 2006 and completed a NCDWQ Stream Identification Form, which scored a 27 for an average over the entire reach of the UT within the Project Area. Mr. Ward and Mr. Wescott determined that under existing circumstances the UT was a perennial stream. Correspondence with Mr. Ward concerning this issue can be found in Appendix B.

Table 7A. Adkin Branch Morphological Stream Characteristics
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Morphological Characteristics of Adkin Branch

Restoration Plan: **Adkin Branch Stream Restoration**
County: **Lenoir County, NC**
Design by: **RVS/RKW**
Checked by: **RKW**

ITEM	Adkin Branch Existing Conditions	Adkin Branch Existing Conditions	Adkin Branch Proposed Conditions	Adkin Branch Proposed Conditions	Adkin Branch Proposed Conditions	Adkin Branch Proposed Conditions	Reference Reach
LOCATION	Rochelle Park (between Wash Ave & Gordon)	Pilot Site (between Caswell & Lincoln)	NC11 to Wash Ave	Wash Ave to Gordon	Gordon to Caswell	Caswell to Lincoln	Johnson Mill
STREAM TYPE	G5	B5	B5c	B5c	B5c	B5c	B5
DRAINAGE AREA, Ac - Sq Mi	2944 Ac - 4.60 Sq Mi	3392 Ac - 5.30 Sq Mi	2945 Ac - 4.60 Sq Mi	3220 Ac - 5.03 Sq Mi	3260 Ac - 5.09 Sq Mi	3495 Ac - 5.46 Sq Mi	8640 Ac - 13.50 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	20.9 ft	23.6 ft	22.0 ft	22.0 ft	22.0 ft	22.0 ft	21.2 ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	1.95 ft	1.83 ft	1.38 ft	1.38 ft	1.47 ft	1.47 ft	2.25 ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	10.7	12.9	16.0	16.0	15.0	15.0	9.4
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	40.9 ft^2	43.3 ft^2	30.3 ft^2	30.3 ft^2	32.3 ft^2	32.3 ft^2	47.6 ft^2
BANKFULL MEAN VELOCITY, fps	1.2 fps	1.3 fps	1.7 fps	1.7 fps	1.8 fps	1.8 fps	1.7 fps
BANKFULL DISCHARGE, cfs	50.0 cfs	55.0 cfs	50.0 cfs	50.0 cfs	54.0 cfs	55.0 cfs	80.9 cfs
Dmax RATIO (d_{max}/d_{bkf})	1.2	1.6	1.2	1.2	1.2	1.2	1.1
BANKFULL MAX DEPTH (d_{max}), ft	2.26 ft	2.98 ft	1.65 ft	1.65 ft	1.76 ft	1.76 ft	2.42 ft
WIDTH Flood-Prone Area (W_{fpa}), ft	29.4 ft	45.0 ft	40.00 ft	40.00 ft	40.00 ft	40.00 ft	34.9 ft
ENTRENCHMENT RATIO (ER)	1.4	1.9	1.8	1.8	1.8	1.8	1.6
MEANDER LENGTH (Lm), ft	175 - 400 ft	224 - 260 ft	264.0 - 418.0 ft	264.0 - 418.0 ft	264.0 - 418.0 ft	264.0 - 418.0 ft	250.0 - 400.0 ft
RATIO OF Lm TO W_{bkf}	8.4 - 19.1	9.5 - 11.0	12.0 - 19.0	12.0 - 19.0	12.0 - 19.0	12.0 - 19.0	11.8 - 18.9
RADIUS OF CURVATURE, ft	150 - 320 ft	40 - 146 ft	66.0 - 110.0 ft	66.0 - 110.0 ft	66.0 - 110.0 ft	66.0 - 110.0 ft	43.0 - 235.0 ft
RATIO OF Rc TO W_{bkf}	7.2 - 15.3	1.7 - 6.2	3.0 - 5.0	3.0 - 5.0	3.0 - 5.0	3.0 - 5.0	2.0 - 11.1
BELT WIDTH, ft	30.00 - 50.00 ft	75.00 - 120.00 ft	44.0 - 176.0 ft	44.0 - 176.0 ft	44.0 - 176.0 ft	44.0 - 176.0 ft	50.0 - 1500.0 ft
MEANDER WIDTH RATIO	1.43 - 2.39 ft	3.18 - 5.08 ft	2.0 - 8.0	2.0 - 8.0	2.0 - 8.0	2.0 - 8.0	2.4 - 70.9
SINUOSITY (K)	1.04	1.12	1.04	1.04	1.07	1.03	1.10
VALLEY SLOPE, ft/ft	0.0005 ft/ft	0.0006 ft/ft	0.0023 ft/ft	0.0021 ft/ft	0.0012 ft/ft	0.0026 ft/ft	0.0011 ft/ft
AVERAGE SLOPE (S), ft/ft	0.0005 ft/ft	0.0007 ft/ft	0.0016 ft/ft	0.0016 ft/ft	0.0011 ft/ft	0.0014 ft/ft	0.0010 ft/ft
POOL SLOPE, ft/ft	0.0000 ft/ft	0.0002 ft/ft	0.0007 ft/ft	0.0006 ft/ft	0.0004 ft/ft	0.0006 ft/ft	0.0002 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE	0.0	0.3	0.4	0.4	0.4	0.4	0.2 - 0.5
MAX POOL DEPTH, ft	3.18 ft	4.14 ft	3.44 ft	3.44 ft	3.67 ft	3.67 ft	3.56 ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	1.6	2.3	2.5	2.5	2.5	2.5	1.6
POOL WIDTH, ft	61.6 ft	22.3 ft	22.00 ft	22.00 ft	22.00 ft	22.00 ft	19.94 ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH	2.9	0.9	1.00	1.00	1.00	1.00	0.94
POOL TO POOL SPACING, ft	183.00 - 231.00 ft	59.62 - 117.86 ft	88.0 - 132.0 ft	88.0 - 132.0 ft	88.0 - 132.0 ft	88.0 - 132.0 ft	91.1 - 130.0 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	8.75 - 11.04 ft	2.53 - 4.99 ft	4.0 - 6.0	4.0 - 6.0	4.0 - 6.0	4.0 - 6.0	4.3 - 6.1

** Existing Conditions data was taken along a reach of Adkin Branch. Data, such as stream and valley slopes, does not correspond to the entire length of Adkin Branch inside of the Project Area.

Table 7B. UT to Adkin Branch Morphological Stream Characteristics
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Morphological Characteristics of UT Adkin Branch
Restoration Plan: **Adkin Branch Stream Restoration**
County: **Lenoir County, NC**
Design by: **RVS/RKW**
Checked by: **RKW**

ITEM	Existing Conditions	UT Adkin Branch Proposed Conditions	Reference Reach
LOCATION	UT to Adkin	Holloway Park	UT to WildCat Branch
STREAM TYPE	E5	E5	E5
DRAINAGE AREA, Ac - Sq Mi	78 Ac - 0.12 Sq Mi	78 Ac - 0.12 Sq Mi	282 Ac - 0.44 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	3.6 ft	6.0 ft	7.7 ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	0.47 ft	0.55 ft	1.03 ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	7.6	11.0	7.5
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	1.7 ft^2	3.3 ft^2	7.9 ft^2
BANKFULL MEAN VELOCITY, fps	2.1 fps	1.1 fps	1.2 fps
BANKFULL DISCHARGE, cfs	3.5 cfs	3.5 cfs	9.2 cfs
BANKFULL MAX DEPTH (d_{max}), ft	3.40 ft	0.85 ft	1.56 ft
WIDTH Flood-Prone Area (W_{fpa}), ft	8.3 ft	15.00 ft	130.0 ft
ENTRENCHMENT RATIO (ER)	2.3	2.5	16.9
MEANDER LENGTH (Lm), ft	212 - 517 ft	18.0 - 48.0 ft	22.5 - 29.0 ft
RATIO OF Lm TO W_{bkf}	59.2 - 144.4	3.0 - 8.0	2.9 - 3.8
RADIUS OF CURVATURE, ft	93 - 105 ft	12.0 - 18.0 ft	10.9 - 15.3 ft
RATIO OF Rc TO W_{bkf}	26.0 - 29.3	2.0 - 3.0	1.4 - 2.0
BELT WIDTH, ft	50.00 - 50.00 ft	12.0 - 36.0 ft	13.8 - 19.4 ft
MEANDER WIDTH RATIO	13.97 - 13.97 ft	2.0 - 6.0	1.8 - 2.5
SINUOSITY (K)	1.00	1.35	1.15
VALLEY SLOPE, ft/ft	0.0001 ft/ft **	0.0092 ft/ft **	0.0027 ft/ft
AVERAGE SLOPE (S), ft/ft	0.0001 ft/ft **	0.0022 ft/ft **	0.0024 ft/ft
POOL SLOPE, ft/ft	0.0001 ft/ft	0.0009 ft/ft	0.0000 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE	0.8	0.4	0.0 - 0.0
MAX POOL DEPTH, ft	1.45 ft	1.36 ft	1.90 ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	3.1	2.5	1.9
POOL WIDTH, ft	4.1 ft	6.90 ft	8.80 ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH	1.1	1.15	1.14
POOL TO POOL SPACING, ft	21.63 - 21.63 ft	12.0 - 36.0 ft	14.0 - 16.6 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	6.04 - 6.04 ft	2.0 - 6.0	1.8 - 2.2

** Existing Conditions data was taken along a *reach* of UT to Adkin Branch. Data, such as stream and valley slopes, does not correspond to the entire length of UT to Adkin Branch inside of the Project Area.

3.2 **Discharge:** Two sections of Adkin Branch were studied to determine existing bankfull discharge. The first section was between Washing Avenue and Gordon Street. The drainage area at Gordon Street is 3220 acres (5.03 square miles) with a bankfull discharge of 50 cubic feet per second. The second section of Adkin Branch studied was between Caswell Street and Lincoln Street. The drainage area at Lincoln Street is 3495 acres (5.46 square miles) with a bankfull discharge of 55 cubic feet per second (Table 7A). The UT to Adkin Branch was also studied to determine bankfull discharge. The drainage area at the confluence of the UT to Adkin Branch and Adkin Branch is 78 acres (0.12 square miles) with a bankfull discharge of 3.5 cubic feet per second (Table 7B).

3.3 **Channel Morphology:** Channel cross-sections and stream profiles were measured for each of the existing reaches. The Morphological Stream Characteristics tables (Tables 7A and 7B) include a summary of dimension, profile, and pattern data for each reach.

3.4 **Channel Stability Assessment:** A visual assessment accompanied by a morphological assessment using data collected during a Rosgen Level II survey was used to determine channel stability. These data, which can be found in Tables 7A and 7B (Morphological Stream Tables) and in Appendices A and B (Project Site Photographs and Project Site NCDWQ Stream Classification Forms), confirmed that the channel attributes do not fall within acceptable ranges for a stable channel.

Excess sedimentation within the channel's banks (from bank scour), bankfull benches/indicators within the channel banks (i.e. an incised channel), severely eroded meander bends, absence of a repetitive sequence of riffles and pools, and timber and concrete lined retaining walls are evidence that Little Lick Creek is degrading and experiencing an excess amount of energy during high flows. If the bankfull discharge were at the existing top of bank, the above indicators of degradation probably would not be as evident.

Sedimentation from bank scour has essentially filled Adkin Branch's substrate, creating a uniform bed form, which lacks a riffle and pool sequence. Much of the existing bed form can be described as a smooth, plane surface. The lack of pool diversity, woody debris in the channel, and the lack of cover from riparian vegetation have severely decreased the ability of aquatic fauna to survive within Adkin Branch. The only areas of the entire Project Area which displayed schools of fish, a diversity of macrobenthos, and amphibians in the same location was within the Pilot Site. Although the Pilot Site does show signs of degradation, it also has a vegetated buffer that shades the channel and provides woody debris. Also very important is the fact that woody structures such as log vanes and log cross-vanes are forming pools, providing cover, and providing woody materials for aquatic life to survive and propagate.

3.5 **<u>Bankfull Verification</u>:** Onsite data was compared with *Hydraulic Geometry Relationships for Rural North Carolina Coastal Plain Streams* (regional curve) (Doll et al. 2006) and reference streams (discussed below) to verify the bankfull discharge. Although there are no reaches on Adkin Branch in the Project which would be considered stable, there are some sections which displayed bankfull indicators which matched consistently from the upstream most point of the project to the downstream most point of the project. Measurements taken at these indicators included channel width, depth, cross-sectional area, and bankfull elevation. As the entire channel was being studied a trend developed which consistently displayed similar data. Data from the existing conditions survey of Adkin Branch near Rochelle Park and at the Pilot Site support these findings (Table 7A).

The bankfull discharge on Adkin Branch is estimated to be 50 to 55 cubic feet per second (depending on the reach) and 3.4 cubic feet per second on the UT to Adkin Branch.

3.6 **<u>Vegetation</u>:** Four plant communities are currently present at the Site: 1) urban/disturbed land, 2) disturbed forest, 3) scrub/shrub, and 4) stream-side assemblage.

Urban/disturbed land contains residential and industrial developments that are generally maintained. These areas contain a range of vegetation from herbaceous to sparse trees and includes fescue (*Festuca* sp.), American wisteria (*Wisteria frutescens*), yellowdicks (*Helenium amarum*), juniper leaf (*Polypremum procumbens*), goldenrod (*Solidago* sp.), buttonweed (*Diodia* sp.), pepper vine (*Ampelopsis* sp.), fleabane (*Erigeron* sp.), ash (*Fraxinus* sp.), dock (*Rumex* sp.), tropical Mexican clover (*Richardia brasiliensis*), Mexican tea (*Chenopodium ambrosiodes*), narrowleaf plantain (*Plantago lanceolata*), flatsedge (*Cyperus* sp.), fanpetals (*Sida* sp.), willow oak (*Quercus phellos*), aster (*Aster* sp.), milktree (*Sapium* sp.), Canadian horseweed (*Conyza canadensis*), and java-bean (*Senna obtusifolia*).

Disturbed forest is scattered throughout the project and contains several invasive species including mimosa (*Albizia julibrissin*), tree-of-heaven (*Ailanthus altissima*), Chinese privet (*Lonicera japonica*), and chinaberry (*Melia azedarach*). This community is characterized by a canopy layer consisting of sweetgum (*Liquidambar styraciflua*), mulberry (*Morus* sp.), bitternut hickory (*Carya cordiformis*), hackberry (*Celtis laevigata*), pecan (*Carya illinoinensis*), red maple (*Acer rubrum*), northern red oak (*Quercus rubra*), water oak (*Quercus nigra*), black cherry (*Prunus serotina*), eastern red cedar (*Juniperus virginiana*), willow oak, sycamore (*Platanus occientalis*), bald cypress (*Taxodium distichum*), loblolly pine (*Pinus taeda*), and river birch (*Betula nigra*). The understory consists of species listed above as well as persimmon (*Diospyros virginiana*), poison ivy (*Toxicodendron radicans*), giant cane (*Arundinaria gigantea*), greenbrier (*Smilax rotundifolia*), wisteria, pepper vine, brome (*Bromus* sp.), and fetterbush (*Lyonia lucida*).

Scrub/shrub areas are in the early stages of succession and include black cherry, plum (*Prunus* sp.), sassafras (*Sassafras albidum*), loblolly pine, sweetgum, eastern baccharis (*Baccharis halimifolia*), willow oak, winged sumac (*Rhus coppalinum*), Callery pear (*Pyrus calleryana*), blackberry (*Rubus argutus*), greenbrier, muscadine (*Vitis rotundifolia*), pepper vine, Virginia creeper (*Parthenocissus quinquefolia*), poison ivy, dog fennel (*Eupatorium capillifolium*), goldenrod, creeping cucumber (*Melothria pendula*), fireweed (*Erechtites hieracifolia*), pokeberry (*Phytolacca americana*), beggarticks (*Bidens* sp.), bahiagrass (*Paspalum notatum*), and Brazilian vervain (*Verbena brasiliensis*).

The stream-side assemblage is on the banks of Adkin Branch and includes sycamore, pecan, mulberry, bald cypress, river birch, willow oak, sweetgum, American elm (*Ulmus Americana*), box elder (*Acer negundo*), and cherrybark oak (*Quercus pagoda*) in the canopy. The subcanopy contains species listed in the canopy as well as northern red oak, mimosa, tree-of-heaven, eastern red cedar, chinaberry, water oak, sassafras, hackberry, and elderberry. The shrub and herbaceous layers include lizard’s tail (*Saururus cernuus*), trumpet creeper (*Campsis radicans*), Brazilian vervain, netted chainfern (*Woodwardia aerolata*), Johnson grass (*Sorghum halapense*), eastern gamagrass (*Tripsacum dactyloides*), alligatorweed (*Alternanthera philoxeroides*), and hydrocotyle (*Hydrocotyle* sp.).

4.0 REFERENCE STREAMS: A reference reach search for both Adkin Branch and the UT was completed to find a B5c (for Adkin Branch) and E5 (for the UT) type channel. A B5c type channel with a relatively large drainage area was not found near the site within the Neuse River Basin, so a search was conducted that covered the areas that would potentially yield a B5c type channel. This search was conducted through the Lumber, Cape Fear, Neuse, and Tar-Pamlico River Basins. Only one suitable reference (Johnsons Mill Run) that displayed B5c type characteristics with a relatively large drainage area was found. Johnsons Mill Run is located near Greenville in the Tar-Pamlico River Basin. A search for an E5 type channel with a relatively high valley slope was completed near the Project area and yielded no potential references, so the search expanded into adjacent river basins. The UT to Wildcat Branch was identified as a suitable reference reach for an E5 type channel with a high valley slope. The UT to Wildcat Branch is located near the Howellsville Township in the Lumber River Basin. The Johnsons Mill Run site vicinity, watershed, and soils are depicted in Figures 5 through 7. The UT to Wildcat Branch site vicinity, watershed and soils maps are depicted in Figures 8 through 10. Photographs for the reference reaches can be found in Appendix D.

Distinct bankfull variables were identifiable in each reference and pattern/profile characteristics appear to have not been degraded, allowing for assistance with proposed design characteristics.

4.1 Watershed Characterization: Land use within the Johnson Mill Run watershed can be characterized as rural and more specifically agricultural in nature. Pine plantations and row cropping dominate the watershed, consuming approximately 90 percent of the land area. Residential development, roads, and other impervious surfaces comprise the remaining 10 percent of the watershed land area.

The UT to Wildcat Branch watershed is dominated by mature forests (approximately 60 percent of the watershed). Deforestation is occurring within the watershed; however, most cleared areas have been replanted with pine. The remainder of the watershed is comprised primarily of agricultural land use practices (approximately 40 percent of the watershed).

4.2 Channel Classification: Johnsons Mill Run is characterized by a B-type, low sinuosity (1.10) channel with sand-dominated substrate (Table 7A). B-type streams are characterized as slightly entrenched, step-pool channels exhibiting low sinuosity. In North Carolina, B-type streams often occur in narrow valleys that limit the development of a wide floodplain (Valley Types II and VI).

UT to Wildcat Branch is characterized as an E-type, moderately sinuous (1.15) channel with sand-dominated substrates (Table 7B). E-type streams are characterized as slightly entrenched, riffle-pool channels with sinuous flow patterns. In North Carolina, E-type streams often occur in narrow to wide valleys with well-developed alluvial floodplains (Valley Type VIII).

4.3 **Discharge:** The Johnsons Mill Run reference reach has a drainage area of 13.5 square miles and a bankfull discharge of 80.9 cubic feet per second (Table 7A); while the UT to Wildcat Branch reference reach has a drainage area of 0.44 square mile and a bankfull discharges of 9.2 cubic feet per second (Table 7B).

4.4 **Channel Morphology:** Channel cross-sections and stream profiles were measured along the reference reaches. Surveys included a plan form analysis, bed material evaluation, and buffer assessment. The reaches are transporting their sediment supply while maintaining their dimension, pattern, and profile. The Tables of Morphological Stream Characteristics (Tables 7A and 7B) include a summary of dimension, profile, and pattern data for each reference reach to assist with the establishment of reconstruction parameters.

The channel streambed material is dominated by sand-sized particles.

4.5 **Channel Stability Assessment:** A visual assessment accompanied by a morphological assessment using data collected during a Rosgen Level II survey was used to determine channel stability. These data, which can be found in Tables 7A and 7B (Morphological Stream Tables) and in Appendix D and E (Reference Site Photographs and Reference Site NCDWQ Stream Classification Forms), confirmed that the channels fell within acceptable ranges for a stable reference channel.

Major components for stability include determining if the channel is conveying its discharge and sediment load without aggrading or degrading. Evidence that a channel does not fit this criteria includes, bank degradation, channel incision, channel widening, channel aggradation, massive amounts of sediment loading within and/or outside of the channel banks, channel armoring, and generally speaking no vegetation on the channel's banks.

4.6 **Bankfull Verification:** Onsite data was compared with *Hydraulic Geometry Relationships for Rural North Carolina Coastal Plain Streams* [regional curve] (Doll et al. 2006) to verify the bankfull discharge. The bankfull discharge on Johnson Mill Run at the point of the survey is estimated to be 80.9 cubic feet per second and for UT to Wildcat Branch is 9.2 cubic feet per second. The regional curve estimates the bankfull discharge to be 107.9 cubic feet per second and 9.2 cubic feet per second, respectively, which verifies the estimated bankfull discharge found on the reference sites.

4.7 **Reference Forest Ecosystem:** According to Mitigation Site Classification (MiST) guidelines (USEPA 1990), a Reference Forest Ecosystem (RFE) must be established for restoration sites. RFEs are forested areas on which to model restoration efforts of the restoration site in relation to soils and vegetation. RFEs should be ecologically stable climax communities and should represent believed historical (predisturbance) conditions of the restoration site. Quantitative data describing plant community composition and structure are collected at the RFEs and subsequently applied as reference data for design of the restoration Project planting scheme.

The RFE for this project is located immediately upstream of the Site. The RFE supports plant community and landform characteristics that restoration efforts will attempt to emulate (Figure 11). Two circular, 0.1-acre plots were randomly established within the reference area. Data collected within each plot include 1) tree species composition, 2) number of stems for each tree species, 3) diameter at breast height (DBH) for each tree species, and 4) a list of understory species. Field data within the following table indicates importance values of dominant tree species calculated based on relative density, dominance, and frequency of tree species composition (Smith 1980). Hydrology, surface topography, and habitat features were also evaluated.

Table 8. Reference Forest Ecosystem
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Tree Species	Number of Individuals *	Relative Density (%)	Frequency * (%)	Relative Frequency (%)	Basal Area * (ft^2/acre)	Relative Basal Area (%)	Importance Value
River birch (*Betula nigra*)	1	2.6	50	6.7	4.6	4.5	0.05
Ironwood (*Carpinus caroliniana*)	12	31.6	100	13.3	13.2	13.0	0.19
Mockernut hickory (*Carya tomentosa*)	1	2.6	50	6.7	2.5	2.4	0.04
Sweetgum (*Liquidambar styraciflua*)	2	5.3	50	6.7	1.3	1.3	0.04
Loblolly pine (*Pinus taeda*)	4	10.5	100	13.3	28.9	28.6	0.17
Black cherry (*Prunus serotina*)	2	5.3	50	6.7	1.8	1.8	0.05
Oak species (*Quercus* sp.)	1	2.6	50	6.7	1.8	1.8	0.04
Southern red oak (*Quercus falcata*)	1	2.6	50	6.7	7.3	7.2	0.06
Water oak (*Quercus nigra*)	8	21.1	100	13.3	34.3	33.8	0.23
Sassafras (*Sassafras albidum*)	4	10.5	100	13.3	4.2	4.2	0.09
Winged elm (*Ulmus alata*)	2	5.3	50	6.7	1.3	1.3	0.04
TOTALS	**38**	**100**	**750**	**100**	**101**	**100**	**1.00**

* Sum of two 0.1-acre plots

Two 0.1-acre plots were established which best characterize expected steady-state forest composition. Forest vegetation was dominated by ironwood, water oak, loblolly pine, and sassafras. Understory species within the RFE include canopy species as well as flowering dogwood, black cherry, American holly, willow oak, eastern red cedar, Japanese honeysuckle, muscadine, and greenbrier.

5.0 PROJECT SITE RESTORATION PLAN

5.1 Restoration Project Goals and Objectives: This stream restoration plan focuses on improving water quality, decreasing floodwater levels, restoring aquatic and riparian habitat, and implementing best management practices (BMPs) for stormwater retention. The plan involves:

- Reducing nonpoint source pollution associated with urban land uses by providing a vegetative buffer adjacent to streams to treat surface runoff.
- Reestablishing stream stability and the capacity to transport watershed flows and sediment loads by restoring stable dimension, pattern, and profile. Consequently, this will reduce sedimentation within onsite and downstream receiving waters.
- Promoting floodwater attenuation through a) excavation of a floodplain at the bankfull discharge stage of flow, b) restoring a secondary, entrenched tributary thereby reducing floodwater velocities within smaller catchment basins; c) increasing storage capacity for floodwaters within the Project; and d) revegetating Project floodplains to increase frictional resistance on floodwaters crossing Project floodplains.
- Improving water quality by implementing BMPs for stormwater runoff and removing creosote timber retaining walls, timber crib walls, and concrete bag crib walls within the Site.
- Improving aquatic habitat by enhancing stream bed variability, and introducing woody debris in the form of rootwads, log vanes, and log sills.
- Providing wildlife habitat, including a forested riparian corridor, within an area highly dissected by urban land uses.
- Raising Adkin Branch's invert through culverted crossings such that the culvert inverts are buried one foot beneath the channel bed. Grade Control log sills will be utilized to step the channel invert down along the project length.
- Provide stable outlets for stormwater outfalls into Adkin Branch (i.e. splash pools, step-pool systems, etc.).

The primary goals of this restoration plan include 1) construction of a stable, riffle-pool stream channel, 2) enhancement of water quality functions in the Project and downstream watersheds, 3) creation of a natural vegetation buffer along restored stream channels, 4) establishment of BMPs for stormwater retention in the Site, and 5) restoration of wildlife functions associated with a riparian corridor/stable stream.

The proposed restoration plan, depicted on Sheets 2 through 2B, is expected to restore 10,137 linear feet of Adkin Branch and a UT to Adkin Branch. Components of this plan may be modified based on construction constraints.

Primary activities proposed at the Project include 1) stream restoration, 2) BMPs for stormwater retention, 3) soil scarification, and 4) plant community restoration.

5.1.1 Designed Channel Classification

Two designs were completed for the Site, one on Adkin Branch and one on the UT to Adkin Branch.

Adkin Branch

Adkin Branch itself presents a unique design challenge because it is a large, urban, laterally confined (because of property and utility constraints), fine sand system. As mentioned in the existing conditions section, a Pilot site was completed on Adkin Branch near Holloway Park in 2002. The Pilot site has been studied extensively and became a useful tool to assist in the design direction of Adkin Branch for this project. The main concern that was discovered from analyzing the Pilot site and from analyzing soil borings is that the native soils adjacent to Adkin Branch are composed of fine sand materials. Fine sands are not cohesive and as was observed on the Pilot site, have the potential to wash from the banks, which can and will lead to mass wasting if not properly addressed.

A solution to the challenges that fine sand presents, is to design a channel that places the least amount of stress on the channel's side slopes (banks), while dissipating most of the channel's energy in pools. The stream type that can help to promote this desired energy distribution is a B5c type channel.

A B5c type design channel will allow for a high width-to-depth ratio and low maximum depth to average depth ratio. A channel with a high width to depth ratio combined with relatively small maximum depths helps to keep sheer stress and stream power low on channel side slopes because energy is spread more evenly through the cross-section. Lower width to depth channels with high maximum depth to average depth ratios tend to experience higher flow velocities, and consequently higher sheer stress on the channel's banks.

Another primary reason why the B5c type channel is ideal for Adkin Branch is that energy dissipation can be obtained through pools rather than strictly through the plan form (meanders). As stated earlier, Adkin Branch is constrained laterally by property boundaries, and the fact that the channel is extremely incised (would have to excavate an immense floodplain to develop a channel with large belt widths). Even if it was desired, the design channel could not meander profusely through the Site. So, the proposed design has what could be described as a gently meandering geometry. Pools will be formed within the meander bends, however pools will also be created through structure in straight sections throughout the site.

The design could not incorporate a large floodplain or a high degree of sinuosity because of the lateral constraints. Again, B5c type channels fit this scenario very well because they do not require large floodplains or very meandering channels, because energy is primarily dissipated in bedform (pools) rather than plan form (menaders). Table 7A depicts all designed morphologic variables for Adkin Branch. Sheets 2 through 2B depict proposed conditions.

UT to Adkin Branch

The UT to Adkin Branch is designed as a C/E5 type channel, and will be constructed as a Priority II restoration. The channel has a moderate width-to-depth ratio of 11 and a moderately high entrenchment ratio (2.5). The channel is somewhat sinuous as evidenced by a 1.35 sinuosity. A floodplain will be excavated at the bankfull elevation to allow bankfull and higher flows to dissipate their energy. Table 7B depicts all designed morphologic variables for the UT to Adkin Branch. Sheet 2B depicts proposed conditions.

5.1.2 Stream Restoration Activities

The stream will be constructed partially on new location and partially in place and the old, entrenched, straightened channel will be abandoned and backfilled. The design ensured that all existing culverts are buried a minimum of one foot. Primary activities that will take place during channel restoration include 1) channel and floodplain bench excavation, 2) sod matting, 3) installation of channel plugs, 4) backfilling of the abandoned channel, 5) removal of timber and concrete bag walls, 6) installation of in-stream structures, and 7) removal of three unsafe pedestrian bridges.

An erosion control plan and construction/transportation plan are expected to be developed during the next phase of this project. Erosion control will be performed locally throughout the Site and will be incorporated into construction sequencing. Exposed surficial soils at the Site are unconsolidated, alluvial sediments, which do not revegetate rapidly after disturbance; therefore, seeding with appropriate grasses and immediate planting with disturbance-adapted shrubs will be employed following the earth-moving process. In addition, onsite root mats (seed banks) and vegetation will be stockpiled and redistributed after disturbance.

A transportation plan, including the location of access routes and staging areas will be designed to minimize Site disturbance to the maximum extent feasible. The number of transportation access points into the floodplain will be maximized to avoid traversing long distances through the Site interior.

Channel and Floodplain Bench Grading
The channel and corresponding floodplain will be excavated along the alignment as shown in Sheets 2 through 2B. Material excavated during grading of the channel and floodplain will be stockpiled immediately adjacent to channel segments to be abandoned and backfilled. These segments will be backfilled after the stream diversion is completed.

Spoil material may be placed to stabilize temporary access roads and to minimize compaction of the underlying floodplain. However, all spoil will be removed from floodplain surfaces upon completion of construction activities. Preliminary earthwork estimates indicate that the project will result in 57,000 cubic yards of waste material. The City of Kinston will remove the waste to one or two disposal sites located within two miles of the Site (the Peachtree Waster Water Plant and/or the Davis Landfill).

Sod Matting
Warm-season grass sod mats will be harvested from Holloway Park and reestablished along outer meander bends to provide instant vegetation within high stress locations. The grass will be harvested and planted as soon as possible after removal during the optimal reestablishment window between April and July.

Channel Plugs
Impermeable plugs will be installed along abandoned channel segments. The plugs will consist of low-permeability materials or hardened structures designed to be of sufficient strength to withstand the erosive energy of surface flow events across the Site. Dense clays may be imported from off-site or existing material, compacted within the channel, may be suitable for plug construction. The plug will be of sufficient width and depth to form an imbedded overlap in the existing banks and channel bed.

Channel Backfilling
After impermeable plugs are installed, the abandoned channel will be backfilled. Backfilling will be performed primarily by pushing stockpiled materials into the channel. The channel will be filled to the extent that onsite material is available and compacted to maximize microtopographic variability, including ruts, ephemeral pools, and hummocks in the vicinity of the backfilled channel.

Removal of Timber and Concrete Bag Walls
As part of this project, creosote timber retaining wall wings will be removed at the inlet and outlet of the box culverts at Gordon and Caswell Streets. In addition, all timber crib walls and concrete bag crib walls located along the project length will be removed. Removal of the walls will assist to improve the overall water quality of the project watershed.

5.1.3 In-stream Structures

Stream restoration using natural stream design techniques, typically involves the use of in-stream structures for bank stabilization, grade control, and habitat improvement. Primary activities designed to achieve these objectives may include the installation of log vanes, log sills, elevated log vanes (logs placed in the middle of the channel or protruding from the banks to help create deep pools and provide cover), root wads, and other log type structures.

5.1.4 Removal and Replacement of Unsafe Pedestrian Bridges

Three unsafe pedestrian bridges will be removed as part of this project including the 1) Towerhill Road, 2) Holloway Park, and 3) South Rochelle Boulevard bridges. An alternative access bridge for the Towerhill Road bridge is located nearby at Washington Avenue. Access from Washington Avenue to the park will run along Adkin Branch within the conservation easement. The Holloway Park and South Rochelle Boulevard bridges will be replaced as part of this project. These bridges provide local residents with access to local parks and schools.

5.1.5 Target Buffer Communities

Restoration of floodplain forest and stream-side habitat allows for development and expansion of characteristic species across the landscape. Community associations that will be utilized to develop primary plant community associations include 1) Coastal Plain Levee Forest (Brownwater subtype), 2) stream-side assemblage, and 3) stormwater BMP wetland assemblage. This is discussed in more detail in Section 5.6 (Natural Plant Community Restoration).

5.2 Sediment Transport Analysis

One of the primary goals of this project is to construct a stable channel on both Adkin Branch and the UT to Adkin Branch that will transport its sediment and flow such that, over time, each stream system neither aggrades nor degrades. This stability is achieved when the sediment input to the design reach equals the sediment output. One of the primary functions of determining the capacity of the channel to transport its sediment load is stream power. Below is a discussion of both sediment concentration and stream power and their relation to stability in the design.

Sediment Concentration

The Engelund-Hansen function was used to analyze sediment transport capacity through the designed channels on-site. The basic principal of the Engelund-Hansen function is to determine if sediment input to the design stream equals the sediment output from the design stream. If sediment input equals or is adequately close to sediment output then the channel is considered a stable channel in equilibrium. Below is the Enguland-Hansen function:

$$g = 0.535\ D^{1/2}\ S^{3/2}\ V\ Q\ /\ d$$

where;

g = sediment discharge (lbs/s)
D = water depth (ft)
S = channel slope (ft/ft)
V = average velocity (ft/s)
Q = discharge (cubic ft/s)
d = median particle diameter of stream bed material (ft)

Stable reference reaches at off-site locations had to be used for sediment input calculations since the existing stream channels are unstable. The reference reaches used (Johnsons Mill for Adkin Branch and UT to Wildcat Branch for the UT to Adkin Branch) each had the same stream type and similar slopes, compared to their corresponding design channel, so that accurate comparisons could be made. A stable reference reach can be used because the sediment input is in balance with sediment output over geologic time. In most cases, the bankfull discharge of a reference reach is different from that of the design reach so, instead of using sediment discharge (lbs/s) for the comparison, sediment concentration (lbs/ft^3.) is used in the analysis because the function of discharge is set equal per cubic foot (ft^3). Below is the equation for sediment concentration:

$$SC = g/Q$$

where;

SC = sediment concentration (lbs/ft^3)
g = sediment discharge (lbs/s)
Q = discharge (ft^3/s)

The sediment concentration input and output for Johnsons Mill is in equilibrium and is equal to 0.05 lbs/ft^3. The sediment output for the proposed design of Adkin Branch is 0.07 lbs/ft^3. The proposed design numbers are similar to those of the stable reference reach, therefore the design channel is considered stable and in equilibrium.

The sediment concentration input and output for the UT to Wildcat Branch is in equilibrium and is equal to 0.09 (lb/ft^3). The sediment output for the proposed design of the UT to Adkin Branch is 0.011 (lb/ft^3). The proposed design numbers are similar to those of the stable reference reach, therefore the design channel is considered stable and in equilibrium.

Stream Power

A stream power analysis was used as a tool to study the capacity of both stream channels to transport their respective sediment loads. To determine if the restoration design stream power will adequately convey sediment loads, analyses of reference stream powers and proposed conditions stream powers were completed.

Johnsons Mill has a unit stream power of 0.20 lbs/ft s. As previously stated, Johnsons Mill is a stable channel that is in equilibrium and adequately conveys it sediment load, so it can be assumed that Johnsons Mill’s unit stream power is adequate to transport its sediment load. The Adkin Branch design displays unit stream powers ranging between 0.17 to 0.23 lbs/ft s (depending on design reach) which corresponds closely to the Johnsons Mill unit stream power. Using Johnsons Mill as a reference, it is determined that the Adkin Branch design has an adequate capacity to transport its sediment load.

The UT to Wildcat Branch has a unit stream power of 0.14 lbs/ft s. As previously stated, the UT to Wildcat Branch is a stable channel that is in equilibrium and adequately conveys it sediment load, so it can be assumed that the UT to Wildcat Branch’s unit stream power is adequate to transport its sediment load. The UT to Adkin Branch design displays a unit stream power of 0.08 lbs/ft s, which corresponds closely to the UT to Wildcat Branch unit stream power. Using the UT to Wildcat Branch as a reference, it is determined that the Adkin Branch design has an adequate capacity to transport its sediment load.

5.3 <u>**HEC-RAS Analysis**</u>**:** Given that the project involves modifications to a stream channel, it is important to analyze the effect of these changes on flood elevations. Floodwater elevations were analyzed using HEC-RAS. HEC-RAS is a software package designed to perform one-dimensional, steady flow, analysis of water surface profiles for a network of natural and constructed channels.

HEC-RAS uses two equations, energy and/or momentum, depending upon the water surface profile. The model is based on the energy equation. The energy losses are evaluated by friction (Manning’s equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is used in situations where the water surface profile rapidly varies, such as hydraulic jumps and stream junctions. The 100-year discharges were taken from the FEMA Flood Study.

Backwater analysis was performed for the existing and proposed conditions for both bankfull and 100-year discharges. In addition to steady flow data, geometric data is also required to run HEC-RAS. Geometric data consists of establishing the connectivity of the river system, which includes: cross-section data, reach lengths, energy loss coefficients (friction losses, contraction, and expansion losses), and stream junction information.

5.3.1 Bankfull Discharge Analysis

The methodology used to evaluate the hydrologic analysis required the evaluation of the existing stream's bankfull elevation and corresponding bankfull area. The existing bankfull elevations and bankfull cross-sectional areas were determined by evaluating bankfull indicators found on-site and using *Hydraulic Geometry Relationships for Rural North Carolina Coastal Plain Streams* [regional curve] (Doll et al. 2006) to verify on-site indicators.

Hydrologic Engineering Center's River Analysis System (HEC-RAS Version 3.0.1, see section 5.3.2) was used to evaluate how the discharge flows within the proposed channel geometry. This evaluation verifies that the proposed plan, dimension, and profile would adequately carry the discharge at the bankfull stage, the point where water begins to overflow onto the floodplain.

The discharge analysis required the evaluation of the existing stream's watershed area, bankfull area and corresponding bankfull discharge. Discharge rates for the bankfull event used in the design of this project were calculated using the Coastal Plain regional curve.

$$\mathbf{Q_{bkf} = 16.56x^{0.72}\,;\ (R^2 = 0.90)}\quad \text{(Doll et al 2006).}$$

The bankfull discharge for the Site is between 50.0 and 55.0 cfs (depending on reach). The existing and proposed geometries were evaluated at the bankfull discharge, using HEC-RAS. A HEC-RAS evaluation of the design's discharge was utilized to determine if the bankfull discharge is carried in the proposed channel's geometry. This evaluation has verified that the proposed plan, dimension, and profile will adequately convey the bankfull discharge, the point where water begins to overflow onto the floodplain.

5.3.2 No-Rise

A HEC-RAS analysis has been prepared and completed on both the existing and proposed conditions of the restored channel(s). The resulting data output has been analyzed to determine if the design channel is adequately conveying its bankfull discharge, and to determine if a rise, fall, or no-rise in water surface elevations during the 100 year flood event has occurred.

The City of Kinston requested that a LOMR (Letter of Map Revision) be prepared and submitted to the North Carolina Floodplain Mapping Program for review and approval. The 100 year flood elevations will be reduced due to the proposed greater flow area. The proposed channel will have a larger flow area below existing ground elevations than the current conditions.

The Effective HEC-RAS Model was obtained from the City of Kinston on March 31, 2006. This model was received from Watershed Concepts, by the North Carolina Floodplain Mapping Program. The Effective FIS (Flood Insurance Study) was prepared using HEC-RAS 3.0.1 in 2004. The current version of HEC-RAS, 3.1.3, is available for use; however, the models used in this LOMR analysis were produced using HEC-RAS 3.0.1 for ease in comparing model results with the Effective FIS data. Inconsistencies were found between HEC-RAS 3.1.3 and 3.0.1 when comparing the output results, and it was determined that version 3.0.1 would be utilized for the LOMR analysis for consistency and comparative reasons. The 100 and 500 year elevations from the Duplicate Effective model were compared with those in the Floodway Data Table within the effective FIS report. It was found that the flood elevations are within 0.1 foot of each other, which is within acceptable limits.

57 geometric cross-sections were modeled along the length of the existing and proposed channels, with 38 of those sections falling within the site limits. Three models, Duplicate Effective, Corrective Effective, and the Proposed Conditions model, were developed and executed to determine the water surface elevations for the 10, 50, 100, 500, and 100 year floodway events. The 100-year discharge varied between 2800 cfs and 3680 cfs along the project reach. The analysis indicates that the proposed channel geometry will not increase the 100-year flood elevations within the project area. In fact, the analysis indicates that the 100 year water surface elevations will be reduced along the project length. Results are located within the HEC-RAS Summary Table in Appendix F.

5.3.3 Hydrologic Trespass

Hydrologic trespass includes any issue which may affect hydrology outside of the property boundaries on which the project is located. These issues were reviewed for this project. All onsite modifications will not affect off site hydrology.

5.4 **Stormwater Best Management Practices:** The implementation of best management practices (BMPs) at selected sites throughout the project will provide benefit by improving water quality and providing attenuation of stormwater flows. The primary BMP devise that is expected to be used is a sand filter. Sand filters were chosen over stormwater wetlands because the water table at selected BMP sites was too far below the invert of the proposed BMP. The BMP's utilized in the project will:

- Reduce nonpoint source pollution associated with urban land uses by providing basins to treat surface runoff.
- Promote floodwater attenuation by increasing storage capacity for stormwater flows.

Sand filters are most effective in removing Total Suspended Solids (TSS). Most studies tend to suggest that sand filters are able to remove up to 85 percent of TSS through sedimentation/filtration. Sand filters are also effective at filtering total nitrogen, total phosphorous, heavy metals, grease, oil, and fecal coliform through adsorption and filtration, but at less effective rates compared with organic based BMPs such as stormwater wetlands or peat based BMPs. The reason that sand filters are less efficient in removing nitrogen, phosphorous, heavy metals, grease, and oil is because, when compared with organics, sand has a much lower cation exchange capacity, which lowers its effectiveness for attracting pollutants.

5.4.1 Narrative of Site-Specific Stormwater Concerns

The project corridor is located within the City of Kinston limits. Land use within the watershed is primarily characterized by urban development. Throughout the restoration reach, there are municipal storm system outfalls that discharge directly into Adkin Branch. It was determined that these existing stormwater outfalls may provide the best opportunities to place BMP devices. The preliminary locations were determined by identifying existing storm system outfalls located on or adjacent to a parcel that is owned by the city and the parcel is of adequate size to for a BMP device to be constructed. Of the thirty-eight (38) stormwater outfalls along the project corridor, only nine (9) locations provided opportunity to construct a BMP device.

Soil borings were obtained at ten preliminary locations and soil conductivity tests were performed at five of the preliminary locations. It was determined that infiltration basins could not be utilized at any of these locations due to the shallow groundwater table. Design guidelines for infiltration basins require that the groundwater table be at least four feet below the invert of the basin (NCDWQ 2005). This requirement can not be achieved at any of the preliminary proposed locations. Therefore, the project will retrofit nine (9) of the existing stormwater outfalls with sand filter BMP devices to improve water quality with secondary stormwater flow attenuation effects.

In addition, an offline stormwater wetland will be incorporated into the project adjacent to the existing reach of the UT located within Holloway Park, to improve water quality and attenuate stormwater.

5.4.2 Device Description and Application

Sand Filter Devices

The proposed sand filter BMP devices will fill with stormwater runoff and allow the water to exit the device by percolating down through the sand layers, where Total Suspended Solids (TSS) and other pollutants are filtered out (see Detail of Sand Filter below). The device design parameters allow the first inch of rain to pass through the filter within a period of 24 hours. Sand filter devices can have a TSS removal efficiency of 85 percent, a Nitrogen removal efficiency of 35 percent, and a Phosphorus removal efficiency of 45 percent (NCDWQ 2005). The implementation of the sand filter devices at these locations will provide improved water quality with secondary stormwater flow attenuation.

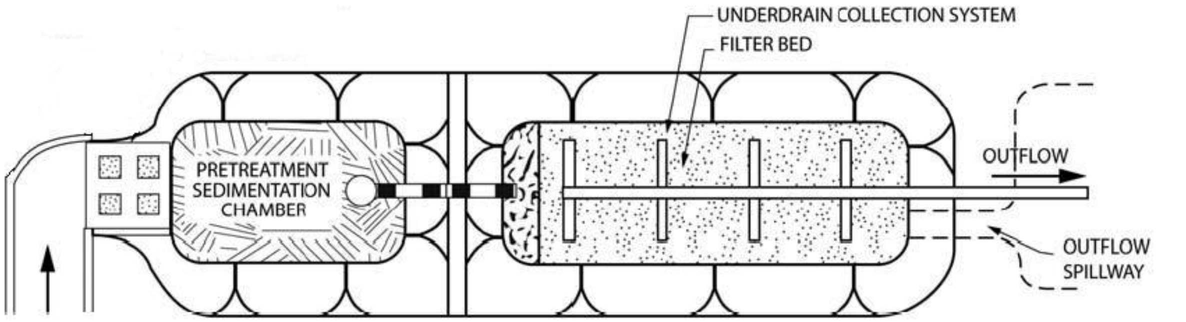
Table 9. Sand Filter Summary

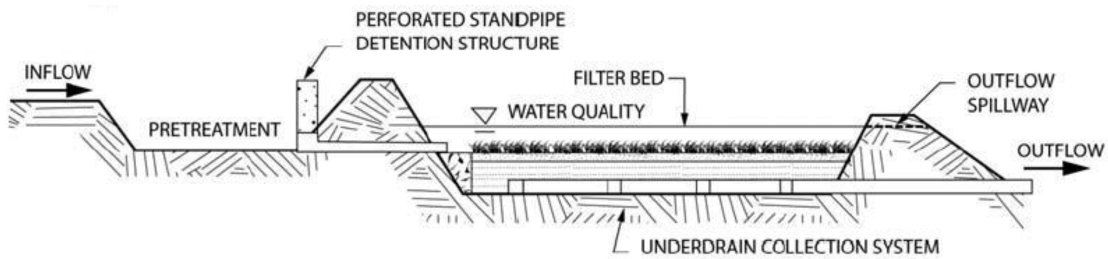
Sand Filter ID & Location	Drainage Area (Ac)	Required Filter Volume (cf)	Required Filter Surface Area (sf)	Nitrogen Reduction (lb/yr)	Phosphorus Reduction (lb/yr)	Sediment Reduction (ton/yr)
BMP1 (Martin Drive)	10.86	2700	1800	16	4	0.50
BMP2 (Martin Drive)	6.8	2700	1800	16	3	0.43
BMP3 (Martin Drive)	10.88	3675	2450	25	5	0.70
BMP4 (Miller Street)	3.45	1875	1250	10	2	0.31
BMP5 (South Dover Street)	8.8	2700	1800	25	5	0.77
BMP6 (South Seacrest Street)	18.39	3675	2450	39	8	1.05
BMP7 (South Myrtle Avenue)	12.19	2700	1800	20	4	0.39
BMP8 (Holloway Drive)	3.8	1200	800	6	1	0.13
BMP9 (East Shine Street)	12.75	3675	2450	33	7	0.97
Total				**190**	**40**	**5**

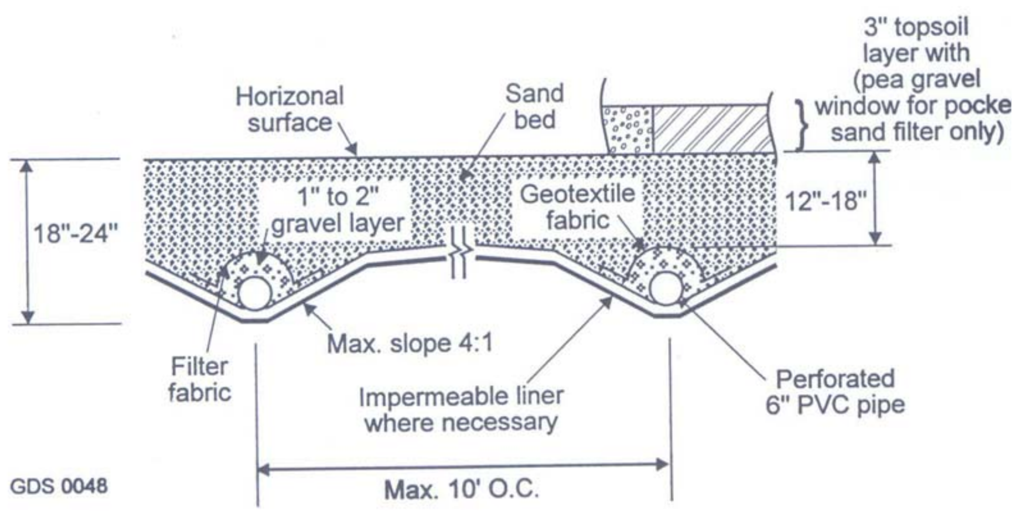
Stormwater Wetland

An inline stormwater wetland BMP was proposed to be placed at the outlet end of the culvert under Cedar Lane on the UT. However, current regulations of the ACOE and NCDWQ do not allow an inline structure for BMPs on perennial streams (Appendix F e-mail documentation). For this reason, a stormwater wetland which is located offline of the UT was devised which will capture flows which are approximately half of the bankfull discharge and higher (see Stormwater Wetland detail below). The proposed stormwater wetland will be constructed to mimic a natural riparian wetland in an effort to mitigate urban impacts on water quality and quantity (see Detail of Stormwater Wetland below). The stormwater wetland will also effectively reduce peak runoff rates and stabilize flow to the adjacent stream. The stormwater wetland will support emergent and riparian vegetation and provide temporary storage, forming an ideal environment for the removal of many pollutants, TSS, nutrients, heavy metal, toxic organic pollutants, and petroleum products. Pollutants within the wetlands are transformed by plants and microbes, immobilized in sediments, and released in reduced concentrations in the outflow. The stormwater wetland vegetation incorporates nitrogen fixing and known excellent toxin uptake plant species. Details of stormwater wetland vegetation can be found in Section 5.6 (Natural Plant Community Restoration).

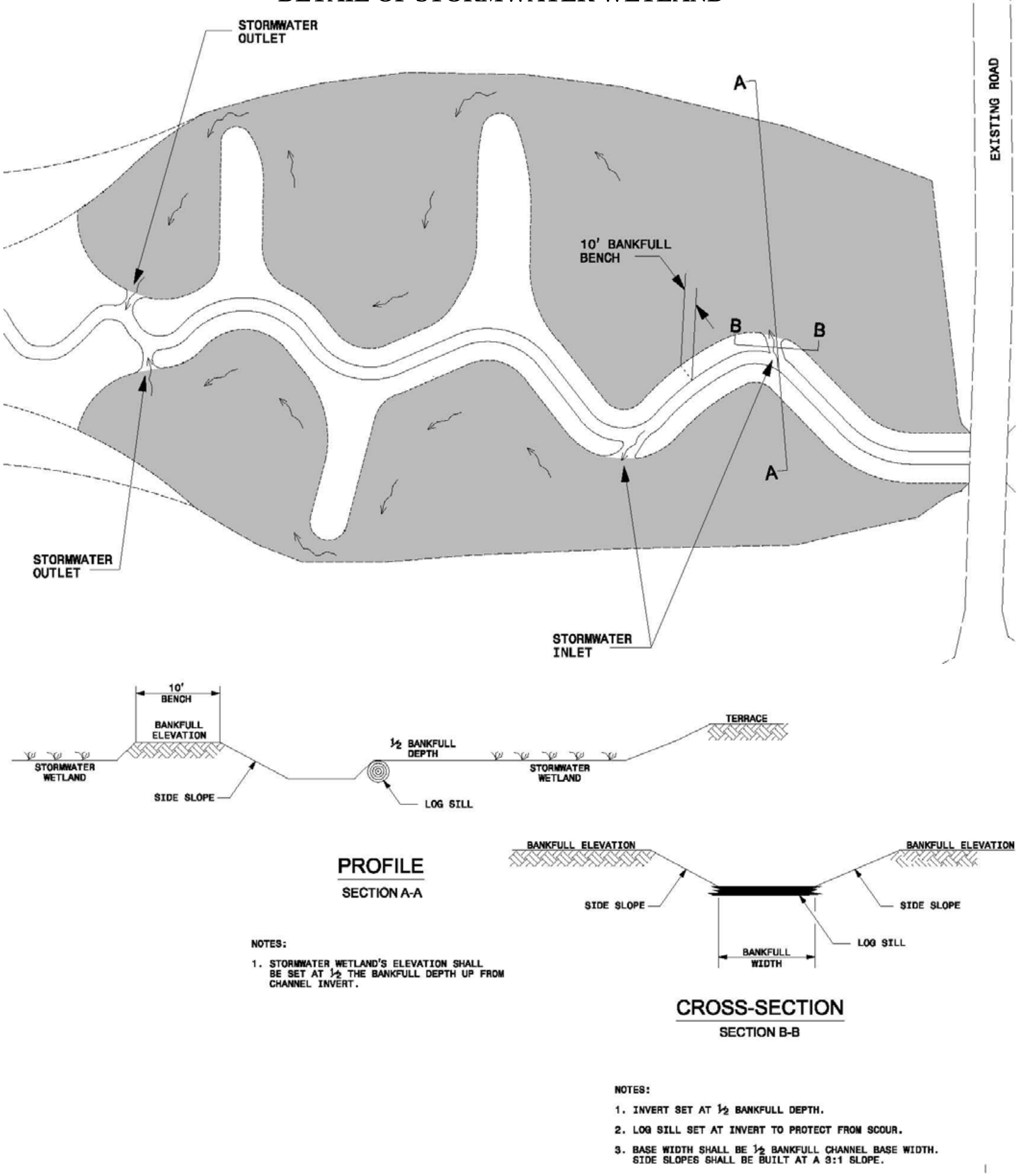
DETAIL OF SAND FILTER







DETAIL OF STORMWATER WETLAND



The stormwater wetland will be located within Holloway Park along the existing UT to Adkin Branch. The USACE will not allow the wetland to occur in line with the stream; therefore, a bankfull channel will be constructed. Inflow and outflow breaks will be placed within the banks at one-half the bankfull channel depth to allow stormwater flows to access the stormwater wetland areas.

Stormwater BMP Maintenance
The City of Kinston has agreed to provide maintenance for the sand filter BMP devices and the stormwater wetland for the life of the BMPs (30 years). A maintenance guideline manual will be provided to the City of Kinston by EEP.

5.5 Soil Restoration

Soil grading will occur during Site stream restoration activities. Topsoils will be stockpiled during construction activities and will be spread on the soil surface once grading activities have been completed. The replaced topsoil will serve as a viable growing medium for community restoration to provide nutrients and aid in the survival of planted species.

Preliminary earthwork estimates indicate that the project will result in 61,000 cubic yards of waste material, much of which would be considered topsoil. The City of Kinston will remove excess waste to one or two disposal sites located within two miles of the Site (the Peachtree Waster Water Plant and/or the Davis Landfill).

5.5.2 Floodplain Soil Scarification

Microtopography and differential drainage rates within localized floodplain areas represent important components of floodplain functions. Reference forests in the region exhibit complex surface microtopography. Efforts to advance the development of characteristic surface microtopography will be implemented; in areas where soil surfaces have been compacted, ripping or scarification will be performed. After construction, the soil surface is expected to exhibit complex microtopography ranging to 1 foot in vertical asymmetry. Subsequently, plant community restoration will be initiated.

5.6 Natural Plant Community Restoration: Restoration of floodplain forest and stream-side habitat allows for development and expansion of characteristic species across the landscape. Ecotonal changes between community types contribute to diversity and provide secondary benefits, such as enhanced feeding and nesting opportunities for mammals, birds, amphibians, and other wildlife.

Reference Forest Ecosystem (RFE) data, onsite observations, and community descriptions from *Classification of the Natural Communities of North Carolina* (Schafale and Weakley 1990) were used to develop the primary plant community associations that will be promoted during community restoration activities. Community associations that will be utilized to develop primary plant community associations include 1) Coastal Plain Levee Forest (Brownwater subtype), 2) stream-side assemblage, and 3) stormwater BMP wetland (Sheet 4B). Planting elements are listed below.

<u>Coastal Plain Levee Forest</u>

1. River birch (*Betula nigra*)
2. Slippery elm (*Ulmus rubra*)
3. Winged elm (*Ulmus alata*)
4. Pignut hickory (*Carya glabra*)
5. Mockernut hickory (*Carya tomentosa*)
6. Southern red oak (*Quercus falcata* var. *falcata*)
7. Water oak (*Quercus nigra*)
8. Ironwood (*Carpinus caroliniana*)
9. Sassafras (*Sassafras albidum*)
10. Black cherry (*Prunus serotina*)

<u>Stream-Side Assemblage</u>

1. Black willow (*Salix nigra*)
2. Silky dogwood (*Cornus amomum*)
3. Buttonbush (*Cephalanthus occidentalis*)
4. Elderberry (*Sambucus canadensis*)
5. Tag alder (*Alnus serrulata*)
6. Common rush (*Juncus effusus*)

<u>Stormwater BMP Wetland Assemblage</u>

1. Tag alder (*Alnus serrulata*)
2. Bald cypress (*Taxodium distichum*)
3. Water tupelo (*Nyssa aquatica*)
4. Buttonbush (*Cephalanthus occidentalis*)
5. Silky dogwood (*Cornus amomum*)
6. Black willow (*Salix nigra*)
7. Arrow arum (*Peltandra virginica*)
8. Emergent herbaceous seed mix
    a. Long hair sedge (*Carex crinita*)
    b. Common rush (*Juncus effusus*)
    c. Lizard’s tail (*Saururus cernuus*)
    d. Bur-reed (*Sparganium americanum*)
    e. Rice-cut grass (*Leersia oryzoides*)
    f. Virginia iris (*Iris virginica*)
    g. Rosemallow (*Hibiscus moscheutos*)

Stream-side trees and shrubs include species with high value for sediment stabilization, rapid growth rate, and the ability to withstand hydraulic forces associated with bankfull flow and overbank flood events. Stream-side trees and shrubs will be planted within 15 feet of the channel throughout the meander belt-width. Shrub elements will be planted along the reconstructed stream banks, concentrated along outer bends.

Coastal Plain Levee Forest is targeted for the majority of the Project outside of the 15-feet immediately adjacent to the restored stream channels. These species were selected due to their ability to withstand drought conditions, due to the well-drained sandy soils present within the Site, as well as tolerate moderate amounts of moisture.

The stormwater BMP wetland assemblage is targeted for the stormwater wetland adjacent to the UT to Adkin Branch within Holloway Park. Species have been selected based on the expected/designed hydrological conditions; in addition, close consideration was given to incorporate plants with the ability to fix nitrogen (tag alder) or with excellent toxin uptake capabilities (common cattail) (NCDWQ 2005). The following planting plan is the blueprint for community restoration.

5.6.1 Planting Plan

Species selected for planting will be dependent upon availability of local seedling sources. Advance notification to nurseries (1 year) would facilitate availability of various noncommercial elements.

Bare-root seedlings of tree species will be planted within specified map areas at a density of approximately 680 stems per acre on 8-foot centers. Shrub species in the stream-side assemblage will be planted at a density of 2720 stems per acre on 4-foot centers and within the stormwater BMP wetland assemblage will be planted at a density of 680 stems per acre on 8-foot centers.

The emergent herbaceous vegetation seed mix outlined above for application in the stormwater BMP wetland will be applied within 14 days of construction completion at rates specified per manufacturer guidelines. Soils may be scarified to a half-inch prior to seeding to aid in more rapid germination.

Table 10 depicts the total number of stems and species distribution within each vegetation association, with the exception of the emergent seed mix outlined above. Planting will be performed between December 1 and March 15 to allow plants to stabilize during the dormant period and set root during the spring season. A total of 42,399 native tree and shrub seedlings may be planted during restoration.

Table 10. Planting Plan

Vegetation Association	Coastal Plain Levee Forest	Stream-side Assemblage	Stormwater BMP Wetland Assemblage	TOTAL
Area (acres)	**34.42 Acres**	**6.87 Acres**	**0.45 Acres**	**41.74 Acres**
Species	**Number planted* (% of total)**	**Number planted** (% of total)**	**Number planted* (% of total)**	**Number planted**
*Betula nigra**	3,511 (15)			3,511
*Ulmus rubra**	2,341 (10)			2,341
*Ulmus alata**	2,341 (10)			2,341
*Carya glabra**	2,341 (10)			2,341
*Carya tomentosa**	3,511 (15)			3,511
*Quercus falcata var. falcata**	2,341 (10)			2,341
*Quercus nigra**	2,341 (10)			2,341
*Carpinus caroliniana**	2,341 (10)			2,341
*Sassafras albidum**	1,171 (5)			1,171
*Prunus serotina**	1,171 (5)			1,171
*Salix nigra***		3,738 (20)	46 (15)	3,784
*Cornus amomum***		3,738 (20)	46 (15)	3,784
*Cephalanthus occidentalis***		2,803 (15)	46 (15)	2,849
*Sambucus canadensis***		2,803 (15)		2,803
*Alnus serrulata***		2,803 (15)	46 (15)	2,849
*Taxodium distichum***			46 (15)	
*Nyssa aquatica***			46 (15)	
*Peltandra virginica***			31 (10)	
*Juncus effuses***		2,803 (15)		2,803
*Juncus effuses****			***	
*Carex crinita****			***	
*Saururus ccrenuus****			***	
*Sparganium americanum****			***	
*Leersia oryzoides****			***	
*Iris virginica****			***	
*Hibiscus moscheutos****			***	
TOTAL	**23,410 (100)**	**18,688 (100)**	**307 (100)**	**42,282**

* Planted at a density of 680 stems/acre (~ 8-foot centers).
** Planted at a density of 2720 stems/acre (~ 4-foot centers) if in Stream-side Assemblage or 680 stems/acres if planted in Stormwater BMP.
*** Emergent herbaceous seed mixed spread at a rate of 50 pounds per acre).

5.6.2 Neuse River Buffers

Neuse River Buffers will be both impacted and restored during construction of the proposed stream and BMPs. Stream restoration activities are exempt activities under the Neuse River Riparian Buffer Rules. The existing Neuse River Riparian Buffer on-site encompasses approximately 7.58 acres of forested buffer (> 100 trees per acre), 13.58 acres of grass/forest buffer (<100 trees per acre), 0.55 acres of sewer easement, and 0.69 acres of impervious area (Sheet 5, and 5a).

A vegetated riparian buffer will be established along both the left and right banks of Adkin Branch and the UT throughout the project's easement area. As a result the total Neuse River Riparian Buffer area following construction will encompass approximately 22.51 acres (Sheet 6, and 6a). Of this area, approximately 21.55 acres will be forested (> 100 trees per acre), 0.65 acres will remain grass/forest (<100 trees per acre), 0.31 acres will remain in an existing sewer easement, and 0.12 acres will remain in impervious area.

5.6.3 Invasive Species Management

Noxious species will be identified and controlled so that none become dominant or alter the desired community structure of the Site. If noxious plants are identified as a problem within the Site, a species-specific control plan will be developed for approval by EEP prior to implementation.

During the five-year monitoring period, where necessary, undesirable plant or animal species will be removed, treated, or otherwise managed by means of physical removal, use of herbicides, live trapping, confining wires, or nets.

All vegetation removal from the Project shall be done by mechanical means only unless EEP has first authorized the use of herbicides or algaecides for the control of plants in or immediately adjacent to the Site.

6.0 PERFORMANCE CRITERIA: Monitoring of Project restoration efforts will be performed until success criteria are fulfilled. Monitoring is proposed for the stream channel of both Adkin Branch and the UT, stormwater management devices, and vegetation. In general, the restoration success criteria, and required remediation actions, are based on Appendix II of the *Stream Mitigation Guidelines* (USACE et al. 2003).

6.1 Streams: The restored stream reaches are proposed to be monitored for geometric activity. Annual fall monitoring will include development of channel cross-sections on riffles and pools and a water surface profile of the channel. The data will be presented in graphic and tabular format. Data to be presented will include 1) cross-sectional area, 2) bankfull width, 3) average depth, 4) maximum depth, 5) width-to-depth ratio, 6) meander wavelength, 7) belt-width, 8) water surface slope, and 9) sinuosity. The stream will subsequently be classified according to stream geometry and substrate (Rosgen 1996). Significant changes in channel morphology will be tracked and reported by comparing data in each successive monitoring year. A photographic record that will include preconstruction and postconstruction pictures has been initiated with current Project photographs (Appendix A).

6.1.1 Stream Success Criteria

Adkin Branch and Lower Section of the UT

Success criteria for stream restoration will include 1) successful classification of the reach as a functioning stream system (Rosgen 1996) and 2) channel variables indicative of a stable stream system.

The channel configuration will be measured on an annual basis in order to track changes in channel geometry, profile, or substrate. These data will be utilized to determine the success in restoring stream channel stability. Specifically, the width-to-depth ratio should characterize a B-type channel for Adkin Branch and an E-type or borderline E-/C-type channel for the UT to Adkin Branch, bank-height ratios indicative of a stable or moderately unstable channel, and minimal changes in cross-sectional area, channel width, and/or bank erosion along the monitoring reach. In addition, channel abandonment and/or shoot cutoffs must not occur and sinuosity values must remain at approximately 1.3 (thalweg distance/straight-line distance) for the UT to Adkin Branch. The field indicator of bankfull will be described in each monitoring year and indicated on a representative channel cross-section figure. If the stream channel is down-cutting or the channel width is enlarging due to bank erosion, additional bank or slope stabilization methods will be employed.

Stream substrate is not expected to coarsen over time; therefore, pebble counts are not proposed as part of the stream success criteria.

Visual assessment of in-stream structures will be conducted to determine if failure has occurred. Failure of a structure may be indicated by collapse of the structure, undermining of the structure, abandonment of the channel around the structure, and/or stream flow beneath the structure.

UT Through Stormwater Wetland Area

It is anticipated that the UT could slightly aggrade through the areas of the Stormwater Wetland area. If this does occur, it would be within the expected process of a stream which has some potions of its bankfull flow diverted. This section of the UT would be expected to remain a C/E5 type channel after monitoring, but movement towards a D type channel with multiple braided small channels is acceptable.

6.1.2 Stream Contingency

In the event that stream success criteria are not fulfilled, a mechanism for contingency will be implemented. Stream contingency may include, but may not be limited to 1) structure repair and/or installation; 2) repair of dimension, pattern, and/or profile variables; and 3) bank stabilization. The method of contingency is expected to be dependent upon stream variables that are not in compliance with success criteria. Primary concerns, which may jeopardize stream success include 1) structure failure, 2) headcut migration through the Site, and/or 3) bank erosion.

Structure Failure

In the event that structures are compromised, the affected structure will be repaired, maintained, or replaced. Once the structure is repaired or replaced, it must function to stabilize adjacent stream banks and/or maintain grade control within the channel. Structures which remain intact, but exhibit flow around, beneath, or through the header/footer pilings will be repaired by excavating a trench on the upstream side of the structure and reinstalling filter fabric in front of the pilings. Structures which have been compromised, resulting in shifting or collapse of header/footer pilings, will be removed and replaced with a structure suitable for Project flows.

Headcut Migration Through the Site

In the event that a headcut occurs within the Project (identified visually or through measurements [i.e. bank-height ratios exceeding 1.4]), provisions for impeding headcut migration and repairing damage caused by the headcut will be implemented. Headcut migration may be impeded through the installation of in-stream grade control structures (log sill and/or log cross-vane weir) and/or restoring stream geometry variables until channel stability is achieved. Channel repairs to stream geometry may include channel backfill with coarse material and stabilizing the material with erosion control matting, vegetative transplants, and/or willow stakes.

Bank Erosion
In the event that severe bank erosion occurs at the Project resulting in elevated width-to-depth ratios, contingency measures to reduce bank erosion and width-to-depth ratio will be implemented. Bank erosion contingency measures may include the installation of log weirs and/or other bank stabilization measures. If the resultant bank erosion induces shoot cutoffs or channel abandonment, a channel may be excavated which will reduce shear stress to stable values.

6.2 Stormwater Management Devices

Stormwater BMP devices will be monitored and maintained periodically, as necessary, to ensure the life of the devices. The City of Kinston has agreed to provide maintenance for the sand filter BMP devices and the stormwater wetland for the life of the BMPs (30 years). A maintenance guideline manual will be provided to the City of Kinston by EEP.

6.2.1 Sand Filter Device Monitoring and Maintenance

Sand filters will be inspected at least once per year after a storm event, to determine if the infiltration capacity of the device is decreasing due to clogging of the top layer. The maintenance guidelines are summarized as follows (NCDWQ 2005):

- The sediment chamber outlet devices should be cleaned or repaired when drawdown times exceed 24 hours. In addition, trash and debris should be removed as necessary and sediment should be cleaned out when it accumulates to 6 inches or more.
- When the infiltration capacity of the filter diminishes or water ponds on the filter bed surface for greater than 24 hours, the topsoil and underlying 3 inches of filter material should be removed and replaced. The removed sediments should be tested and disposed of appropriately. Sediment/silt should be removed from the filter bed when accumulation exceeds 1 inch.
- Vegetation within the sediment chamber should be mowed to limit the height to 12 inches.
- Direct maintenance access should be provided to the pretreatment area and the filter bed.

6.2.2 Stormwater Wetland Monitoring and Maintenance

Plant coverage within the stormwater wetland should be assessed and documented each growing season. If a minimum of 70 percent coverage is not achieved after the second growing season, supplemental planting should be completed. Plant coverage of 90 to 95 percent is desirable. Maintenance guidelines are as follows (NCDWQ 2005):

- Wetland should be inspected annually after a rain event, and after all large (mean annual or greater) storm events to ensure the basin is operating as designed. At a minimum the following items should be corrected if observed.
    - Clogging of the outlet or very rapid water release
    - Appearance of invasive species or a monoculture
    - Erosion on the wetland banks or at the inlet/outlet
    - Sediment accumulation
    - Damage to, or blockage of, the emergency spillway
    - Woody vegetation in the embankment or dam
- Sediment should only be selectively removed; sediment removal disturbs stable vegetation cover and disrupts flow paths through the wetland.

6.3 **Vegetation:** Restoration monitoring procedures for vegetation will monitor plant survival and species diversity. After planting has been completed in winter or early spring, an initial evaluation will be performed to verify planting methods and to determine initial species composition and density. Supplemental planting and additional modifications will be implemented, if necessary. A photographic record of plant growth should be included in each annual monitoring report.

During the first year, vegetation will receive a cursory, visual evaluation on a periodic basis to ascertain the degree of overtopping of planted elements by nuisance species. Subsequently, quantitative sampling of vegetation will be performed between June 1 and September 30, after each growing season, until the vegetation success criteria are achieved.

During quantitative vegetation sampling in early fall of the first year, up to 47 sample plots (10 meters by 10 meters) will be randomly placed within the Site; however, best professional judgment may be necessary to establish vegetative monitoring plots upon completion of construction activities. In each sample plot, vegetation parameters to be monitored include species composition and species density.

6.3.1 Vegetation Success Criteria

Success criteria have been established to verify that the vegetation component supports community elements necessary for forest development. Success criteria are dependent upon the density and growth of characteristic forest species. Additional success criteria are dependent upon density and growth of "Character Tree Species." Character Tree Species include planted species along with species identified through visual inventory of an approved reference (relatively undisturbed) forest community used to orient the project design. All canopy tree species planted and identified in the reference forest will be utilized to define "Character Tree Species" as termed in the success criteria.

An average density of 320 stems per acre of Character Tree Species must be surviving in the first three monitoring years. Subsequently, 290 Character Tree Species per acre must be surviving in year 4 and 260 Character Tree Species per acre in year 5.

6.3.2 Vegetation Contingency

If vegetation success criteria are not achieved based on average density calculations from combined plots over the entire restoration area, supplemental planting may be performed with tree species approved by regulatory agencies. Supplemental planting will be performed as needed until achievement of vegetation success criteria.

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6.4 Scheduling and Reporting: A tentative phasing schedule for the proposed project is presented below; certain tasks may be dependant on seasonal conditions.

Table 11. Project Scheduling and Reporting
Project ID No. 0506056101 (Adkin Branch Stream Restoration Project)

Task Description	Date of Scheduled Completion
Restoration Plan Finalized	March 8, 2007
Submission of Final Design	May 10, 2007
Permitting Initiated	June 21, 2007
Advertise for Bidders	August 9, 2007
Bid Opening	September 6, 2007
Begin Construction	December 6, 2007
End Construction	June 5, 2008
Prepare As-built Mitigation Plan and Mitigation Plan	July 3, 2008
First Year Monitoring Report	December 1, 2008
Second Year Monitoring Report	December 1, 2009
Third Year Monitoring Report	December 1, 2010
Fourth Year Monitoring Report	December 1, 2011
Fifth Year Monitoring Report	December 1, 2012

7.0 REFERENCES

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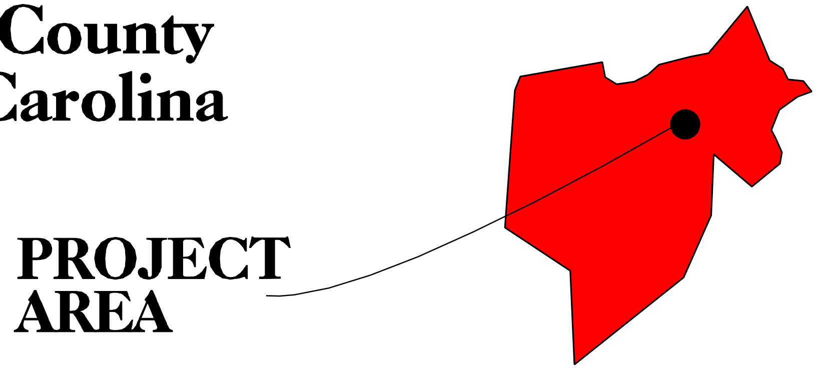
Lenoir County
North Carolina



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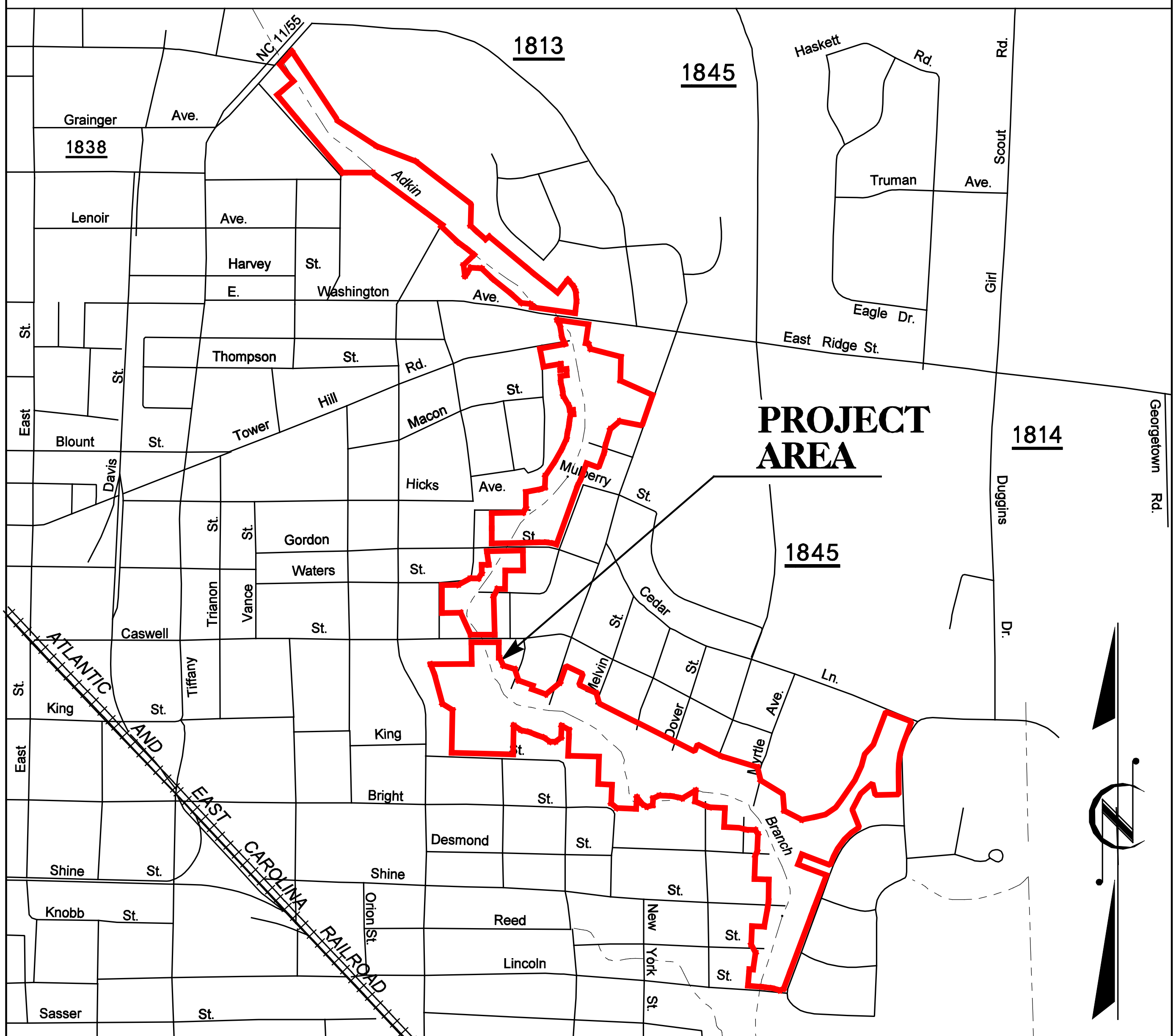

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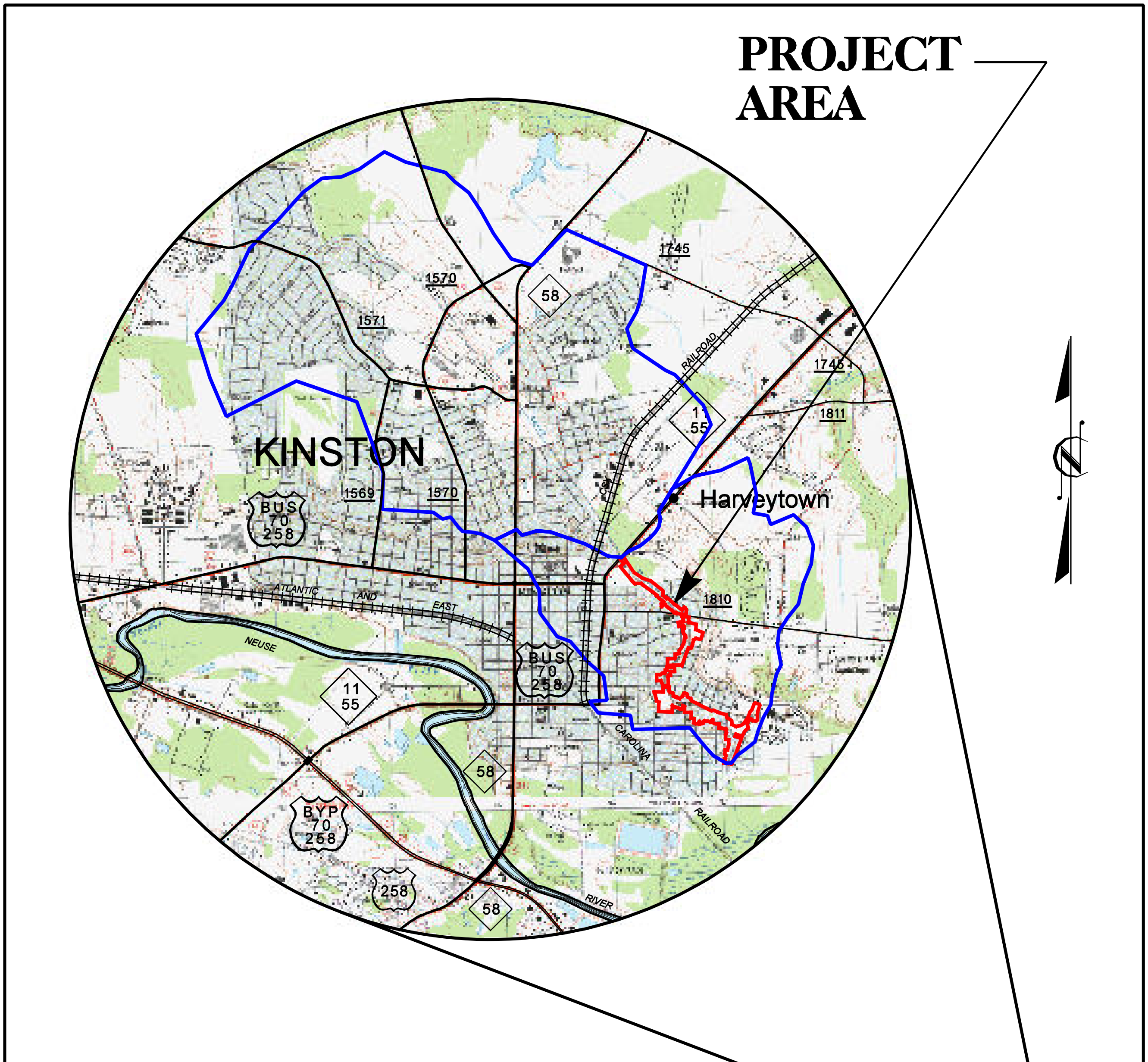
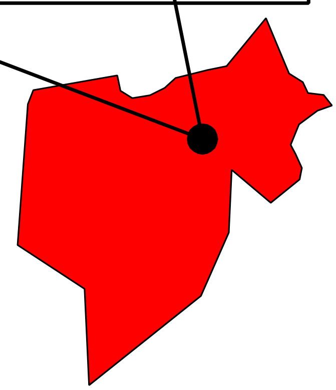
Vicinity Map

**Adkin Branch
Restoration Plan
Lenoir County, North Carolina**

Date: 03/23/07	Figure: 1





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LEGEND

Blue line	Watershed
Red line	Project Area

Lenoir County
North Carolina

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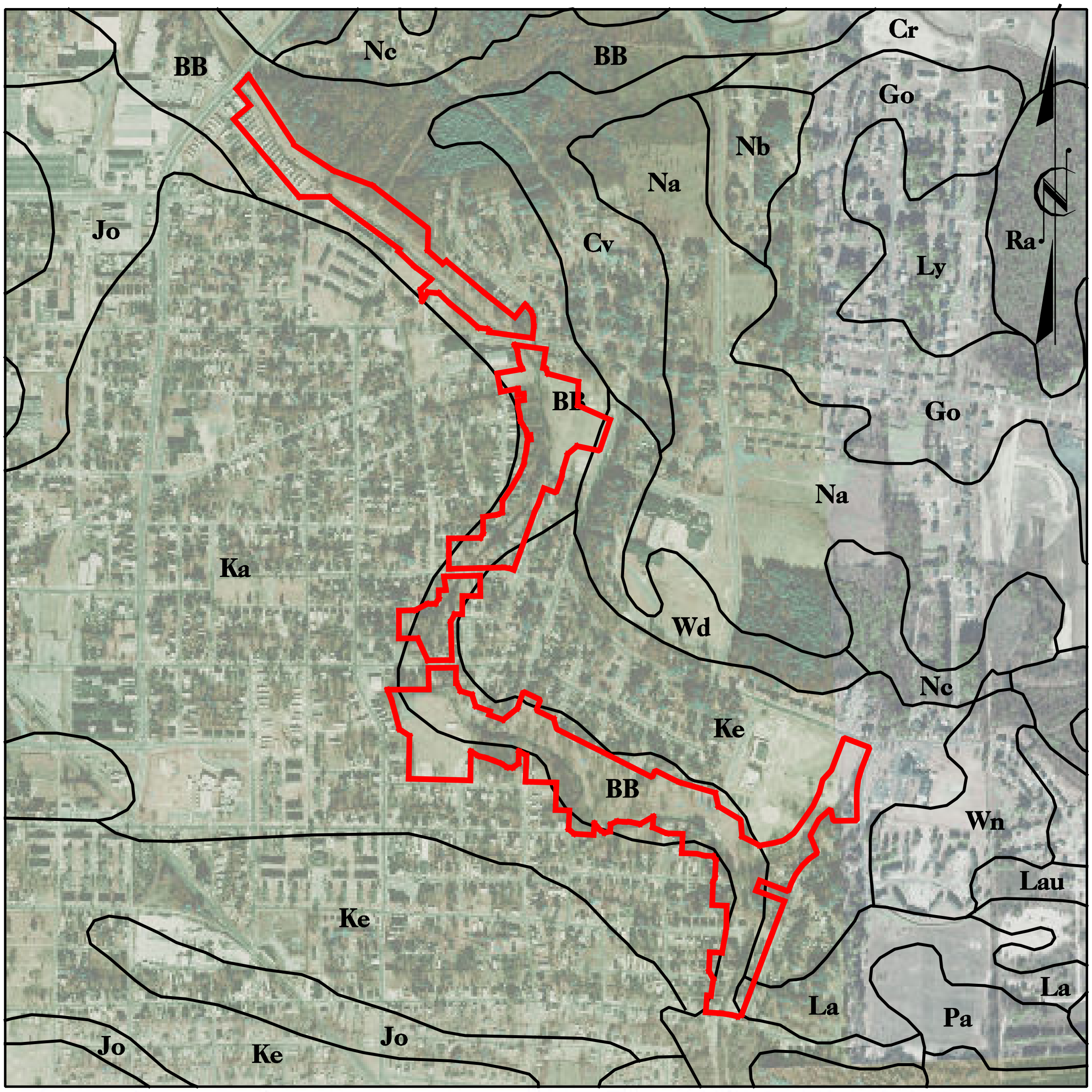
Watershed Map

Adkin Branch
Restoration Plan
Lenoir County, North Carolina

Date: 03/23/07

Figure: 2



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FEET

LEGEND

Symbol		Name
BB	-	Bibb
Ka	-	Kalmia
Ke	-	Kenansville
(red line)	-	Project Area

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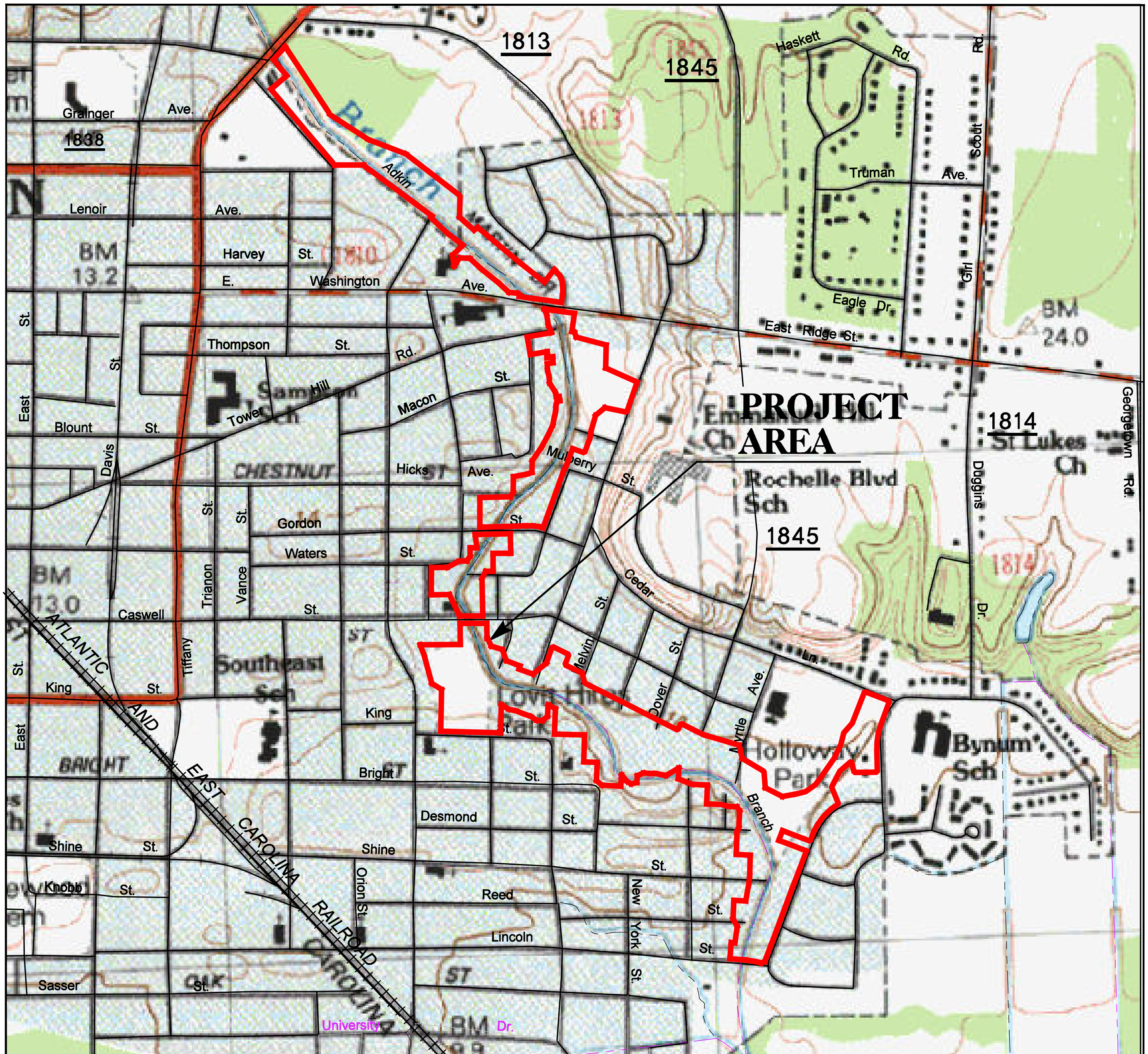
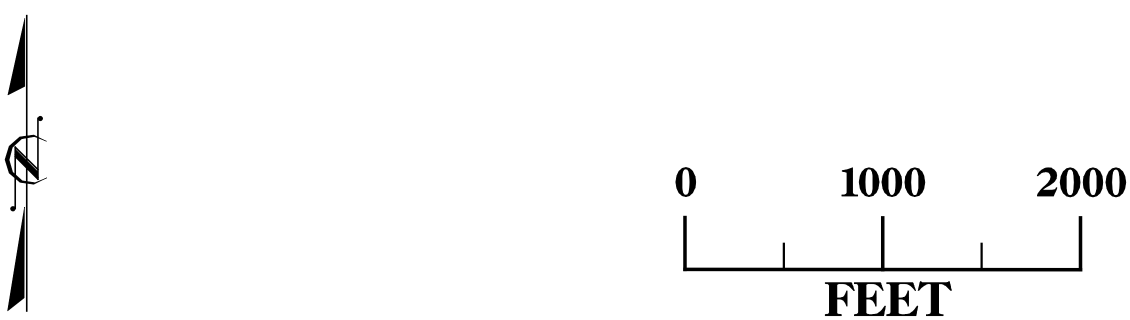
Soil Survey Map

Adkin Branch
Restoration Plan
Lenoir County, North Carolina

Date: 03/23/07	Figure: 3





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Hydrological Features Map

Adkin Branch Restoration Plan
Lenoir County, North Carolina

Date: 03/23/07	Figure: 4

Pitt County
North Carolina

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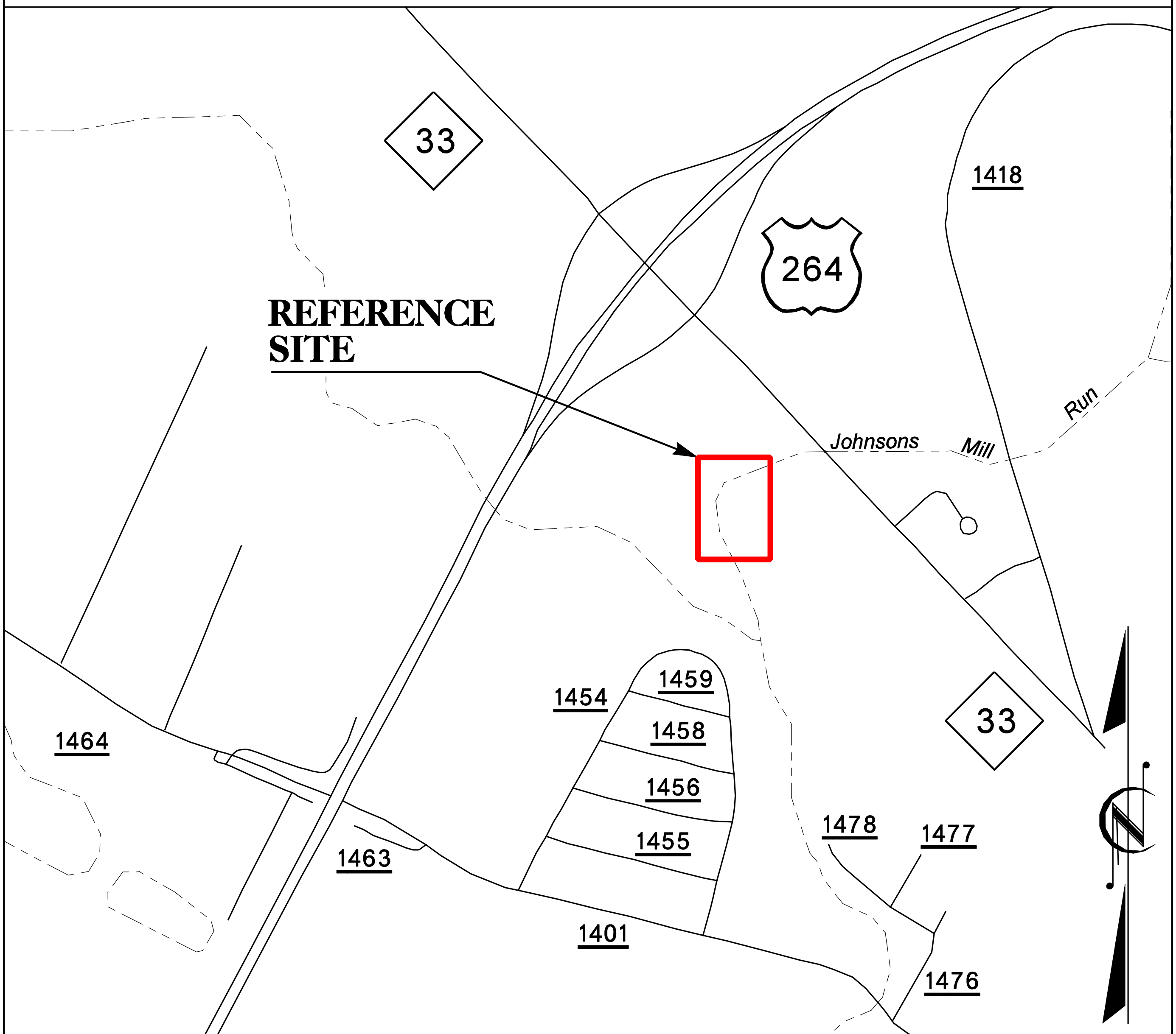
FEET



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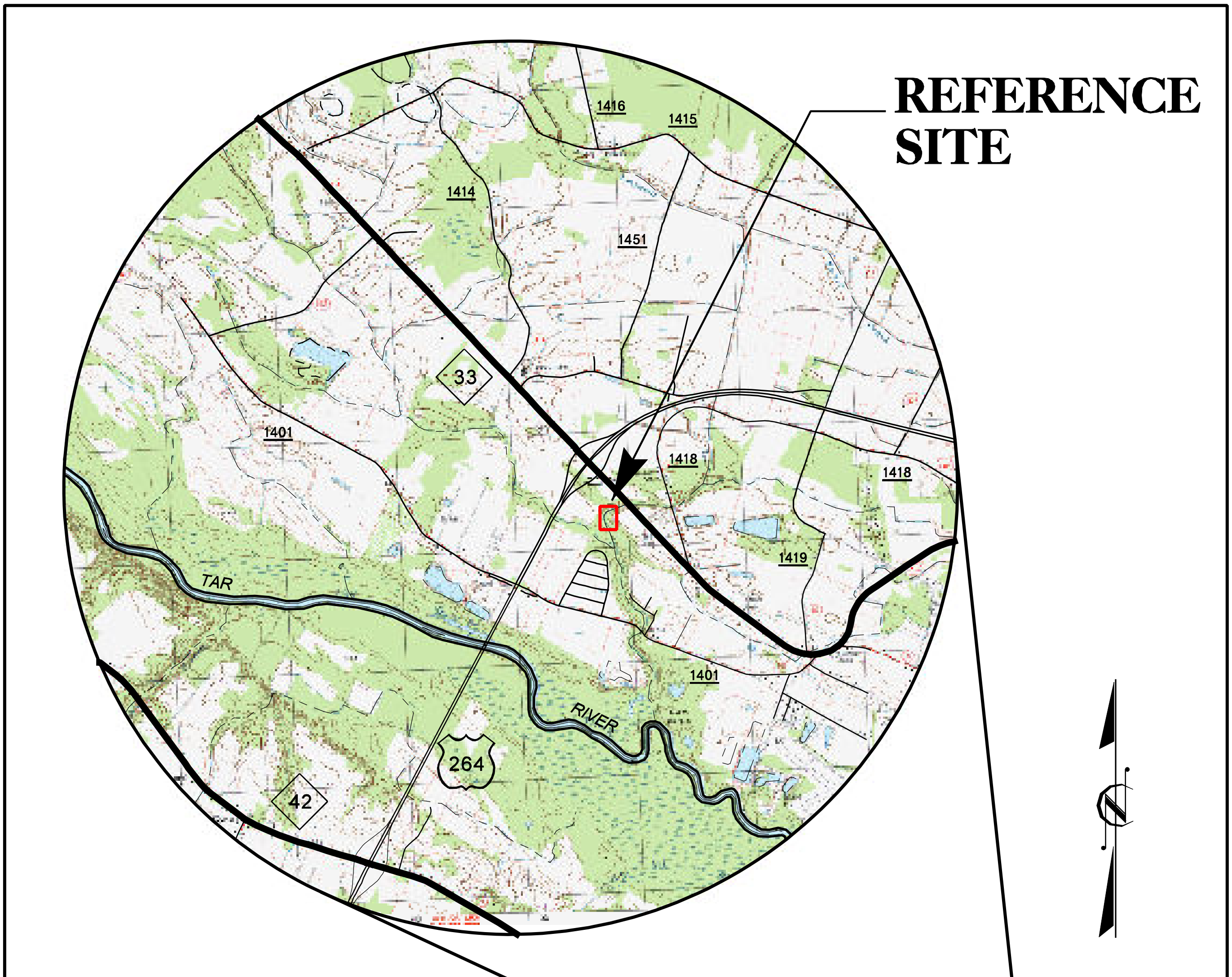
Johnsons Mill Run Vicinity Map

Adkin Branch
Restoration Plan
Lenoir County, North Carolina

Date: 03/23/07	Figure: 5



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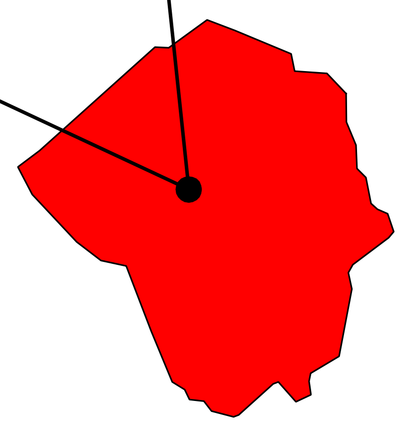
Reference Site
Pitt County
North Carolina



LEGEND

Watershed
Project Area

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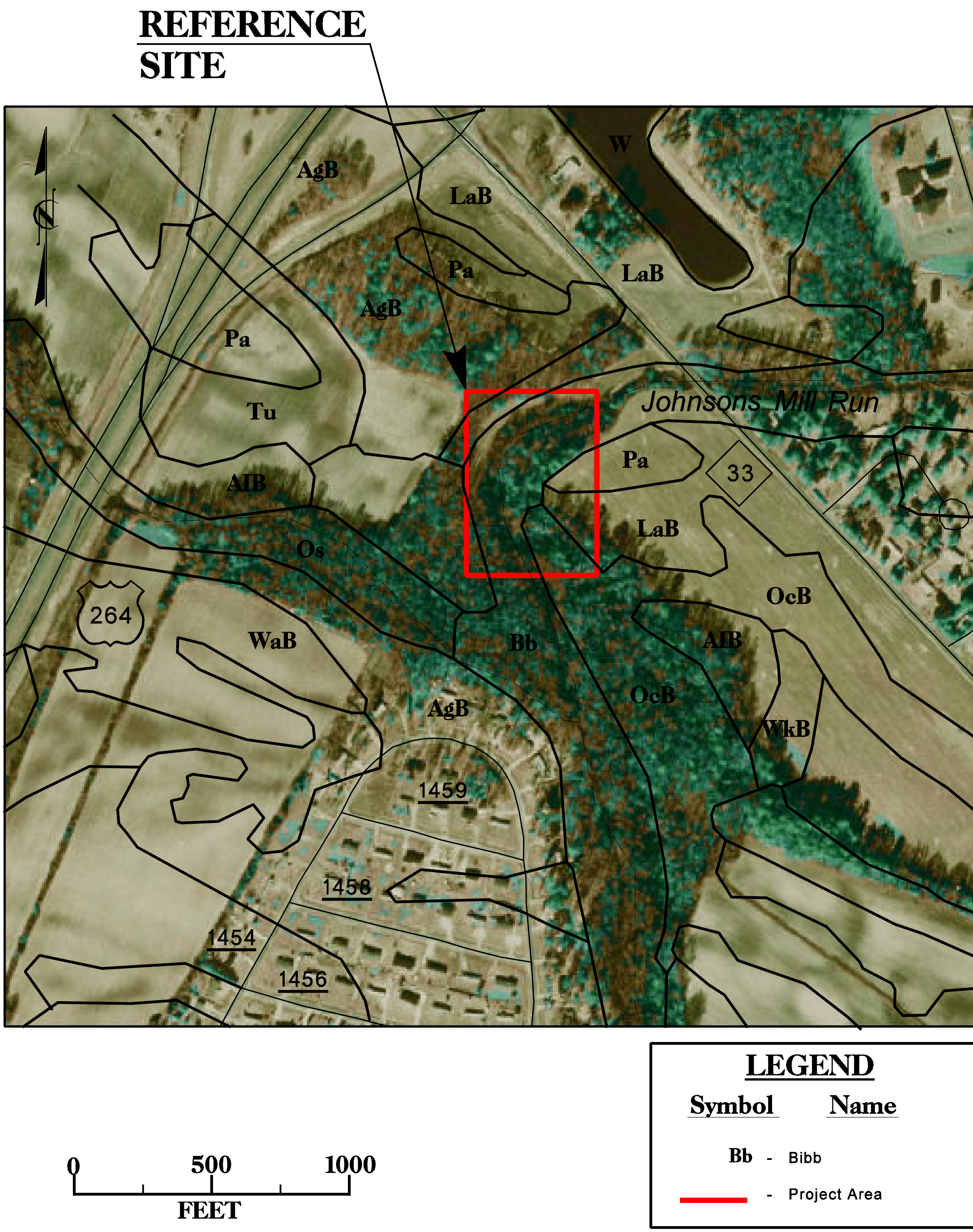
Johnsons Mill Run Watershed Map

Adkin Branch
Restoration Plan
Lenoir County, North Carolina

Date: 03/23/07	Figure: 6



LEGEND

Symbol	Name
Bb	- Bibb
(red line)	- Project Area

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Johnson Mill Run Soil Survey Map

Adkin Branch
Restoration Plan
Lenoir County, North Carolina

Date: 3/23/07

Figure: 7

Robeson County
North Carolina

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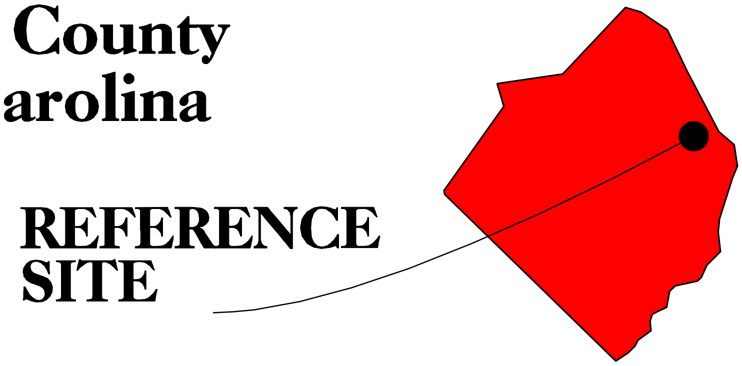
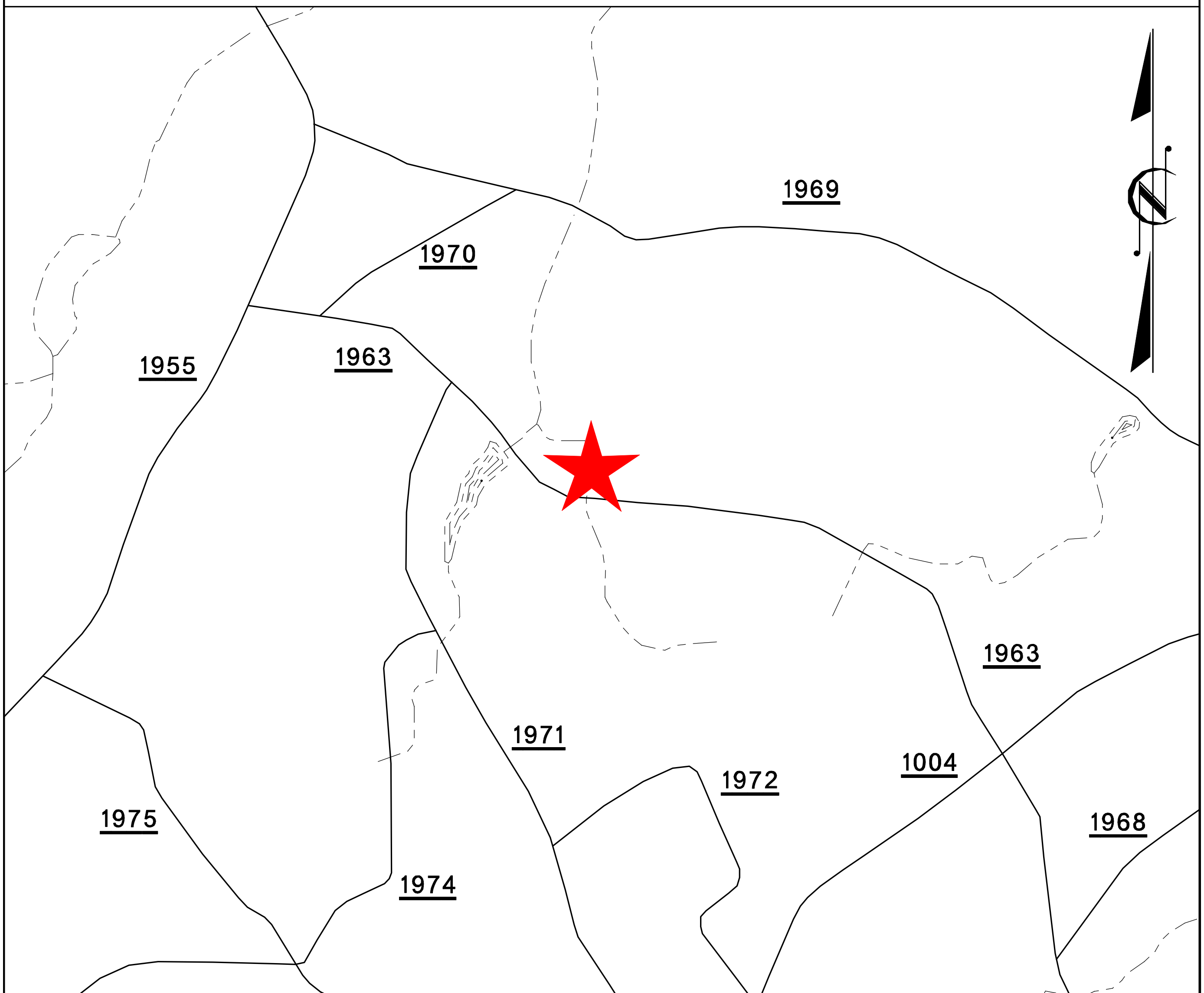
FEET





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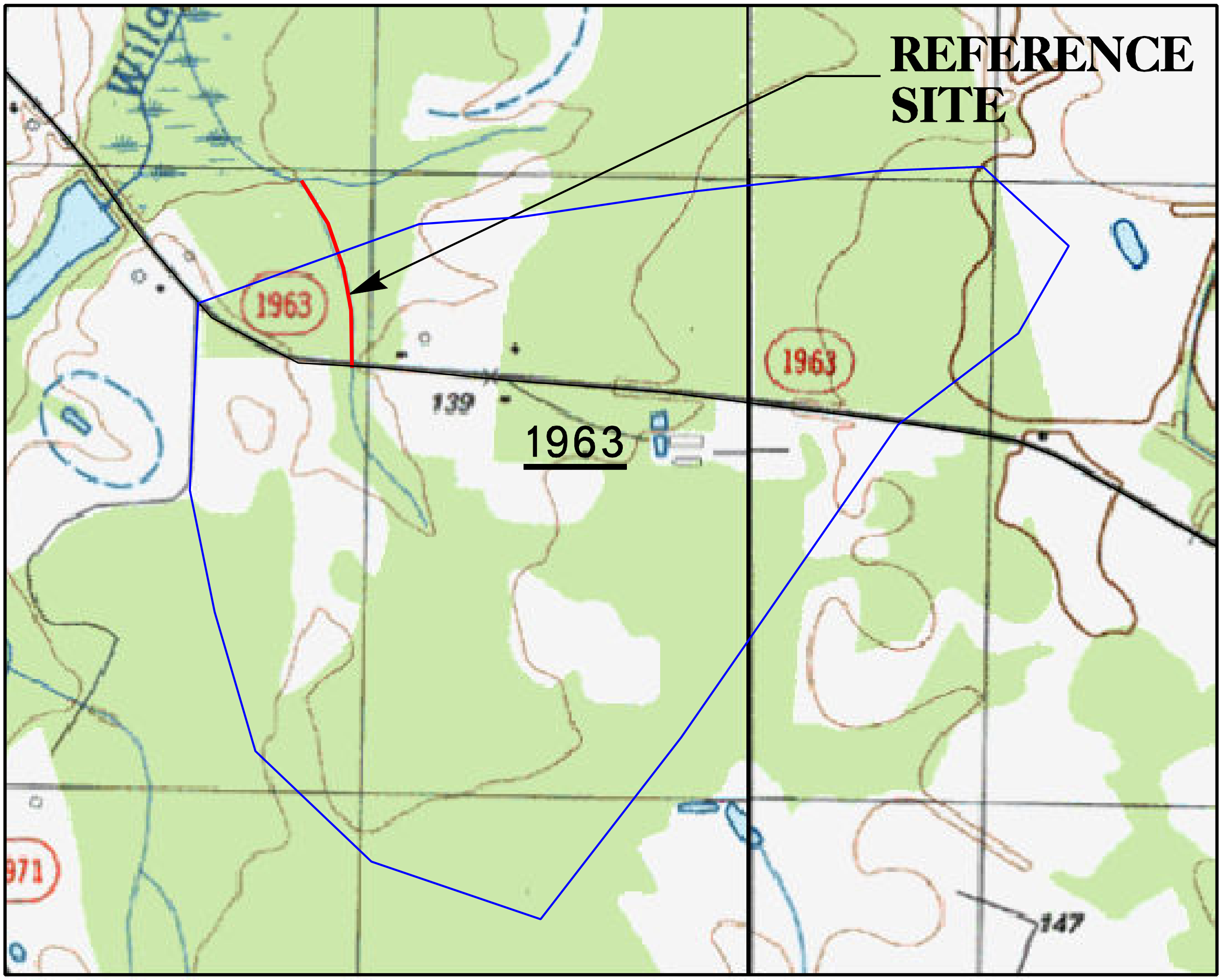
Ut to Wildcat Branch
Vicinity Map

Adkin Branch
Restoration Plan
Lenoir County, North Carolina

Date: 03/23/07	Figure: 8



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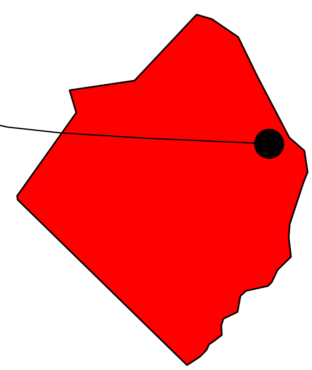
LEGEND

Watershed

Project Area

N



Reference Site
Robeson County
North Carolina

UT to Wildcat Branch Watershed Map

Adkin Branch
Restoration Plan
Lenoir County, North Carolina

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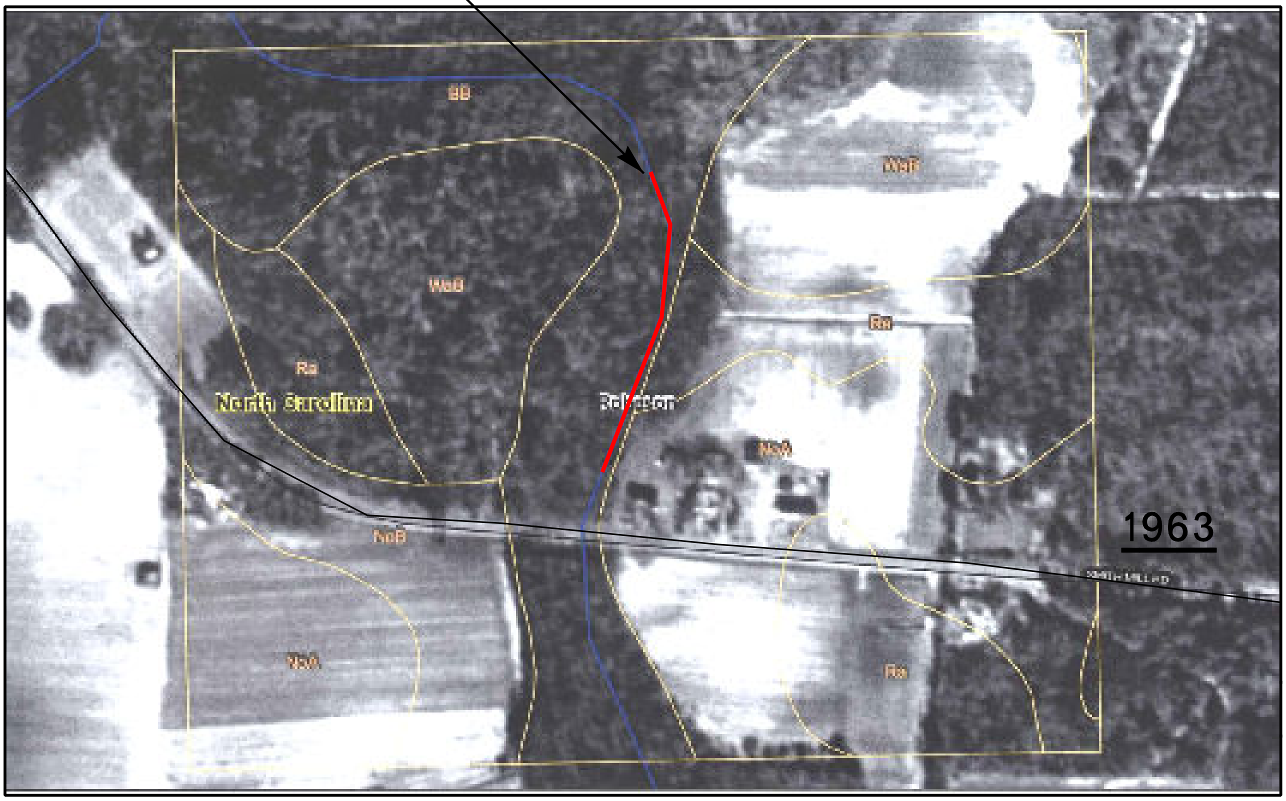
Date:	03/23/07	Figure:	9

REFERENCE SITE



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LEGEND

Symbol	Name
BB	- Bibb
(red line)	- Project Area

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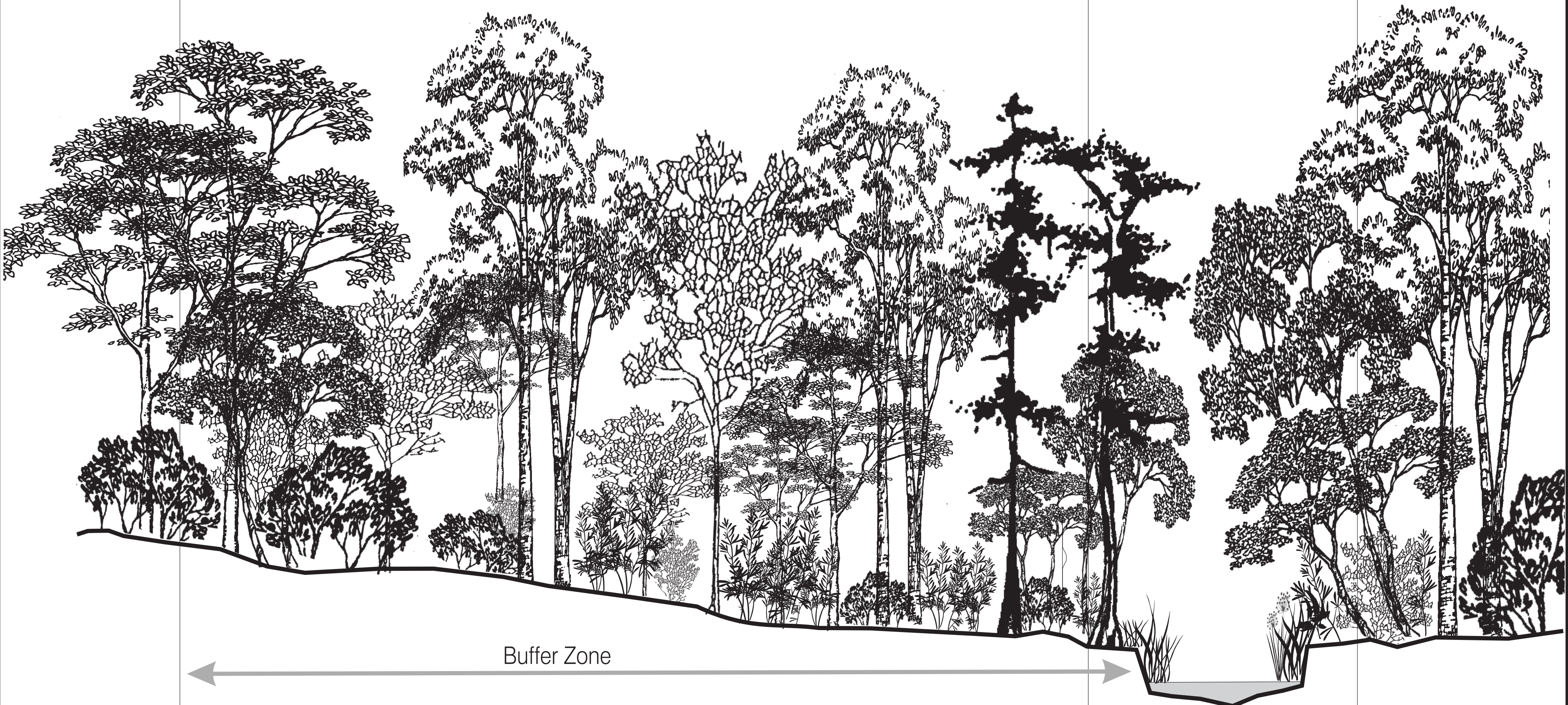
UT to Wildcat Branch Soil Survey Map

Adkin Branch
Restoration Plan
Lenoir County, North Carolina

Date: 03/23/07

Figure: 10

VEGETATIVE ZONE	Coastal Plain Levee Forest			Stream-Side Shrub Assemblage	Coastal Plain Levee Forest
DIAGNOSTIC VEGETATION	River Birch Sweetgum Mockernut Hickory Loblolly Pine Southern Red Oak Eastern Red Cedar Oak Species	Water Oak Willow Oak Winged Elm Black Cherry Sassafras Ironwood American Holly	Flowering Dogwood American Beautyberry Japanese Honeysuckle Muscadine Greenbrier	River Birch American Elm Sweetgum Red Maple Ironwood	See species list to left.



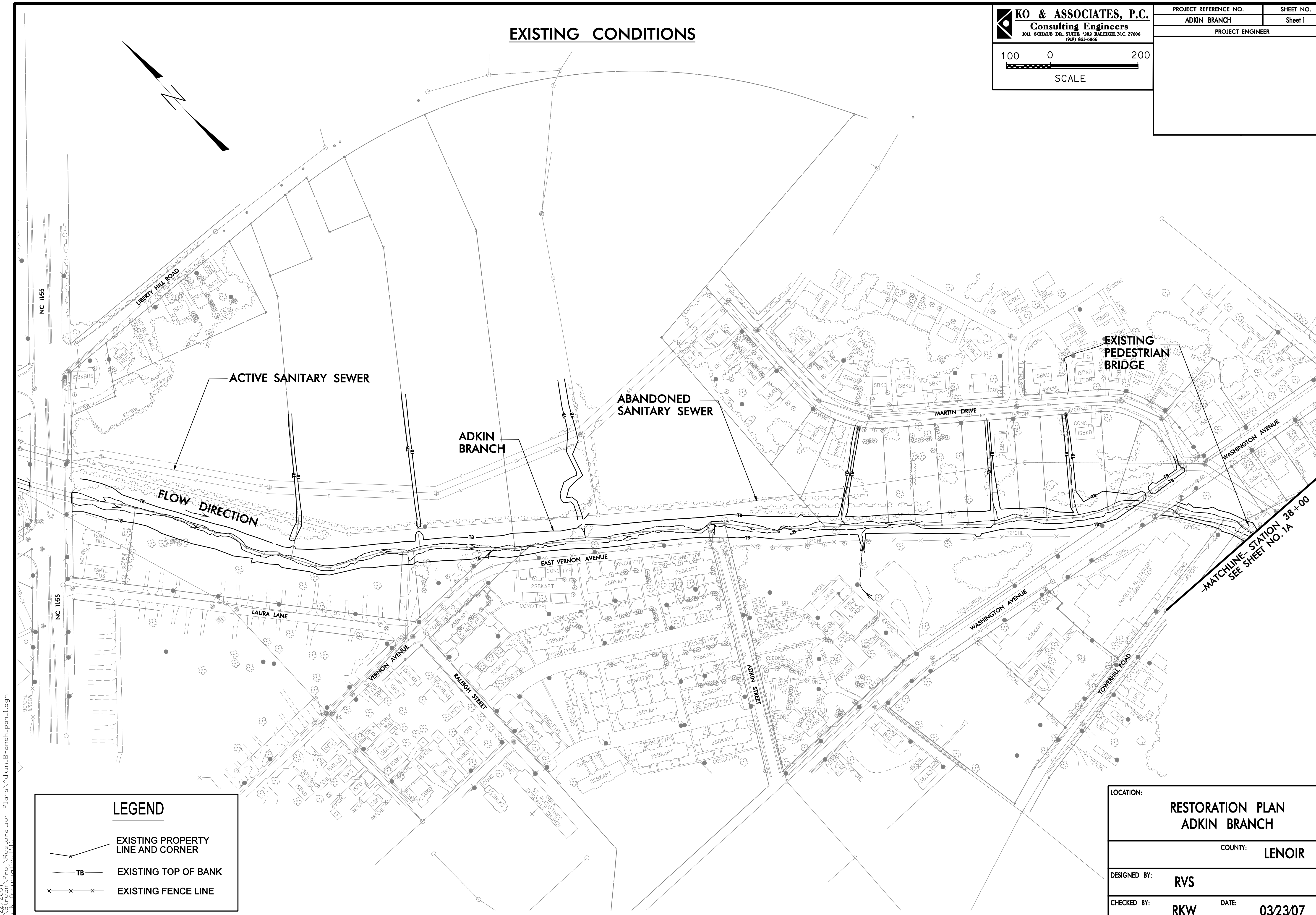
PHYSIOGRAPHIC LANDSCAPE UNIT	Levee	Riparian Zone	Levee
SOILS	Kalmia/Kenansville/Bibb Well-drained to Poorly Drained	Bibb Soils Poorly Drained	

Axiom Environmental
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

REFERENCE VEGETATIVE COMMUNITIES MAP
ADKINS BRANCH STREAM RESTORATION SITE
LENOIR COUNTY, NORTH CAROLINA

Figure: 11
Project: 06-014
Date: JANUARY 2007

EXISTING CONDITIONS



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100 0 200
SCALE

PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 1

PROJECT ENGINEER

LEGEND

- EXISTING PROPERTY LINE AND CORNER
- TB EXISTING TOP OF BANK
- EXISTING FENCE LINE

LOCATION:

RESTORATION PLAN
ADKIN BRANCH

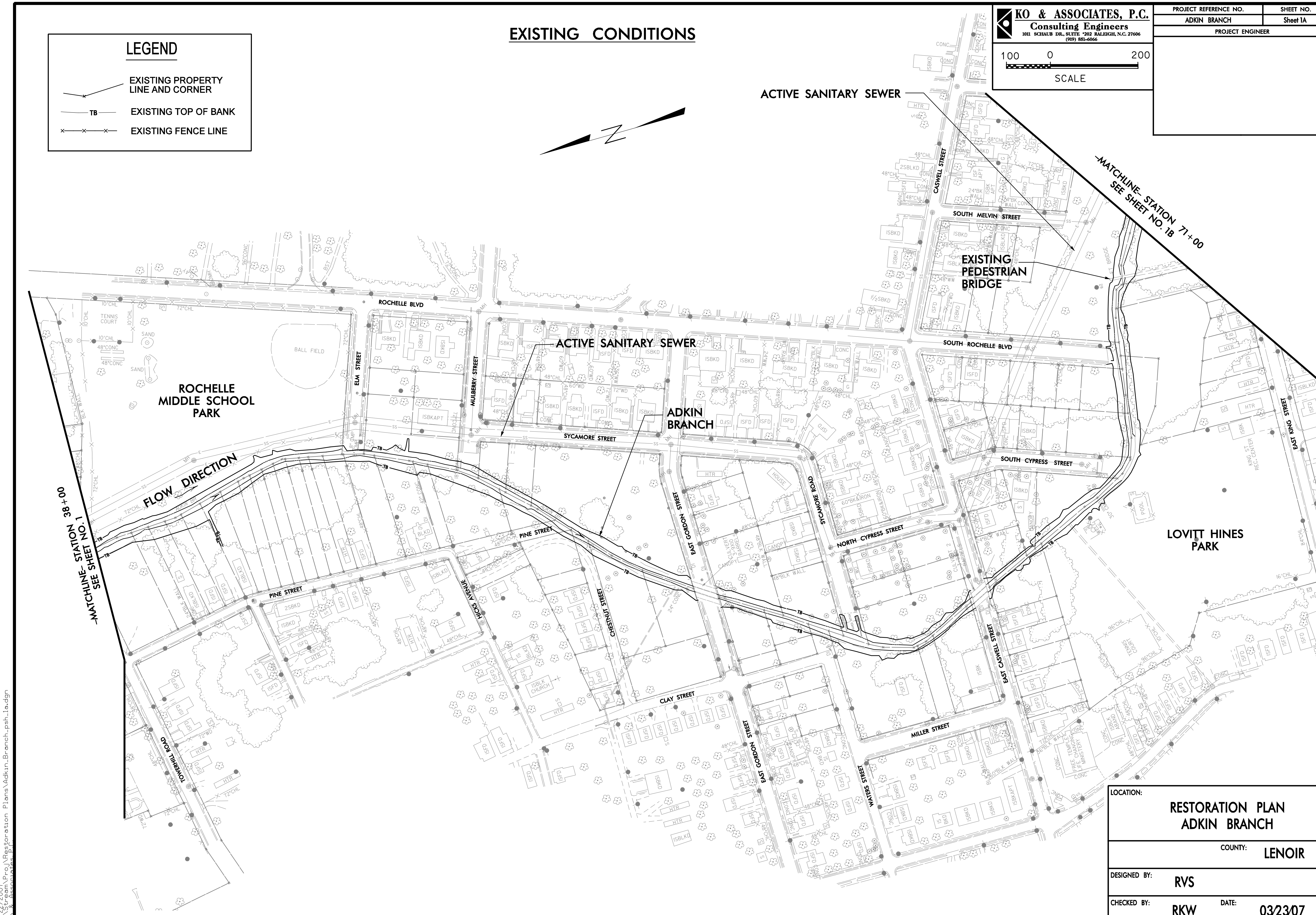
COUNTY: LENOIR

DESIGNED BY: RVS

CHECKED BY: RKW

DATE: 03/23/07

EXISTING CONDITIONS



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PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 1A

PROJECT ENGINEER

LOCATION:

RESTORATION PLAN
ADKIN BRANCH

COUNTY: LENOIR

DESIGNED BY: RVS

CHECKED BY: RKW DATE: 03/23/07

3/22/2007
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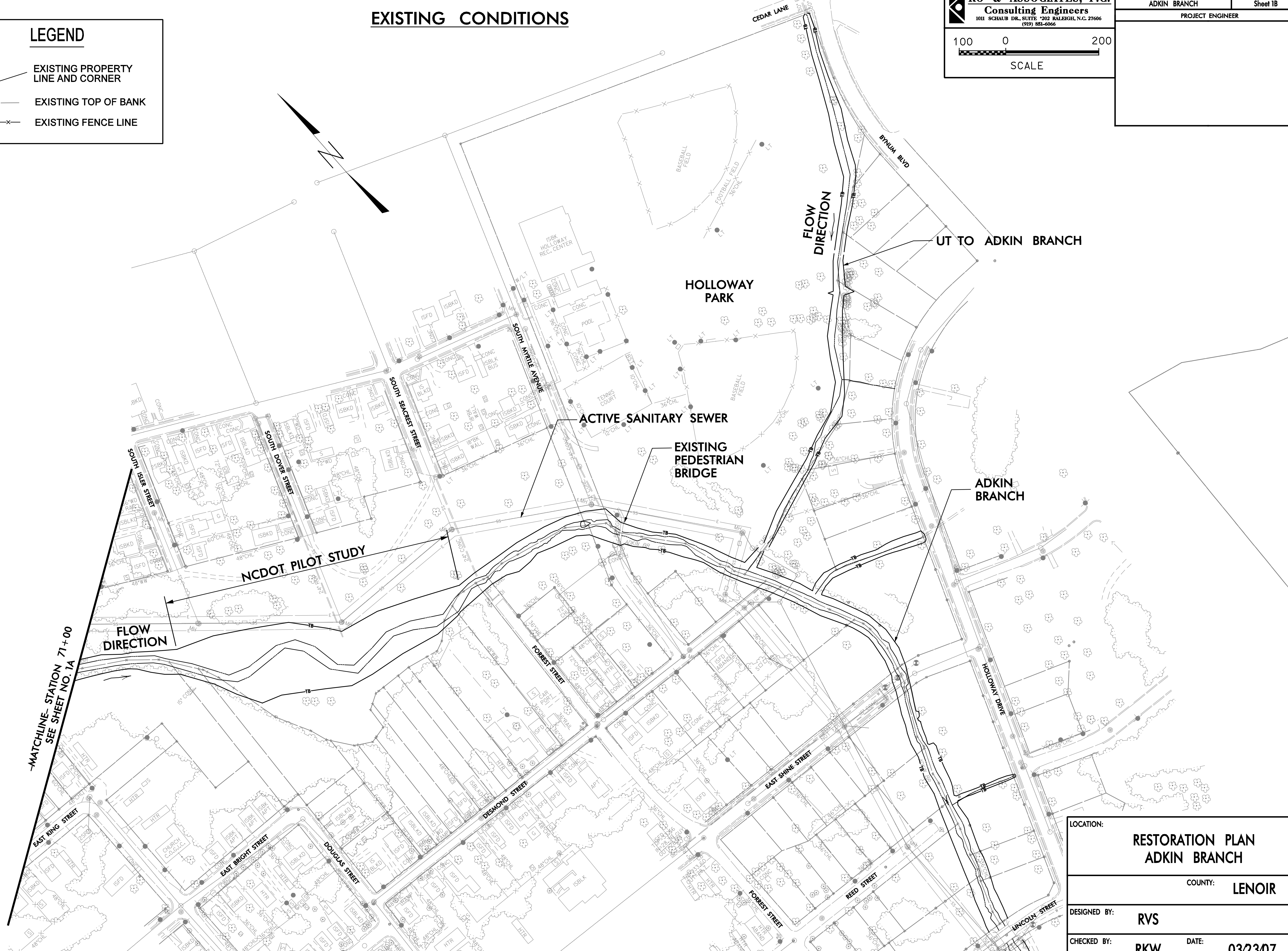
EXISTING CONDITIONS

LEGEND

EXISTING PROPERTY LINE AND CORNER
EXISTING TOP OF BANK
EXISTING FENCE LINE



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100 0 200
SCALE

PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 1B

PROJECT ENGINEER

LOCATION:

RESTORATION PLAN
ADKIN BRANCH

COUNTY: LENOIR

DESIGNED BY: RVS

CHECKED BY: RKW DATE: 03/23/07

3/22/2007
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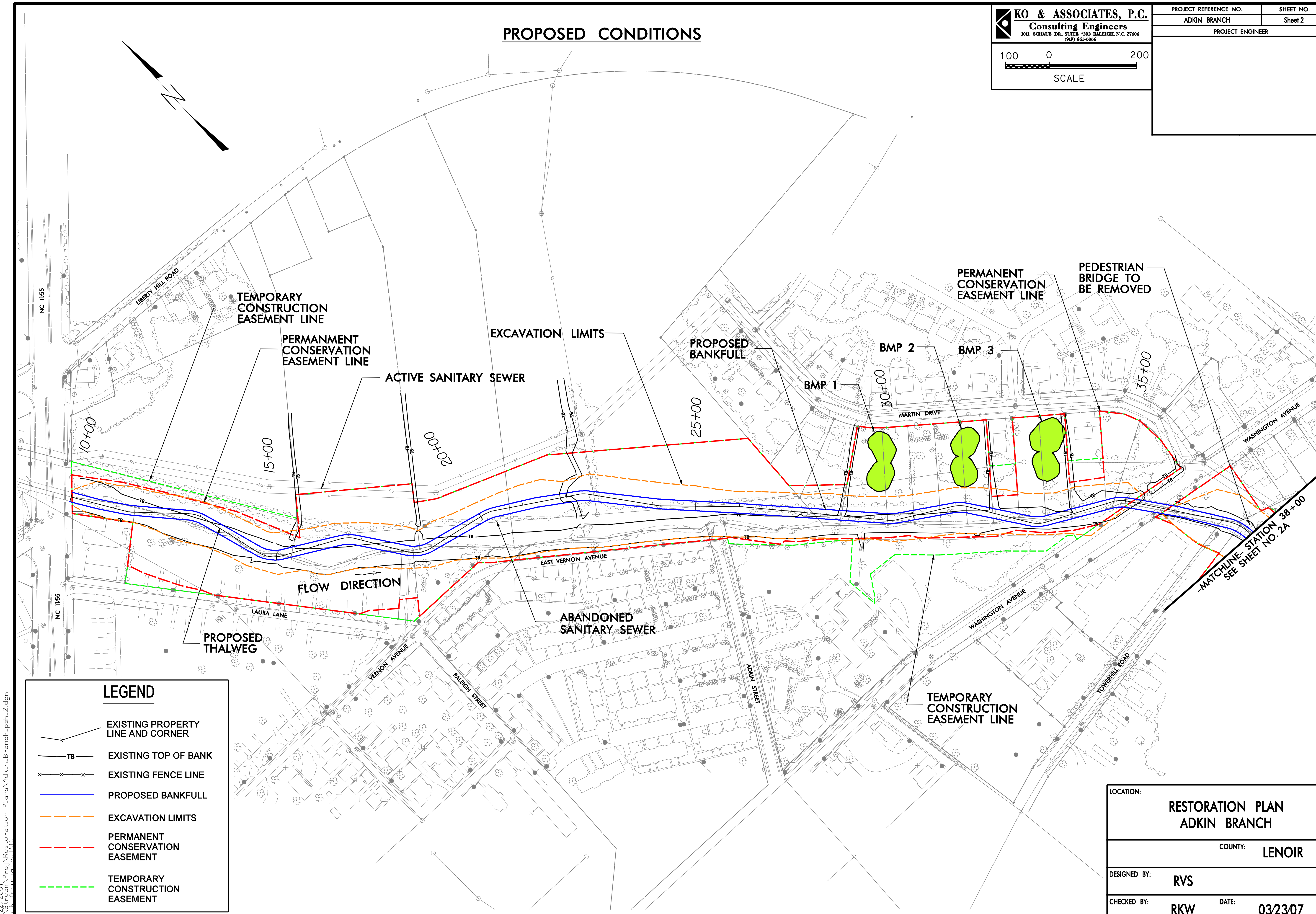
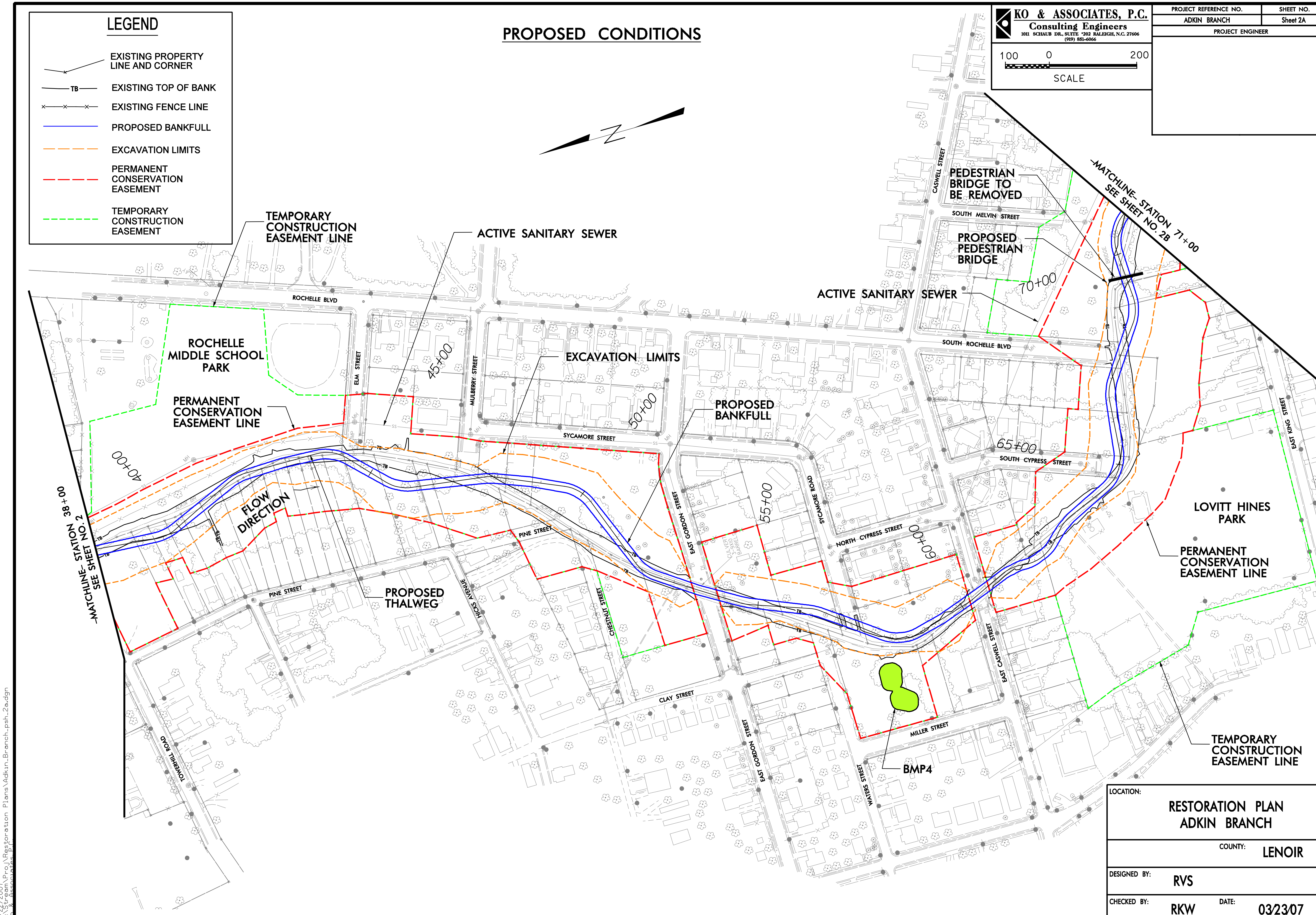
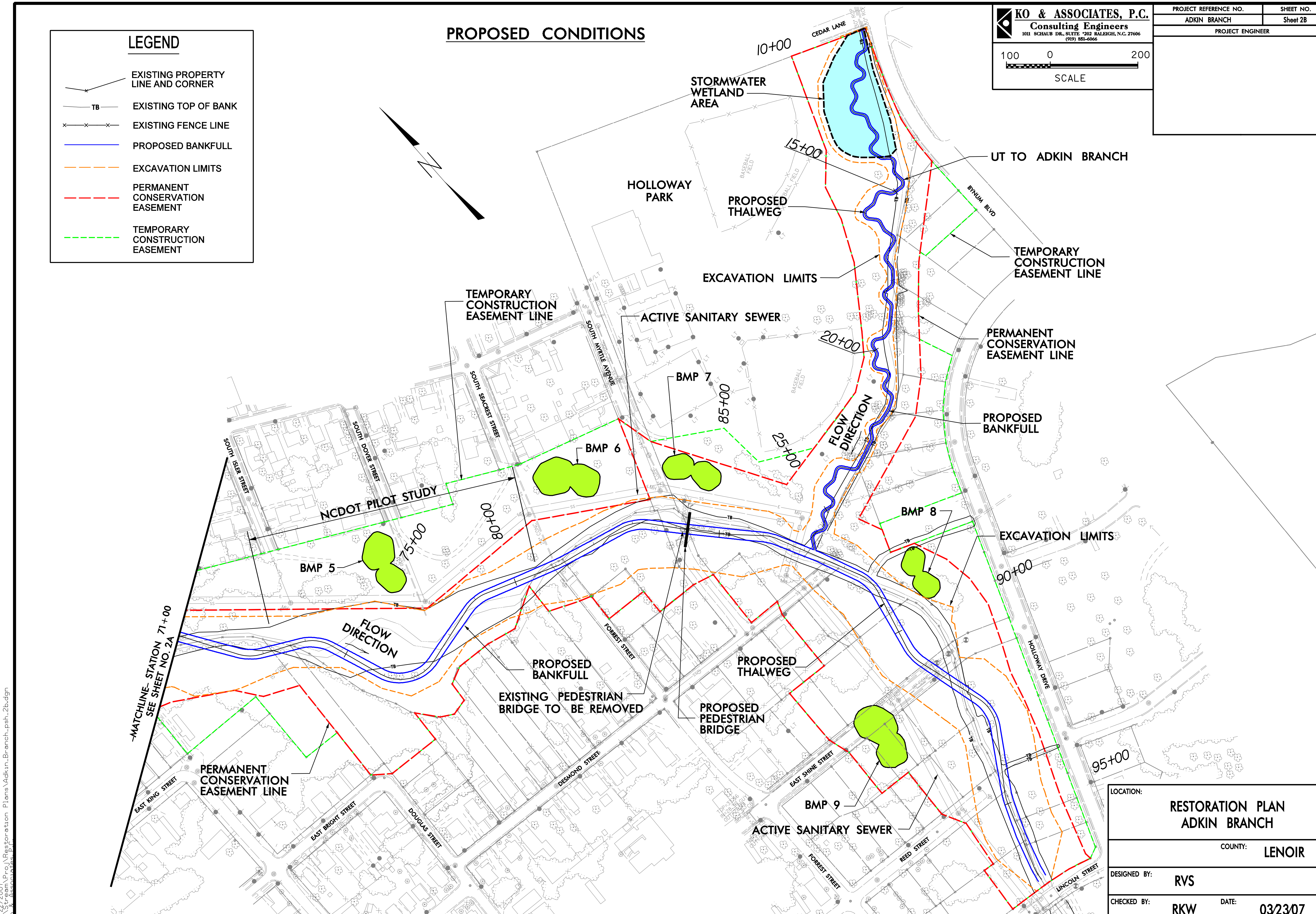

PROPOSED CONDITIONS
KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606
(919) 851-6066
PROJECT REFERENCE NO.
ADKIN BRANCH
SHEET NO.
Sheet 2
PROJECT ENGINEER
100 0 200
SCALE
TEMPORARY CONSTRUCTION EASEMENT LINE
PERMANENT CONSERVATION EASEMENT LINE
ACTIVE SANITARY SEWER
EXCAVATION LIMITS
PROPOSED BANKFULL
BMP 1
BMP 2
BMP 3
PERMANENT CONSERVATION EASEMENT LINE
PEDESTRIAN BRIDGE TO BE REMOVED
LIBERTY HILL ROAD
NC 1155
10+00
15+00
20+00
25+00
30+00
35+00
MARTIN DRIVE
WASHINGTON AVENUE
EAST VERNON AVENUE
FLOW DIRECTION
LAURA LANE
ABANDONED SANITARY SEWER
PROPOSED THALWEG
VERNON AVENUE
RALEIGH STREET
ADKIN STREET
TEMPORARY CONSTRUCTION EASEMENT LINE
TOWERHILL ROAD
MATCHLINE- STATION 38+00
SEE SHEET NO. 2A
LEGEND
EXISTING PROPERTY LINE AND CORNER
EXISTING TOP OF BANK
EXISTING FENCE LINE
PROPOSED BANKFULL
EXCAVATION LIMITS
PERMANENT CONSERVATION EASEMENT
TEMPORARY CONSTRUCTION EASEMENT
LOCATION:
RESTORATION PLAN
ADKIN BRANCH
COUNTY:
LENOIR
DESIGNED BY:
RVS
CHECKED BY:
RKW
DATE:
03/23/07


PROPOSED CONDITIONS
LEGEND
EXISTING PROPERTY LINE AND CORNER
EXISTING TOP OF BANK
EXISTING FENCE LINE
PROPOSED BANKFULL
EXCAVATION LIMITS
PERMANENT CONSERVATION EASEMENT
TEMPORARY CONSTRUCTION EASEMENT
KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606
(919) 851-6066
100 0 200
SCALE
PROJECT REFERENCE NO.
SHEET NO.
ADKIN BRANCH
Sheet 2A
PROJECT ENGINEER
TEMPORARY CONSTRUCTION EASEMENT LINE
ACTIVE SANITARY SEWER
ROCHELLE MIDDLE SCHOOL PARK
PERMANENT CONSERVATION EASEMENT LINE
EXCAVATION LIMITS
PROPOSED BANKFULL
FLOW DIRECTION
PROPOSED THALWEG
PEDESTRIAN BRIDGE TO BE REMOVED
PROPOSED PEDESTRIAN BRIDGE
ACTIVE SANITARY SEWER
LOVITT HINES PARK
PERMANENT CONSERVATION EASEMENT LINE
TEMPORARY CONSTRUCTION EASEMENT LINE
BMP4
-MATCHLINE- STATION 38+00 SEE SHEET NO. 2
-MATCHLINE- STATION 71+00 SEE SHEET NO. 2B
40+00
45+00
50+00
55+00
60+00
65+00
70+00
ROCHELLE BLVD
ELM STREET
MULBERRY STREET
SYCAMORE STREET
PINE STREET
HICKS AVENUE
CHESTNUT STREET
EAST GORDON STREET
SYCAMORE ROAD
NORTH CYPRESS STREET
SOUTH CYPRESS STREET
SOUTH ROCHELLE BLVD
SOUTH MELVIN STREET
CASWELL STREET
EAST CASWELL STREET
EAST KING STREET
CLAY STREET
MILLER STREET
WATERS STREET
TOWERHILL ROAD
LOCATION:
RESTORATION PLAN
ADKIN BRANCH
COUNTY:
LENOIR
DESIGNED BY:
RVS
CHECKED BY:
RKW
DATE:
03/23/07
3/22/2007

PROPOSED CONDITIONS



PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 3
PROJECT ENGINEER	

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Consulting Engineers
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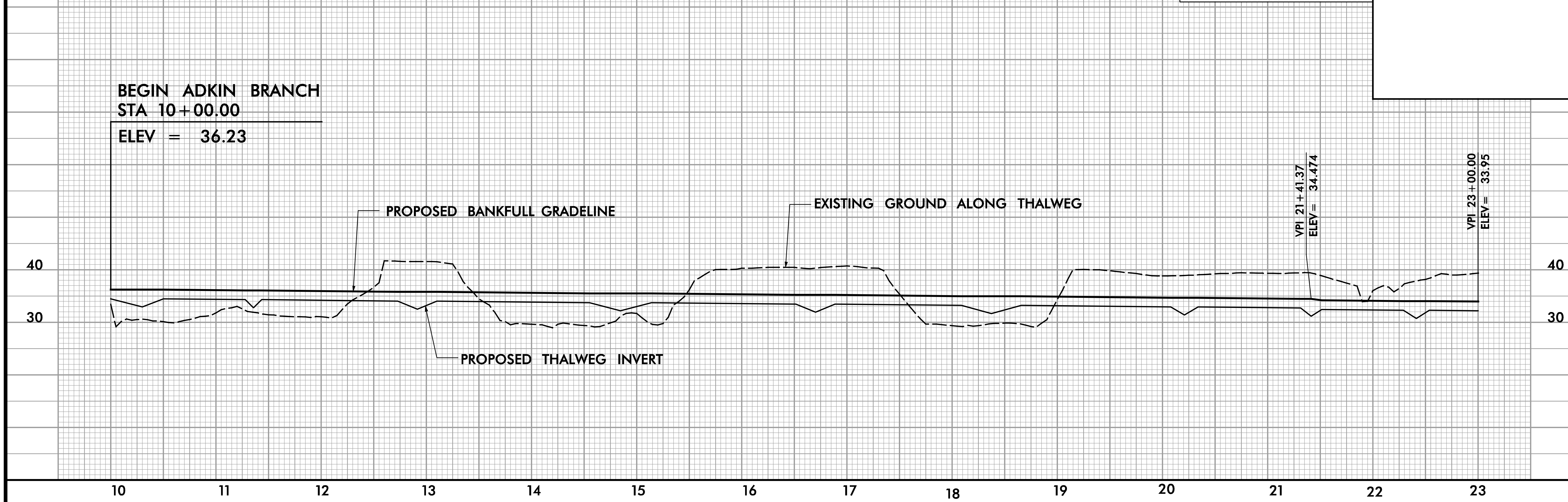
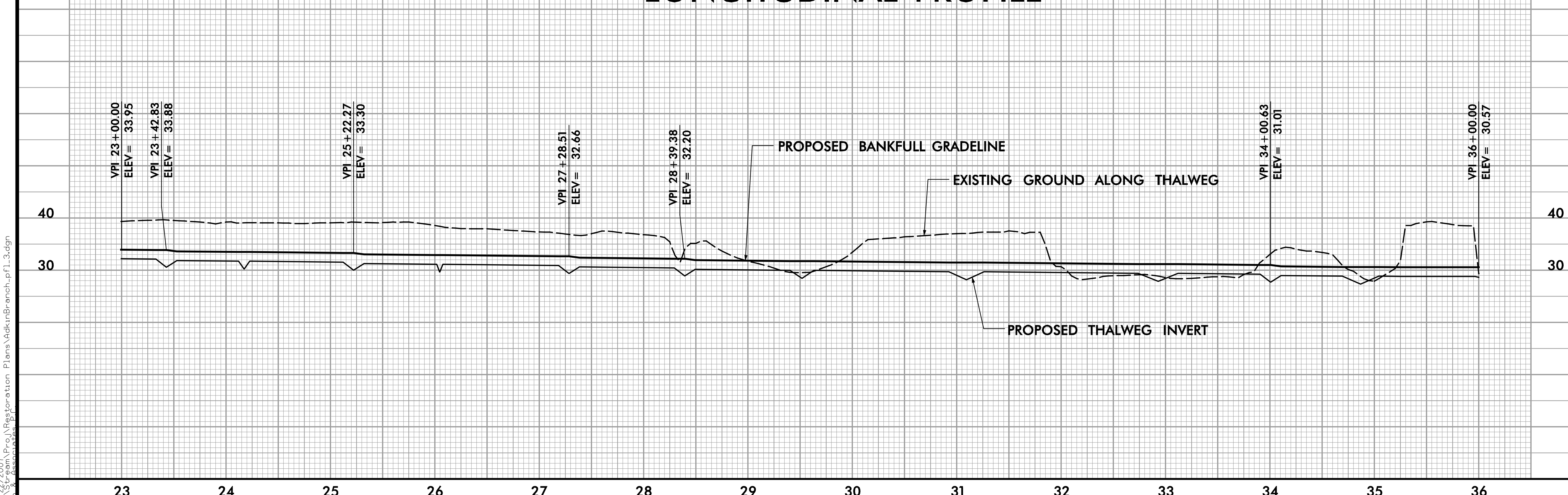
(919) 851-6066

LONGITUDINAL PROFILE



LONGITUDINAL PROFILE



5/28/99

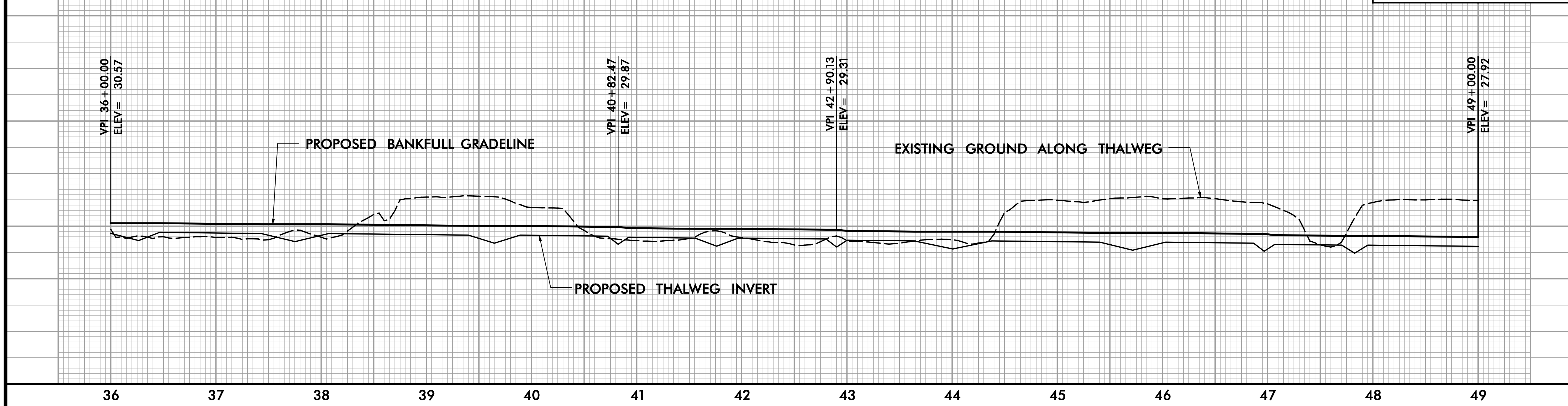
3/22/2007
R:\Stream\Proj\Restoration Plans\AdkinBranch_pfl_3.dgn
Ko & Associates, P.C.

KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE 202 RALEIGH, N.C. 27606
(919) 851-6066

PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 3A
PROJECT ENGINEER	

5/28/99

LONGITUDINAL PROFILE



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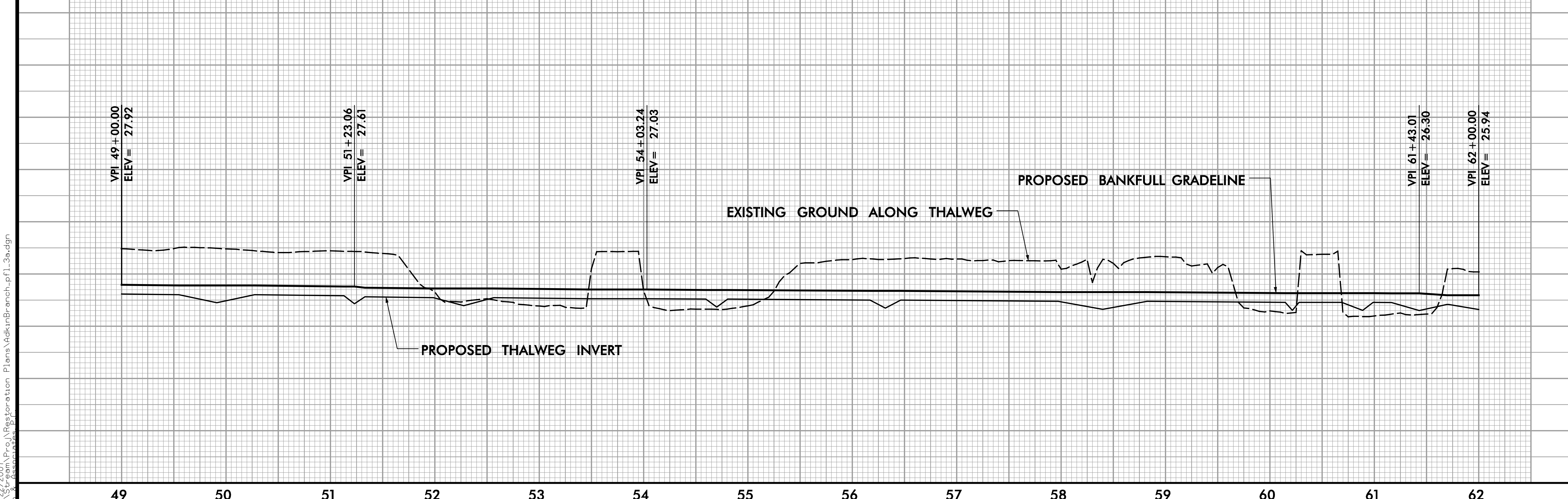

3/22/2007
R:\Stream\Proj\Restoration Plans\AdkinBranch_pfl_3a.dgn

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Consulting Engineers
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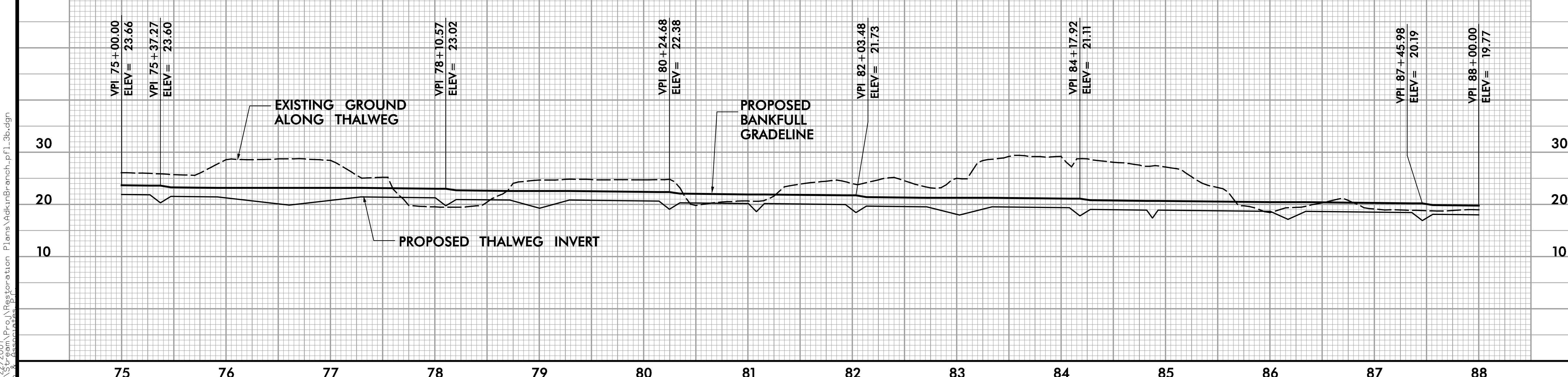
(919) 851-6066

PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 3B
PROJECT ENGINEER	

LONGITUDINAL PROFILE

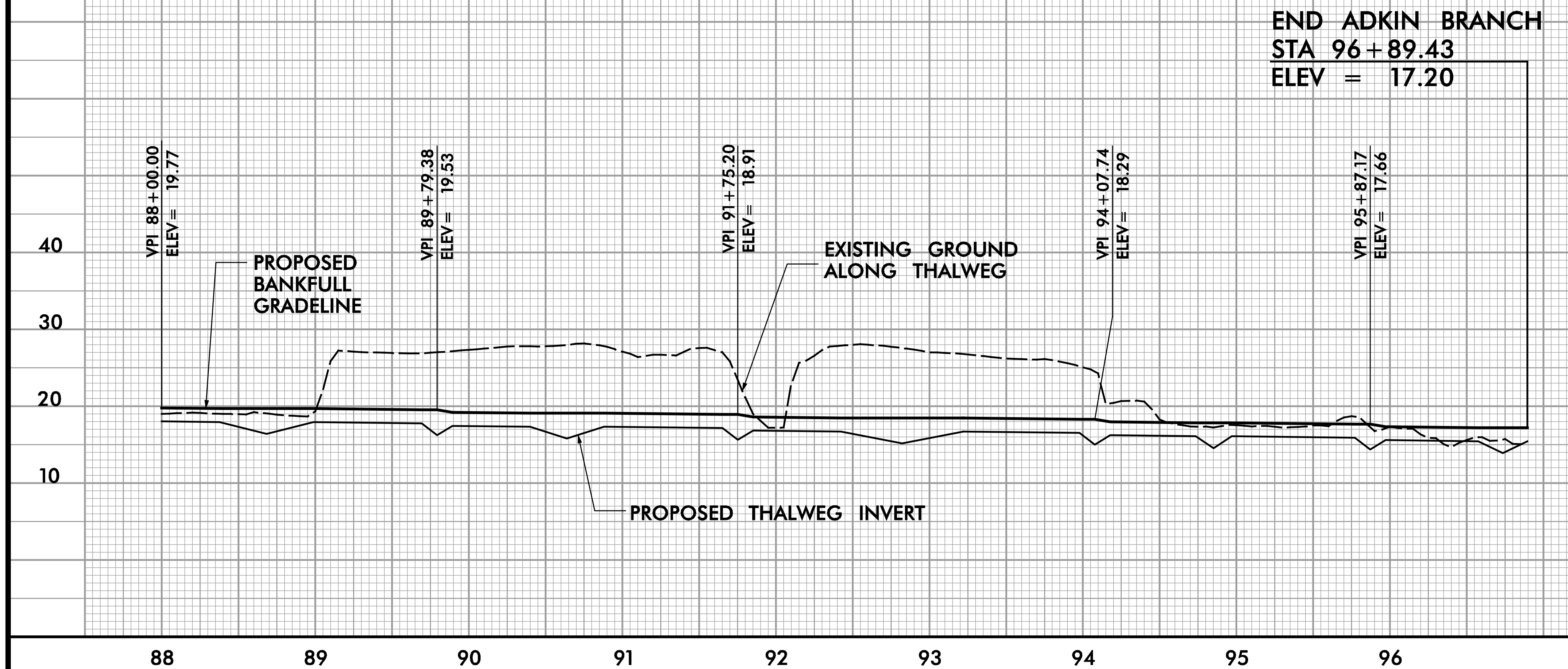
LONGITUDINAL PROFILE



5/28/99
3/22/2007 R:\Stream\Proj\Restoration Plans\AdkinBranch_pfl_3b.dgn

KO & ASSOCIATES, P.C. Consulting Engineers 1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606 (919) 851-6066	PROJECT REFERENCE NO.	SHEET NO.
	ADKIN BRANCH	Sheet 3C
	PROJECT ENGINEER	

LONGITUDINAL PROFILE



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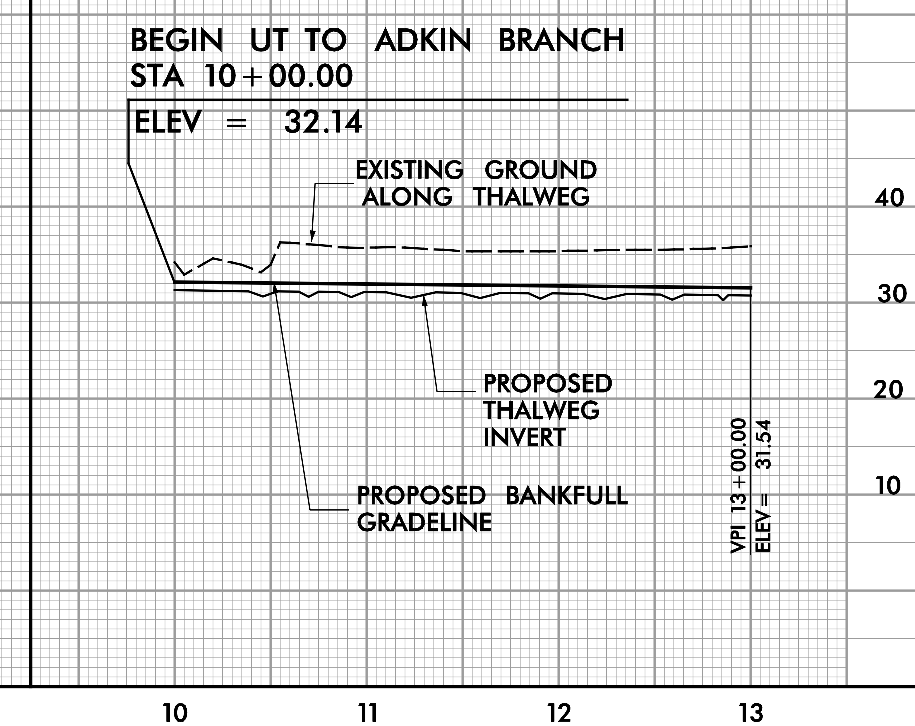

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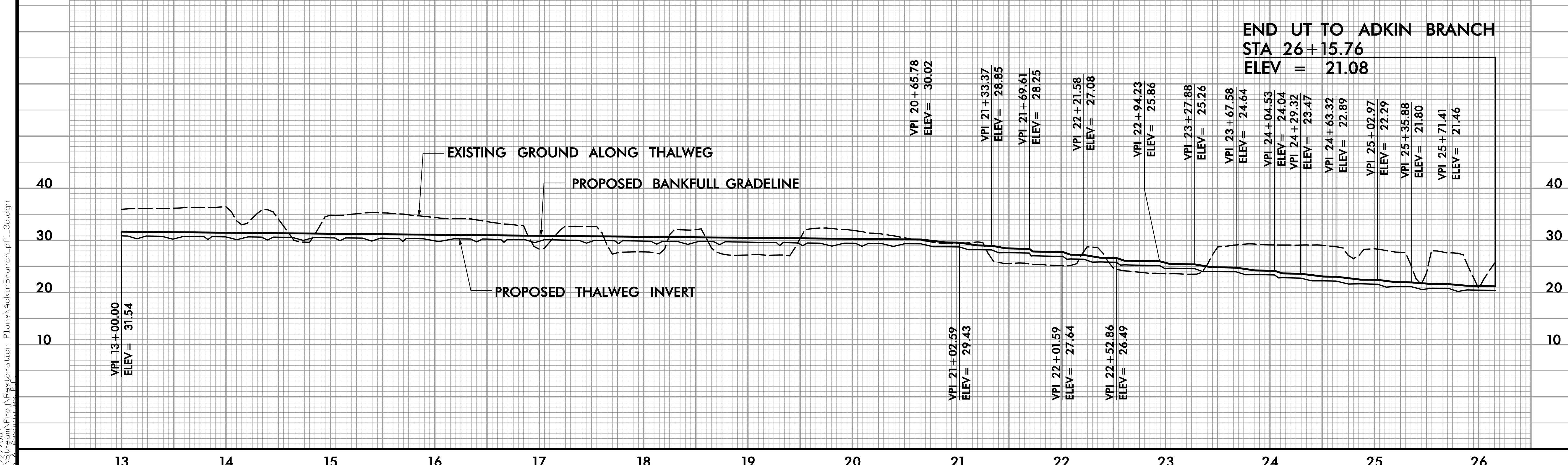
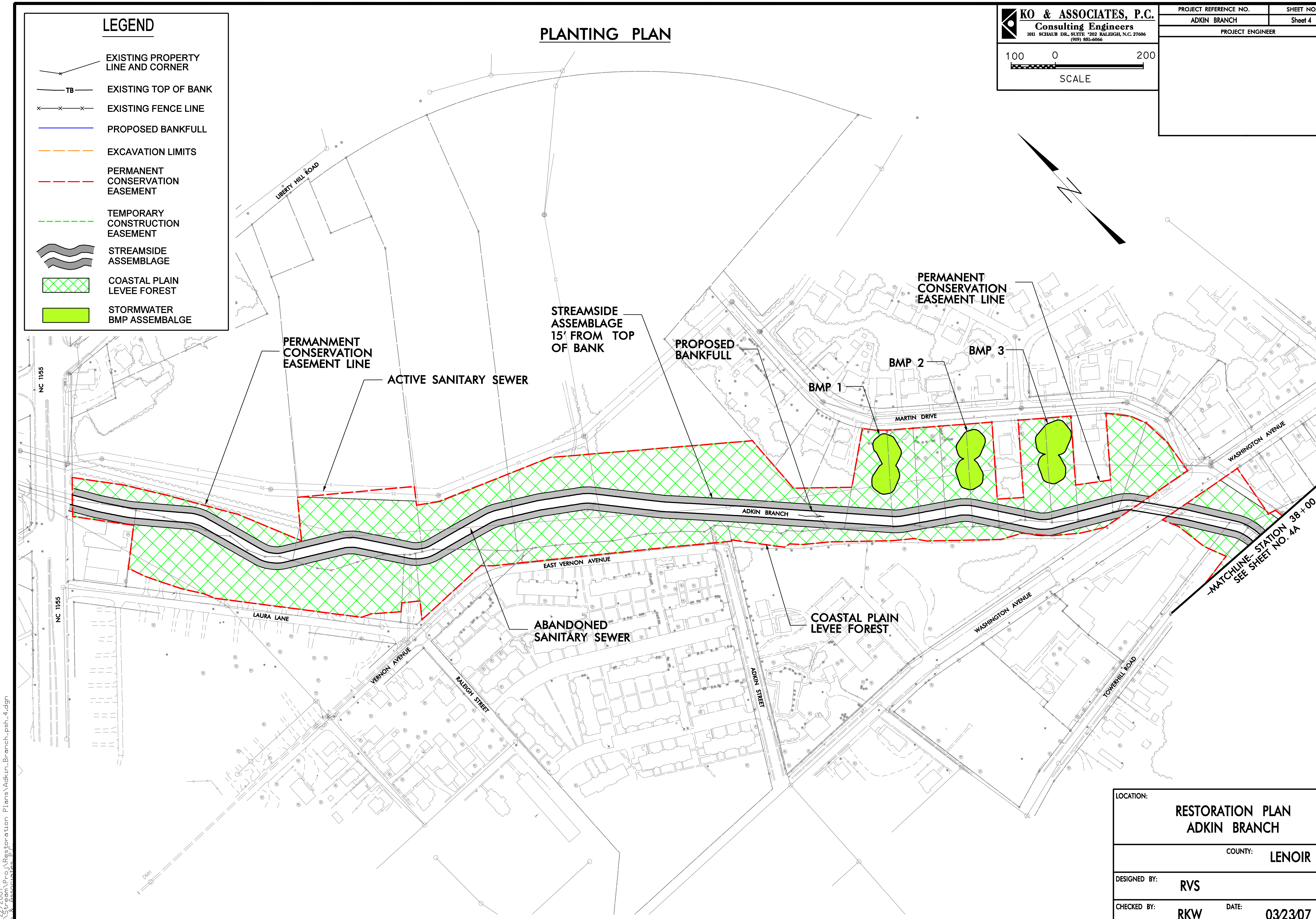


5/28/99

PLANTING PLAN



KO & ASSOCIATES, P.C.
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1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606
(919) 851-6066

PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 4
PROJECT ENGINEER	

LOCATION:
RESTORATION PLAN
ADKIN BRANCH

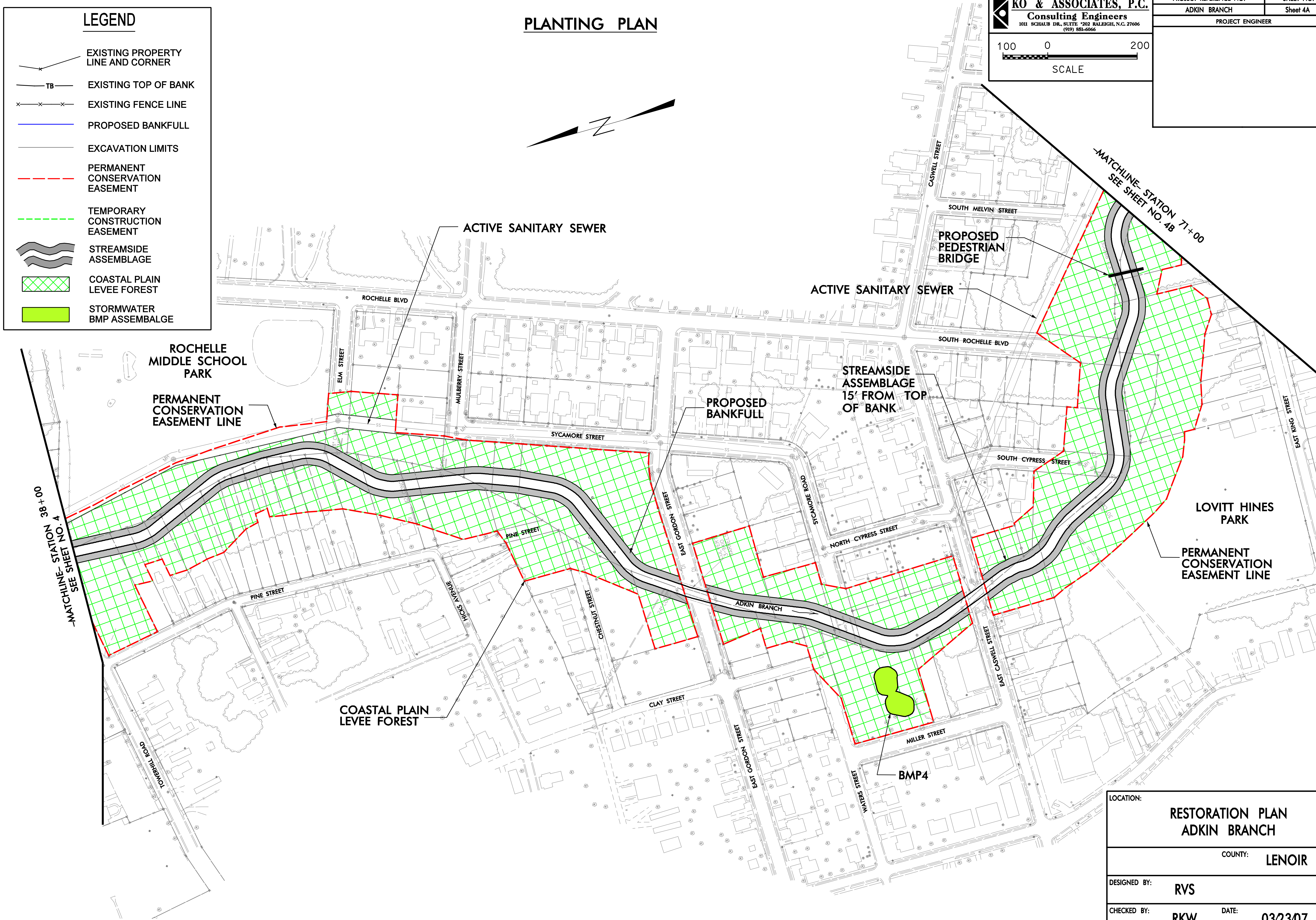
COUNTY: LENOIR

DESIGNED BY: RVS

CHECKED BY: RKW DATE: 03/23/07

3/22/2007
R:\Stream\Proj\Restoration Plans\Adkin_Branch_psh_4.dgn

PLANTING PLAN



KO & ASSOCIATES, P.C.
Consulting Engineers
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(919) 851-6066

PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 4A
PROJECT ENGINEER	

LOCATION:
RESTORATION PLAN
ADKIN BRANCH

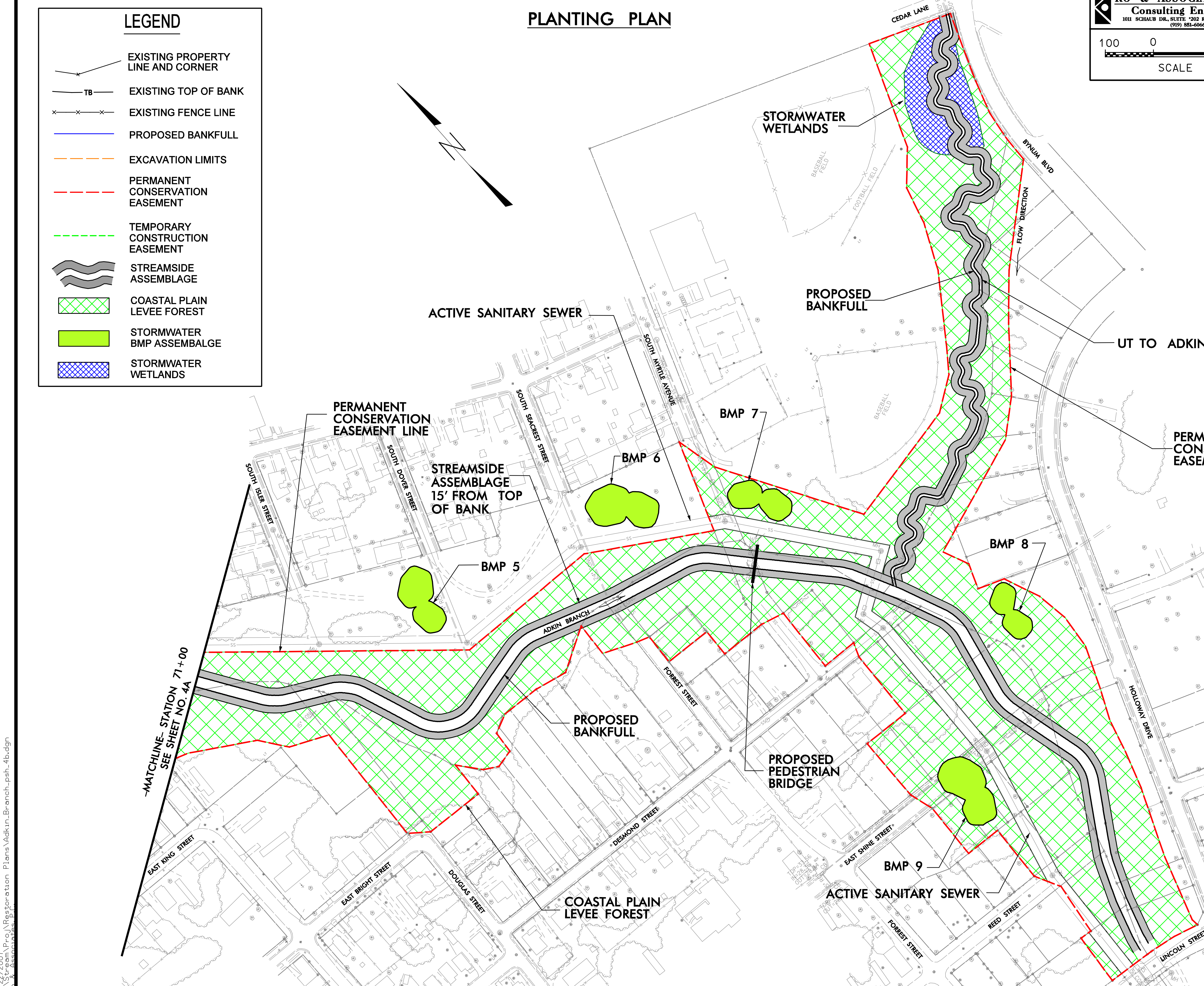
COUNTY: LENOIR

DESIGNED BY: RVS

CHECKED BY: RKW DATE: 03/23/07

3/22/2007
R:\Stream\Proj\Restoration Plans\Adkin_Branch_psh_4a.dgn

PLANNING PLAN



KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606
(919) 851-6066

100 0 200
SCALE

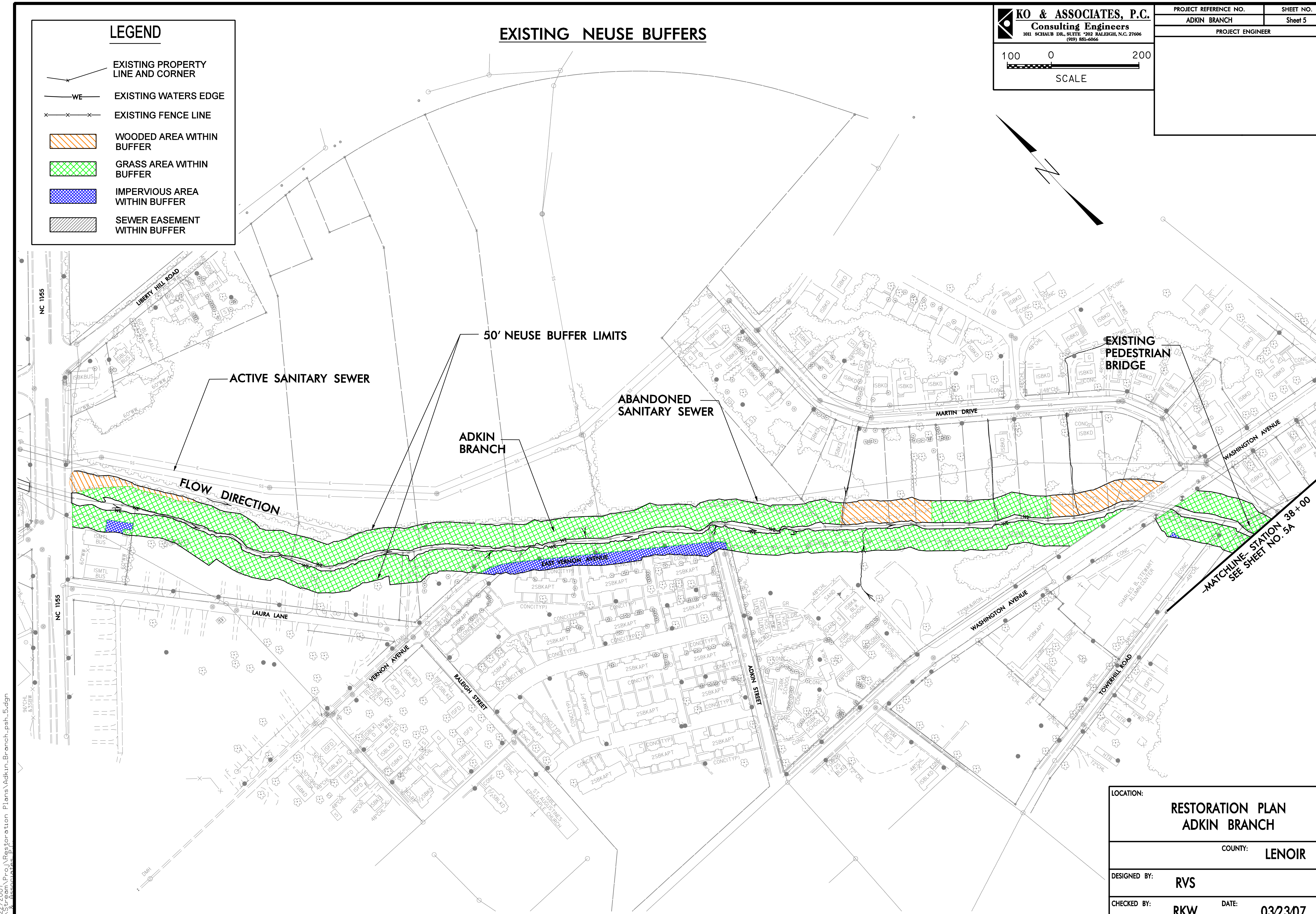
PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 4B
PROJECT ENGINEER	

LOCATION:
RESTORATION PLAN
ADKIN BRANCH

COUNTY: LENOIR

DESIGNED BY: RVS

CHECKED BY: RKW
DATE: 3/23/07



KO & ASSOCIATES, P.C.
Consulting Engineers
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(919) 851-6066

PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 5

PROJECT ENGINEER

LOCATION:
RESTORATION PLAN
ADKIN BRANCH

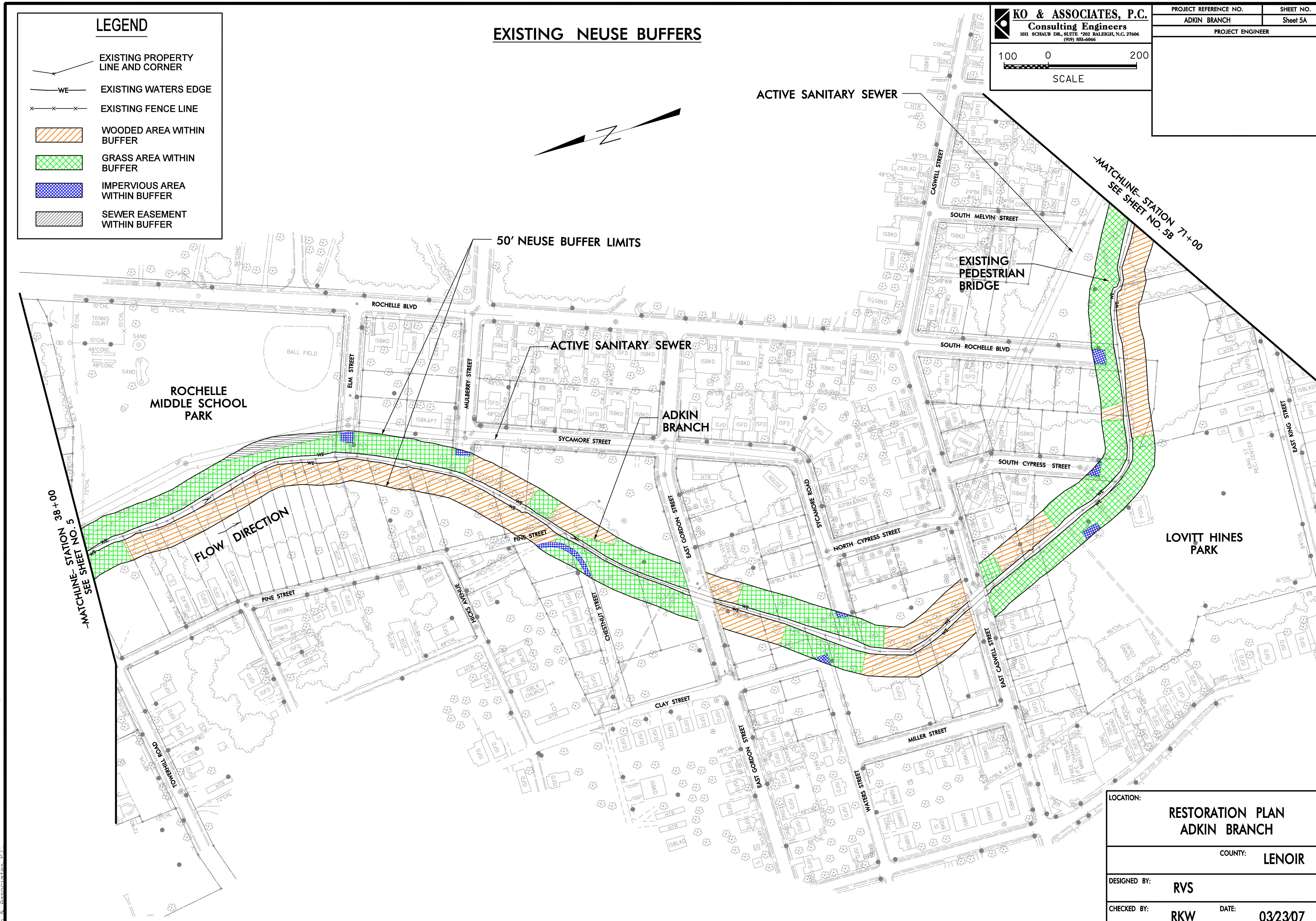
COUNTY: LENOIR

DESIGNED BY: RVS

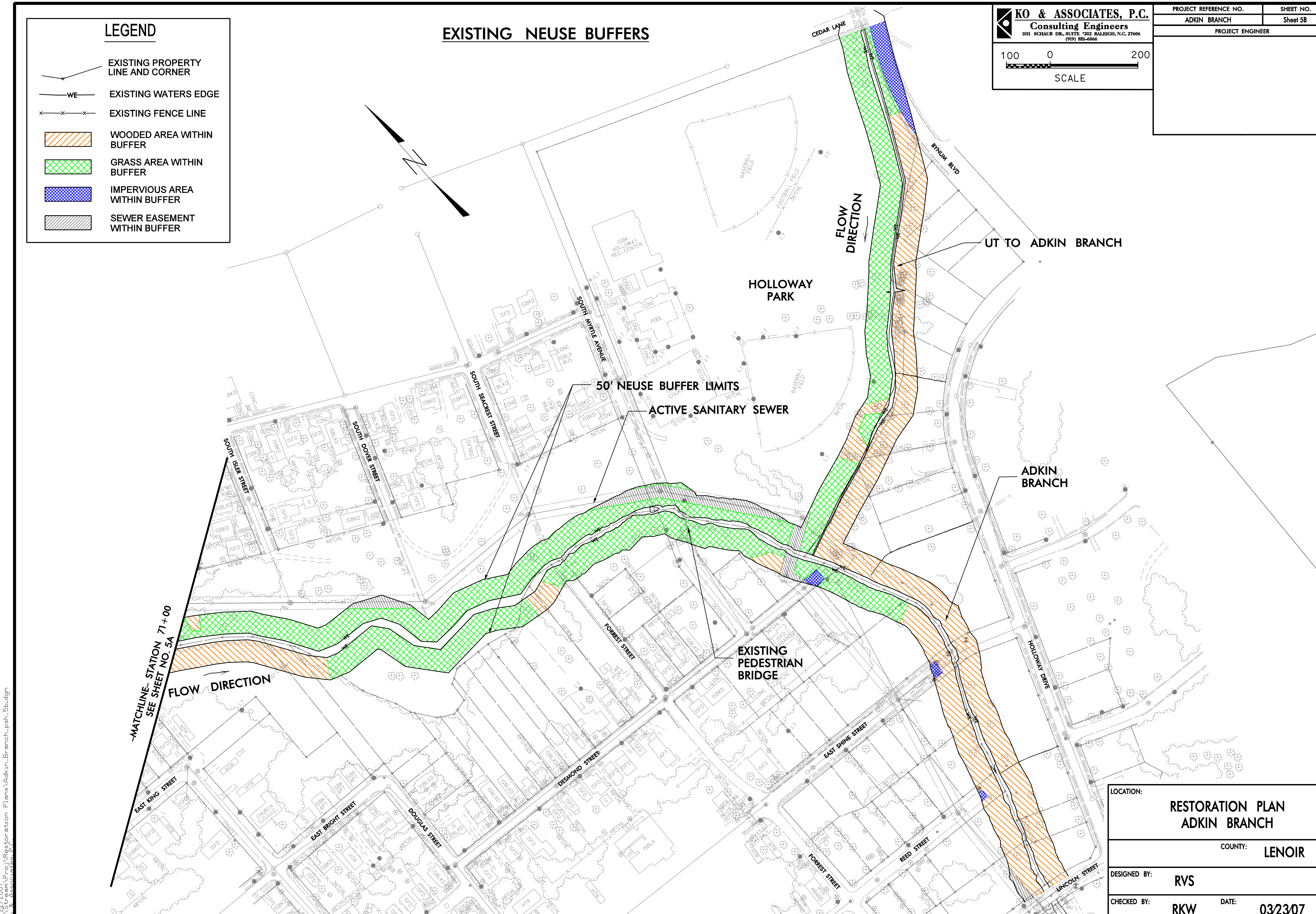
CHECKED BY: RKW

DATE: 03/23/07

3/22/2007
K:\Stream\Proj\Restoration Plans\Adkin_Branch_psh_5.dgn


EXISTING NEUSE BUFFERS
LEGEND
EXISTING PROPERTY LINE AND CORNER
EXISTING WATERS EDGE
EXISTING FENCE LINE
WOODED AREA WITHIN BUFFER
GRASS AREA WITHIN BUFFER
IMPERVIOUS AREA WITHIN BUFFER
SEWER EASEMENT WITHIN BUFFER
KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606
(919) 851-6066
100 0 200
SCALE
PROJECT REFERENCE NO.
SHEET NO.
ADKIN BRANCH
Sheet 5A
PROJECT ENGINEER
ACTIVE SANITARY SEWER
50' NEUSE BUFFER LIMITS
-MATCHLINE- STATION 71+00 SEE SHEET NO. 5B
EXISTING PEDESTRIAN BRIDGE
ROCHELLE BLVD
SOUTH MELVIN STREET
SOUTH ROCHELLE BLVD
ACTIVE SANITARY SEWER
ROCHELLE MIDDLE SCHOOL PARK
ADKIN BRANCH
SYCAMORE STREET
SOUTH CYPRESS STREET
NORTH CYPRESS STREET
LOVITT HINES PARK
FLOW DIRECTION
-MATCHLINE- STATION 38+00 SEE SHEET NO. 5
PINE STREET
CLAY STREET
MILLER STREET
ELM STREET
MULBERRY STREET
HICKS AVENUE
CHESTNUT STREET
EAST GORDON STREET
SYCAMORE ROAD
EAST CASWELL STREET
CASWELL STREET
WATERS STREET
EAST KING STREET
TOWERHILL ROAD
LOCATION:
RESTORATION PLAN
ADKIN BRANCH
COUNTY: LENOIR
DESIGNED BY: RVS
CHECKED BY: RKW
DATE: 03/23/07

EXISTING NEUSE BUFFERS



KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE 202 RALEIGH, N.C. 27606
(919) 851-6066

PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 5B
PROJECT ENGINEER	

LOCATION:
RESTORATION PLAN
ADKIN BRANCH

COUNTY: LENOIR

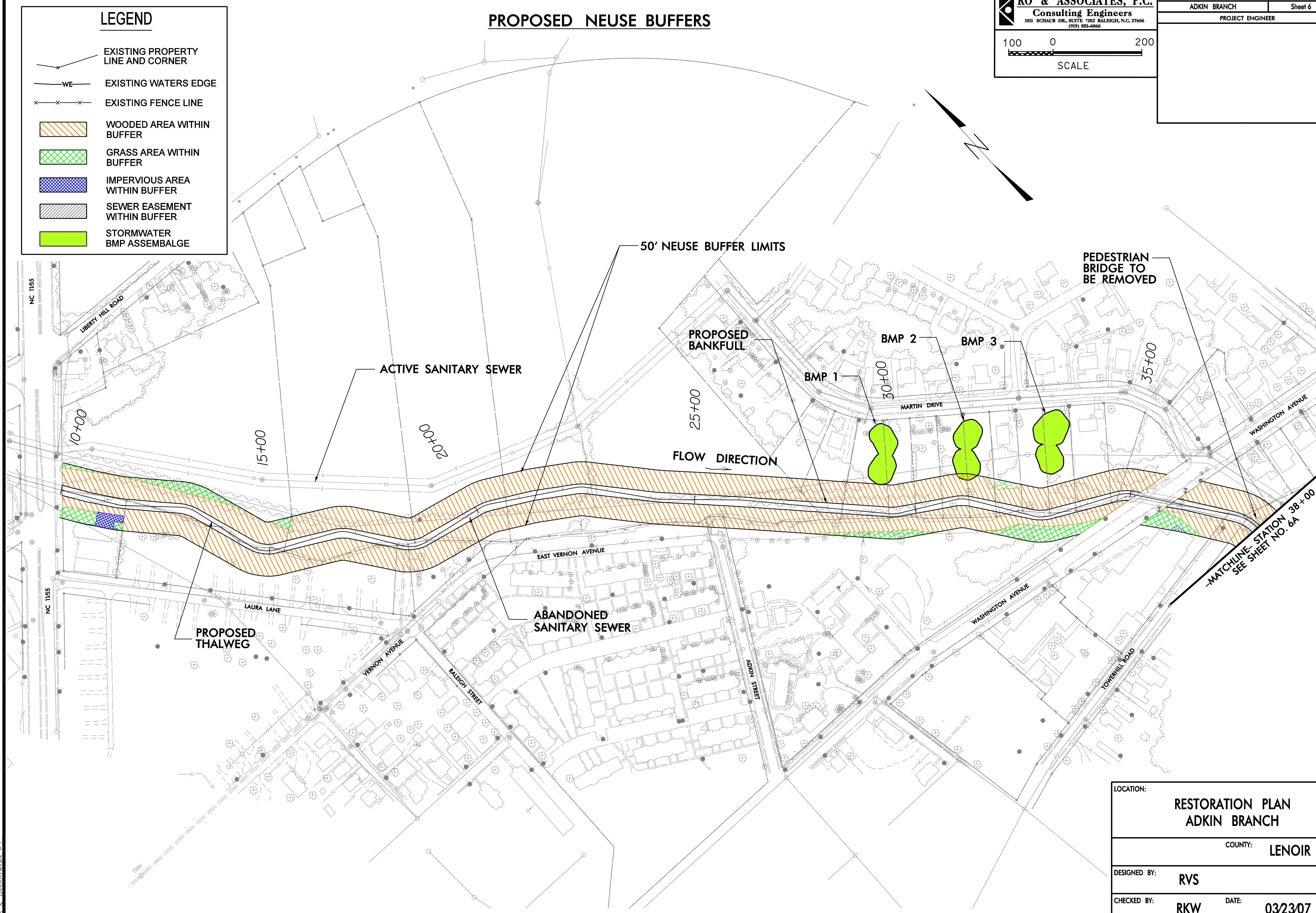
DESIGNED BY: RVS

CHECKED BY: RKW DATE: 03/23/07

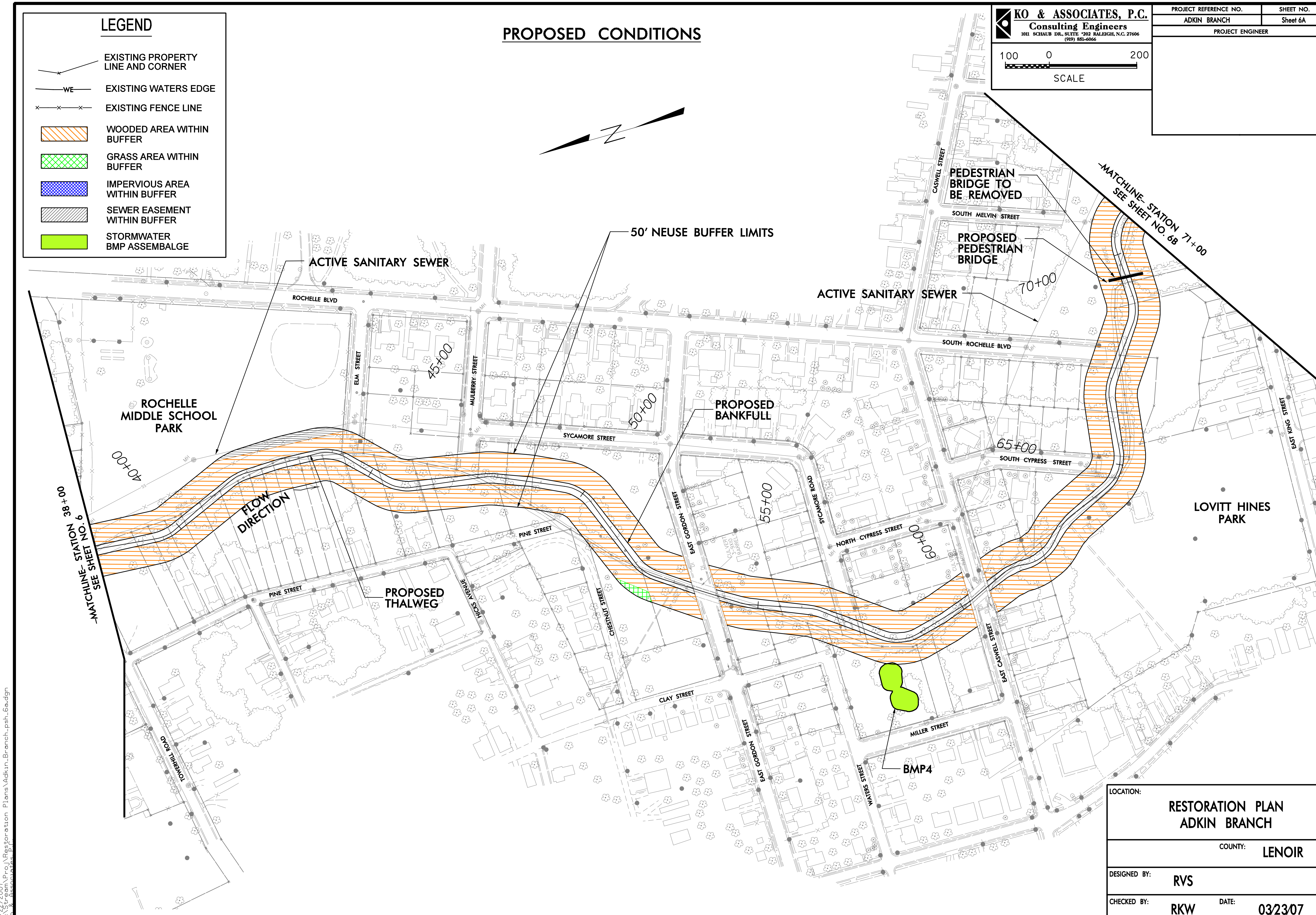
3/22/2007
R:\Stream\Proj\Restoration Plans\Adkin_Branch_psh_5b.dgn

KO & ASSOCIATES, P.C. Consulting Engineers 1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606 (919) 851-6066	PROJECT REFERENCE NO.	SHEET NO.
	ADKIN BRANCH	Sheet 6
	PROJECT ENGINEER	

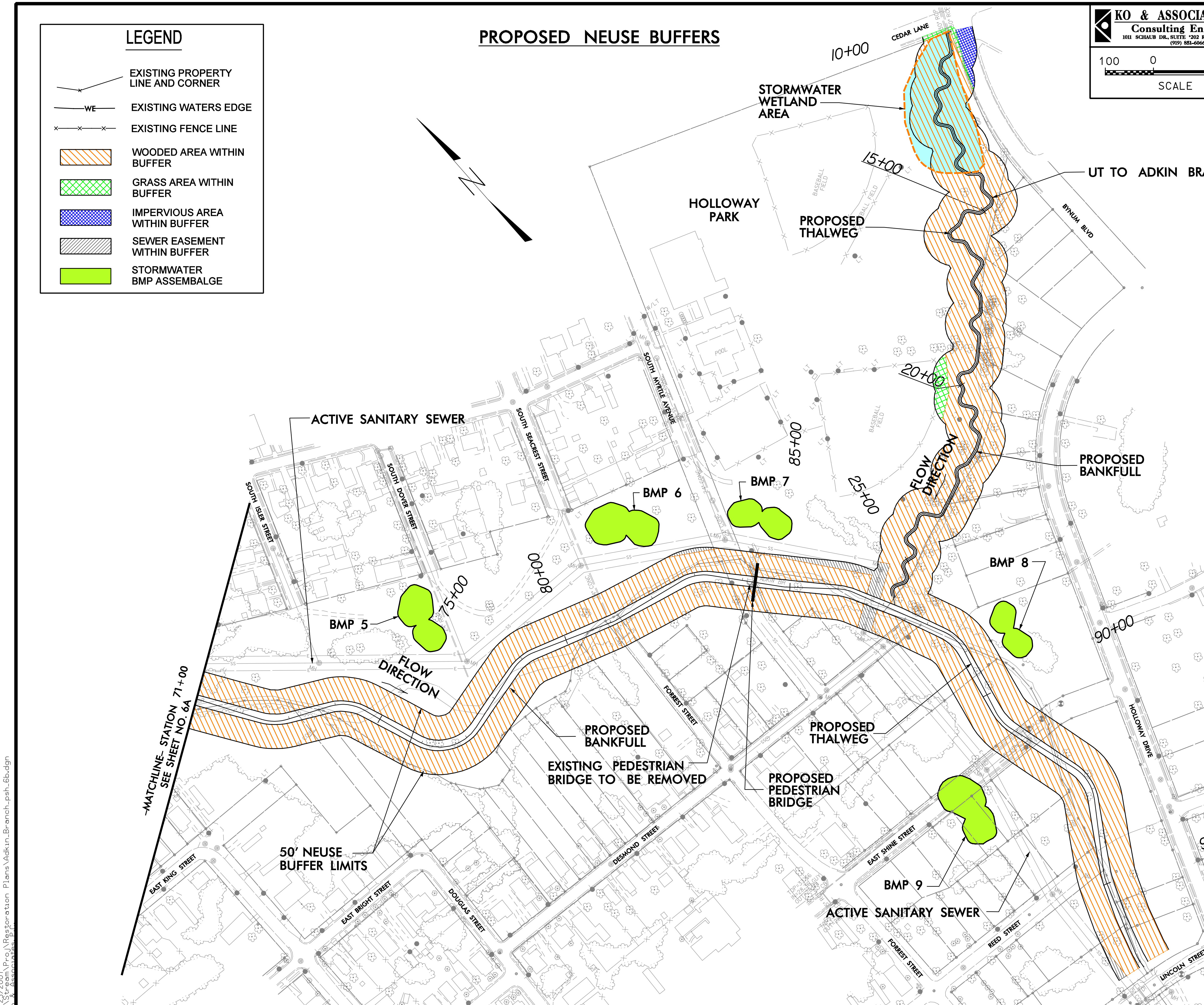
PROPOSED NEUSE BUFFERS



LOCATION:	RESTORATION PLAN ADKIN BRANCH		
	COUNTY:	LENOIR	
DESIGNED BY:	RVS		
CHECKED BY:	RKW	DATE:	03/23/07



PROPOSED CONDITIONS
LEGEND
EXISTING PROPERTY LINE AND CORNER
EXISTING WATERS EDGE
EXISTING FENCE LINE
WOODED AREA WITHIN BUFFER
GRASS AREA WITHIN BUFFER
IMPERVIOUS AREA WITHIN BUFFER
SEWER EASEMENT WITHIN BUFFER
STORMWATER BMP ASSEMBALGE
KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606
(919) 851-6066
PROJECT REFERENCE NO.
ADKIN BRANCH
SHEET NO.
Sheet 6A
PROJECT ENGINEER
100 0 200
SCALE
ACTIVE SANITARY SEWER
50' NEUSE BUFFER LIMITS
PEDESTRIAN BRIDGE TO BE REMOVED
PROPOSED PEDESTRIAN BRIDGE
ACTIVE SANITARY SEWER
MATCHLINE- STATION 71+00 SEE SHEET NO. 6B
ROCHELLE BLVD
SOUTH MELVIN STREET
SOUTH ROCHELLE BLVD
CASWELL STREET
ELM STREET
MULBERRY STREET
SYCAMORE STREET
SYCAMORE ROAD
SOUTH CYPRESS STREET
NORTH CYPRESS STREET
EAST KING STREET
ROCHELLE MIDDLE SCHOOL PARK
PROPOSED BANKFULL
LOVITT HINES PARK
40+00
45+00
50+00
55+00
60+00
65+00
70+00
MATCHLINE- STATION 38+00 SEE SHEET NO. 6
FLOW DIRECTION
PINE STREET
PINE STREET
EAST GORDON STREET
PROPOSED THALWEG
HICKS AVENUE
CHESTNUT STREET
EAST CASWELL STREET
CLAY STREET
MILLER STREET
TOWERHILL ROAD
EAST GORDON STREET
WATERS STREET
BMP4
LOCATION:
RESTORATION PLAN
ADKIN BRANCH
COUNTY:
LENOIR
DESIGNED BY:
RVS
CHECKED BY:
RKW
DATE:
03/23/07



KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606
(919) 851-6066

100 0 200
SCALE

PROJECT REFERENCE NO.	SHEET NO.
ADKIN BRANCH	Sheet 6B
PROJECT ENGINEER	

LOCATION:
RESTORATION PLAN
ADKIN BRANCH

COUNTY: LENOIR

DESIGNED BY: RVS

CHECKED BY: RKW DATE: 03/23/07

3/23/2007
K:\Stream\Proj\Restoration Plans\Adkin_Branch_psh_6b.dgn

APPENDIX A
ADKIN BRANCH SITE PHOTOGRAPHS

Adkin Branch Looking Downstream near NC11/55

Erosion along Adkin Branch Banks - Looking Downstream

Adkin Branch Looking Downstream near Charter School

Erosion along Adkin Branch Banks - Looking Downstream

Existing Storm System Outfall

Adkin Branch - Looking Upstream

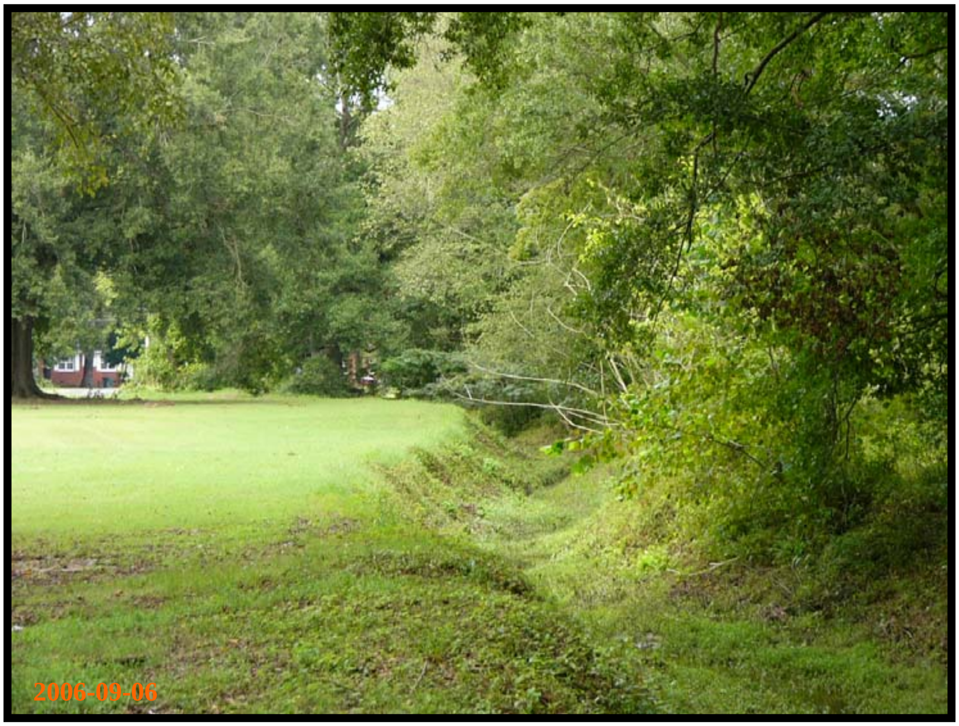
Adkin Branch Looking Upstream near Gordon Street

Adkin Branch Looking Upstream near Gordon Street

Existing Pedestrian Bridge near Washington Street

Existing Culvert Crossing with Timber Retaining Walls

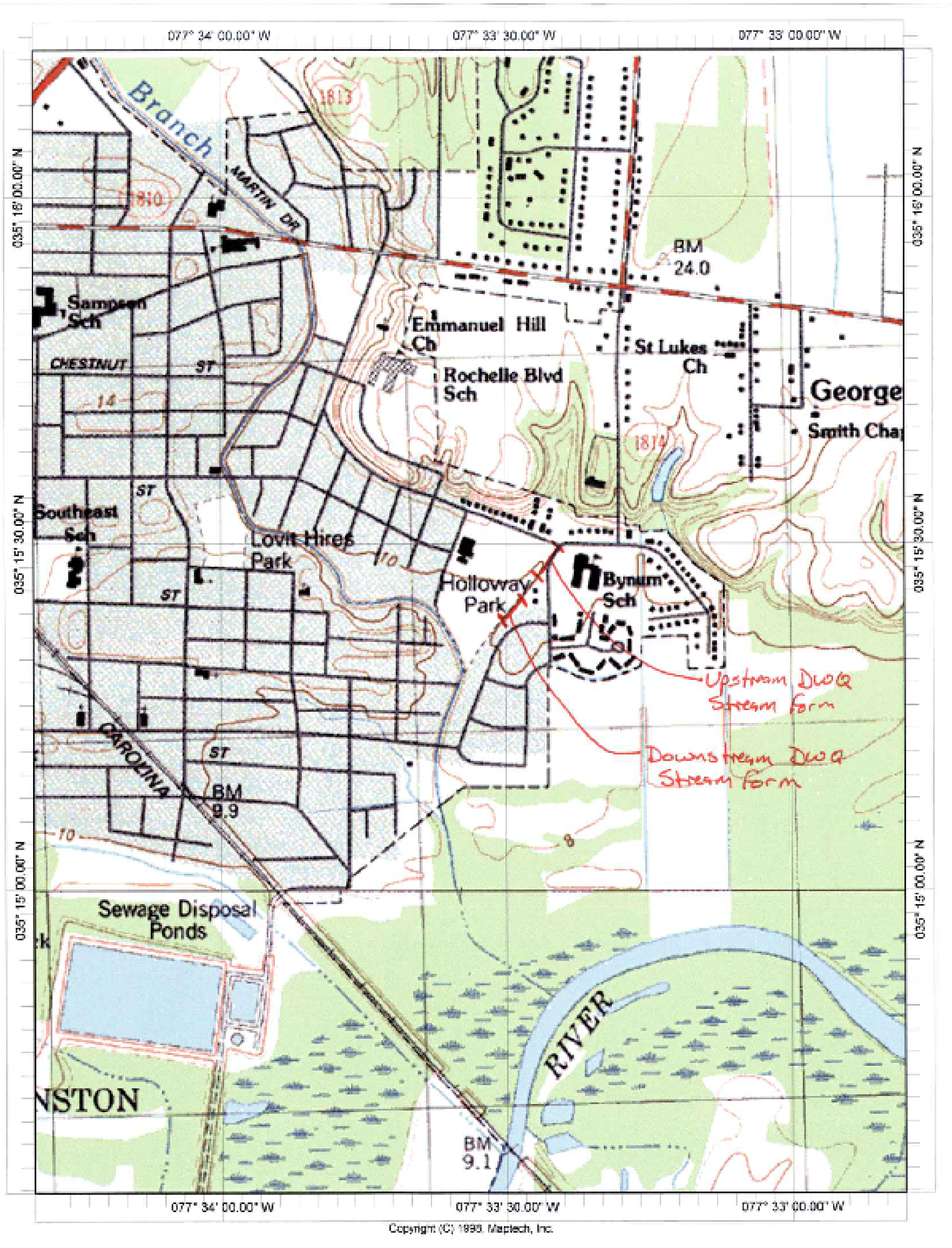
UT to Adkin Branch: Overwidened (F type) channel.



UT to Adkin Branch: Channelized and Incised Reach

APPENDIX B
RESTORATION SITE NCDWQ STREAM CLASSIFICATION FORMS

1. Stream Forms Location Map
2. Stream Forms
3. Email Documenting Perennial Status Determination of UT to Adkin Branch


077° 34' 00.00" W
077° 33' 30.00" W
077° 33' 00.00" W
035° 16' 00.00" N
035° 15' 30.00" N
035° 15' 00.00" N
Branch
MARTIN DR
Sampson Sch
CHESTNUT ST
Emmanuel Hill Ch
Rochelle Blvd Sch
St Lukes Ch
George
Smith Cha
BM 24.0
Southeast Sch
Lovit Hires Park
Holloway Park
Bynum Sch
Upstream DWQ Stream form
Downstream DWQ Stream form
CAROLINA
BM 9.9
Sewage Disposal Ponds
NSTON
RIVER
BM 9.1
Copyright (C) 1998, Maptech, Inc.

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date:	7/20/06	Project:	Adkin Branch	Latitude:	35° 15' 53"
Evaluator:	Axiom	Site:	Adkin Branch	Longitude:	77° 33' 49"
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30*	39.5	County:	Lenoir	Other *e.g. Quad Name:*	Kinston

A. Geomorphology (Subtotal = 20)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	0	(1)	2	3
4. Soil texture or stream substrate sorting	0	1	(2)	3
5. Active/relic floodplain	0	1	(2)	3
6. Depositional bars or benches	0	1	~~(2)~~	(3)
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	1	(2)	3
9[a] Natural levees	0	(1)	2	3
10. Headcuts	(0)	1	2	3
11. Grade controls	0	(0.5)	1	1.5
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		(Yes = 3)	

[a]Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7)	Absent	Weak	Moderate	Strong
14. Groundwater flow/discharge	(0)	1	2	3
15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season	0	1	2	(3)
16. Leaflitter	(1.5)	1	0.5	0
17. Sediment on plants or debris	0	0.5	(1)	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	(1.5)
19. Hydric soils (redoximorphic features) present?	(No = 0)		Yes = 1.5	

C. Biology (Subtotal = 12.5)	Absent	Weak	Moderate	Strong
20[b]. Fibrous roots in channel	(3)	2	1	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	0	0.5	(1)	1.5
23. Bivalves	(0)	1	2	3
24. Fish	0	0.5	(1)	1.5
25. Amphibians	0	0.5	(1)	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	(1)	1.5
27. Filamentous algae; periphyton	0	0.5	(1)	1.5
28. Iron oxidizing bacteria/fungus.	0	0.5	(1)	1.5
29[b]. Wetland plants in streambed	(FAC = 0.5); FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b]Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 6-20-06	Project: UT to Adkin Branch	Latitude: 035° 15' 25.68" N
Evaluator: Ryan Smith	Site: Holloway Park Downstream	Longitude: 077° 33' 28.62 W
Total Points: 25.25 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30*	County: Lenoir	Other *e.g. Quad Name:* Kinston

A. Geomorphology (Subtotal = 17)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	1	(2)	3
3. In-channel structure: riffle-pool sequence	0	1	(2)	3
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	(2)	3
6. Depositional bars or benches	0	1	2	(3)
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	(1)	2	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	(0)	1	2	3
11. Grade controls	(0)	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	(1)	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 4.5)	Absent	Weak	Moderate	Strong
14. Groundwater flow/discharge	0	(1)	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	(1)	2	3
16. Leaflitter	1.5	(1)	0.5	0
17. Sediment on plants or debris	(0)	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	(0)	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		(Yes = 1.5)	

C. Biology (Subtotal = 3.75)	Absent	Weak	Moderate	Strong
20[b]. Fibrous roots in channel	3	2	(1)	0
21[b]. Rooted plants in channel	3	2	(1)	0
22. Crayfish	(0)	0.5	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	0	0.5	(1)	1.5
25. Amphibians	(0)	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	(0)	0.5	1	1.5
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; (FACW = 0.75); OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

- Form completed on a ~300' section of the UT that is ~400' downstream of culvert @ Cedar Lane. This section of channel displays a natural bankfull and low flow channel.

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 6-20-06	Project: UT to Adkin Branch	Latitude: 035° 15' 29.78" N
Evaluator: Ryan Smith	Site: Holloway Park Upstream	Longitude: 077° 33' 25.15 W
Total Points: 22.25 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30*	County: Lenoir	Other *e.g. Quad Name:* Kinston

A. Geomorphology (Subtotal = 13)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	0	(1)	2	3
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	(2)	3
6. Depositional bars or benches	0	(1)	2	3
7. Braided channel	0	(1)	2	3
8. Recent alluvial deposits	(0)	1	2	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	(0)	1	2	3
11. Grade controls	(0)	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	(1)	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 5.5)				
14. Groundwater flow/discharge	0	(1)	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	(1)	2	3
16. Leaflitter	1.5	(1)	0.5	0
17. Sediment on plants or debris	0	(0.5)	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	(0.5)	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		(Yes = 1.5)	

C. Biology (Subtotal = 3.75)				
20[b]. Fibrous roots in channel	3	(2)	1	0
21[b]. Rooted plants in channel	3	2	1	(0)
22. Crayfish	(0)	0.5	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	0	0.5	(1)	1.5
26. Macrobenthos (note diversity and abundance)	(0)	0.5	1	1.5
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; (FACW = 0.75); OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

Form completed on a ~200' section of the UT directly downstream of the culvert @ Cedar Lane. This section of the channel is overwidened and has no to little base flow channel b/c carex, juncus and polygonum have grown in the channel and choked off natural flow.

-----Original Message-----
From: Garcy.Ward [mailto:garcy.ward@ncmail.net]
Sent: Tuesday, August 08, 2006 4:46 PM
To: Ryan Smith
Cc: Chris Pullinger; William. G. Wescott; julia.hunt@ncmail.net
Subject: Re: UT to Adkin Branch

Ryan
We rated the UT to Adkins Branch today. It was much drier than when we were there in June but there were still pockets of water in stretches, particularly farther downstream. We got a rating of 27 on the Stream Identification Form. This was taking into account the whole 1200' length from the culvert down to where it emptied into Adkins Branch and trying to come up with an average for this entire stretch. Given the modified nature of the stream and the time of year, we feel this is a sufficient enough score to warrant perennial status. Feel free to give me a call if you have any questions.

Garcy

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: Aug. 8, 2006	Project: UT to Adkin Br	Latitude: 35.25745
Evaluator: G. Ward, C. Pullinger	Site: Holloway Park Kinston	Longitude: 77.55754
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 27	County: Lenoir	Other *e.g. Quad Name:*

A. Geomorphology (Subtotal = 11.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	(2)	3
2. Sinuosity	0	1	(2)	3
3. In-channel structure: riffle-pool sequence	0	(1)	2	3
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	(1)	2	3
6. Depositional bars or benches	0	(1)	2	3
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	(0)	1	2	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	(0)	1	2	3
11. Grade controls	0	(0.5)	1	1.5
12. Natural valley or drainageway	0	0.5	(1)	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = (0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 9)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	2	(3)
16. Leaflitter	1.5	1	(0.5)	0
17. Sediment on plants or debris	0	(0.5)	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	(0.5)	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = (1.5)	

C. Biology (Subtotal = 6.5)				
20[b]. Fibrous roots in channel	3	(2)	1	0
21[b]. Rooted plants in channel	3	2	1	(0)
22. Crayfish	0	(0.5)	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	0	0.5	(1)	1.5
25. Amphibians	0	0.5	(1)	1.5
26. Macrobenthos (note diversity and abundance)	0	(0.5)	1	1.5
27. Filamentous algae; periphyton	0	(1)	2	3
28. Iron oxidizing bacteria/fungus.	0	(0.5)	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = (0)			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

- mosquitofish only fish caught
- Snapping turtle ~3"
- stream ~1200' from Road to Adkins Br.
we rated the whole 1200' segment

Sketch:

APPENDIX C

RESTORATION SITE CONCURRENCE LETTERS

1. NCWRC Letter
2. NCSHPO Letter

North Carolina Wildlife Resources Commission

Richard B. Hamilton, Executive Director

MEMORANDUM

To: W. Grant Lewis
Axiom Environmental, Inc.
2126 Rowland Pond Drive
Willow Spring, NC 27592

From: Steven H. Everhart, PhD
Southeastern Permit Coordinator
Habitat Conservation Program
127 Cardinal Drive
Wilmington, NC 28405

Date: August 29, 2006

RE: Adkin Branch Stream Restoration Project, Lenoir County

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have reviewed the subject project for impacts to wildlife and fishery resources. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.), and Sections 401 and 404 of the Clean Water Act (as amended).

The project is located just inside the city limits of Kinston, in its southeastern quadrant. Adkin Branch is a tributary of the Neuse River. A letter and vicinity map was submitted for review of fish and wildlife issues associated with the project.

The applicant proposes to restore approximately 12,000 linear feet of Adkin Branch. The reach has been channelized to promote rapid drainage resulting in channel incision and subsequent lateral bank erosion and channel downcutting. The stated goals of the project are:

- Construction of a stable, riffle-pool stream channel

- Enhancement of water quality functions

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

- Restoration of wildlife habitat
- Implementation of best management practices concerning stormwater retention
- Coordination with the City of Kinston

Although there is a 2003 bald eagle (F-T; NC-T) record about one-half mile from the southern extent of the project area, there do not appear to be any threatened or endangered species that would be impacted by the project and we do not foresee any fish and wildlife issues that might arise from the project. Thank you for the opportunity to review and comment on this project. If you have any questions or require additional information regarding these comments, please call me at (910) 796-7217.

North Carolina Department of Cultural Resources
State Historic Preservation Office
Peter B. Sandbeck, Administrator

Michael F. Easley, Governor
Lisbeth C. Evans, Secretary
Jeffrey J. Crow, Deputy Secretary

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

March 1, 2007

Grant W. Lewis
Axiom Environmental, Inc.
2126 Rowland Pond Drive Willow Spring
Raleigh, NC 27592

Re: Follow-up visit Adkin Branch Stream Restoration Project, Lenoir County, ER 06-2189

Dear Mr. Lewis:

Based on your meeting today with our Environmental Review Specialist, Juliana Hoekstra, we find the proposed undertaking is unlikely to affect any historic resources of the National Register-listed Queen Gordon Street Historic District. We, therefore, have no comment on the proposed undertaking.

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 comments, please contact Renee Gledhill-Early, environmental review coordinator, at 919-733-4763, ext. 246. In all future communication concerning this project, please remember to cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

Peter Sandbeck

	Location	Mailing Address	Telephone/Fax
ADMINISTRATION	507 N. Blount Street, Raleigh NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-4763/733-8653
RESTORATION	515 N. Blount Street, Raleigh NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-6547/715-4801
SURVEY & PLANNING	515 N. Blount Street, Raleigh, NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-6545/715-4801

APPENDIX D
REFERENCE SITE PHOTOGRAPHS
1. Johnson Mill Run
2. UT to Wildcat Creek

Johnson Mill Run Reference Site – Looking Downstream

Johnson Mill Run Reference Site – Looking Upstream

Johnson Mill Run Reference Site – Looking Downstream

Johnson Mill Run Reference Site - Looking Upstream

UT to Wildcat Branch Reference Site – Looking Upstream

UT to Wildcat Branch Reference Site – Looking Upstream

APPENDIX E

REFERENCE SITE NCDWQ STREAM CLASSIFICATION FORMS

1. Johnson Mill Run
2. UT to Wildcat Creek

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 8/8/06	Project: Adkin Branch	Latitude: 35° 39' 23"
Evaluator: Axiom Env.	Site: Adkin Reference	Longitude: 77° 24' 36"
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 42.5	County: Pitt	Other *e.g. Quad Name:* Greenville NW

A. Geomorphology (Subtotal = 22.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	**3**
2. Sinuosity	0	1	**2**	3
3. In-channel structure: riffle-pool sequence	0	1	**2**	3
4. Soil texture or stream substrate sorting	0	1	**2**	3
5. Active/relic floodplain	0	1	**2**	3
6. Depositional bars or benches	0	1	2	**3**
7. Braided channel	**0**	1	2	3
8. Recent alluvial deposits	0	**1**	2	3
9[a] Natural levees	0	1	**2**	3
10. Headcuts	**0**	1	2	3
11. Grade controls	0	0.5	**1**	1.5
12. Natural valley or drainageway	0	0.5	1	**1.5**
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		**Yes = 3**	

[a]Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7)	Absent	Weak	Moderate	Strong
14. Groundwater flow/discharge	**0**	1	2	3
15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season	0	1	2	**3**
16. Leaflitter	**1.5**	1	0.5	0
17. Sediment on plants or debris	0	0.5	**1**	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	**1.5**
19. Hydric soils (redoximorphic features) present?	**No = 0**		Yes = 1.5	

C. Biology (Subtotal = 13)	Absent	Weak	Moderate	Strong
20[b]. Fibrous roots in channel	**3**	2	1	0
21[b]. Rooted plants in channel	**3**	2	1	0
22. Crayfish	0	0.5	1	**1.5**
23. Bivalves	**0**	1	2	3
24. Fish	0	0.5	**1**	1.5
25. Amphibians	0	0.5	**1**	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	**1**	1.5
27. Filamentous algae; periphyton	0	0.5	**1**	1.5
28. Iron oxidizing bacteria/fungus.	0	0.5	**1**	1.5
29[b]. Wetland plants in streambed	**FAC = 0.5**; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

KO & ASSOCIATES, P.C.
Consulting Engineers

NCDWQ Stream Classification Form S500

Project Name: UT to Wildcat Branch River Basin: Lumber County: Robeson Evaluators: R. Smith

DWQ Project Number: N/A Nearest Named Stream: Wildcat Branch Latitude: 34°42'36.63"N Signature:

Date: 8/2/04 USGS QUAD: Northeast Lumberton Longitude: 78°52'55.14"W

Location/Directions:

***PLEASE NOTE:** *If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgment of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used**

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Riffle-Pool Sequence?	0	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	1	2	3
3) Are Natural Levees Present?	0	1	2	3
4) Is The Channel Sinuous?	0	1	2	3
5) Is There An Active (Or Relic) Floodplain Present?	0	1	2	3
6) Is The Channel Braided?	0	1	2	3
7) Are Recent Alluvial Deposits Present?	0	1	2	3
8) Is There A Bankfull Bench Present?	0	1	2	3
9) Is A Continuous Bed & Bank Present?	0	1	2	3
*(*NOTE: If Bed & Bank Caused By Ditching And WITHOUT Sinuosity Then Score=0*)*				
10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map *And/Or* In Field) Present?	*Yes*=3		*No*=0	

***PRIMARY GEOMORPHOLOGY INDICATOR POINTS:* 21**

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	3

***PRIMARY HYDROLOGY INDICATOR POINTS:* 2**

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fibrous Roots Present In Streambed?	3	2	1	0
2) Are Rooted Plants Present In Streambed?	3	2	1	0
3) Is Periphyton Present?	0	1	2	3
4) Are Bivalves Present?	0	1	2	3

***PRIMARY BIOLOGY INDICATOR POINTS:* 6**

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Head Cut Present In Channel?	0	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	.5	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	.5	1	1.5

***SECONDARY GEOMORPHOLOGY INDICATOR POINTS:* 2**

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	1	.5	0
2) Is Sediment On Plants (Or Debris) Present?	0	.5	1	1.5
3) Are Wrack Lines Present?	0	.5	1	1.5
4) Is Water In Channel *And* >48 Hrs. Since Last *Known* Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	1	1.5
5) Is There Water In Channel During Dry Conditions *Or* In Growing Season)?	0	.5	1	1.5
6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)?		*Yes*=1.5		*No*=0

***SECONDARY HYDROLOGY INDICATOR POINTS:* 9**

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fish Present?	0	.5	1	1.5
2) Are Amphibians Present?	0	.5	1	1.5
3) Are AquaticTurtles Present?	0	.5	1	1.5
4) Are Crayfish Present?	0	.5	1	1.5
5) Are Macrobenthos Present?	0	.5	1	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	0	.5	1	1.5
7) Is Filamentous Algae Present?	0	.5	1	1.5

8) Are Wetland Plants In Streambed? N/A	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	1	.75	.5	0	0

***SECONDARY BIOLOGY INDICATOR POINTS:* 7**

TOTAL POINTS (Primary + Secondary)= **46** *(If Greater Than Or Equal To 19 Points The Stream Is At Least Intermittent)*

APPENDIX F
HEC-RAS ANALYSIS

Adkin Branch: HEC-RAS SUMMARY TABLE

			DUPLICATE EFFECTIVE FEMA MODEL			CORRECTED/EXISTING MODEL			DIFFERENCE (Existing - Duplicate)		REVISED/PROPOSED MODEL			DIFFERENCE (Proposed - Existing)	
	SECNO	Q	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL	TOPWID
10-yr	18117	1180	53.21	636.25		53.21	636.35		0.00	0.10	53.21	636.26		0.00	-0.09
50-yr	18117	1870	54.11	807.03		54.11	807.24		0.00	0.21	54.11	806.97		0.00	-0.27
100-yr	18117	2080	54.32	836.80		54.32	836.01		0.00	-0.79	54.32	836.95		0.00	0.94
500-yr	18117	2650	54.83	917.93		54.83	917.90		0.00	-0.03	54.83	917.96		0.00	0.06
100-yr floodway	18117	2080	54.75	188.80	0.43	54.75	188.80	0.43	0.00	0.00	54.75	188.80	0.43	0.00	0.00
10-yr	17282	1400	52.66	451.40		52.67	451.57		0.01	0.17	52.66	451.42		-0.01	-0.15
50-yr	17282	2190	53.33	563.09		53.33	563.41		0.00	0.32	53.33	563.00		0.00	-0.41
100-yr	17282	2420	53.47	579.06		53.46	577.79		-0.01	-1.27	53.47	579.31		0.01	1.52
500-yr	17282	3040	53.83	622.27		53.83	622.22		0.00	-0.05	53.83	622.33		0.00	0.11
100-yr floodway	17282	2420	53.80	225.00	0.33	53.80	225.00	0.34	0.00	0.00	53.80	225.00	0.33	0.00	0.00
	NC 58														
10-yr	17176	1400	51.52	40.00		51.53	40.00		0.01	0.00	51.52	40.00		-0.01	0.00
50-yr	17176	2190	52.80	537.32		52.80	537.17		0.00	-0.15	52.80	537.36		0.00	0.19
100-yr	17176	2420	53.08	573.34		53.08	573.70		0.00	0.36	53.08	573.30		0.00	-0.40
500-yr	17176	3040	53.79	661.91		53.79	661.93		0.00	0.02	53.79	661.89		0.00	-0.04
100-yr floodway	17176	2420	53.54	225.00	0.46	53.54	225.00	0.46	0.00	0.00	53.54	225.00	0.46	0.00	0.00
10-yr	16674	1400	51.22	447.15		51.23	448.10		0.01	0.95	51.22	447.21		-0.01	-0.89
50-yr	16674	2190	52.46	578.63		52.46	578.57		0.00	-0.06	52.46	578.65		0.00	0.08
100-yr	16674	2420	52.72	592.99		52.73	593.21		0.01	0.22	52.72	592.97		-0.01	-0.24
500-yr	16674	3040	53.41	630.10		53.41	630.11		0.00	0.01	53.41	630.09		0.00	-0.02
100-yr floodway	16674	2420	53.20	342.48	0.48	53.21	342.48	0.48	0.01	0.00	53.21	342.48	0.49	0.00	0.00
10-yr	16253	1400	51.01	465.70		51.02	466.28		0.01	0.58	51.01	465.74		-0.01	-0.54
50-yr	16253	2190	52.21	523.92		52.21	523.88		0.00	-0.04	52.22	523.93		0.01	0.05
100-yr	16253	2420	52.47	532.05		52.47	532.20		0.00	0.15	52.47	532.04		0.00	-0.16
500-yr	16253	3040	53.14	553.36		53.14	553.36		0.00	0.00	53.14	553.35		0.00	-0.01
100-yr floodway	16253	2420	52.96	305.03	0.49	52.97	305.03	0.50	0.01	0.00	52.96	305.03	0.49	-0.01	0.00
10-yr	15603	1400	50.53	443.39		50.54	446.43		0.01	3.04	50.53	443.57		-0.01	-2.86
50-yr	15603	2190	51.62	541.02		51.62	540.95		0.00	-0.07	51.62	541.04		0.00	0.09
100-yr	15603	2420	51.85	549.03		51.86	549.29		0.01	0.26	51.85	549.00		-0.01	-0.29
500-yr	15603	3040	52.47	587.99		52.47	588.03		0.00	0.04	52.47	587.95		0.00	-0.08
100-yr floodway	15603	2420	52.38	287.28	0.53	52.39	287.28	0.53	0.01	0.00	52.38	287.28	0.53	-0.01	0.00
	Daniels St.														
10-yr	15527	1400	50.50	468.44		50.51	470.41		0.01	1.97	50.50	468.30		-0.01	-2.11
50-yr	15527	2190	51.62	545.18		51.62	545.10		0.00	-0.08	51.62	545.21		0.00	0.11
100-yr	15527	2420	51.86	553.76		51.86	553.89		0.00	0.13	51.85	553.50		-0.01	-0.39
500-yr	15527	3040	52.47	600.82		52.47	600.86		0.00	0.04	52.47	600.77		0.00	-0.09
100-yr floodway	15527	2420	52.36	287.28	0.50	52.37	287.28	0.51	0.01	0.00	52.37	287.28	0.52	0.00	0.00
10-yr	15380	1600	50.30	306.76		50.30	308.33		0.00	1.57	50.30	306.64		0.00	-1.69
50-yr	15380	2470	51.33	544.09		51.32	544.00		-0.01	-0.09	51.33	544.12		0.01	0.12
100-yr	15380	2720	51.56	551.50		51.57	551.63		0.01	0.13	51.56	551.23		-0.01	-0.40
500-yr	15380	3400	52.16	575.94		52.16	575.97		0.00	0.03	52.15	575.91		-0.01	-0.06
100-yr floodway	15380	2720	52.04	151.60	0.48	52.05	151.60	0.48	0.01	0.00	52.04	151.60	0.48	-0.01	0.00
10-yr	14824	1600	49.54	376.44		49.55	378.53		0.01	2.09	49.54	376.10		-0.01	-2.43
50-yr	14824	2470	50.17	463.83		50.16	462.69		-0.01	-1.14	50.17	464.14		0.01	1.45
100-yr	14824	2720	50.27	486.39		50.27	491.87		0.00	5.48	50.25	475.88		-0.02	-15.99
500-yr	14824	3400	50.55	568.20		50.55	568.60		0.00	0.40	50.55	567.53		0.00	-1.07
100-yr floodway	14824	2720	50.92	210.00	0.65	50.93	210.00	0.66	0.01	0.00	50.92	210.00	0.67	-0.01	0.00
	Highland Ave.														

APPENDIX F

Adkin Branch: HEC-RAS SUMMARY TABLE

			DUPLICATE EFFECTIVE FEMA MODEL			CORRECTED/EXISTING MODEL			DIFFERENCE (Existing - Duplicate)		REVISED/PROPOSED MODEL			DIFFERENCE (Proposed - Existing)	
	SECNO	Q	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL	TOPWID
10-yr	14735	1600	47.85	53.54		47.87	53.67		0.02	0.13	47.85	53.52		-0.02	-0.15
50-yr	14735	2470	48.88	299.26		48.89	300.19		0.01	0.93	48.88	299.01		-0.01	-1.18
100-yr	14735	2720	49.11	321.14		49.13	322.51		0.02	1.37	49.11	320.87		-0.02	-1.64
500-yr	14735	3400	49.71	389.02		49.73	391.27		0.02	2.25	49.71	388.60		-0.02	-2.67
100-yr floodway	14735	2720	49.99	210.00	0.88	50.01	210.00	0.88	0.02	0.00	49.98	210.00	0.87	-0.03	0.00
10-yr	14305	1600	47.12	629.69		47.14	635.72		0.02	6.03	47.11	627.05		-0.03	-8.67
50-yr	14305	2470	48.29	796.95		48.31	799.28		0.02	2.33	48.28	796.32		-0.03	-2.96
100-yr	14305	2720	48.57	824.06		48.60	826.90		0.03	2.84	48.56	823.49		-0.04	-3.41
500-yr	14305	3400	49.25	891.78		49.28	894.59		0.03	2.81	49.25	891.25		-0.03	-3.34
100-yr floodway	14305	2720	49.15	248.00	0.58	49.19	248.00	0.59	0.04	0.00	49.14	248.00	0.58	-0.05	0.00
10-yr	13846	1600	46.51	372.39		46.55	378.02		0.04	5.63	46.49	370.25		-0.06	-7.77
50-yr	13846	2470	47.74	484.30		47.78	486.02		0.04	1.72	47.73	483.83		-0.05	-2.19
100-yr	13846	2720	48.02	524.19		48.07	532.86		0.05	8.67	48.01	522.43		-0.06	-10.43
500-yr	13846	3400	48.71	640.50		48.75	645.82		0.04	5.32	48.70	639.49		-0.05	-6.33
100-yr floodway	13846	2720	48.63	195.52	0.61	48.69	195.52	0.62	0.06	0.00	48.61	195.52	0.60	-0.08	0.00
10-yr	13492	1600	46.03	337.44		46.10	338.67		0.07	1.23	46.01	337.04		-0.09	-1.63
50-yr	13492	2470	47.27	489.74		47.32	497.41		0.05	7.67	47.25	485.35		-0.07	-12.06
100-yr	13492	2720	47.55	517.55		47.61	522.94		0.06	5.39	47.54	516.44		-0.07	-6.50
500-yr	13492	3400	48.24	577.71		48.30	582.72		0.06	5.01	48.23	576.75		-0.07	-5.97
100-yr floodway	13492	2720	48.17	225.00	0.62	48.25	225.00	0.64	0.08	0.00	48.14	225.00	0.60	-0.11	0.00
10-yr	13100	1600	45.68	505.59		45.76	514.01		0.08	8.42	45.66	502.79		-0.10	-11.22
50-yr	13100	2470	46.91	622.87		46.98	627.67		0.07	4.80	46.89	620.87		-0.09	-6.80
100-yr	13100	2720	47.19	634.84		47.27	637.49		0.08	2.65	47.18	634.29		-0.09	-3.20
500-yr	13100	3400	47.88	657.74		47.95	662.90		0.07	5.16	47.87	657.21		-0.08	-5.69
100-yr floodway	13100	2720	47.74	225.00	0.55	47.84	225.00	0.57	0.10	0.00	47.70	225.00	0.52	-0.14	0.00
10-yr	12597	1660	45.02	288.44		45.14	310.19		0.12	21.75	44.98	281.06		-0.16	-29.13
50-yr	12597	2540	46.09	429.15		46.19	439.09		0.10	9.94	46.06	426.21		-0.13	-12.88
100-yr	12597	2800	46.32	513.85		46.44	553.12		0.12	39.27	46.30	487.58		-0.14	-65.54
500-yr	12597	3500	46.91	595.30		47.03	606.83		0.12	11.53	46.88	592.98		-0.15	-13.85
100-yr floodway	12597	2800	46.86	79.50	0.54	47.01	79.50	0.57	0.15	0.00	46.81	79.50	0.51	-0.20	0.00
10-yr	12205	1660	44.56	220.97		44.72	223.66		0.16	2.69	44.50	220.04		-0.22	-3.62
50-yr	12205	2540	45.50	240.34		45.66	249.75		0.16	9.41	45.45	238.43		-0.21	-11.32
100-yr	12205	2800	45.69	252.11		45.86	262.05		0.17	9.94	45.65	249.49		-0.21	-12.56
500-yr	12205	3500	46.16	294.40		46.36	323.18		0.20	28.78	46.12	288.45		-0.24	-34.73
100-yr floodway	12205	2800	46.25	130.43	0.56	46.45	130.43	0.59	0.20	0.00	46.17	130.43	0.52	-0.28	0.00
10-yr	11620	1660	43.98	618.65		44.03	620.35		0.05	1.70	43.89	614.54		-0.14	-5.81
50-yr	11620	2540	44.81	646.41		44.88	648.75		0.07	2.34	44.72	643.39		-0.16	-5.36
100-yr	11620	2800	44.95	651.16		45.04	654.05		0.09	2.89	44.87	648.27		-0.17	-5.78
500-yr	11620	3500	45.27	661.79		45.42	666.58		0.15	4.79	45.18	658.88		-0.24	-7.70
100-yr floodway	11620	2800	45.69	440.10	0.74	45.82	440.10	0.78	0.13	0.00	45.57	440.10	0.70	-0.25	0.00
	NC 55/11														
10-yr	11503	1660	41.86	210.98		41.75	207.08		-0.11	-3.90	41.66	204.07		-0.09	-3.01
50-yr	11503	2540	42.86	563.62		42.74	519.73		-0.12	-43.89	42.39	317.44		-0.35	-202.29
100-yr	11503	2800	43.08	604.31		42.99	591.21		-0.09	-13.10	42.57	383.69		-0.42	-207.52
500-yr	11503	3500	43.63	626.20		43.57	624.27		-0.06	-1.93	43.00	591.94		-0.57	-32.33
100-yr floodway	11503	2800	44.00	440.10	0.92	43.99	440.10	1.00	-0.01	0.00	43.40	440.10	0.83	-0.59	0.00

APPENDIX F

Adkin Branch: HEC-RAS SUMMARY TABLE

			DUPLICATE EFFECTIVE FEMA MODEL			CORRECTED/EXISTING MODEL			DIFFERENCE (Existing - Duplicate)		REVISED/PROPOSED MODEL			DIFFERENCE (Proposed - Existing)	
	SECNO	Q	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL	TOPWID
10-yr	11270	1860	41.59	897.19		41.40	920.25		-0.19	23.06	41.40	944.89		0.00	24.64
50-yr	11270	2830	42.70	1263.40		42.45	1077.98		-0.25	-185.42	42.21	1009.34		-0.24	-68.64
100-yr	11270	3110	42.94	1588.03		42.70	1285.22		-0.24	-302.81	42.42	1063.10		-0.28	-222.12
500-yr	11270	3870	43.46	2097.73		43.25	2038.26		-0.21	-59.47	42.93	1587.87		-0.32	-450.39
100-yr floodway	11270	3110	43.74	382.76	0.80	43.69	425.00	0.99	-0.05	42.24	43.12	382.76	0.70	-0.57	-42.24
10-yr	10705	1860	40.99	761.22		40.98	792.79		-0.01	31.57	40.48	737.77		-0.50	-55.02
50-yr	10705	2830	42.10	1164.59		42.04	980.64		-0.06	-183.95	41.41	826.15		-0.63	-154.49
100-yr	10705	3110	42.37	1294.88		42.29	1097.21		-0.08	-197.67	41.63	852.90		-0.66	-244.31
500-yr	10705	3870	42.88	1748.60		42.81	1574.45		-0.07	-174.15	42.18	1043.77		-0.63	-530.68
100-yr floodway	10705	3110	42.99	344.26	0.62	43.22	365.00	0.93	0.23	20.74	42.03	344.26	0.40	-1.19	-20.74
10-yr	10097	1860	40.23	505.32		40.25	563.55		0.02	58.23	39.50	421.41		-0.75	-142.14
50-yr	10097	2830	41.30	680.46		41.29	867.56		-0.01	187.10	40.44	589.70		-0.85	-277.86
100-yr	10097	3110	41.59	889.75		41.57	911.91		-0.02	22.16	40.65	625.90		-0.92	-286.01
500-yr	10097	3870	42.07	955.44		42.04	1000.03		-0.03	44.59	41.17	843.68		-0.87	-156.35
100-yr floodway	10097	3110	42.24	290.50	0.65	42.53	290.50	0.96	0.29	0.00	41.08	290.50	0.43	-1.45	0.00
10-yr	9559	2130	39.79	821.76		39.81	919.94		0.02	98.18	38.77	528.87		-1.04	-391.07
50-yr	9559	3180	40.84	1036.11		40.86	1064.52		0.02	28.41	39.69	902.07		-1.17	-162.45
100-yr	9559	3480	41.14	1118.32		41.15	1079.17		0.01	-39.15	39.88	934.63		-1.27	-144.54
500-yr	9559	4290	41.57	1231.54		41.58	1102.09		0.01	-129.45	40.42	1042.37		-1.16	-59.72
100-yr floodway	9559	3480	41.72	211.46	0.58	41.96	211.46	0.81	0.24	0.00	40.32	211.46	0.44	-1.64	0.00
10-yr	9001.5	2130	39.59	934.23		39.59	935.72		0.00	1.49	38.26	582.35		-1.33	-353.37
50-yr	9001.5	3180	40.60	1136.01		40.61	1137.81		0.01	1.80	38.93	793.55		-1.68	-344.26
100-yr	9001.5	3480	40.89	1191.02		40.90	1192.96		0.01	1.94	39.04	821.82		-1.86	-371.14
500-yr	9001.5	4290	41.27	1255.95		41.28	1257.68		0.01	1.73	39.35	883.85		-1.93	-373.83
100-yr floodway	9001.5	3480	41.44	390.10	0.55	41.71	390.10	0.81	0.27	0.00	39.64	390.10	0.60	-2.07	0.00
	Washington St.														
10-yr	8931.7	2130	39.58	986.18		39.59	987.95		0.01	1.77	37.16	73.81		-2.43	-914.14
50-yr	8931.7	3180	40.61	1187.00		40.62	1189.00		0.01	2.00	38.39	630.53		-2.23	-558.47
100-yr	8931.7	3480	40.90	1239.37		40.91	1241.05		0.01	1.68	38.67	792.58		-2.24	-448.47
500-yr	8931.7	4290	41.29	1296.48		41.30	1298.31		0.01	1.83	39.35	939.92		-1.95	-358.39
100-yr floodway	8931.7	3480	41.42	390.10	0.52	41.69	390.10	0.78	0.27	0.00	39.00	390.10	0.33	-2.69	0.00
10-yr	8764.3	2130	38.36	338.31		38.37	343.29		0.01	4.98					
50-yr	8764.3	3180	39.55	882.60		39.52	872.61		-0.03	-9.99					
100-yr	8764.3	3480	40.49	1444.05		40.51	1453.03		0.02	8.98					
500-yr	8764.3	4290	41.00	1532.04		41.02	1535.61		0.02	3.57					
100-yr floodway	8764.3	3480	40.81	160.00	0.32	41.15	160.00	0.64	0.34	0.00					
	Towerhill Rd.														
10-yr	8739.3	2130	38.38	366.28		38.39	371.78		0.01	5.50					
50-yr	8739.3	3180	39.49	880.35		39.61	920.45		0.12	40.10					
100-yr	8739.3	3480	39.75	975.58		39.90	1102.04		0.15	126.46					
500-yr	8739.3	4290	40.36	1405.97		40.54	1465.37		0.18	59.40					
100-yr floodway	8739.3	3480	40.17	160.00	0.42	40.75	160.00	0.85	0.58	0.00					
10-yr	8411	2130	37.08	319.85		37.78	362.57		0.70	42.72	36.52	277.50		-1.26	-85.07
50-yr	8411	3180	38.28	399.86		38.86	456.44		0.58	56.58	37.68	357.79		-1.18	-98.65
100-yr	8411	3480	38.56	476.52		39.11	481.58		0.55	5.06	37.93	370.19		-1.18	-111.39
500-yr	8411	4290	39.23	567.25		39.71	645.64		0.48	78.39	38.59	415.52		-1.12	-230.12
100-yr floodway	8411	3480	39.07	184.39	0.51	40.09	184.39	0.98	1.02	0.00	38.33	184.39	0.40	-1.76	0.00

Adkin Branch: HEC-RAS SUMMARY TABLE

			DUPLICATE EFFECTIVE FEMA MODEL			CORRECTED/EXISTING MODEL			DIFFERENCE (Existing - Duplicate)		REVISED/PROPOSED MODEL			DIFFERENCE (Proposed - Existing)	
	SECNO	Q	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL	TOPWID
10-yr	8127	2130	36.27	244.61		37.28	394.64		1.01	150.03	36.00	314.45		-1.28	-80.19
50-yr	8127	3180	37.45	351.61		38.30	464.58		0.85	112.97	37.18	387.29		-1.12	-77.29
100-yr	8127	3480	37.71	375.55		38.52	478.90		0.81	103.35	37.43	405.43		-1.09	-73.47
500-yr	8127	4290	38.36	434.51		39.09	514.07		0.73	79.56	38.07	451.13		-1.02	-62.94
100-yr floodway	8127	3480	38.27	116.52	0.56	39.22	116.52	0.70	0.95	0.00	37.80	116.52	0.37	-1.42	0.00
10-yr	7632	2130	35.56	429.91		35.59	413.66		0.03	-16.25	35.35	394.33		-0.24	-19.33
50-yr	7632	3180	36.77	538.04		36.82	564.98		0.05	26.94	36.59	549.66		-0.23	-15.32
100-yr	7632	3480	37.03	573.91		37.07	582.53		0.04	8.62	36.84	566.33		-0.23	-16.20
500-yr	7632	4290	37.65	662.04		37.75	629.48		0.10	-32.56	37.49	610.52		-0.26	-18.96
100-yr floodway	7632	3480	37.68	243.41	0.65	37.72	243.41	0.65	0.04	0.00	37.26	243.41	0.42	-0.46	0.00
10-yr	7253.7	2130	35.19	559.45		35.25	567.20		0.06	7.75	34.82	515.87		-0.43	-51.33
50-yr	7253.7	3180	36.38	810.76		36.38	811.38		0.00	0.62	36.05	777.21		-0.33	-34.17
100-yr	7253.7	3480	36.64	830.82		36.63	829.77		-0.01	-1.05	36.28	801.81		-0.35	-27.96
500-yr	7253.7	4290	37.26	965.09		37.28	968.52		0.02	3.43	36.97	881.17		-0.31	-87.35
100-yr floodway	7253.7	3480	37.40	380.00	0.76	37.43	380.00	0.80	0.03	0.00	36.83	380.00	0.55	-0.60	0.00
	Gordon St.														
10-yr	7187.4	2130	35.16	560.85		35.23	569.31		0.07	8.46	34.73	510.63		-0.50	-58.68
50-yr	7187.4	3180	36.37	813.70		36.38	814.41		0.01	0.71	36.04	781.25		-0.34	-33.16
100-yr	7187.4	3480	36.63	833.13		36.63	832.77		0.00	-0.36	36.27	804.98		-0.36	-27.79
500-yr	7187.4	4290	37.26	969.92		37.28	972.46		0.02	2.54	36.96	887.00		-0.32	-85.46
100-yr floodway	7187.4	3480	37.37	380.00	0.74	37.40	380.00	0.77	0.03	0.00	36.80	380.00	0.53	-0.60	0.00
10-yr	6855	2130	34.91	770.56		35.02	801.22		0.11	30.66	34.54	738.03		-0.48	-63.19
50-yr	6855	3180	36.17	897.32		36.20	888.94		0.03	-8.38	35.90	871.15		-0.30	-17.79
100-yr	6855	3480	36.42	918.36		36.44	917.40		0.02	-0.96	36.13	883.35		-0.31	-34.05
500-yr	6855	4290	37.05	980.59		37.08	979.30		0.03	-1.29	36.81	958.11		-0.27	-21.19
100-yr floodway	6855	3480	37.11	325.82	0.69	37.16	325.82	0.72	0.05	0.00	36.61	325.82	0.48	-0.55	0.00
10-yr	6557	2130	34.22	175.81		34.37	208.95		0.15	33.14	33.82	85.53		-0.55	-123.42
50-yr	6557	3180	35.10	453.76		35.19	482.87		0.09	29.11	34.78	329.66		-0.41	-153.21
100-yr	6557	3480	35.26	505.00		35.31	516.84		0.05	11.84	34.84	346.46		-0.47	-170.38
500-yr	6557	4290	35.57	662.52		35.66	678.86		0.09	16.34	35.14	465.54		-0.52	-213.32
100-yr floodway	6557	3480	36.15	160.00	0.89	36.23	160.00	0.92	0.08	0.00	35.49	160.00	0.65	-0.74	0.00
	Caswell St.														
10-yr	6499.5	2130	33.29	53.62		33.48	54.02		0.19	0.40	33.04	53.12		-0.44	-0.90
50-yr	6499.5	3180	34.46	209.16		34.62	269.38		0.16	60.22	34.02	95.09		-0.60	-174.29
100-yr	6499.5	3480	34.73	293.45		34.86	326.47		0.13	33.02	34.23	165.20		-0.63	-161.27
500-yr	6499.5	4290	35.42	519.51		35.49	632.11		0.07	112.60	34.72	291.18		-0.77	-340.93
100-yr floodway	6499.5	3480	35.40	160.00	0.67	35.54	160.00	0.68	0.14	0.00	34.58	147.77	0.35	-0.96	-12.23
10-yr	6177	2130	32.82	588.84		33.04	574.34		0.22	-14.50	32.41	532.12		-0.63	-42.22
50-yr	6177	3180	34.19	638.98		34.31	629.96		0.12	-9.02	33.50	591.64		-0.81	-38.32
100-yr	6177	3480	34.49	650.27		34.58	732.63		0.09	82.36	33.74	602.65		-0.84	-129.98
500-yr	6177	4290	35.23	875.98		35.25	925.80		0.02	49.82	34.35	631.46		-0.90	-294.34
100-yr floodway	6177	3480	35.12	350.00	0.63	35.25	350.00	0.67	0.13	0.00	34.13	350.00	0.39	-1.12	0.00
10-yr	5776	2130	32.44	444.26		32.62	493.43		0.18	49.17	31.43	402.78		-1.19	-90.65
50-yr	5776	3180	33.82	511.69		33.92	584.70		0.10	73.01	32.76	500.75		-1.16	-83.95
100-yr	5776	3480	34.13	525.00		34.17	602.80		0.04	77.80	33.01	517.50		-1.16	-85.30
500-yr	5776	4290	34.85	597.00		34.84	651.58		-0.01	54.58	33.63	563.87		-1.21	-87.71
100-yr floodway	5776	3480	34.81	285.34	0.68	34.88	285.34	0.71	0.07	0.00	33.49	285.34	0.48	-1.39	0.00

APPENDIX F

Adkin Branch: HEC-RAS SUMMARY TABLE

			DUPLICATE EFFECTIVE FEMA MODEL			CORRECTED/EXISTING MODEL			DIFFERENCE (Existing - Duplicate)		REVISED/PROPOSED MODEL			DIFFERENCE (Proposed - Existing)	
	SECNO	Q	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL	TOPWID
10-yr	5642	2130				32.47	349.29								
50-yr	5642	3180				33.72	444.63								
100-yr	5642	3480				33.96	464.04								
500-yr	5642	4290				34.59	518.97								
100-yr floodway	5642	3480				34.72	236.00	0.76							
10-yr	5615	2130				32.16	319.20								
50-yr	5615	3180				33.58	433.31								
100-yr	5615	3480				33.86	456.36								
500-yr	5615	4290				620.76	134.85								
100-yr floodway	5615	3480				34.54	236.00	0.68							
10-yr	5375	2130	32.20	282.88		31.70	250.72		-0.50	-32.16	30.60	221.70		-1.10	-29.02
50-yr	5375	3180	33.54	339.29		33.08	321.08		-0.46	-18.21	32.11	282.04		-0.97	-39.04
100-yr	5375	3480	33.83	350.11		33.33	333.97		-0.50	-16.14	32.35	292.76		-0.98	-41.21
500-yr	5375	4290	34.51	368.74		33.92	360.84		-0.59	-7.90	32.92	318.55		-1.00	-42.29
100-yr floodway	5375	3480	34.54	151.94	0.71	34.03	151.94	0.70	-0.51	0.00	32.95	151.94	0.60	-1.08	0.00
10-yr	4871	2270	31.77	474.32		31.42	507.59		-0.35	33.27	30.03	447.83		-1.39	-59.76
50-yr	4871	3360	33.12	586.21		32.84	666.73		-0.28	80.52	31.71	520.65		-1.13	-146.08
100-yr	4871	3680	33.39	627.65		33.08	676.34		-0.31	48.69	31.92	539.60		-1.16	-136.74
500-yr	4871	4510	34.05	692.43		33.66	698.61		-0.39	6.18	32.45	651.18		-1.21	-47.43
100-yr floodway	4871	3680	34.02	181.90	0.63	33.65	181.90	0.57	-0.37	0.00	32.55	181.90	0.63	-1.10	0.00
10-yr	4322	2270	31.23	275.07		30.98	389.44		-0.25	114.37	29.60	345.64		-1.38	-43.80
50-yr	4322	3360	32.53	314.89		32.43	450.26		-0.10	135.37	31.38	464.22		-1.05	13.96
100-yr	4322	3680	32.77	326.51		32.64	456.82		-0.13	130.31	31.57	466.60		-1.07	9.78
500-yr	4322	4510	33.34	357.77		33.16	469.38		-0.18	111.61	32.04	472.44		-1.12	3.06
100-yr floodway	4322	3680	33.40	198.48	0.63	33.17	198.48	0.53	-0.23	0.00	32.18	198.48	0.61	-0.99	0.00
10-yr	4194	2270									29.44	286.55			
50-yr	4194	3360									31.23	514.68			
100-yr	4194	3680									31.41	529.86			
500-yr	4194	4510									31.85	552.36			
100-yr floodway	4194	3680									32.07	212.14	0.66		
10-yr	4191	2270				30.72	311.46								
50-yr	4191	3360				32.17	565.81								
100-yr	4191	3680				32.38	573.82								
500-yr	4191	4510				32.89	595.82								
100-yr floodway	4191	3680				32.95	220.70	0.57							
10-yr	4166	2270				30.67	309.15								
50-yr	4166	3360				31.96	556.74								
100-yr	4166	3680				32.15	565.15								
500-yr	4166	4510				32.64	584.76								
100-yr floodway	4166	3680				32.81	220.70	0.66							
10-yr	4163	2270									29.35	283.58			
50-yr	4163	3360									31.16	507.06			
100-yr	4163	3680									31.34	524.37			
500-yr	4163	4510									31.79	549.82			
100-yr floodway	4163	3680									31.90	212.14	0.56		

Adkin Branch: HEC-RAS SUMMARY TABLE

			DUPLICATE EFFECTIVE FEMA MODEL			CORRECTED/EXISTING MODEL			DIFFERENCE (Existing - Duplicate)		REVISED/PROPOSED MODEL			DIFFERENCE (Proposed - Existing)	
	SECNO	Q	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL	TOPWID
10-yr	3858	2270	30.28	425.71		30.31	534.46		0.03	108.75	29.04	340.56		-1.27	-193.90
50-yr	3858	3360	31.67	580.00		31.63	993.00		-0.04	413.00	30.94	675.86		-0.69	-317.14
100-yr	3858	3680	31.87	615.88		31.81	1067.67		-0.06	451.79	31.10	718.35		-0.71	-349.32
500-yr	3858	4510	32.36	784.66		32.27	1247.36		-0.09	462.70	31.51	952.73		-0.76	-294.63
100-yr floodway	3858	3680	32.44	229.90	0.57	32.43	229.90	0.62	-0.01	0.00	31.67	229.90	0.57	-0.76	0.00
10-yr	3440	2270	29.37	432.99		29.68	535.17		0.31	102.18	28.78	265.35		-0.90	-269.82
50-yr	3440	3360	31.03	882.94		31.17	1056.96		0.14	174.02	30.76	991.99		-0.41	-64.97
100-yr	3440	3680	31.19	921.85		31.32	1078.33		0.13	156.48	30.90	1018.40		-0.42	-59.93
500-yr	3440	4510	31.61	1453.61		31.75	1663.28		0.14	209.67	31.28	1072.59		-0.47	-590.69
100-yr floodway	3440	3680	31.77	287.05	0.58	31.87	287.05	0.55	0.10	0.00	31.51	287.05	0.61	-0.36	0.00
10-yr	2915	2270	28.56	447.59		28.59	459.51		0.03	11.92	28.54	445.19		-0.05	-14.32
50-yr	2915	3360	30.61	1646.36		30.64	1277.39		0.03	-368.97	30.60	1257.53		-0.04	-19.86
100-yr	2915	3680	30.73	1690.19		30.76	1374.21		0.03	-315.98	30.72	1355.55		-0.04	-18.66
500-yr	2915	4510	31.10	1976.73		31.11	1634.80		0.01	-341.93	31.05	1602.44		-0.06	-32.36
100-yr floodway	2915	3680	31.33	440.00	0.60	31.35	440.00	0.59	0.02	0.00	31.35	440.00	0.63	0.00	0.00
10-yr	2812.1	2270				27.72	57.00				27.72	57.00		0.00	0.00
50-yr	2812.1	3360				30.09	617.74				30.09	617.74		0.00	0.00
100-yr	2812.1	3680				30.10	643.77				30.10	643.77		0.00	0.00
500-yr	2812.1	4510				30.11	679.58				30.11	679.58		0.00	0.00
100-yr floodway	2812.1	3680				31.08	200.00	0.98			31.08	200.00	0.98	0.00	0.00
10-yr	2807.1	2270	27.59	50.00											
50-yr	2807.1	3360	30.09	618.44											
100-yr	2807.1	3680	30.10	632.58											
500-yr	2807.1	4510	30.11	687.18											
100-yr floodway	2807.1	3680	31.08	200.00	0.98										
	Lincoln St.														
10-yr	2756.2	2270	26.79	50.00											
50-yr	2756.2	3360	27.89	231.24											
100-yr	2756.2	3680	28.05	249.55											
500-yr	2756.2	4510	28.43	295.36											
100-yr floodway	2756.2	3680	28.92	200.00	0.87										
10-yr	2751.2	2270				26.80	57.00				26.80	57.00		0.00	0.00
50-yr	2751.2	3360				27.86	228.15				27.86	228.15		0.00	0.00
100-yr	2751.2	3680				28.01	245.61				28.01	245.61		0.00	0.00
500-yr	2751.2	4510				28.39	289.84				28.39	289.84		0.00	0.00
100-yr floodway	2751.2	3680				28.91	197.00	0.90			28.91	197.00	0.90	0.00	0.00
10-yr	2692	2310	26.66	181.52		26.66	181.52		0.00	0.00	26.66	181.52		0.00	0.00
50-yr	2692	3430	27.46	295.49		27.46	295.49		0.00	0.00	27.46	295.49		0.00	0.00
100-yr	2692	3750	27.59	304.87		27.59	304.87		0.00	0.00	27.59	304.87		0.00	0.00
500-yr	2692	4600	27.94	329.94		27.94	329.94		0.00	0.00	27.94	329.94		0.00	0.00
100-yr floodway	2692	3750	28.58	188.00	0.99	28.58	188.00	0.99	0.00	0.00	28.58	188.00	0.99	0.00	0.00
10-yr	2308	2310	26.07	942.31		26.07	942.31		0.00	0.00	26.07	942.31		0.00	0.00
50-yr	2308	3430	26.93	1837.32		26.93	1837.32		0.00	0.00	26.93	1837.32		0.00	0.00
100-yr	2308	3750	27.13	1865.78		27.13	1865.78		0.00	0.00	27.13	1865.78		0.00	0.00
500-yr	2308	4600	27.69	2085.73		27.69	2085.73		0.00	0.00	27.69	2085.73		0.00	0.00
100-yr floodway	2308	3750	27.99	340.00	0.86	27.99	340.00	0.86	0.00	0.00	27.99	340.00	0.86	0.00	0.00

APPENDIX F

Adkin Branch: HEC-RAS SUMMARY TABLE

			DUPLICATE EFFECTIVE FEMA MODEL			CORRECTED/EXISTING MODEL			DIFFERENCE (Existing - Duplicate)		REVISED/PROPOSED MODEL			DIFFERENCE (Proposed - Existing)	
	SECNO	Q	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL NAVD 88	TOPWID	CWSEL NAVD 88	TOPWID	Surcharge	CWSEL	TOPWID
10-yr	1791	2310	24.81	686.74		24.81	686.74		0.00	0.00	24.81	686.74		0.00	0.00
50-yr	1791	3430	25.72	793.94		25.72	793.94		0.00	0.00	25.72	793.94		0.00	0.00
100-yr	1791	3750	25.95	820.47		25.95	820.47		0.00	0.00	25.95	820.47		0.00	0.00
500-yr	1791	4600	26.59	1318.97		26.59	1318.97		0.00	0.00	26.59	1318.97		0.00	0.00
100-yr floodway	1791	3750	26.49	300.00	0.54	26.49	300.00	0.54	0.00	0.00	26.49	300.00	0.54	0.00	0.00
10-yr	1054	2310	22.24	506.77		22.24	506.77		0.00	0.00	22.24	506.77		0.00	0.00
50-yr	1054	3430	23.30	570.38		23.30	570.38		0.00	0.00	23.30	570.38		0.00	0.00
100-yr	1054	3750	23.53	583.89		23.53	583.89		0.00	0.00	23.53	583.89		0.00	0.00
500-yr	1054	4600	24.10	651.19		24.10	651.19		0.00	0.00	24.10	651.19		0.00	0.00
100-yr floodway	1054	3750	24.14	373.10	0.61	24.14	373.10	0.61	0.00	0.00	24.14	373.10	0.61	0.00	0.00
10-yr	395	2310	20.75	1008.05		20.75	1008.05		0.00	0.00	20.75	1008.05		0.00	0.00
50-yr	395	3430	21.85	1349.07		21.85	1349.07		0.00	0.00	21.85	1349.07		0.00	0.00
100-yr	395	3750	22.08	1360.12		22.08	1360.12		0.00	0.00	22.08	1360.12		0.00	0.00
500-yr	395	4600	22.64	1383.94		22.64	1383.94		0.00	0.00	22.64	1383.94		0.00	0.00
100-yr floodway	395	3750	23.08	300.00	1.00	23.08	300.00	1.00	0.00	0.00	23.08	300.00	1.00	0.00	0.00
	FEMA FIS HECRAS FIRST CROSS SECTION														

APPENDIX F

APPENDIX G
BMP SUPPORTING DOCUMENTATION

Ryan Smith

From: Wescott, William G SAW [William.G.Wescott@saw02.usace.army.mil]
Sent: Thursday, August 10, 2006 7:02 AM
To: Ryan Smith
Cc: Kristie Corson; Kevin Williams
Subject: RE: UT to Adkin Branch

Ryan,

If you are referring to the specific BMP we discussed onsite which involved putting a retaining structure in and across the stream channel in order to create a stormwater retention/wetland area then you are correct.

-----Original Message-----
From: Ryan Smith [mailto:rsmith@koassociates.com]
Sent: Wednesday, August 09, 2006 10:35 PM
To: Wescott, William G SAW
Cc: 'Kristie Corson'; 'Kevin Williams'
Subject: FW: UT to Adkin Branch

Thanks for the information. So am I to surmise from this that we will not be able to install a BMP just down stream of the culvert at the upstream end of the UT to Adkin Branch?

Thnaks,

Ryan V. Smith, CPESC, PWS
1011 Schaub Drive, Suite 202
Raleigh, NC 27606
Office #: 919-851-6066
Fax #: 919-851-6846
rsmith@koassociates.com
-----Original Message-----
From: Wescott, William G SAW [mailto:William.G.Wescott@saw02.usace.army.mil]

Sent: Wednesday, August 09, 2006 7:02 AM
To: Garcy.Ward; Ryan Smith
Cc: Chris Pullinger; julia.hunt@ncmail.net
Subject: RE: UT to Adkin Branch

I checked with the Raleigh field office since they handle much more stream work than we do here in the coastal plain. In-stream sediment basins, stormwater retention basins, etc. are not allowed in perennial streams. The Tarboro example I mentioned while onsite with you would not be considered in-stream since the channel will no longer run through it.

William Wescott

-----Original Message-----
From: Garcy.Ward [mailto:garcy.ward@ncmail.net]
Sent: Tuesday, August 08, 2006 4:46 PM
To: Ryan Smith
Cc: Chris Pullinger; Wescott, William G SAW; julia.hunt@ncmail.net
Subject: Re: UT to Adkin Branch

Ryan
We rated the UT to Adkins Branch today. It was much drier than when we were there in June but there were still pockets of water in stretches, particularly farther downstream. We got a rating of 27 on the Stream Identification Form. This was taking into account the whole 1200' length from the culvert down to where it emptied into Adkins Branch and

1

trying to come up with an average for this entire stretch. Given the modified nature of the stream and the time of year, we feel this is a sufficient enough score to warrant perennial status. Feel free to give me a call if you have any questions.

Garcy

Ryan Smith wrote:
> Thanks for the info Garcy.
>
> Take it easy,
>
>
> -----Original Message-----
> From: Garcy.Ward [mailto:garcy.ward@ncmail.net]
> Sent: Thursday, August 03, 2006 6:55 PM
> To: Ryan Smith
> Subject: Re: UT to Adkin Branch
>
> Ryan
> I haven't been back, but I may be able to get out there tomorrow. If
> not, I will get out there the first of next week. I will let you know
> as soon as I make a determination.
>
> Ryan Smith wrote:
>
>> Has there been a decision made as to the jurisdictional status of the
>> UT to Adkin Branch that we had looked at?
>>
>>
>>
>> Thanks,
>>
>>
>>
>> **Ryan V. Smith, CPESC, PWS**
>>
>> 1011 Schaub Drive, Suite 202
>>
>> Raleigh, NC 27606
>>
>> Office #: 919-851-6066
>>
>> Fax #: 919-851-6846
>>
>> rsmith@koassociates.com
>>
>>
>>
>>
>
>

Surface Sand Filter Design

Drainage Areas by Soil Series

Series	Group	SF	Ac	Percent
BB	**D**	233050	5.35	49.3%
Cr	**C**			
Cv	**C**	200109	4.59	42.3%
Go	**B**			
Jo	**B**			
Ka	**B**			
Ke	**A**			
La	**A**			
Na	**B**	39692.7	0.91	8.4%
Nc	**B**			
Wd	**A**			
Wn	**B/D**			
		472851.7	10.86	100.0%

Time of Concentration Details

	L	S	n
Sheet	50	0.5%	0.41
Shallow	275	6.5%	0.05
Channel	415	5.8%	0.035
Channel	870	1.6%	0.035
	1610		

Calculated % Impervious Area of Basin

Total Basin - IA	**20.4%**
Residential - IA	30.6%
Residential: Lots 0.16 - 0.3	

Drainage Areas by Hydrologic Soil Groups

Group	SF	Ac	Percent
A	0	0.00	0.0%
B	39692.7	0.91	8.4%
C	200109	4.59	42.3%
D	233050	5.35	49.3%
TOTAL	472851.7	10.86	100.0%

Land Use by Hydrologic Soil Groups

IA - Road	IA - Roof, etc	Lawn	Woods
8.00%	12.40%	35.30%	44.30%
0.00	0.00	0.00	0.00
0.07	0.11	0.32	0.40
0.37	0.57	1.62	2.04
0.43	0.66	1.89	2.37
10.86	<= Area Check		

NCDENR Stormwater BMP Manual:
3.12.6.3 Design Specs & Meth. Design Requirements

Sediment Chamber:	**NCDENR Minimum**		**Site Design Summary**	
Volume (Vs):	5862	cf	3375	cf
Surface Area (As):	3908	sf	2250	sf
Depth (hs):	1.5	ft	1.5	ft
Sand Filter Chamber:				
Filter Volume (Vf):	5862	cf	2700	cf
Surface Area (Af):	3908	sf	1800	sf
Filter Depth (df):	1.5	ft	1.5	ft

Austin Sand Filter:
Sed. Surface Area 1970 sf

Step 1 - Compute Runoff Control Volumes:

Water Quality Volume (WQv):

Uniform 1/2" Runoff (WQv)	=	0.452	Ac-ft		
WQv	=	19702	cf		
Simple Method:					
IA	=	20.4%			
Rv	=	0.23	in / in		
Runoff from 1" Rainfall (WQv)	=	9205	cf	Mod. CN	
Q	=	0.23	in		
Mod. CN	=	87			
THEREFORE, USE:					2:1
WQv	=	**9205**	cf	60	120

Step 2 - Site Feasibility:

Ditch Inv / Inflow Elev	=	36.0	ft - Based on 1-ft Tailwater Depth
Stream Inv /Outflow Elev	=	31.2	ft - Between INV & BKF based on Adkin Br Restoration
Total Available Depth	=	4.8	ft
Check Design Depth	=	3.9	ft
NG Elev at Boring	=	37.2	
Water depth	=	6.0	
Water Elev at Boring	=	31.2	ft

Step 3 - Confirm local design criteria and applicability:

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

N/A - Per meeting on Jan 30, 2007, City of Kinston has no additional criteria and defers to the NCDENR design criteria.

Step 4 - Compute WQ v peak discharge:

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures (see subse

(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 5 - Compute WQ v peak discharge:

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 6 - Size filtration basin chamber:

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:
- A_f = surface area of filter bed (ft^2)
- d_f = filter bed depth (typically 18 inches, no more than 24 inches)
- k = coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
- h_f = average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically ≤ 6 feet)
- t_f = design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Set preliminary dimensions of filtration basin chamber.

WQv	=	9205	cf			
df	=	1.5	ft - filter depth			
k	=	3.5	ft/day - sand			
hf	=	0.75	ft			
tf	=	1	day - drain time			
Af	=	1755	sf	< NCDENR Min Filter SA		
HOWEVER, USE:						
Af	=	1755	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	25	50	1.5	2:1	

Step 7 - Size sedimentation basin:

***Surface sand filter*:** The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * Ln(1-E)$$

Where:
- A_s = sedimentation basin surface area (ft^2)
- Q_o = rate of outflow = the WQ_v over a 24-hour period
- w = particle settling velocity (ft/sec)
- E = trap efficiency

Assuming:
- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness ≥ 75%
- average of 24 hour holding period

Then:

A_s = $(0.066)(WQ_v)\ ft^2$ for $I < 75\%$
A_s = $(0.0081)(WQ_v)\ ft^2$ for $I \geq 75\%$

Set preliminary dimensions of sedimentation chamber.

Qo	=	9205	cf / day			
w	=	0.0004	ft/sec	**for IA < 75%**		
E	=	0.9				
As	=	608	sf	< NCDENR Min Sed Basin SA		
HOWEVER, USE:						
As	=	608	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	25	50	1.5	2:1	

Step 8 - Compute Vmin:

$V_{min} = 0.75 * WQ_v$

Vmin	=	6904	cf

Step 9 - Compute storage volumes within entire facility and sedimentation chamber orifice size:

Surface sand filter:

$$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-temp}}$$

(1) Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$
Where: n = porosity = 0.4 for most applications

(2) Compute $V_{f\text{-temp}}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$

(3) Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-temp}}$

(4) Compute h_s = height in sedimentation chamber = V_s/A_s

(5) Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary in design iterations until all site dimensions fit.

(6) Size orifice from sediment chamber to filter chamber to release V_s within 24-hours at average release rate with 0.5 h_s as average head.

(7) Design outlet structure with perforations allowing for a safety factor of 10 (see example)

(8) Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Vf	=	1053	cf	Filter Bed Volume
Vf-temp	=	2633	cf	Temp Storage above Filter Bed
Vs	=	3219	cf	Sediment Chamber Volume
hs	=	**2.570**	cf	Sediment Chamber Height>Design Head, Adj Geometry

BMP Final Design Summary

DRE, ADJ'D BASIN GEOMETRY:		W	L	hs or hf	Dim Ratio
Filter Basin Dimensions:	=	30	60	1.50	2.0:1
Sed Basin Dimensions:	=	30	75	1.50	2.5:1

	Site Design	
Sediment Chamber:		
Volume (Vs):	3375	cf
Surface Area (As):	2250	sf
Depth (hs):	1.50	ft
Sand Filter Chamber:		
Filter Volume (Vf):	2700	cf
Surface Area (Af):	1800	sf
Filter Depth (df):	1.50	ft

BMP Site Design Elevations

	Elev	Length	Slope
Nat Gnd	37.2		
Inflow Elev	36.0		
Spillway	36.0	75	6.40%
Freeboard	0.3		
WQpool	35.7		
Depth to Bed	3.0-ft		
SF bed	34.2		
Underdrain	32.0	165	0.50%
Outflow	31.2		
Adkin Inv	30.2		

Surface Sand Filter Design

Drainage Areas by Soil Series

Series	Group	SF	Ac	Percent
BB	**D**	200955	4.61	67.9%
Cr	**C**	0		
Cv	**C**	95114.4	2.18	32.1%
Go	**B**	0		
Jo	**B**	0		
Ka	**B**	0		
Ke	**A**	0		
La	**A**	0		
Na	**B**	0		
Nc	**B**	0		
Wd	**A**	0		
Wn	**B/D**	0		
		296069.4	6.80	100.0%

Time of Concentration Details

	L	S	n
Sheet	50	0.5%	0.41
Shallow	0		0.05
Channel	625	2.2%	0.035
Channel	240	2.4%	0.035
	915		

Calculated % Impervious Area of Basin

Total Basin - IA	**30.6%**
Residential - IA	30.6%
Residential: Lots 0.16 - 0.3	

Drainage Areas by Hydrologic Soil Groups

Group	SF	Ac	Percent
A	0	0.00	0.0%
B	0	0.00	0.0%
C	95114.4	2.18	32.1%
D	200955	4.61	67.9%
TOTAL	296069.4	6.80	100.0%

Land Use by Hydrologic Soil Groups

IA - Road	IA - Roof, etc	Lawn	Woods
12.00%	18.60%	69.40%	0.00%
0.26	0.41	1.52	
0.55	0.86	3.20	
6.80	<<= Area Check		

NCDENR Stormwater BMP Manual:
3.12.6.3 Design Specs & Meth. Design Requirements

Sediment Chamber:	**NCDENR Minimum**		**Site Design Summary**	
Volume (Vs):	3671	cf	2925	cf
Surface Area (As):	2447	sf	1950	sf
Depth (hs):	1.5	ft	1.5	ft
Sand Filter Chamber:				
Filter Volume (Vf):	3671	cf	2700	cf
Surface Area (Af):	2447	sf	1800	sf
Filter Depth (df):	1.5	ft	1.5	ft

Austin Sand Filter:
Sed. Surface Area 1234 sf

Surface Sand Filter Design

Step 1 - Compute Runoff Control Volumes:

Water Quality Volume (WQv):

Uniform 1/2" Runoff (WQv)	=	0.283	Ac-ft	
WQv	=	12336	cf	
Simple Method:				
IA	=	30.6%		
Rv	=	0.33	in / in	
Runoff from 1" Rainfall (WQv)	=	8028	cf	Mod. CN
Q	=	0.33	in	
Mod. CN	=	90		

THEREFORE, USE:

					2:1
WQv	=	**8028**	cf	55	110

Step 2 - Site Feasibility:

Ditch Inv / Inflow Elev	=	35.3	ft - Based on 1-ft Tailwater Depth
Stream Inv /Outflow Elev	=	30.4	ft - Between INV & BKF based on Adkin Br Restoration
Total Available Depth	=	4.9	ft
Check Design Depth	=	3.9	ft
NG Elev at Boring	=	37.2	
Water depth	=	6.0	
Water Elev at Boring	=	31.2	ft

Step 3 - Confirm local design criteria and applicability:

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

N/A - Per meeting on Jan 30, 2007, City of Kinston has no additional criteria and defers to the NCDENR design criteria.

Step 4 - Compute WQ v peak discharge:

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures (see subse

(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 5 - Compute WQ v peak discharge:

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 6 - Size filtration basin chamber:

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:

A_f	=	surface area of filter bed (ft^2)
d_f	=	filter bed depth (typically 18 inches, no more than 24 inches)
k	=	coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
h_f	=	average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically ≤ 6 feet)
t_f	=	design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Set preliminary dimensions of filtration basin chamber.

WQv	=	8028	cf			
df	=	1.5	ft - filter depth			
k	=	3.5	ft/day - sand			
hf	=	0.75	ft			
tf	=	1	day - drain time			
Af	=	1530	sf	< NCDENR Min Filter SA		
HOWEVER, USE:						
Af	=	1530	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	25	50	1.5	2:1	

Step 7 - Size sedimentation basin:

Surface sand filter: The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * Ln(1-E)$$

Where:

A_s = sedimentation basin surface area (ft^2)
Q_o = rate of outflow = the WQ_v over a 24-hour period
w = particle settling velocity (ft/sec)
E = trap efficiency

Assuming:

- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness ≥ 75%
- average of 24 hour holding period

Then:

A_s = (0.066) (WQ_v) ft^2 for $I < 75\%$
A_s = (0.0081) (WQ_v) ft^2 for $I \geq 75\%$

Set preliminary dimensions of sedimentation chamber.

Qo	=	8028	cf / day			
w	=	0.0004	ft/sec	**for IA < 75%**		
E	=	0.9				
As	=	530	sf	< NCDENR Min Sed Basin SA		
HOWEVER, USE:						
As	=	530	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	25	50	1.5	2:1	

Step 8 - Compute Vmin:

$V_{min} = 0.75 * WQ_v$

Vmin	=	6021	cf

Step 9 - Compute storage volumes within entire facility and sedimentation chamber orifice size:

Surface sand filter:

$$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-}temp}$$

(1) Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$
Where: n = porosity = 0.4 for most applications

(2) Compute $V_{f\text{-}temp}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$

(3) Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-}temp}$

(4) Compute h_s = height in sedimentation chamber = V_s/A_s

(5) Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary in design iterations until all site dimensions fit.

(6) Size orifice from sediment chamber to filter chamber to release V_s within 24-hours at average release rate with 0.5 h_s as average head.

(7) Design outlet structure with perforations allowing for a safety factor of 10 (see example)

(8) Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Vf	=	918	cf	Filter Bed Volume
Vf-temp	=	2295	cf	Temp Storage above Filter Bed
Vs	=	2808	cf	Sediment Chamber Volume
hs	=	**2.250**	cf	Sediment Chamber Height>Design Head, Adj Geometry

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BMP Final Design Summary

ORE, ADJ'D BASIN GEOMETRY:		W	L	hs or hf	Dim Ratio
Filter Basin Dimensions:	=	30	60	1.50	2.0:1
Sed Basin Dimensions:	=	30	65	1.50	2.2:1

	Site Design	
Sediment Chamber:		
Volume (Vs):	2925	cf
Surface Area (As):	1950	sf
Depth (hs):	1.50	ft
Sand Filter Chamber:		
Filter Volume (Vf):	2700	cf
Surface Area (Af):	1800	sf
Filter Depth (df):	1.50	ft

BMP Site Design Elevations

	Elev	Length	Slope
Nat Gnd	37.2		
Inflow Elev	35.3		
Spillway	35.3	75	6.53%
Freeboard	0.4		
WQpool	34.9		
Depth to Bed	3.8-ft		
SF bed	33.4		
Underdrain	31.2	165	0.50%
Outflow	30.4		
Adkin Inv	29.4		

Drainage Areas by Soil Series

Series	Group	SF	Ac	Percent
BB	**D**	120794	2.77	25.5%
Cr	**C**	0		
Cv	**C**	316442	7.26	66.8%
Go	**B**	0		
Jo	**B**	0		
Ka	**B**	0		
Ke	**A**	0		
La	**A**	0		
Na	**B**	36799.9	0.84	7.8%
Nc	**B**	0		
Wd	**A**	0		
Wn	**B/D**	0		
		474035.9	10.88	100.0%

Time of Concentration Details

	L	S	n
Sheet	50	0.5%	0.410
Shallow	250	6.4%	0.050
Channel	330	3.6%	0.035
Channel	520	2.6%	0.035
	1150		

Calculated % Impervious Area of Basin

Total Basin - IA	**30.6%**
Residential - IA	30.6%
Residential: Lots 0.16 - 0.3	

Drainage Areas by Hydrologic Soil Groups

Group	SF	Ac	Percent
A	0	0.00	0.0%
B	36799.9	0.84	7.8%
C	316442	7.26	66.8%
D	120794	2.77	25.5%
TOTAL	474035.9	10.88	100.0%

Land Use by Hydrologic Soil Groups

IA - Road	IA - Roof, etc	Lawn	Woods
12.00%	18.60%	69.40%	0.00%
0.10	0.16	0.59	
0.87	1.35	5.04	
0.33	0.52	1.92	
10.88	<= Area Check		

NCDENR Stormwater BMP Manual:
3.12.6.3 Design Specs & Meth. Design Requirements

Sediment Chamber:	**NCDENR Minimum**		**Site Design Summary**	
Volume (Vs):	5877	cf	4725	cf
Surface Area (As):	3918	sf	3150	sf
Depth (hs):	1.5	ft	1.5	ft
Sand Filter Chamber:				
Filter Volume (Vf):	5877	cf	3675	cf
Surface Area (Af):	3918	sf	2450	sf
Filter Depth (df):	1.5	ft	1.5	ft

Austin Sand Filter:
Sed. Surface Area 1975 sf

Step 1 - Compute Runoff Control Volumes:

Water Quality Volume (WQv):

Uniform 1/2" Runoff (WQv)	=	0.453	Ac-ft	
WQv	=	19751	cf	
Simple Method:				
IA	=	30.6%		
Rv	=	0.33	in / in	
Runoff from 1" Rainfall (WQv)	=	12854	cf	Mod. CN
Q	=	0.33	in	
Mod. CN	=	90		

THEREFORE, USE:

					2:1
WQv	=	**12854**	cf	70	140

Step 2 - Site Feasibility:

Ditch Inv / Inflow Elev	=	35.3	ft - Based on 1-ft Tailwater Depth
Stream Inv /Outflow Elev	=	30.0	ft - Between INV & BKF based on Adkin Br Restoration
Total Available Depth	=	5.3	ft
Check Design Depth	=	3.9	ft
NG Elev at Boring	=	37.2	
Water depth	=	7.0	
Water Elev at Boring	=	30.2	ft

Step 3 - Confirm local design criteria and applicability:

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

N/A - Per meeting on Jan 30, 2007, City of Kinston has no additional criteria and defers to the NCDENR design criteria.

Step 4 - Compute WQ v peak discharge:

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures (see subse

(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 5 - Compute WQ v peak discharge:

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 6 - Size filtration basin chamber:

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:

- A_f = surface area of filter bed (ft^2)
- d_f = filter bed depth (typically 18 inches, no more than 24 inches)
- k = coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
- h_f = average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically ≤ 6 feet)
- t_f = design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Set preliminary dimensions of filtration basin chamber.

WQv	=	12854	cf			
df	=	1.5	ft - filter depth			
k	=	3.5	ft/day - sand			
hf	=	0.75	ft			
tf	=	1	day - drain time			
Af	=	2450	sf	< NCDENR Min Filter SA		
HOWEVER, USE:						
Af	=	2450	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	30	60	1.5	2:1	

Step 7 - Size sedimentation basin:

***Surface sand filter*:** The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * Ln(1-E)$$

Where:

A_s = sedimentation basin surface area (ft^2)
Q_o = rate of outflow = the WQ_v over a 24-hour period
w = particle settling velocity (ft/sec)
E = trap efficiency

Assuming:

- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness ≥ 75%
- average of 24 hour holding period

Then:

A_s = $(0.066)(WQ_v)\ ft^2$ for I < 75%
A_s = $(0.0081)(WQ_v)\ ft^2$ for I ≥ 75%

Set preliminary dimensions of sedimentation chamber.

Qo	=	12854	cf / day			
w	=	0.0004	ft/sec	**for IA < 75%**		
E	=	0.9				
As	=	848	sf	< NCDENR Min Sed Basin SA		
HOWEVER, USE:						
As	=	848	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	30	60	1.5	2:1	

Step 8 - Compute Vmin:

$V_{min} = 0.75 * WQ_v$

Vmin	=	9641	cf

Step 9 - Compute storage volumes within entire facility and sedimentation chamber orifice size:

Surface sand filter:

$$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-}temp}$$

(1) Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$
Where: n = porosity = 0.4 for most applications

(2) Compute $V_{f\text{-}temp}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$

(3) Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-}temp}$

(4) Compute h_s = height in sedimentation chamber = V_s/A_s

(5) Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary in design iterations until all site dimensions fit.

(6) Size orifice from sediment chamber to filter chamber to release V_s within 24-hours at average release rate with 0.5 h_s as average head.

(7) Design outlet structure with perforations allowing for a safety factor of 10 (see example)

(8) Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Vf	=	1470	cf	Filter Bed Volume
Vf-temp	=	3675	cf	Temp Storage above Filter Bed
Vs	=	4496	cf	Sediment Chamber Volume
hs	=	**2.500**	cf	Sediment Chamber Height>Design Head, Adj Geometry

BMP Final Design Summary

DRE, ADJ'D BASIN GEOMETRY:		W	L	hs or hf	Dim Ratio
Filter Basin Dimensions:	=	35	70	1.50	2.0:1
Sed Basin Dimensions:	=	35	90	1.50	2.6:1

	Site Design	
Sediment Chamber:		
Volume (Vs):	4725	cf
Surface Area (As):	3150	sf
Depth (hs):	1.50	ft
Sand Filter Chamber:		
Filter Volume (Vf):	3675	cf
Surface Area (Af):	2450	sf
Filter Depth (df):	1.50	ft

BMP Site Design Elevations

	Elev	Length	Slope
Nat Gnd	37.2		
Inflow Elev	35.3		
Spillway	35.3	75	7.07%
Freeboard	0.7		
WQpool	34.6		
Depth to Bed	4.1-ft		
SF bed	33.1		
Underdrain	30.9	180	0.50%
Outflow	30.0		
Adkin Inv	29.0		

Surface Sand Filter Design

Drainage Areas by Soil Series

Series	Group	SF	Ac	Percent
BB	**D**	22765.5	0.52	15.1%
Cr	**C**	0		
Cv	**C**	0		
Go	**B**	0		
Jo	**B**	0		
Ka	**B**	127668	2.93	84.9%
Ke	**A**	0		
La	**A**	0		
Na	**B**	0		
Nc	**B**	0		
Wd	**A**	0		
Wn	**B/D**	0		
		150433.5	3.45	100.0%

Time of Concentration Details

	L	S	n
Sheet	50	0.5%	0.24
Shallow	397	1.8%	
C&G	155	0.7%	0.012
System	178	1.1%	0.012
	780		

Calculated % Impervious Area of Basin

Total Basin - IA **45.3%**

Residential - IA

Residential: Lots 0.11 Ac (Avg)

Drainage Areas by Hydrologic Soil Groups

Group	SF	Ac	Percent
A	0	0.00	0.0%
B	127668	2.93	84.9%
C	0	0.00	0.0%
D	22765.5	0.52	15.1%
TOTAL	150433.5	3.45	100.0%

Land Use by Hydrologic Soil Groups

IA - Road	IA - Roof, etc	Lawn/Open	Woods
	25.00%		0.00%
0.69	0.73	1.51	
0.00	0.14	0.38	
3.45	<= Area Check		

NCDENR Stormwater BMP Manual:
3.12.6.3 Design Specs & Meth. Design Requirements

Sediment Chamber:	**NCDENR Minimum**		**Site Design Summary**	
Volume (Vs):	1865	cf	2063	cf
Surface Area (As):	1244	sf	1375	sf
Depth (hs):	1.5	ft	1.5	ft
Sand Filter Chamber:				
Filter Volume (Vf):	1865	cf	1875	cf
Surface Area (Af):	1244	sf	1250	sf
Filter Depth (df):	1.5	ft	1.5	ft

Austin Sand Filter:
Sed. Surface Area 627 sf

Step 1 - Compute Runoff Control Volumes:

Water Quality Volume (WQv):					
Uniform 1/2" Runoff (WQv)	=	0.14	Ac-ft		
WQv	=	6268	cf		
Simple Method:					
IA	=	45.3%			
Rv	=	0.46	in / in		
Runoff from 1" Rainfall (WQv)	=	5732	cf		
Q	=	0.46	in		
Mod. CN	=	93			
THEREFORE, USE:		0.14	Ac-ft		2:1
WQv	=	**5732**	cf	45	90

Step 2 - Site Feasibility:

Sys Inv / Inflow Elev	=	30.3	ft - Based on 1-ft Tailwater Depth
Stream Inv /Outflow Elev	=	**25.9**	ft - Between INV & BKF based on Adkin Br Restoration
Total Available Depth	=	4.4	ft
Check Design Depth	=	3.9	ft
NG Elev at Boring	=	31.3	
Water depth	=	3.0	
Water Elev at Boring	=	28.3	ft

Step 3 - Confirm local design criteria and applicability:

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

N/A - Per meeting on Jan 30, 2007, City of Kinston has no additional criteria and defers to the NCDENR design criteria.

Step 4 - Compute WQ v peak discharge:

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures (see subse

(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 5 - Compute WQ v peak discharge:

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 6 - Size filtration basin chamber:

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:

- A_f = surface area of filter bed (ft^2)
- d_f = filter bed depth (typically 18 inches, no more than 24 inches)
- k = coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
- h_f = average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically ≤ 6 feet)
- t_f = design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Set preliminary dimensions of filtration basin chamber.

WQv	=	5732	cf			
df	=	1.5	ft - filter depth			
k	=	3.5	ft/day - sand			
hf	=	0.75	ft			
tf	=	1	day - drain time			
Af	=	1095	sf	< NCDENR Min Filter SA		
HOWEVER, USE:						
Af	=	1095	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	20	40	1.5	2:1	

Step 7 - Size sedimentation basin:

***Surface sand filter*:** The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * Ln(1-E)$$

Where:

A_s = sedimentation basin surface area (ft^2)
Q_o = rate of outflow = the WQ_v over a 24-hour period
w = particle settling velocity (ft/sec)
E = trap efficiency

Assuming:

- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness ≥ 75%
- average of 24 hour holding period

Then:

A_s = (0.066) (WQ_v) ft^2 for I < 75%
A_s = (0.0081) (WQ_v) ft^2 for I ≥ 75%

Set preliminary dimensions of sedimentation chamber.

Qo	=	5732	cf / day		
w	=	0.0004	ft/sec	**for IA < 75%**	
E	=	0.9			
As	=	378	sf	< NCDENR Min Sed Basin SA	
HOWEVER, USE:					
As	=	378	sf		
		W	L	hmax	Dim Ratio
Approx Chamber Dim:	=	20	40	1.5	2:1

Step 8 - Compute Vmin:

$V_{min} = 0.75 * WQ_v$

Vmin	=	4299	cf	>= NCDENR Min Volume for Total Basin

Step 9 - Compute storage volumes within entire facility and sedimentation chamber orifice size:

Surface sand filter:

$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-}temp}$

(1) Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$
Where: n = porosity = 0.4 for most applications

(2) Compute $V_{f\text{-}temp}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$

(3) Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-}temp}$

(4) Compute h_s = height in sedimentation chamber = V_s/A_s

(5) Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary in design iterations until all site dimensions fit.

(6) Size orifice from sediment chamber to filter chamber to release V_s within 24-hours at average release rate with 0.5 h_s as average head.

(7) Design outlet structure with perforations allowing for a safety factor of 10 (see example)

(8) Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Vf	=	657	cf	Filter Bed Volume
Vf-temp	=	1643	cf	Temp Storage above Filter Bed
Vs	=	2000	cf	Sediment Chamber Volume
hs	=	**2.500**	cf	Sediment Chamber Height>Design Head, Adj Geometry

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BMP Final Design Summary

DRE, ADJ'D BASIN GEOMETRY:		W	L	hs or hf	Dim Ratio
Filter Basin Dimensions:	=	25	50	1.50	2.0:1
Sed Basin Dimensions:	=	25	55	1.50	2.2:1

	Site Design	
Sediment Chamber:		
Volume (Vs):	2063	cf
Surface Area (As):	1375	sf
Depth (hs):	1.50	ft
Sand Filter Chamber:		
Filter Volume (Vf):	1875	cf
Surface Area (Af):	1250	sf
Filter Depth (df):	1.50	ft

BMP Site Design Elevations

	Elev	Length	Slope
Nat Gnd	31.3		
Inflow Elev	30.3		
Spillway	30.3	75	5.91%
Freeboard	0.0		
WQpool	30.3		
Depth to Bed	2.5-ft		
SF bed	28.8		
Underdrain	26.6	150	0.50%
Outflow	25.9		
Adkin Inv	24.9		

Surface Sand Filter Design

Drainage Areas by Soil Series

Series	Group	SF	Ac	Percent
BB	**D**	58036.4	1.33	15.1%
Cr	**C**	0		
Cv	**C**	0		
Go	**B**	0		
Jo	**B**	0		
Ka	**B**	0		
Ke	**A**	325458	7.47	84.9%
La	**A**	0		
Na	**B**	0		
Nc	**B**	0		
Wd	**A**	0		
Wn	**B/D**	0		
		383494.4	8.804	100.0%

Time of Concentration Details

	L	S	n
Sheet	50	0.5%	0.24
Shallow	270	1.1%	
C&G	471	0.5%	0.012
System	499	1.0%	0.012
	1290		

Calculated % Impervious Area of Basin

Total Basin - IA	**43.3%**
Residential - IA	
Residential: Lots 0.16 - 0.3	

Drainage Areas by Hydrologic Soil Groups

Group	SF	Ac	Percent
A	325458	7.47	84.9%
B	0	0.00	0.0%
C	0	0.00	0.0%
D	58036.4	1.33	15.1%
TOTAL	383494.4	8.80	100.0%

Land Use by Hydrologic Soil Groups

IA - Road	IA - Roof, etc	Lawn/Open	Woods
	26.60%		0.00%
1.58	1.99	3.90	
0.15	0.09	1.09	0.00
8.80	<= Area Check		

NCDENR Stormwater BMP Manual:
3.12.6.3 Design Specs & Meth. Design Requirements

Sediment Chamber:	**NCDENR Minimum**		**Site Design Summary**	
Volume (Vs):	4755	cf	4500	cf
Surface Area (As):	3170	sf	2250	sf
Depth (hs):	1.5	ft	2	ft
Sand Filter Chamber:				
Filter Volume (Vf):	4755	cf	3600	cf
Surface Area (Af):	3170	sf	1800	sf
Filter Depth (df):	1.5	ft	1.5	ft

Austin Sand Filter:
Sed. Surface Area 1598 sf

Step 1 - Compute Runoff Control Volumes:

Water Quality Volume (WQv):

Uniform 1/2" Runoff (WQv)	=	0.37	Ac-ft		
WQv	=	15979	cf		
Simple Method:					
IA	=	43.3%			
Rv	=	0.44	in / in		
Runoff from 1" Rainfall (WQv)	=	14040	cf		
Q	=	0.44	in		
Mod. CN	=	93			
THEREFORE, USE:		0.33	Ac-ft		2:1
WQv	=	**14040**	cf	60	120

Step 2 - Site Feasibility:

Sys Inv / Inflow Elev	=	26.8	ft - Based on NO Tailwater Depth
Stream Inv /Outflow Elev	=	**21.2**	ft - Between INV & BKF based on Adkin Br Restoration
Total Available Depth	=	5.6	ft
Check Design Depth	=	4.4	ft
NG Elev at Boring	=	31.3	
Water depth	=	6.0	
Water Elev at Boring	=	25.3	ft

Step 3 - Confirm local design criteria and applicability:

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

N/A - Per meeting on Jan 30, 2007, City of Kinston has no additional criteria and defers to the NCDENR design criteria.

Step 4 - Compute WQ v peak discharge:

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures (see subse

(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 5 - Compute WQ v peak discharge:

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 6 - Size filtration basin chamber:

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:

A_f	=	surface area of filter bed (ft^2)
d_f	=	filter bed depth (typically 18 inches, no more than 24 inches)
k	=	coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
h_f	=	average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically ≤ 6 feet)
t_f	=	design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Set preliminary dimensions of filtration basin chamber.

WQv	=	14040	cf			
df	=	1.5	ft - filter depth			
k	=	3.5	ft/day - sand			
hf	=	1	ft			
tf	=	1	day - drain time			
Af	=	2410	sf	< NCDENR Min Filter SA		
HOWEVER, USE:						
Af	=	2410	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	25	50	2	2:1	

Step 7 - Size sedimentation basin:

Surface sand filter: The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * Ln(1-E)$$

Where:

A_s = sedimentation basin surface area (ft^2)
Q_o = rate of outflow = the WQ_v over a 24-hour period
w = particle settling velocity (ft/sec)
E = trap efficiency

Assuming:

- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness ≥ 75%
- average of 24 hour holding period

Then:

A_s = (0.066) (WQ_v) ft^2 for I < 75%
A_s = (0.0081) (WQ_v) ft^2 for I ≥ 75%

Set preliminary dimensions of sedimentation chamber.

Qo	=	14040	cf / day			
w	=	0.0004	ft/sec	**for IA < 75%**		
E	=	0.9				
As	=	927	sf	< NCDENR Min Sed Basin SA		
HOWEVER, USE:						
As	=	927	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	25	50	2	2:1	

Step 8 - Compute Vmin:

$V_{min} = 0.75 * WQ_v$

Vmin	=	10530	cf	>= NCDENR Min Volume for Total Basin

Step 9 - Compute storage volumes within entire facility and sedimentation chamber orifice size:

Surface sand filter:

$$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-}temp}$$

(1) Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$
Where: n = porosity = 0.4 for most applications

(2) Compute $V_{f\text{-}temp}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$

(3) Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-}temp}$

(4) Compute h_s = height in sedimentation chamber = V_s/A_s

(5) Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary in design iterations until all site dimensions fit.

(6) Size orifice from sediment chamber to filter chamber to release V_s within 24-hours at average release rate with 0.5 h_s as average head.

(7) Design outlet structure with perforations allowing for a safety factor of 10 (see example)

(8) Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Vf	=	1446	cf	Filter Bed Volume
Vf-temp	=	4820	cf	Temp Storage above Filter Bed
Vs	=	4264	cf	Sediment Chamber Volume
hs	=	**3.410**	cf	Sediment Chamber Height>Design Head, Adj Geometry

BMP Final Design Summary

DRE, ADJ'D BASIN GEOMETRY:		W	L	hs or hf	Dim Ratio
Filter Basin Dimensions:	=	30	60	2.00	2.0:1
Sed Basin Dimensions:	=	30	75	2.00	2.5:1

	Site Design	
Sediment Chamber:		
Volume (Vs):	4500	cf
Surface Area (As):	2250	sf
Depth (hs):	2.00	ft
Sand Filter Chamber:		
Filter Volume (Vf):	2700	cf
Surface Area (Af):	1800	sf
Filter Depth (df):	1.50	ft

BMP Site Design Elevations

	Elev	Length	Slope
Nat Gnd	31.3		
Inflow Elev	26.8		
Spillway	26.8	175	3.18%
Freeboard	0.1		
WQpool	26.7		
Depth to Bed	6.6-ft		
SF bed	24.7		
Underdrain	22.5	265	0.50%
Outflow	21.2		
Adkin Inv	20.2		

Surface Sand Filter Design

Drainage Areas by Soil Series

Series	Group	SF	Ac	Percent
BB	**D**	94128	2.16	11.8%
Cr	**C**	0		
Cv	**C**	0		
Go	**B**	0		
Jo	**B**	0		
Ka	**B**	0		
Ke	**A**	145505	3.34	18.2%
La	**A**	0		
Na	**B**	233198	5.35	29.1%
Nc	**B**	0		
Wd	**A**	328122	7.53	41.0%
Wn	**B/D**	0		
		800953	18.39	100.0%

Time of Concentration Details

	L	S	n
Sheet	50	0.5%	0.24
Shallow	700	3.1%	
C&G	940	2.6%	0.016
24" Conc	230	1.3%	0.012
	1920		

Calculated % Impervious Area of Basin

Total Basin - IA	**27.2%**
Residential - IA	
Residential: Lots 0.16 - 0.3	

Drainage Areas by Hydrologic Soil Groups

Group	SF	Ac	Percent
A	473627	10.87	59.1%
B	233198	5.35	29.1%
C	0	0.00	0.0%
D	94128	2.16	11.8%
TOTAL	800953	18.39	100.0%

Land Use by Hydrologic Soil Groups

IA - Road	IA - Roof, etc	Lawn/Open	Woods
14.04%	13.17%	66.55%	6.24%
1.82	1.01	7.64	0.40
0.67	1.27	2.67	0.75
0.10	0.15	1.92	0.00
18.39	<= Area Check		

NCDENR Stormwater BMP Manual:
3.12.6.3 Design Specs & Meth. Design Requirements

Sediment Chamber:	**NCDENR Minimum**		**Site Design Summary**	
Volume (Vs):	9930	cf	6300	cf
Surface Area (As):	6620	sf	3150	sf
Depth (hs):	1.5	ft	2	ft
Sand Filter Chamber:				
Filter Volume (Vf):	9930	cf	4900	cf
Surface Area (Af):	6620	sf	2450	sf
Filter Depth (df):	1.5	ft	1.5	ft

Austin Sand Filter:
Sed. Surface Area 3337 sf

Surface Sand Filter Design

Step 1 - Compute Runoff Control Volumes:

Water Quality Volume (WQv):

Uniform 1/2" Runoff (WQv)	=	0.77	Ac-ft
WQv	=	33373	cf
Simple Method:			
IA	=	27.2%	
Rv	=	0.29	in / in
Runoff from 1" Rainfall (WQv)	=	19683	cf
Q	=	0.29	in
Mod. CN	=	89	

THEREFORE, USE:		0.46	Ac-ft		2:1
WQv	=	**19683**	cf	75	150

Step 2 - Site Feasibility:

Sys Inv / Inflow Elev	=	25.7	ft - Based on 1-ft Tailwater Depth
Stream Inv /Outflow Elev	=	**20.4**	ft - Between INV & BKF based on Adkin Br Restoration
Total Available Depth	=	5.3	ft
Check Design Depth	=	4.4	ft
NG Elev at Boring	=	26.5	
Water depth	=	3.0	
Water Elev at Boring	=	23.5	ft

Step 3 - Confirm local design criteria and applicability:

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

N/A - Per meeting on Jan 30, 2007, City of Kinston has no additional criteria and defers to the NCDENR design criteria.

Step 4 - Compute WQ v peak discharge:

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures (see subse

(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 5 - Compute WQ v peak discharge:

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 6 - Size filtration basin chamber:

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:
- A_f = surface area of filter bed (ft^2)
- d_f = filter bed depth (typically 18 inches, no more than 24 inches)
- k = coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
- h_f = average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically ≤ 6 feet)
- t_f = design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Set preliminary dimensions of filtration basin chamber.

WQv	=	19683	cf			
df	=	1.5	ft - filter depth			
k	=	3.5	ft/day - sand			
hf	=	1	ft			
tf	=	1	day - drain time			
Af	=	3375	sf	< NCDENR Min Filter SA		
HOWEVER, USE:						
Af	=	3375	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	30	60	2	2:1	

Step 7 - Size sedimentation basin:

Surface sand filter: The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * Ln(1-E)$$

Where:
- A_s = sedimentation basin surface area (ft^2)
- Q_o = rate of outflow = the WQ_v over a 24-hour period
- w = particle settling velocity (ft/sec)
- E = trap efficiency

Assuming:
- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness ≥ 75%
- average of 24 hour holding period

Then:

A_s = $(0.066)(WQ_v)\ ft^2$ for $I < 75\%$
A_s = $(0.0081)(WQ_v)\ ft^2$ for $I \geq 75\%$

Set preliminary dimensions of sedimentation chamber.

Qo	=	19683	cf / day			
w	=	0.0004	ft/sec	**for IA < 75%**		
E	=	0.9				
As	=	1299	sf	< NCDENR Min Sed Basin SA		
HOWEVER, USE:						
As	=	1299	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	30	60	2	2:1	

Step 8 - Compute Vmin:

$V_{min} = 0.75 * WQ_v$

Vmin	=	14763	cf	< NCDENR Min Volume for Total Basin

Step 9 - Compute storage volumes within entire facility and sedimentation chamber orifice size:

Surface sand filter:

$$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-}temp}$$

(1) Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$
Where: n = porosity = 0.4 for most applications

(2) Compute $V_{f\text{-}temp}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$

(3) Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-}temp}$

(4) Compute h_s = height in sedimentation chamber = V_s/A_s

(5) Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary in design iterations until all site dimensions fit.

(6) Size orifice from sediment chamber to filter chamber to release V_s within 24-hours at average release rate with 0.5 h_s as average head.

(7) Design outlet structure with perforations allowing for a safety factor of 10 (see example)

(8) Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Vf	=	2025	cf	Filter Bed Volume
Vf-temp	=	6750	cf	Temp Storage above Filter Bed
Vs	=	5988	cf	Sediment Chamber Volume
hs	=	**3.330**	cf	Sediment Chamber Height>Design Head, Adj Geometry

---

BMP Final Design Summary

DRE, ADJ'D BASIN GEOMETRY:		W	L	hs or hf	Dim Ratio
Filter Basin Dimensions:	=	35	70	2.00	2.0:1
Sed Basin Dimensions:	=	35	90	2.00	2.6:1

	Site Design	
Sediment Chamber:		
Volume (Vs):	6300	cf
Surface Area (As):	3150	sf
Depth (hs):	2.00	ft
Sand Filter Chamber:		
Filter Volume (Vf):	3675	cf
Surface Area (Af):	2450	sf
Filter Depth (df):	1.50	ft

BMP Site Design Elevations

	Elev	Length	Slope
Nat Gnd	26.5		
Inflow Elev	25.7		
Spillway	25.7	75	7.01%
Freeboard	0.2		
WQpool	25.5		
Depth to Bed	3.0-ft		
SF bed	23.5		
Underdrain	21.3	180	0.50%
Outflow	20.4		
Adkin Inv	19.4		

Surface Sand Filter Design

Drainage Areas by Soil Series

Series	Group	SF	Ac	Percent
BB	**D**	95597.4	2.19	18.0%
Cr	**C**	0		
Cv	**C**	0		
Go	**B**	0		
Jo	**B**	0		
Ka	**B**	0		
Ke	**A**	435610	10.00	82.0%
La	**A**	0		
Na	**B**	0		
Nc	**B**	0		
Wd	**A**	0		
Wn	**B/D**	0		
		531207.4	12.19	100.0%

Time of Concentration Details

	L	S	n
Sheet	50	0.5%	0.24
Shallow	280	1.1%	
Channel	330	2.1%	0.035
24" Conc	0		0.012
	660		

Calculated % Impervious Area of Basin

Total Basin - IA	**14.3%**
Residential - IA	
Residential: Lots 0.16 - 0.3	

Drainage Areas by Hydrologic Soil Groups

Group	SF	Ac	Percent
A	435610	10.00	82.0%
B	0	0.00	0.0%
C	0	0.00	0.0%
D	95597.4	2.19	18.0%
TOTAL	531207.4	12.19	100.0%

Land Use by Hydrologic Soil Groups

IA - Road	IA - Roof, etc	Lawn/Open	Woods
6.04%	8.22%	85.74%	0.00%
0.67	0.97	8.36	
0.06	0.04	2.09	0.00
12.19	<= Area Check		

NCDENR Stormwater BMP Manual:
3.12.6.3 Design Specs & Meth. Design Requirements

Sediment Chamber:	**NCDENR Minimum**		**Site Design Summary**	
Volume (Vs):	6586	cf	2925	cf
Surface Area (As):	4391	sf	1950	sf
Depth (hs):	1.5	ft	1.5	ft
Sand Filter Chamber:				
Filter Volume (Vf):	6586	cf	2700	cf
Surface Area (Af):	4391	sf	1800	sf
Filter Depth (df):	1.5	ft	1.5	ft

Austin Sand Filter:
Sed. Surface Area 2213 sf

Step 1 - Compute Runoff Control Volumes:

Water Quality Volume (WQv):

Uniform 1/2" Runoff (WQv)	=	0.51	Ac-ft		
WQv	=	22134	cf		
Simple Method:					
IA	=	14.3%			
Rv	=	0.18	in / in		
Runoff from 1" Rainfall (WQv)	=	7894	cf		
Q	=	0.18	in		
Mod. CN	=	85			
THEREFORE, USE:		0.19	Ac-ft		2:1
WQv	=	**7894**	cf	55	110

Step 2 - Site Feasibility:

Sys Inv / Inflow Elev	=	24.6	ft - Based on 1-ft Tailwater Depth
Stream Inv /Outflow Elev	=	**19.6**	ft - Between INV & BKF based on Adkin Br Restoration
Total Available Depth	=	5.0	ft
Check Design Depth	=	3.9	ft
NG Elev at Boring	=	28.5	
Water depth	=	3.0	
Water Elev at Boring	=	25.5	ft

Step 3 - Confirm local design criteria and applicability:

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

N/A - Per meeting on Jan 30, 2007, City of Kinston has no additional criteria and defers to the NCDENR design criteria.

Step 4 - Compute WQ v peak discharge:

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures (see subse

(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 5 - Compute WQ v peak discharge:

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 6 - Size filtration basin chamber:

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:

- A_f = surface area of filter bed (ft^2)
- d_f = filter bed depth (typically 18 inches, no more than 24 inches)
- k = coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
- h_f = average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically ≤ 6 feet)
- t_f = design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Set preliminary dimensions of filtration basin chamber.

WQv	=	7894	cf			
df	=	1.5	ft - filter depth			
k	=	3.5	ft/day - sand			
hf	=	0.75	ft			
tf	=	1	day - drain time			
Af	=	1505	sf	< NCDENR Min Filter SA		
HOWEVER, USE:						
Af	=	1505	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	25	50	1.5	2:1	

Step 7 - Size sedimentation basin:

Surface sand filter: The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * \ln(1-E)$$

Where:

A_s = sedimentation basin surface area (ft^2)
Q_o = rate of outflow = the WQ_v over a 24-hour period
w = particle settling velocity (ft/sec)
E = trap efficiency

Assuming:

- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness ≥ 75%
- average of 24 hour holding period

Then:

A_s = (0.066) (WQ_v) ft^2 for I < 75%
A_s = (0.0081) (WQ_v) ft^2 for I ≥ 75%

Set preliminary dimensions of sedimentation chamber.

Qo	=	7894	cf / day			
w	=	0.0004	ft/sec	**for IA < 75%**		
E	=	0.9				
As	=	521	sf	< NCDENR Min Sed Basin SA		
HOWEVER, USE:						
As	=	521	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	25	50	1.5	2:1	

Step 8 - Compute Vmin:

$V_{min} = 0.75 * WQ_v$

Vmin	=	5921	cf	< NCDENR Min Volume for Total Basin

Step 9 - Compute storage volumes within entire facility and sedimentation chamber orifice size:

***Surface sand filter*:**

$$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-}temp}$$

(1) Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$
Where: n = porosity = 0.4 for most applications

(2) Compute $V_{f\text{-}temp}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$

(3) Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-}temp}$

(4) Compute h_s = height in sedimentation chamber = V_s/A_s

(5) Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary in design iterations until all site dimensions fit.

(6) Size orifice from sediment chamber to filter chamber to release V_s within 24-hours at average release rate with 0.5 h_s as average head.

(7) Design outlet structure with perforations allowing for a safety factor of 10 (see example)

(8) Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Vf	=	903	cf	Filter Bed Volume
Vf-temp	=	2258	cf	Temp Storage above Filter Bed
Vs	=	2761	cf	Sediment Chamber Volume
hs	=	**2.210**	cf	Sediment Chamber Height>Design Head, Adj Geometry

---

BMP Final Design Summary

DRE, ADJ'D BASIN GEOMETRY:		W	L	hs or hf	Dim Ratio
Filter Basin Dimensions:	=	30	60	1.50	2.0:1
Sed Basin Dimensions:	=	30	65	1.50	2.2:1

	Site Design	
Sediment Chamber:		
Volume (Vs):	2925	cf
Surface Area (As):	1950	sf
Depth (hs):	1.50	ft
Sand Filter Chamber:		
Filter Volume (Vf):	2700	cf
Surface Area (Af):	1800	sf
Filter Depth (df):	1.50	ft

BMP Site Design Elevations

	Elev	Length	Slope
Nat Gnd	28.5		
Inflow Elev	24.6		
Spillway	24.6	150	3.35%
Freeboard	0.2		
WQpool	24.4		
Depth to Bed	5.6-ft		
SF bed	22.9		
Underdrain	20.8	240	0.50%
Outflow	19.6		
Adkin Inv	18.6		

Drainage Areas by Soil Series

Series	Group	SF	Ac	Percent
BB	**D**	32798	0.75	19.8%
Cr	**C**	0		
Cv	**C**	0		
Go	**B**	0		
Jo	**B**	0		
Ka	**B**	0		
Ke	**A**	132521	3.04	80.2%
La	**A**	0		
Na	**B**	0		
Nc	**B**	0		
Wd	**A**	0		
Wn	**B/D**	0		
		165319	3.80	100.0%

Time of Concentration Details

	L	S	n
Sheet	50	0.5%	0.24
Shallow			
C&G	680	0.3%	0.016
System	360	0.3%	0.012
	1090		

Calculated % Impervious Area of Basin

Total Basin - IA	**15.2%**
Residential - IA	

Drainage Areas by Hydrologic Soil Groups

Group	SF	Ac	Percent
A	132521	3.04	80.2%
B	0	0.00	0.0%
C	0	0.00	0.0%
D	32798	0.75	19.8%
TOTAL	165319	3.80	100.0%

Land Use by Hydrologic Soil Groups

IA - Road	IA - Roof, etc	Lawn/Open	Woods
15.17%	0.00%	84.83%	0.00%
0.58	0.00	2.47	
0.00	0.00	0.75	0.00
3.80	<= Area Check		

NCDENR Stormwater BMP Manual:
3.12.6.3 Design Specs & Meth. Design Requirements

Sediment Chamber:	**NCDENR Minimum**		**Site Design Summary**	
Volume (Vs):	2050	cf	900	cf
Surface Area (As):	1367	sf	600	sf
Depth (hs):	1.5	ft	1.5	ft
Sand Filter Chamber:				
Filter Volume (Vf):	2050	cf	1200	cf
Surface Area (Af):	1367	sf	800	sf
Filter Depth (df):	1.5	ft	1.5	ft

Austin Sand Filter:

Sed. Surface Area 689 sf

Surface Sand Filter Design

Step 1 - Compute Runoff Control Volumes:

Water Quality Volume (WQv):

Uniform 1/2" Runoff (WQv)	=	0.16	Ac-ft
WQv	=	6888	cf
Simple Method:			
IA	=	15.2%	
Rv	=	0.19	in / in
Runoff from 1" Rainfall (WQv)	=	2570	cf
Q	=	0.19	in
Mod. CN	=	86	

THEREFORE, USE:		0.06	Ac-ft		2:1
WQv	=	**2570**	cf	30	60

Step 2 - Site Feasibility:

Sys Inv / Inflow Elev	=	23.6	ft
Stream Inv /Outflow Elev	=	**17.8**	ft - Between INV & BKF based on Adkin Br Restoration
Total Available Depth	=	5.8	ft
Check Design Depth	=	3.9	ft
NG Elev at Boring	=	25.5	
Water depth	=	7.0	
Water Elev at Boring	=	18.5	ft

Step 3 - Confirm local design criteria and applicability:

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

N/A - Per meeting on Jan 30, 2007, City of Kinston has no additional criteria and defers to the NCDENR design criteria.

Step 4 - Compute WQ v peak discharge:

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures (see subse

(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 5 - Compute WQ v peak discharge:

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 6 - Size filtration basin chamber:

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:

A_f = surface area of filter bed (ft^2)
d_f = filter bed depth (typically 18 inches, no more than 24 inches)
k = coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
h_f = average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically ≤ 6 feet)
t_f = design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Set preliminary dimensions of filtration basin chamber.

WQv	=	2570	cf			
df	=	1.5	ft - filter depth			
k	=	3.5	ft/day - sand			
hf	=	0.75	ft			
tf	=	1	day - drain time			
Af	=	490	sf	< NCDENR Min Filter SA		
HOWEVER, USE:						
Af	=	490	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	15	30	1.5	2:1	

Step 7 - Size sedimentation basin:

Surface sand filter: The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * Ln(1\text{-}E)$$

Where:

A_s = sedimentation basin surface area (ft^2)
Q_o = rate of outflow = the WQ_v over a 24-hour period
w = particle settling velocity (ft/sec)
E = trap efficiency

Assuming:

- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness ≥ 75%
- average of 24 hour holding period

Then:

A_s = $(0.066)(WQ_v)\ ft^2$ for $I < 75\%$
A_s = $(0.0081)(WQ_v)\ ft^2$ for $I \geq 75\%$

Set preliminary dimensions of sedimentation chamber.

Qo	=	2570	cf / day		
w	=	0.0004	ft/sec	**for IA < 75%**	
E	=	0.9			
As	=	170	sf	< NCDENR Min Sed Basin SA	
HOWEVER, USE:					
As	=	170	sf		
		W	L	hmax	Dim Ratio
Approx Chamber Dim:	=	15	30	1.5	2:1

Surface Sand Filter Design

Step 8 - Compute Vmin:

$V_{min} = 0.75 * WQ_v$

Vmin	=	1928	cf	< NCDENR Min Volume for Total Basin

Step 9 - Compute storage volumes within entire facility and sedimentation chamber orifice size:

Surface sand filter:

$$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-}temp}$$

(1) Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$
Where: n = porosity = 0.4 for most applications

(2) Compute $V_{f\text{-}temp}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$

(3) Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-}temp}$

(4) Compute h_s = height in sedimentation chamber = V_s/A_s

(5) Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary in design iterations until all site dimensions fit.

(6) Size orifice from sediment chamber to filter chamber to release V_s within 24-hours at average release rate with 0.5 h_s as average head.

(7) Design outlet structure with perforations allowing for a safety factor of 10 (see example)

(8) Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Vf	=	294	cf	Filter Bed Volume
Vf-temp	=	735	cf	Temp Storage above Filter Bed
Vs	=	899	cf	Sediment Chamber Volume
hs	=	**2.000**	cf	Sediment Chamber Height>Design Head, Adj Geometry

---

BMP Final Design Summary

DRE, ADJ'D BASIN GEOMETRY:		W	L	hs or hf	Dim Ratio
Filter Basin Dimensions:	=	20	40	1.50	2.0:1
Sed Basin Dimensions:	=	20	30	1.50	1.5:1

	Site Design	
Sediment Chamber:		
Volume (Vs):	900	cf
Surface Area (As):	600	sf
Depth (hs):	1.50	ft
Sand Filter Chamber:		
Filter Volume (Vf):	1200	cf
Surface Area (Af):	800	sf
Filter Depth (df):	1.50	ft

BMP Site Design Elevations

	Elev	Length	Slope
Nat Gnd	25.5		
Inflow Elev	23.6		
Spillway	23.6	150	3.84%
Freeboard	1.0		
WQpool	22.5		
Depth to Bed	4.5-ft		
SF bed	21.0		
Underdrain	18.9	210	0.50%
Outflow	17.8		
Adkin Inv	16.8		

Surface Sand Filter Design

Drainage Areas by Soil Series

Series	Group	SF	Ac	Percent
BB	**D**	20851.9	0.48	3.8%
Cr	**C**	0		
Cv	**C**	0		
Go	**B**	0		
Jo	**B**	0		
Ka	**B**	395962	9.09	71.3%
Ke	**A**	138682	3.18	25.0%
La	**A**	0		
Na	**B**	0		
Nc	**B**	0		
Wd	**A**	0		
Wn	**B/D**	0		
		555495.9	12.75	100.0%

Time of Concentration Details

	L	S	n
Sheet	50	0.3%	0.24
Shallow	300	0.8%	
Swale	785	0.7%	0.045
System	665	0.7%	0.016
	1800		

Calculated % Impervious Area of Basin

Total Basin - IA	**36.9%**
Residential - IA	
Residential: Lots 0.11 Ac (Avg)	

Drainage Areas by Hydrologic Soil Groups

Group	SF	Ac	Percent
A	138682	3.18	25.0%
B	395962	9.09	71.3%
C	0	0.00	0.0%
D	20851.9	0.48	3.8%
TOTAL	555495.9	12.75	100.0%

Land Use by Hydrologic Soil Groups

IA - Road	IA - Roof, etc	Lawn/Open	Woods
15.97%	20.94%	63.10%	0.00%
0.54	0.69	1.96	
1.41	1.98	5.70	0.00
0.09	0.00	0.39	0.00
12.75	<= Area Check		

NCDENR Stormwater BMP Manual:
3.12.6.3 Design Specs & Meth. Design Requirements

Sediment Chamber:	**NCDENR Minimum**		**Site Design Summary**	
Volume (Vs):	6887	cf	5600	cf
Surface Area (As):	4591	sf	2800	sf
Depth (hs):	1.5	ft	2	ft
Sand Filter Chamber:				
Filter Volume (Vf):	6887	cf	4900	cf
Surface Area (Af):	4591	sf	2450	sf
Filter Depth (df):	1.5	ft	1.5	ft

Austin Sand Filter:
Sed. Surface Area 2315 sf

Surface Sand Filter Design

Step 1 - Compute Runoff Control Volumes:

Water Quality Volume (WQv):

Uniform 1/2" Runoff (WQv)	=	0.53	Ac-ft		
WQv	=	23146	cf		
Simple Method:					
IA	=	36.9%			
Rv	=	0.38	in / in		
Runoff from 1" Rainfall (WQv)	=	17690	cf		
Q	=	0.38	in		
Mod. CN	=	92			
THEREFORE, USE:		0.41	Ac-ft		2:1
WQv	=	**17690**	cf	70	140

Step 2 - Site Feasibility:

Sys Inv / Inflow Elev	=	23.6	ft - Based on 1-ft Tailwater Depth
Stream Inv /Outflow Elev	=	**18.2**	ft - Between INV & BKF based on Adkin Br Restoration
Total Available Depth	=	5.4	ft
Check Design Depth	=	4.4	ft
NG Elev at Boring	=	27.5	
Water depth	=	6.0	
Water Elev at Boring	=	21.5	ft

Step 3 - Confirm local design criteria and applicability:

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply.

N/A - Per meeting on Jan 30, 2007, City of Kinston has no additional criteria and defers to the NCDENR design criteria.

Step 4 - Compute WQ v peak discharge:

The peak rate of discharge for water quality design storm is needed for sizing of off-line diversion structures (see subse

(a) Using WQ_v, compute CN
(b) Compute time of concentration using TR-55 method
(c) Determine appropriate unit peak discharge from time of concentration
(d) Compute Q_{wq} from unit peak discharge, drainage area, and WQ_v.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 5 - Compute WQ v peak discharge:

A flow regulator (or flow splitter diversion structure) should be supplied to divert the WQ_v to the sand filter facility.

Size low flow orifice, weir, or other device to pass Q_{wq}.

N/A - Structure is designed for project site as an In-line BMP with disversion from Sediment chamber.

Step 6 - Size filtration basin chamber:

The filter area is sized using the following equation (based on Darcy's Law):

$$A_f = (WQ_v)(d_f) / [(k)(h_f + d_f)(t_f)]$$

where:
- A_f = surface area of filter bed (ft^2)
- d_f = filter bed depth (typically 18 inches, no more than 24 inches)
- k = coefficient of permeability of filter media (ft/day) (use 3.5 ft/day for sand)
- h_f = average height of water above filter bed (ft) (1/2 h_{max}, which varies based on site but h_{max} is typically ≤ 6 feet)
- t_f = design filter bed drain time (days) (1.67 days or 40 hours is recommended maximum)

Set preliminary dimensions of filtration basin chamber.

WQv	=	17690	cf			
df	=	1.5	ft - filter depth			
k	=	3.5	ft/day - sand			
hf	=	1	ft			
tf	=	1	day - drain time			
Af	=	3035	sf		< NCDENR Min Filter SA	
HOWEVER, USE:						
Af	=	3035	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	30	60	2	2:1	

Step 7 - Size sedimentation basin:

Surface sand filter: The sedimentation chamber should be sized to at least 25% of the computed WQ_v and have a length-to-width ratio of 2:1. The Camp-Hazen equation is used to compute the required surface area:

$$A_s = -(Q_o/w) * Ln(1-E)$$

Where:
- A_s = sedimentation basin surface area (ft^2)
- Q_o = rate of outflow = the WQ_v over a 24-hour period
- w = particle settling velocity (ft/sec)
- E = trap efficiency

Assuming:
- 90% sediment trap efficiency (0.9)
- particle settling velocity (ft/sec) = 0.0004 ft/sec for imperviousness < 75%
- particle settling velocity (ft/sec) = 0.0033 ft/sec for imperviousness ≥ 75%
- average of 24 hour holding period

Then:

A_s = $(0.066)(WQ_v)$ ft^2 for $I < 75\%$
A_s = $(0.0081)(WQ_v)$ ft^2 for $I \geq 75\%$

Set preliminary dimensions of sedimentation chamber.

Qo	=	17690	cf / day			
w	=	0.0004	ft/sec		**for IA < 75%**	
E	=	0.9				
As	=	1168	sf		< NCDENR Min Sed Basin SA	
HOWEVER, USE:						
As	=	1168	sf			
		W	L	hmax	Dim Ratio	
Approx Chamber Dim:	=	30	60	2	2:1	

Step 8 - Compute Vmin:

$V_{min} = 0.75 * WQ_v$

Vmin	=	13268	cf	< NCDENR Min Volume for Total Basin

Step 9 - Compute storage volumes within entire facility and sedimentation chamber orifice size:

***Surface sand filter*:**

$$V_{min} = 0.75\ WQ_v = V_s + V_f + V_{f\text{-temp}}$$

(1) Compute V_f = water volume within filter bed/gravel/pipe = $A_f * d_f * n$
Where: n = porosity = 0.4 for most applications

(2) Compute $V_{f\text{-temp}}$ = temporary storage volume above the filter bed = $2 * h_f * A_f$

(3) Compute V_s = volume within sediment chamber = $V_{min} - V_f - V_{f\text{-temp}}$

(4) Compute h_s = height in sedimentation chamber = V_s/A_s

(5) Ensure h_s and h_f fit available head and other dimensions still fit – change as necessary in design iterations until all site dimensions fit.

(6) Size orifice from sediment chamber to filter chamber to release V_s within 24-hours at average release rate with 0.5 h_s as average head.

(7) Design outlet structure with perforations allowing for a safety factor of 10 (see example)

(8) Size distribution chamber to spread flow over filtration media – level spreader weir or orifices.

Vf	=	1821	cf	Filter Bed Volume
Vf-temp	=	6070	cf	Temp Storage above Filter Bed
Vs	=	5377	cf	Sediment Chamber Volume
hs	=	**2.990**	cf	Sediment Chamber Height>Design Head, Adj Geometry

BMP Final Design Summary

DRE, ADJ'D BASIN GEOMETRY:		W	L	hs or hf	Dim Ratio
Filter Basin Dimensions:	=	35	70	2.00	2.0:1
Sed Basin Dimensions:	=	35	80	2.00	2.3:1

	Site Design	
Sediment Chamber:		
Volume (Vs):	5600	cf
Surface Area (As):	2800	sf
Depth (hs):	2.00	ft
Sand Filter Chamber:		
Filter Volume (Vf):	3675	cf
Surface Area (Af):	2450	sf
Filter Depth (df):	1.50	ft

BMP Site Design Elevations

	Elev	Length	Slope
Nat Gnd	27.5		
Inflow Elev	23.6		
Spillway	23.6	75	7.25%
Freeboard	0.4		
WQpool	23.3		
Depth to Bed	6.2-ft		
SF bed	21.3		
Underdrain	19.1	180	0.50%
Outflow	18.2		
Adkin Inv	17.2		

Upper Neuse Site Evaluation Tool - Site Performance Analysis

Adkin Branch
City of Kinston, NC
BMP-1 (Martin Drive)

Land Use Summary

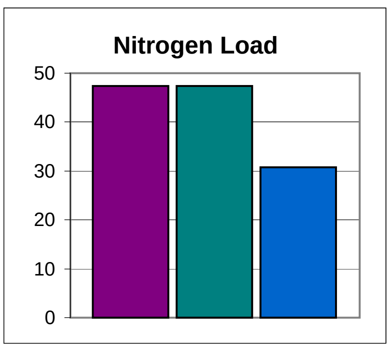
Total Site Area (acres)	**10.86**
Pre-development impervious percentage	**20.4%**
Post-development impervious percentage	**20.4%**

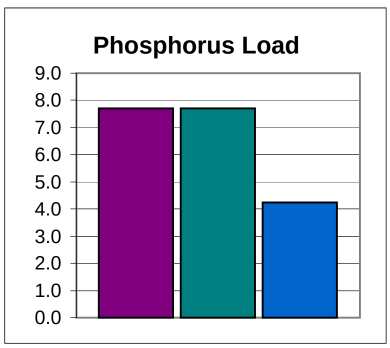
Annual Hydrology Summary

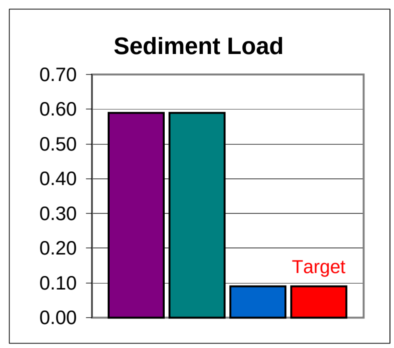
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	9.39	9.39	9.39
Annual Infiltration (inches/yr)	3.65	3.65	3.65

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	47	47	31		
Total Phosphorus (lb/yr)	7.7	7.7	4.2		
Sediment (ton/yr)	0.59	0.59	0.09	0.09	Yes

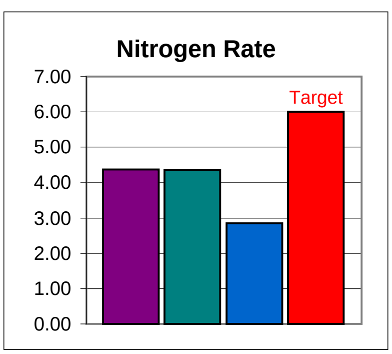


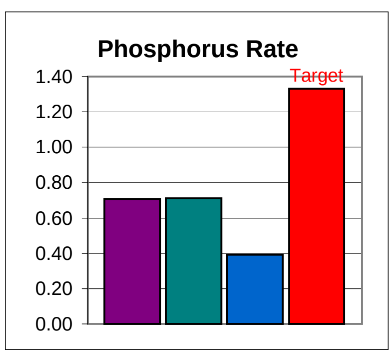


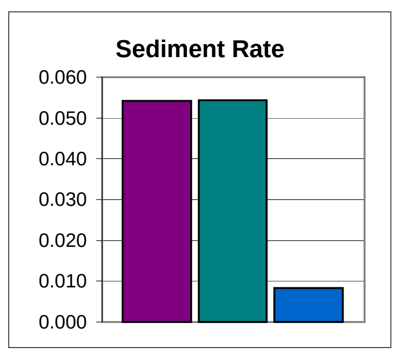


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	4.36	4.36	2.84	6.00	Yes
Total Phosphorus (lb/ac/yr)	0.71	0.71	0.39	1.33	Yes
Sediment (ton/ac/yr)	0.054	0.054	0.008		

Site is located in Urban Residential Nutrient Zone
TN loading rate is below the buy-down range of 3.6 to 6 lb/ac/yr

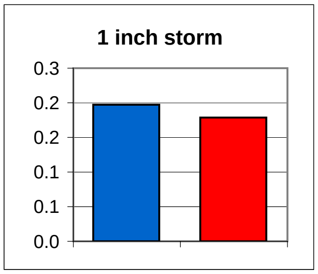


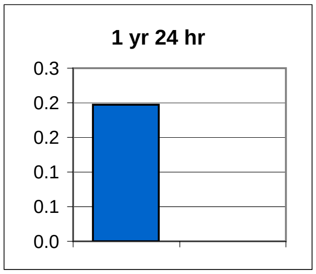




Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.179	0.179	0.197	0.179	Yes
1-yr 24-hr storm	1.153	1.153	0.197	0.000	Yes





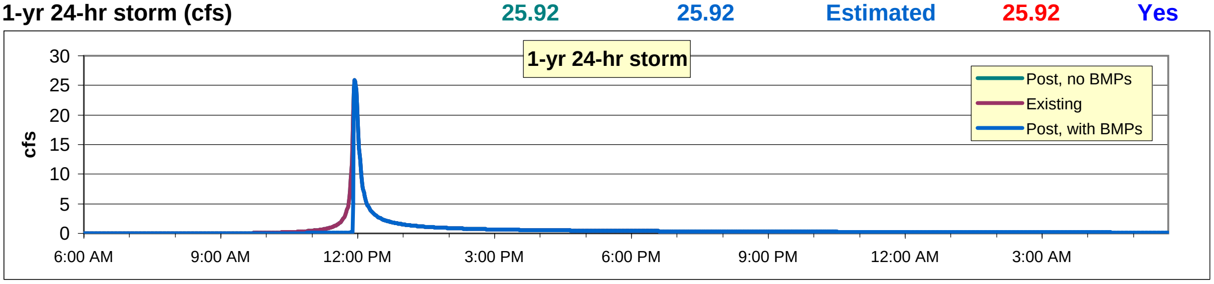
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	18.60	25.92	18.60	25.92

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	25.92	25.92	Estimated	25.92	Yes



Upper Neuse Site Evaluation Tool - Site Performance Analysis

Adkin Branch
City of Kinston, NC
BMP-2 (Martin Drive)

Land Use Summary

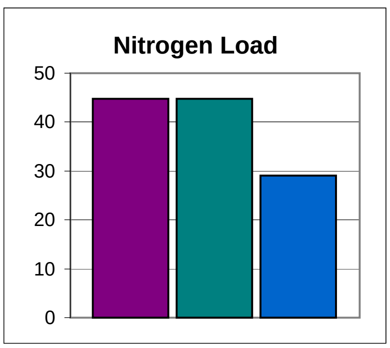
Total Site Area (acres)	**6.7968**
Pre-development impervious percentage	**30.6%**
Post-development impervious percentage	**30.6%**

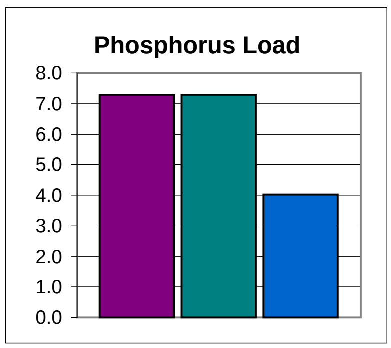
Annual Hydrology Summary

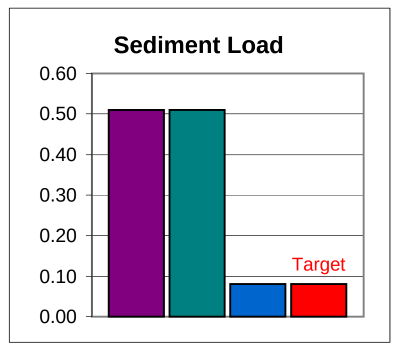
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	13.11	13.11	13.11
Annual Infiltration (inches/yr)	2.20	2.20	2.20

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	45	45	29		
Total Phosphorus (lb/yr)	7.3	7.3	4.0		
Sediment (ton/yr)	0.51	0.51	0.08	0.08	Yes

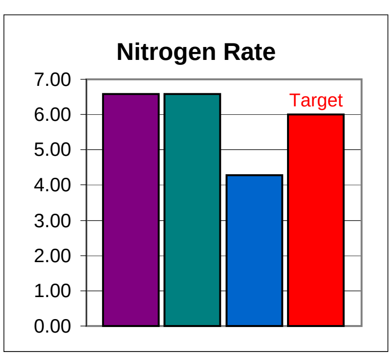


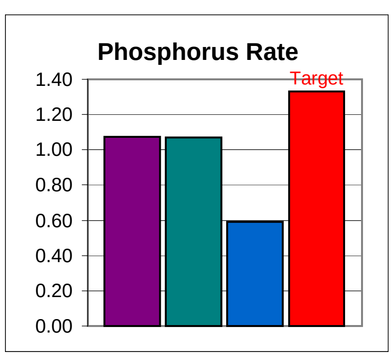


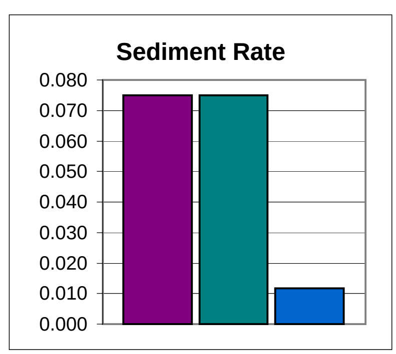


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	6.58	6.58	4.28	6.00	Yes
Total Phosphorus (lb/ac/yr)	1.07	1.07	0.59	1.33	Yes
Sediment (ton/ac/yr)	0.075	0.075	0.012		

Site is located in Urban Residential Nutrient Zone
TN loading rate is within the buy-down range of 3.6 to 6 lb/ac/yr

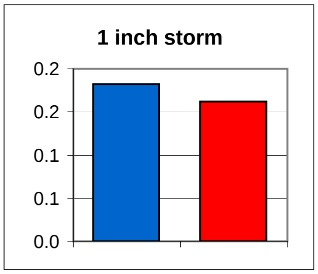


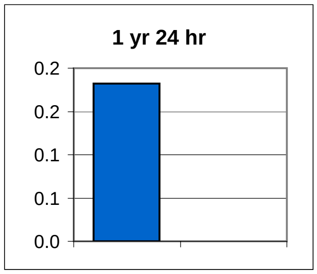




Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.162	0.162	0.182	0.162	Yes
1-yr 24-hr storm	0.874	0.874	0.182	0.000	Yes





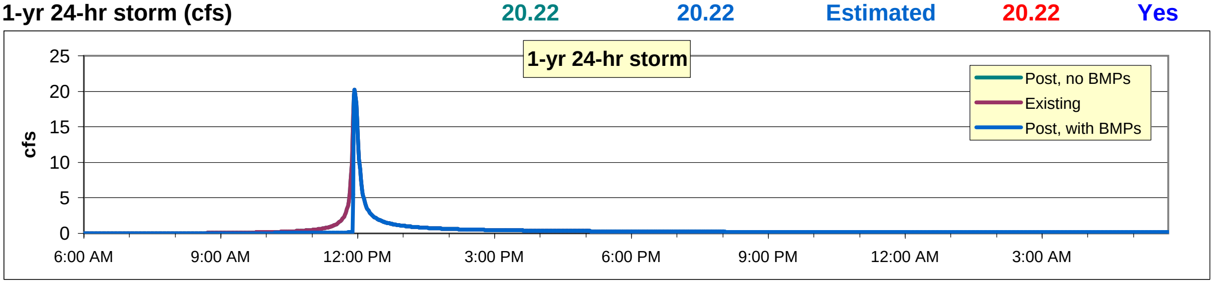
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	16.06	20.22	16.06	20.22

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	20.22	20.22	Estimated	20.22	Yes



Upper Neuse Site Evaluation Tool - Site Performance Analysis

Adkin Branch
City of Kinston, NC
BMP-3 (Martin Drive)

Land Use Summary

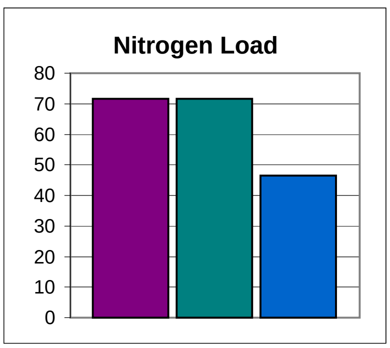
Total Site Area (acres)	**10.8824**
Pre-development impervious percentage	**30.6%**
Post-development impervious percentage	**30.6%**

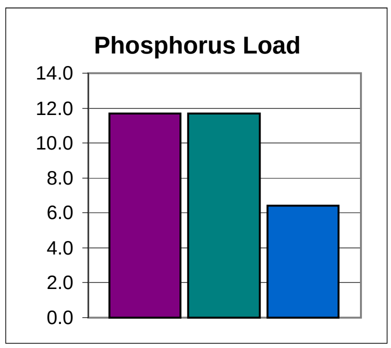
Annual Hydrology Summary

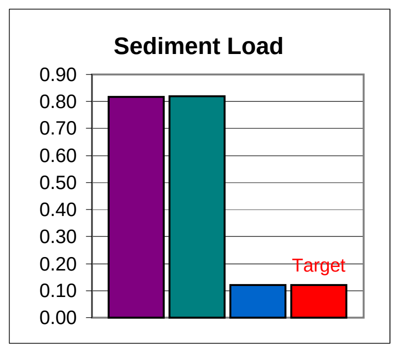
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	13.11	13.11	13.11
Annual Infiltration (inches/yr)	3.17	3.17	3.17

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	72	72	47		
Total Phosphorus (lb/yr)	11.7	11.7	6.4		
Sediment (ton/yr)	0.82	0.82	0.12	0.12	Yes

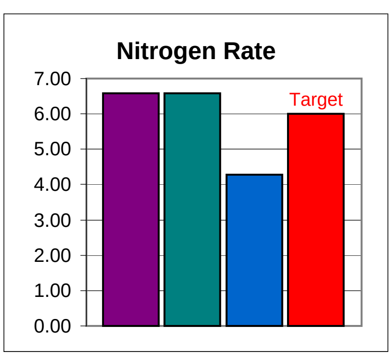


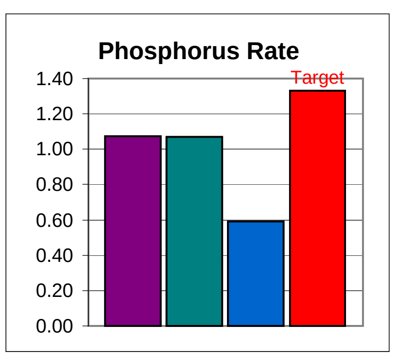


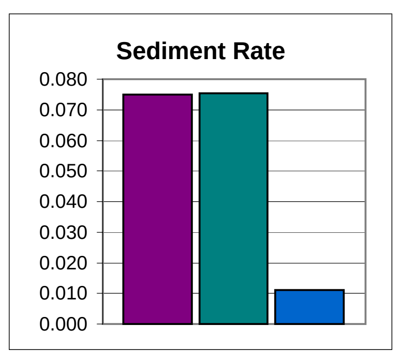


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	6.58	6.58	4.28	6.00	Yes
Total Phosphorus (lb/ac/yr)	1.07	1.07	0.59	1.33	Yes
Sediment (ton/ac/yr)	0.075	0.075	0.011		

Site is located in Urban Residential Nutrient Zone
TN loading rate is within the buy-down range of 3.6 to 6 lb/ac/yr

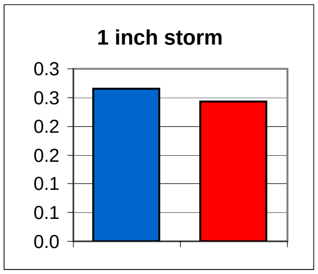


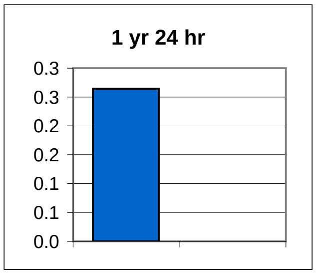




Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.243	0.243	0.265	0.243	Yes
1-yr 24-hr storm	1.287	1.287	0.265	0.000	Yes





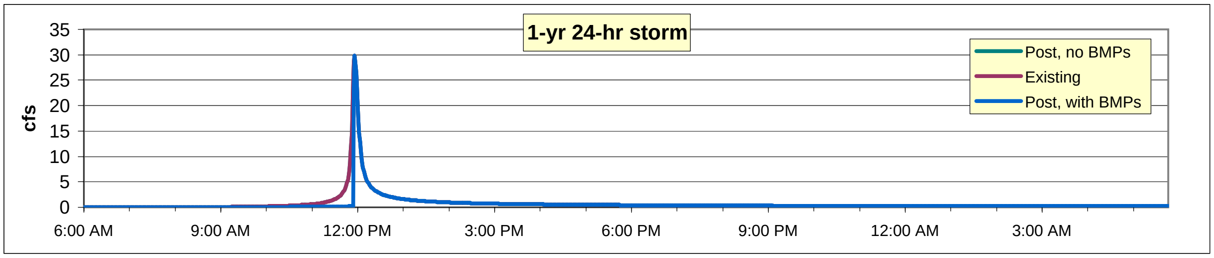
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	24.85	29.86	24.85	29.86

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	29.86	29.86	Estimated	29.86	Yes



Upper Neuse Site Evaluation Tool - Site Performance Analysis

Adkin Branch
City of Kinston, NC
BMP-4 (Miller Street)

Land Use Summary

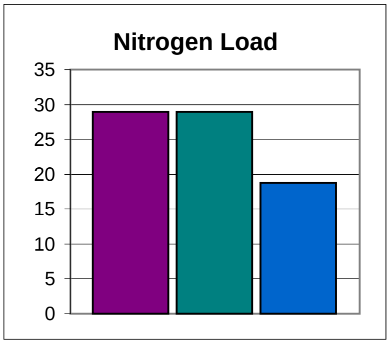
Total Site Area (acres)	3.453
Pre-development impervious percentage	45.3%
Post-development impervious percentage	45.3%

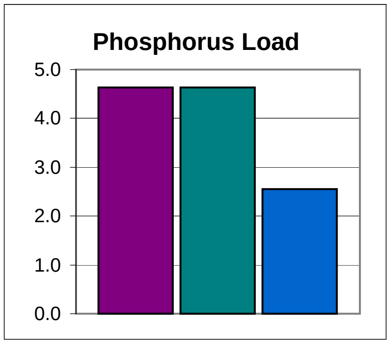
Annual Hydrology Summary

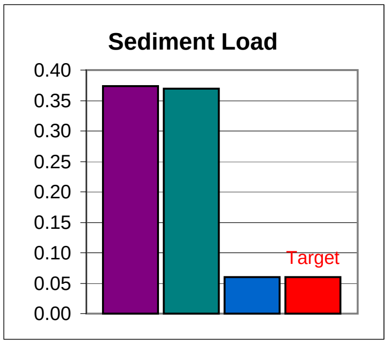
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	18.43	18.43	18.43
Annual Infiltration (inches/yr)	4.66	4.66	4.66

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	29	29	19		
Total Phosphorus (lb/yr)	4.6	4.6	2.5		
Sediment (ton/yr)	0.37	0.37	0.06	0.06	Yes

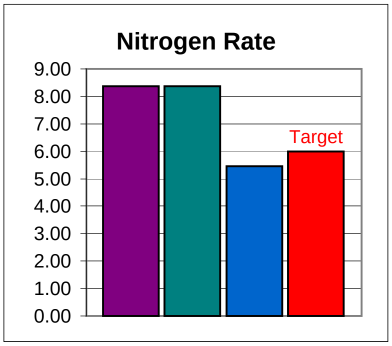


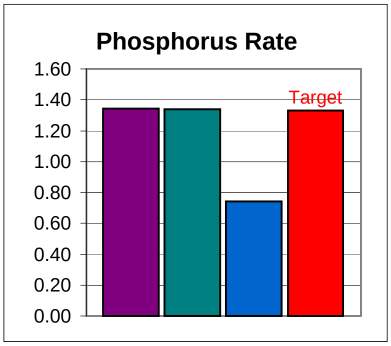


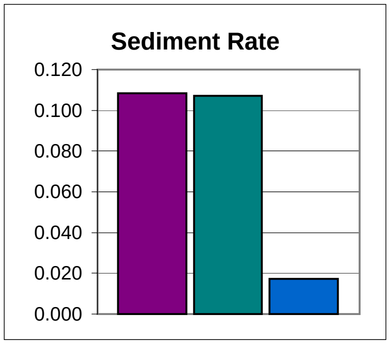


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	8.38	8.38	5.45	6.00	Yes
Total Phosphorus (lb/ac/yr)	1.34	1.34	0.74	1.33	Yes
Sediment (ton/ac/yr)	0.108	0.107	0.017		

Site is located in Urban Residential Nutrient Zone
TN loading rate is within the buy-down range of 3.6 to 6 lb/ac/yr

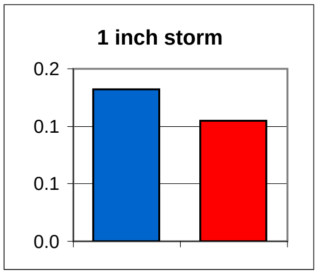


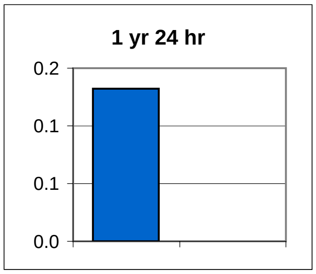




Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.105	0.105	0.132	0.105	Yes
1-yr 24-hr storm	0.416	0.416	0.132	0.000	Yes





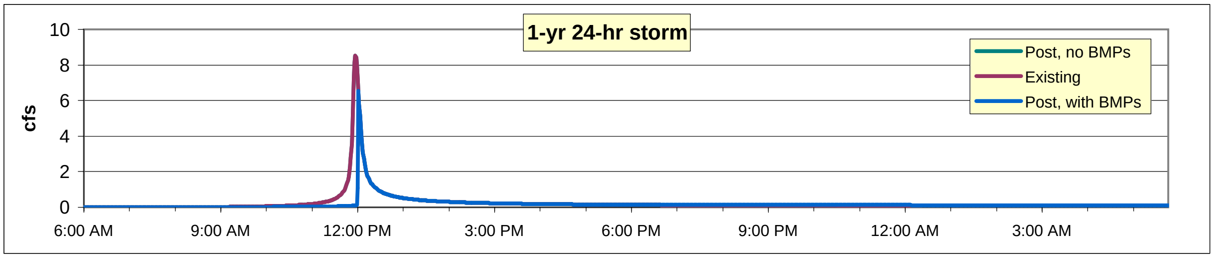
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	8.46	8.51	8.46	8.51

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	8.51	6.56	Estimated	8.51	Yes



Upper Neuse Site Evaluation Tool - Site Performance Analysis

Adkin Branch
City of Kinston, NC
BMP-5 (South Dover Street)

Land Use Summary

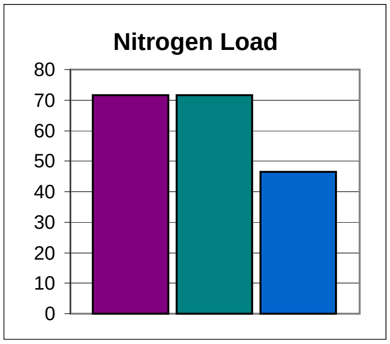
Total Site Area (acres)	**8.803820018**
Pre-development impervious percentage	**43.3%**
Post-development impervious percentage	**43.3%**

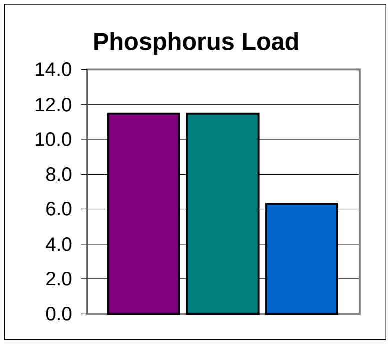
Annual Hydrology Summary

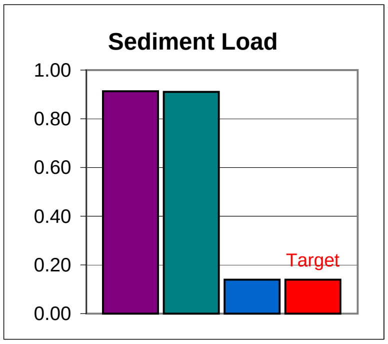
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	17.69	17.69	17.69
Annual Infiltration (inches/yr)	7.14	7.14	7.14

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	72	72	47		
Total Phosphorus (lb/yr)	11.5	11.5	6.3		
Sediment (ton/yr)	0.91	0.91	0.14	0.14	Yes

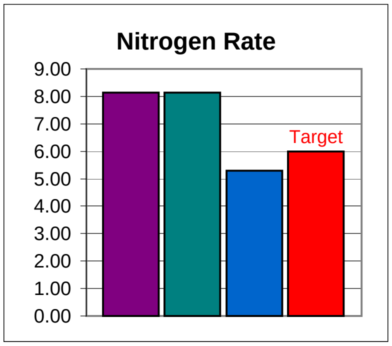


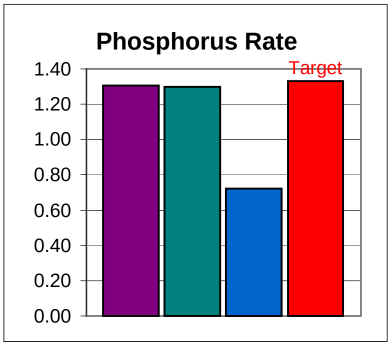


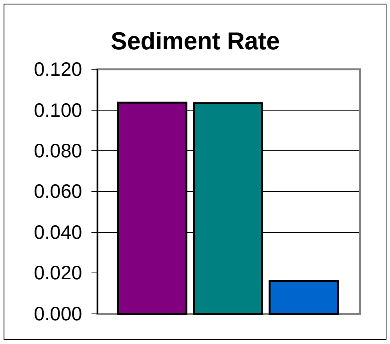


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	8.13	8.13	5.29	6.00	Yes
Total Phosphorus (lb/ac/yr)	1.30	1.30	0.72	1.33	Yes
Sediment (ton/ac/yr)	0.104	0.103	0.016		

Site is located in Urban Residential Nutrient Zone
TN loading rate is within the buy-down range of 3.6 to 6 lb/ac/yr

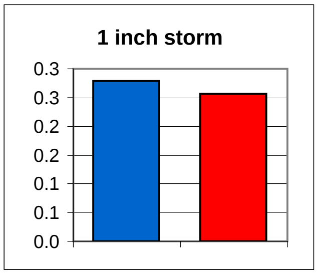


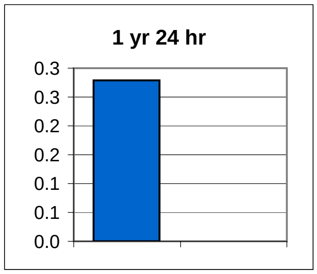




Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.256	0.256	0.279	0.256	Yes
1-yr 24-hr storm	0.914	0.914	0.279	0.000	Yes





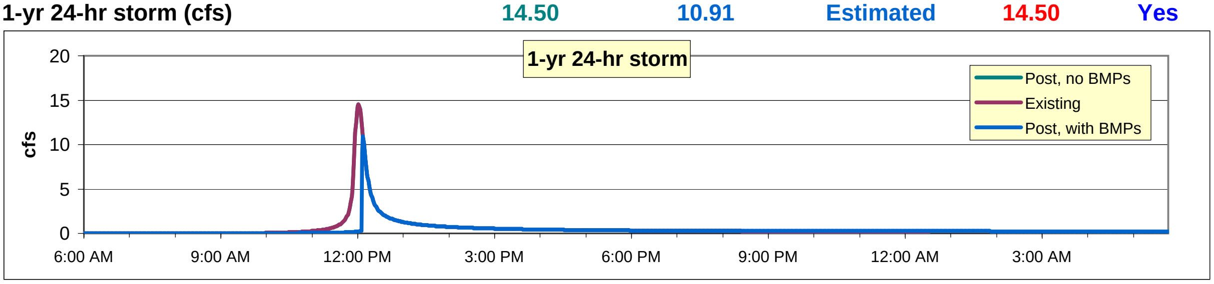
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	18.32	14.50	18.32	14.50

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	14.50	10.91	Estimated	14.50	Yes



Upper Neuse Site Evaluation Tool - Site Performance Analysis

Adkin Branch
City of Kinston, NC
BMP-6 (South Seacrest Street)

Land Use Summary

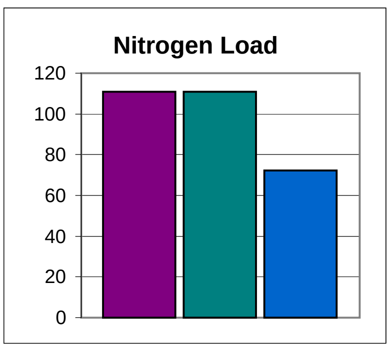
Total Site Area (acres)	18.38735078
Pre-development impervious percentage	27.2%
Post-development impervious percentage	27.2%

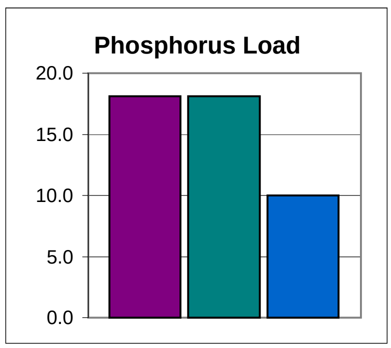
Annual Hydrology Summary

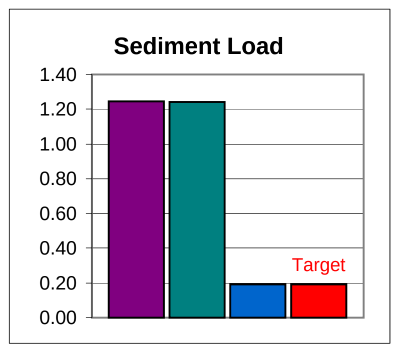
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	11.88	11.88	11.88
Annual Infiltration (inches/yr)	8.62	8.62	8.62

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	111	111	72		
Total Phosphorus (lb/yr)	18.1	18.1	10.0		
Sediment (ton/yr)	1.24	1.24	0.19	0.19	Yes

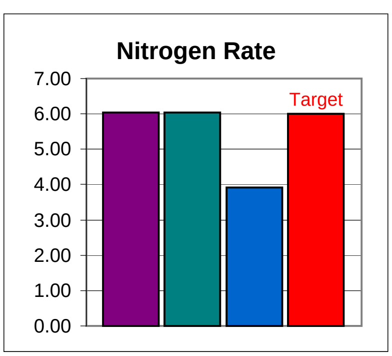


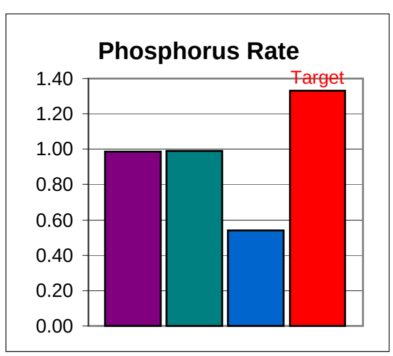


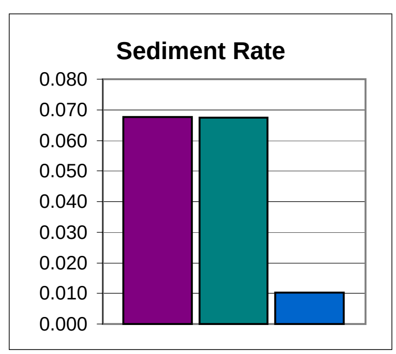


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	6.03	6.03	3.92	6.00	Yes
Total Phosphorus (lb/ac/yr)	0.99	0.99	0.54	1.33	Yes
Sediment (ton/ac/yr)	0.068	0.067	0.010		

Site is located in Urban Residential Nutrient Zone
TN loading rate is within the buy-down range of 3.6 to 6 lb/ac/yr

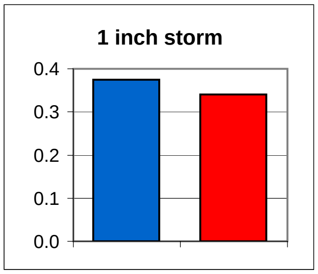


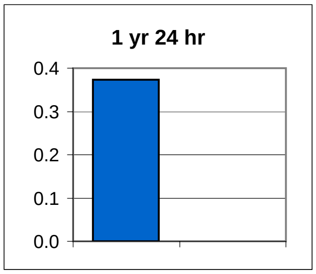




Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.341	0.341	0.374	0.341	Yes
1-yr 24-hr storm	1.360	1.360	0.374	0.000	Yes





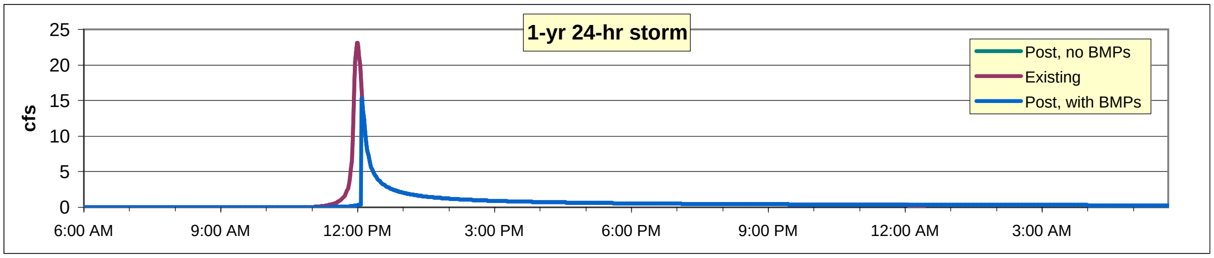
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	34.14	23.11	34.14	23.11

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	23.11	15.30	Estimated	23.11	Yes



Upper Neuse Site Evaluation Tool - Site Performance Analysis

Adkin Branch
City of Kinston, NC
BMP-7 (South Myrtle Avenue)

Land Use Summary

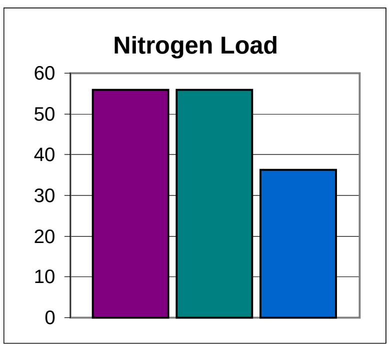
Total Site Area (acres)	**12.19484389**
Pre-development impervious percentage	**14.3%**
Post-development impervious percentage	**14.3%**

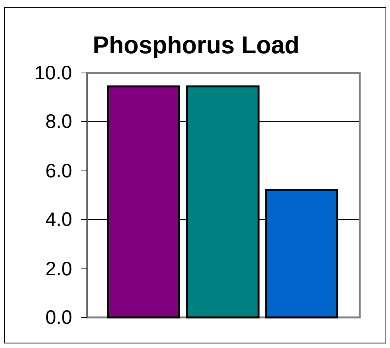
Annual Hydrology Summary

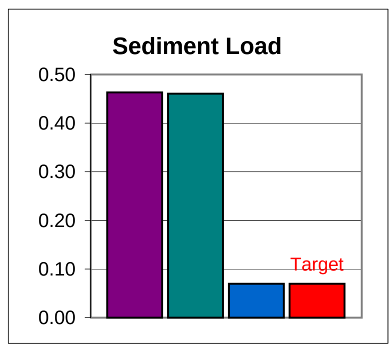
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	7.18	7.18	7.18
Annual Infiltration (inches/yr)	10.49	10.49	10.49

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	56	56	36		
Total Phosphorus (lb/yr)	9.5	9.5	5.2		
Sediment (ton/yr)	0.46	0.46	0.07	0.07	Yes

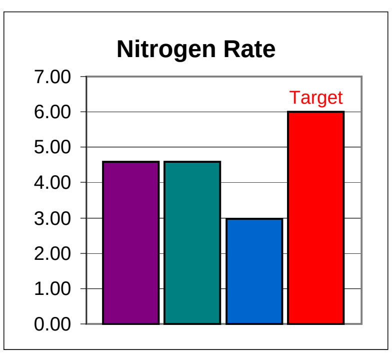


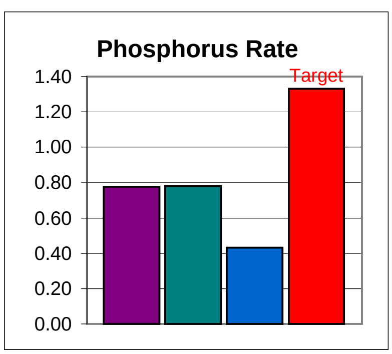


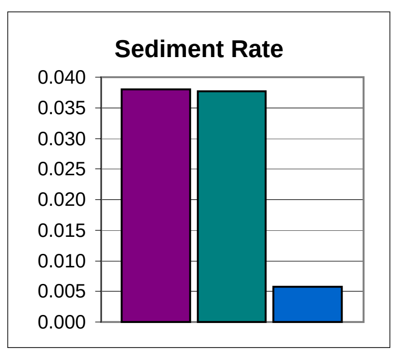


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	4.58	4.58	2.98	6.00	Yes
Total Phosphorus (lb/ac/yr)	0.78	0.78	0.43	1.33	Yes
Sediment (ton/ac/yr)	0.038	0.038	0.006		

Site is located in Urban Residential Nutrient Zone
TN loading rate is below the buy-down range of 3.6 to 6 lb/ac/yr

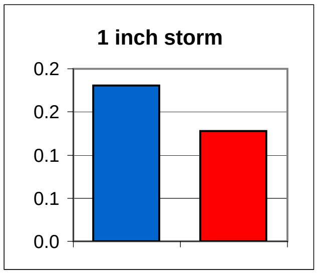


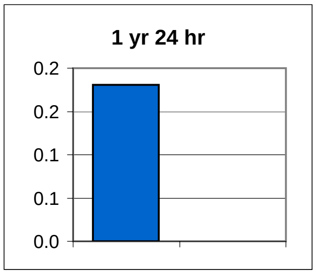




Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.128	0.128	0.181	0.128	Yes
1-yr 24-hr storm	0.566	0.566	0.181	0.000	Yes





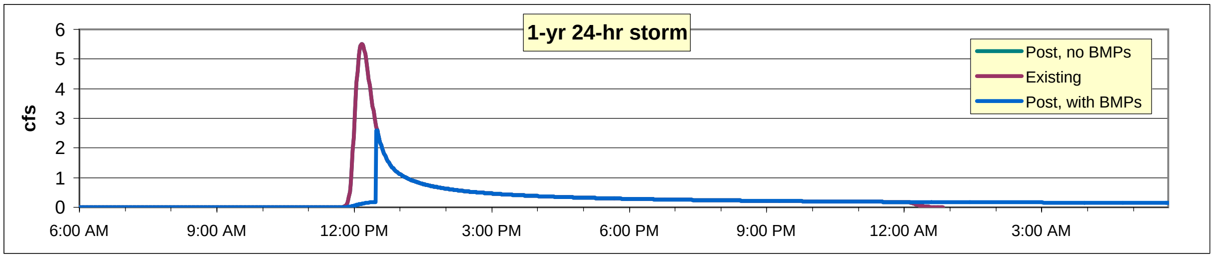
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse: Rational	Existing Landuse: Unit Hyd	Design without BMPs: Rational	Design without BMPs: Unit Hyd
1-yr 24-hr storm (cfs)	13.75	5.51	13.75	5.51

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	5.51	2.60	Estimated	5.51	Yes



Upper Neuse Site Evaluation Tool - Site Performance Analysis

Adkin Branch
City of Kinston, NC
BMP-8 (Holloway Drive)

Land Use Summary

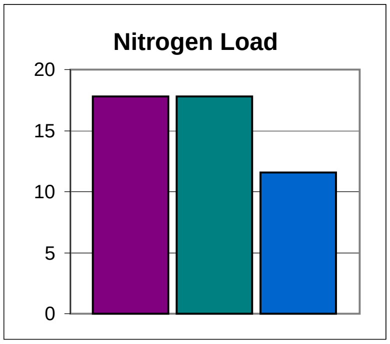
Total Site Area (acres)	**3.79520202**
Pre-development impervious percentage	**15.2%**
Post-development impervious percentage	**15.2%**

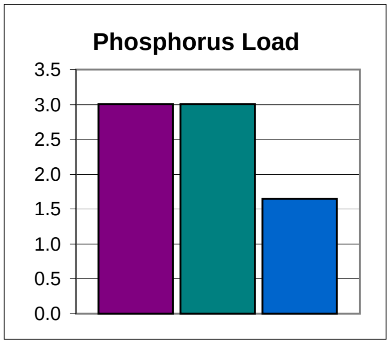
Annual Hydrology Summary

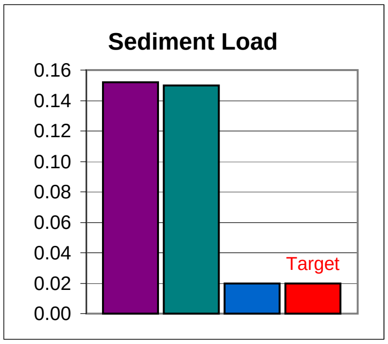
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	7.51	7.51	7.51
Annual Infiltration (inches/yr)	10.20	10.20	10.20

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	18	18	12		
Total Phosphorus (lb/yr)	3.0	3.0	1.7		
Sediment (ton/yr)	0.15	0.15	0.02	0.02	Yes

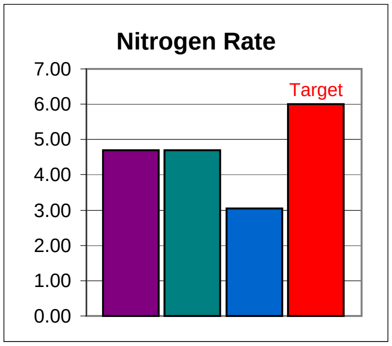


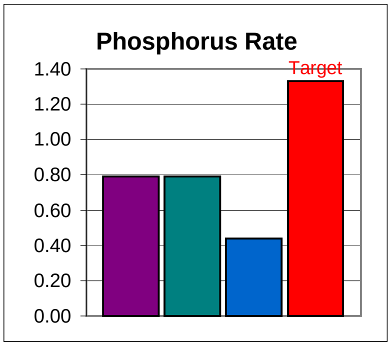


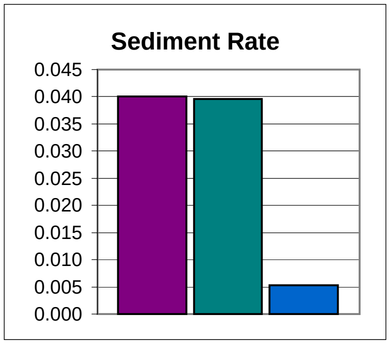


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	4.70	4.70	3.05	6.00	Yes
Total Phosphorus (lb/ac/yr)	0.79	0.79	0.44	1.33	Yes
Sediment (ton/ac/yr)	0.040	0.040	0.005		

Site is located in Urban Residential Nutrient Zone
TN loading rate is below the buy-down range of 3.6 to 6 lb/ac/yr

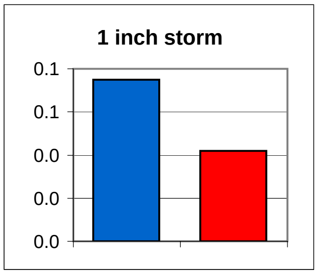


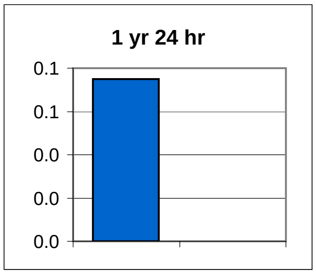




Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.042	0.042	0.075	0.042	Yes
1-yr 24-hr storm	0.189	0.189	0.075	0.000	Yes





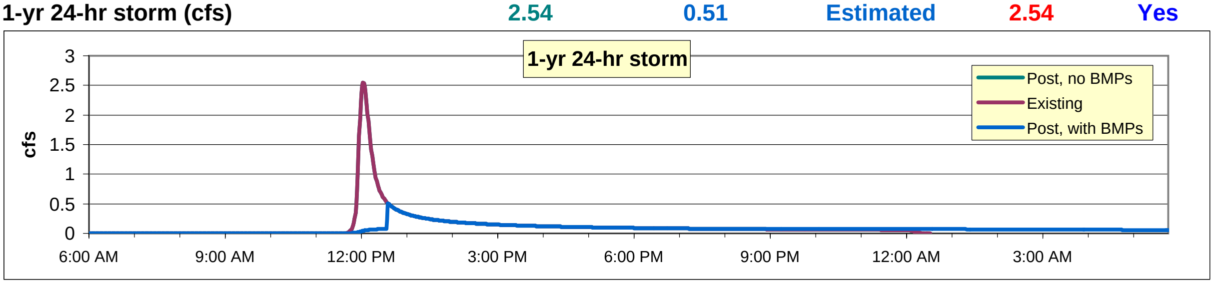
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	4.97	2.54	4.97	2.54

Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	2.54	0.51	Estimated	2.54	Yes



Upper Neuse Site Evaluation Tool - Site Performance Analysis

Adkin Branch
City of Kinston, NC
BMP-9 (East Shine Street)

Land Use Summary

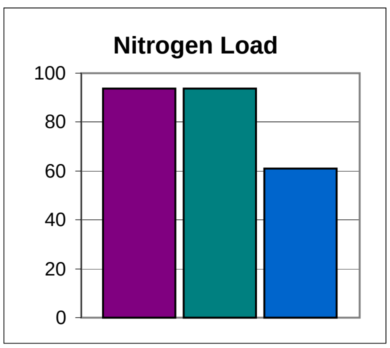
Total Site Area (acres)	**12.75243113**
Pre-development impervious percentage	**36.9%**
Post-development impervious percentage	**36.9%**

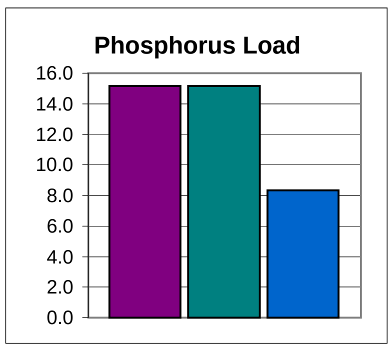
Annual Hydrology Summary

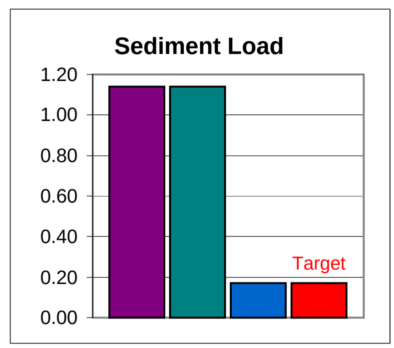
	Existing Landuse	Design without BMPs	Design with BMPs
Annual Surface Runoff (inches/yr)	15.39	15.39	15.39
Annual Infiltration (inches/yr)	6.64	6.64	6.64

Annual Pollutant Load and Target Summary

Total Site Annual Load	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/yr)	94	94	61		
Total Phosphorus (lb/yr)	15.2	15.2	8.3		
Sediment (ton/yr)	1.14	1.14	0.17	0.17	Yes

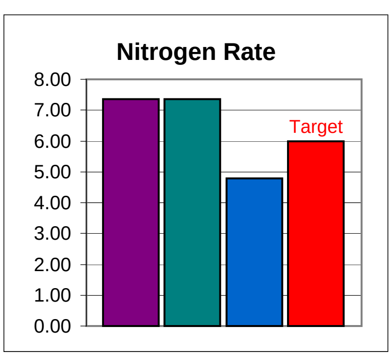


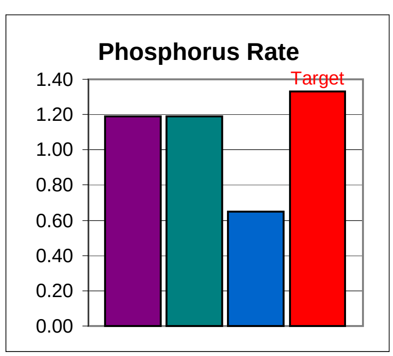


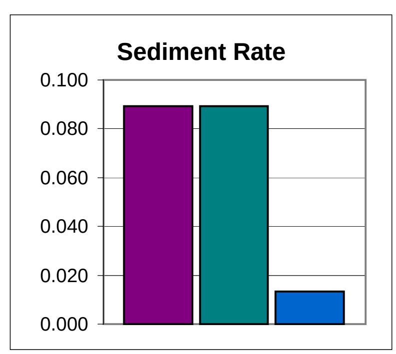


Areal Loading Rates	Existing Landuse	Design without BMPs	Design with BMPs	Target	Meets Goal?
Total Nitrogen (lb/ac/yr)	7.36	7.36	4.78	6.00	Yes
Total Phosphorus (lb/ac/yr)	1.19	1.19	0.65	1.33	Yes
Sediment (ton/ac/yr)	0.089	0.089	0.013		

Site is located in Urban Residential Nutrient Zone
TN loading rate is within the buy-down range of 3.6 to 6 lb/ac/yr

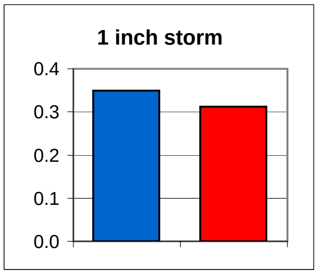


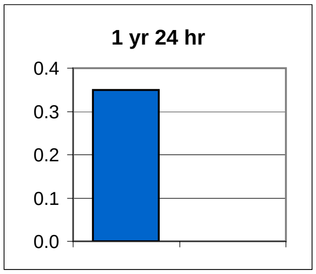




Storm Event Runoff Volume and Target Summary

Runoff Volume (ac-ft)	Existing Landuse	Design without BMPs	BMP Storage Volume	Target	Meets Goal?
1 inch storm	0.312	0.312	0.350	0.312	Yes
1-yr 24-hr storm	1.221	1.221	0.350	0.000	Yes





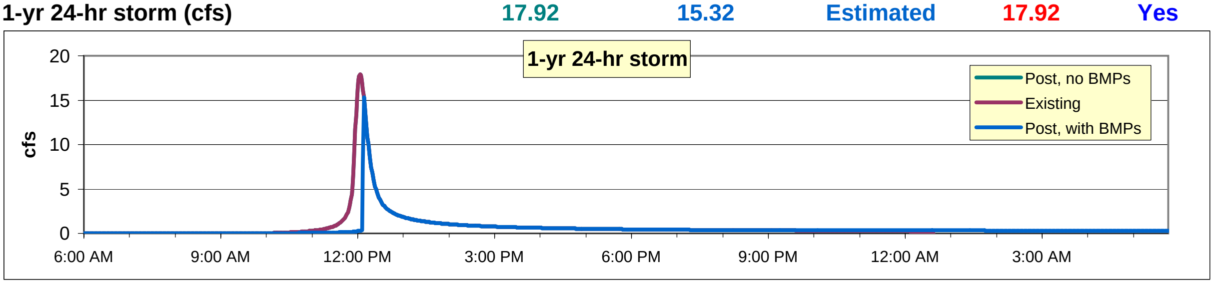
Storm Event Not Selected

Storm Event Not Selected

Peak Flow and Hydrograph Summary

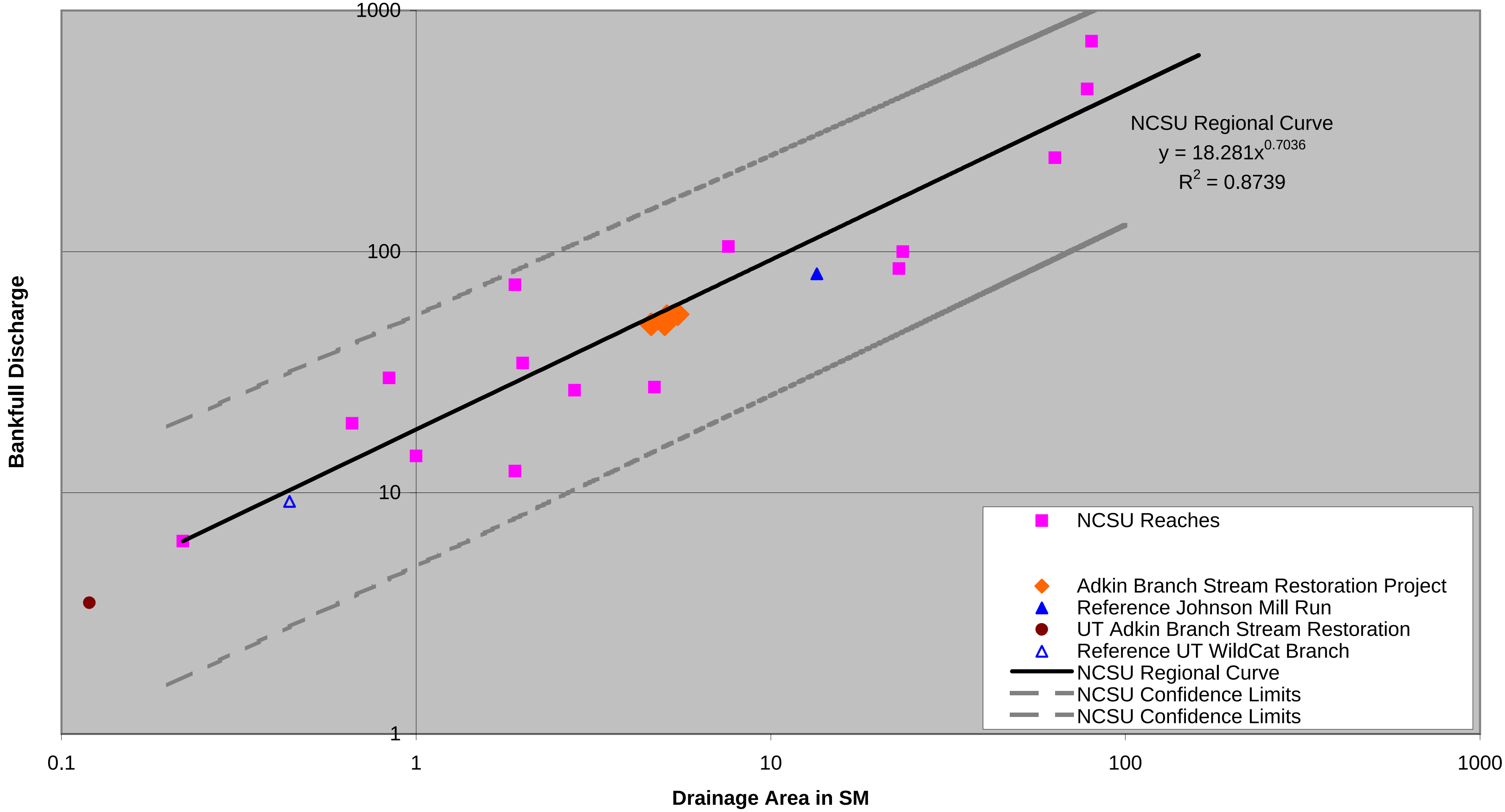
Estimated Peak Flows, Rational and SCS Unit Hydrograph Methods	Existing Landuse		Design without BMPs	
	Rational	Unit Hyd	Rational	Unit Hyd
1-yr 24-hr storm (cfs)	23.63	17.92	23.63	17.92

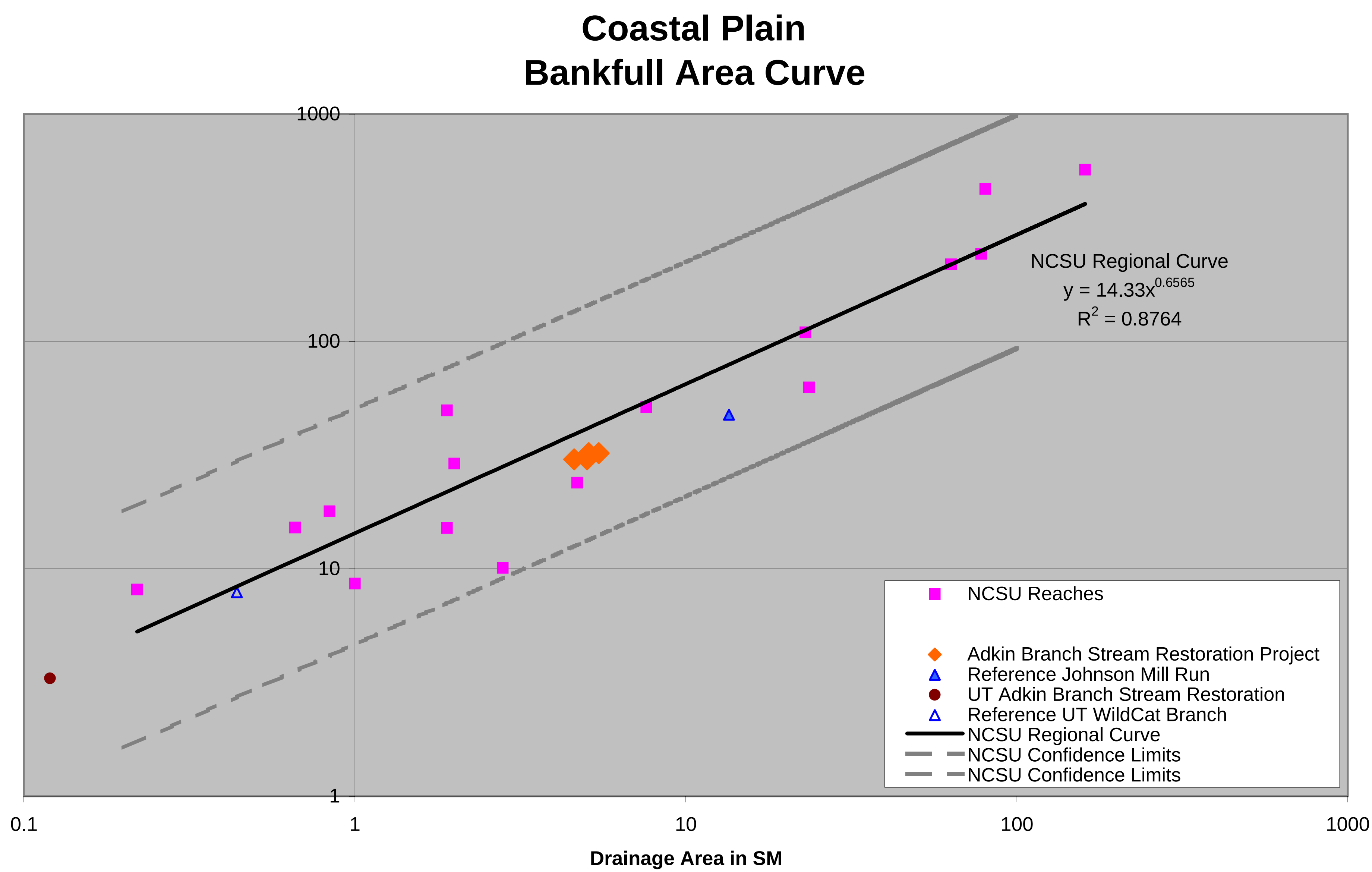
Comparison of SCS peak to Design with BMPs	Design without BMPs	Design with BMPs	Source	Target	Meets Goal?
1-yr 24-hr storm (cfs)	17.92	15.32	Estimated	17.92	Yes



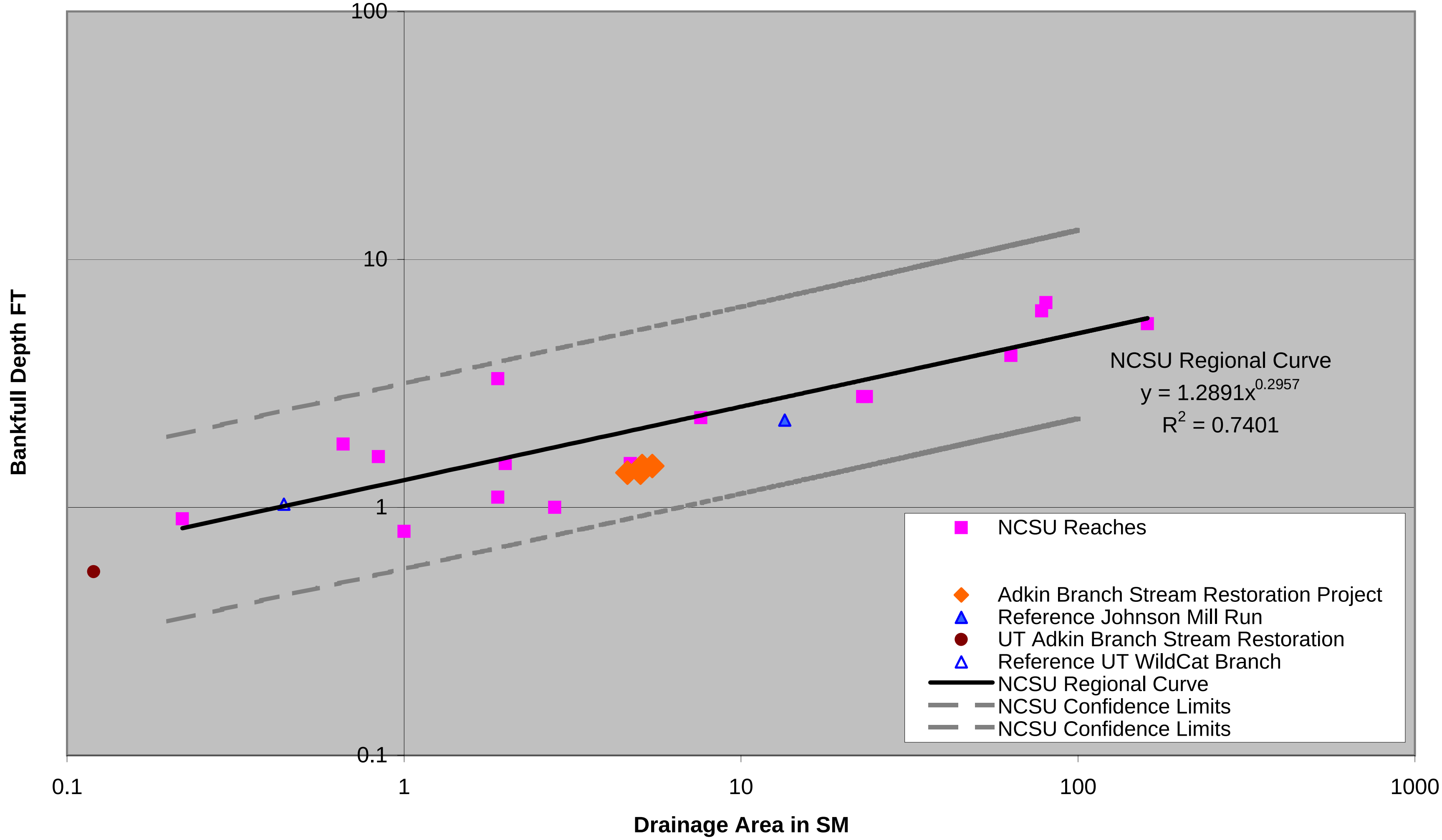
APPENDIX H
REGIONAL CURVE DOCUMENTATION

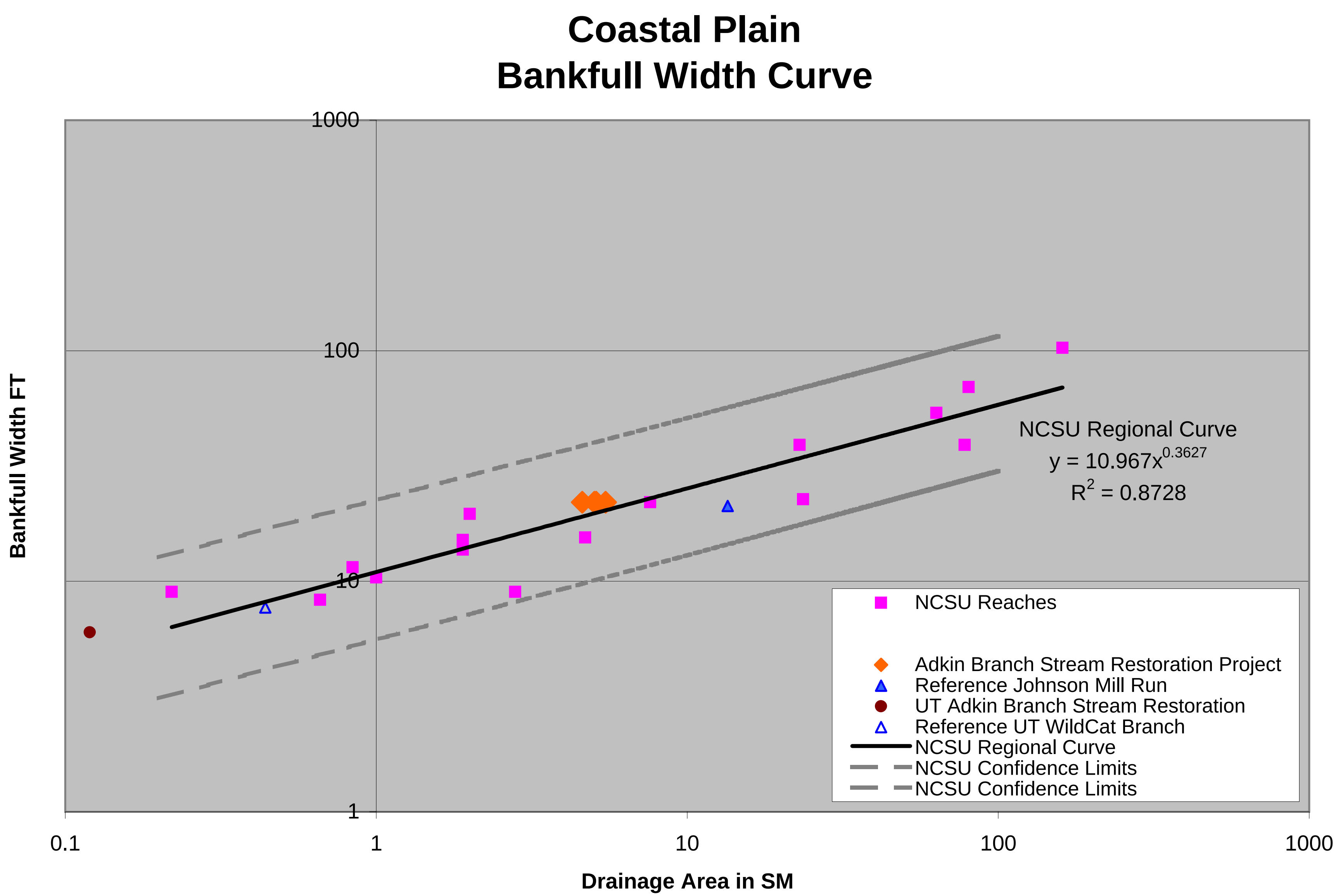
Coastal Plain
Bankfull Discharge Curve




Coastal Plain
Bankfull Area Curve
Bankfull Area SF
1000
100
10
1
0.1
1
10
100
1000
Drainage Area in SM
NCSU Regional Curve
y = 14.33x^0.6565
R^2 = 0.8764
NCSU Reaches
Adkin Branch Stream Restoration Project
Reference Johnson Mill Run
UT Adkin Branch Stream Restoration
Reference UT WildCat Branch
NCSU Regional Curve
NCSU Confidence Limits
NCSU Confidence Limits

Coastal Plain
Bankfull Mean Depth Curve




Coastal Plain
Bankfull Width Curve
Bankfull Width FT
1000
100
10
1
0.1
1
10
100
1000
Drainage Area in SM
NCSU Regional Curve
y = 10.967x^0.3627
R^2 = 0.8728
NCSU Reaches
Adkin Branch Stream Restoration Project
Reference Johnson Mill Run
UT Adkin Branch Stream Restoration
Reference UT WildCat Branch
NCSU Regional Curve
NCSU Confidence Limits
NCSU Confidence Limits